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Is Gaza Sandy Shoreline Region Contaminated with Human Gastrointestinal Parasites?

Ahmed H. Hilles[1] , Adnan I. Al Hindi[2,*] and Yousef A. Abu Safieh[3]

[1]Institute of Water and Environment, Al Azhar University ,[2]Department of Biology, Faculty of Science, The Islamic University of Gaza, P.O.Box 108, Gaza,[3]Ministry of Environment Affairs, Palestinian National Authority,Palestine

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Abstract

The study was implemented to test if the sandy shoreline of Gaza city is contaminated with human gastrointestinal parasites or not and to determine the types of intestinal parasites and the extent of contamination. A total of 104 sand samples (52 dry sand and 52 wet sand) were analyzed during the summer season period. Samples were collected from the study area of about 12km along the seashore region of Gaza City. Dry samples and wet sand samples were analyzed using water-sedimentation technique and a light microscope. The results showed that the percentage of the parasitic contamination was 40.4% of the wet sand samples and 34.6% of the dry sand samples along the shoreline region of the Gaza City. The human gastrointestinal parasites detected were the following: *Ascaris lumbricoides, S. stercoralis, E. vermicularis, E. histolytica/dispar, G. lamblia, E. coli* and *Taenia. spp*. The findings showed that there was no statistically significant difference in the concentration of parasitic contamination between the dry and wet sand samples at confidence level of p-value < 0.05. It is recommended to conduct a periodical routine sampling of sand at the swash zone because the results of this study showed that the wet and the dry sand may pose a high level of health risk. Residents should be informed clearly by posting signs indicating polluted areas to keep them safe.

Keywords: Sandy shoreline**,** Intestinal parasites**,** Contamination, Wastewater, Gaza city

1. Introduction

The population of Gaza City is about 552,000 (PCBS, 2011), and receives a water supply through the Coastal Municipalities Water Utility (CMWU) water supply system. High percentage of the wastewater that is generated in Gaza City is currently discharged without sufficient treatment into the sea in addition to the Wadi Gaza's wetland effluent channel for the raw sewage from refugee camps adjacent to the watercourse, estimated of about 6-8MLD (Hilles and Abu Amr, 2010).

The population of Gaza Strip continues to grow rapidly, which increase the amounts of poorly treated or untreated sewage being discharged into the coastal water. With the Palestinian population growth rate of around 4.8% per annum, which would result in a doubling of the population in 15 years, effective management and sustainable development of Gaza resources will be a huge challenge for the Palestinian Authority (UNEP, 2003).

In Gaza City, there is only one insufficient and inefficient wastewater treatment plant (GWWTP) which is considered to be the largest in Gaza Strip. Insufficient means that the quantity of the wastewater discharged from the city and arrived to the plant exceeds its capacity, while, inefficient means that the plant suffers from lack of maintenance and operational problems. GWWTP discharges about 50MLD of partially treated wastewater directly into the sea along with 10MLD of untreated wastewater (raw sewage) is currently discharged directly into the sea of Gaza City (EWASH, 2009).

The only study conducted in Gaza was the assessment of total coliform and faecal coliform in Gaza sea shore (Elmanama, 2004). The present study is the first one to assess the parasitic contamination of Gaza sea shore.

The lack of sufficient wastewater treatment facilities makes wastewater which discharges into the sea the main source of pollution of the coastal zone of Gaza Strip. There are more than 20 individual sewage drains, ending either on the beach or a short distance away in the surf zone. Insufficient number of sewage treatment plants in operation, combined with poor operating conditions of available treatment plants, and the present disposal practices are likely to have an adverse effect on the quality of seawater (EQA and UNEP, 2005).

The main aim of the current study is to examine if Gaza shoreline region is contaminated with human gastrointestinal parasites (identify them up to the species

* Corresponding author. e-mail: ahindi@iugaza.edu.ps.

level) and to determine the extent of parasitic pollution in the seashore sand..

2. Materials and Methods

2.1. The study area:

About 12km of Gaza City shoreline was divided into six sampling zones in order to facilitate the sampling process as it is shown in table 1 and Fig 1.

