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Prevalence and Associated Risk Factors of Intestinal Protozoa and Parasites Among Food Handlers in Ibb City, Yemen

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Abstract

Background and objectives: *Food handlers are crucial in the spread of food-borne illnesses, which are a serious global public health concern. This study looked at the incidence of intestinal protozoa and parasites in food handlers in Ibb City, Yemen, as well as risk factors for infection.*

Subjects and methods: *Three hundred and fifteen food handlers, ages ranging from 14 to 65, participated in a cross-sectional survey. Each person was employed at an Ibb City restaurant, cafeteria, or school buffet. The information was gathered using a pre-tested, standardized questionnaire. Using conventional laboratory procedures, stool samples were examined for intestinal parasites.*

Results: *This research comprised 315 food employees in Ibb City over the course of a 12-month period; their ages ranged from 14 to 65, with a mean ± SD age of 31.2 ± 11.9 years. Intestinal protozoa were found to be 20% common, of which 15.6% were Entamoeba histolytica, 12.1% were intestinal Ascaris lumbricoides, 4.4% were Hymenolepis nana, and 3.2% were Schistosomia mansoni. The frequency of intestinal parasites (IPs) in food handlers was substantially correlated with the following factors: not receiving food hygiene training (OR=1.67), not getting regular checkups (OR=8.4), not washing hands frequently (OR=2.8), being unskilled (OR=1.8), and having poor personal hygiene practices (OR=2.1).*

Conclusion: *In particular, the pooled prevalence of IPs was quite high with Giardia lamblia, Entamoeba histolytica, and Ascaris lumbricoides. Risk variables substantially linked to the occurrence of IPs were hand washing behaviors, periodic medical checkups, and food handlers without proper training in food hygiene. Food-borne illness transmission is facilitated by untrained and unhygienic food handlers. Food handlers should get training on food safety from local health authorities, and human waste disposal should be improved. Food handlers should also undergo focused medical examinations on a regular basis.*

Keywords*: Food handlers, intestinal protozoa, intestinal parasites, Ibb city, Yemen.*

Introduction

Ingestion of pathogenic microorganisms (bacteria, fungus, viruses, and parasites) or their toxins (bacteria and fungi) can result in food-borne disorders [1,2]. Ebola epidemics have the potential to cause financial and health damages. The World Health Organization (WHO) [3] estimates that food contamination causes 600 million serious illnesses and 420,000 deaths globally each year. An estimated 48 million Americans contract food-borne diseases annually in the US, leading to 128,000 hospital admissions and 3,000 fatalities [4,5]. According to projections, food-borne and waterborne diseases also result in over 700,000 fatalities annually in Africa [6] and cause a variety of long- and short-term disorders, including tissue damage, cancer, kidney or liver failure, brain problems, and neurological disorders, in addition to short-term symptoms including nausea, vomiting, and diarrhea. Worldwide, intestinal parasite infections are common; however, in less developed countries, the prevalence is higher because of factors such as inadequate personal cleanliness, unsanitary environments, socioeconomic status, demographics, and health-related practices [7]. Intestinal parasite infections can pass from person to person by fecal-oral contact, although contaminated food and water are the most prevalent means of transmission [8]. Approximately one-third of the world's population is infected with intestinal parasites, with the tropics and subtropics having the highest burden [9].

Globally, the number of cases of *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, *Entamoeba histolytica*, and *Giardia lamblia* infections is estimated to be 1.2 billion, 795 million, 740 million, 500 million, and 2.8 million [10,11]. In Yemen, intestinal parasites, or IPs, are quite prevalent. Thus, among the Arabic countries, Yemen has one of the highest incidences of ascariasis and trichuriasis, respectively [12–18].

