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Enterobius vermicularis infections in Iraq

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Summary

Enterobiasis continues to be among the highest parasitic infections affecting the human population worldwide. A study was conducted between 2011 – 2015 in Iraq to evaluate the enterobiasis reported by the Communicable Diseases Control Center (n=220,607 cases) in relation to demographic (age, sex, rural population and family size) and spatial variables (local and regional sources). Females were more parasitized than males, as well as children and youth ages 4 to 15. Approximately 40 % of cases are from the South region provinces (Thiqr, Miasan, Basrah and Wassit). However, most cases occurred in regions with high rural populations and a high family size average. The results may provide insights for researchers assessing management approaches to control enterobiasis in Iraq.

Keywords: Enterobiasis; GIS; Iraq; spatial analysis

Introduction

Seat worms, pinworms, and threadworms are all common names for the parasitic helminth *Enterobius vermicularis* (Nematoda, Oxyuridae). This parasite was first described in humans nearly about 10,000 years. *E. vermicularis* is a cosmopolitan parasite that affects over 200 million people worldwide (Fan *et al.*, 2019). Tropical residents and school-aged children are among the most vulnerable groups (Dudlová *et al.*, 2018; Fan *et al.*, 2019). The feces-oral route is the most typical method of transmission. People catch pinworm infections by swallowing (ingesting), frequently accidentally, infected pinworm eggs present on fingers, under fingernails, on clothing, bedding, and other contaminated objects and surfaces. Due to their tiny size, pinworm eggs can occasionally become airborne and get inhaled when breathing (Cook, 1994). Poor personal hygiene, contaminated food or water consumption, poor environmental sanitation, and living with sick individuals have all been linked to a high incidence rate of *E. vermicularis*

(Muliawati *et al.*, 2020). In Iraq, many elements have contributed to considerable societal changes since 2003, including developing a public health system that focuses on preventative and control programs, particularly those dealing with parasite infections. Despite these advances, *E. vermicularis* remains the most prevalent helminth parasite and severe public health concern (Al-Saqur *et al.*, 2016; Al-Saqur *et al.*, 2020). On the other hand, Iraq has suffered from many wars and internal migrations. ISIS directly affected the health system. This could cause the spread of some diseases, especially parasitic diseases (Ibrahim *et al.*, 2021). Many studies have documented the epidemiology of *E. vermicularis* in Iraqi populations from various regions.

A total prevalence of pinworm infection (70.75 %) was reported among 212 children aged 6 – 12 years in Al-Basrah province (Jarallah & Mansour, 2014). In Duhok, north of Iraq, a prevalence rate of (18.01 %) was reported among 261 children aged between 3 – 12 years (Hussein & Meerhan, 2019). In Baghdad, the capital, the prevalence rate was (73.77 %) among 122 children aged

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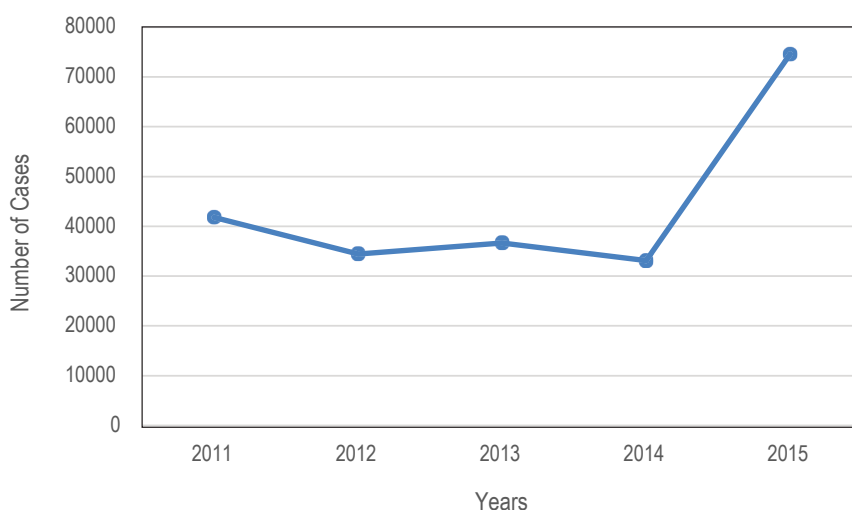


