International Journal of Public Health and Epidemiology ISSN: 2326-7291 Vol. 3 (2), pp. 007-016, February, 2014. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Prevalence of pathogenic protozoa infection in humans and their associated risk factors in Benue State, Nigeria

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Accepted 21 January, 2014

Pathogenic intestinal protozoa have been associated with human gastrointestinal disorders worldwide. This study was designed to determine the prevalence & associated risk factors of *Cryptosporidium parvum* (CP), *Entamoeba histolytica* (EH) and *Giardia lamblia* (GL) infections in people living in the senatorial districts of Benue state (zones A, B and C). A cross-sectional study was designed in which 733 stool samples were collected from out-patients and apparently healthy individuals from homes. Ethical consent was sought and approved before sample collection. Samples were analyzed using the Rida® Quick immunochromatographic method. A structured questionnaire was administered to subjects to obtain information on their socio-demographic characteristics. The results showed a total prevalence rate of 47.8, 31.5 and 43.9% in zones A, B and C respectively. While source of drinking water was positively associated with protozoa infections in zones A and C, age, hand washing habit and source of food were statistically significant only in zone A ($p < 0.05$). In zone B, literacy level, household toilet facility and care of fruits significantly increased infection rates ($p < 0.05$). This study has identified specific risk factors responsible for pathogenic protozoa infections in humans in Benue state.

Key words: Cryptosporidium parvum, Entamoeba histolytica, Giardia lamblia, risk factors, Benue State, Nigeria.

INTRODUCTION

Many intestinal protozoa parasites inhabit the gastrointestinal tract of humans (Fontanet, 2000; Arora and Arora, 2009). However, majority of them are non-pathogenic commensals or only result in mild disease while a few of them such as *Cryptosporidium parvum (*CP), *Entamoeba histolytica* (EH) and *Giardia lamblia* (GL) are pathogenic and have been associated with human gastrointestinal disorders worldwide among children and adults alike (Arora and Arora, 2009). In Nigeria, transmissions of these pathogens to man is through contaminated water, oo (cysts) passed by food handlers (in homes, eating places on streets), flies and faeco-oral contamination (Ajero et al., 2008).

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Other environmental factors which aid acquisition include occupation and standard of living within the population (Oyerinde et al., 1981). Spencer et al., (1976) and Koopman (1987) observed a striking association between prevalence of intestinal parasites and domestic water supply, toilet facilities, sewage and garbage disposal as well as environmental sanitation. Communal eating habit, contaminated fruits and vegetables, poor hygiene and sanitation, poor housing, poor education, poverty, ignorance, climate, oral and anal sex, wilderness travel with ingestion of contaminated water and food, exposure to infected animals as well as close contact with source case such as day care centres, nursery schools, prisoners and mental homes have also been implicated in the transmission of these protozoal parasites (Molbak et al.,1994b; Cox, 2002; Benetton et al., 2005, Rinne et al., 2005; Petri and Singh, 2006; Arora and Arora, 2009; Fadeyi et al., 2009). Deficient immunologic

factors such as immunoglobulin (Ig) A and T-cell responses are also important predisposing factors for transmission (Rinne et al., 2005).

In Benue State and Nigeria as a whole, the problems of sanitation and hygiene as they affect sources of drinking water, food preparation, communal eating habit, care of fruits and vegetables and hand washing are common place. These have resulted in wide cases of diarrhoea due to *C. parvum*, *E. histolytica* and or *G. lamblia* as reported by Inabo et al., 2000; Ikeh et al., 2006; Yemisi et al., 2007; Nyamgee et al., 2009 and Oyibo et al., 2009.

While the prevalence of CP, EH and GL is fairly documented in patients and children with human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) in the state, there are no data on the distribution of these parasites in apparently healthy individuals. We report the result of a prevalence study of CP, EH and GL infection and the associated risk factors in people living in Benue State Nigeria with the aim of making suggestions for their control and prevention.

MATERIALS AND METHODS

Study Area

The study was conducted in the three senatorial districts of Benue State namely: Benue North East (zone A), Benue North West (zone B) and Benue South (zone C) between January 2012 to March 2013. Benue State also known as "Food Basket of the Nation" is located within the north central geo-political zone of Nigeria and shares boundaries with five other states. Most people from the hinterland are farmers while the inhabitants of the riverine areas engage in fishing as their primary occupation (Complete guide to Nigeria tourism: Benue state, 2013).

