Pakistan J. Zool., vol. 49(5), pp 1889-1899, 2017. DOI: http://dx.doi.org/10.17582/journal.pjz/2017.49.5.1889.1899

Intestinal Parasitic Infections among Patients of Prince Sultan Military Medical City in Riyadh Region, Saudi Arabia: A 5-year Retrospective Study

Omar S.O. Amer[1,3,*], Mohamed I. Waly[2,4] and Saeed A. Al-Zahrani[1]

[1]*Medical Laboratory Sciences Department, College of Applied Medical Sciences, Majmaah University, Al-Majmaah, Saudi Arabia*

[2]*Medical Equipment Technology, College of Applied Medical Sciences, Majmaah University, Al-Majmaah, Saudi Arabia*

[3]*Zoology Department, Faculty of Science, Al-Azhar University (Assiut branch), Assiut, Egypt*

[4]*Higher Institute for Engineering, El Shorouk Academy, Cairo, Egypt*

Article Information
Received 21 February 2017
Revised 15 March 2017
Accepted 25 March 2017
Available online 22 September 2017

Authors' Contribution
OSOA conceived and designed the study and analyzed the data. MIW statistically analyzed the data. SAA collected the patients' data. All authors participated in write-up of the article.

Key words
Intestinal parasitic infections, Protozoa, Helminthes, Riyadh, KSA, Retrospective study.

ABSTRACT

This is a retrospective analysis of reported intestinal parasitic infections for patients visiting Prince Sultan Military Medical City, Riyadh, KSA from 2010 to 2014. Our retrospective study estimated a total 775 case out of 11110 case were infected with one or more intestinal parasites, with prevalence rate 6.98 %. The prevalence of intestinal parasitic infection during the period of study was as follows; *Ascaris lumbricoides* (n= 205, 1.8%), *Giardia lamblia* (n= 178, 1.6%), *Entamoeba histolytica* (n= 174, 1.57%), *Trichuris trichiura* (n= 118, 1.06%), *Hymenolepis nana* (n= 51, 0.46 %), *Enterobius vermicularis* (n= 28, 0.25%) and *Taenia saginata* (n= 21, 0.19%) respectively. The prevalence rate of these parasites in males and females as well as different age groups per month / year is provided. Intestinal parasitic infection is still a public health problem in Riyadh region, KSA. It is necessary to update the epidemiologic survey of the parasitic infection at regular intervals using different statistical methods to develop effective prevention and control strategies.

INTRODUCTION

Parasitic infections are considered the significant public health problem globally, particularly in the developing countries and constituting the major cause of illness and disease (Savioli *et al*., 1992; Mehraj *et al*., 2008).

Recently, at least 30 % of the total population in the world is infected with intestinal parasites. Some 3.5 billion people worldwide are affected, and that 450 million are ill as a result of these infections (Keiser and Utzinger, 2010; Brooker *et al*., 2009). Most infections are in tropical and subtropical parts of the world. The prevalence of intestinal parasitic infections varies in the different regions of the world. It depends on geographic and socio-economic factors, relatively humid areas, poverty, malnutrition, personal and community hygiene, high population density, unavailability of potable water and low health status, poor sanitary facilities. All these factors provide optimum conditions for the growth, transmission and increase the probability of exposure to intestinal parasites (Thapar and Sanderson, 2004; Sayyari *et al*., 2005; Raza and Sami, 2009). It also affected by the diagnostic methods employed and the number of stool examinations done (Amer *et al*., 2015). The contamination of food or drinking water or personal contact via fecal – oral route is considered the major tracks for transmission of intestinal parasites (WHO, 2010). It well known that, Saudi Arabia is considered one of the largest destinations of expatriate workers, particularly the food handlers and catering staff, from different countries of the world including Bangladesh, Philippine, India, Indonesia, Pakistan, Sri Lanka and Egypt. All of these countries are known to be endemic for many diseases including those caused by intestinal parasites (Amer *et al*., 2015). Many studies were conducted in different regions of Saudi Arabia, revealed the high prevalence rates of infection with

* Corresponding author: o.amer@mu.edu.sa
0030-9923/2017/0005-1889 $ 9.00/0

intestinal parasites among specific populations including food handlers (23%), school children (33.8%), expatriates (ranging from 14.9% to 55%), and Saudi and Non-Saudi patients attending hospitals (ranging from 39.7% to 77.1%) (Amer *et al*., 2015; Zaglool *et al*., 2011; Taha *et al*., 2013; Koshak and Zakai, 2003; Al-Braiken, 2008; Mohammad and Koshak, 2011; Al-Megrin, 2010; Barnawi *et al*., 2007; Al-Harthi and Jamjoom, 2007; Amer *et al*., 2011). As per the available literature, there is no previous studies were conducted on the military hospitals and military personnel in KSA. Thus the aim of the present study is to throw the light upon the intestinal parasitic infections of this sector of Saudi citizens which includes mainly the military personnel and their families. Also, to produce an update report of the epidemiologic status of intestinal parasitic infections in Riyadh region.

MATERIALS AND METHODS

The present study is a retrospective analysis of all intestinal parasitic infections reported for both in and outpatients visiting the Prince Sultan Military Medical City, Riyadh, KSA based on prior permission. The specimens were normally examined by the routine methods of stool analysis.

Data collection

Information regarding positive cases detected during the study period was collected from the hospital records. The patients of the hospital are mainly from military personnel and their families. The records were collected from the microbiology laboratory between 2010 and 2014. The parameters available from the patients' records were age, sex and seasonality.

