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Prevalence of Gastrointestinal Parasitic Infections among Food Handlers in Eldoret Municipality, Kenya

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Abstract
Intestinal parasitic infections remain an important public health problem in the tropics where poor hygiene and sanitation are a norm rather than an exception. Food handlers play a significant role in the transmission of these parasites to consumers. The objective of this cross sectional study was to determine the prevalence and distribution of single and multiple species of intestinal parasitic infections among food handlers working in Eldoret Municipality between May to December 2007. Stool samples from 335 food handlers of both sexes, aged between 16 and 58 years were analyzed using macroscopic and microscopic direct stool examination of wet and Lugol's iodine preparations and Formal-Ether concentration techniques. Positive fecal samples were found in 79 (23.7%) food handlers. The results indicated that there was presence of intestinal protozoans and helminthes among food handlers with protozoans being the majority, infecting 14.1% food handlers and consisting of *E. histolytica* (7.2%), *E. coli* (5.7%) and *G. lamblia* (1.2%). The overall prevalence of helminthes was 6.6% in the order of *T. saginata* (2.4%), *A. duodenale* (2.1%), *A. lumbricoides* (1.5%), and *H. nana* (0.6%). Among the species of protozoans and helminthes, the genus *Entamoeba* had significantly ($p < 0.05$) the highest prevalence than all the others. High prevalence of the intestinal parasitic infections was recorded among the food handlers working in butcheries (51.0%), Supermarkets (31.6%) and slaughterhouses (30.3%). Temporal variation in the prevalence of intestinal parasitic infections was significant ($p < 0.05$) with prevalence of intestinal protozoans and *T. saginata* being the highest during the rainy period. The results of this study indicated improper hygiene and sanitation conditions. Interventions were therefore needed to address the root behavioural and occupational related causes of these parasitic infections to reduce the intolerable burden caused by these parasites. There is need to increase awareness of the food handlers and the responsible officials in various food establishments on the importance of personal hygiene and pre-employment and periodic stool examination for ova and cysts of the parasites to curtail transmission.
Keywords: Intestinal parasites, prevalence, food handlers, Eldoret Municipality

1. Introduction

Intestinal parasitic infections have been described as constituting one of the greatest single most important worldwide causes of illness and disease (Nyarango *et al.*, 2008). Studies have shown that the incidence of intestinal parasite infections may approach 99% in developing countries (Allergerer *et al.*, 1994; Bern and Glass, 2004). A survey of opportunistic intestinal parasitic infections in Sub Saharan Africa over a ten year period between 1999 and 2009 reported a 30.2%-55.6% prevalence of intestinal parasites among the vast majority of the people (Fisseha *et al.*, 1999; Adamu *et al.*, 2009)..

Gastrointestinal parasites of man can either be protozoans or helminthes. There are thousands of types of gastrointestinal parasites that live in the human body and not only do they thrive on the food eaten by humans (Huang and White, 2006), but they also do destroy vital organs from within in a bid to accelerate their multiplication thereby causing injury and even death (Hetsko *et al.*, 1998). The detrimental effects of parasites have been established to be species specific (Que, 2007).

The parasites are not easily detected when they get into the human body, hence can live in human body for long without being diagnosed (McGowan *et al.,* 2007). They are responsible for major health problems with socio-economic effects in the world and especially so in developing countries in tropical and sub tropical areas (Babiker *et al.*, 2011). These effects usually vary according to species and burden of infection (Que, 2007).

In humans, occurrence of intestinal parasites have usually caused serious health conditions by making the body weak and undernourished, thereby increasing its vulnerability to viral, fungal and bacteria diseases as well as chemical and metal poisoning worldwide (WHO, 2008). Globally, some 3.5 billion people are affected with intestinal parasitic infections, with 450 million are symptomatic (WHO, 1998) and more than 1.2 million deaths being reported annually (WHO, 2008). In developed countries, an estimated one-third of the population is affected by intestinal parasitic agents each year (Schlundt *et al.*, 2004) but the infections are more severe in the tropical regions of the world (Al-Ballaa *et al.*, 2003).

In Kenya, the presence of intestinal parasitic infections has been reported to cause close to 50,000 deaths annually (MoH, 2004) mainly due to the low standards of hygiene in the country. The situation appears to be more aggravated in rapidly expanding areas especially in the urban centres such as Nairobi (Wabukala *et al.*, 2000), Migori (Kamunvi *et al.*, 2004), Mombasa (Ouma *et al.*, 2001) and Eldoret (Andrew *et al.*, 1999). This indicates that there are underlying causes of the intestinal parasitic infections that cause the higher occurrence of these parasites in these regions.

The occurrence of these intestinal parasites is associated with their modes of transmission. Epidemiological research carried out in different countries including Kenya, has shown that the social and economic situation of individuals was important in contributing to the prevalence of intestinal parasites (Phiri *et al*., 2000; Nguhiu *et al*., 2009; Houmsou and Amuta, 2009; Takizawa *et al*., 2009). In addition, poor sanitary and environmental conditions are known to be relevant in the propagation of these infectious agents (Tellez *et al*., 1997; Gamboa *et al*., 1998; Phiri *et al*., 2000).