Sampling Procedure and Study Population

A cross-sectional study was designed in which 733 stool samples were collected from out-patients and apparently healthy individuals from homes and analyzed using Rida® Quick Immunochromatographic test strip method. A preliminary visit was made to the Benue state Epidemiologic Unit to obtain information on the extent of surveillance and monitoring program of parasitic infections affecting the people of Benue state. Findings showed that such surveillance program had not being conducted in some local government areas (LGA) in the state including Ukum, Vandeikya, Logo, Gboko, Buruku, Guma, Ado, Agatu and Okpokwu. Based on this information, one government general hospital from each LGA (That is 9 hospitals, 3 from each zone) was randomly selected and sick patients who presented with diarrhoea and were sent to the laboratory for stool examination were included in the study. Samples were collected from patients using a systematic random sampling method. The first patient and patients at an interval of 3 counts were selected for inclusion in the study**.** Also, samples were collected from randomly selected volunteers who were apparently healthy from different homes in the 3 zones of the study area.

Ethical Consideration

For patients, ethical approval was obtained from the Ethical Committee of the Benue State Hospitals Management Board (BSHMB) with reference number: HMB / CIR 13 VOL1 / 118 before stool samples were collected. Apparently healthy individuals who consented to inclusion in the study were counseled towards participation.

Inclusion Criteria

Patients presented with diarrhoea to the selected government general hospitals and who were referred to the laboratory for stool examination in the three zones of the state, were included in the study. Also included were apparently healthy home based people of all ages.

Exclusion Criteria

Both patients and apparently healthy people who were on antimicrobial agent(s) such as metronidazole, tetracycline, erythromycin and antacids (For example, bismuth or laxative) within a week prior to sample collection or have just completed investigation with barium meal/enema diarrhoea were excluded from the study. This was necessary because the aforementioned antimicrobials and antacids prevent the shedding of intestinal parasites in the stool of such individual for several weeks and this may lead to false negative result when such individual is examined.

Questionnaire

Information on the subject's sex, age, literacy level (not of school age, nursery, primary, secondary, tertiary, illiteracy) and related risk/socio-demographic factors including source of drinking water (well, pond, river, stream, borehole, sachet), household toilet facility (pit latrine with cover, pit latrine without cover, water closet, no toilet[open field]), hand washing habit (after toilet with soap, after toilet without soap, after handling diarrhoea patient, no hand washing), hand eating habit (eat with hands after washing with soap, eat with hands after washing without soap, eat with hands without washing,

Table 1. Prevalence rate of pathogenic protozoal infection in humans detected by Rida® Quick test in zones A, B and C of Benue State, Nigeria.

Parasites	Zones A (%) [n = 251]	B (%) [n = 254]	C (%) [n = 228]	Total (%) [n = 733]
CP	50 (19.9)	29 (11.4)	24 (10.5)	103 (14.1)
EH	17 (6.8)	18 (7.1)	12 (5.3)	47 (6.4)
GL	36 (14.3)	16 (6.3)	45 (19.7)	97 (13.2)
GL/EH	7 (2.8)	4 (1.6)	6 (2.6)	17 (2.3)
GL/CP	0	4 (1.6)	1 (0.4)	5 (0.7)
CP/EH	4 (1.6)	3 (1.2)	7 (3.1)	14 (1.9)
CP/EH/GL	6 (2.4)	6 (2.4)	5 (2.2)	17 (2.3)
Total	120 (47.8)	80 (31.5)	100 (43.9)	300 (40.9)

n- Number examined, CP- *Cryptosporidium parvum*, EH- *Entamoeba histolytica,* GL- *Giardia lamblia*.

eat communally with hands, eat with cutleries), washing of fruits before eating (always, do not wash, sometimes), source of food (home cooked food, food vendors, both), using a structured questionnaire were obtained.

Sample Collection

Freshly passed single stool was collected from each subject. All subjects were advised against contaminating their stool with urine, water, dirt and or disinfectant as this might confuse the exact source of contamination of the protozoa parasite that may be detected. Samples were collected using clean, dry, wide mouthed, sterile, grease free bottles. Each sample was processed within 1 hour of collection using Rida® Quick immunochromatographic test (R-biopharm, Germany).