Data preprocessing

Data pre-processing includes the following:

Outlier analysis

Outliers are referred to as abnormalities, discordant, deviants, or anomalies in the data mining (Hautamaki *et al*., 2004). The basic computational complexity of this method is to evaluate the measured distance between all samples in an n-dimensional data set. Then, a sample s_i in a data set S is an outlier if at least a fraction p of the samples in S lies at a distance greater than d. In other words, distance-based outliers are those samples which do not have enough neighbors, where neighbors are defined through the multidimensional distance between samples.

Obviously, the criterion for outlier detection is based on two parameters, p and d, which may be given in advance using knowledge about the data as shown in equation (1) and (2) , or which may be changed during the iterations (trial-and-error approach) to select the most representative outliers.

Euclidian distances,

$$d = [(x1 - x2)2 + (y1 - y2)2]1/2 \quad (1)$$

The threshold value,

$$p = \text{Mean}+2 \times \text{Standard deviation} \quad (2)$$

Smooth out noisy data and fill in missing values

One of the most important methods that used for smooth out noisy data and fill in missing values is polynomial regression. Polynomial regression is a method for fitting a smooth curve between two variables, or fitting a smooth surface between an outcome and up to four predictor variables. Polynomial regression is a procedure of linear regression in which the relationship stuck between the independent variable X and the dependent variable Y is demonstrated as an n^{th} degree polynomial. The goal of regression analysis is prototypical the expected value of a dependent variable Y in terms of the value of an independent variable X. In simple linear regression, the model is used:

$$Y=a\_0+a\_1 X+\varepsilon \quad (4)$$

Where, ε is an unobserved random error with mean zero conditioned on a scalar variable x. a0 and a1 are the parameters. In all-purpose, the expected value of y as an nth degree polynomial, yielding the general polynomial regression model:

$$Y=a\_0+a\_1 X+a\_2 X\^2+a\_3 X\^3+......+a\_n X\^n+\varepsilon \quad (5)$$

Statistics analysis

The Shapiro-Wilks test for normality is one of three general normality tests designed to detect all departures from normality. It is comparable in power to the other two tests. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05. Failing the normality test allows you to state with 95% confidence the data does not fit the normal distribution. Passing the normality test only allows you to state no significant departure from normality was found.

This test gives a guide in determination of which statistics test will use parametric or non-parametric test; we will apply independent t-test for parametric and Mann-Whitney- U test for non-parametric test to compare the mean average infection of female and male during the five years distributed on 12 months.

The basic computational complexity of this method is the evaluation of distance measures between all samples in an n-dimensional data set. Then, a sample s_i in a data set *S* is an outlier if at least a fraction *p* of the samples in S lies at a distance greater than *d*. In other words, distance-based outliers are those samples which do not have enough neighbors, where neighbors are defined through the multidimensional distance between samples.

Obviously, the criterion for outlier detection is based on two parameters, p and d, which may be given in advance using knowledge about the data as shown in equation (1) and (2) , or which may be changed during the iterations (trial-and-error approach) to select the most representative outliers.

RESULTS

Our retrospective study revealed that out of 11110 examined patients, during the period from 2010 – 2014, 775 were infected with one or more intestinal parasite with prevalence rate (6.98 %).

Prevalence of intestinal parasites

Seven intestinal parasites; five helminths (*Ascaris lumbricoides*, *Enterobius vermicularis*, *Trichuris trichiura*, *Hymenolepis nana* and *Taenia saginata*) and two Protozoa (*Entamoeba histolytica* and *Giardia lamblia*) were reported in this study (Table I). The prevalence of all intestinal parasitic infections per years ranged from (4.7 - 7.9 %). As shown in Table I, there is a variance in the prevalence rate of different parasites during the period of study. In the period 2010 – 2012 and 2014, the helminth nematode, *Ascaris lumbricoides* was the most common parasite with prevalence rates 1.88 %, 1.9 %, 2.2 % and 2 % followed by the nematode, *Trichuris trichiura* in 2010 with prevalence rate 1.61 %, the protozoan, *Giardia lamblia* in 2011 - 2012 with prevalence rates 1.3 % and 2.1 % and the protozoan, *Entamoeba histolytica* in 2104 with prevalence rate 1.9 %, respectively. In 2013, *Entamoeba histolytica* was the most common parasite (2.8 %) followed by *Giardia lamblia* (1.7 %).

Parasitic infection in both males and females

The parasitic infection of both male and female patients was displayed in (Table II). It was found that the prevalence of all intestinal parasitic infection in males (405 = 3.65%) and in females (370 = 3.33%). The most common intestinal parasites in males were; *Giardia lamblia*, *Entamoeba histolytica*, *Ascaris lumbricoides* and *Trichuris trichiura* with prevalence rates 1.13 %, 0.87 %, 0.73 % and 0.37 %, while in females were; *Ascaris lumbricoides, Entamoeba histolytica, Trichuris trichiura* and *Giardia lamblia* with prevalence rates 1.12 %, 0.69 %, 0.69 % and 0.48 %, respectively. To examine the significance of intestinal parasitic infection in both males and females, Shapiro-Wilks test, independent t-test and Mann-Whitney- test were applied and the results are shown in Tables III and IV.

As shown in Table IV, *Ascaris lumbricoides, Trichuris trichiura, Hymenolepis nana* and *Giardia lamblia* have a significant difference between males and females; while there is no significance detected in *Entamoeba histolytica.*

Prevalence of intestinal parasitic infections and age groups

As shown in Table V, the examined patients (males – females) were classified into seven age groups against the

Table I.- Prevalence of intestinal parasitic infection during the period of study (2010 - 2014).