Fig. 1 The distribution of enterobiasis in Iraq for the years 2011 – 2015.

between (1 – 14) years (Dohan & Al-Warid, 2020). Other researchers looked at enterobiasis and its relationship to enuresis, anemia, biochemical parameters, and micronutrients deficiencies (Al-Qadhi *et al.*, 2011; Al-Daoudy & Al-Bazzaz, 2020; Dohan & Al-Warid, 2022). Despite the fact that *E.vermicularis* has been the subject of numerous studies, there is still a knowledge gap in its regional distribution. Because the spread of Enterobiasis in Iraq has gotten little attention, even a simple spatial mapping of reported cases could be useful. The overall purpose of this research was to examine data on enterobiasis spread provided by the Communicable Diseases Control Center (CDCC). At a macro-epidemiological level, the geographic information system (GIS) approaches were used to identify the basic demographic and spatial variables to highlight basic spatial and demographic patterns that may be useful in developing future management strategies for national public health institutes.

Materials and Methods

Study area

Iraq has a population of almost 40 million people. Iraq lies between the latitudes of 29° 5' and 37° 22' N and the longitudes of 38° 45' and 48° 45' E. The total area is 437,000 km². Iran, Turkey, Syria, Jordan, Saudi Arabia, and Kuwait are bordering countries. Except

for the northern and northeastern mountainous parts, which have a Mediterranean climate, most of Iraq has a continental and subtropical semiarid climate. Iraq environment: mostly desert; mild to cool winters; dry, hot, cloudless summers; cold winters with sporadic heavy snowfall that melts in early spring, occasionally producing severe flooding in northern mountainous regions along Iranian and Turkish borders (Osman *et al.*, 2017).

Population data

In Iraq, enterobiasis is an observed disease with diagnoses reported from all provinces to the CDCC, Ministry of Health, Baghdad. Diagnoses and demographic characteristics were derived from each province's Central Statistical Organization annual reports (CSO, 2011; CSO, 2012; CSO, 2013; CSO, 2014; CSO, 2015). Data from 220607 patients admitted to Iraqi hospitals and primary health care centers between 2011 – 2015 were included in the study. Diagnoses of Enterobiasis were confirmed by scotch tape. Before attaching the tape to a glass slide, cellophane tape (Scotch, USA) was applied to the participant's anal and perianal regions utilizing the adhesive side of the tape for a few repetitions (Dudlová *et al.*, 2018). For each patient, information was collected and classified according to sex, age group as <1, 1 – 4, 5 – 14, and >15 years, province, population (rural and urban), family size and the month of diagnosis.

Table 1. Sex of 220607 Iraqi enterobiasis patients reported between 2011 and 2015.

Sex	2011		2012		2013		2014		2015		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Male	18024	43.11	14548	42.22	20171	55.02	15992	48.29	33279	44.62	102014	46.24
Female	23783	56.88	19903	57.77	16485	44.97	17120	51.7	41302	55.37	118593	53.75
Total	41807		34451		36656		33112		74581		220607	

Table 2. Age of 220607 Iraqi enterobiasis patients reported between 2011 and 2015.

Age	2011		2012		2013		2014		2015		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
<1	97	0.23	109	0.31	799	2.17	5440	16.42	4437	5.94	10882	4.93
(1 – 4)	5023	12.04	5028	14.95	6605	18.01	5812	17.55	18084	24.24	40552	18.38
(5 – 14)	13009	31.11	13893	40.32	11004	30.01	6825	20.61	22743	30.49	67474	30.58
(15 – 44)	19233	46	9803	28.45	10916	29.77	8878	26.81	14916	19.99	63746	28.89
>45	4445	10.63	5618	16.3	7332	20	6157	18.59	14401	19.3	37953	17.2
Total	41807		34451		36656		33112		74581		220607	

Spatial data and statistical analyses

ArcGIS version 10.4 ([http:// www.esri.com/arcgis](http://www.esri.com/arcgis)) was used to map geospatial and related demographic information.

