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RESEARCH PAPER

PREVALENCE OF *ASCARIS LUMBRICOIDES* AMONG FOOD VENDORS ON A UNIVERSITY CAMPUS IN GHANA

A. S. Adams¹ and B. W. Lawson²

¹P.O. Box 9128, Airport, Accra-Ghana.
santanima05@yahoo.com

²Department of Theoretical and Applied Biology
College of Science, KNUST, Kumasi.
bwalterlawson@yahoo.com

ABSTRACT

*Intestinal parasitic infections (IPIs) constitute one of the major public health problems in developing countries and are transmitted in poor hygienic conditions. One of the modes of transmission of IPIs is through ingestion of contaminated food. Therefore, the high patronage of food outside the home in recent years, pose a threat to public health safety. In view of this, a study was undertaken to determine the types and prevalence of intestinal parasites among food vendors on the campus of the Kwame Nkrumah University of Science and Technology (K.N.U.S.T.), Kumasi. A total of 140 food vendors from five different food stalls on campus, namely: the University Hall, Africa Hall, Queens Hall, Republic Hall and the Biology Canteen, were examined for the presence of parasite eggs, cysts and larvae using the saline method and the formol-ether concentration technique. Questionnaires were used to collect demographic data from the food vendors. The study revealed significant burden ($p < 0.05$) of gastrointestinal parasitic infections among the food vendors in the study area with seventeen different intestinal parasites, namely: *Ascaris lumbricoides* (37.1%), Hookworm (17.9%), *Entamoeba coli* (12.1%), *Taenia sp.* (11.4%), *Fasciola hepatica* (11.4%), *Giardia duodenalis* (10.7%), *Entamoeba histolytica/dispar* (7.1%), *Iodamoeba butschlii* (7.1%), *Hymenolepis nana* (6.4%), *Schistosoma mansoni* (6.4%), *Balantidium coli* (5.7%), *Schistosoma haematobium* (2.9%), *Strongyloides stercoralis* (2.9%), *Fasciolopsis buski* (2.1%), *Diphyllobothrium latum* (1.4%), *Trichostrongyle* (1.4%) and *Trichuris trichiura* (0.7%). The study revealed majority (78.6%) of the food vendors had IPIs with a high prevalence of *Ascaris lumbricoides* recorded, followed by Hookworm. *Trichuris trichiura* however, recorded the lowest prevalence. This raises the concern that, there is the need for the implementation of food handling policies and workshops to educate food vendors on the importance of personal and environmental hygiene and also deworming at least once in every three months.*

Keywords: Food vendors, Intestinal parasites, K.N.U.S.T., Kumasi, Prevalence

INTRODUCTION

Globally, millions of people suffer from infec-

tions such as *Ascaris lumbricoides* (1.2 billion), *Trichuris trichiura* (795 million), hookworm

(*Ancylostoma duodenale* and *Necator americanus*) (740 million) (de Silva, *et al.*, 2003), *Entamoeba histolytica* (50 million) (Samuel *et al.*, 2001) and *Giardia lamblia* now known as *Giardia duodenalis* (2.8 million) (Ali and Hill, 2003). More than 2 billion people are infected with intestinal parasites, of which *Ascaris lumbricoides*, *Trichuris trichiura*, *Necator americanus* and *Ancylostoma duodenale* are of major concern to humans (W.H.O., 2013).

Morbidity and mortality caused by intestinal parasites are significant worldwide especially in under-developed or third-world countries. Over 70 species of protozoan and helminthic parasites can infect humans through food and water contamination (Pozio, 2003). The mode of transmission of intestinal parasites is varied. However, the most common mode of transmission is by the faecal-oral route.

Studies have indicated that amoebiasis is known to cause about 450 million infections per annum in the developing world with an incidence of about 50 million cases and 100,000 deaths (Ravdin, 1988). Giardiasis is more common in children and has a worldwide prevalence of about 1 to 30% (Woo and Paterson, 1986). Reinthaler *et al* (1988) revealed that *Ascaris* is the commonest nematode of man especially in tropical Africa with a prevalence of about 40% in Ogun state of Nigeria.