2.2. Sampling processes

Sampling were conducted throughout the summer season months (from June to October, 2011).During the study 500gm of sand were collected from every sample of the previously mentioned areas (Table 1 and Figure 1) of 2m², which were divided into five cores of 100gm taken from each corner of the sampling site and another one from the central part of the area within the superficial layer of the ground at an approximate depth of 5-10cm (Colli *et al*., 2010). The samples were stored in suitable plastic bags, and directly labeled and signed with special water-resistant pen. Dry sand samples were collected from non flooded areas (above high tide line) in the areas out of reach of seawater, and wet sand sample was taken from an intermediate area between the dry sand area and the seawater (Swash zone or Intermediate zone) where it was very close to the seashore and the seawater usually reach and moisten the sand in these sites, and where bathers could be found most of the time.

Table 1. Zones of Sampling and Related Information

Zone Symbol	Zone Boundaries	Zone length	Total number of samples	Number of samples	
				Wet Sand	**Dry Sand**
A	From Wadi Gaza to Al-Zahra City	1800m	**(24 Samples)** -First 5 samples every50m. -Second 5 samples every 250m.	12	12
B	Al-Zahra City to Al-Baydar resturant	2000m	**(10 samples)** -Every 500m	5	5
C	From Al-Byder restaurant to Khalel Alwazer mosque	1800m	**(12 samples)** - Sample every 300m.	6	6
D	From Khalel Alwazer mosque to the southern part of the Gaza marina	2500m	**(24 samples)** - Sample every 200m.	12	12
E	The basin of the Gaza marina	450m	**(8 samples)** -Every 100m.	4	4
F	From the northern part of the Gaza marina to the Intelligence Building	2800m	**(26 samples)** - Sample every 200	13	13
Total	**Study area**	**12km**	**104 samples**	**52**	**52**

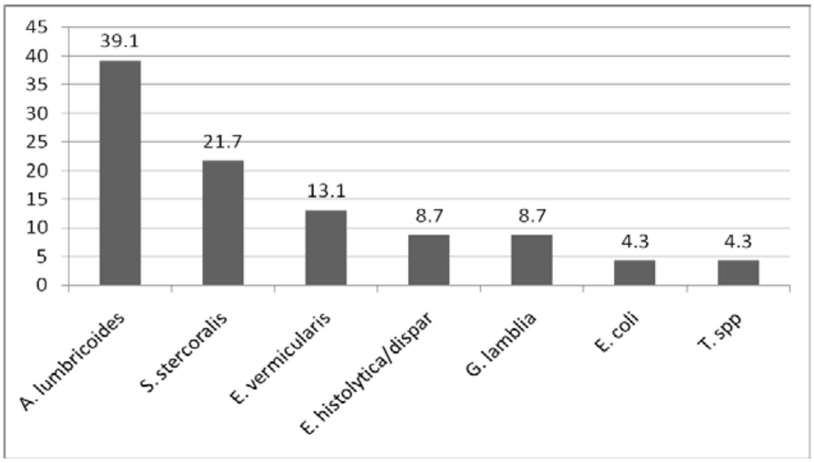

Figure 1. Distribution of the detected parasites in the dry sand within the six zones

2.3. Using water-sedimentation technique,

35gm of sand was diluted (washing gently for 15 sec) in 150 ml of distilled water, filtered through a sieve meshes (75µm) and allowed to settle for between six and eight hours in a suitable 250 ml measuring cylinder. Two ml of the surface of the cylinder (floated parasites in the upper part of the aqueous solution) were taken and discarding the rest of the supernatant, about eight ml of the stagnant sediment were collected, and the two amounts were centrifuged together to concentrate the sample by 1500 rpm for about 10 min and a concentrated sediment was collected (Colli et al., 2010).

The sand analysis process was completed by applying the following steps: One drop of the sediment was placed in the center of the slide. The drop was covered with a cover slip by holding the coverslip at an angle, touching the edge of the drop, and gently lowering the coverslip on top of the slide so that air bubbles are not produced. The slide was examined with 10X objective or, when needed for more identification, higher power objectives of the microscope have been applied in a systematic manner (either up and down or laterally) so that the entire coverslip area was surveyed. When organisms or suspicious objects were seen, switching to higher magnification was necessary to see more detailed morphology of the object in question. The sediment were stored in a labeled suitable tube which is known as opened rove (with a sharp bottom and snap cap) for further analyses and inspection.

3. Results

The present study showed a diversity of human gastrointestinal parasites in both dry and wet sand in Gaza sandy shoreline region.

