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Prevalence of intestinal parasites in Erbil, Iraq

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Summary

Background: Infections with intestinal parasites are the major cause of infectious disease globally and have been described as a public health issue in developing countries.
Objective: This study aimed to determine prevalence of intestinal parasitic infections and their associated factors among the population of Erbil province in Iraq over the period 2011–2021.
Methods: The results of 614455 stool examinations of all public health facilities of the province were collected from the register in the directorate of preventive health affairs and the data were analyzed.
Result: The overall prevalence of intestinal parasitic infections was 4.24 % in the province. The total number of reported cases of intestinal parasites decreased from 4352 for 2011 to 1728 for 2018 and then increased to 2014 cases for 2021. Nearly half of the intestinal parasitic infections were detected among age group of 15 to 44 years. The prevalence of intestinal parasitic infections was higher in males (65.73 %) than females (34.27 %). The prevalence of intestinal parasitic infections was 90.47 % for protozoan infections, while the rate of helminth infection was lower (9.53 %). *Entamoeba histolytica/dispar* were the most common parasite (60.92 %) followed by *Giardia lamblia* (29.54 %) and *Enterobius vermicularis* (8.56 %). Prevalence of infection with intestinal parasites was lowest in March and highest in February.
Conclusion: In spite of that intestinal parasitic infection rates appear to be decreasing, intestinal parasitic infection remains an important health problem in the province. Therefore, there is still a need for prevention efforts in the community.
Keywords: prevalence; intestinal parasites; Erbil; Iraq

Introduction

Intestinal parasitic infections are caused by intestinal protozoan parasites and helminths, which are widely distributed throughout the world. Infections with intestinal parasites are the most common infections (Haque, 2007) and considered as the significant health problem in developing countries (Jejaw *et al*., 2014). The diseases burden associated with parasitic infections of the digestive system is massive. Globally about two billion people are affected, with 300 million suffering from severe morbidity (Östan *et al*., 2007). These infections with intestinal parasites are associated with overcrowding, poor sanitation and malnutrition, contaminated food and water, and poverty (Chala, 2013). Intestinal parasites infect people of all ages, but small children and pregnant women are highly susceptible (Jejaw *et al*., 2014).
Protozoan and helminthic infections may cause serious public health problems which may include: malabsorption, abdominal pain, hemorrhage, diarrhea, reduced work ability and negative

impact on growth, especially in children (Pino Santos *et al*., 2014). The prevalence of different intestinal parasite species varies from country to country and even from region to region within a country. The objective of this study was to determine the prevalence of intestinal parasites in people living in Erbil province in Iraq between 2011 and 2021, and their association with some epidemiologic risk factors such as age, gender, month, and year. This retrospective cross-sectional study is the first in the province of Erbil which include the data of 11 years. Public health service can use these prevalence data to better understand the epidemiology of intestinal parasites in the province, develop strategic policies to prevent the spread of infections, and establish research priorities.

Materials and Methods

Study area

The study area was the province of Erbil, the capital of Kurdistan Region, in the north of Iraq. The province is located at 36.19° N, 43.99° E, with altitude of 390 m. According to Kurdistan Region Statistics Office, the estimated total population of this province in 2021 was about 2.25 million. Erbil has a Mediterranean climate with hot summer and cold rainy winter. Public healthcare system in Erbil province is consisted of 15 public hospitals and 186 health centers.

Type and design of the study

This retrospective cross-sectional study was conducted through the analysis of parasitological stool examination records from 614455 individuals aged between less than one year and 90 years old with signs and symptoms indicative of intestinal parasitic infections. The patients attended at public health care facilities in the province of Erbil, Iraq. Sociodemographical data (sex and age), date of infection and laboratory test results of the patients from 2011 to 2021 were collected using a data extraction checklist.

This study of intestinal parasites was carried out by reviewing 11 years laboratory records (between January 1, 2011, and December 31, 2021) of the directorate of preventive health affairs, all records of infection in all public health facilities in Erbil province were collected in the mentioned directorate. In the laboratories of public health facilities, fecal samples were examined through a microscope using saline wet mount for detection of intestinal protozoa and helminths.

Inclusion and exclusion criteria

All individuals with gastrointestinal symptoms such as diarrhea, flatulence, abdominal cramp, bloating, malabsorption, blood and/or mucus in stools, irritable bowel had been sent to the laboratory by the physician for stool examination. The study involved Iraqi as well as foreign citizens residing in the province. The patients who attended to the facilities of public hospitals and health care centers in Erbil province with full recorded sociodemographic characteristics such as age, sex, month, year and species of intestinal parasites isolated in the registration book within the period from 2011 to 2021, were included in the study. Any data lacking sociodemographic information and date of stool examination were excluded. Also patients on anti-parasitic drugs were excluded from the study. In the end, data of 614455 patients were included in this study.