According to Andargie *et al* (2008), earlier studies by Schlundt *et al* (2004) confirmed that diarrhoeal diseases are mostly caused by food-borne or water-borne microbial pathogens and are the leading causes of illness and death in developing countries, killing an estimated 1.9 million people annually at the global level. Even in developed countries, an estimated one-third of the population is affected by microbiological food-borne diseases each year (Schlundt *et al.*, 2004).

Street foods have recently begun to attract the attention of government and various international agencies including World Health Organ-

isation because one of the features of urbanization in developing countries has been a proliferation of the street food trade (F.A.O., 1989). An estimated 2.1 billion people patronize food vendors worldwide (Nyarango *et al.*, 2008). Food vendors and handlers are, therefore, an integral part of the society's sustainability as they continue to provide nutritious food at affordable prices to consumers outside the home. In this regard, their personal and environmental hygiene during the preparation and handling of the food they sell, have become a major concern to the World Health Organization (W.H.O.), because they are a major source of possible transmission of intestinal parasites.

In Ghana, barbecue-grilled or roasted spiced animal meat—attracts the appetite of the citizens and in almost every restaurant or corner of the main street, they are found. Any not-well-cooked, infected, meat is likely to infect healthy individuals. Tapeworm is known to be transmitted to humans through infected pork, not well cooked. According to Yanney (1996), infectious diseases of sheep and goats that are communicable to man could be avoided if proper treatment and preventive measures were taken. This also applies to other foods such as vegetables where they are eaten raw, uncleaned or under-cooked to retain the natural taste and preserve heat-labile nutrients (Slifko *et al.*, 2000), the risk of infection with intestinal parasites to the population is increased. For instance, previous study by Nyarango *et al.*, (2008) in Kisii Municipality, in Kenya, showed high contamination rates of 52.4%, 57.1%, 81.0% and 71.4% for kales, cabbage, spider flower and black nightshade respectively, with a combination of these parasites: *Entamoeba histolytica*, *Giardia lamblia*, *Balantidium coli*, *Ascaris lumbricoides*, *Trichuris trichiura*, and Hookworms.

Thus, even though street food has become an indispensable part of both urban and rural diets in developing countries, some public health risk is associated with the consumption of these foods. Accordingly, food vendors with poor

personal hygiene who harbour and excrete intestinal parasites and enteropathogenic bacteria through their stools may contaminate foods with their hands, finger nails and wristlets and therefore pass on these pathogens through food processing and handlings to healthy consumers.

Epidemiological research carried out in different countries has also shown that the social and economic situation of individuals is an important contributor to the prevalence of intestinal parasites. In addition, poor sanitary and environmental conditions are known to be relevant in the propagation of these infectious agents (Phiri *et al.*, 2000 and Tellez *et al.*, 1997). Epidemiological surveys undertaken among Kenya's poor periurban and urban school children revealed a high prevalence of intestinal parasitic infections such as *Ascaris lumbricoides* (82.0%), *Trichuris trichiura* (60.0%), *Entamoeba histolytica* (41.0%) and *Giardia lamblia* (30.0%) (Rijspra, 1975).

OBJECTIVES OF THE STUDY

The main objective of the study, therefore, was to determine the status of food vendors on the campus of the Kwame Nkrumah University of Science and Technology with regards to intestinal parasitic infections.

The specific objectives were to determine:

- The types of intestinal parasitic infections among food vendors on the university campus,
- The prevalence of these infections.
- The behavioural and workplace environmental factors that may predispose the food vendors to these infections.

MATERIALS AND METHODS

STUDY AREA

The study was conducted among food vendors at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The university campus which is about 16 square kilometers of an undulating land is loc-

ated about 7 kilometers away from the city center of Kumasi in the Ashanti Region of Ghana, West Africa. The university has a population of 21,285 undergraduates and 2306 postgraduates. There are six halls of residence and five hostels on the main campus (knust.edu.gh, 2014). Each hall has a canteen service and food vendors around the hall.

Sample Population

A total of 140 food vendors participated in the study. Food handlers who could not avail themselves after three visits were considered unwilling to provide their stool samples, so they were excluded from the study.