Intestinal parasites are commonly transmitted through ingestion of contaminated food or water as a result of poor sanitation and hygiene within the immediate environment. Transmission to the next stage is usually accelerated through human induced factors (Visser *et al*., 2010), for instance through close contact between infected and uninfected individuals as in the case of infected food handlers and consumers (Esparar *et al.*, 2003; Visser *et al*., 2010; Thomas *et al*., 2010).

Food handlers are responsible for either preparation or serving food and have to make sure it is kept clean from the point of preparation, during the process of cooking and up to the time it is served to consumers. However, contamination of food and the equipment and utensils used by food handlers has always been reported, the result of which has usually been the transmission of ova and cysts of intestinal parasites to the consumers (Mohan, *et al*., 2006).

Food handlers comprise of hotel workers, restaurant workers, butchery workers, food factory workers (cooking oil manufacturers, wheat and maize millers), slaughter house workers, institutional catering unit workers, supermarket workers, vegetable and fruit vendors. Although many rapidly expanding urban centers have large numbers of food handlers, there is little systematic research on their role in transmission of intestinal parasitic infections, especially to consumers of their food and food products.

On the basis of the foregoing, this study was designed to determine the prevalence of intestinal parasitic infections among food handlers within Eldoret Municipality. The study focused on food handlers attending Pioneer and West Health centers (run by Eldoret Municipal Council) seeking for a medical certificate, with a view of designing targeted control strategies.

2. Materials and Methods

2.1 *The Study Area*

This study was conducted between May to December 2007 in Eldoret Municipality, Uasin-Gishu County in the Rift Valley Province of Kenya. The municipality is situated in the highlands west of the Rift valley at latitude 0°24' N, longitude 35°14' E, and at an altitude of 2100 m above sea level with an average daily temperature of 16.6°C (Weatheronline.co.uk, Website, 2011).

Eldoret municipality extends over an area of 147 km^2 and has a population of over 500,000 people (KNBS, 2010; City population.de Website, 2011). Food handlers registered with Eldoret Municipal Council by April 2007 numbered about 1300.The municipality is administratively divided into two locations, which are further divided into two sub-locations each. Kapsoya Location is made up of Kapsoya and Kamukunji Sub-locations, while Pioneer Location is made up of Langas and Huruma Sub-locations.

There is a considerable variation in the weather pattern throughout the year. The area has maximum temperature that varies over the year between 18°C and 28°C with minimum temperature range of 8°C and 12°C. The mean temperature is 25°C with the lowest temperature 8.4°C in September and highest 28°C in March (Survey of Kenya, 2004). The mean rainfall is just over 1100 mm annually. Long rains are experienced between the months of March to May while December to February are dry months and September to October is the period of short rains. Rainfall patterns recorded by the Kenya Meteorological Department, Uasin-Gishu District during the same period of this study indicated that higher rainfalls occurred between late March to September 2007 while October 2007 marked the onset of the dry season.

2.2 *Research Design*

The study adopted a cross sectional survey design. Stool samples and personal historical data were collected from randomly selected food handlers between 0900 to 1300 hours three days a week (Monday, Wednesday and Friday). A maximum of ten respondents were handled each day which was considered adequate to enable stool analysis to be done on time.

Data on precipitation and average daily temperatures were recorded from Eldoret International Airport weather station to capture information for temporal variations during the study period.

2.3 *Sample Size Determination*

The following Cochran (1977) formula was used:

$$n = \frac{z_{\alpha}^{2} p(1-p)}{d^{2}}$$

where n = the desired sample size, $z_{\propto}$ = Standard normal deviate (at 95% = 1.96), d = the acceptable range of error (0.05), p = the proportion of intestinal parasitic infections in Kenya estimated at 25% (CBS, 2003), q = the proportion of Kenyans without intestinal parasitic infections (75%)

Calculation using the above formula yields n = 288. Since the target population was below 10,000 (there were 1300 food handlers) the sample size was adjusted from the above formula to:-

$$N_1 = \frac{n}{1 + 245/1300} = 235$$

Thus, 235 participants were taken as the minimum threshold. A sample size fairly above this was adequate for the study, hence 335 was taken as the sample size.

2.4 *Inclusion and Exclusion Criteria*

The study included food handlers in Eldoret Municipality who visited two health centres (Eldoret West and Pioneer) to seek health certificates. Food handlers with any terminal illnesses were excluded from the study. Those who had been included in the study previously were excluded in subsequent check up.

2.5 *Ethical Consideration*

The studies were conducted with the approval of the Institutional Scientific Research and Ethics Committee (ISREC). Participants were informed that they were free to withdraw from the study any time and that their medical records and specimens collected were to be examined by qualified persons. Moreover, all personal information of the participants was treated with strict confidentiality. Codes were used instead of the names of participants. The administrators and Medical laboratory personnel were informed about the study and their permission and support requested.

