

Prevalence of intestinal parasitic infections and their relation with socio-economic factors and hygienic habits among workers from high end hotels in Nairobi Kenya

Saadia Adan Ibrahim[1@], Simon Karanja [1], Yeri Kombe[2]
[1]College of Health Sciences, Jomo Kenyatta University of Agriculture and Technology, off Thika Road, P.O. Box 103122 - 00101, Nairobi, Kenya;
[2]Centre for Public Health Research, Kenya Medical Research Institute (CPHR-KEMRI) Kenyatta National Hospital Complex off Ngong Road, P.O. Box 20752 - 00202, Nairobi, Kenya
[@]Email of corresponding author: brhmsaadia@gmail.com

ABSTRACT

Background: Intestinal parasite infections are major public health problems of majorly among children contributed in part by the adults in developing countries. Food handlers play a critical role in the spread of disease globally. Food contamination may occur at any of the stages including; production, processing, distribution, and preparation. The risk of food contamination therefore depends largely on the health status of the food handlers, their personal hygiene, knowledge and practice of food hygiene.

Method: This cross sectional study was nested within the KEMRI routine medical examination and certification of food handlers from various eateries and food industries in Nairobi Kenya between 2015 and 2016. Structured questionnaire was used to collect socio demographic data and associated risk factors. Stool samples were collected and examined for intestinal parasites using single Kato-Katz and single Sodium acetate-acetic acid-formalin (SAF) solution concentration methods.

Result: A total of 298 food handlers were enrolled in the study. The majority of study participants were males (58.4%), aged between 21 to 30 years (59.4%), had secondary level of education (41.6%), 46% were currently married, had between 1 to 3 children (74.6%) and used pipped water for domestic purposes (68.1%). About 43 (14.4%) of food handlers were found to be positive for different intestinal parasites with the most abundant parasite of *Entameoba histolytica* 30 (69.8%) followed by *Iodamoeba butschlii* 7(16.3%), *Giardia lamblia* 4 (9.3%), *Endolimax nana* 1 (2.3%) and *Trichomonas hominis* 1 (2.3%). Consumption of borehole water (OR 2.2, 95% CI 1.2 to 4.1) and general personal hygienic characteristics such as hand washing before eating (OR 0.5, 95% CI 0.2 to 0.9), after using toilet (OR 0.1, 95% CI 0.02 to 0.5), cooking (OR 0.1, 95% CI 0.02 to 0.6) and wearing of protective gears (OR 1.7, 95% CI 1.1 to 6.4) were associated with intestinal parasitic infection.

Conclusion: The present study revealed a high prevalence of intestinal parasite in asymptomatic (apparently healthy) food handlers working in various eateries and food industries in Nairobi Kenya and that water quality and personal hygiene contribute significantly to parasitic infection. Such infected food handlers can contaminate food, drinks and could serve as source of infection to consumers via food chain.

Keywords: Intestinal parasites, Food handlers, eateries/hotels and food industries, Nairobi Kenya

BACKGROUND

Infections caused by intestinal parasites and protozoan are widespread causing significant problems in individuals and public health, particularly in developing countries, with a prevalence rate of 30-60% (Saab *et al*., 2004). The helminths; *Taenia saginata, Hymenolepis nana, Ascaris lumbricoides, Strongyloides stercoralis, Trichuris trichiura, Enterobius vermicularis* and hookworms and the protozoans Giardia *lamblia* and *Entamoeba histolytica* are the major intestinal parasites leading to digestive disorders (Cheesbrough, 2009). Intestinal parasites are transmitted either directly or indirectly through food, water or hands highlighting the importance of fecal-oral human-to-human transmission (Zaglool *et al*., 2011).

The spread of disease by food handlers is a common and persistent problem globally (Zain *et al*., 2002; Sharif *et al*., 2015). Food handlers with poor personal hygiene working in the food service settings can be infected by different enteropathogens (Takalkar *et al*., 2010), where they can cause fecal contamination of foods by their hands during food preparation, and which may be transmitted to the public (Sharif *et al*., 2015). Therefore, a proper screening procedure for food handlers is helpful in the prevention of probable morbidity and the protection of consumer health.

Various prevalence has been reported; In Ethiopia, 45.3% of food handlers were found to be positive for different intestinal parasites (Aklilu *et al*., 2015). In Sudan, 29.4% of food-handlers were harboring intestinal protozoa (Babiker *et al*., 2009). In Iran intestinal parasites were found in 15.5% food handlers (Sharif *et al*., 2015). None of the food-handlers were found positive for protozoan cysts and helminthic ova in Mangalore, India (Solanki *et al*., 2014). In Kenya, intestinal parasitic infections among food handlers ranging 5 to 23.7% have been reported (Onyango *et al*., 2009; Biwott *et al*., 2014).

Reports indicates, food-handlers working in hotels, hostel mess and other catering services personal hygiene and sanitation conditions are the major potential sources of intestinal helminths and protozoa from many developed and developing countries all over the world (Takizawa *et al*., 2008; Nyarango *et al*., 2008; Zaglool *et al*., 2011; Aklilu *et al*., 2015).

Nairobi has one of the highest numbers of eateries (hotels, hostel mess and other catering services) in Kenya. Most of food handlers from these eateries have an agreement with Kenya Medical Research Institute for their medical examination and certification program. At the time of this study, well over 70,000 eateries had enrolled into this program. Unfortunately, data is skewed on the epidemiology of intestinal parasites among these eateries in the KEMRI program. This study is among the now growing reports documenting prevalence and correlates of parasitic infections among food handlers in the capital city of Kenya.

METHODS

Study design and Settings

Cross-sectional study was designed from December 2015 - January 2017 to determine the magnitude and patterns of intestinal parasitism in Nairobi County, the capital city of Kenya.