Data collection

The data of each patient with intestinal parasitic infection such as age group, gender, as well as the date (month and the year) of the analysis were recorded. In the records of the directorate of preventive health affairs of the province, patients were grouped in five age categories: children (<1 year old), children (1 – 4 years old), children (5 – 14 years old), teenagers and adults (15 – 44 years old) and adults (>45 years old). For this study, formal consent is not required.

Before extracting patient's data from the laboratory records, a data extraction form was developed for capturing patients' data like age, gender, month, and year of infection using Microsoft Excel. These variables are then transferred to the prepared Excel sheet. In order to guarantee data quality and consistency, data collectors were trained on the data collection tools, the variables and the purpose of the study.

Data analysis

The collected data were entered into a Microsoft Excel database and analyzed using Stata 12 statistical software (Stata Corporation, Texas USA). Chi-squared statistics were used to determine the association between the dependent variable (prevalence of intestinal parasites) and the independent variables (age group, gender, month and year). For all statistics, *P*-value of <0.05 was considered significant.

Ethical Approval and/or Informed Consent

The current study was reviewed and approved by the Scientific Committee of the Biology Department in Salahaddin University—Erbil. It was conducted in accordance with the Declaration of Helsinki. An official letter was written to the directorate of preventive health affairs in Erbil for permission. No patient names were collected from the data.

Results

The overall prevalence of intestinal parasites among tested patients was 26034 (4.24 %) out of 614455 included individuals. There was an increase in the number of collected stool samples since 2011 until 2015 and then it was followed by a linear decrease until 2018, the number of samples increased again in 2019. The proportion of patients positive for intestinal parasites decreased from 16.72 % in 2011 to 6.64 % in 2018, then increased to 8.60 % and 7.74 % in 2019 and 2021 respectively (Fig. 1). The maximum number of laboratory diagnosed cases of intestinal parasites was

reported in 2011 with 4352 infected persons and the minimum was reported in 2020 with only 167 infected persons.

In this study, nine different species of intestinal parasites were identified in the laboratory registries of the stool specimens of the patients, two protozoans (*Entamoeba histolytica/dispar*, *Giardia lamblia*), and seven helminth species (*Enterobius vermicularis*, *Hymenolepis nana*, *Taenia Saginata, Ascaris lumbricoides*, *Trichuris trichiura, Ancylostoma duodenale* and *Strongyloides stercoralis*).

The prevalence of protozoan infection was nine times the prevalence of helminthic infection. The prevalence of intestinal protozoa and helminths were 90.47 % (23552/26034) and 9.53 % (2482/26034), respectively.

Only two protozoan parasites had been recorded by the facilities of health care centers in Erbil province, *E. histolytica/dispar* and *G. lamblia*. The highest prevalence was due to *E. histolytica/dispar* (60.92 %) and followed by *G. lamblia* (29.54 %). The highest and lowest numbers of infected persons with *E. histolytica/dispar* (2181 and 132) were recorded in 2011 and 2020 respectively. The same years also recorded the highest and lowest numbers of infected persons with *G. lamblia* (1509 and 27) in 2011 and 2020 respectively. The numbers of infection with protozoan parasites declined in 2018, then the number of cases showed an escalation in 2019 (Table 1).

Intestinal helminthic infections were identified as *E. vermicularis* (8.56 %), *H. nana* (0.68 %), *T. saginata* (0.16 %), *A. lumbricoides* (0.08 %), *T. trichiura* (0.04 %), *A. duodenale* (0.01 %) and *S. stercoralis* (0.004 %) as shown in Figure 2. Helminthes (*A. duodenale, T. trichiura, H. nana* and *T. saginata*) were higher in 2012, while *E. vermicularis* and *A. lumbricoides* were higher in 2011 and 2019 respectively. The prevalence of *E. vermicularis* and *H. nana* declined over the years, which dropped to only 29 and 7 respectively in 2021. By 2015, till 2021, no cases of *A. duodenale*, *T. trichiura* and *S. stercoralis* were diagnosed. In 2016 – 2021, Erbil reported no cases of *T. saginata* for the first time, and there were no cases of *A. lumbricoides* after 2020 (Table 1).

Furthermore, males had higher overall prevalence rate of infection (65.73 %) compared to Females (34.27 %).