2.6 Collection and Processing of Stool Samples

Stool samples were collected from consenting study participants (n = 335). Participants were provided with a labeled leak proof container, tissue paper, applicator stick and informed to provide about 5 g stools. A portion of the stool was 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 until laboratory processing.

2.7 Laboratory Procedures

Stool specimens were examined for intestinal parasites by direct saline iodine wet mount preparation and formal ether sedimentation methods following standard procedures as described by Ash *et al*., 1994.
Two smears were prepared from each sample and one examined by an experienced senior medical laboratory technician and the other by the principal investigator independently. Stool analysis was done by use of wet mount and Formalin-ethyl Acetate concentration techniques.

2.8 Calculation of Prevalence Rate

Prevalence rate for infected food handlers was calculated as follows:

$$\text{Prevalence (\%)} = \frac{\text{Number of food handlers infected by a species of IP}}{\text{Total number of food handlers examined}} X100$$

3. Results

3.1 *Prevalence of Intestinal Parasitic Infection among Food Handlers in Eldoret Municipality*

The intestinal parasites identified in stool samples of 335 food handlers comprised protozoans and helminthes. There were three species of intestinal protozoan parasites recorded. These were *E. histolytica*, *E. coli* and *G. lamblia*. On the other hand four species of helminthes were recorded among the food handlers namely *A. lumbricoides*, *H. nana, Anc. duodenale* and *T. saginata.* From the 335 food handlers sampled in this study, 79 tested positive for the intestinal parasite species, which represented an overall prevalence of 23.7%. This comprised both intestinal protozoans and helminth parasites. The overall and specific prevalence of intestinal parasitic infections among the food handlers are presented in Table 1. The prevalence of intestinal protozoan species was higher than that of intestinal helminth species. There was a significant difference in the prevalence of different species of intestinal parasite infecting the food handlers (χ^2 = 63.9114, df = 9, P = 0.0000). Generally, the prevalence of the species *E. histolytica* and *E. coli* was higher than all the other species among food handlers. The least prevalent intestinal parasite among food handlers was *H. nana* and co-occurrence of the parasites *E. coli* with either *A. lumbricoides* or *T. saginata.* Intestinal protozoan parasite infection was significantly higher than intestinal helminth infections (χ^2 = 9.058, df = 1, P = 0.003).

Table 1. Prevalence of the Intestinal Parasite Species among the Food Handlers in Eldoret Municipality

i) Prevalence of Intestinal protozoan's

	Number of infections	Prevalence (%)
Entamoeba histolytica	24	7.2
Entamoeba coli	19	5.7
Giardia lamblia	4	1.2
Total	47	14.1

ii) Prevalence of Intestinal helminthes

	Number of infections	Prevalence (%)
Ascaris lumbricoides	5	1.5
Hymenolepis nana	2	0.6
Ancylostoma duodenale	7	2.1
Taenia saginata	8	2.4
Total	22	6.6

iii) Prevalence of Multiple Parasites

	Number of infections	Prevalence (%)
Entamoeba coli + Ascaris lumbricoides	3	0.9
Entamoeba coli + Taenia saginata	3	0.9
Giardia lamblia + Ancylostoma duodenale	4	1.2
Total	10	3.0

3.2 Intestinal Parasitic Infections among Different Occupations of Food Handlers

There were eight categories of food handlers that were identified in this study (Figure1). From a total of 335 food-handlers included in this study the majority were hotel workers comprising 33.2%, followed by food factory workers (15.1%), slaughter house workers (13.9%), institutional catering unit workers, (12.6%) were restaurant workers (9.2%), supermarket workers (7.6%), bakery workers (6.7%) while butchers comprise the least with 1.7% of study population. There was a significant difference in the prevalence of intestinal parasitic infections among food handlers in the various job categories (χ^2 = 44.85018, df = 7, P = 0.0000146). Higher prevalence of intestinal parasitic infections was observed among butchers (51.0%), supermarket workers (31.6%) and slaughter house workers (30.3%). They were significantly higher than food handlers working in hotels (21.4%), catering units (20.6%), food factory (18.1%), restaurants (14.3%) and bakeries (11.4%).