Nairobi county is bordered by three other major counties namely: Kajiado, Machakos and Kiambu Counties. The county is divided into eight sub counties, namely; Dagoretti, Kibera, Central, Westland, Makadara, Pumwani, Kasarani and Embakasi. The population of county is among those in Kenya consistently on the rise from below 120,000 people in 1948 to about 3.2 million people in 2009. The current population density is estimated at 3,079 people per square kilometer with the average household size was 5.2 and the mean monthly income per household was 7200 Ksh (about 72 USD) (The World Factbook. *Cia.gov.*). Seventy-five percent of the population had access to piped potable water while the remaining 25% used wells, springs and other sources (The World Factbook. *Cia.gov*).

Study population

This study recruited all persons employed and working as food handlers in selected eateries in Nairobi County. The study was nested within an existing program in KEMRI that involved regular (6 monthly) examination and certification of food handlers in Nairobi Kenya. The program involved collection of specimens (blood, stool and urine) from food handlers working within hotels/food industries in Nairobi for mandatory medical examination and certification.

Data collection

Sampling

Sample size was determined using a general formula considering the level of significances at 5% and assuming the prevalence of intestinal parasitosis of 24% among food handlers in Western part of Kenya (Biwott *et al*., 2014). Consequently, 298 food handlers (attending the KEMRI food handler's certification program, aged 18 years and above, working in a food eatery, willing to participate and willing to provide written consent) were consented and recruited. All the participants provided stool specimen and underwent through a face to face interviews to gather information that could be associated with intestinal parasitic infection.

The first participant was randomly selected while the remaining participants were selected using systematic sampling method. Stool specimens (about 5g) were collected from all study participants in a tight lead plastic container. A portion of the stool were preserved in 10% formalin in a proportion of 5g of stool in 3 ml of formalin or in PVA (polyvinyl- alcohol) where one volume of the stool specimen was added to three volumes of the preservative for future laboratory analysis. The stool specimens were transported in cool box immediately to the Center for Microbiology Research (CMR) – KEMRI for laboratory analysis.

Structured face to face interviews

Three well trained persons collected the data through structured questionnaires to obtain information regarding age, sex, residence, family size, and occupation.

Further, an in-depth interview was conducted to collect qualitative data. The study interviewed key informants from a pool of managers, supervisors and the team leaders after gaining consent. Summary notes were taken and tape recording done for data collection.

Laboratory analysis

The specimens were examined microscopically for the presence of eggs, trophozoites and cysts. All stool specimens were examined by direct saline thin smear and formal-ether concentration methods and the findings were recorded using pre-prepared formats. Direct saline thin smear was chosen because of its cost, simplicity, and reliability

Direct saline thin smear microscopy

Direct stool examination was done as follows; briefly, two wet preparations of fresh stool from the same food-handler were made as follows: a drop of fresh normal saline was placed on one end of a microscopic glass slide and a drop of Lugol's iodine on the other end. The proper amount of stool specimen (0.25 mg) was picked with an applicator stick and emulsified with the formal saline on one end of a glass slide; a same-size stool sample was treated in the same way with the Lugol's iodine on the opposite end of the same slide. The two preparations were then covered with glass cover slips (22 mm×22 mm) and examined under an ordinary light microscope for the presence of any parasites. The different intestinal parasites species identified were recorded with respect to type of eatery, gender, age, and educational level (Paul *et al.*, 2012).

Formal ether concentration technique

The concentration technique was carried-out using 3g of fresh stool sample emulsified in 7 mL of formal saline. The resulting suspension was filtered through three layers of wet cotton gauze in a funnel into a centrifuge tube and 3 mL of diethyl ether added. The centrifuge tube was corked, shaken vigorously and then centrifuged at 1000 *g* to 2500 *g* for 3-5 min. The plug was dislodged with an applicator stick and the supernatant poured off. Two wet preparations were made out of the deposit after slight shaking, and covered using a glass cover slip (22 mm×22 mm) and examined for the presence of parasites, type of parasites and intensity (Paul *et al.,* 2012).

Ethical consideration

The research protocol was presented for scientific and ethical approvals by the Kenyatta National Hospital and University of Nairobi (KNH & UoN) Ethical Review Committee prior to commencement of field activities (P540/0/2015). Written informed consent was obtained from each participant. Confidentiality was maintained by assigning all participants with a unique identification number. All data were stored in a restricted-access room at the research station. This research adhered to the STROBE guidelines for observational studies as outlined at: http://www.strobe-statement.org.

Statistical analyses

Proportions were used to describe categorical variables. Chi-square or Fisher's exact test were used to test for significance where applicable. The overall prevalence of intestinal parasitic infection was determined for all participants. In bivariate analyses, odds ratios (OR) and 95% confidence intervals (CI) for the association between intestinal parasitic infection and socio-demographic, and knowledge and practices characteristics were calculated using Poisson regression. In multivariate analyses, a manual backward elimination approach was utilized to reach the most parsimonious model, including factors that were independently associated with intestinal parasitic infection at the significance level of $p \leq 0.05$. All statistical analyses were performed using STATA version 13 (StataCorp LP, Texas, USA).

The qualitative data (KII) were subjected to a thematic content analysis. This approach entails the categorization of recurrent data collected under thematic areas (Green & Thorogood, 2010). The analysis was done manually using general purpose software tools using Microsoft Word (La Pelle, 2004).

RESULTS

Baseline characteristics of the study participants

A total of 298 participants working in the hospitality industry visiting KEMRI for medical examination met the inclusion criteria and were recruited into this cross sectional study. Table 4.1 describes the baseline demographic characteristics of the study participants. The participants were drawn from 6 different hospitality industries ranging from 11.7% hotel I, through 15.1 hotel – III to 22.8% hotel VI. The majority 58.4% were males versus 41.6% females with a mean age of 29.14 (SD 7.07) years ranging between 24 to 35 years. The majority, 59.4% participants were aged between 21 to 30 years, 41.6% had secondary level of education, 46% were currently married, 28.2% earned monthly income of between Ksh 5001 to 10,000 while 74.6% had between 1 to 3 children. The majority 77.2% of the participants resided in rental houses, 68.1% used pipped water for domestic use, 49.3% used gas for cooking while 67.8% used electricity as their lighting energy source.