Rida® Quick Immunochromatographic Test Strip Method

The procedure was performed as prescribed on the manufacturer's kits. Briefly, the reagent (extraction buffer) which was kept at 4^{o}C in the refrigerator was brought to room temperature (27.5-30^{o}C). One milliliter of the buffer was dispensed into a test tube using the disposable pipette provided. Exactly 100µl watery or pea size stool was added into the test tube containing the buffer using 100µl Eppendorf pipette or applicator stick as the case may be per sample. The mixture (buffer and stool) was homogenized for 30 seconds by suction and ejection using the disposable pipette. The immunochromatographic test strip was immersed into the mixture up to but not higher than the arrow mark on the strip for 5 seconds. It was brought out and allowed to stand for 3 minutes at room temperature. Positive result was visual to the eyes by the appearance of green, red or blue test band indicating the presence of EH, GH or CP respectively. Mixed infections of two or three of the parasites were seen by the appearance of the two or three test bands depending on the parasites involved. Negative result was shown by the appearance of only the crimson control band on the test strip.

Statistical Analysis of Data

Data collated at the end of the study were analyzed using Statistical Package for Social Science (SPSS) version 16.0 (SPSS Inc. Chicago, IL, USA). Statistical methods employed included descriptive statistics employing frequencies and percentages. To assess the association between the socio-demograhic factors and PI, data was subjected to binary logistic regression. Categories of variables with $p < 0.05$ and 95 % confidence interval of odds ratio OR not including 1 were considered statistically significant.

RESULTS

The results showed the following number of cases in zones A, B and C as 120 (251; 47.8%), 80 (254; 31.5%) and 100 (228; 43.9%) respectively, with *C. parvum* having the highest total prevalence: 103 (733; 14.1%) in

Table 2. Effects of associated risk factors on the prevalence of protozoa infections among the people living in zone A of Benue state.

Risk factors	NE	NP (%)	P value	OR	95% CI	
					Lower	Upper
Sex: male[a]	108	53 (49.1)				
Female	143	67 (46.9)	0.397	0.69	0.30	1.62
Age:0-9[a]	62	26 (41.9)				
10-17	51	28 (54.9)	0.917	0.91	0.17	5.05
18-45	95	55 (57.9)	0.642	0.56	0.05	6.37
46 & above	36	9 (25.0)	0.019	0.03	0.00	0.58
Literacy: not of school age[a]	19	9 (47.4)				
Nursery	24	10(41.7)	0.889	0.90	0.20	4.11
Primary	39	16 (41.0)	0.842	0.84	0.16	4.51
Secondary	69	38 (55.1)	0.745	1.49	0.13	16.54
Tertiary	39	15 (38.5)	0.438	3.23	0.17	62.85
Illiterate	61	32 (52.5)	0.118	10.40	0.55	195.94
Drinking water: private well[a]	74	27 (36.5)				
Public well	80	40 (50.0)	0.053	2.20	0.99	4.91
Pond	43	28 (65.1)	0.001	5.55	2.00	15.36
Stream	13	11 (84.6)	0.004	18.18	2.56	129.17
Borehole	26	11 (42.3)	0.426	1.65	0.48	5.66
Pipe borne	12	3 (25.0)	0.279	0.39	0.07	2.16
Sachet water	3	0 (0)	0.999	0.00	0.00	
Toilet: pit latrine with cover[a]	42	22 (52.4)				
Pit latrine without cover	60	26 (43.3)	0.133	0.45	0.15	1.28
Open field	108	51 (47.2)	0.698	0.83	0.32	2.16
Water closet	41	21 (51.2)	0.915	1.07	0.32	3.51
Hand washing**:** after toilet with soap[a]	70	27 (38.6)				
After toilet without soap	45	31 (68.9)	0.002	5.78	1.91	17.48
After handling diarrhoea patient	4	2 (50.0)	0.699	0.59	0.04	8.45
No hand washing at all	132	60 (45.5)	0.140	1.91	0.81	4.50
Hand eating habit: eat with hands after washing with soap[a]	35	16 (45.7)				