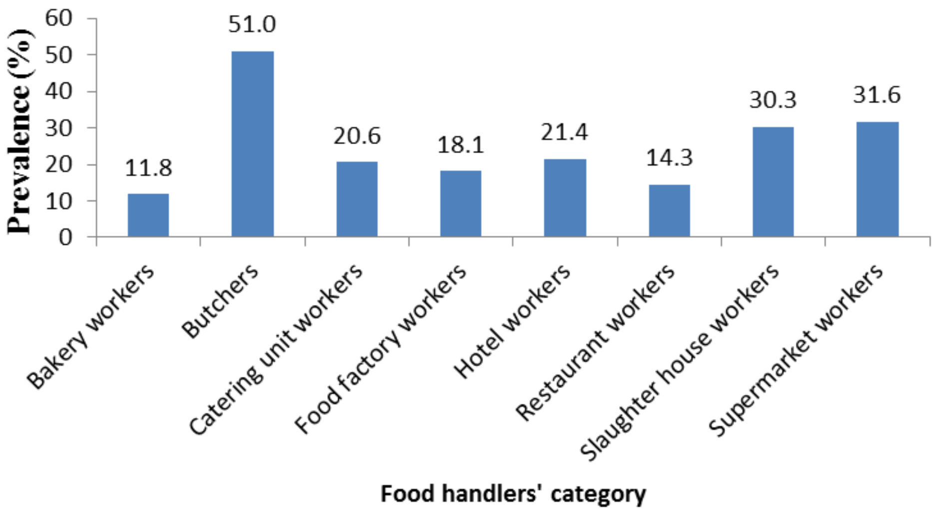

Figure 1. Prevalence of intestinal parasites in food handlers of various categories

The study further discriminated the various categories of food handlers and the species of intestinal parasites that were more prevalent in the various categories (Table 2). There was significant difference in the prevalence level of various species of intestinal parasites among various categories of food handlers (χ^2 = 333.232, df = 63, P = 0.011). The highest prevalence of *E. histolytica* and *E. coli* was associated with food handlers working in the slaughterhouses and butcheries. A high prevalence of *G. lamblia* was found in hotel workers and butchers while *A. lumbrocoides* was more prevalent in hotel and supermarket workers. A high prevalence of *T. saginata* was also recorded in slaughterhouse workers and butchers. There was a notable co-occurrence of two parasites among some of the food handlers but at low prevalence levels among various categories of food handlers in the study area.

Table2. Prevalence (%) of intestinal protozoa, helminthes and multiple infections in food handlers working in various occupational categories

	Bakery	Butchery	Catering unit	Food factory	Hotel	Restaurant	Slaughter house	Supermarket
E. histolytica	0.0	11.0	3.8	5.0	8.0	1.3	15.0	10.0
E. coli	2.5	9.4	3.8	5.0	5.8	2.5	12.5	8.8
G. lamblia	0.0	8.0	0.0	0.0	3.0	0.0	1.0	0.0
Total	**2.5**	**28.4**	**7.6**	**10.0**	**16.8**	**3.8**	**28.5**	**18.8**
A. lumbricoides	0.0	1.3	0.0	1.3	2.5	0.0	1.0	4.0
H. nana	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0
A. duodenale	0.0	0.0	0.0	3.8	2.1	0.0	1.3	1.3
T. saginata	0.0	7.5	1.2	1.0	2.0	0.0	10.0	0.0
Total	**0.0**	**8.5**	**1.2**	**6.1**	**6.6**	**2.5**	**12.3**	**5.3**
E. coli + A. lumbricoides	0.0	0.0	0.0	0.0	1.3	0.0	1.3	1.3
E. coli + T. saginata	0.0	0.0	1.3	1.3	0.0	0.0	1.3	0.0
G. lamblia + A. duodenale	0.0	0.0	0.0	0.0	1.3	0.0	3.8	0.0
Total	**0.0**	**0.0**	**1.3**	**1.3**	**2.6**	**0.0**	**6.4**	**1.3**

3.3 Temporal Variations in the Prevalence of Intestinal Parasitic Infections among Food Handlers

The monthly variations in prevalence of intestinal protozoan and helminthic infection among the food handlers are shown in Figure 2. There was a significant difference in the prevalence of intestinal protozoans and helminthic parasites based on temporal variation. *E. histolytica* had significantly (χ^2 = 27.338, df = 8, p = 0.0000) the highest prevalence between May to July 2007 with another lower peak between October and November 2007. Significantly different bimodal peaks (χ^2 = 21.338, df = 8, p = 0.0001) were recorded for the prevalence of *E. coli* between May and July and between September and November 2007.

Although *E. histolytica* and *E. coli* were generally lower in prevalence a significantly high (χ^2 = 7.338, df = 8, p = 0.003) prevalence of *G. lamblia* was recorded between May to June and between the months of October and November 2007. There was also a significant difference in the prevalence of helminthic parasite infections among the sampled months (χ^2 test, $p < 0.05$ for each trend line). The trends in prevalence of the helminthic infections were similar and indicated that infections gradually increased from a minimum in April to a maximum in May to June before gradually reducing to a minimum from September to December 2007.

The relationship between prevalence of various parasitic infections and monthly rainfall patterns was also determined using linear regression during the study (Figure 3). Generally, there was a positive correlations (R^2 =0.24) between the prevalence of all parasites with the recorded amounts of rainfall. The correlations were strong for all the protozoans species (R^2 = 0.65) and for only *T. saginata* (R^2 = 0.86) among the helminthic parasites.