Type of parasite	2010		2011		2012		2013		2014	
	No	P (%)	No	P (%)	No	P (%)	No	P (%)	No	P (%)
Ascaris lumbricoides	28	1.88%	30	1.9%	46	2.2%	54	1.5%	47	2.0%
Entamoeba histolytica	1	0.07%	6	0.4%	21	1.0%	100	2.8%	46	2.0%
Enterobius vermicularis	3	0.20%	3	0.2%	9	0.4%	10	0.3%	3	0.1%
Giardia lamblia	8	0.54%	21	1.3%	45	2.1%	60	1.7%	44	1.9%
Hymenolepis nana	5	0.34%	3	0.2%	13	0.6%	25	0.7%	5	0.2%
Taenia saginata	2	0.13%	1	0.1%	9	0.4%	7	0.2%	2	0.1%
Trichuris trichiura	24	1.61%	21	1.3%	24	1.1%	27	0.8%	22	0.9%
Total infected	71	4.76%	85	5.44%	167	7.90%	283	7.86%	169	7.22%
Total examined	**1492**		**1563**		**2115**		**3600**		**2340**	

P, prevalence.

Table II.- Prevalence of intestinal parasitic infection in both males and females (2010 – 2014).

Type of parasite	2010				2011				2012				2013				2014				Total			
	F	P	M	P	F	P	M	P	F	P	M	P	F	P	M	P	F	P	M	P	F	P	M	P
A. lumbricoides	14	0.94%	14	0.94%	21	1.34%	9	0.58%	24	1.13%	22	1.04%	36	1.00%	18	0.50%	29	1.24%	18	0.77%	124	1.12%	81	0.73%
E. histolytica	0	0.00%	1	0.07%	3	0.19%	3	0.19%	9	0.43%	12	0.57%	43	1.19%	57	1.58%	22	0.94%	24	1.03%	77	0.69%	97	0.87%
E. vermicularis	1	0.07%	2	0.13%	2	0.13%	1	0.06%	2	0.09%	7	0.33%	4	0.11%	6	0.17%	0	0.00%	3	0.13%	9	0.08%	19	0.17%
G. lamblia	3	0.20%	5	0.34%	7	0.45%	14	0.90%	16	0.76%	29	1.37%	22	0.61%	38	1.06%	5	0.21%	39	1.67%	53	0.48%	125	1.13%
H. nana	1	0.07%	4	0.27%	2	0.13%	1	0.06%	5	0.24%	8	0.38%	6	0.17%	19	0.53%	1	0.04%	4	0.17%	15	0.14%	36	0.32%
T. saginata	0	0.00%	2	0.13%	0	0.00%	1	0.06%	7	0.33%	2	0.09%	6	0.17%	1	0.03%	2	0.09%	0	0.00%	15	0.14%	6	0.05%
T. trichiura	17	1.14%	7	0.47%	18	1.15%	3	0.19%	10	0.47%	14	0.66%	16	0.44%	11	0.31%	16	0.68%	6	0.26%	77	0.69%	41	0.37%
Total infected	36	2.4%	35	2.3%	53	3.4%	32	2.0%	73	3.45%	94	4.44%	133	3.69%	150	4.17%	75	3.21%	94	4.02%	370	3.33%	405	3.65%
Total examined	**1492**				**1563**				**2115**				**3600**				**2340**				**1110**			

F, female; M, male; P, prevalence.

Table III.- Results of Shapiro-Wilks test.

Type intestinal parasite	Groups	Sig (P-value)	Normal distribution
Ascaris lumbricoides	Male	0.234	Yes
	Female	0.502	Yes
Enterobius vermicularis	Male	0.282	Yes
	Female	0.004	No
Trichuris trichiura	Male	0.149	Yes
	Female	0.467	Yes
Hymenolepis nana	Male	0.213	Yes
	Female	0.051	Yes
Taenia saginata	Male	0.002	No
	Female	0.022	No
Entamoeba histolytica	Male	0.143	Yes
	Female	0.444	Yes
Giardia lamblia	Male	0.793	Yes
	Female	0.475	Yes

Table IV.- Results of independent t-test for intestinal parasitic infection in both males and females.

Type intestinal parasite	Levene's Test for Equality of Variances Sig	t-value	Sig. (2-tailed)
Ascaris lumbricoides	0.021	-2.06	0.05*
Trichuris trichiura	0.29	-2.19	0.038*
Hymenolepis nana	0.036	2.59	0.01*
Entamoeba histolytica	0.111	1.11	0.27
Giardia lamblia	0.084	3.65	0.0013*

*, means significant.

prevalence of intestinal parasitic infections. The highest prevalence was reported in the age group (21 – 30) in both sexes. The most common parasites in males were; *Giardia lamblia* (2.2%), *Entamoeba histolytica* (1.78%), *Ascaris lumbricoides* (1.18%) and *Trichuris trichiura* (0.72%), while in females were; *Ascaris lumbricoides* (2.39%), *Entamoeba histolytica* (1.6%), *Trichuris trichiura* (1.41%) and *Giardia lamblia* (0.87%), respectively. Table VI shows the significance of intestinal parasitic infections between age groups in males, females and between the age group (21 – 30) in both sexes. There is significant difference between the age group (21 – 30) and all the other groups except the age group (31 – 40) in males.

Seasonal variation of intestinal parasites

Figures 1 and 2 show the trend analysis of parasitic infections in both male and female patients per month for five years. The high prevalence rates of parasitic infection per months in both males and females were as follow: *Ascaris lumbricoides* in May (0.11 %) and March (0.16 %), *Enterobius vermicularis* in March (0.04 %) and April (0.02 %), *Trichuris trichiura* in March (0.06 %) and February (0.13 %), *Hymenolepis nana* in April (0.06 %) and April (0.03 %), *Taenia saginata* in October (0.02 %) and March (0.04%), *Entamoeba histolytica* in November (0.17 %) and February (0.1 %) and *Giardia lamblia* in April (0.19 %) and February (0.08 %).