STUDY METHOD

A letter granting a permission to undertake the study among the food vendors was obtained from the Head of Department of Theoretical and Applied Biology, and from the Head of the Canteen services in the various food stalls in and around the Halls of Residence. Platforms were then created on different days to address the food vendors of each hall on the objectives of the study. Then after, sterilized and appropriately numbered stool containers were given to them to provide about 1- 2 grams of their morning stool sample.

A pretested questionnaire was used to collect demographic details of the food vendors and information relating to personal hygiene, personal habits, history of deworming, and practices during preparation of their food. Observations were made of the surroundings and food handling practices of the vendors.

Stool sample collection and examination

Sterilized containers were given out to the food vendors of each hall the previous day and stool samples were collected in the morning of the following day over a period on daily basis. The collected samples were sent immediately to the Microbiology laboratory at the Department of Theoretical and Applied Biology (TAB) and processed for microscopic examination; using the Leica simple light microscope under low

light intensity. Stool samples that were not examined immediately were preserved under 10% formalin to be examined later, but within the next 24 hours. Evidence of infection was based on the identification of trophozoites, cysts, oocysts, ova and larvae from direct saline wet mount, iodine preparation, and concentration technique (formalin-ether sedimentation technique) (Ayeh-Kumi *et al*, 2009).

Wet mount method (Saline method) for stool examination

The stools were emulsified with 2ml of 0.85 percent of saline solution. A drop each of the emulsified samples was transferred to both ends of a glass slide, a drop of Lugol's iodine was added to one drop, leaving the other sample drop unstained. Each was covered with a cover slip. The preparations were examined first under 10x objective lens, then later 40x for easy and detailed identification of intestinal parasites. Trophozoites, larvae, eggs and cysts were identified under low light intensity.

Concentration technique (Formol-ether concentration method) for stool examination

About a gram of each stool sample was emulsified with 3ml of 10% formol-saline in a test tube. The emulsified sample was fix-gauzed into another test tube, then 4ml of diethyl ether were added to the filtrate and mixed thoroughly; an additional 3ml of 10% formol-saline were added to the filtrate to reach the 10ml mark; it was then corked and mixed by inverting and shaking intermittently for 1 minute.

The preparation was then centrifuged at 3000 rpm for 5 minutes. After centrifugation, the supernatant containing the debris, ether and formol saline were discarded and the sediment containing the parasites was re-suspended in 1ml formol saline. A drop each was transferred unto a slide and examined microscopically under 100x and then 400x magnifications.

Identification of parasites.

Identification of parasites was done using the World Health Organization (W.H.O.) intestinal

parasite identification chart and that by Cheesbrough (2006). Photographs of suspicious but unidentified parasites were taken using a digital camera and sent to the K.N.U.S.T. Hospital for further identification.

Prevalence of Intestinal parasitic infections.

Prevalence of infection with a particular parasite species was determined as the number of cases of infection present in a sampled population at a given time expressed as a percentage.

It was calculated as follows:

$$\text{Prevalence (\%)} = A/B \times 100$$

Where A = Number of food vendors infected

and

B = Total number of food vendors examined

Proportion of Infection by Age group, Educational group and Deworming history

The proportion of infection was determined using the formula:

$$\text{Proportion of Infection (\%)} = Q/Y \times 100$$

Where, Q = Number of positive cases in a particular group

Y = Total number of positive cases examined

Information on deworming history was obtained from the study participants through interviews using a pretested questionnaire. Where an interviewee did not understand the English Language very well, the questions were asked in the local language by the interviewer or help was sought from people who understood both the English language and the local dialect to help with the translation.

Statistical analysis

Data obtained from the 140 food vendors who participated in the study were entered in Microsoft excel 2007 version and validated for errors. After which the data was exported to Prism 5

statistical software for analysis of frequency, prevalence and infection rate with respect to IPIs. Statistical significance was tested for burden of IPIs among the vendors using chi square test. Alpha value was taken as 0.05 (p values less than 0.05 were considered statistically significant).

RESULTS

Out of the total of 140 food vendors examined, 135 (96.0%) were females, whilst the remaining five (4.0%) were males. The males were mainly barbecue vendors and the females sold a variety of dishes.