Analyzing the age trends of infection revealed that patients of age group ranging from 15 to 44 years old had the highest prevalence rate at 52.32 % when compared to other age groups, and the lowest (2.78 %) was in infants less than one year of age. The highest prevalence of protozoan infection was found in the 15 to 44 aged group (55.56 %), while prevalence of helminthic infection was higher in the younger age group of 5 – 14 years (48.59 %). One age group was responsible for all the infections with *A. duodenale* which included children and adolescents aged 5 – 14 years (Table 2).

In terms of seasonality, monthly prevalence of infections increased to the maximum of 2431 and 2485 in January and February, respectively, while the lowest prevalence was registered in March and December (1715 and 1901 respectively) as shown in Figure 3. Monthly accumulated infections with *A. duodenale*, *H. nana* and *T. saginata* presented the highest peak (18.24 %, 9.54 % and 9.76 % respectively) during February. *S. stercoralis, E. vermicularis* and *G. lamblia* were more frequently detected in January (9.79 %, 9.54 % and 9.31 % respectively). The number of patients infected

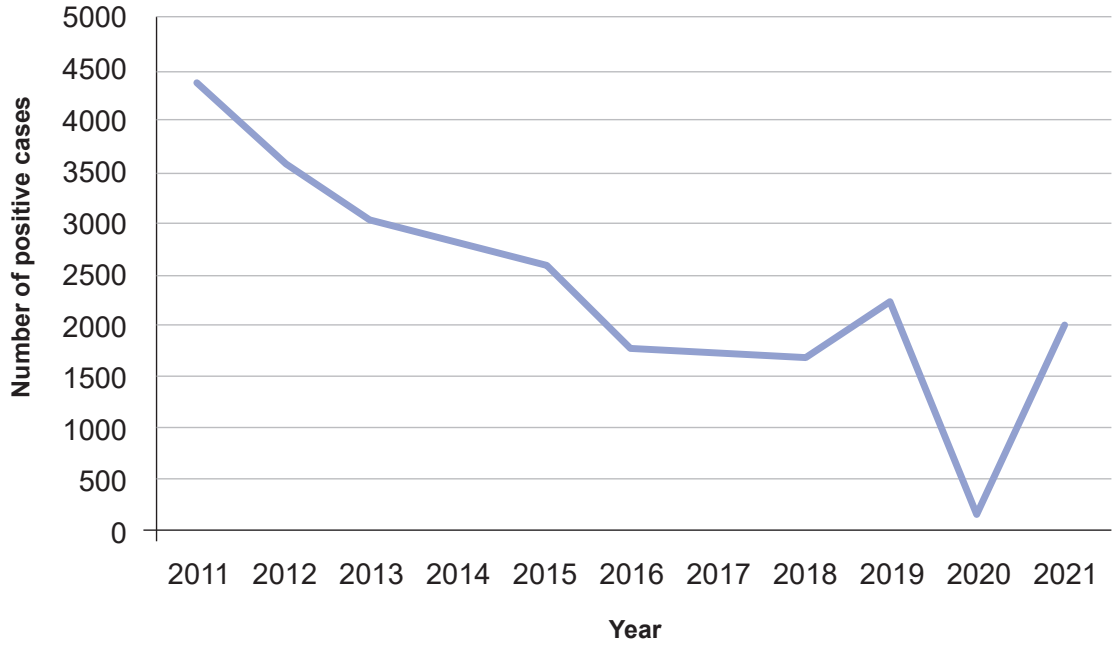

Fig. 1 Positive cases for intestinal parasites by year in Erbil province, Iraq.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

Table 1. The overall prevalence of intestinal parasites from 2011 – 2021 in Erbil province, Iraq.