Spearman’s correlation coefficient and multiple linear regressions were used for contrasting correlations of the population (rural and urban) and family size on Enterobiasis incidence using Statistical Package for the Social Sciences (SPSS Inc, Chicago IL, USA). Values of P < 0.05 are considered statistically significant.

Ethical Approval and/or Informed Consent

This study protocol was approved by the local ethics committee

(Ref.: BEC/0122/0018) in the College of Science, University of Baghdad.

Results

Between 2011 and 2014, the cases of infection fluctuated between 33,112 and 41,807. However, in 2015 the infection by *E. vermicularis* increased considerably to 74,581 cases (Fig. 1).

Nonetheless, there were strong biases towards diagnoses in females and older individuals each year. A more significant percentage of cases was observed in females (53.75 %) across the five-year reporting time frame, although there was variability in the

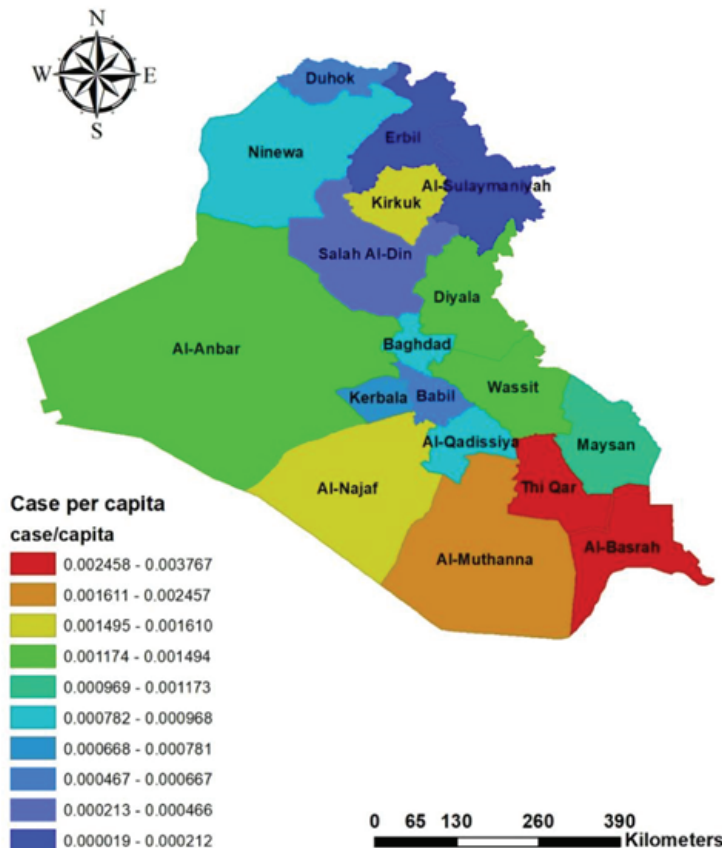


Fig. 2. The number of cases of enterobiasis in Iraq per 100000 capita between 2011 and 2015

Table 3. The distribution of enterobiasis among the Iraqi provinces for the years 2011 – 2015.

Province	Year					total	average	SD	Population size of 2011
	2011	2012	2013	2014	2015				
Al-Anbar	1545	737	4104	3628	1583	11597	2319.4	1461.438	1675600
Al-Basrah	8310	10613	7317	5974	15480	47694	9538.8	3728.468	2532000
Al-Muthanna	2053	1128	1164	1417	3702	9464	1892.8	1077.186	770500
Al-Najaf	904	914	1223	1698	5574	10313	2062.6	1989.311	1285500
Al-Qadissiya	621	1459	1382	944	1503	5909	1181.8	384.4265	1220300
Al-Sulaymaniyah	0	37	53	74	12	176	35.2	30.01166	1878800
Babil	952	1097	728	1825	1666	6268	1253.6	471.2518	1878700
Baghdad	2482	1723	3183	5483	19904	32775	6555	7593.631	7055200
Diyala	1751	2603	4056	1335	1038	10783	2156.6	1214.269	1443200
Duhok	117	273	713	870	1721	3694	738.8	629.7223	1128700
Erbil	617	350	332	255	159	1713	342.6	170.9131	1612700
Kerbala	164	1049	797	575	1581	4166	833.2	529.5236	1066600
Kirkuk	3435	3553	1371	574	2301	11234	2246.8	1292.884	1395600
Maysan	828	1742	2016	753	357	5696	1139.2	705.333	971400
Ninewa	8112	2434	2205	1619	391	14761	2952.2	2991.135	3270400
Salah Al-Din	1321	999	744	216	0	3280	656	545.7916	1408200
Thi Qar	7301	2396	2717	4051	15890	32355	6471	5611.617	1836200
Wassit	1294	1379	2516	1821	1719	8729	1745.8	484.3157	1210600