Parasitological profiles of the food vendors

Seventeen different species of intestinal parasites namely *Ascaris lumbricoides* (37.1%), Hookworm (17.9%), *Entamoeba coli* (12.1%), *Taenia sp.* (11.4%), *Fasciola hepatica* (11.4%), *Giardia duodenalis* (10.7%), *Entamoeba histolytica/dispar* (7.1%), *Iodamoeba butschlii* (7.1%), *Hymenolepis nana* (6.4%), *Schistosoma mansoni* (6.4%), *Balantidium coli* (5.7%), *Schistosoma haematobium* (2.9%), *Strongyloides stercoralis* (2.9%), *Fasciolopsis buski* (2.1%), *Diphyllobothrium latum* (1.4%), *Trichostrongyle* (1.4%) and *Trichuris trichiura* (0.7%), were identified among the food vendors.

Majority (78.6%) of them were infected whereas only a few (30, 21.4%) of them had no infection. Out of the 110 infected food vendors, over a half of them (59.1%) had multi-parasitic infections—their stool had more than one type of protozoan, and/or helminth parasites—while the remaining 40.9% had single parasitic infections, i.e. their stool had only one type of protozoan or helminthic parasites.

Educational background and age distribution of food vendors.

The literacy level of the food vendors varied from the basic to the secondary or vocational level of education. Among the food vendors, majority i.e. 79.0% had attained some level of formal education, while 21.0% had no formal

education. Out of those educated, 77.5% were infected with gastrointestinal parasites while 82.7% of the illiterate food vendors were also infected. Food vendors with basic level of education recorded the highest proportion of infection (Table 1). The ages of the food vendors ranged between 10-70 years, of which over a third (55, 39.2%) of them were in the 21-30 years' age group. The highest proportion of infection 40.9% was recorded among this age group. Vendors above 60 years of age were all infected (Table 1).

Deworming history of food vendors

Out of the study population, 36 (25.7%) admitted deworming themselves once or twice in the past three months, out of which 16 of them were infected with intestinal parasites. However, food vendors who admitted not taking dewormers for over a year were all infected with intestinal parasites (Table 2).

Prevalence of intestinal parasites in the various food establishments

Five different food stalls were considered in the study, namely the University Hall, Africa Hall, Queen's Hall, Republic Hall and the Biology Canteen. The prevalence of IPIs varied with each food stall, indicating significant ($p=0.0001$) burden of IPIs among the total food vendors examined.

It is evident from Table 3 that vendors of the Biology Canteen, located near the Biology Department recorded the highest burden of intestinal parasitic infections (IPIs) with all the seventeen different species of intestinal parasites while vendors at Africa Hall recorded the least number of different species (10) of parasites. It is noteworthy that even though food vendors in Africa Hall recorded the highest prevalence (14, 87.5%) of intestinal parasites within the individual food stalls; of the total number of food vendors infected (110), University Hall recorded the highest proportion (31, 28.2%) of those infected. Over a third (37.1%) of the food vendors were infected with *Ascaris lumbricoides* the study area with *Trichuris trichiura*

recording the lowest (0.7%) IPIs among the food vendors examined (Table 3).

Table 1: Profile of vendors with respect to their intestinal parasitic infections status

Vendors Profile	Infected		Uninfected	
	Number	Percent (%)	Number	Percent (%)
Basic	49	44.6	13	43.3
Secondary	26	23.6	10	33.3
Vocational	11	10.0	2	6.7
None	24	21.8	5	16.7
Total	110	100.0	30	100.0
Age group				
≤ 20	14	12.7	4	13.3
21– 30	45	40.9	10	33.3
31– 40	30	27.3	10	33.3
41– 50	14	12.7	3	10.0
51– 60	5	4.5	3	10.0
≥ 61	2	1.8	0	0.0
Total	110	100.0	30	100.0

Table 2: Proportion of infection with respect to deworming history of food vendors

De-worming History	Infected		Uninfected	
	Number	Percent (%)	Number	Percent (%)
≤ 3 months	16	14.5	20	66.7
≤ 6 months	33	30.0	9	30.0
> 6 months	38	34.5	1	3.3
> 12 months	23	20.9	0	0.0
Total	110	100.0	30	100.0

Table 3: Types and prevalence of intestinal parasitic infections in the various food stalls