Year	No. of examined cases	Infected cases with parasites No. (%)									No. of infected cases	*P*-value
		Protozoa				Helminth						
		Entamoeba histolytica/dispar	*Giardia lamblia*	*Enterobius vermicularis*	*Hymenolepis nana*	*Taenia saginata*	*Ascaris lumbricoides*	*Trichuris trichiura*	*Ancylostoma duodenale*	*Strongyloides stercoralis*		
2011	61364	2181 [a] (50.11)	1509 [a] (34.67)	617 [a] (14.18)	33 [a] (0.76)	6 (0.14)	3 (0.07)	3 (0.07)	0 (0)	0 (0)	4352	
2012	76244	1835 [b] (51.07)	1342 [a] (37.35)	345 [b] (9.60)	38 [a] (1.06)	24 (0.67)	3 (0.08)	5 (0.14)	1 (0.03)	0 (0)	3593	
2013	89377	1751 [b] (57.87)	915 [b] (30.24)	332 [b] (10.97)	16 [b] (0.53)	9 (0.30)	3 (0.10)	0 (0)	0 (0)	0 (0)	3026	
2014	90487	1775 [b] (63.44)	743 [b] (26.55)	255 [b] (9.11)	17 [b] (0.61)	1 (0.04)	2 (0.07)	3 (0.11)	1 (0.04)	1 (0.04)	2798	
2015	90221	1726 [b] (66.62)	681 [b] (26.28)	169 [b] (6.52)	14 [b] (0.54)	1 (0.04)	0 (0)	0 (0)	0 (0)	0 (0)	2591	
2016	57214	1120 [c] (63.21)	542 [b] (30.59)	106 [b] (5.98)	1 [d] (0.06)	0 (0)	3 (0.17)	0 (0)	0 (0)	0 (0)	1772	*P*<0.05
2017	46723	1130 [c] (64.39)	498 [b] (28.38)	109 [b] (6.21)	16 [b] (0.91)	0 (0)	2 (0.11)	0 (0)	0 (0)	0 (0)	1755	
2018	35669	1196 [c] (69.21)	375 [b] (21.70)	140 [b] (8.10)	15 [b] (0.87)	0 (0)	2 (0.12)	0 (0)	0 (0)	0 (0)	1728	
2019	43533	1594 [b] (71.22)	502 [b] (22.43)	119 [b] (5.32)	19 [b] (0.85)	0 (0)	4 (0.18)	0 (0)	0 (0)	0 (0)	2238	
2020	4225	132 [d] (79.04)	27 [c] (16.17)	7 [c] (4.19)	1 [d] (0.60)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	167	
2021	19398	1421 [b] (70.56)	557 [b] (27.66)	29 [c] (1.44)	7 [c] (0.35)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2014	

Two numbers with the same letter in the same column between the years are not significantly different at α = 0.05.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

with *T. trichiura* and *E. histolytica/dispar* peaked in April 37.84 % and 31.82 % respectively, while *A. lumbricoides* was especially frequent in November (10.45 %), as shown in Table 3.
Statistically significant relations (p <0.05) were found between the incidence of parasites and each of the sex and age of the patients, year and month.

Discussion

As per our knowledge, this is the first retrospective cross-sectional study in Erbil province analyzing the results of 11 years of intestinal parasitic infections. Infection with Intestinal parasites considered as neglected tropical disease and is a global public health problem (Jejaw *et al*., 2014). Planning and evaluating the current in order to design an appropriate intervention program need maintaining frequent monitoring and tracking the trend distribution of intestinal parasite infections in each community. Accordingly, the current study made an effort to analyze and assess the prevalence of intestinal parasites in the province of Erbil between 2011 and 2021.
In the current study of data records, the overall prevalence of intestinal parasitism over the last eleven years was 4.24 % in Erbil province in Iraq. This result was lower than those found in other studies in Iraq. In previous studies conducted in the country, prevalence rates of parasitic infections in hospital patients varied from 7.36 % to 84.67 % and 0 % to 18.01 % of the protozoa and helminth infections respectively (Mahdi, 2022). Although our findings were in agreement with studies reported in Istanbul, Turkey (4 %), the prevalence of intestinal parasitic infections contrasts strongly with that reported in northern Jordan, Van province in Turkey and southern district in Tehran, Iran (44 %, 34.1 % and 10.7 % respectively).
From 2011 to 2015, intestinal parasitic infection rates appear to be decreasing. Possible reasons for the decreased rates of infection during this period might include increasing living standards and hygienic practices in Erbil province, which is part of the Kurdistan region in Iraq, because of the economic boom during this period in the region as a result of high crude oil prices in an oil-dependent country's economy with oil prices recorded more than 100 U.S. dollars per barrel. After that, the economic crisis hit the region, leading to reduced GDP growth and increased poverty. Low-income and poverty are considered as an important risk factor for infection with intestinal parasites. Several studies have shown higher prevalence as a result of lower socioeconomic conditions (Östan *et al*., 2007; Mehraj *et al*., 2008; Singer *et al*., 2020).
For the first time in 11 years, the prevalence of intestinal parasites in Erbil province showed a great decline in 2020. This decline could be related to the absence of data during the quarantine due to the COVID-19 pandemic. People in lockdown also may face difficulties getting public health help to diagnose intestinal parasites. Also, the quarantine period increased people's sensitivity to personal hygiene measures, leading to lower infection rates. These reasons resulted in a decrease in the prevalence of intestinal parasites in 2020.
The results of this study showed the incident of nine intestinal parasites of public health importance among residents of the province. The rate of intestinal parasites varies by age and sex. The 15 – 44 years age group harbored more than the half of the intes-