sex ratio of cases (Table 1). In 2011 and 2012, there were 1.3 diagnosed females per diagnosed males, with that ratio decreasing slightly in 2014 (1.07) and 2015 (1.2). Enterobiasis also occurred in a high percentage (30.58 %) among the age group (5 – 14) years old compared to other age groups that showed fewer percentages (Table 2).

Patients with *E. vermicularis* were reported from all of Iraq's provinces. About half (51.14 %) of the cases were reported in Al-Basrah, Baghdad and Thi Qar (Table 3). However, the high numbers of cases were not significantly ($rs=0.43$, $P=0.07$) related to greater population size (the data of 2011 was considered). The per capita occurrence rates were higher in these provinces, particularly in Al-Basrah and Thi Qar. At the same time, the highest per capita rate was noticed in Al-Sulaymaniyah province, with the lowest occurrence rate across the five years (Fig. 2).

The south region provinces (Thiqr, Miasan, Basrah and Wasit provinces) showed the highest number of cases ($n=94474$, 42.82 %), followed by the middle region (Baghdad, Al-Anbar, Diyala and Salah Al-Din provinces) ($n=58849$, 26.67 %). While both the middle Euphrates region (Babil, Kerbala, Al-Najaf, Al-Qadissiya and Al-Muthanna provinces) and the north region (Ninewa, Al-Sulaymaniyah, Kirkuk, Erbil and Duhok provinces) showed the lowest number of cases ($n=36120$, 16.37 %) and ($n=20344$, 9.22 %) respectively (Table 4 and Fig. 3).

Diagnoses of enterobiasis revealed no clear patterns of seasonality (Fig. 4). The peak of cases differed from one year to another. The peaks of enterobiasis were in April (2011), December (2012), November (2013 and 2015) and March (2014), while the declines in the number of cases were noticed in December (2011), March (2012), January (2013 and 2015) and February (2015).

Statistical analyses revealed no significant relation ($rs= 0.02$; $P=0.9$) between the rural population and disease occurrence. Results also showed that 15.7 % of the cases occurred in provinces with a rural population below 20 %, while the other 84.3 % of cases occurred in provinces with a rural population of 20.1 % – 56.3 % (Fig. 5).

The result also revealed that the average size of a family member had no significant effect ($rs= 0.13$; $P=0.5$) on the occurrence of the disease. 72.4 % of cases were reported in the province with an average family size ≥ 7 , while the other 27.6 % of cases were reported in provinces with an average family member from 5 to 6.6 (Fig. 6). The adults percentages also had no significant relation ($rs= -0.3$; $P=0.1$) with the occurrence of enterobiasis. The results indicated that 33.9 % of infections occurred in governorates whose population consisted of a high percentage of adults (60 – 68 %). At the same time, about 60 % of cases occurred in governorates whose population consisted of fewer percentages of adults that ranged between 56 % – 59.7 % (Fig. 7).