Food stalls Intestinal parasites	Biology Canteen N= 25n(%)	Republic Hall N= 26n(%)	University Hall N= 37n(%)	Queens Hall N= 36n(%)	Africa Hall N= 16n(%)	Total no. of vendors examined N= 140n(5)
Nematodes						
<i>Ascaris lumbricoides</i>	11(44.0)	8(31.0)	17(45.9)	9(25.0)	7(43.7)	52(37.1)
<i>Hookworm</i>	7(28.0)	6(23.1)	5(13.5)	4(11.1)	3(18.7)	25(17.8)
<i>Strongyloides stercoralis</i>	2(8.0)	1(3.9)	1(2.7)	ND	ND	4(2.9)
<i>Trichostrongyle</i>	1(4.0)	1(3.9)	ND	ND	ND	2(1.4)
<i>Trichuris trichiura</i>	1(4.0)	ND	ND	ND	ND	1(0.7)
Tape worms						
<i>Taenia sp</i>	4(16.0)	1(3.9)	6(16.2)	5(13.9)	ND	16(11.4)
<i>Hymenolepis nana</i>	4(16.0)	1(3.9)	ND	3(8.3)	1(6.2)	9(6.4)
<i>Diphyllobothrium latum</i>	1(4.0)	1(3.9)	ND	ND	ND	2(1.4)
Flukes						
<i>Fasciola hepatica</i>	6(24.0)	3(11.5)	1(2.7)	4(11.1)	2(12.5)	16(11.4)
<i>Schistosoma mansoni</i>	1(4.0)	3(11.5)	4(10.8)	ND	1(6.2)	9(6.4)
<i>Schistosoma haematobium</i>	1(4.0)	1(3.9)	1(2.7)	1(2.8)	ND	4(2.9)
<i>Fasciolopsis buski</i>	2(8.0)	1(3.9)	ND	ND	ND	3(2.1)
Protozoans						
<i>Entamoeba coll</i>	5(20.0)	1(3.9)	ND	6(16.7)	5(31.2)	17(12.1)
<i>Giardia duodenalis</i>	4(16.0)	1(3.9)	2(5.4)	5(13.9)	3(18.7)	15(10.7)
<i>E. histolytica/ dispar</i>	1(4.0)	3(11.5)	1(2.7)	1(2.8)	4(25.0)	10(7.1)
<i>Iodamoeba butschlii</i>	3(12.0)	1(3.9)	1(2.7)	3(8.3)	2(12.5)	10(7.1)
<i>Balantidium coli</i>	1(4.0)	1(3.9)	1(2.7)	4(11.1)	1(6.2)	8(5.7)
Total burden of parasites	55	34	40	45	29	203
Multi parasitism	12(48.0)	15(57.7)	14(37.8)	19(52.8)	5(31.2)	65(46.5)
Single parasitism	6(24.0)	4(15.4)	17(45.9)	9(25.0)	9(56.3)	45(32.1)
Number examined	25	26	37	36	16	140
Number infected	18(72.0)	19(73.1)	31(83.8)	28(77.8)	14(87.5)	110(78.6)

^aN=The study population in the various food stalls; n% is the prevalence of parasites in each food stall expressed as a percentage; ND means not detected

Prevalence of multiple and single parasitic infections of food vendors in the various food stalls

The study considered, 140 food vendors, of which a substantial number (110, 78.6%) of them were infected with gastrointestinal parasites. Almost half of the food vendors (65, 46.5%) examined had multiple parasitic infections, while 45 (32.1%) had single infections (Table 3).

At each stall, the vendors come from suburbs around the University campus. Majority of the vendors at each food stall had multiple infections, except for University Hall and Africa hall which recorded more single infections than multiple infections (Table 3). The food stalls with the highest and lowest proportion of multi-parasitism were at Queens (19, 52.8%) and Africa hall (5, 31.2%), respectively. On the other hand, Africa Hall and Republic Hall recorded the highest (9, 56.3%) and lowest (4, 15.4%) rates of single parasitic infections in the individual food stalls respectively as indicated in (Table 3).