Table 1: Baseline demographic characteristics of the study participants

Variable	Unit	Number	Percentage	χ2	df	P value
Hotel	Hotel I	41	13.8	14	5	0.001
	Hotel II	55	18.5			
	Hotel III	45	15.1			
	Hotel IV	54	18.1			
	Hotel V	35	11.7			
	Hotel VI	68	22.8			
Gender	Male	174	58.4	8.389	1	0.001
	Female	124	41.6			
Age (Years)	Mean (± SD)	29.14(7.07)		219	3	0.001
	Median (IQR)	28(24-34)				
	Range	38(17-55)				
	15-20	20	6.7			
	21-30	177	59.4			
	31-40	80	26.8			
	>41	21	7			
Education level	Primary	39	13.1	114.268	3	0.001
	Secondary	124	41.6			
	Tertiary	116	38.9			
	Non-Formal	19	6.4			
Marrital status	Single	135	45.3	204.067	3	0.001
	Married	137	46			
	Divorced	19	6.4			
	Separated	7	2.3			
Family Monthly Income (USD)	<5000	30	10.1	29.617	4	0.001
	5001-10000	84	28.2			
	10001-15000	71	23.8			
	15001-20000	65	21.8			
	>20001	48	16.1			
Number of children (Persons)	Mean (± SD)	1.78(1.262)		114.268	3	0.001
	Median (IQR)	2(1-3)				
	Range	5(0-5)				
	1-3	223	74.8			
	>4	32	10.7			
	None	43	14.4			
Housing	Self owned	38	12.8	258.148	2	0.001
	Rental	230	77.2			
	Other	30	10.1			
Household water source	Bore hole	66	22.1	169.174	2	0.001
	Rain	29	9.7			
	Pipped	203	68.1			
Source cooking energy	Firewood	12	4	209.356	3	0.001
	Kerosene	126	42.3			
	Gas	147	49.3			
	Others	13	4.4			
Source of energy for lighting	Kerosene	77	25.8	176.101	2	0.001
	Solar	19	6.4			
	Electricity	202	67.8			

IQR- Interquartile range; SD - Standard deviation; χ2-chi square; df-degrees of freedom; P-Level of significance; $P \leq 0.05$ indicates the relationship is significant

Participant's knowledge and practices of intestinal parasites

Table 2 describes the participant's knowledge of intestinal parasites. The majority (92.3%) of the participants were aware/knowledgeable about the intestinal parasite versus only 7.7% who stated that they were not aware of the intestinal parasites. There 45.6% of the participants who stated that intestinal parasite causes diarrhea while 26.5% stated stomach ache was major outcome of intestinal parasitic infection. When asked if they have ever been infected with intestinal parasites, majority (75.8%) reported having been infected. Among those ever been infected, the majority (38.3%) was due to amoeba, followed by 28.2% bacterial. Most 75.5% of study participants strongly agreed that washing hands before eating food is very important. Surprisingly, about 70.1% were not aware on the purpose for the routine medical examination that were undergoing in the hospitality industries. There were 55.7% participants who were aware of the frequency of medical examinations yearly with 57.7% participants aware of the legal consequences of not taking these medical examinations in the hospitality industries. When asked on the work section requiring medical examination; the majority 63.4% stated that all workers in all section of hospitality industry require medical examination, with 11% stating only workers in the Kitchen and 10.1% stating those in drinks and beverage section.

The majority 72.8% of study participants stated regularly washing their hands within the working environment. The frequency of hand washing included; 58.1% always, 24.2% on sometimes basis while 17.8% rarely wash their hands. Purpose of hand washing was majorly (44.3%) for eating purpose, 14.8% after using the toilet while 12.4% washed hands for cooking purposes. Most (86.9%) of the participants regularly cut their nails and 68.1% of the participants acknowledged wearing protective cloths during work.

Table 2: Participants knowledge related with intestinal parasites

Variable	Unit	Number	Percentage	$\chi 2$	df	P value
	KNOWLEDGE					
Know intestinal parasite	Yes	275	7.7			
	No	23	92.3	213.101	1	0.001
Ever been infected with intestinal parasites?	Yes	226	75.8			
	No	72	24.2	79.584	1	0.001
Types of intestinal parasites	Bacteria	84	28.2			
	Amoeba	114	38.3			
	Virus	13	4.4	188.564	5	0.001
	Eschirichia coli	8	2.7			
	Diarrhoea	20	6.7			
	Other	59	19.8			
Washing hands before eating very important	Strongly agree	225	75.5			
	Agree	58	19.5	62.067	2	0.001
	Disagree	15	5.1			
Know need for medical certificate	Yes	89	29.9			
	No	209	70.1	48.322	1	0.001
Know the Frequency of medical examinations	Yes	166	55.7			
	No	132	44.3	3.879	1	0.049
Aware of legal consequence for lack of medical examinations	Yes	172	57.7			
	No	126	42.3	7.101	1	0.008
Know specific work section Requiring Medical Certificate	Yes	90	30.2			
	No	208	69.8	46.725	1	0.001
Specify Work Station requiring Medical Certificate	All sections	189	63.4			
	Waiter and serving sections	21	7			
	Kitchen	33	11.1	352.604	4	0.001
	Drinks and beverages	30	10.1			
	Others	25	8.4			
	PRACTICES					
Do you wash hands	Yes	217	72.8			
	No	81	27.2	62.067	1	0.001
Frequency of hand washing	Sometimes	72	24.2			
	Rarely	53	17.8	83.765	2	0.001
	Always	173	58.1			
Specific people wash the toilets	Yes	173	58.1			
	No	125	41.9	7.732	1	0.005
Regular nail cutting	Yes	259	86.9			
	No	39	13.1	162.914	1	0.05
Do you wear protective clothing	Yes	203	68.1			
	No	95	31.9	39.141	1	0.001

$\chi 2$-chi square; df-degrees of freedom; P-Level of significance; $P \leq 0.05$ indicates the relationship is significant

Laboratory diagnosis of intestinal parasites

Out of the 298 enrolled participants 43 (14.4%) had one type of intestinal parasite infection while 255 (85.6%) had no cysts detected. Of these 43 intestinal parasites detected, the majority 22 (51.2%) was *Entamoeba histolytica*. Others included 8/43 (18.6%) *Escherichia coli*, 7/43 (16.3%) *Iodamoeba butschlii*, 4/43 (9.3%) *Giardia lamblia*, 1/43 (2.3%) *Endolimax nana* and 1/43 (2.3%) *Trichomonas hominis* (Figure 1).

