African Journal of Microbiology Research Vol. 6(14), pp. 3465-3479, 16 April, 2012
Available online at http://www.academicjournals.org/AJMR
DOI: 10.5897/AJMR11.1535
ISSN 1996-0808 ©2012 Academic Journals

Full Length Research Paper

Domestic water use, sanitation and diarrhea incidence among various communities of Ikare – Akoko, Southwestern, Nigeria

Ayeni Amidu Owolabi

Department of Geography, University of Lagos, Akoka – Yaba, Lagos – Nigeria. E-mail: aayeni@unilag.edu.ng or ayeniao2000@yahoo.com. Tel: +234 (0) 8035894730.

Accepted 20 March, 2012

Potable water supply in Ikare – Akoko, Nigeria has been on continuous decrease due to deficiency in safe water supply infrastructure. The productive time of active labour force is being spent in sourcing water due to distance of available sources. In recognition of these problems, this paper examines the domestic water, sanitation and diarrhea situations among the five communities of Ikare – Akoko, Southwestern, Nigeria. The study adopted the concept of Ecosystem Approach to Human Health (Eco-Health). The research was conducted within trans-disciplinary protocol. As observed from the findings, poverty and lack of education among gender especially women, have deprived the residents of all communities particularly the indigenes the knowledge of environmental protection and health awareness. The result also revealed that majority of residents depend on unsafe surface water as the major domestic water supply source. About 80% of domestic activities that degraded habitable environment are carried out indiscriminately. Wastes are disposed illegally within and around human immediate environment. Most people used open space for defecation, while almost 90% of latrines are open type and not well maintained. These have enhanced wide linkages between unsanitary environment and human health which has really promoted and increased diarrhea cases.

Key words: Domestic, surface water, sanitation, diarrhea, communities.

INTRODUCTION

Improved sanitation and safe domestic water will minimize the burden of water-related disease and encourage a healthy environment (Cairncross, 1990; Ekugo, 1998; Ajiwe et al., 2000; Mahvi and Karyab, 2007; Ademiluyi and Odugbesan, 2008), and also reduces the risk of communicable diseases that might arise from contaminated and poor sanitary environment (Bateman and Smith, 1991; Ifabiyi, 2000; Sasaki et al., 2008; Davis et al., 2008; Jyothi et al., 2011). The need for hygienic environment and potable water for the well being of the Ikare - Akoko population has become a great environmental concern among communities. Most of the dump sites and household toilets especially pit latrines are located close to residential areas and around domestic water (wells, ponds and streams) sources. The waste contaminants later find their way into domestic water body through leaching and erosion (Olorunfemi and Odita, 1998).

Diarrhea is caused by the infection of parasitic, viral and bacterial organism which can be acquired by drinking water that had been contaminated with human and animal faeces (Boadi and Kuitunen, 2005). Relative to the individual usual pattern, diarrhea is characterized with intensified water evacuations and in some cases with mucus/blood (Teran, 1991; Osumanu, 2007). In developing countries, diarrhea diseases remain one of the most significant and the leading causes of morbidity and mortality particularly among children in sub-Saharan

Africa (Olugbemiro et al., 1994; WHO, 1996; Simon et al., 2007; Graf et al., 2008; Wilunda and Panza, 2009), because a large amount of transmission occurs in the domestic sphere, which is the principal habitat of children. About 88% of diarrhea disease is attributed to unsafe water supply, inadequate sanitation and hygiene (Jyothi et al., 2011). WHO (1996) report also indicates that each child in the developing region has five episodes of diarrhea per year and 800,000 die each year from diarrhea and dehydration. This could be prevented by adjusting the domestic hygiene behavior of vulnerable households/communities (Cairncross, 1990; Cairncross et al., 1996).