Food handlers are those who work in the food preparation and serving industry. If they have bacterial or parasite diseases in their gastrointestinal tract and maintain poor personal hygiene, they may pose a major risk of spreading IPs to the general public. Food handlers who are afflicted with enteric bacterial infections (EBIs) and IPs face difficulties in the integrated control and elimination of infections, as they are asymptomatic carriers and show subclinical symptoms [8]. As a result, they are ignorant of their potential contribution to the spread of illness. Food handlers can also directly or indirectly spread infections to a large number of food and drink consumers in food service establishments, such as restaurants, hotels, factories, canteens, schools, hospitals, prisons, or other locations where food is prepared and served to a variety of users [19, 20] and this has a significant impact on the spread of IPs and EBIs.

The availability of clean water, the capacity of pathogenic parasites and bacteria to survive in a range of environmental settings, and public and personal hygiene practices are additional factors that considerably contribute to the spread of IPs and EBIs in addition to socioeconomic issues [12,21]. Yemen is one of the nations with the lowest rates of both toilet usage and access to clean water [12,17]. Yemen studies on personal hygiene factors such as washing hands after using the restroom, medical cheek examinations including stool exams, eating raw meat and vegetables, washing hands before handling food and meal, finger nail status, food hygiene training, and knowledge of enteric parasites and bacteria were found to have an impact on the prevalence of IPs and EBIs among the community and food handlers [14,22,23].

Al-Ghaithi *et al.*'s recent study [23] is the only one to date that looked into the prevalence of intestinal parasite infections among food handlers in Yemen. Numerous researches on the prevalence of intestinal parasite infections in Yemeni general populations have been carried out, however the findings have been inconsistent and indicate a significant incidence of intestinal protozoa and parasite infections [12-18,24]. Therefore, this study's goal was to present verifiable data regarding the overall prevalence and risk factors for intestinal parasitic infections among food handlers. Additionally, the findings of this study may have a substantial impact on policy makers, users, and healthcare practitioners.

Subjects and Methods

Study population: This cross-sectional study was conducted from 1-2-2019 to 1-2-2020, during the course of a calendar year. Three hundred and fifteen food handlers, ranging in age from 14 to 65, were included. Each person was employed at an Ibb City restaurant, cafeteria, or school buffet.

Sample size: The following factors were taken into account when calculating the sample size in Epi Info 6 version 6.04: There were 5000 people in the population from which the sample was taken. The factor was projected to occur 5% of the time. With a 99% confidence level, if the population's true rate is 5% and the lowest allowable rate is 1%, the sample size should not be less than 302 people. To achieve more accurate findings, the number was raised to 315.

Data collection: Every person under study had their complete medical history, demographic information, and risk factors for infection collected; the results were entered into a pre-made questionnaire. Name, age at study, sex, place of residence, employment status, personal hygiene habits, history of typhoid, intestinal parasite and protozoa infections, and other information were among the data gathered, also it includes the stool investigation laboratory results.

Laboratory methods

Collection and transferring stool samples: Stool specimens were collected from food handlers in Ibb city. Specimens were collected in sterile screw caped containers. Then prepared for microscopic examination.

Microscopically: Each fresh sample were examined microscopically for cysts and Trophozoites of *Entamoeba histolytica*, and *Giardia lamblia by* using a saline and trachoma stain and examined specimens by concentration method for cysts of *Entamoeba histolytica*, and *Giardia lamblia* and intestinal helminthes [25].

Ethical consideration: Consents were taken from all the participants and the participants were informed that participation is voluntary and that they can refuse without giving any reason.

Results

The ages of the food handlers that were examined ranged from 14 to 65 years old; the majority of the participants fell into the 20–29 age group (40%) and the 30-39 age group (32.2%). Table 1 shows that the tested food handlers' mean age ±SD was 31.2 ± 11.9 years.

Table 1: Age distribution of the food handlers whom tested for intestinal parasitic in Ibb city - Yemen.

Age groups	Total (n =315)	
	No.	%
< 20 years	31	9.8
20-29 years	126	40
30 -39 years	95	30.2
≥ 40 years	63	20
Mean Age	31.2 years	
SD	11.9 years	
Min	14 years	
Max	65 years	

The majority of people (46.3%) only completed primary school, with illiteracy coming in second (30.2%), but only 13% and 10.5% of people completed secondary school or above (Table 2).