Knowledge, attitude and practice of personal and environmental hygiene

Although all the food vendors had fair knowledge about personal and environmental hygiene, majority (61.0%) of them had bracelets on and a significant proportion of the vendors (105, 75.0%) wore either no apron or head cover. Only 25.0% (35) of them wore both apron and head cover. Almost all (133, 95.0%) of the food vendors handled food and collected money at the same time with their bare hands. All the food vendors admitted washing their hands with ordinary soap and water after visiting the toilet.

DISCUSSION

Patronage of food from food vendors cannot be avoided by workers, students and indeed the public, since most of the day is spent away from home and very few people get the time to cook food for themselves. Thus, unhygienic conditions of food stalls and poor food hand-

ling practices are likely to make a large number of people vulnerable to infection with food-borne pathogens including intestinal parasites.

The KNUST, like other tertiary educational institutions funded by Government Subvention, abolished the Hall Catering System over two decades ago. This made way for private individuals and catering enterprises to come into operation to provide food services. Whilst some of these entrepreneurs prepared the food in the Hall Kitchens, a number of individuals either cooked their food on the campus at designated places or cooked them at home and brought them to the campus to be sold. Such individuals had to undergo medical screening and finally authorization, before being allowed to sell food on the University campus. Investigations done suggest that after a Permit has been issued to individuals there is no active periodic monitoring of the activities of food vendors.

Moreover, a number of unauthorized individuals have also entered the trade and operate without any guidelines. The fact that this study has shown that a substantial proportion (78.6%) of those who sell food items on campus have significant burden ($p=0.0001$) of intestinal parasitic infections (IPIs); should be of major concern to the university authorities, consumers and the food vendors themselves.

Ascaris lumbricoides was the highest prevailing intestinal parasitic infection (37.1%) among the food vendors examined, followed by hookworm (17.8%). Although these findings differ from those of Alemeshet *et al*, 2011, they are consistent with those of others including Ayeh-Kumi *et al*, (2009), Nyarango *et al*, (2008), de Silva *et al*, (2003) and Nichols, (1999). The fact that majority of the vendors were adults, meant that they wore shoes or sandals reducing the risk of transmission of hookworm which is primarily through skin penetration as compared to *Ascaris* which is mainly oro-faecal.

Most of these adult food vendors were young, in their active years between the ages of 21 and

and 40 years and they recorded high levels of IPIs as compared to vendors below 20 and above 40 years. It is worth noting that all the food stalls had vendors aged between 21 to 30 years recording the highest prevalence of IPIs, except University hall, where the only two vendors in the age group above 60 years harboured infection. These outcomes concur with earlier studies conducted among food vendors in Accra which recorded high IPIs in the same 21 to 30 year age group (Ayeh-Kumi *et al*, 2009). This suggests that individuals in their active years patronized food vending as a career compared to older generations and hence are more likely to get exposed to IPIs especially in situations where the conditions are favourable for the transmission of these parasites.

Even though, majority of the vendors were not highly educated, they had a fair knowledge of personal and environmental hygiene. However, the screening showed that they lacked knowledge of the mode of transmission of gastrointestinal parasites through the oral-faecal route.

Some food vendors had no access to toilet facilities; this was evident in University hall, Republic hall and the Biology canteen. Previous studies have reported similar incidence with respect to lack of toilet facilities for food vendors (Jasem *et al*, 2012 and Nichols, 1999). These vendors had to seek other places for defecation when the need arose whilst they are at work, probably by using the toilet facilities provided for the students. In the University hall—a solely male hall—the female vendors had challenges since they are provided with no toilet facility and had to sneak into the toilet facility meant for the junior staff. Food handlers with toilet facilities provided for by the halls were allowed access to them, but they either misuse the facility or do not heed to the use of medicated soap in washing their hands after defecation. Almost all (98.0%) the food vendors admitted using water and ordinary or non-medicated soap—which are not effective in getting rid of, or killing any pathogens that may have contaminated their hands—to wash

their hands after defecation without adding any detergent. The food vendors who had dewormed themselves within a year, had significant proportion of them being re-infected with parasites whereas vendors whose last time of deworming, was over a year, were all re-infected with gastrointestinal parasites (Table 2). Most of the food vendors admitted deworming at least once within a year. Contrary to expectations, an appreciable number of vendors (16) who had dewormed themselves within the last three months, were re-infected nevertheless. A possible explanation for this might be the use of ineffective de-wormers or intake of de-wormers at times other than at bed time. In addition, ignorance about the type of parasites may lead to the prescription and use of inappropriate de-wormers and dosage. Most intestinal protozoan parasites may not be affected by a number of anti-helminthic drugs. Furthermore, pre-disposing factors may still be prevalent.