The results of the dry and wet sand analysis for the entire study area (six zones = 52 samples) are shown in Table 2. Eighteen (34.6%) were found to be contaminated with human gastrointestinal parasites. It was found that 14 samples were contaminated by one type of parasites (single) and 4 samples were contaminated by several types of parasites (mixed).

For wet samples, 21 samples (40.4%) were contaminated by human gastrointestinal parasites: 18 samples were contaminated by one type of parasites (single) and 3 samples were contaminated by more than one species (mixed) of human gastrointestinal parasites as shown in Table 2.

Figure 1 shows that the dry sand samples were contaminated with seven species of human gastrointestinal parasites, distributed in order as follows: 39.1% *Ascaris lumbricoides,* 21.7% *S. stercoralis,* 13.1% *E. vermicularis,* 8.7% *E. histolytica/dispar*, 8.7 % *G. lamblia,* 4.3 % *E. coli* and 4.3 % *Taenia.* spp.

According to Figure 2, the results of contamination with parasites in dry sand according to the different six zones shows that zone (A) has the highest level of contamination with 44.4% of polluted samples, followed by 22.2% in zone (D), 22.2% in zone (B), 5.6% in zone (C), and finally 5.6% in zone (E). No parasitic pollution was detected in zone (F).

Figure 3 shows that wet sand samples were contaminated with six species of human gastrointestinal parasites and distributed as follows: 58.2% *S. stercoralis,* 25.0% *A. lumbricoides* and 4.2% for each of *E. histolytica*/*dispar*, *G. lamblia, E. coli* and *Taenia.* spp.

As illustrated in Figure 4, contamination with parasites in wet sand depending on the different six zones shows that zones (A) and (D) have the highest level of contamination with 28.6% for each zone, followed by 19.0% in zone (C), 14.3% in zone (B) and finally by 9.5% in zone (E). No parasitic pollution was found in zone (F).

The images of the human gastrointestinal parasites which have been recorded and identified in the samples from the six zones and all sampling sites are presented in Figure 5.

No statistical significant difference in the concentration of parasitic contamination between the dry and wet samples at a confidence level of a *p*-value < 0.05 was found (Table 3.).

Table 3 illustrates the results of a single factor one way-ANOVA test for the spatial variation in the parasitic contamination within the six different zones along the entire study area to examine whether there is a significant statistical difference in the contamination level through those zones and the level of significance. The results indicate that there is a significant variation among the zones within the confidence level of a *p*-value of < 0.05).

Table 3 shows a significant mean difference between the higher polluted zone (A) and the other zones. Also, there was a significant mean difference between uncontaminated zone (F) compared to the other zones using multiple comparisons (LSD) as a statistical analysis method.

Table 2. Percentage of Contaminated Dry and Wet Sand Samples

		Dry Sand		Wet Sand	
		No.	(%)	No.	(%)
Contaminated samples	Single	14		18	
	Mixed	4		3	
	Total contaminated samples	18	34.6	21	40.4
Uncontaminated		34	65.4	31	59.6
Total samples		52	100.0	52	100.0

Table 3. Statistical analysis done during the study

t-Test for the Means of the Dry and Wet Sand	Independent Samples Test				
	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.399	0.240	0.603	102	0.548
Equal variances not assumed			0.603	101.903	0.548

2. One way –ANOVA Test for the Parasitic Pollution within the Six Zones (A, B, C, D, E, F)

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	11.133	5	2.227	13.011	.001
Within Groups	43.467	254	.171		
Total	54.600	259			

3. Multiple Comparisons (LSD) for the Parasitic Pollution Within the Six Zones

(I) ZONE	(J) ZONE	Mean Difference (I-J)	Std. Error	p-value
A	B	.2300(*)	.09848	0.020
	C	-.1397	.09356	0.137
	D	-.1057	.07522	0.161
	E	-.2500(*)	.10681	0.020
	F	-.4500(*)	.07406	0.001
F	A	.4500(*)	.07406	0.001
	B	.6800(*)	.09736	0.001
	C	.3103(*)	.09238	0.001
	D	.3443(*)	.07374	0.001
	E	.2000	.10578	0.060