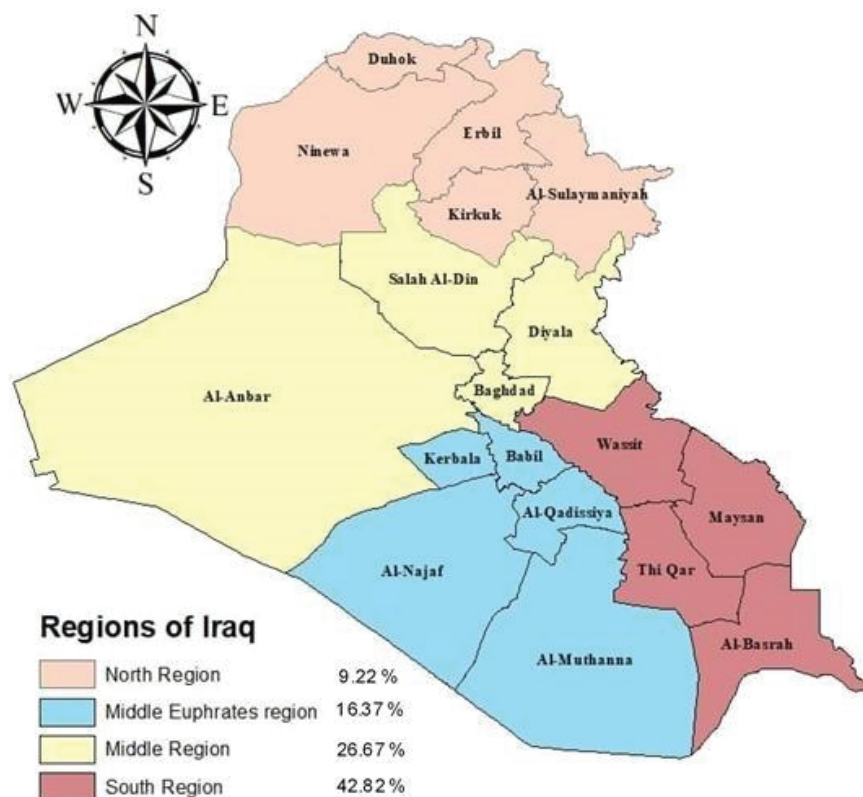


Fig. 3. The distribution of enterobiasis among the Iraqi regions.

Discussion

In Iraq, enterobiasis is not considered a serious disease, but the morbidity level is significant, especially in children (Al-Qadhi & Al-Warid, 2011; Al-Daoudy & Al-Bazzaz, 2020; Dohan & Al-Warid, 2022). The results showed that the number of infected people fluctuated yearly. This discrepancy in the results can be explained due to some factors that may influence the *E. vermicularis* infectivity rate, such as people's activities and behavior (Dudlová *et al.*, 2018), hygienic status, education status, availability of effective anti-helminthic drugs and overcrowding (Kubiak *et al.*, 2017). Nonetheless, there was a dramatic increase in the number of cases recorded between 2014 and 2015. This rise was most likely caused by the violence that displaced almost a million people due to ISIS' occupation of these parts of Iraq. ISIS significantly influenced a

health system that had already been damaged by years of strife and underfunding. Despite the fact that ISIS had been operating in several areas for some time, many health facilities had little notice of the imminent attack (Ibrahim *et al.*, 2021). Most cases were detected in female individuals compared to males. This result agreed with other investigation that presented higher infection rates of *E. vermicularis* among females (Al-Daoudy & Al-Bazzaz, 2020). This bias is nonetheless disagreed with other reports in Iraq such as those (Hussein & Meerhan, 2019) and (Dohan & Al-Warid, 2022). They showed high infection rates in males compared to females. The results showed that more than half of cases were noticed in governorates whose population consisted of fewer percentages of adults. As well as, the overall incidence of Enterobiasis is far greater among (4 – 15) years old compared to other age classes. This high infection rate among children could be due to direct con-

Table 4. The distribution of enterobiasis among the Iraqi regions (South region provinces, Middle region provinces, Middle Euphrates provinces and North region provinces) for the years

Region	Provinces	Number	%
South	(Thiqr, Miasan, Al-Basrah and Wassit)	94474	42.82
Middle	(Baghdad, Al-Anbar, Diyala and Salah Al-Din)	58849	26.67
Middle Euphrates	(Babil, Kerbala, Al-Najaf, Al-Qadissiya and Al-Muthanna)	36120	16.37
North region	(Ninewa, Al-Sulaymaniyah, Kirkuk, Erbil and Duhok)	20344	9.22