Researches to correlate the symptoms and signs of diarrheal diseases with a specific etiology have only yielded little success. Adequate comparisons of patients with diarrhea of different origin generally have not been possible, although, a few trends have been noted (Mattila, 1994; Cook, 2001). Nonetheless, diarrhea caused predominantly by *Escherichia coli (E. coli), Salmonella* and *Shigella* species had been shown to be a primary cause of morbidity and mortality in Sub-Sahara Africa due to the nature of their symptoms (Mikhail et al., 1990; Trueman, 1995; Shah et al., 2002). For instance, *enterotoxigenic E. coli* (ETEC) which is known to be spread through food and water contaminated by feaces had been identified as the common cause of acute watery diarrhea in infants and young children (Begum et al., 2005). Enteritis associated with *E. coli* varies considerably and usually of relatively short duration; nevertheless, some strains e.g. *E. coli* O157: H7, could cause serious bloody diarrhea with abdominal cramps, followed by other severe organ system damage, including kidney failure. *Shigella* is common among Sub-Saharan high-risk populations (such as children, the elderly and immuno-compromised individuals) that depend and live in an environment characterised with inadequate sanitation and fecal contamination of waters, particularly surface water used for domestic purpose (Olusanya et al., 1990; Kinge and Mbewe, 2010). It is typically associated with bloody or watery stools, abdominal pain, and fever especially the *Shigella enteritis*. On the other hand, *Salmonellosis* had been linked with classic enteric fever or severe diarrhea with abdominal pain (Mattila, 1994).

Scientific study of an infectious disease such as diarrhea forms the base of the appropriate interventions for controlling the disease in any region. This is because the features and the patterns of isolation of causal agents of the disease vary from place to place depending on the local climate, spatial location and the socioeconomic characteristics (Haque et al., 2003; Riddle et al., 2006). Rowland (1985) noted that some bacteria can always multiply in the environment, especially when nutrients and warmth are available. Some of these bacteria survive for long periods in apparently hostile environments such as on fingertips. The pathogen species familiar with this strategy include *E. coli*, *Shigella* spp., and *Salmonella* spp (Knittle et al., 1975; Haque et al., 2003). They could accidentally be ingested from exposure to contaminated food or water and also through person-to-person contact. They are easily spread from person to person and pass to food, most especially once the infected adults and children fail to adequately wash their hands before eating (Begum et al., 2005; Kinge and Mbewe, 2010).

Therefore, in order to understand the etiology, frequency, and consequences of acute diarrhea in the developing countries, this study assesses domestic water sources and unsanitary environment as well as conducting diarrhea surveillance among the population of Ikare – Akoko communities. This will enable the stakeholders in the designing of serious and up-to-date interventions to improve infants' children and adults' health in a friendly environment free from diarrhea diseases. It is on this recognition that the aim of this research is to examine diarrhea cases by assessing the consequences of using unsafe water in Ikare – Akoko, Southwestern, Nigeria. The specific objectives are:

i) Examine the sources of water used for domestic purposes and sanitary condition in the area;
ii) Analyze the linkage between bacteriological result of surface water quality and clinical specimen of the sample population in Ikare – Akoko;
iii) Assess diarrhea incidences as a result of poor surface water quality and poor sanitary condition; and
iv) To suggest what can be done to contribute and promote surface water quality and habitable sanitary environment through dialogue with community and stake holders.

METHODOLOGY

The study area

The study area lies between Longitudes 5° 44' 00"and 5° 46' 30" East, and between Latitudes 7° 31' 00" and 7° 32' 30" North of the Equator (Figure 1). It covers about 32.26 km^2 land area with a total population of about 126,625 according to the 2006 Census (FBS, 2007). Ikare - Akoko comprises of five paramount communities, namely; Edo, Ikado, Ilepa, Iyometa and Orun-un. The study area falls within a sub-tropical climate with annual rainfall of over 150 cm. The area experiences high temperature ranging between 30 and 38°C depending on the seasons (Uluocha and Ekop, 2002; Ayeni et al., 2009).