Table 2: Educational distribution of the food handlers whom tested for intestinal parasitic in Ibb city - Yemen.

Educational_level	Total (n =315)	
	No.	%
Illiterate	95	30.2
Primary School	146	46.3
Secondary	41	13
Higher	33	10.5

Intestinal protozoa were found in 20% of cases; Entamoeba histolytica was found in 15.6% of cases, Giardia lamblia in 4.4% of cases, trophozoites in 3.5% of cases, and cysts in 4.4% of cases (Table 3).

Table 3: The prevalence of intestinal protozoa among 315 food handlers in Ibb city, Yemen

Protozoa	frequency	
	Number	percentage
Entamoeba histolytica Trophozoites Cysts	49/315 4/315 48/315	15.6 1.3 15.2
Giardia lamblia Trophozoites Cysts	14/315 11/315 14/315	4.4 3.5 4.4
Total	63/315	20

Ascaris lumbricoides accounted for 12.1% of the total intestinal parasite prevalence, followed by *Hymenolepis nana* (4.4%) and *Schistosoma mansoni* (3.2%) (Table 4).

Table 4: The prevalence of intestinal parasites (helminthes) among 315 food handlers in Ibb city, Yemen

Parasites	frequency	
	Number	percentage
Ascaris lumbricoides	38/315	12.1
Hymenolepis nana	14/315	4.4
Schistosoma mansoni	10/315	3.2
Total	62	19.7

210 (66.7%) food handlers reported that they merely wash their hands with water after using the restroom. Only 189 (or 60%) food workers, however, made it a habit to wash their hands with soap and water after using the restroom. But fewer food handlers (49.8%) reported that they always wash their hands after handling unclean objects and after touching their nose, ears, and hair. Merely 31 individuals, or 9.8%, had previously undergone a medical examination that included a stool examination.

Table 5: The association of intestinal protozoa infections with different age groups of food handlers.

Age groups	Intestinal protozoa (n=63)		OR	CI	χ^2	*Pv*
	No.	%				
< 20 years (n=31)	11	35.5	2.45	1.1-5.8	5.2	0.02
20-29 years (n=126)	35	27.8	2.2	1.2-4.1	7.9	0.004
30 -39 years (n=)95)	10	10.5	0.37	0.17-0.8	7.6	0.005
≥ 40 years (n=63	7	11.1	0.44	0.21-1.1	3.9	0.04
Crude rate (n=315)	63	20	-			
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, $\chi 2$: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Table 6: The association of intestinal parasites infections with different age groups of food handlers.

Age groups	Intestinal parasites (n=62)		OR	CI	χ^2	*Pv*
	No.	%				
< 20 years (n=31)	8	25.8	1.4	0.6-3.5	0.64	0.42
20-29 years (n=126)	32	25.4	1.8	1-3.2	4.3	0.037
30 -39 years (n=95)	16	16.8	0.77	0.39-1.49	0.69	0.4
≥ 40 years (n=63)	16	25.4	1.52	0.85-2.29	1.63	0.2
Crude rate (n=315)	62	19.7	-			
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, $\chi 2$: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Table 7 shows that 210 (66.7%) food handlers received certification for their food handling and preparation training. 20% of the sites utilized tank water, whereas 80% of the sites used tape water when we looked at the sources of water use in the restraints.

Table 7: The frequency of hygienic practices of food handlers.

Variables	Frequency	
	No.	%
Certified in food training Yes	210	66.7
No	105	33.3
Hand washing after toilet by water only Yes	189	60
No	126	40
Hand washing after toilet by soap Yes	60	20
No	252	80
Hand washing after touching dirty materials Yes	157	49.8
No	158	50.2
Touching body parts during food handling Yes	221	70.2
No	94	29.8
Medical check up Yes	31	9.8
No	284	90.2

60% of those handling food were dressed specifically for handling it, and 40% did not follow the 79% of participants who reused plastic tools. Just 6 (1.9%) of the food handlers had ever experienced typhoid disease (Table 8).