Factors that predisposes the food vendors to intestinal parasitic infections (IPIs)

The study was undertaken between February and April in 2011, the beginning of the rainy season and most places on campus were damp. The refuse dump behind the halls, were left open without any cover. The dampness of the refuse with the scent emanating from decaying organic waste, attracted houseflies which may accidentally carry microbes from the refuse to exposed food. Environmental conditions, such as high humidity and optimal temperatures for larval/egg development/viability, coupled with economic deprivation may have contributed to the transmission and maintenance of infective stages of these intestinal parasites (Ayeh-Kumi *et al*, 2009).

Interviews of vendors during the period and observation revealed that, dustbins were left exposed to flies which could transmit the cysts and eggs of these pathogens unto the exposed food being sold. All the food vendors were without hand gloves and most of them handled food and money at the same time, as they served their consumers. Thus microbes on the

money the vendors handled could be transmitted onto the food dispensed with the bare hands. An insignificant number of vendors used fork or wrapped their hands in a polythene sheet or bag before picking food to serve customers.

The food vendors washed their utensils and hands in water retaining receptacles, using the same water for several rounds of washing. Most of them had no head cover and/or apron; a few however used both. Some scratched their hair with their bare hands and at the same time used them in serving food to the consumers. Even though this study didn't take into account the possible intestinal parasites that may be hidden beneath the fingernails of the vendors, earlier reports and studies done suggested the presence of cysts and eggs of intestinal parasites (Sriptiastuti and Widiastuti, 2011; Sahlemariam and Mekete, 2001 and Okubagzhi, 1998). This attests to possible transmission and spread of IPIs from the finger nails of vendors to consumers, especially in cases where the vendors used bare hands to scratch their hair and serve food at the same time. That these food vendors were asymptomatic carriers further increased the risk of disease transmission to their consumers (Idowu and Rowland, 2006).

Limitations of the study

The main weakness of the study was the failure to culture stool samples containing eggs of hookworm and *Taenia sp.* Hence the study was unable to identify the species of hookworm and *Taenia* present in the stool samples that contained them.

Each stool sample was collected on one occasion for the detection of parasites. This could have underestimated the prevalence of IPIs, as using successive stool specimens of each food vendor would have increased the effective diagnosis of intestinal parasites. Notwithstanding the limitations, the levels of infection were found to be significant.

CONCLUSION

The types and prevalence of intestinal parasitic infections in food vendors on KNUST campus were determined. The burden of IPIs among the food vendors was statistically significant ($p < 0.05$), with *Ascaris lumbricoides* being the most prevalent.

Most of the food vendors were conscious of deworming as a healthy practice but lacked effective personal hygiene for, in spite of their deworming practice, a significant proportion of them were re-infected. Environmental conditions may also have contributed to the high prevalence of intestinal parasitic infections since refuse dumps and the surroundings were cleared irregularly. This study was also undertaken during the rainy season when climatic and environmental conditions favoured egg, cyst and larval development, viability and survival.

RECOMMENDATIONS

The risk of food contamination depends largely on the health status of food vendors, their personal hygiene, knowledge attitude and practice of food hygiene (Abhay *et al.*, 2010). Therefore, there is the need by the University Authorities for periodic health education seminars and workshops for the food vendors, in order to sensitize them to observe personal and environmental hygiene regulations and to address any problems that might be facing them.

Enactment of food handling policies including the need for periodic deworming and strict adherence to these policies must be ensured.

A system should be put in place by the University to monitor the quality of the items used in the preparation of the food and the dispensing process, as well as the surrounding environment periodically. Refuse dumps around the Halls of residence must be covered and emptied regularly, even daily to prevent houseflies and rodents from getting on them. Also, toilet facilities should be made available at food stalls with no such facilities especially Biology Can-

teen and University Hall. Similar interventions made elsewhere in Iran, revealed valuable reduction of IPIs among food handlers (Jasem *et al*, 2012).

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