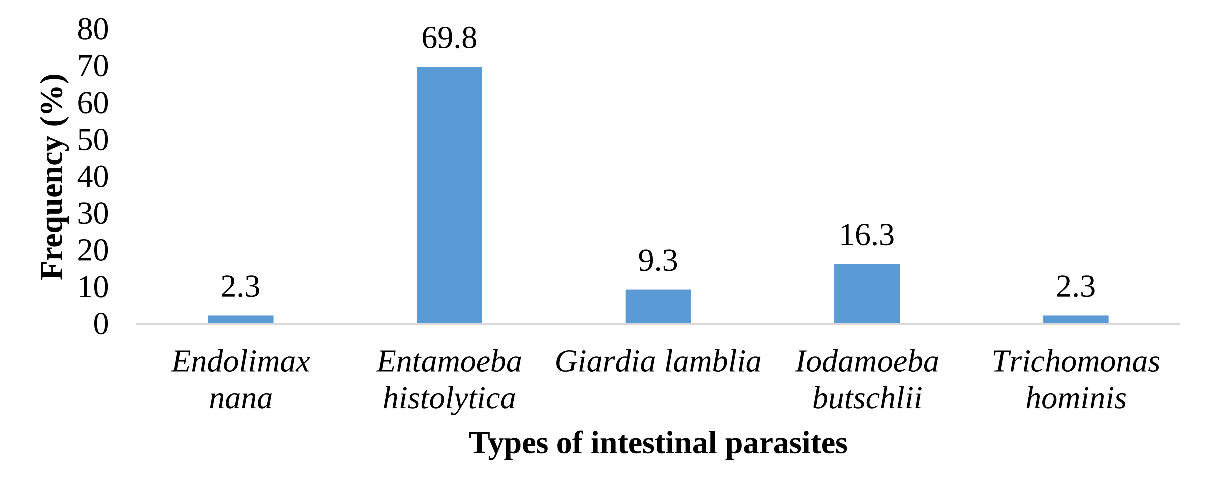

Figure 1: Distribution of intestinal parasitic infection among study participants

Demographic and socio-economic factors associated with intestinal parasite infections

Table 3 shows socio-economic factors associated with infection with intestinal parasites. In bivariate analysis, participants whose household consumed borehole water were more likely to be infected with intestinal parasite compared to those who had pipped water (OR 2.2, 95% CI 1.2 to 4.1). Further, in multivariate analyses, after adjusting for participant's residency, age, education level, marital status, income and household population size only participants who consumed water from borehole (OR 2.2, 95% CI 1.2 to 4.1) remained independently associated with intestinal parasitic infection.

Participant knowledge characteristics associated with intestinal parasite infections

Both in bivariate and multivariate analysis none of the factors assessed; (Knowledge of intestinal parasite, transmission of intestinal parasite; Problems associated with intestinal parasite; and past infection) were found associated with intestinal parasite infections

Table 3: Socio-demographic and economic factors associated with intestinal parasite infections

Variable	Sample size	Infection with intestinal parasite No	%	P value	Bivariate OR (95% CI)	P value	Multivariate OR (95% CI)
Hotel							
Hotel I	41	0	0	1	ND	0.99	ND
Hotel II	55	1	1.8	0.995	ND	0.99	ND
Hotel III	45	0	0	1	ND	0.99	ND
Hotel IV	54	11	20.4	0.994	ND	0.99	ND
Hotel V	35	31	88.6	0.994	ND	0.99	ND
Hotel VI	68	0	0	Referent	Referent	Referent	Referent
Gender							
Male	174	25	14.4	0.847	1.1(0.6-1.7)	0.973	0.9(0.5-1.8)
Female	124	18	14.5	Referent	Referent	Referent	Referent
Age grouping							
15- 20	20	3	15	0.482	1.5(0.4-5.5)	0.828	1.1(0.6-1.9)
21-30	177	28	15.8	0.826	0.9(0.3-2.5)	0.928	1.1(0.6-1.8)
31-40	80	11	13.8	0.844	1.1(0.4-3.3)	0.893	0.9(0.6-1.7)
≥41	21	1	4.8	Referent	Referent	Referent	Referent
Education level							
Primary	39	7	17.9	0.627	0.7(0.2-2.5)	0.876	1.1(0.7-1.4)
Secondary	124	11	8.9	0.95	1.1(0.3-2.9)	0.653	1.1(0.7-1.8)
Tertiary	116	22	19	0.715	0.8(0.3-2.3)	0.415	0.7(0.3-1.6)
Non-Formal	19	3	15.8	Referent	Referent	Referent	Referent
Marrital status							
Single	135	21	15.6	0.989	ND	0.99	ND
Married	137	20	14.6	0.989	ND	0.99	ND
Divorced	19	2	10.5	0.989	ND	0.99	ND
Separated	7	0	0	Referent	Referent	Referent	Referent
Monthly Income (USD)							
<5000	30	3	10	0.57	1.3(0.5-4.1)	0.289	0.4(0.3-1.8)
5001-10000	84	11	13.1	0.773	1.1(0.4-2.8)	0.433	0.6(0.3-1.8)
10001-15000	71	5	7	0.418	1.4(0.6-3.5)	0.078	0.4(0.1-1.1)
15001-20000	65	15	23.1	0.316	1.5(0.6-3.8)	0.594	1.2(0.5-2.6)
>20001	48	9	18.8	Referent	Referent	Referent	Referent
Household size							
1-3	223	31	13.9	0.206	1.8(0.7-4.5)	0.754	1.2(0.4-3.1)
>4	32	7	21.9	0.64	1.3(0.4-4.6)	0.218	2.2(0.6-8)
None	43	5	11.6	Referent	Referent	Referent	Referent
Housing							
Self owned	38	4	10.5	0.486	0.7(0.3-1.6)	0.695	0.7(0.8-3.1)
Rental	230	35	15.2	0.486	0.7(0.3-1.6)	0.983	0.9(0.3-2.8)
Other	30	4	13.3	Referent	Referent	Referent	Referent
Household water source							
Bore hole	66	18	27.3	0.01	2.2(1.2-4.1)	0.011	2.2(1.2-4.1)
Rain	29	0	0	0.989	ND	0.987	ND
Pipped	203	25	12.3	Referent	Referent	Referent	Referent
Source cooking energy							
Firewood	12	0	0	0.936	ND	0.991	ND
Kerosene	126	21	16.7	0.772	1.2(0.3-5.2)	0.658	1.3(0.3-6.2)
Gas	147	20	13.6	0.734	1.3(0.3-5.3)	0.807	1.2(0.3-5.2)
Others	13	2	15.4	Referent	Referent	Referent	Referent
Source of energy for lighting							
Kerosene	77	8	10.4	0.783	0.9(0.5-1.6)	0.271	0.6(0.3-1.4)
Solar	19	4	21.1	0.705	0.8(0.2-2.5)	0.216	1.9(0.6-5.7)
Electricity	202	31	15.3	Referent	Referent	Referent	Referent