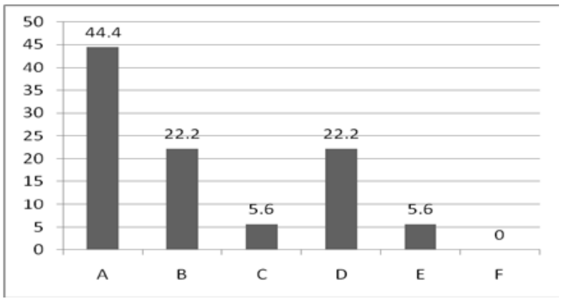

Figure 2. Percentages of contamination in dry sand according to the six zones

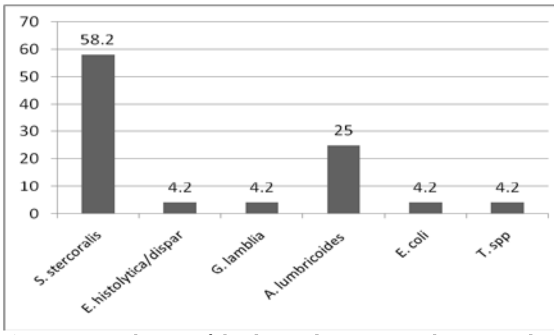

Figure 3. Distribution of the detected parasites in the wet sand within the six zones

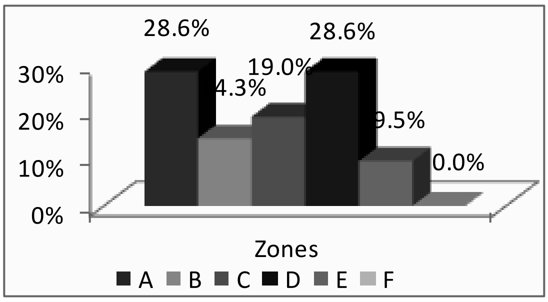

Figure 4. Percentages of contamination in the wet sand according to the six zones

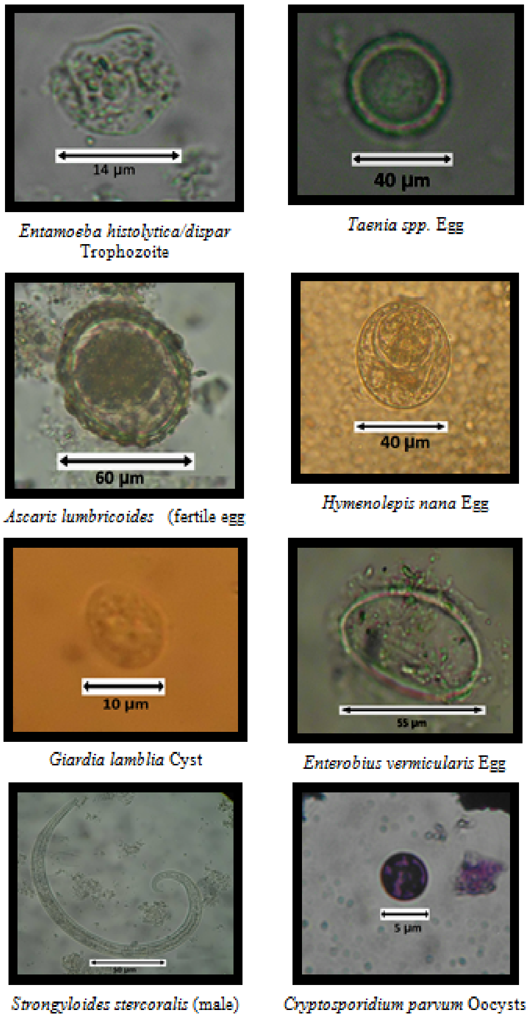

Figure 5. Images of Human Gastrointestinal Parasites

4. Discussion

The present study focused on the contamination of sandy shore of Gaza City, the detected human gastrointestinal parasites in the sandy shore considered as evidence of contamination. It is clear that the observed discharge points reach the sandy beach are the main source for the existence of the detected intestinal parasites where moisture and suitable temperature are available. Sandy soils represents an important source of human infection by parasites, due to their geological characteristics, being formed by sand particles with diameters ranging from 0.02 to 2 mm, and with the ability to retain water between the spaces of soil particles (Rocha *et al.*, 2011).

In the same regard it is very important to mention that since wastewater treatment plants in Gaza strip are partially active, so untreated sewage is discharged to the Mediterranean Sea directly. Fathers reach sandy beaches with their children where they are digging in the sand, not knowing they will be exposed to contaminate their hands with parasites, according to the OPAS 2002 report, it is estimated that two billion people in the world are infected by some form of parasites acquired through the contact with soil, 800 million of the infected are children (40%) (Da Silva *et al*., 2012).

