

Original papers

Prevalence of intestinal parasites among the population of the Gaza Strip, Palestine

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ABSTRACT. Intestinal parasitic diseases in Gaza Strip are a significant health problem. The main aim of this study is to determine the prevalence of parasitic infection among patients in the five governorates of the Gaza Strip. A cross-sectional parasitological survey was conducted on 600 patients. Stool specimens were examined microscopically for the presence of parasite eggs or larvae/cysts per wet amount by the saline iodine and formol-ether concentration method. Of 600 subjects examined, 245 (40.8%) were infected with one or more intestinal parasites. *Entamoeba histolytica/dispar* and *Giardia lamblia* were the most prevalent parasites amongst the population (28.8%), (9.5%). Female patients demonstrated a higher prevalence of intestinal parasitic infections (42.7%) than males (39.0%). However, this difference was not significant ($p>0.05$). According to occupation, the rate of infection was highest among farmers (56.0%), followed by employers (44.2%) with laborers showing the lowest rate (30.17%). These differences in occupational prevalence were found to be statistically significant ($p<0.05$). The present study demonstrates that intestinal protozoan infections are still a public health problem in the Gaza strip, with *Entamoeba* and *Giardia* infections being most common. Therefore, it is necessary to develop effective prevention and control strategies, including health education and environmental sanitation improvement.

Key words: intestinal parasites, Gaza, population

Introduction

Parasitic infection is not only considered to be a public health hazard, but also causes significant morbidity and mortality in children, and is responsible for malnutrition in various countries around the world [1]. The World Health Organization estimates that about 3.5 billion people worldwide are affected and that 450 million are ill as a result of these infections [2]. Generally, these infections are more prevalent in developing countries (30% to 60%) than in developed ones (≤2%) and in populations with lower socioeconomic status [3]. The Gaza Strip Governorates included a narrow, elongated zone of land with a surface area of 365 square kilometers. It extends longitudinally for 45 kilometers along the shore of the Mediterranean, and its width ranges from 5 kilometers in the northern part to 12 kilometers in the southern part. The Gaza Governorates consist of five provinces: North, Gaza, Mid-Zone, Khan Younis, and Rafah (Fig.1) [4].

Intestinal parasitic infections are historically common in the Gaza strip and most data on the prevalence of intestinal parasites in Gaza has been obtained from school and pre-school children [5–7]. More than 50% of pre-school children in the Gaza Strip refugee camps are infected with intestinal parasites due to poor socioeconomic and environmental sanitation conditions in addition to lack of personal hygienic practices [8]. The overall distribution of parasites is consistent with those identified in studies undertaken in the Gaza Strip: *Giardia lamblia*, *Entamoeba histolytica/dispar*, *Cryptosporidium* spp., *Enterobius vermicularis*, *Ascaris lumbricoides*, *Hymenolepis nana*, and *Trichuris trichura* [5,9–10]. Although the epidemiological characteristics of these infections

have been studied in some populations, mostly children, in Gaza [9,11], no extensive epidemiological survey has been conducted in the area. Nevertheless, Al-Hindi and Al-Louh [12] report a high occurrence of *Entamobea histolytica /dispar* and *Giardia lamblia* among Gaza Strip residents according to a study of governmental records.

Protozoan parasites are routinely diagnosed by microscopic examination of fresh or fixed stool samples [10], a procedure which is rarely accurate and not strain-specific. This epidemiological survey was performed to profile intestinal parasitic infections and identify associated sociodemographic and environmental factors among Palestinian patients.

Materials and Methods

Ethical consideration. An approval was obtained from the Ministry of Health before the commencement of the study**.** Informed consent was obtained from all patients after clear explanation for the objectives of the study.

Population. The study was conducted using random sampling among outpatients at hospitals in Gaza Strip. A total of 600 stool samples were collected from patients aged between 1 and 69 years old. The study was conducted in the five governorates of the Gaza Strip.

Questionnaire. Information was collected through a pre-tested standard questionnaire which included socio-demographic information such as age, gender, education, residence, occupation and health conditions with a history of symptoms (e.g., diarrhea, nausea, vomiting and abdominal pain).

Parasitological methods. The stool samples were collected from patients in wide-mouthed, screw-capped, labeled containers. Primary detection of (oo) cysts and ova were made by the examination of a wet preparation taken from fresh stool. The formalin ether sedimentation technique was used [13].