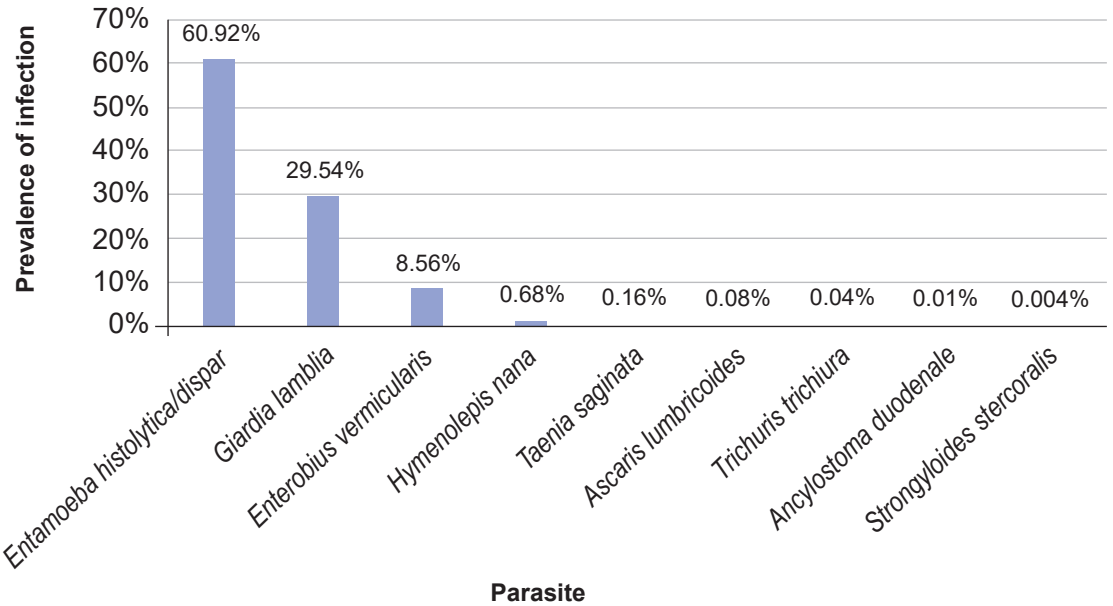

Fig. 2 Intestinal parasites from 2011 – 2021 in Erbil province, Iraq.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

Table 2. Distribution of intestinal parasites by gender and age groups in Erbil province from 2011 – 2021.

Characters of infected persons	Parasite									*P*-value
	Protozoa			Helminth						
	Entamoeba histolytica/dispar	*Giardia lamblia*	*Enterobius vermicularis*	*Hymenolepis nana*	*Taenia saginata*	*Ascaris lumbricoides*	*Trichuris trichiura*	*Ancylostoma duodenale*	*Strongyloides stercoralis*	
Gender n (%)										
Male	10778 [a] (67.95)	4992 [a] (64.9)	1176 (52.78)	119 [a] (67.23)	23 (56.10)	17 [a] (77.27)	7 (63.64) [a]	1 (50.00)	0 [b] (0.00)	*P*<0.05
Female	5083 [b] (32.05)	2699 [b] (35.09)	1052 (47.22)	58 [b] (32.77)	18 (43.90)	5 [b] (22.73)	4 (36.36) [b]	1 (50.00)	1 [a] (100.00)	
Age n (%)										
< 1 yr	487 [d] (3.07)	200 [c] (2.60)	31 [d] (1.39)	5 [d] (2.82)	1 [b] (2.44)	0 [c] (0.00)	0 [d] (0.00)	0 [b] (0.00)	0 [b] (0.00)	*P*<0.05
1-4 yrs	834 [d] (5.26)	475 [c] (6.18)	288 [b] (12.93)	9 [c,d] (5.08)	2 [b] (4.88)	1 [b] (4.55)	1 [c] (9.09)	0 [b] (0.00)	0 [b] (0.00)	
5-14 yrs	3103 [b] (19.56)	2062 [b] (26.81)	1148 [a] (51.53)	32 [b] (18.08)	15 [a] (36.59)	9 [a] (40.91)	0 [d] (0.00)	2 [a] (100.00)	0 [b] (0.00)	
15-44 yrs	9269 [a] (58.44)	3817 [a] (49.63)	387 [b] (17.37)	117 [a] (66.10)	12 [a] (29.27)	11 [a] (50.00)	8 [a] (72.73)	0 [b] (0.00)	1 [a] (100.00)	
> 45 yrs	1730 [c] (10.91)	815 [c] (10.60)	109 [c] (4.89) [c]	11 [c] (6.21)	10 [a] (24.39)	2 [b] (4.55)	2 [b] (18.18)	0 [b] (0.00)	0 [b] (0.00)	