Table 2. Cont.

eat with hands after washing without soap	64	31 (48.4)	0.424	0.60	0.17	2.11
eat with hands without washing at all	22	10 (45.5)	0.222	0.33	0.06	1.95
eat communally with bare hands	123	60 (48.8)	0.208	0.46	0.14	1.54
eat with cutleries	7	3 (42.9)	0.670	1.53	0.22	10.87
Washing of fruit: always wash fruits before eating[a]	87	38 (43.7)				
do not wash fruits before eating	48	24 (50.0)	0.869	1.09	0.39	3.05
Wash fruits sometimes before eating	116	58 (50.0)	0.323	1.49	0.67	3.31
Source of food: home cooked food[a]	126	49 (38.9)				
food vendors	39	16 (41.0)	0.240	1.98	0.63	6.22
HCF +FV	86	55 (64.0)	0.001	3.55	1.65	7.64

NE= number examined, NP = number of positive, [a] Reference category.

the state (Table 1). Specific rates for CP, EH, GL as well as GL/EH, CP/EH and CP/EH/GL mixed infections were 19.9, 6.8, 14.3 2.8, 1.6 and 2.4 % respectively for zone A. Zone B had rates of 11.4, 7.1, 6.3, 1.6, 1.6 1.2 and 2.4 for CP, EH, GL and mixed infections of GL/EH, GL/CP, CP/EH and CP/EH/GL respectively while 10.5, 5.3, 19.7, 2.6, 0.4, 3.1, and 2.2 were the rates for CP, EH, GL, GL/EH, GL/CP CP/EH and CP/EH/GL respectively in zone C (Table 1).

Age and sex distribution of the sample population in the 3 zones are as shown in Tables 2, 3 & 4 respectively. Age and sex did not significantly influence the prevalence of protozoa infections (PI) in all the zones except for zone A where a negative association was observed.

In Zone A, source of drinking water, hand washing habit and source of food significantly influenced the prevalence of PI ($p < 0.05$) (Table 2). Protozoal transmission increased with age but a sharp decrease was recorded for individuals 46 years & above (25.0%, OR = 0.03, 95% CI =0.00, 0.58; p = 0.019). Respondents whose sources of drinking water were pond and stream significantly had high rates of infection (pond: 65.1%, OR = 5.55, 95% CI =2.00, 15.36, p = 0.001; stream: 84.6%, OR = 18.18, 95% CI = 2.56, 129.17, p = 0.004). Respondents who reportedly did not use soap for hand washing after using the toilet were significantly infected (68.9%, OR = 5.78, 95% CI = 1.91, 17.48, p = 0.002). PI were significantly higher in those who ate both home cooked food and food from vendors (64.0%, OR = 3.55, 95% CI = 1.65, 7.64, p = 0.001).

In zone B, literacy level, household toilet facility and care of fruits were reportedly significant factors that influenced PI ($p < 0.05$) (Table 3). PI were significantly higher in primary school pupils and illiterates (primary: 27.0%, OR = 14.03, 95% CI = 1.27, 154.51, p = 0.031; illiterates: 41.4%, OR = 94.65, 95% CI =1.35, 6.65E3, p = 0.036). Respondents that reportedly defecate in open fields (34.4%, OR = 4.09, 95% CI =1.18, 14.15, p = 0.026) and those who did not wash fruits before eating (45.5%, OR = 2.55, 95% CI = 1.06, 6.17, p = 0.038) were significantly more likely to be infected with PI.

In zone C, respondents that reportedly drank water from pond (66.7%, OR = 6.00, 95% CI = 1.97, 18.27, p = 0.002), river (66.7%, OR = 11.33, 95% CI = 1.27, 100.87, p = 0.030) and stream (83.3%, OR = 31.0, 95% CI = 4.30, 223.55, p = 0.001) were significantly more likely to be infected with PI (Table 4). Hand eating habit (eating communally with bare hands: 37.1%, OR = 0.18, 95% CI = 0.04, 0.88, p = 0.034) and source of food (food vendors: 35.0%, OR = 0.16, 95% CI = 0.03, 0.87, p = 0.034) were negatively associated with PI, therefore the factors may be protective.