Table 8: The frequency of risk factors that affect spread of protozoa and parasitic infections.

Variables	Frequency	
	No.	%
Source of water Tape water	252	80
Tank water	63	20
Wearing food clothes Yes	189	60
No	126	40
Reuse plastic tools Yes	249	79
No	66	21
Past History of typhoid Yes	6	1.9

The relevance of related factors for intestinal protozoa infections in food handlers is displayed in Table 9. The absence of food training certification, hand washing without soap after using the restroom, and medical check-ups were significantly linked to the risk of developing IPs (Table 9).

Table 9: The significance of associated factors of intestinal protozoal infections among food handlers.

Variables	Intestinal Protozoa (n=63)		*OR*	*CI*	χ^2	*Pv*
	No.	%				
Certified in food training 1-Yes (n=210)	36	17.1	0.6	0.33-1.09	3.2	0.07
2-No (n=105)	27	25.7	1.67	1-3.1	3.2	0.07
Hand washing after toilet by water only 3-Yes (n=189)	36	19.1	0.57	0.32-0.99	4.5	0.03
4-No (n=126)	27	21.4	1.2	0.64-2.1	4.5	0.03
Hand washing after toilet by soap 5-Yes (n=63)	6	9.5	0.36	0.13-0.9	5.4	0.02
6-No (n=252)	57	22.6	2.8	1-7.6	5.4	0.02
Hand washing after touching dirty materials 7-Yes (n=157)	28	17.8	0.76	0.42-1.38	0.92	0.33
8-No (n=158)	35	22.2	1.3	0.73-2.4	0.92	0.33
Touching body parts during food handling 9-Yes (n=221)	51	23.1	2.1	1-4.3	4.4	0.03
10-No (n=94)	12	12.8	0.49	0.23-1.01	4.4	0.03
Medical check up 11-Yes (n=31)	1	3.2	0.12	0.01-0.84	6.05	0.01
12-No (n=284)	62	21.8	8.4	1.2 -168	6.05	0.01
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, χ2: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Table 10 presents the correlation between intestinal protozoal infections in food handlers and the parameters connected to water supply, wearing food-grade clothing, and using reusable plastic tools.

Table 10: The significance of associated factors related to source of water, wearing food clothes and used of reused plastic tools with intestinal protozoal infections among food handlers.

Variables	Intestinal Protozoa (n=63)		*OR*	*CI*	χ^2	*Pv*
	No.	%				
Source of water 1-Tape water (n=252)	42	16.7	0.4	0.21-0.7	8.75	0.003
2-Tank water (n=63)	21	33.3	2.5	1.3-4.9	8.75	0.003
Wearing food clothes 3-Yes (n=189)	32	16.9	0.65	0.4-1.13	2.78	0.095
4-No (n=126)	29	23	1.4	0.75-2.5	2.78	0.095
Reuse plastic tools 5-Yes (n=249)	48	19.3	0.81	0.4-1.62	0.39	0.53
6-No (n=66)	15	22.7	1.23	0.61-2.5	0.39	0.53
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, χ2: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Protozoal infections were significantly associated with the tank water supply. The importance of risk variables for intestinal parasite infections in food handlers is displayed in Table 11. Among these risk factors, a lack of medical examination was found to be significantly connected with intestinal parasite infection.

Table 11: The significance of associated factors of intestinal parasite infections among food handlers.