Quality and management of data. All stool samples were collected, stored and examined according to WHO guidelines [13]. Each stool

Table 1. Frequency distribution by sex, age, location and occupation of the study subjects for positive parasites in Gaza Strip, Palestine (n=600)

Characteristics	No. tested	No. infected (%)	P*
Gender			
Male	300	117(39.0)	0.203
Female	300	128(42.7)	
Age Group			
01-10	323	142(44.0)	
11-20	119	047(39.5)	
21-30	069	023(33.3)	0.465
31-40	042	015(35.7)	
>40	047	018(38.3)	
Location			
Rafah	087	26(29.9)	
Khanyons	124	42(33.9)	
Med zone	099	46(46.5)	0.001
Gaza	180	68(37.8)	
North Gaza	110	63(57.3)	
Occupation			
Employer	265	117(44.2)	
Farmer	25	14(56.0)	0.019
Labor	141	43(30.5)	
Un-employed	169	71(42.0)	

$p<0.05$ is significant

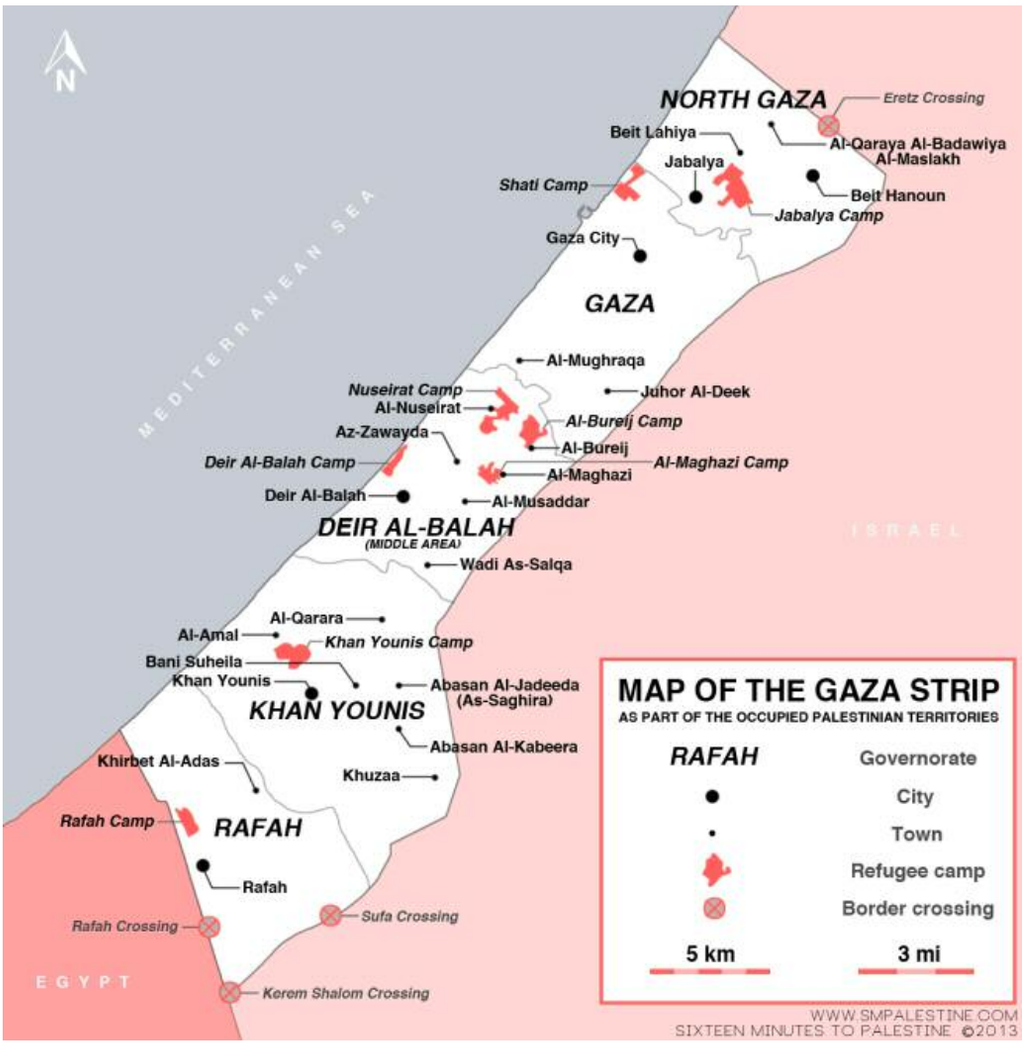

Fig. 1. Map of the Gaza Strip

sample was examined twice to ensure accuracy. The questionnaire data was validated by professionals in Public Health and Parasitology.