Two numbers with the same letter in the same column between sexes are not significantly different at α = 0.05.
Two numbers with the same letter in the same column between age groups are not significantly different at α = 0.05.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

tinal parasitic infections (52.32 %), followed by those aged 5 – 14 years, while infants >1 year (2.78 %) were the least infected age group. This can be explained by the characteristics of the young and active age group (15 – 44 years), such as eating in restaurants and the difficulties in ensuring hygiene in all restaurants. Infants smaller than one year old recorded the lowest rate of intestinal parasitic infection. This may be due to the fact that during the first six months of life, infants should be exclusively fed on human milk, so there is little chance of eating contaminated raw vegetables and fruits.

The finding of present study is consistent with a previous study carried out in Debre Tabor, Northwest Ethiopia from 2017 to 2021 (Workineh *et al*., 2022), where the highest intestinal parasitic infections were recorded in the age groups of over 14 years (27.7 %). A 6-year retrospective study of patients attending two hospitals in French Guiana reported the prevalence of intestinal parasites to be 67.7 % among the 18 – 64 year old group, but they recorded 3.3 % in patients less than one year old, which is higher than the finding of our study (Aboikoni *et al*., 2021). Our findings are in agreement with previous studies in Sharjah, in the United Arab Emirates, where the highest rate of infection with intestinal parasites was reported in the age groups 26 – 34 years (Dafalla *et al*., 2017).

Regarding protozoan infection, the age group 15 – 44 years showed the highest association of infection than other age groups. The burden of these protozoan parasites in developing countries is mainly due to fecal contamination as a result of poor sewage and poor water quality. In Iraq, the fresh and tap water could be contaminated with pathogenic protozoan parasites like *E. histolytica/dispar* and *G. lamblia* in some provinces (Todd, 2023).

Prevalence of helminthic infection was higher in the age group 5 – 14 years. The possible reasons might be due to children playing with soil which facilitates the infection with the helminthic parasites including soil-transmitted helminths.

The prevalence of intestinal parasitic infections is higher in males than females in most age groups, especially among adults aged 15 – 44 years, which was 3.45 times higher than in females for this age group. this could be explained by the immunological differences exist between the sexes that may contribute to increased parasitic infection in males compared to females (Klein, 2004). The other reason may be due to fact that these males recorded higher outdoor activities than females in the province, which increases their susceptibility to parasitic infections. The finding of the present study was similar to the findings of previous studies performed across Iraq which reported higher rates of infection in males than females (Mahdi, 2022). These findings that males are more likely to be infected are also found in other countries, such as in N'Djamena in Chad Republic where males recorded higher infection rates with intestinal parasites (Hamit *et al*., 2008). Infection with intestinal parasites in expatriate workers in Sharjah in United Arab Emirates were associated with gender as males showed higher infection rates than females (Dafalla *et al*., 2017). Also, students attending clinic at university of Gondar in Ethiopia showed higher infection rates in males than females (Derso *et al*., 2021).