Variables	Intestinal Parasites (n=62)		OR	CI	χ^2	*Pv*
	No.	%				
Certified in food training Yes (n=210)	38	18.1	0.89	0.4-1.6	0.16	0.68
No (n=105)	24	22.9	1.34	0.72-2.4	1.0	0.31
Hand washing after toilet by water only 1-Yes (n=189)	36	19.05	0.86	0.48-1.6	0.27	0.60

2-No (n=126)	26	20.6	1.1	0.6-1.9	0.27	0.60
Hand washing after toilet by soap 3-Yes (n=63)	8	12.7	0.52	0.22-1.22	2.58	0.1
4-No (n=252)	54	21.4	1.64	0.72-3.81	2.58	0.1
Hand washing after touching dirty materials 5-Yes (n=157)	27	17.2	0.7	0.4-1.27	1.54	0.21
6-No (n=158)	35	22.2	1.3	0.73-2.4	0.92	0.33
Touching body parts during food handling 7-Yes (n=221)	48	21.7	1.46	0.8-2.9	1.37	0.24
8-No (n=94)	14	14.9	0.61	0.3-1.23	2.2	0.13
Medical check up 9-Yes (n=31)	1	3.2	0.12	0.01-0.84	6.1	0.01
10-No (n=284)	61	21.5	4	1-24.7	3.94	0.04
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, χ2: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Table 12: The significance of associated factors related to source of water, wearing food clothes and used of reused plastic tools with intestinal parasite infections among food handlers.

Variables	Intestinal Parasites (n=62)		*OR*	*CI*	χ^2	*Pv*
	No.	%				
Source of water 1-Tape water (n=252)	44	17.5	0.53	0.27-1.05	3.94	0.04
2-Tank water (n=63)	18	28.6	1.89	1-3.7	3.94	0.04
Wearing food clothes 3-Yes (n=189)	35	18.5	0.80	0.44-1.46	0.6	0.44
4-No (n=126)	27	21.4	1.2	0.7-2.1	0.4	0.52
Reuse plastic tools 5-Yes (n=249)	46	18.5	0.71	0.35-1.43	1.1	0.29
6-No (n=66)	16	24.2	1.4	0.7-2.8	1.1	0.29
OR: odds ratio ≥ 1 (risk), CI: Confidence intervals 1 to more than 1, χ2: Chi-square ≥ 3.9 (significant), Pv: Probability value ≤ 0.05 (significant)						

Discussion

Food-borne parasite and enteric bacterial infections are serious global public health issues that can lead to morbidity and mortality, particularly in developing nations such as Yemen [12–18]. As crucial as hygienic food preparation and delivery are food handler education programs and personal cleanliness. On many different levels, this group of people handles, stores, transports, processes, and prepares food for consumers. It is helpful for stakeholders and governmental and nonprofit policymakers to know the precise pooled prevalence of intestinal parasite (IP) infections among Yemeni food handlers in order to control food-related disorders [23].

Intestinal protozoa were present in 20% of the research participants overall. Table 5 shows that the frequency of intestinal Entamoeba histolytica was 15.6%, with only 1.3% of cases showing cysts and 15.2% showing trophozoites. Nonetheless, there was a 4.4% low frequency of Giardia lamblia among food workers. The overall prevalence of intestinal protozoa among food handlers in our study was lower than that reported by Abera *et al.* in Bahir Dar Town, Ethiopia, where 6.5% of food handlers had intestinal protozoa [27], but similar to a previous study conducted at Gondar town (20.1%) in North West Ethiopia [26]. The high incidence of intestinal protozoa is linked to inadequate personal hygiene habits and unsanitary surroundings. *E. histolytica* and *G. lamblia* active trophozite forms have been linked to diarrheal food handlers. Because *G. lamblia* cysts do not require environmental maturation, food handlers who are infected with the parasite can directly infect customers through contaminated food and water [25]. Additionally, food handlers infected with Giardia lamblia were revealed to be a conduit for the *Giardia* outbreak in commercial food establishments by Mintz *et al.* [28]. Food handlers should therefore be in good health, and those who have diarrhea should not be allowed to return to work until their symptoms have entirely disappeared following treatment. This study found that the majority of food handlers in the kitchens were very young adults in the age groups of 20 to 29 years (40%) (table 1), and that the majority had little experience and low educational levels, with the majority only having completed primary school (46.3%) or being illiterate (30.2%) (Table 2), which is consistent with earlier research conducted in developing nations [27,29-31].