Statistical analysis. The data was analyzed using Statistical Package for Social Sciences for Windows, version 17 (SPSS Inc., Chicago. IL, USA). Chi-square analyses were used to investigate the association between dependent and independent variables. Differences were considered significant at $p>0.05$.

Results

Over the course of the study, the stool samples of 600 patients with suspected intestinal parasites referred to private and public hospitals in different five governorates of the Gaza Strip were analysed (Rafah=87, Khanyounis=124, Mid zone=99, Gaza=180, Gaza north=110). These samples were laboratory diagnosed according to wet amount and subjected to formalin-ether stool concentration techniques. Equal numbers of samples were collected from males and females: 300 per gender. The median age of the patients was 24 years, ranging from 1 to 69 years. The majority (323%) were in the 1–10 years age group. The standard of living among the population was determined according to the occupation of the father (Table 1).

The prevalence of infection by various intestinal helminths and protozoan parasites for patients is shown in Tables 1 and 2. Overall, 40.8% (245/600) of patients produced stools contaminated with parasites, and a total of 309 intestinal parasites were counted throughout all the samples. Fifty-five patients, i.e. 9.1% (55/600), had more than one parasite counted in their stools. Protozoa predominated and were identified in 30.5% (183/600) of the subjects. In contrast to protozoan infections; the prevalence of helminth infections in the present study was low: 3.1% (19/600).

Table 2. Prevalence of intestinal parasites in stool specimens singly or multiply infecting patients examined in Gaza Strip (n=600)

Type of parasite	Sex of patients		
	Male n=300 No (%)	Female n=300 No (%)	Total (%)
Pathogenic protozoa			
Entamoeba histolytica/dispar	78(26.0)	93(31.0)	171(28.5)
Giardia lamblia	33(11.0)	24(8.0)	57(9.5)
Non-pathogenic protozoa			
Entamoeba coli	17(5.7)	14(4.7)	31(5.2)
Entamoeba hartmanni	10(3.3)	18(6.0)	28(4.7)
Endolimax nana	2(0.7)	1(0.3)	3(0.5)
Helminths			
Hymenolepis nana	4(1.3)	5(1.7)	9(1.5)
Strongyloides stercoralis	1(0.3)	6(2.0)	7(1.2)
Ascaris lumbricoides	2(0.7)	1(0.3)	3(0.5)
Multiple infections	26(9.0)	29(9.6)	55(9.2)
Single infection	91(30.0)	99(33.1)	190(31.7)

The most common parasites found in the stool samples were *Entamoeba histolytica/dispar* 28.5% (171/600), *Giardia lamblia* 9.5% (57/600), *Entamoeba coli* 4.5% (31/600), *Entamoeba hartmanni* 4.0% (28/600), *Hymenolepis nana* 1.5% (9/600), *Strongyloides stercoralis* larva was found in 1.2% (7/600), *Ascaris lumbricoides* and *Endolimax nana* were isolated in less than 1% of the examined samples. The distribution of intestinal parasites stratified by sex is shown in Table 2. The prevalence of parasitic infections was higher in females, 42.7% (128/300), than in males, 39.0 % (117/300). However, this difference is not statistically significant ($p>0.05$).

Protozoa accounted for the vast majority of the infections, being detected in 30.5% (183/600) of patients infected by intestinal parasites. Among those, *E. histolytica/dispar was* the most common, detected in 28.5% (171/600) of the patients. Although the difference was not significant, more females appeared to be infected than males: 31% (93/300) compared to 26% (78/300), respectively. *G. lamblia* was the second most common species. The infection rate of *G. lamblia* in males, 11.0% (33/300), was higher than in females, 8.0% (24/300) ($p>0.05$).

With regard to helminths, *S. stercoralis* were more frequently diagnosed in females 2.0 % (6/300) than that in males 0.3% (1/300) ($p=0.05$). Other parasitic infection rates did not vary notably with regard to sex. A single parasitic infection was more prevalent than multiple parasitic infections, although 9.1% (55/600) of samples presented two or more parasites, and up to four parasite associations could be observed. *E. histolytica/dispar* was the most conspicuous parasite in patients with multiple infections as well as in mono-parasitized individuals.