Sampling design

The concept of Ecosystem Approach to Human Health (Eco-Health) was adopted in this research work (Figure 2). Based on eco-health three pillars, the following data were collected for the research; social survey data, field work data, literature and administrative

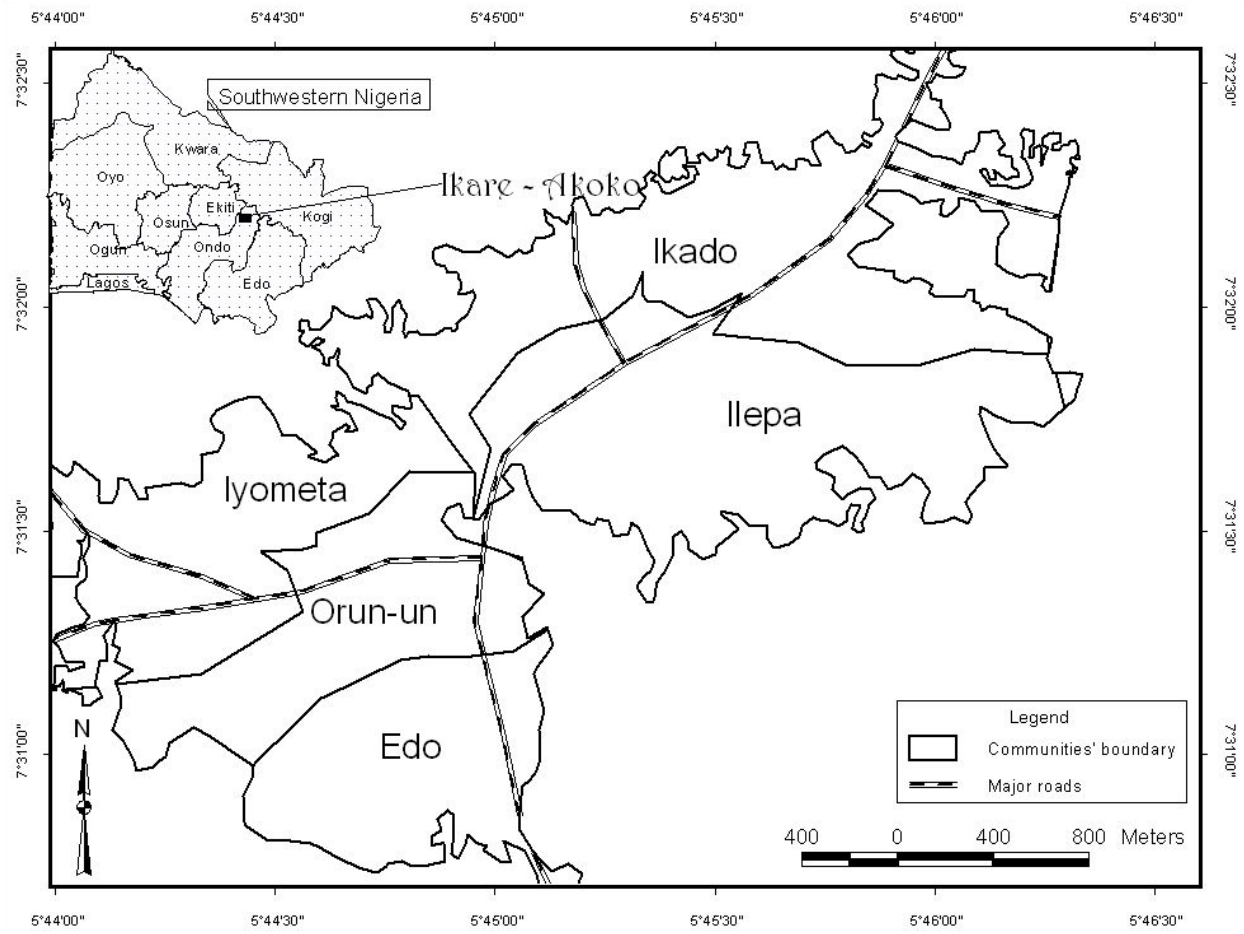

Figure 1. Study area.