With a pooled incidence of 12.1%, *Ascaris lumbricoides* was the most common intestinal parasite in the current study (Table 4). This was in line with the results of a related study that was carried out in Ethiopia [35], South Africa [33], Nigeria [34], and South Asia [32]. The high frequency of *A. lumbricoides* observed in this study may be explained by several factors, including the high degree of environmental contamination brought on by a large number of infected individuals, the resilience of Ascaris eggs in a variety of settings, high fertility, and the sticky texture of the Ascaris egg shell, which facilitates the parasite's attachment to hands, fruits, and vegetables.

In contrast to food handlers who had received food hygiene training, those who had not received it were 1.67 times (OR) (Table 9) more likely to have intestinal protozoa. Other research carried out in Yemen by Baswaid and Al-Haddad [36] and in Ethiopia by Abera *et al.* [27], Nigusse *et al.* [23], and Gizaw *et al.* [37] also support it. This may be because there are disparities in the number of safety-focused organizations, businesses tend

to hire food handlers without requiring a health certificate as a fundamental requirement, and food handlers in other study areas receive lower monthly wages (paid). In Table 9, the likelihood of intestinal protozoa (IPs) was 8.4 times (OR) with CI=1.2-168, p=0.01 greater in food handlers who skipped a medical visit compared to those who did. It is consistent with research done in Ethiopia by Marami *et al.* [38]. Thus, in order to lower the incidence of IPs among themselves and their clientele, it is preferable for Yemeni food handlers to update their medical certifications every three months. When food handlers did not wash their hands with soap before handling food, the odds (OR) of having IPs were 2.8 times greater (CI=1.1-7.6, p=0.02) than when they did (Table 9). According to research done in Ethiopia by Tegen *et al.* [39], Nigeria by Amuta *et al.* [40], Indonesia by Pasaribu *et al.* [41], and Cameroon by Tchakounté *et al.* [42], this result was consistent. Effective hand washing practices may be the cause of this, as they break the IP chain of transmission. Our study's evaluation of hand washing habits produced a range of findings. 210 (66.7%) food handlers always washed their hands under running water after using the restroom. Only 189 (or 60%) food workers, however, made it a habit to wash their hands with soap and water after using the restroom. Our findings concurred with earlier reports from Ethiopia and India [26,27,31]. Less people, nonetheless, followed up with hand washing after handling unclean objects and various body areas before handling food. These demonstrated that food handlers are ignorant of the risk of food contamination from inadequate hygiene procedures. To guarantee food safety throughout processing, preparation, and storage at food services enterprises, health education interventions on food safety and cleanliness must be strengthened.

Limitation of The Study

The current study did not account for other bacterial and viral infections that could be spread from restaurant employees to patrons from the community, despite the numerous recent studies that examined food-borne illnesses, gastrointestinal infections, bacterial infections, and protozoa in the digestive system in Yemen. As such, these limitations must be considered in this investigation. We suggest doing a more systematic evaluation of several approaches to investigate this health issue, including the use of infectious diseases that have been tested among food handlers and other groups in Yemen in the past.

Conclusions

In particular, the pooled prevalence of IPs was quite high with *Giardia lamblia*, *Entamoeba histolytica*, and *Ascaris lumbricoides*. Risk variables substantially linked to the occurrence of IPs were hand washing behaviors, periodic medical checkups, and food handlers without proper training in food hygiene. Educating food handlers on personal hygiene practices and the need for routine medical examinations for IPs might be a suitable course of action. The results highlight the possibility that food workers carrying distinct dangerous bacteria could put customers at serious risk for health problems. Therefore, it is advised to control intestinal protozoa infections and intestinal parasitic infections in food handlers through ongoing epidemiological surveillance, biannual routine parasitological testing, treatment of infected cases, and improved environmental sanitation.

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Conflict of Interest

No conflict of interest associated with this work.

Author Contributions

This research is part of a master's degree in the Department of Medical Microbiology, the second author, who conducted field work, and who did laboratory work and other authors contributed to data analysis, drafting and review of the paper, and gave final approval to the research.

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