Very little information exists concerning the presence of viruses and parasites in the beach sand. In a three-year study in Romania by Nestor *et al.* (1984), the incidence of parasites was found to depend on season, during non-vacation seasons no parasites being present in seawater and beach sand. In a study of two sand beaches in Marseilles, France, *Toxocara canis* was found to be the most common parasite, being present on average in 150 g of sand (Signorile *et al.*, 1992). However, in a study carried out on “dog beaches” in Perth, Australia, a total of 266 samples showed no traces of *Toxocara canis* eggs or other eggs/larvae of parasitic nematodes (Dunsmore *et al.*, 1984). It was emphasized in that study that the major risk to humans was from an environment in which puppies, not older dogs, were found. The presence of other parasites transmitted by water (Marshall *et al.*, 1997) that have not been investigated in recreational sand areas may be potentially significant.

The evidence of contaminated Gaza sandy shoreline region has been supported by many studies. Beaches represent the unconsolidated sediment that lies at the junction between water (oceans, lakes and rivers) and land and are usually composed of sand, mud or pebbles. From a recreational viewpoint, sand beaches should be clear and healthy. Especially in higher latitudes, a significant percentage of time is spent on the beach itself rather than in the water. Microorganisms are a significant component of the polluted beach sand. Bacteria, fungi, parasites and viruses have all been isolated from polluted beach sand. A number of genera and species that may be encountered through contact with sand are potential pathogens. Accordingly, concern has been expressed that beach sand or similar materials may act as reservoirs or vectors of infection (Nestor *et al.*, 1984; Roses *et al.*, 1988; Mendes *et al.*, 1997) although transmission by this route has not been demonstrated in epidemiological studies.

The prevalence of parasites in wet sand (swash zone) may attribute to the nature of the sand which act as filter and cumulative tool, but the prevalence of parasites in the dry sand may be attributed to the tidal action, when seawater cover the dry sand the parasites remain in the dry sand.

As mentioned, wastewater effluent may transport faecal-associated microorganisms such as parasites, which are implicated in thousands of illnesses each year among people who consume contaminated shellfish (Burkhardt and Calci, 2000; Shieh *et al.*, 2000). There is a substantial need for better detection and identification of wastewater influences on coastal systems to inform bathers and fisheries management and protect public health (Randall, 2003; Savage, 2005).

The situation of random discharge points of sewage exists since decades, only four WWTPs present in Gaza Strip, the situation of contamination sandy beach will be worse in case of no municipal or environmental actions were taken.

The cycle of parasitic diseases still exist in Gaza Strip, and could be found within infected human, some animals, contaminated food, polluted environments and unsuitable drinking water reservoirs. Additionally, many reported literatures were carried out in Gaza Strip confirm the endemicity of the human gastrointestinal parasites is in one of the most crowded and overpopulated area in the world. Yassin *et al*. (1999) reported that the prevalence of intestinal among school children which was 27.6%.

In a study carried out by Kanoa (2006) the impact of health education programmer's intervention on the prevalence of intestinal parasites among school children in Gaza city, Beit-lahia villages and Jabalia refugee camp "Gaza Strip" were examined for 6 months. The rule of health education in decreasing prevalence of intestinal parasitic infection was statistically significant (P= 0.001). A comparison study was carried out between two regions in Gaza strip, it was found that Prevalence of intestinal parasites was high in Jabalia village (more than 53%) in comparison to Rimal area 33% (Al Agha and Teodorescu, 2002). A house hold survey included 1000 individuals from all ages was conducted in Biet-lahia, Palestine It was found that (72.9%) of examined individuals were infected with different types of intestinal parasites (Al-Zain and Al Hindi, 2005).

These studies confirm the source of intestinal parasites from decades and continue to exist from the infected hosts to the sewers which find its way to the shoreline region.

5. Conclusion

It is concluded that the prevalence of parasites in wet sand is higher than in adjacent dry sand, as the wet sand behaves as a passive harbor for cumulative pollution.

6. Recommendations

It is recommended that contaminated areas should be identified and residents should be aware of such risk which is a result of the contamination of sandy Gaza sea shore, and the multiple discharge point should be grouped into one.

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