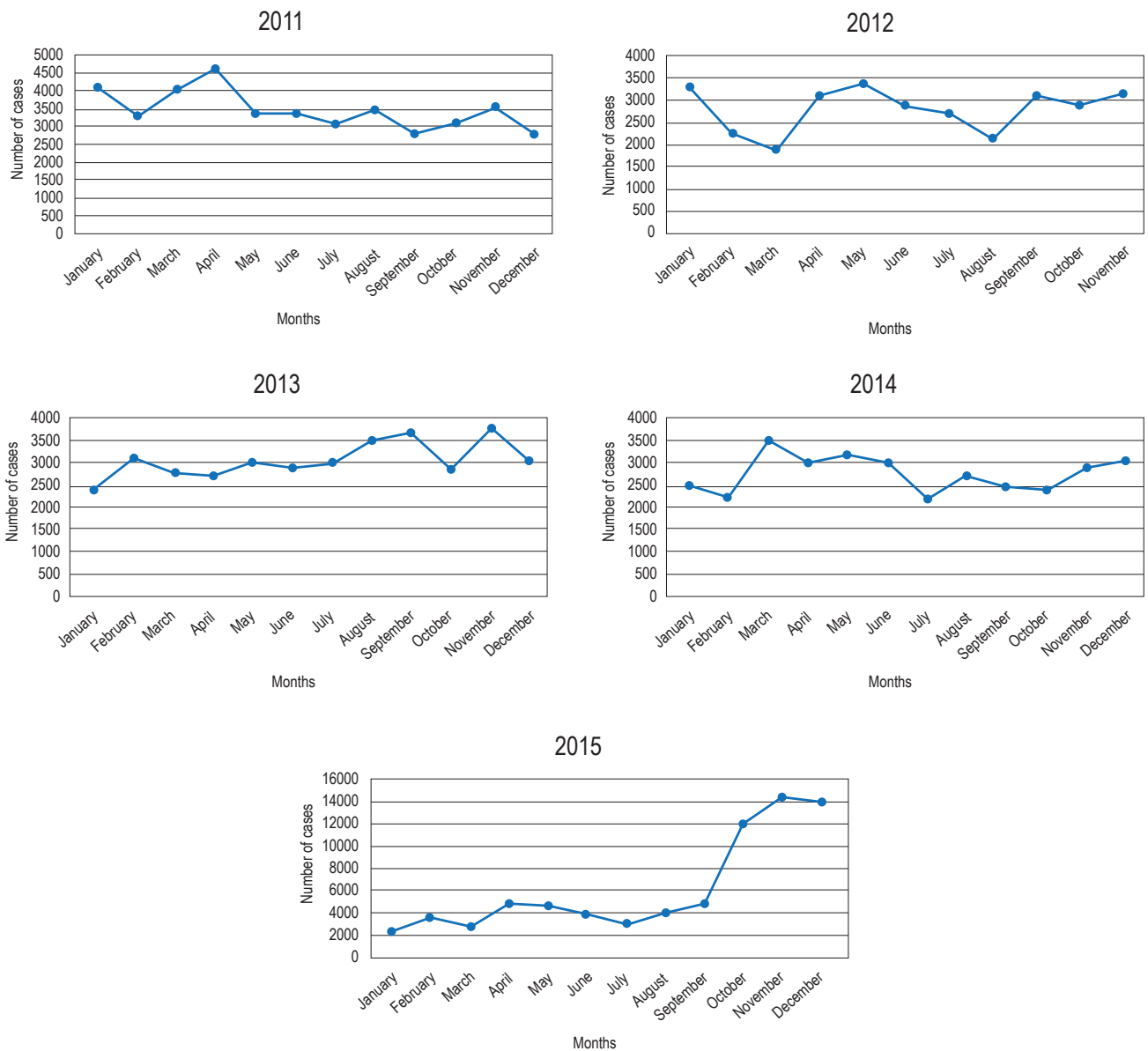


Fig. 4. The annual pattern of enterobiasis in Iraq based on data collected between 2011 and 2015.

tact transmission, which is particularly common among children in kindergartens and elementary schools (Park *et al.*, 2005). As well as such age school children demonstrate changes in exposure to settings that encourage the transmission of the infective stages of most helminths, including *E. vermicularis*; other researchers found that this age group's hand-washing practice is very poor (Curtis & Cairncross, 2003). Most of the cases in this survey were reported as having a high prevalence in South region provinces followed by the middle region provinces. It is well known that *E. vermicularis* is more common in warm climates (Fan *et al.*, 2019) and this may be the reason for the high prevalence rates in the country's southern area. The majority of enterobiasis in the current survey also

occurred in provinces with a rural population of 20.1 % – 56.3 %. This came in line with a study (Lee *et al.*, 2000), which found that people who live in rural areas had higher chances of acquiring pinworm infections.