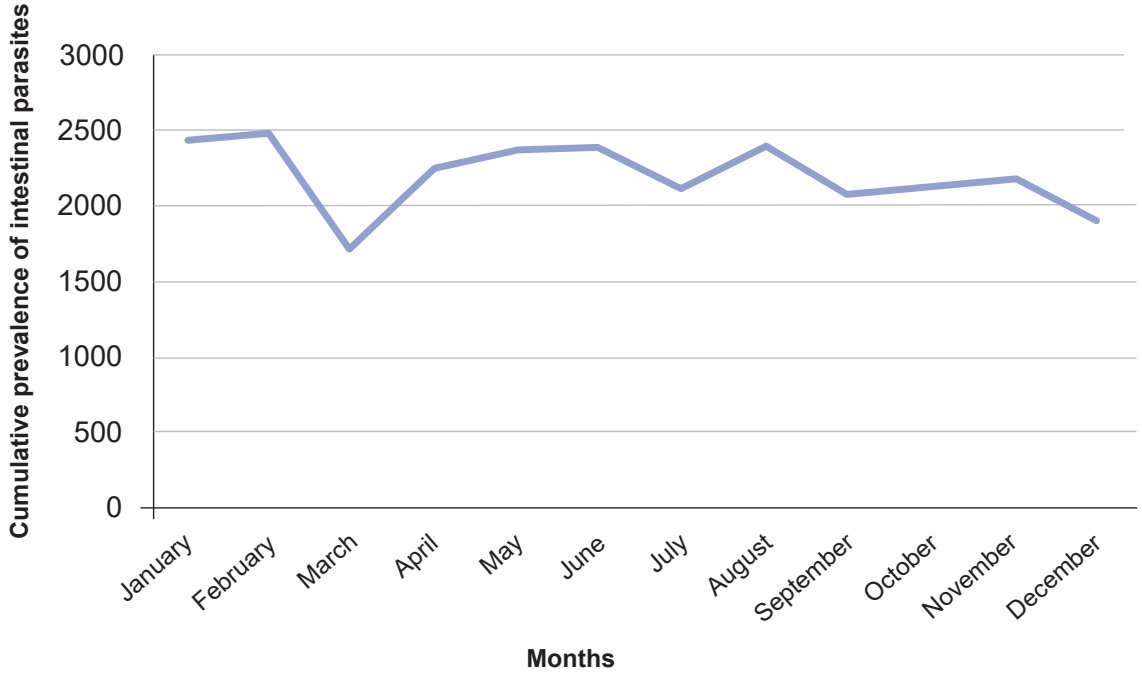

Fig. 3 Cumulative monthly distribution of intestinal parasites cases in Erbil province, Iraq.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

Table 3. The overall prevalence of intestinal parasites stratified by cumulative months from 2011 – 2021 in Erbil province.

Month	No. of examined cases	Infected cases with parasites No. (%)									No. of infected cases	*P*-value
		Protozoa				Helminth						
		Entamoeba histolytica/dispar	*Giardia lamblia*	*Enterobius vermicularis*	*Hymenolepis nana*	*Taenia saginata*	*Ascaris lumbricoides*	*Trichuris trichiura*	*Ancylostoma duodenale*	*Strongyloides stercoralis*		
January	54854	1510 [a] (62.11)	672 [a] (27.64)	224 [a] (9.21)	19 [b] (0.78)	0 (0)	1 [b] (0.04)	5 [a] (0.21)	0 (0)	0 (0)	2431	
February	47261	1466 [a] (58.99)	769 [a] (30.95)	213 [a] (8.57)	32 [a] (1.29)	2 (0.08)	1 [b] (0.04)	2 [b] (0.08)	0 (0)	0 (0)	2485	
March	47933	1017 [b] (59.30)	525 [a, b] (30.61)	149 [b] (8.69)	13 [b] (0.76)	6 (0.35)	5 [a] (0.29)	0 [c] (0)	0 (0)	0 (0)	1715	
April	46604	1376 [a, b] (61.02)	719 [a] (31.88)	134 [b] (5.94)	9 [b] (0.40)	14 (0.62)	2 [b] (0.09)	0 [c] (0)	1 (0.04)	0 (0)	2255	
May	60994	1477 [a] (62.01)	734 [a] (30.81)	162 [b] (6.80)	6 [c] (0.25)	1 (0.04)	1 [b] (0.04)	0 [c] (0)	1 (0.04)	0 (0)	2382	
June	55718	1408 [a] (59.04)	716 [a] (30.02)	239 [a] (10.02)	14 [b] (0.59)	6 (0.25)	1 [b] (0.04)	0 [c] (0)	0 (0)	1 (0.04)	2385	
July	52751	1257 [b] (59.26)	655 [a] (30.88)	187 [b] (8.82)	12 [b] (0.57)	7 (0.33)	2 [b] (0.09)	1 [b] (0.05)	0 (0)	0 (0)	2121	*P*<0.05
August	49787	1456 [a] (60.69)	672 [a] (28.01)	261 [a] (10.88)	7 [c] (0.29)	1 (0.04)	1 [b] (0.04)	1 [b] (0.04)	0 (0)	0 (0)	2399	
September	54943	1322 [a, b] (63.93)	592 [a, b] (28.63)	143 [b] (6.91)	10 [b] (0.48)	1 (0.05)	0 [c] (0)	0 [c] (0)	0 (0)	0 (0)	2068	
October	45397	1342 [a, b] (63.66)	581 [a] (27.56)	170 [b] (8.06)	14 [b] (0.66)	1 (0.05)	0 [c] (0)	0 [c] (0)	0 (0)	0 (0)	2108	
November	46448	1374 [a, b] (62.97)	593 [a, b] (27.18)	199 [a] (9.12)	12 [b] (0.55)	2 (0.09)	2 [b] (0.09)	0 [c] (0)	0 (0)	0 (0)	2182	
December	47965	1221 [b] (64.23)	477 [b] (25.09)	162 [b] (8.52)	32 [a] (1.68)	0 (0)	7 [a] (0.37)	2 [b] (0.11)	0 (0)	0 (0)	1901	

Two numbers with the same letter in the same column between months are not significantly different at α = 0.05.
Source: data from directorate of preventive health affairs in Erbil province, Iraq.