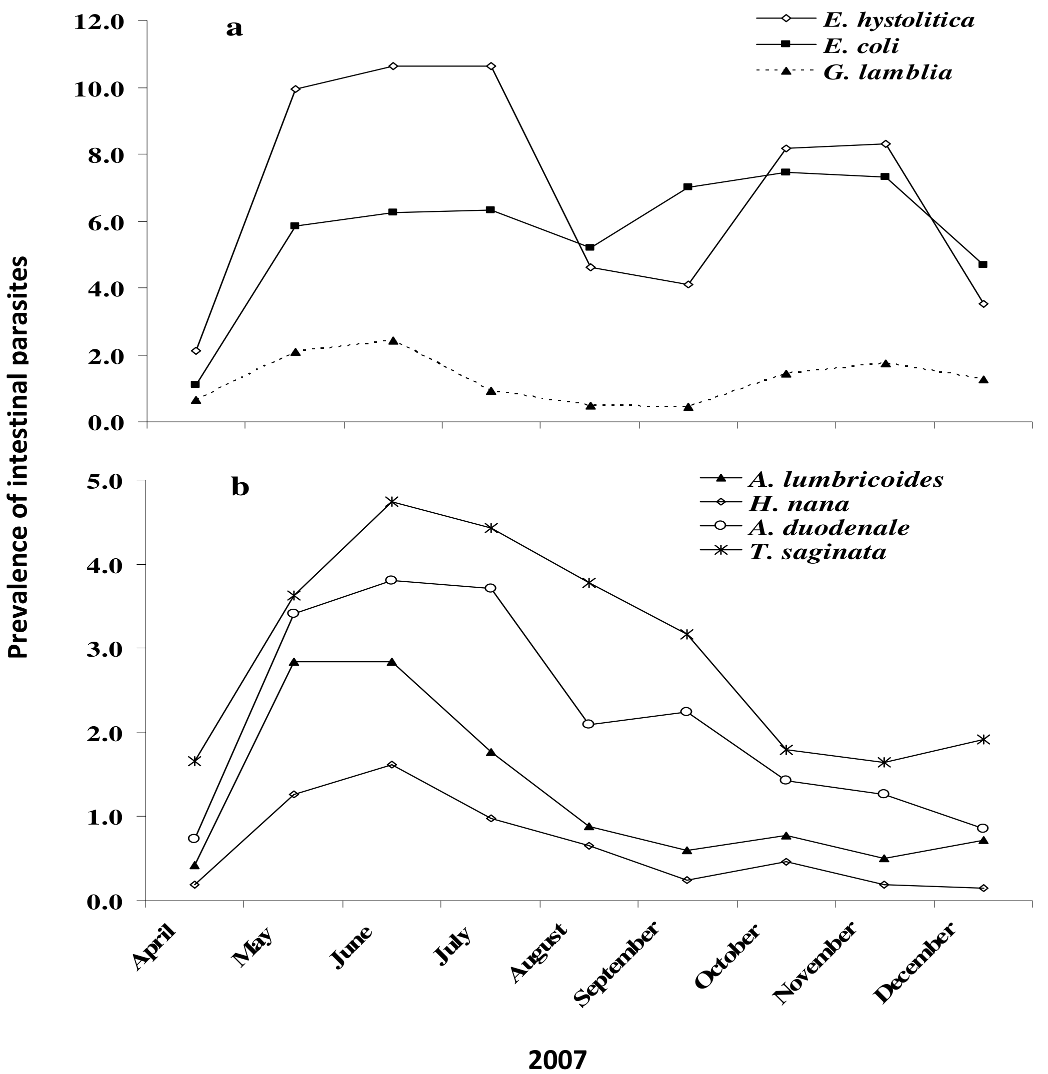

Figure 2. Temporal variations in prevalence of intestinal parasitic infections in food handlers in Eldoret Municipality between April and December 2007

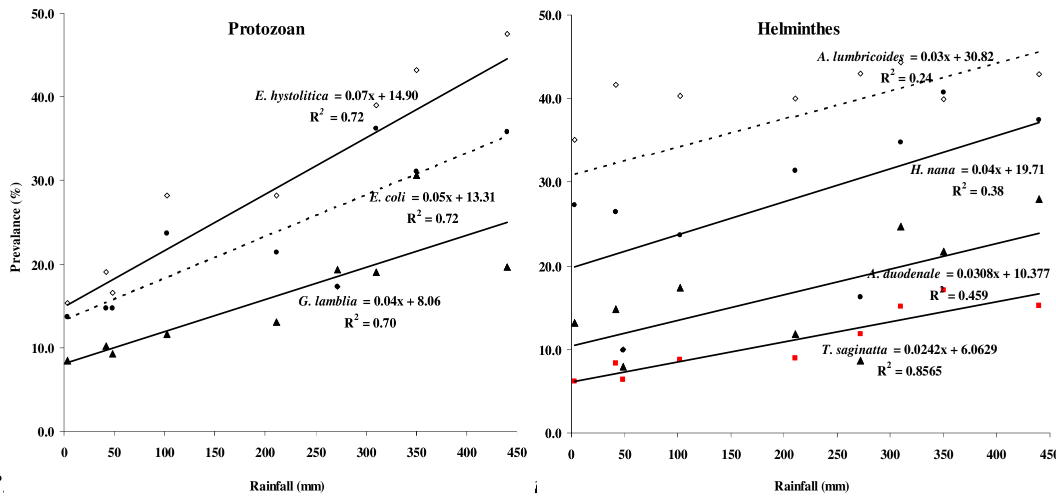

Figure 3. ... nthic parasites (b) among food handlers and the amount of rainfall in Eldoret