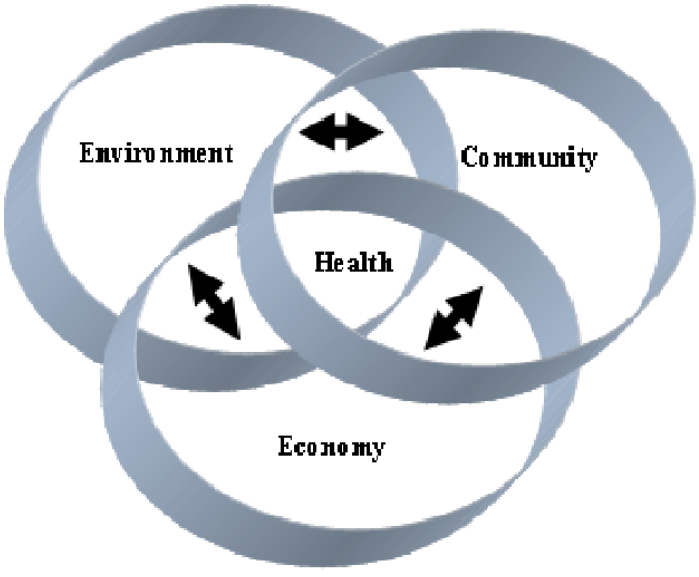

Figure 2. Ecosystem approach and its elements (Gillies et al., 2001).

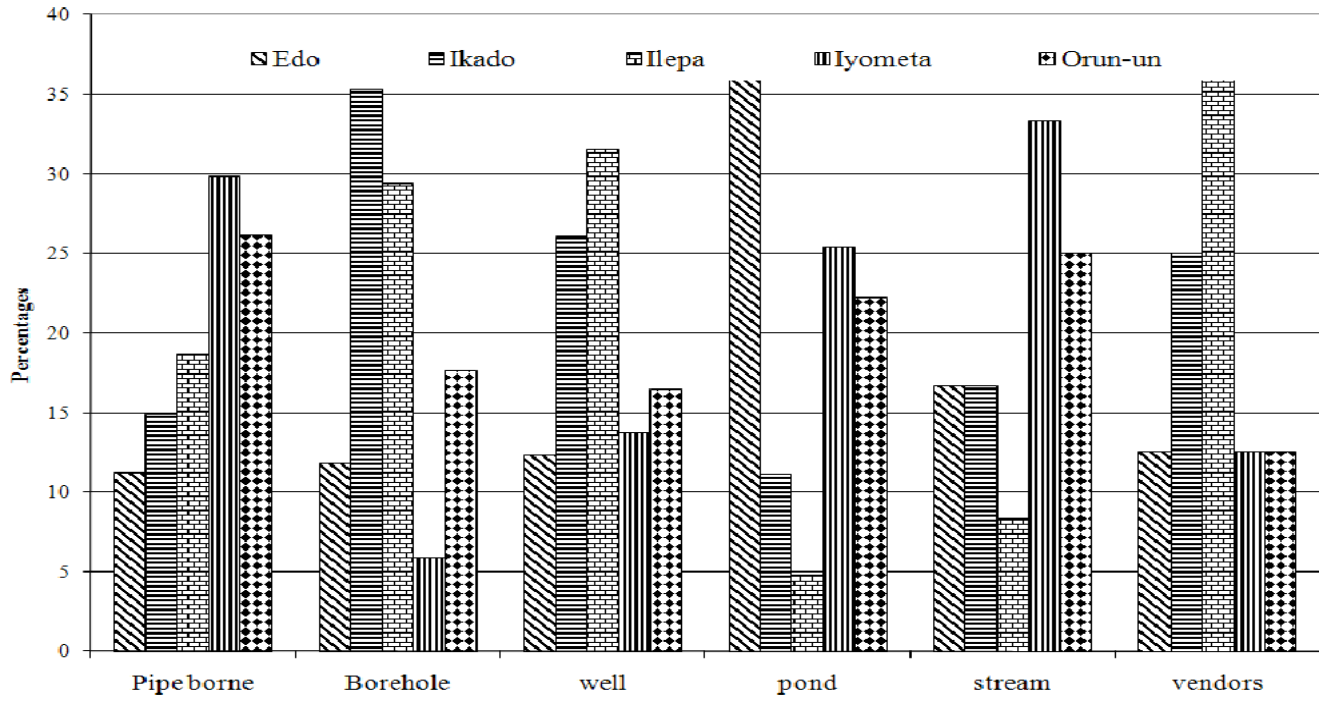

Figure 3. Sources of water supply in each community.

data. The data were used to generate and update information for this research through the assemblage of trans-disciplinary protocol. Scientists from distinct disciplines (Geography, Medicine, Public health, Sociology, Microbiology), community members and decision makers were consulted and incorporated without gender bias.