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval; ND-Not done

Participant practice characteristics associated with intestinal parasite infections

Table 4 shows practices related to intestinal infection. In bivariate analysis, participants who stated washing hands for the purposes of eating (OR 0.3, 95% CI 0.6 to 0.7), after using toilet (OR 0.1, 95% CI 0.1 to 0.3), cooking (OR 0.09, 95% CI 0.02 to 0.4) or two of these reasons (OR 0.03, 95% CI 0.03 to 0.3) were less likely to get intestinal infection compared to those who stated three different reasons for hand washing. On the other hand, the participants who stated wearing protective head gears (OR 3.5, 95% CI 1.3 to 9.1) were more likely to get intestinal parasitic infection compared to those who did not wear any protective gear.

In multivariate analyses, participants who stated washing hands for the purposes of eating (OR 0.5, 95% CI 0.2 to 0.9), after using toilet (OR 0.1, 95% CI 0.02 to 0.5), cooking (OR 0.1, 95% CI 0.02 to 0.6) or two of these reasons (OR 0.1, 95% CI 0.03 to 0.4) and stated wearing protective head gears (OR 1.7, 95% CI 1.1 to 6.4) remained associated with intestinal parasitic infection.

Table 4: Participant practice characteristics associated with intestinal parasite infections

Variable	Sample size	Infection with intestinal parasite		P value	Bivariate	P value	Multivariate
		No	%		OR (95% CI)		OR (95% CI)
Do you wash hands							
Yes	217	34	15.7	0.359	1.4(0.6-2.9)	0.707	0.8(0.2-2.4)
No	81	9	11.1	Referent	Referent	Referent	Referent
Frequency of hand washing							
Sometimes	72	10	13.9	0.678	0.8(0.4-1.7)	0.989	1.1(0.2-2.5)
Rarely	53	5	9.4	0.266	0.6(0.2-1.5)	0.415	0.5(0.2-2.2)
Always	173	28	16.2	Referent	Referent	Referent	Referent
Why wash hands							
Eating purpose	132	25	18.9	0.004	0.3(1.6-0.7)	0.011	0.5(0.2-0.9)
Toilet purpose	44	2	4.5	0.001	0.1(0.01-0.3)	0.005	0.1(0.02-0.5)
Cooking purpose	37	2	5.4	0.003	0.09(0.02-0.4)	0.006	0.1(0.02-0.6)
Two of them	67	4	6	0.001	0.1(0.03-0.3)	0.001	0.1(0.03-0.4)
Three of them	18	10	55.6	Referent	Referent	Referent	Referent
Specific people wash the toilets							
Yes	173	30	17.3	0.124	1.6(0.8-3.2)	0.614	1.2(0.5-2.5)
No	125	13	10.4	Referent	Referent	Referent	Referent
Regular nail cutting							
Yes	259	42	16.2	0.068	6.3(0.9-45)	0.264	3.4(0.3-28.8)
No	39	1	2.6	Referent	Referent	Referent	Referent
Do you wear protective clothing							
Yes	203	38	18.7	0.008	3.5(1.3-9.1)	0.048	1.7(1.1-6.4)
No	95	5	5.3	Referent	Referent	Referent	Referent

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval; ND-Not done

Key Informant response on the factors contributing to intestinal parasitic infection

Varied response were gathered on the problems in this industry that contribute to intestinal parasitic infection. These included staff-based factors (awareness, experiences, expectations, income, employment, family); health facility-based factors (interactions with care providers, availability of care, quality of care, distance, affordability, logistics availability, follow up and service administration); and policy and standards (service standards, implementation manuals and policy documents) were mentioned.

One KII participant (CEO) said *"mostly to prevent infection we enforce cleanliness both from workers and the facilities"*.

Second KII participant (Head of environment) said *"Occasionally when we have pest infestation…we normally spray especially at odd hours when no clients are available"*.
Third KII participant (CEO) said "*Yes, we also ensure our employees comply with the regulation of the hospitality industry…. all my employed have been medically certified from KEMRI…except the gate watchman and I can provide the documentations"*.