No significant seasonal variation of *E. vermicularis* infections was identified in this survey. Although the peaks of enterobiasis were noticed in November, December, March, and April for different years, all these months fall within the school season in Iraq. Overcrowding, which is very common in kindergartens and primary schools during the school season, is an essential element related to the transmission of infections.

The average family member had no significant effect on the oc-

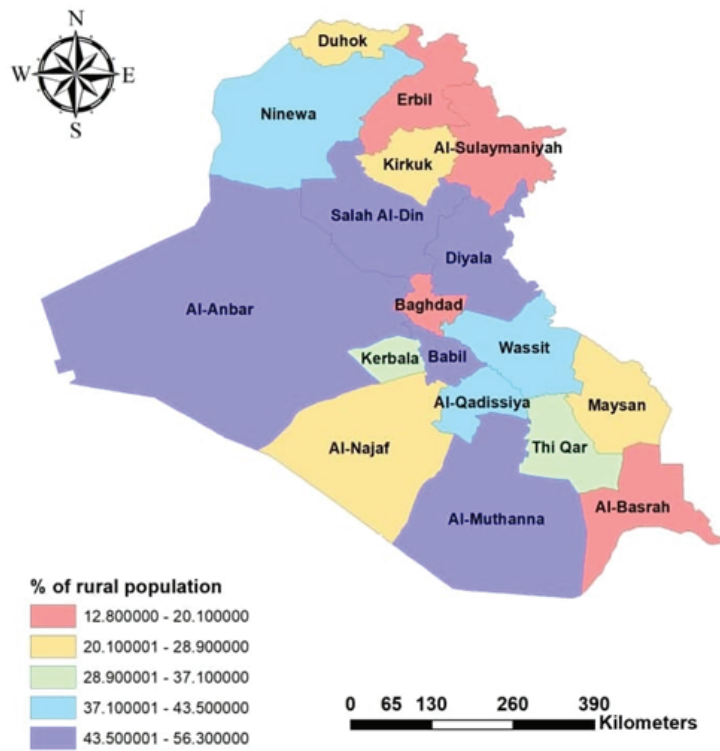


Fig. 5. Distribution of the percentage of rural people inhabiting Iraqi provinces.