4. Discussion

Food handlers are an important group in the society but are probable sources in the transmission and epidemiology of gastrointestinal parasitic infections. Several authors from all over the world (Oteri and Ekanem, 1989; Tsega and Nadew, 1992; Jonnalagadda, and Bhat, 1995; Okubagzhi, 1998; Yamada *et al*., 1999; Wiwanitkit and Assawawitoontip, 2002; Feglo *et al*., 2004; Al-Lahham *et al*., 2005; de Rezende *et al*., 2007; Andargie *et al*., 2008; Hundy and Cameron, 2009) have stressed the importance of food-handlers as threats in transmission of parasitic and bacterial diseases.

In this study, food handlers were found to be infested with several intestinal parasites including protozoans (*E. histolytica*, *E. coli* and *G. lamblia*) and helminthic parasites (*A. lumbricoides, H. nana, Anc. duodenale* and *T. saginata*). These intestinal parasites have been commonly earlier been reported among the general population (Brooker *et al*., 2006) and are always present in high prevalence in areas where the food handling strategies are poor (Feglo *et al*., 2004; de Rezende *et al*., 2007; Legese and Erko, 2011).

The overall prevalence of intestinal parasitic infections among food handlers in Eldoret Municipality was found to be about 24%. According to Laskey and Ezenskey (2007), intestinal nematode infections affect one fourth to one third of the world's population. Therefore the prevalence rates in the current study compared well with what had been reported among the world population. However, compared to other studies on food handlers, the current prevalence level was low especially when considering studies done in a tertiary hospital in Manila where the prevalence was 42.4% (Esparar *et al*., 2003), 60 % in fast food chains in Metro Manila and in Metro Cebu (Belizario, 2006) and 63% in Awassa Town, Southern Ethiopia (Mariam *et al.*, 2000), 39% in Pakistan (Abdul Bari *et al*., 2005) but higher than the 21% recorded among food handlers in Accra, Ghana (Ayeh-Kumi *et al*., 2009).

In each of the above studies, it has been asserted that it may be difficult for food handlers to encounter intestinal parasitic infections and that they were likely to transmit either the agents of the parasite or the parasite themselves (Joshi *et al*., 2002) may be by ensuring that they serve themselves with hardly contaminated food.

Reports also indicated that high prevalence of intestinal parasites among the population could have occurred due to contamination of raw materials, equipment and utensils or the hands of food handlers, as this could transmit eggs of helminths to the food handlers (Mohan *et al*, 2006). However, even if the prevalence rate appeared to be low as compared to some previous studies, intestinal parasitic infections among food handlers should not exist, considering the kind of work that they are engaged in and its impact on the customers whom they serve.

The high prevalence of intestinal protozoan parasitic species than the intestinal helminthic species could be attributed to their modes of transmission. The intestinal protozoans are transmitted by the fecal-oral route or by ingestion of contaminated water or food containing cysts from faeces of infected persons or by interpersonal contact (Chan, 1997; WHO, 2010).

The kinds of lavatories used by food handlers may have influenced the passage and transmission of the parasites identified. Some food handlers had no access to modern toilet facilities, while a good proportion of those who used modern toilet facilities did not use appropriate methods of cleaning after defecation. This practice served to contaminate hands of the handlers and thus enhanced transmission of gastrointestinal infections (Nicholas, 1999). Inadequate hand washing after defecation was a major problem among the food handlers in Eldoret Municipality. Most of the study subjects perceived washing of hands with soap as an extra cost that would reduce their profit margins.

Most intestinal helminthes such as *Ascaris* are acquired by ingestion of infective eggs from foodstuff, water or soil contaminated with human faeces containing the parasite eggs. Hookworm infections occur when the infective larvae from the soil penetrate the bare skin, usually of the foot. Man acquires taeniasis by ingestion of raw or inadequately cooked beef or pork containing the infective larvae (cysticerci) (Morenikeji *et al*., 2011). Majority of food handlers working in food establishments always washed their foodstuff thoroughly with plenty of water before cutting or pairing thus getting rid of soil or fecal contaminants and this could also explain the low prevalence of *A. lumbricoides*. The low prevalence of *T. saginata* could be due to the fact that most of the food handlers did not consume raw or undercooked beef, which has been reported to cause high prevalence of the cestode elsewhere (Giboda *et al*., 1991).