Fourth KII participant (Head of environment**) said "***The biggest problem in this industry to health include, cleanliness, good working environment including having hand sanitizers at strategic positions.*

Third KII participant (CEO) said *"sometimes the health evaluation is not done on a regular basis. Sometimes we as the leaders must take leadership and check the expiry dates of medical certificate. Upon expiry we must send the staff for re-evaluation…. not all in this industry get medical examinations done regularly"*.

Third KII participant (Kitchen head) said *"to ensure we avoid contamination; most industries try to produce their own food items in hygienic conditions…. we rarely buy food items grown using the sewage irrigation wastes".*

Fifth KII participant (Kitchen head) said *"the other major challenge in getting food items is the lack of sufficient produce…. the market in our locality is very small and its far, so sometimes we might compromise on the quality of food by cooking stale food items".*

Fourth KII participant (Head of environment) said "*the other challenge is the lack of regular inspection of these premises by the health workers…. these workers are still at the central government and not devolved so they take long to come…we always benefit from their inspection".*

Fifth KII participant (senior worker hospitality industry) said "*most of contamination occurs from the staff themselves…. maybe they have low level of education and consequently poor socio-economic and hygienic conditions of families which are brought to work stations".*

Fourth KII participant (Head of environment) said "*other items that reduces contamination includes; having the correct uniform and protective cloths such as dust coats, gumboots, head gears etc depending on the work station".*

Sixth KII participant (Health worker) said "*in my years of service we have shown that intestinal parasitic infections are more common in rural than urban areas. People living in rural areas may lack sanitary water supplies and live close to sources of parasites in social and environmental conditions that predispose to intestinal parasitic infections. Further, the common intestinal parasitic infections generally occur more frequent in children because of their interaction with other children and their poor hygiene. Families with children are known to have adult infected with these parasites as well"*

Fourth KII participant (Health worker) said *"intestinal infection and transmission are also contributed by other underlying health conditions…. such as those who have compromised immunity such as HIV are more likely to have these persistent infections. Medical checkup should include such kind of evaluation as well for control and management".*

DISCUSSION

Food handlers may be carrying a wide range of enteropathogens and have been implicated in the transmission of many infections to the public in the community and to patients in hospitals. Reports globally have emphasized the significance of food handlers with poor personal hygiene as a risk in the transmission of parasitic and bacterial diseases (Takalkar *et al*., 2010). There are currently over 70,000 eateries and hotels in Nairobi including close to 400 five star rated. These eateries and hotels are not only visited by the locals but also attract high numbers of international tourists including dignitaries. With this understanding in early 90s, Kenya Medical Research Institute (KEMRI) initiated the food handler program to hotels, restaurants and food processors in selected cities in Kenya. The service involves certification of all people who directly handle foodstuff (preparation, serving or packing) in hotels and food-based industries that they are free from any food borne diseases thus minimizing risks associated with food contamination. In 2015 the Nairobi government and the KEMRI signed an agreement to test food handlers in all eateries and hotels within Nairobi county.

This study is therefore among the first to report on the prevalence and correlates of intestinal parasitic infection among food handlers within the KEMRI cliental. The overall prevalence of protozoan infections was 14.4%. Mixed intestinal parasite infections were detected in 1.9% of the study participants. Higher prevalence rates have been reported from food handlers in Nigeria (97%) (Idowu *et al*., 2006), in Iran (74%) (Fallah *et al*., 2004), in 52.2% in Anatolia Turkey (Simsek *et al*., 2009), in Ethiopia (45.3%) (Aklilu *et al*., 2015), Sudan (29.4%) (Babiker *et al*., 2009), and Gaza Strip, Palestine (24.3%) (Al-Hindi *et al*., 2012). However lower prevalence was in Turkey (8.8%) (Selman *et al*., 2008), Khuzestan, Southwest of Iran (7.78%) (Saki *et al*., 2012), North India (1.3 to 7%) (Khurana *et al*., 2008), and Thailand 10.3% (Kusolsuk *et al*., 2011). This difference can be explained largely due to epidemiological, environmental distribution difference, poor personal hygiene practices, environmental sanitation and ignorance of health-promotion practices.

The current study, the majority of parasitic infection (51.2%) was *Entamoeba histolytica* others included 9.3% *Iodamoeba butschlii*, 2.3% *Giardia lamblia*, 2.3% *Endolimax nana* and 2.3% *Trichomonas hominis*. Similar parasitic dominancy of *E. histolytica* and *G. lamblia* was reported in Ethiopia (Aklilu *et al*., 2015), and in Turkey (Selman *et al*., 2008). Other studies have reported *G. lamblia* as the leading parasite followed by other parasites such as in Ethiopia (Abera *et al*., 2010), and in Iran (Saki *et al*., 2012)

In our study, consumption of water from borehole was associated with parasitic infection. It is particularly not surprising for this association, boreholes in most parts of Kenya are never handled according to the WHO standards including proper treatment and protection from external contamination. Studies have shown that environmental route of transmission is important for many protozoan and helminth parasites, with water, soil and food being particularly significant. Both the potential for producing large numbers of transmissive stages and their environmental robustness, being able to survive in moist microclimates for prolonged periods of time, pose a persistent threat to public and veterinary health (Karanis *et al*., 2007). Drinking water has been shown as a major source of microbial pathogens in developing regions (Baldursson and Karanis, 2011).

Further, food handler's sanitation and hygiene was associated with intestinal parasitic infection. Other studies have also reported several environmental and behavioral variables significantly contributing to intestinal parasite infection (Sharif *et al*., 2015). Like in our study, reduced hand washing with soap prior to eating, after using the toilet, or in both situations, and contact with soil, significantly increased the risk of infection (Zaglool *et al*., 2011; Sharif *et al*., 2015). Improper hand washing before handling food is one obvious route for dissemination of infections. Parasite eggs in the soil can be transmitted to vegetables, then on to hands and hence directly into the mouth (Koyabashi, 1999), or ingested by eating raw vegetables (Ulukanligil *et al*., 2001).