DISCUSSION

Results of this study showed a high prevalence of CP, EH, GL in the 3 zones of Benue State. In England and Wales, a higher prevalence of PI was reported in children between 1-2 years of age than in any other age group (Nicholas et al., 2006]. This is not different from most cases in Nigeria where infection was found mostly among children less than 5 years (John et al., 1998; Aminu and Yakubu, 2008). However, the findings of this study are in contrast to previous studies. Children between 0-9 years of age in the 3 zones of the state had a lower prevalence

Table 3. Effects of associated risk factors on the prevalence of protozoa infections among the people living in zone B of Benue state.

					95% CI	
Risk factors	**NE**	**NP (%)**	**P value**	**OR**	**Lower**	**Upper**
***Sex**:* male[a]	108	38 (35.2)				
Female	146	42 (28.8)	0.393	0.72	0.34	1.53
Age: 0-9[a]	75	19 (25.3)				
10-17	62	20 (32.3)	0.767	0.68	0.05	8.77
18-45	86	26 (30.2)	0.649	0.48	0.02	11.09
46 & above	27	12 (44.4)	0.529	0.33	0.01	10.70
Literacy: not of school age[a]	17	3 (17.6)				
Nursery	22	5 (22.7)	0.109	6.01	0.67	53.94
Primary	37	10 (27.0)	0.031	14.03	1.27	154.51
Secondary	73	24 (32.9)	0.053	36.96	0.96	1.43E3
Tertiary	35	9 (25.7)	0.116	31.94	0.43	2.40E3
Illiterate	70	29 (41.4)	0.036	94.65	1.35	6.65E3
Drinking water: private well[a]	67	21 (31.3)				
Public well	77	20 (26.0)	0.769	0.87	0.35	2.19
Pond	45	19 (42.2)	0.245	1.80	0.67	4.82
Stream	20	10 (50.0)	0.205	2.31	0.63	8.41
Borehole	32	7 (21.9)	0.997	0.10	0.29	3.44
Pipe borne	11	3 (27.3)	0.857	0.85	0.14	5.16
Sachet water	2	0 (0)	0.999	0.00	0.00	
***Toilet**:* pit latrine with cover[a]	33	7 (21.2)				
Pit latrine without cover	71	25 (35.2)	0.066	3.25	0.93	11.42

Table 3. Cont.

Open field	122	42 (34.4)	0.026	4.09	1.18	14.15
Water closet	28	6 (21.4)	0.750	1.31	0.25	6.86
Hand washing**:** After toilet with soap[a]	58	16 (27.6)				
After toilet without soap	91	27 (29.7)	0.346	0.61	0.22	1.70
After handling diarrhoea patient	9	4 (44.4)	0.118	4.47	0.69	29.21
No hand washing at all	96	33 (34.4)	0.604	1.32	0.47	3.71
Hand eating habit: eat with hands after washing with soap[a]	16	4 (25.0)				
eat with hands after washing without soap	117	30 (25.6)	0.276	0.43	0.10	1.95
eat with hands without washing at all	18	7 (38.9)	0.061	10.23	0.90	116.73
eat communally with bare hands	96	36 (37.5)	0.784	1.24	0.27	5.60
eat with cutleries	7	3 (42.9)	0.862	0.81	0.08	8.42
Washing of fruit: always wash fruits before eating[a]	100	25 (25.0)				
do not wash fruits before eating	55	25 (45.5)	0.038	2.55	1.06	6.17
Wash fruits sometimes before eating	99	30 (30.0)	0.835	1.09	0.50	2.34
Source of food: home cooked food[a]	142	37 (26.1)				
food vendors	9	5 (55.6)	0.613	1.63	0.25	10.84
HCF + FV	103	38 (36.9)	0.368	1.44	0.65	3.17

NE= number examined, NP = number of positive, [a] Reference category.

of PI compared to those above 10 years and adults. In zones A and C, adults between 18-45 years of age had the highest prevalence. Though, adults may be aware of the importance of personal hygiene than children, the high prevalence may be due to unlimited exposure to contaminated foods from different sources as against children or teenagers whose exposures are limited.