Table V.- Prevalence of intestinal parasitic infection in both males and females per age group (2010 – 2014).

Type of parasite	Age group													
	0-10	P	11-20	P	21-30	P	31-40	P	41-50	P	51-60	P	61-70	P
Male														
Ascaris lumbricoides	0	0.00%	3	1.61%	39	1.18%	14	1.11%	11	2.13%	0	0.00%	14	3.62%
Entamoeba histolytica	1	1.16%	3	1.61%	59	1.78%	20	1.59%	8	1.55%	2	3.49%	4	1.03%
Enterobius vermicularis	0	0.00%	0	0.00%	11	0.33%	4	0.32%	4	0.78%	0	0.00%	0	0.00%
Giardia lamblia	5	5.81%	5	2.68%	73	2.20%	30	2.38%	9	1.74%	1	1.74%	2	0.52%
Hymenolepis nana	0	0.00%	0	0.00%	21	0.63%	10	0.79%	1	0.19%	1	1.74%	3	0.78%
Taenia saginata	0	0.00%	0	0.00%	4	0.12%	2	0.16%	0	0.00%	0	0.00%	0	0.00%
Trichuris trichiura	0	0.00%	2	1.07%	24	0.72%	8	0.63%	3	0.58%	0	0.00%	4	1.03%
Total	6	0.05%	13	0.12%	231	2.08%	88	0.79%	36	0.32%	4	0.04%	27	0.24%
Female														
Ascaris lumbricoides	1	0.78%	7	1.53%	85	2.39%	20	2.45%	2	2.33%	2	2.79%	7	3.76%
Entamoeba histolytica	1	0.78%	7	1.53%	57	1.60%	10	1.22%	2	2.33%	0	0.00%	0	0.00%
Enterobius vermicularis	2	1.55%	1	0.22%	4	0.11%	2	0.24%	0	0.00%	0	0.00%	0	0.00%
Giardia lamblia	5	3.88%	10	2.18%	31	0.87%	7	0.86%	0	0.00%	0	0.00%	0	0.00%
Hymenolepis nana	0	0.00%	0	0.00%	12	0.34%	3	0.37%	0	0.00%	0	0.00%	0	0.00%
Taenia saginata	0	0.00%	0	0.00%	9	0.25%	4	0.49%	1	1.16%	0	0.00%	1	0.54%
Trichuris trichiura	0	0.00%	7	1.53%	50	1.41%	11	1.35%	1	1.16%	3	4.19%	5	2.68%
Total	**9**	**0.08%**	**32**	**0.29%**	**248**	**2.23%**	**57**	**0.51%**	**6**	**0.05%**	**5**	**0.05%**	**13**	**0.12%**

Table VI. Results of Bonferroni test.

(I) Age group	(J) Age group	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Male age 21-30	Male age 0-10	26.37500*	6.39247	.008	3.4054	49.3446
	Male age 11-20	30.14286*	6.58525	.001	6.4805	53.8052
	Male age 31-40	19.42857	6.58525	.374	-4.2338	43.0909
	Male age 41-50	26.85714*	6.58525	.009	3.1948	50.5195
	Male age 51-60	31.42857*	6.58525	.001	7.7662	55.0909
	Male age 61-70	28.14286*	6.58525	.005	4.4805	51.8052
Female Age 21-30	Female Age 0-10	34.14286*	6.32690	.000	11.4088	56.8769
	Female Age 11-20	30.85714*	6.32690	.000	8.1231	53.5912
	Female Age 31-40	27.28571*	6.32690	.004	4.5517	50.0198
	Female Age 41-50	34.57143*	6.32690	.000	11.8374	57.3055
	Female Age 51-60	34.71429*	6.32690	.000	11.9802	57.4483
	Female Age 61-70	33.57143*	6.32690	.000	10.8374	56.3055
Female Age 21-30	Male age 21-30	3.42857	6.58525	1.000	-20.2338	27.0909