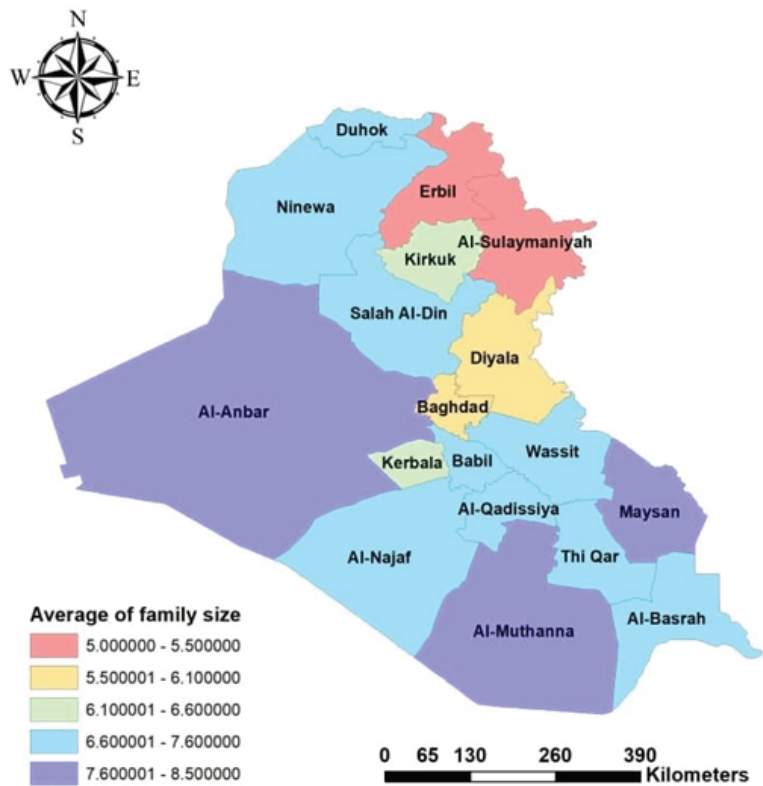


Fig. 6. Distribution of the average family size among Iraqi provinces.

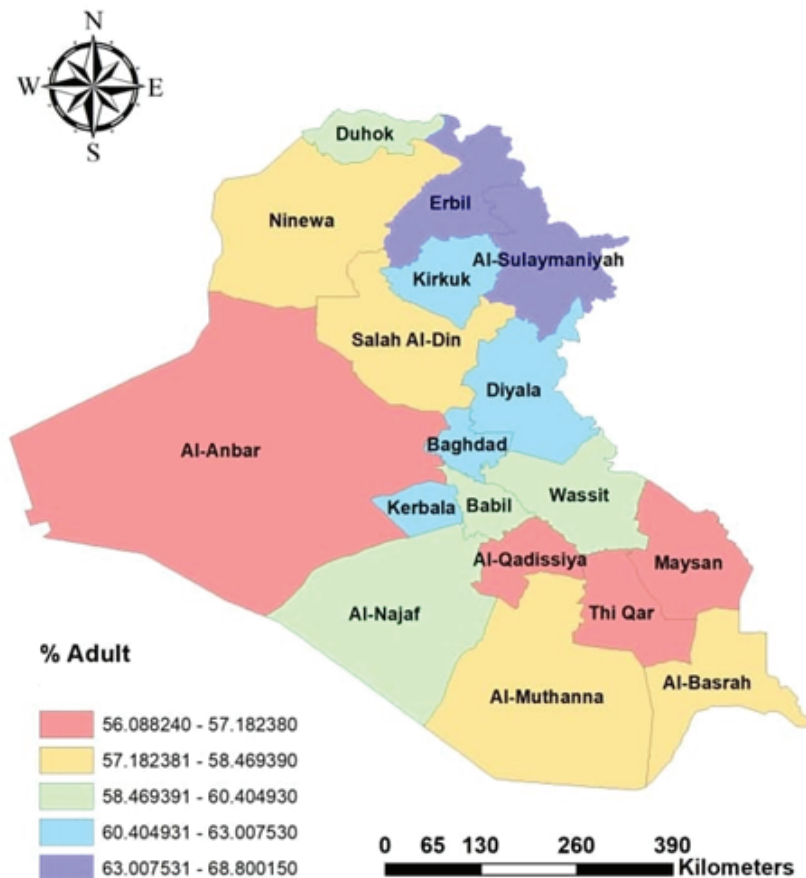


Fig. 7. Distribution of the adult people inhabiting Iraqi provinces.

currence of enterobiasis in this current study, although most cases were reported in provinces with an average of family $7 \geq$ members. Overcrowding, even in the home can be considered a significant factor related to the occurrence of enterobiasis (Remm & Remm, 2008). Enterobiasis is transmitted directly from one person to another and does not require any intermediate host. Therefore, it is more likely to spread among members of the same family. In addition, clinically mild cases and asymptomatic infected individuals may provide a hidden reservoir of infection in the family population (Matsen & Turner, 1969). This result agrees with some other investigators, who reported that the rate of enterobiasis could be increased as a function of large family size (Cazorla *et al.*, 2006; Artan *et al.*, 2008; Al-Daoudy & Al-Bazzaz, 2020). Finally, our survey showed a significant incidence of pinworm in the sampled community, necessitating long-term control actions to enhance living and sanitary conditions, including treating afflicted people. In addition, a coordinated health education campaign would help to maximize the effects of these actions by promoting healthy behavior and decreasing the risk of contracting the *E. vermicularis* infections.

Conflict of Interest

The authors have no conflict of interest to declare.

Acknowledgments

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