Low infection of helminthic parasites may be considered to be usual, and the presence of *Ascaris* and hookworms has been noted to be common especially in developing countries (Belizario, 2001). Results in a majority of those who submitted stool samples for examination for pre-employment screening purposes showed that many had undergone earlier treatment with anti-helminthic drugs, and that self medication reduced the prevalence of intestinal helminths, but with no effect on intestinal protozoa similar to reports by Raso *et al*., (2004). Information on deworming and intestinal parasitic infections is shown in Appendix IX.

For to the specific intestinal parasites, the prevalence was similar to those found in several developing tropical countries, with an average prevalence rate of between 2.5% and 40% in African countries namely (Nigeria, Togo, and Guinea-Bissau, Mozambique and Uganda) (Roche and Benito, 2009). The findings were in line with those by Bayeh *et al*., (2010) in Bahir Dar town Northwest of Ethiopia, where a high prevalence of *E. histolytica* (12.76%) was found. Similar work done in the Holy City of Makkah, Saudi Arabia during the Haji season revealed different results whereby higher prevalence of intestinal helminthic parasites (38.71%) than intestinal protozoan parasites were responsible for 11.9% infection rate (Wakid *et al.*, 2009).

E. histolytica and *E. coli* were recorded at a relatively very high prevalence among the food handlers in Eldoret. The prevalence of the parasites of the genus *Entamoeba* has been reported to be very high in developing countries where it is one of the leading causes of death (Abdul Bari *et al.*, 2005). About 10% of the world population is estimated to be infected by this parasite (WHO, 2010). Both detected species of *Entamoeba* can be transmitted orally by drinking infected water or food and both are environmental contaminants of the water supply and in unclean foods.

Drinking of contaminated water is a common problem in Eldoret Municipality due to the lower quality of water and faulty sewage lines (Kwedho, 2009). The high prevalence of *Entamoeba* in the current study might be due to improper hygiene including not washing hands with soap before handling food, before eating and before preparing foods. It was also observed that many food handlers had no dry cloths to wipe their hands before touching food and very few if any washed their hands after selling food to their customers. Therefore this poor handling strategy may have been the cause of the high prevalence of *Entamoeba* in the study area.

E. coli was the second most prevalent species of protozoa in this study. Even though it is known to be a non pathogenic commensal intestinal protozoa, evidence indicates that when it is in abundance, it may produce a mild inflammation in certain regions of the large intestine, causing abdominal discomfort and diarrhoea (Larsh, 2008). The presence of *E. coli* among the study participants indicated that the food and water consumed were probably contaminated with fecal material. It is also documented that the presence of nonpathogenic amoebae in stool indicated a reservoir of infection and low standards of hygiene among the population (Everland *et al*., 1975). This was emphasized by a study by Utzinger *et al*., (1999) which showed that an infection with *E. histolytica* was significantly associated with an *E. coli* infection.

It must be pointed out that the prevalence of *A. lumbricoides* was low in this study compared to other studies elsewhere. According to Laskey and Ezenskey (2011), intestinal nematode infections affect one fourth to one third of the world's population. Of these, the intestinal roundworm *A. lumbricoides* is the most common and is a staggering worldwide public health problem. Gonzales (2005) reported that in some underdeveloped countries, the prevalence rate of *Ascaris* infection was as high as 90% and that it was the most commonly found roundworm among Filipinos. These findings were not similar with those of the present study.

Ascaris is a "soil-transmitted" helminth that is not spread directly from one person to another. To become infected, an individual has to consume the eggs of the worm by the fecal-oral route of transmission. Foods that are normally eaten raw such as salads and vegetables readily convey the infection (Brown, 1996; Hotez, 2003). Since there was no evidence of consumption of raw food, this may explain the low prevalence of this parasite.

It is apparent that multiple intestinal parasites infestations were experienced in the sampled population. Generally multiple parasitic infections (3.0%) were quite low as compared to single parasitic infection (20.7%). All the double parasite infections involved a protozoan and a helminth, none was between one helminth and another helminth nor an intestinal protozoan and another intestinal protozoan. This strengthened the evidence of protozoa-helminth interaction, which had already been reported in Egypt (Mansour *et al*., 1997) and in Cote d'Ivoire (Raso *et al*., 2004).

It was noted that *G. lamblia* and *Anc. duodenale* had the highest prevalence among multiple infections. The interesting finding was that most of the concomitancy was experienced in people infected with *E. coli.* Infections with both *E. coli* and *A. lumbricoides* could have been acquired from different sources because *A. lumbricoides* was a common geo-helminth while *E. coli* was associated with food or water contaminated with feacal matter, but poor personal hygiene could have been responsible for transmission of both organisms.

The extent of polyparasitism was high in females (2.1%) than in males (0.9%). Similarly higher rates of polyparasitism in females than in males were reported in Cote d'Ivore with regard to intestinal protozoa (Raso *et al.,* 2004). The reason for such high infection rate in females was not apparent immediately but could be attributed to the fact that female were the regular persons who were in charge of food preparation at home and therefore came in contact with foodstuffs and water regularly which if contaminated then would pose a risk. The other possible reason was that females usually have closer contact with young children who are believed to transmit infections acquired from playing ground and their association with domestic pets. A Combination of these factors could have increased female chances of acquiring multiple intestinal parasites.