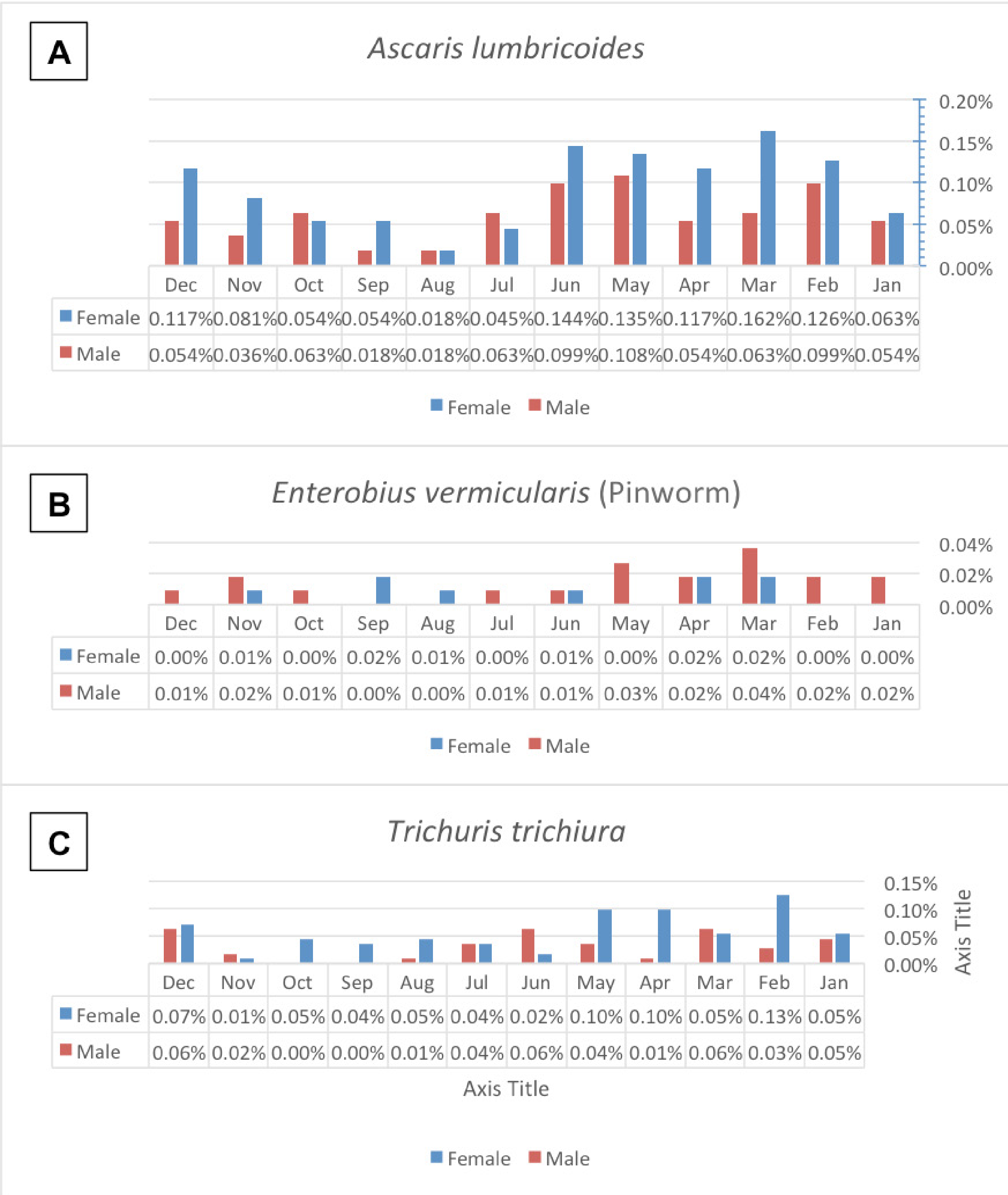

Fig. 1. The trend analysis of *Ascaris lumbricoides* (A), *Enterobius vermicularis* (B) and *Trichuris trichiura* (C) in both male and female patients per month during (2010-2014).

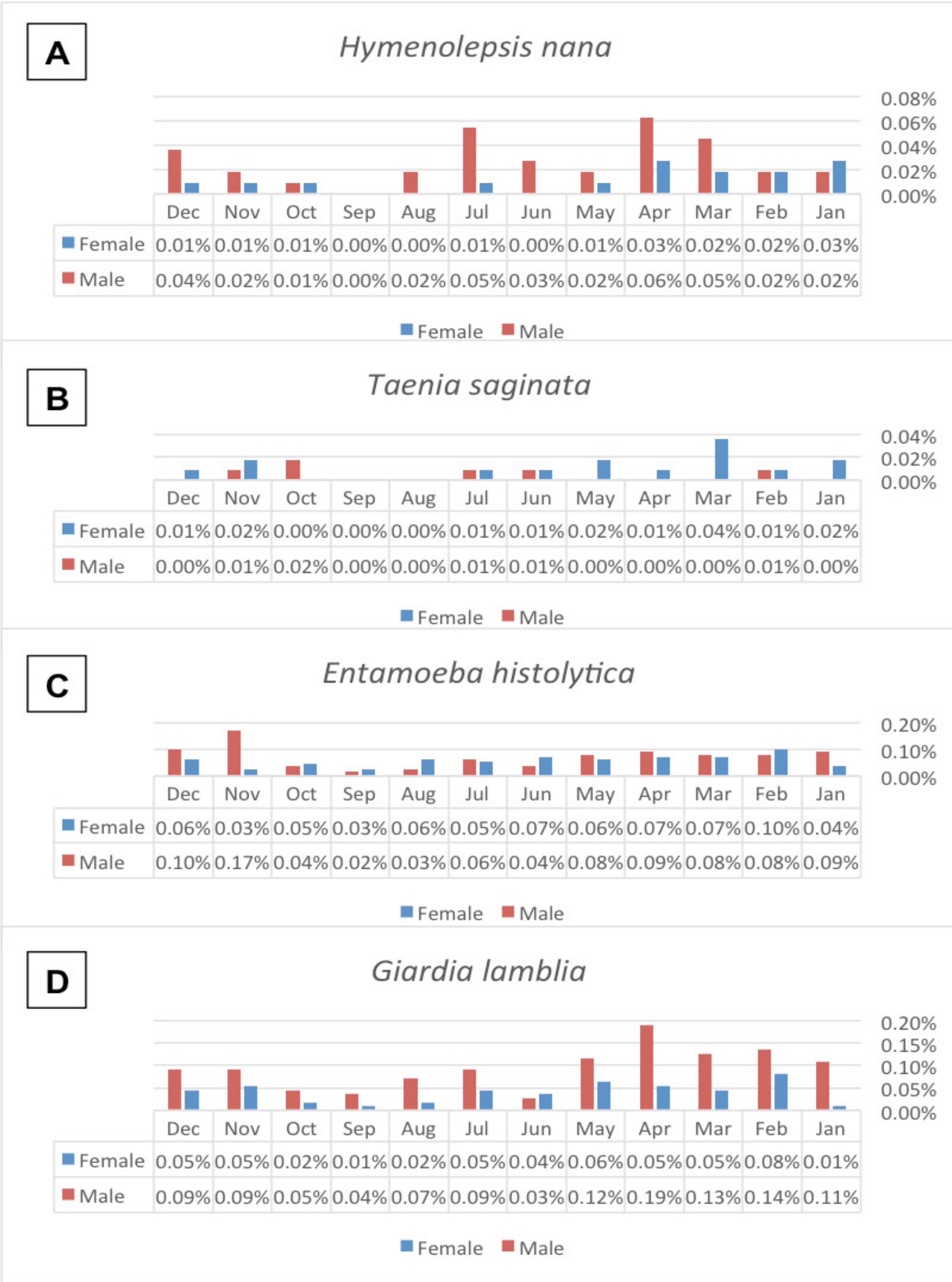

Fig. 2. Trend analysis of *Hymenolepis nana* (A), *Taenia saginata* (B), *Entamoeba histolytica* (C) and *Giardia lamblia* (D) in both male and female patients per month during (2010-2014).