The high prevalence of PI among children in primary schools and adults in this study could be attributed to their state of poor hygiene and sanitation. For example, in the rural areas, people spend long periods of time on their farms with their children roasting yams and cassava which they eat with unwashed hands and drink water from nearby pond or stream. The exposure to pathogenic protozoa is facilitated in such circumstances with children and adults having significant infection as in this study. Similarly, in as much as children compromise personal hygiene, the adults (irrespective of their standard of education) become exposed to PI due to unlimited exposure to different sources of contaminated foods.

Table 4. Effects of associated risk factors on the prevalence of protozoa infections among the people living in zone C of Benue state.

Risk factors	NE	NP (%)	P value	OR	95% CI Lower	Upper
Sex: male[a]	97	52(53.6)				
Female	131	49(37.4)	0.310	0.64	0.27	1.52
Age: 0-9[a]	64	30(46.9)				
10-17	58	24(41.4)	0.937	1.09	0.14	8.63
18-45	74	36(48.6)	0.411	0.30	0.02	5.31
46 & above	25	9 (36.0)	0.248	0.12	0.00	4.32
Literacy: not of school age[a]	25	15(60.0)				
Nursery	31	14(45.2)	0.131	0.38	0.11	1.34
Primary	46	16(34.8)	0.161	0.24	0.03	1.76
Secondary	57	28(49.1)	0.543	0.44	0.03	6.28
Tertiary	30	13(43.3)	0.500	0.31	0.01	9.40
Illiterate	39	15(38.5)	0.683	0.47	0.01	17.96
Drinking water: private well[a]	44	16(36.4)				
Public well	95	35(36.8)	0.516	1.35	0.55	3.34
Pond	42	28(66.7)	0.002	6.00	1.97	18.27
River	6	4 (66.7)	0.030	11.33	1.27	100.87
Stream	12	10(83.3)	0.001	31.00	4.30	223.55
Borehole	29	8 (27.6)	0.424	0.60	0.17	2.09
Toilet*:* pit latrine with cover[a]	34	15(44.1)				
Pit latrine without cover	63	22(34.9)	0.732	1.21	0.41	3.52
Open field	95	48(50.5)	0.321	1.67	0.61	4.63
Water closet	36	16(44.4)	0.878	0.91	0.28	3.01
Hand washing**:** after toilet with soap[a]	39	16(41.0)				
After toilet without soap	72	31(43.1)	0.782	1.16	0.40	3.43
After handling diarrhoea patient	9	7 (77.8)	0.052	10.19	0.09	95.08
No hand washing at all	108	47(43.5)	0.844	1.13	0.34	3.74
Hand eating habit: eat with hands after washing with soap[a]	23	14(60.9)				
eat with hands after washing without soap	56	24(42.9)	0.068	0.24	0.05	1.11
eat with hands without washing at all	40	22(55.0)	0.124	0.26	0.05	1.45
eat communally with bare hands	97	36(37.1)	0.034	0.18	0.04	0.88
eat with cutleries	12	5 (41.7)	0.305	0.33	0.04	2.72
Washing of fruit: always wash fruits before eating[a]	71	36(50.7)				
do not wash fruits before eating	26	14(53.8)	0.601	0.72	0.20	2.51
Wash fruits sometimes before eating	131	51(38.9)	0.068	0.47	0.21	1.06
Source of food: home cooked food[a]	165	73(44.2)				
food vendors	20	7 (35.0)	0.034	0.16	0.03	0.87
HCF + FV	43	21(48.8)	0.201	2.29	0.64	8.13

NE= number examined, NP = number of positive, [a] Reference category.

Water contamination has been reported to be the source of infections in most communities with outbreak of parasitic diseases (WHO, 1968). Cryptosporidiosis for example, was reported in the largest water borne outbreak of disease where more than four hundred thousand (400,000) people were affected after drinking water supply of Milwaukee, USA (Corso, 2003). In Benue State, drinking water sources available to the people are appalling in terms of sanitation and hygiene (personal observation). It is common to see children and women dipping their bare legs into a water source they intend to fetch from for drinking purposes. Faecal matter and their offensive odour are also common sight and perception around some water sources. The implication is that, contamination by protozoans due to surface run-offs, floods as well as users with poor personal hygiene and dirty habits prevails. The results of this study showed a significant positive association between the source of drinking water and PI in zones A and C. This may be due to the factors enumerated above. In zone B, the source of water did not influence PI. Based on personal observation during the study, boreholes were spotted in almost all the sampling units in the zone. Also, zone B had a lower prevalence of PI based on literacy level compared to the other zones.