The most common clinical presentation was recurrent colic discomfort (77.3%), diarrhea (59.5%), blood in stool (11.3%) and constipation (19%). About 190 patients with single infections, 70% (132/190) experienced overt symptoms and 30% (58/190) had none. Table 3 indicates the prevalence of intestinal parasitic organisms in stools of the study subjects, with or without diarrhea. Infections with pathogenic protozoa included 24–27% asymptomatic infections. Protozoans regarded as non-pathogenic were associated with symptoms in 58–60% of cases. *Hymenolepis nana* produced symptoms in two of three cases. Fifty-five patients (10% of cases) were concurrently infected with 2–4 species of parasites. Among these, 22 patients experienced no symptoms. The remaining 33 patients with concurrent infections were symptomatic. In total, all parasitic agents was highly significant ($p=0.008$).

The age distributions of commonly detected

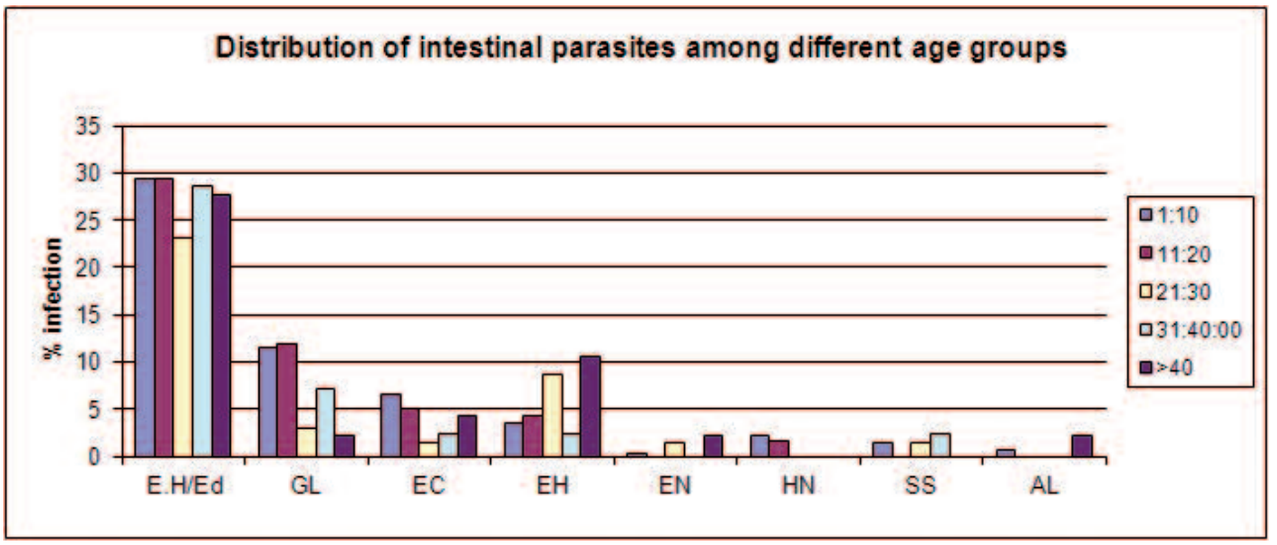

Fig. 2. Distribution of intestinal parasites among different age groups

protozoans and helminths are presented in Fig. 2. The greatest intestinal parasitic infection rate was found among the subjects in the first decade of life, 55.4% (179/232), while patients aged 21–30 years showed the lowest prevalence: (39.0%; 27/69). This observed difference in prevalence by age was not statistically significant ($p>0.05$). *E. histolytica/dispar* was found equally among individuals in all age groups while *G. lamblia* was most encountered among the subjects in the first two decades of life: 11.55% (37/323) and 11.8 (14/119). Helminth infection was found to be greater in the first decade.

The prevalence of infection with different intestinal protozoan and helminth parasites according to region is shown in Table 4. While the region with the greatest infection rate, 85.45% (94/110), was North Gaza, the lowest prevalence was observed among patients from Rafah, 36.7% (32/87). This difference was statistically significant ($p<0.05$).