DISCUSSION

Parasitic infections are globally significant public health problem and considered the major cause of illness and disease (Savioli *et al*., 1992; Mehraj *et al*., 2008; Keiser and Utzinger, 2010). The intestinal parasitic infections are closely related to poor sanitary habits, lack access to safe potable water and improper hygiene. The relation between these factors and the prevalence of parasitic infection varies worldwide and in different regions of KSA (Zaglool *et al*., 2011). The previous published surveys of some countries revealed that, the prevalence rate was 13.3% in India (Assudani *et al*., 2015), 32.0 – 41.5 % in Palestine (Bdir and Adwan, 2010), 8.8 % in Iran (Saki *et al*., 2012), 57.9 % in Iraq (Hussein *et al*., 2011), 10.2 % in Qatar (Abu-Madi *et al*., 2010), 64.4% in Sudan (Gabbad and Elawad, 2014), 7.7% in UAE (Dash *et al*., 2010) and 58.7% in Yemen (Al-Haddad and Baswaid, 2010). However in KSA, the prevalence rate was; 27.2% in Al-Ahsa (Al-Mohammed *et al*., 2010), 47.01% in Jeddah (Wakid, 2010), 6.2% in Makkah (Zaglool *et al*., 2011), 8.4 % in Tabuk (Aly and Mostafa, 2010) and 2.3 – 39.7% in Riyadh (Al-Megrin, 2010; Alkhalife, 2006; Kalantan *et al*., 2001; Al-Shammari *et al*., 2001). The current study has indicated that 6.98 % of the examined patients were infected with one or more intestinal parasites. Compared with most of the previous studies outside or inside the Saudi Arabia, the prevalence rate in this study is relatively low and this may be due to the type of examined patients who are mainly Saudis (Military personnel and their families). In addition, they are mostly urban dwellers with moderate to high socioeconomic status.

The most common parasite in this study was *Ascaris lumbricoides* and this finding disagrees with the previous studies in Saudi Arabia and other countries in the region which reported *Giardia lamblia* as the most common parasite. This finding also disagrees with the results of some surveys conducted in Riyadh region (Al-Megrin, 2010; Alkhalife, 2006; Kalantan *et al*., 2001; Al-Shammari *et al*., 2001) which reported the same for *Giardia lamblia*. This result can be explained if we took in consideration the nature of examined patients who include large numbers of military personnel and soldiers, however, *Giardia lamblia* is mostly parasitize the children. In addition to, the favourable ecological (temperature, humidity and nature of soil) and socio-cultural factors that influence survival and transmission of soil transmitted helminths. The infection of *Taenia saginata* detected in patients has been probably acquired due to eating the insufficient cooked meat inside the military camps.

The overall intestinal parasitic infections in both males and females indicated that the prevalence rate is slightly higher in males (3.65 %) than females (3.33 %). This result complies with the finding of one survey in Iraq (Hussein *et al*., 2011) and disagrees with that survey of Madina (Imam *et al*., 2015). The high prevalence of infection in males can be justified due to the lifestyle of military personnel and soldiers who spend most of their times inside the camps which sometimes lack the proper hygiene. Statistically, it was found significant difference between males and females infected by; *Ascaris lumbricoides, Trichuris trichiura, Hymenolepis nana* and *Giardia lamblia* but no significance with *Entamoeba histolytica.* This result does not match with the study of Hussein *et al*. (2011) in Iraq for all parasites except *Entamoeba histolytica*. The prevalence of parasitic infection with *Ascaris lumbricoides, Trichuris trichiura* and *Taenia saginata* was higher in females than males and this can be attributed to the exposure of females to parasites infective stages due to the nature of the chores they perform in the house and their lifestyle (Imam *et al*., 2015).

The current study revealed that the most affected group of patients for parasitic infection was 21 - 30 years old group (2.08%) and (2.23%) for both males and females however, the less affected group was 51 - 60 years old group (0.04%) in males and 41 - 50, 51 - 60 years old group in females. This result is in agreement with that of Alkhalife (2006), who mentioned that approximately half of the positive cases in his study fall under the age group (21 – 40). However, this finding disagrees with the studies of Hussien *et al*. (2011), Molan and Farag (1989) and Kadhim (1986) and this may be due to two reasons; the first reason concerning with target groups in the previous studies who are the children only but in our study, the target groups are the different age groups. The second one is that large number of our target groups is the soldiers and military personnel who have ages ranged between 21 – 30 years old and those people spend most of their times in the desert and expose to the risk of intestinal parasitic infections which mentioned in details previously. Statistically, it was found that there is significant difference between the age group 21 – 30 and all the other groups except the age group 31 – 40 in males and this may be attributed to the nature of work or life of this group which is similar to the life and work of the age group 21 – 30.