The current study recorded low multiple infections as compared to previous studies conducted in rural Cote d'Ivoire where three-quarters of the population harboured three or more parasites concurrently (Raso *et al*., 2004). Low multiple infection in this study suggest a possibility that food handlers working in urban centres practice a better personal hygiene as compared to general population living in the rural areas. The other possibility is that the urban centers have a good supply of treated water than the rural areas.

Multivariate analysis revealed significant association between several pairs of parasites (Raso *et al*., 2004). Multiple species parasitic infections were the norm rather than the exception in the community of Eldoret Municipality, as is probably the case elsewhere in developing countries. Consequently, it was speculated that capturing multiple parasitic infections could serve as a basis for measuring the dynamics of morbidity and co-morbidity in order to design specific and targeted comprehensive intervention/measures.

Prevalence of intestinal parasitic infections was also associated with the types of food handling categories, where it was observed that butchers, supermarket workers and slaughterhouse workers had high prevalence of these parasites. High infection in butchers was not a surprise because high infectivity of meat has been reported in Kisii, Kenya, where meat had the highest intestinal parasitic infection of 75.9% as compared to other foodstuffs (Nyarango *et al.*, 2008). This finding however contrasted with what was reported in Khartoum, Sudan where food handlers working in hotels (42.9%) had the highest infection followed by those working in food factories (36.3%), cafeterias (34.4%), restaurants (33.8%) and bakery workers (27.7%), while butchers (24.4%) were the least infected (Babiker *et al.*, 2011).

Further, the highest prevalence of *E. histolytica* and *E. coli* was associated with food handlers in slaughterhouses and butcheries. High prevalence of *G. lamblia* was found in hotel workers and butchers while *A. lumbricoides* was more prevalent in catering unit and slaughterhouse workers. High prevalence of *T. saginata* was also recorded in slaughterhouse workers and butchers. The infections could have been acquired from undercooked beef and that meat inspection may have not been done thoroughly.

The presence of seven species of intestinal parasites in this study area suggested that the prevailing environmental conditions supported the transmission of a wide range of parasites, which had been reported in other areas (Jonnalagadda and Bhat, 1995; Sahlemariam and Mekete, 2001; Thomas *et al*., 2010).

Studies on the temporal variation in intestinal parasitic infections are rare. It was therefore challenging to understand the seasonal changes in the epidemiology of these parasites. Community ecology establishes whether or not parasites experience temporal changes in their structure and species composition in response to seasonal variations in biotic and abiotic environmental factors (Visser *et al*., 2010). This determines the roles of different parasite species within a community, and if their infection levels are constant and predictable over time and is vital for implementation of biological control methods.

Most of the parasites both the protozoan and helminthes were high in prevalence during the months of May to June and October to November of the study period. An increase in the prevalence of intestinal parasites during this period could be attributed to changes in weather conditions from dry months to rainy months and the associated epidemiology of these parasites due to rainfall. Precipitation levels during the study period alluded to this. Temporal variations in the intestinal parasitic infections have previously been observed in some food handlers in Kenya by Nyarango *et al*. (2003) and in Accra Ghana by Ayeh-Kumi *et al.,* (2009). Rain water run-off would contaminate water sources during the rainy season and thus might have contributed to higher prevalence to such periods.

Similarities in the environmental conditions, seasonality and large variations in the humidity and optimal temperatures for larval/egg development and viability, coupled with economic deprivation, may have contributed to the transmission and maintenance of infective stages of intestinal parasites in the community during some of the seasons. Variations in environmental conditions may have influenced endoparasite population dynamics either through their influence on host behaviour or nutritional condition (Combes, 2001). In turn, this may resulted in geographical or inter-annual variation in the dynamics of both the host-parasite associations and any diseases for which endoparasites caused.

Variations in factors associated with the prevailing weather conditions within the study area explains the differences in the rates of infestation observed as reported in a similar study in Accra Ghana by Obeng *et al*., (2007). A positive correlation between the prevalence of various parasitic infections and monthly rainfall patterns also indicated that rainfall played a significant role in development and transmission of parasite stages. However, the correlation was strong for all species of protozoan and only for *T. saginata* among the helminth parasites. This relationship could be attributed to the transmission of the parasites being favoured by wet and humid conditions that enhanced persistence of ova and cysts of the parasites in the soil.

Helminthic eggs in particular were dormant during the dry spell, but growth and multiplication and transmission got enhanced during the wet and humid season. Previous work done by Nzeako (1992) in Nigeria reported a seasonality of infection of intestinal protozoan parasites but recent work done on food handlers in Khartoum, Northern Sudan failed to establish temporal variation in the infection of intestinal parasites (Babiker *et al.,* 2011).

5. Conclusion

The data supported the value of standard fecal examinations in food handlers, even in the absence of diarrhea, since these examinations can easily be performed, with low costs, and frequently disclose treatable conditions.

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