Occupational prevalence showed that the infection rate was highest among farmers (56.0%), followed by employers (44.2%) while laborers showed the least prevalence (30.17%) of infection

Table 3. Relationship between diarrhea and patients infected with single species of intestinal parasites (n=190)

Type of parasite	Patients singly infected with parasite		
	With diarrhea n=132 (%)	Without diarrhea n=58 (%)	Total n=190 (%)
Pathogenic protozoa			
Entamoeba histolytica/dispar	92(73)	34(27)	126(66.3)
Giardia lamblia	19(76)	6(24)	25(13.1)
Non-pathogenic protozoa			
Entamoeba coli	9(60)	6(40)	15(7.9)
Entamoeba hartmanni	10(58.8)	7(41.1)	17(8.9)
Endolimax nana	3(0.6)	0	3(1.5)
Helminths			
Hymenolepis nana	2(66.7)	1(33.3)	3(1.5)
Strongyloides stercoralis	0	3(100)	3(1.5)
Ascaris lumbricoides	0	1(100)	1(0.5)
Multiple infections	33(60)	22(40)	55(28.9)

$c^2=24.031$, P=0.008

Table 4. Distribution of intestinal parasites among different region groups in Gaza Strip

Type of parasite	Locations of patients					
	Rafah 87 26(29.9)	Khanyouns 124 42(33.9)	Midzon 99 46(46.5)	Gaza180 68(37.8)	N-Gaza 110 63(57.)	P(value)
Pathogenic protozoa						
Entamoeba histolytica/ dispar n=171	14(16.1)	26(21.0)	30(30.3)	61(33.9)	40(36.4)	0.003
Giardia lamblia n=57	11(12.6)	11(8.9)	10(10.1)	6(3.3)	19(17.3)	0.002
Non-pathogenic protozoa						
Entamoeba coli n=31	2(2.3)	6(4.8)	10(10.1)	4(2.2)	9 (8.2)	0.02
Entamoeba hartmanni n=28	5(4.0)	5(5.1)	3(1.7)	11(10.0)	0.02	
Endolimax nana n=3	0	1(0.8)	0	0	2(1.8)	0.20
Helminths						
Hymenolepis nana n=9	0	0	2(2.0)	0	7(6.4)	0.001
*Strongyloides stercoralis*n=7	1(1.1)	0	1(1.0)	1(0.6)	4(3.6)	0.09
Ascaris lumbricoides n=3	0	0	1(1.0)	0	2(1.8)	0.176
Total*	**32(36.7)**	**49(39.5)**	**59(59.6)**	**79(43.9)**	**94(85.4)**	

with intestinal parasites (Table 5). This difference in occupational prevalence was found to be statistically significant ($p<0.05$).

Table 5. Prevalence of intestinal parasite infections among children due to father occupation, Gaza Strip

Type of parasite	600 patients (245 infected patients, 40.8%) due to father occupation				
	employer 265 117(44.2)	farmer 25 14(56)	labour 141 43(30.5)	un-employed 169 71(42)	P-value
Pathogenic protozoa					
Entamoeba histolytica/*dispar* n=171	86(32.5)	10(40.0)	26(18.4)	49(29.0)	0.014
Giardia lamblia n=57	25(9.4)	2(8.0)	12(8.5)	18(10.7)	0.922
Non-pathogenic protozoa					
Entamoeba coli n=31	18(6.8)	2(8.0)	4(2.8)	7(4.1)	0.22
Entamoeba hartmanni n=28	6(2.3)	3(12.0)	8(5.7)	11(6.3)	0.04
Endolimax nana n=3	0	1(4.0)	0	3(0.5)	0.01
Helminths					
Hymenolepis nana n=9	1(0.4)	11(12.6)	2(2.3)	4(4.6)	0.06
Strongyloides stercoralis n=7	2(0.8)	0	0	5(3.0)	0.07
Ascaris lumbricoides n=3	0	1(4.0)	0	2(1.2)	0.02
Total*	**138(52.1)**	**30(120)**	**52(36)**	**99(58)**	

Explanations: n – number of subjects infected with parasite; *total number of infected subjects is higher than 245, because a patient could be infected with more than one parasite species. Also, the total of percentage infection with different parasite types will exceed 100% for the same reason.

Discussion

The prevalence and epidemiological features of intestinal parasites vary in different parts of the world. For instance, the prevalence of *E. histolytica* ranges from 5% to 81% and is thought to infect approximately 480 million people globally [3]. In the present study, a total of 145 (40.8%) of the 600 examined patients were infected with one or more parasite, based on a single stool sample. This prevalence is different from previous reports, which have observed 28.9% [9], 24.5 % [14], 36.3% [15] and 48% [16]. The difference could be due to the type of patients examined. This study was based on patients referred to hospitals in all five governorates of the Gaza Strip, with or without signs and symptoms of diarrhea and abdominal pain. Other studies used either subjects from the rural community [9,17] or school children [16]. In addition, diagnostic methods varied from one study to another, and this could also be considered a possible reason for the disparity in the infection rates [7,17]. The prevalence rates given in reports from neighboring countries differ from our findings: 12.4% in Lebanon [18], 22.2% West Bank [19], 16.9% Jordan [20], 27% Egypt [21]. It seems that these differences can be attributed to a number of possibilities such as geographic and socioeconomic factors, climate, poverty, malnutrition, personal hygiene and population density, as well as the availability of potable water and sanitary facilities. These factors play a key role in determining the prevalence of any parasite [22].