Information related to facility factors contributing to intestinal infection were gather through employee in-depth interviews. Some of the highlights eateries and hotel facility-based factors included general cleanliness affirmed by one participant "*mostly to prevent infection we enforce cleanliness both from workers and the facilities*". **"***The biggest problem in this industry to health include, cleanliness, good working environment including having hand sanitizers at strategic positions"* reported another participant. Uncleanliness is associated with presence of pests implicated in transition of infections. "*Occasionally when we have pest infestation…we normally spray especially at odd hours when no clients are available"* reported a participant. Both individual and facility environmental characteristics have been shown to significantly contribute to intestinal parasite infection (Zaglool *et al*., 2011; Sharif *et al*., 2015). The source of food raw material is key. "*the other major challenge in getting food items is the lack of sufficient produce…. the market in our locality is very small and its far, so sometimes we might compromise on the quality of food by cooking stale for items"* one participant asserts. Many companies now produce their own food and water purification systems within the facility to minimize contaminations. *"to ensure we avoid contamination; most industries try to produce their own food items in hygienic conditions…. we rarely buy food items grown using the sewage irrigation wastes"* said another. The carefully developed networks for the distribution of drinking water and food items is key in reducing the incidence of infections over the years in many food industries and hotels (Balarak et al., 2016).

Other facility related factors such as availability of institutional health care, distance, policy and standards (service standards, implementation manuals and policy documents) have been shown to eventually influence the general employee's health. Confirmed by one employee *"Yes, we also ensure our employees comply with the regulation of the hospitality industry…. all my employed have been medically certified by KEMRI…except the gate watchman and I can provide the documentations"*. Yet another commended about the policy *"sometimes the health evaluation is not done on a regular basis. Sometimes we as the leaders must take leadership and check the expiry dates of medical certificate. Upon expiry we must send the staff for re-evaluation…. not all in this industry get medical examinations done regularly"*. The role of company's policy and standards on the overall wellbeing of worker's health has been well documented (Angelillo et al., 2000; Kheyrandish et al., 2004; Balarak et al., 2016) showing a positive correlation.

No association was found between the frequency of parasite infection and age, sex, occupation, duration of work and place of work. This illustrates the equal exposure to the infection and suggests an effect of environmental conditions on infection. Undoubtedly, continuous health supervision, annual medical examination and prompt treatment of infected food-handlers minimizes the effect of duration of work on infection rates

One of the major strength of this study is the ability to contribute to wealth of knowledge by showing that food handlers working in various eateries and hotels in Nairobi are potential carriers of intestinal parasitic infection. The study also showed the potential association between duration of food handling, hygienic condition with intestinal parasitic infection. However, some of the limitation to our assessment of intestinal parasitic infection outcomes needs to be pointed out: Firstly, cross-sectional nature of our study only allowed us to describe associations between potential factors and intestinal parasitic infection, not a causal conclusion. Such outcomes can be confirmed in a longitudinal study. Secondly, we only enrolled a small fraction less than 5% of all the food handlers enrolled in the KEMRI medical examination program, as such we may not have captured the true distribution of intestinal parasitic infection outcomes in this study. Thirdly, although we reported high carriage of intestinal parasitic infection among the food handler's, we cannot conclusively predict the source of exposure to these intestinal parasitic infections. Fourthly, although we might expect some seasonal variation in transmission of intestinal helminths (Babiker *et al*., 2009), the present study did not evaluate temporal and seasonal variability of intestinal parasitic infection. Difference in climatic conditions may explain the different findings.

These limitations notwithstanding, our findings indicate that a high prevalence of intestinal parasite in asymptomatic (apparently healthy) food handlers. Such infected food handlers can contaminate food, drinks and could serve as source of infection to consumers via food chain.

Competing interests

The authors declare no competing interests.

Authors' contributions

This work was part of Master of Science degree for SAI in Public Health at the Jomo Kenyatta University of Agriculture and Technology. SAI, YK and SK conceived and designed the study. SAI conducted field work and collected data. SAI conducted data analysis and wrote the draft manuscript. YK and SK advised and supervised data analysis and reviewed the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We acknowledge all participants for their valuable contribution to the study.

REFERENCES

1. Abera B, Biadegelgen F, Bezabih B. 2010. Prevalence of salmonella typhi and intestinal parasites among food handlers in Bahir Dar town. Northwest Ethiopia. *Ethiop J Health Dev.* 24(1):47–50.

2. Aklilu A, Kahase D, Dessalegn M, Tarekegn N, Gebremichael S, Zenebe S, Desta K, Mulugeta G, Mamuye Y and Mama M. 2015. Prevalence of intestinal parasites, salmonella and shigella among apparently health food handlers of Addis Ababa University student's cafeteria, Addis Ababa, Ethiopia. *BMC Research Notes*. 8:17

3. Al-Hindi A, Abdelraouf A, Elmanama, Ashour N, Hassan I, Salamah A. 2012. Occurrence of intestinal parasites and hygiene characters among food handlers in Gaza strip, Palestine. *Ann Alquds Med*. 1433(8):2–3.

4. Angelillo IF, Viggiani NM, Rizzo L, Bianco A. 2000. Food handlers and foodborne diseases: knowledge, attitudes, and reported behavior in Italy. Journal of Food Protection. 63. 381–385, 2000.
5. Babiker MA, Ali MS, Ahmed ES. 2009. Frequency of intestinal parasites among food-handlers in Khartoum, Sudan. *Eastern Mediterranean Health Journal*. 15. 1099-1104.