The availability of toilets / latrines is important in determining the prevalence of protozoa organisms in a given domain (Atu and Akpera, 2007). This is because, if these are absent, faecal matter with offensive odour and unpleasant sight would litter the household surroundings. The faecal matter bearing pathogenic parasite(s) could contaminate surface drinking water sources, vegetables and fruits during overland run-offs or be blown into food sources during windy thunder storms. This was truly evident in zone B where respondents who reportedly had no toilet in their homes and defecate in open field or their surroundings, where 4 times more infected as those who had latrines with cover in their home.

Hand washing habit was positively associated with PI in zone A. The findings of this study showed that respondents who reportedly did not wash their hands with soap after using the toilet were 5.78 times more likely to be infected as those who wash their hands with soap after using the toilet (Table 3). Soap in conjunction with soft water if properly applied remove dirt and contaminants of any kind (Joan, 2012). Respondents in zone B also had the highest prevalence of PI among those who after using the toilet did not wash their hands with soap and did not wash their hands at all. In zones A and C, the proportion of infected people as to their habit of hand washing after using the toilet was statistically the same, therefore the effect was not significant.

The findings of this study showed that hand eating habit was negatively associated with PI in zone C, hence the factor may be protective (Table 4). Respondents that reportedly ate communally with bare hands were 0.18 times less likely to be infected as those who ate with their hands after washing with soap. Interestingly, those that ate with their hands after washing with soap had the highest prevalence of PI. This is possible because the personal hygiene of the respondent and his/her awareness of PI might be questionable.

The care of fruits by washing before eating is very important as it reduces faeco-oral transmission of parasitic agents such as the ones under study. In this study, the people of zone ‘B’ were seen to have shown an indifferent attitude towards this, hence the significant influence of the risk factor in the transmission of the parasite in the zone (Table 3). Those that did not wash fruits before eating where 2.6 times more likely to be infected as those that wash fruits before eating. Also, PI was most prevalent in those who did not wash fruits before eating. This zone in Benue State is characterized by orchards of mango and orange trees; meaning that fruits ploughed from such orchards are liable to contamination upon coming in contact with the already contaminated soil in the orchard.

The habit of purchasing and consuming meals and snacks prepared outside the home is typical of the present life styles of some homes in Benue State and Nigeria as a whole. A study in 1998 showed that two-third of Nigeria’s population daily meals are bought from vendors and fast food chains and that street food constituted at least one-third of their daily nutrient intake (Akinyele, 1998). The role of food handlers and vendors in the spread of faeco-oral parasitic diseases is epidemiologically significant as most of them lack personal hygiene. Thus, they help in conveying viable cysts to ready foods and other foods consumed without further processing as evident in zone A.

CONCLUSION

Important demographic factors have been identified in this study as being significantly responsible for the transmission of CP, EH and GL in Benue State. To this end, we recommend that government should come up with some measures to mitigate the effect of PI on the people of the state including health education on personal hygiene and sanitation. The government should also provide steady supply of potable water such as borehole and pipe borne water to avoid the use of polluted waters. Where these are not available, the people should be educated on the need to boil water from streams, wells and ponds to kill harmful germs before drinking. We also recommend that a school curricula which emphasizes strongly on environmental health, hygiene and sanitation from the elementary class up to the general studies courses at the university, should be developed and adopted by the schools in the state. This would help internalize the culture of personal and environmental sanitation among children as they grow to adulthood to become caregivers and parents.

Surveillance and monitoring program on parasitic infections among the people and animals in the state and prevention, control and treatment program be instituted. Limitations of this study include financial, time, material and other logistical constraints.

ACKNOWLEDGEMENTS

We acknowledge the financial support of the step B-project of Ahmadu Bello University (ABU) Zaria, Nigeria which enabled us to purchase the ELISA Rida® test kits from R-biopharm AG Darmstadt, Germany for the laboratory examination of the stool samples. Our appreciations also go to the authority of the BSHMB for allowing us access into the government hospitals premises for sampling and to the patients and volunteers who availed us with the samples and demographic information used for the study.

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