Six types of intestinal parasites were detected during this study. The most common protozoan parasite detected was *E. histolytica/dispar* (28.5%) followed by *G. lamblia* (9.5%). Other studies found *G. lamblia* then *E. histolytica/dispar* to be the most common [21], others report *G. lamblia* then *E. coli* [23], *G. lamblia* [24–25] or *E. histolytica/dispar* [26]. In general, protozoan infections were found to be much common than helminth infection. Type variation could be attributed to the techniques used. The prevalences of *E. coli*, *E. nana* and *E. hartmanni* were 5.2%, 4.7%, 0.5%, respectively, and are considered nonpathogenic parasites with a worldwide distribution. This high prevalence rate may reflect the state of poor environmental sanitation in Gaza Strip. Detection of these non-pathogenic parasites in humans would suggest ingestion of contaminated water or food, and may indicate possible exposure to pathogenic organisms [27–28].

In this study, the prevalence of intestinal parasitic infections was slightly higher in females than males. Therefore, the sex predominance for parasitic infection is still not confirmed. Some studies report a higher rates in males [29–30], others in females [18, 31], and others report a similar rate in both sexes [32]. The infection may relate to the daily activity of the patients rather than sex.

However, the present study indicated that higher incidence rate was observed in individuals aged over 20 than those under 20. This result confirms those of many other studies in Gaza [22,33]. The findings of this study showed that the prevalence of *G. lamblia* was usually high during childhood and declined by age, but *E. histolytica/dispar* is by far the most common species in both male and female patients, as well as in adults and children. Although the younger age group was shown to be at a higher risk of infection of intestinal protozoa than the older age group, the risk of infection was the same for all ages. This is may be due to the environment and problems in social behavior.

In Gaza Strip regions, up to 76% of patients with G. *lamblia* and 73% with *E. histolytica/dispar* suffer from acute diarrhea and dysentery. In 1983, in the United States of America, *G. lamblia* was identified as the cause of 68% of waterborne outbreaks of diarrhoea [34]. The asymptomatic cases of *Entamoeba* are attributed to *E. dispar* infections [17]. A recent study in Gaza also identified *E. histolytica/dispar*, among other organisms, as major cause of acute diarrhoea in Palestinian children aged less than five years [35–36]. Three species of presumably non-pathogenic protozoa singly infecting 18.4% of patients were associated with symptoms. A host body, particularly if immune-compromised, will not be indifferent to the presence of foreign organisms, irrespective of their purported nonpathogenic status [37]. Awareness of the pathogenic potential of such “harmless” organisms such as *E. coli* and *E. hartmanni* has been detailed in previous studies [38–39]. The non-pathogenic status of these organisms is questioned in light of our findings. In the present study, the high prevalence of protozoan and helminth parasites may be associated with environmental contamination and the consequences of sewage directed to the sea without treatment.

The distribution of infection among the various regions of Gaza Strip was high in the north Gaza (57.3%) and Mid Zone (46.5%) which is considered a farming area. This prevalence of intestinal

parasites approximately agrees with the findings of other studies in the Gaza Strip [15]. However, statistical analysis showed that these differences in infection between regions were not significant ($p<0.05$).

The prevalence of intestinal parasites in reference to occupation given in this study showed that infection rate was highest among patients belonging to the family of a farmer (56%). This could possibly be due to the unhealthy practices of walking bare footed while farming and the rampant defecation in farm lands, which agreed with previous studies [11]. Laborers showed the lowest prevalence (30.2%) of infection with intestinal parasites. Theses differences in prevalence according to occupation were found to be statistically significant ($p=0.01$).

The implementation of such preventive strategies as health education or improving sanitation to reduce the risk of intestinal parasitic infections is highly needed in such areas. Launching awareness regarding parasitic diseases to the mothers, children and whole community should be one of the priorities for Palestine.

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