6. Balarak D, Modrek MJ, Bazrafshan E, Ansari H, Mostafapour FK. 2016. Prevalence of Intestinal Parasitic Infection among Food Handlers in Northwest Iran. Journal of Parasitology Research. 2016, Article ID 8461965, 6 pages, 2016. doi:10.1155/2016/8461965

7. Baldursson S, Karanis P. 2011. Waterborne transmission of protozoan parasites: Review of worldwide outbreaks – An update 2004–2010. *Water Research*. 45. 20: 6603–6614

8. Biwott G, Wanjala P, Ngeiywa M. 2014. Prevalence of Gastrointestinal Parasitic Infections among Food Handlers in Eldoret Municipality, Kenya: *Journal of Biology, Agriculture and Healthcare*. 4:27
9. Cheesbrough M. *Medical laboratory manual for tropical countries*, 2nd ed. Oxford, Butterworth, 2009.

10. Fallah M, Sadeghian S, Taherkhani H, Habibi F, Barghi ZH. 2004. Study of parasitic and bacterial infections in the food-handling personnel, Ramadan, Iran. *J Res Health Sci*. 4:3-10.

11. Green, J., & Thorogood, N. (2010): Qualitative Methods for Health Research, (2 edn.) Lodon: Sage Publication, 2010.

12. Idowu OA, Rowland SA. 2006. Oral fecal parasites and personal hygiene of food handlers in Abeokuta, Nigeria. *Afr Health Sci*. 6:160–4.

13. Karanis P, Kourenti C, Smith H. 2007. Waterborne transmission of protozoan parasites: *A worldwide review of outbreaks and lessons learnt*. 5 (1) 1-38; DOI: 10.2166/wh.2006.002

14. Kheyrandish F, Badparva E, Tarahi M. 2004. Prevalence of intestinal parasites in Khorramabad bakeries' workers in 2001. Yafteh. 5: 17. 45–50

15. Khurana S, Taneja N, Thapar R, Sharma M, Malla N. 2008. Intestinal bacterial and parasitic infections among food handlers in a tertiary care hospital of North India. *Trop Gastroenterol.* 29(4):207–9.

16. Koyabashi A. Ascaris. 1999. In: Japan International Cooperation Agency. Textbook for seminar on parasite control administration for senior officers-a step towards primary health care. Tokyo: *JICA*; 233-42.

17. Kusolsuk T, Maipanich W, Nuamtanong S, Pubampen S, Sa-nguankiat S. 2011. Parasitic and enteric bacterial infections among food handlers in tourist-area restaurants and educational-institution cafeterias, Sai-Yok district, Kanchanaburi province, Thailand. *J Trop Med Parasitol.* 34:49–53.

18. La Pelle N. 2004. Simplifying qualitative data analysis using general purpose software tools. *Field Methods.* 16: 85-108

19. Nyarango RM, Aloo PA, Kabiru EW, Nyanchongi1 BO. 2008. The risk of pathogenic intestinal parasite infections in Kisii Municipality, Kenya. *BMC Public Health*. 8:237 -239.

20. Onyango AB, Kenya EU, Mbithi J, Ng'ayo MO. 2009. Pathogenic *Escherichia coli* and Food Handlers in Luxury Hotels in Nairobi, Kenya. *Journal of Travel Medicine and Infectious Disease.* 7. 359 - 366

21. Paul, Kamau., Penina, Aloo-Obudho., Ephantus, Kabiru., Kepha, Ombacho., Bernard, Langat., Obadiah, Mucheru., and Laban, Ireri. 2012. Prevalence of intestinal parasitic infections in certified food-handlers working in food establishments in the City of Nairobi, Kenya. *Journal of Biomedical Research.* 26(2): 84–89.

22. Saab BR, Musharrafieh U, Nassar NT, Khogali M, Araj GF. 2004. Intestinal parasites among presumably healthy individuals in Lebanon. *Saudi Med J*. 25:34–37.

23. Saki J, Khademvatan S, Masoumi K, 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(10):2475–80.

24. Selman CA, Green LR. 2008. Environmental health Specialists' self-reported Foodborne illness outbreak investigation practices. *J Env Health*. 0(6):16–21. quiz 53–4.

25. Sharif M, Daryani A, Kia E, Rezaei F, Nasiri M, Nasrolahei M. 2015. Prevalence of Intestinal Parasites Among Food Handlers of Sari, Northern Iran. *Revista do Instituto de Medicina Tropical de São Paulo*. 57(2):139-144.

26. Simsek Z, Koruk I, Copur AC, Gürses G. 2009. Prevalence of Staphylococcus aureus and intestinal parasites among food handlers in Sanliurfa, Southeastern Anatolia. *J Publ Health Manag Pract.* 15:518–23.

27. Solanki R, Kaiya RN, Jaysawal A, Dhanashree B, Meghna C, Vidyalakshmi K. 2014. Study of Prevalence of Intestinal Parasites in Food Handlers in Mangalore. *Int J Cur Res Rev.* 6 (22). 14-16.

28. Takalkar AA, Madhekar NS, Kumavat AP, Bhayya SM. 2010. Prevalence of intestinal parasitic infections amongst food handlers in hotel and restaurants in Solapur city, India. *Indian J Public Health*. 54:47-8.

29. Takizawa MGMH, Falavigna DLM, Gomes ML. 2008. Enteroparasitosis and their ethnographic relationship to food handlers in a tourist and economic center in Paraná, southern Brazil. *Rev Inst Med trop S Paulo*. 51: 31-35.

30. The World Factbook. Cia.gov. Retrieved 28 March 2017

31. Ulukanligil M, Seyrek A, Aslan G, Ozbilge H, Atay S. 2001. Environmental pollution with soil-transmitted helminths in Sanliurfa, Turkey. *Mem Inst Oswaldo Cruz*. 96:903-9.

32. Zaglool DA, Khodari YA, Othman RA, Faroog MU. 2011. Prevalence of intestinal parasites and bacteria among food handlers in a tertiary care hospital. *Niger Med J*. 52:266–270

33. Zain MM, Naing NN. 2002. Sociodemographic characteristics of food handlers and their knowledge, attitude and practice towards food sanitation: a preliminary report. *Southeast Asian J Trop Med Public Health*. 33:410–417