The protozoan infection rate was 9.58 times greater than that of helminthic infection. Other studies also reported higher infection with protozoa than helminths in Riyadh, the capital of Saudi Arabia and in Sana'a, the capital of Yemen (Abdelkareem *et al*., 2022; Al-Yousofi *et al*., 2022). This may be due to the method of transmission and life cycle of the protozoan parasites which facilitate human infection with them more than helminthic parasites. This finding contrasts with that reported in rural and remote west Malaysia where infections with soil-transmitted helminth were higher than infections with protozoa (Ngui *et al*., 2011).

Only two species of protozoan parasites (*E. histolytica/dispar* and *G. lamblia*) were detected in the feces of patients in Erbil province. This could be due to the use of only wet mount method for diagnosis in health facilities in the province.

E. histolytica/dispar was the most prevalent intestinal parasite with a rate of 60.92 % in our study. These findings are consistent with those reported in Côte d'Ivoire and Ethiopia (Ouattara *et al*., 2010; Eyayu *et al*., 2021). These findings do not agree with other previous studies carried out in Cuban rural areas where the prevalence of soil transmitted infections was found to be higher (Pino Santos *et al*., 2014). Amoebiasis is the third leading cause of death worldwide especially in developing countries. Nevertheless, more than 90 % of recorded infections with *E. histolytica* are confusing because they are due to *E. dispar* not *E. histolytica* (Amin, 2002). The wide spectrum of amoebiasis ranges from asymptomatic infection to the development of a severe infection with amoebic colitis and even the liver may be involved and causing amoebic liver abscesses.

The results of our study showed that *G. lamblia* was the second most prevalent protozoan parasite in the population. This result was in line with research conducted at Agboville Area (Côte d'Ivoire), where *E. histolytica* and *G. lamblia* were the most prevalent protozoa (Ouattara *et al*., 2010).

In the current study, only 9.53 % of the samples tested positive for helminths, with the pinworm *E. vermicularis* being the most often reported helminth (8.56 %). However, their prevalence may have been underestimated since they were not diagnosed using the Graham Test. The possible reason for the low prevalence of soil-transmitted helminths: *A. lumbricoides*, *T. trichiuria* and *A. duodenale*) may be explained with the temperatures higher than 40°C in Iraq during summer which can limit the viability of these helminths in the environment (Brooker *et al*., 2006).

Regarding seasonality, the maximum peaks of intestinal parasitic infections were recorded during winter (January and February), which are rainy months in Erbil. These results are consistent with those reported by González-Moreno *et al*. (2011) in Spain and by Riaz *et al*. (2020) who reported higher infection rates in the rainy season. While the lowest prevalence was observed in March (spring). This may be due to the fact that heavy winter rains may have an impact on the spread of intestinal parasites to humans because rain wash the contaminated soil and may make it easier for parasite cysts and eggs to enter surface water.

Limitation

The standard diagnostic method for intestinal parasitic infections in Erbil province is wet mount for stool samples, which could underestimate the prevalence of infection, compared to Formol–Ether concentration technique (Mengist *et al*., 2018; Demeke *et al*., 2021). Another limitation was the lack of information regarding polyparasitic infections in the registries.

Conclusions

In general, the present study showed a significant decrease of overall prevalence of intestinal parasitic infections in the province over the eleven years period. Prevalence of protozoan parasites were higher than helminthic parasites in the studied community. Protozoan parasites were more prevalent in adolescents and adults, while helminthic parasites were most common in children, with predominance of positivity among males. *E. histolytica/dispar* and *G. lamblia* were found to be the most prevalent intestinal parasites among persons visited the public health facilities in the province. Public health efforts should focus on education and awareness to improve personal hygiene practices.

Recommendation

Further studies are needed to explore molecular epidemiology for a better understanding of the epidemiology and strain identification of intestinal parasites. The combination of microscopic and concentration techniques for routine laboratory and community-based research is recommended for the diagnosis of intestinal parasitic infections. In intestinal parasites, three stool samples must be collected on three consecutive days for the determination of infection. Investigations of other associated risk factors among the population are recommended to improve understanding of infections and improve future prevention strategies.

Conflict of Interest

Author has no potential conflict of interest pertaining to this sub-mission to Helminthologia.

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