In regard to the relation between the prevalence of parasitic infection and seasonality in this study, it was found that most of intestinal parasites were increased in spring and summer seasons and this finding agrees with that of Imam *et al*. (2012), who studied the frequency and seasonality of intestinal parasitism in Qassim region. They attributed the increase of intestinal parasites to the frequent human exposure to valley water collections containing the infective stages of parasites during outdoor activities in summer time. This explanation can be accepted to some extent in our study because of some target groups spend most of their times in the deserts and valleys. In general, most parasites increase and distribute in the favourable environmental conditions such as; optimum temperature and humidity.

CONCLUSION

The intestinal parasitic infections are still major public health problem in tropical and subtropical countries and KSA as well. Overall rates of intestinal parasitic infection in this study are relatively lower than the previous comparable studies and this may be due to the general improvement in health services. *Ascaris lumbricoides* and *Giardia lamblia* were found to be the common etiologic agents of intestinal parasitic diseases among the study population. The intestinal parasitic infections among males are slightly higher than females. Spring and summer are the seasons of increase of most parasitic infections. The age group 21 – 30 was the most affected group in this study. Improving sanitation facilities, instilling health education and promoting ways of keeping personal hygiene can be good strategies to control the intestinal parasitic infections.

ACKNOWLEDGMENTS

The authors would like to thank and appreciate the director of Prince Sultan Military Medical City and the head of Microbiology laboratory for their kind co-operation in providing the records of parasitic infection in ethical and appropriate manner. The authors extend their appreciation to Dr. Refaat M. Khalifa, the professor of Parasitology, college of Medicine, Assiut University for revising the manuscript. Finally, the authors would like to thank the Deanship of Scientific Research at Majmaah University for supporting this work under Project Number No. 37/89.

Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

Abu-Madi, M.A., Behnke, J.M. and Doiphode, S.H., 2010. Changing trends in intestinal parasitic infections among long-term-residents and settled immigrants in Qatar. *Parasit. Vectors*, **3**: 98. https://doi.org/10.1186/1756-3305-3-98

Al-Braiken, F.A., 2008. Is intestinal parasitic infection still a public health concern among Saudi children? *Saudi med. J.,* **29**: 1630-1635.

Al-Haddad, A.M. and Baswaid, S.H., 2010. Frequency of intestinal parasitic infection among children in Hadhramout Governorate (Yemen). *J. Egypt. Soc. Parasitol*., **40**: 479-488.

Al-Harthi, S.A. and Jamjoom, M.B., 2007. Preliminary study of the prevalence of intestinal parasites among diarrheic inhabitants in Makkah Al-Mukarramah. *J. Egypt. Soc. Parasitol*., **37**: 671-680.

Alkhalife, I.S., 2006. Retrospective analysis of intestinal parasitic infections diagnosed at a University hospital in central, Saudi Arabia. *Saudi med. J.,* **27**: 1714-1718.

Al-Megrin, W.A.I., 2010. Intestinal parasites infection among immunocompromised patients in Riyadh, Saudi Arabia. *J. biol. Sci.,* **13**: 390-394. https://doi.org/10.3923/pjbs.2010.390.394

Al-Mohammed, H.I., Amin, T.T., Aboulmagd, E., Hablus, H.R. and Zaza, B.O., 2010. Prevalence of intestinal parasitic infections and its relationship with socio-demographics and hygienic habits among male primary schoolchildren in Al-Ahsa, Saudi Arabia. *Asian Pac. J. trop. Med*., **3**: 906-912. https://doi.org/10.1016/S1995-7645(10)60218-0

Al-Shammari, S., Khoja, T., El-Khwasky, F. and Gad, A., 2001. Intestinal parasitic diseases in Riyadh, Saudi Arabia: prevalence, sociodemographic and environmental associates. *Trop. Med. Int. Hlth.,* **6**: 184-189. https://doi.org/10.1046/j.1365-3156.2001.00698.x

Aly, N.S.M. and Mostafa, M.M.M., 2010. Intestinal parasitic infection among Children in the Kingdom of Saudi Arabia. *Austr. J. Basic appl. Sci.,* **4**: 4200-4204.

Amer, O.H., Ashankyty, I.M. and Haouas, N.A., 2015. Prevalence of intestinal parasite infections among patients in local public hospitals of Hail, Northwestern Saudi Arabia. *Asian Pac. J. trop. Med*., **9**: 44-48. https://doi.org/10.1016/j.apjtm.2015.12.009

Amer, O.H., Fareid, M.A. and Al-Shankyty, I.M., 2011. Prevalence of intestinal parasitic and bacterial pathogens in diarrhoeal and non diarrhoeal school children at Hail, Saudi Arabia. *N. Y. Sci. J.,* **4**: 106-113.

Assudani, H., Gusani, J., Mehta, S. and Agravat, H., 2015. Intestinal parasitic infections in pediatric patients with diarrhea with special emphasis to opportunistic parasites and predisposing factors.

Int. J. med. Sci. Publ. Hlth., **4**: 841-844.

Barnawi, A.B., Tonkal, A.M., Fouad, M.A. and Al-Braiken, F.A., 2007. Detection of *Entamoeba histolytica / dispar* in stool specimens by using enzyme linked immunosorbent assay in the population of Jeddah City, Saudi Arabia. *J. Egypt. Soc. Parasitol*., **37**: 143-150.

Bdir, S. and Adwan, G., 2010. Prevalence of intestinal parasitic infections in Jenin Governorate, Palestine: A 10-year retrospective study. *Asian Pac. J. trop. Med*., **3**: 745-747. https://doi.org/10.1016/S1995-7645(10)60179-4

Brooker, S., Kabatereine, N.B., Smith, J.L., Mupfasoni, D., Mwanje, M.T., Ndayishimiye, O., Lwambo, N.J., Mbotha, D., Karanja, P., Mwandawiro, C., Muchiri, E., Clements, A.C., Bundy, D.A. and Snow, R.W., 2009. An updated atlas of human helminth infections: the example of East Africa. *Int J. Hlth. Geogr*., **8**: 42. https://doi.org/10.1186/1476-072X-8-42

Dash, N., Al-Zarouni, M., Anwar, K. and Panigrahi, D., 2010. Prevalence of intestinal parasitic infections in Sharjah, United Arab Emirates. *Human Parasit. Dis.,* **2**: 21-24. https://doi.org/10.4137/HPD.S5081

Gabbad, A.A. and Elawad, M.A., 2014. Prevalence of intestinal parasite infection in primary school children in Elengaz Area, Khartoum, Sudan. *Acad. Res. Int.,* **5**: 86-90.

Hautamaki, V., Karkkainen, I. and Franti, P., 2004. Outlier detection using k-nearest neighbor graph. In: *Proc. 17th Int. Confer. Pattern Recognition, 2004*, Vol. 3, Cambridge, UK, pp. 430-433.

Hussein, R.A., Shaker, M.J. and Majeed, H. A., 2011. Prevalence of intestinal parasitic infections among children in Baghdad City. *J. Col. Basic Edu*., **71**: 130-147.

Imam, A., Altayyar, A., Eltayeb, E. and Almushawa, Y., 2012. Frequency and seasonality of intestinal parasitism in Qassim region, Saudi Arabia. *Pak. J. med. Sci.,* **28**: 913-916.

Imam, N.F.A., Abdulbaqi, Z.B. and Fahad, R.A., 2015. The Prevalence of intestinal parasitic infections among foreign workers in Madinah, Kingdom of Saudi Arabia. *Saudi J. Med. med. Sci.,* **3**: 112-117.

Kadhim, T.A., 1986. *A study in the epidemiology of intestinal parasites in elementary school children in Baghdad governorate*, M.Sc. thesis. Collage of Medicine, University of Baghdad.

Kalantan, K.A., Al-Faris, E.A. and Al-Taweel, A.A., 2001. Pattern of intestinal parasitic infection among food handlers in Riyadh, Saudi Arabia. *J. Family Commun. Med*., **8**: 67-72.

Keiser, J. and Utzinger, J., 2010. The drugs we have and the drugs we need against major helminth infections. *Adv. Parasitol*., **73**: 197-230. https://doi.org/10.1016/S0065-308X(10)73008-6

Koshak, E.A. and Zakai, H.A., 2003. A spectrum of pathogenic and nonpathogenic intestinal parasites in pre-employment medical checkup for workers and their family. *J. Family Commun. Med.,* **10**: 47-53.

Mehraj, V., Hatcher, J., Akhtar, S., Rafique, G. and Beg, M.A., 2008. Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Karachi. *PLoS One*, **3**: e3680. https://doi.org/10.1371/journal.pone.0003680

Mohammad, K.A. and Koshak, E.A., 2011. A prospective study on parasites among expatriate workers in Al-Baha from 2009–2011, Saudi Arabia. *J. Egypt. Soc. Parasitol*., **41**: 423-443.

Molan, A.L. and Farag, A.M., 1989. Prevalence of intestinal parasites in school children of Arbil, northern Iraq. *Saudi. Med. J*., **10**: 107-110.

Raza, H.H. and Sami, R.A., 2009. Epidemiological study on gastro-intestinal parasites among different sexes, occupations and age groups in Sulaimani district. *J. Duhok Univ*., **12**: 317-323.

Saki, J., Khademvatan, S., Masoumi, K. and Chafghani, M., 2012. Prevalence of intestinal parasitic infections among food handlers in Khuzestan, Southwest of Iran: A 10-year retrospective study. *Afr. J. Microbiol. Res*., **6**: 2475-2480.

Savioli, L., Bundy, D. and Tomkins, A., 1992. Intestinal parasitic infections: a soluble public health problem. *Trans. R. Soc. trop. Med. Hyg*., **86**: 353-354. https://doi.org/10.1016/0035-9203(92)90215-X

Sayyari, A.A., Imanzadeh, F., Bagheri Yazdi, S.A., Karami, H. and Yaghoobi, M., 2005. Prevalence of intestinal parasitic infections in the Islamic Republic of Iran. *East Mediterr. Hlth. J*., **11**: 377-383.

Taha, H.A., Soliman, M.I. and Banjar, S.A.N., 2013. Intestinal parasitic infections among expatriate workers in Al-Madina Al-Munawara, Kingdom of Saudi Arabia. *Trop. Biomed*., **30**: 78-88.

Thapar, N. and Sanderson, I.R., 2004. Diarrhea in children: an interface between developing and developed countries. *Lancet*, **363**: 641-653. https://doi.org/10.1016/S0140-6736(04)15599-2

Wakid, M.H., 2010. Fecal occult blood test and gastrointestinal parasitic infection. *J. Parasitol. Res.,* **2010**: Article ID 434801. https://doi.

org/10.1155/2010/434801

WHO, 2010. *Intestinal parasites*. Available at: http://apps.who.int/etd/intpara/ burdens.htm.

Zaglool, D.A.M., Khodari, Y.A.W., Gazzaz, Z.J., Dhafar, K.O., Shaker, H.A.S. and Farooq, M.U., 2011. Prevalence of intestinal parasites among patients of Al-Noor Specialist Hospital, Makkah, Saudi Arabia. *Oman med. J.*, **6**: 182-185. https://doi.org/10.5001/omj.2011.44

Zaglool, D.A., Khodari, Y.A., Othman, R.A.M. and Farooq, M.U., 2011. Prevalence of intestinal parasites and bacteria among food handlers in a tertiary care hospital. *Niger. med. J.*, **52**: 266-270. https://doi.org/10.4103/0300-1652.93802