The research was conducted between September, 2009 and August 2010. Using stratified random sampling protocol, fourty (40) questionnaire were administered in each of the five (5) paramount communities (Edo, Ikado, Ilepa, Iyometa and Orun-un). The questionnaire included variables such as sex of respondent, age, number of children in each sampled household, the number of years respondents had lived in the community, diarrhea experience, information on health care centres, agents of diarrhea disease, and sources of drinking water. The questionnaire targeted households, precisely household heads that were able to provide information for the research subject. Interviews were held with community leaders, Water and Sanitation Officer (WATSAN), Ondo State Waste Management Agency. In order to incorporate community members and to be well represented in the research, Focus Group Discussions were held at each community's meeting square. The discussions allowed stakeholders to express views on the research subject and how to minimize future impact on water supply challenges on household well-being.

Collection and analysis of water samples

Using standard method of water sample collection and analysis (APHA, 1998), water samples were collected in new 500 ml clean plastic bottles from major surface water (ponds) used for drinking and domestic purposes in the study area. The samples were coded to avoid error and then transported to the laboratory for isolated pathogen analysis. The analysis was carried out at the of Department of Microbiology analytical laboratory, University of Lagos, Lagos – Nigeria.

Collection and analysis of clinical specimens:

Ten (10) stool samples were collected from each community with at least 6 from children under five years. The samples were collected in clean 5 ml tubes covered, screwed and transported to the laboratory. The specimens were collected in the morning when the person first woke up from sleep and preserved from urine or water contamination, then coded appropriately to avoid mix up. The samples were kept at temperature below 6°C and transported to the laboratory for microbiologic examination tests. The specimens were preserved and analyzed within 72 h from time of collection.

The services of physicians were employed for the clinical specimens. Analyses were done at the clinical laboratory of Ondo State Comprehensive Health Center, Isakunmi – Edo, Ikare. The tests were done to detect and identify isolated pathogens (*E. coli* and the members of the *Enterobateriae* family such as *Salmonella, Shigella*) in the specimens using standardized bacteriologic and parasitologic methods.

RESULTS AND DISCUSSION

The sources of water supply are pipe borne water, well, borehole, stream, pond, rain water and vendor. The population of households using each source varies from one community to another (Figure 3). The population of households using pipe borne water was highest at Iyometa community (29.85%) and lowest at Edo

Figure 4. Situations of boreholes and wells in Ikare – Akoko.

Figure 5. Nature of ponds in Ikare – Akoko.

community (11.2%); the population using borehole was highest and lowest at Ikado (35.3%) and Iyometa (5.9%) respectively. Also, the highest and the lowest households population using well water are recorded for Ilepa community (31.5%) and Edo community (12.3%) respectively; pond water users are highest and lowest at Edo (36.5%) and Ilepa (4.8%) respectively; households using stream water are highest and lowest at Iyometa (33.3%) and Ilepa (8.3%) respectively. More so, 37.5% of Ilepa population that relied on vendors was from Ilepa, 25.0% are from Ikado while 12.5% each are from Edo, Iyometa and Orun-un communities (Figure 3). Result shows that 66.7% of the 75 (12 at Edo, 14 at Ikado, 15 at Ilepa, 17 at Iyometa and 17 at Orun-un) public pipe borne water taps installed in Ikare – Akoko are not functioning. As a result, therefore, majority of households sourced their domestic water from unprotected sources such as stream, ponds and wells.

Only 35% of the 25 boreholes (5 at Edo, 7 at Ikado, 6 at Ilepa, 5 at Iyometa and 2 at Orun-un) in Ikare – Akoko are functioning. On the other hand, about 99.8% of the wells in Ikare – Akoko are dug and owned by individual households or clans (Figure 4) while ponds are owned by the community or group of clans (Figure 5). Based on

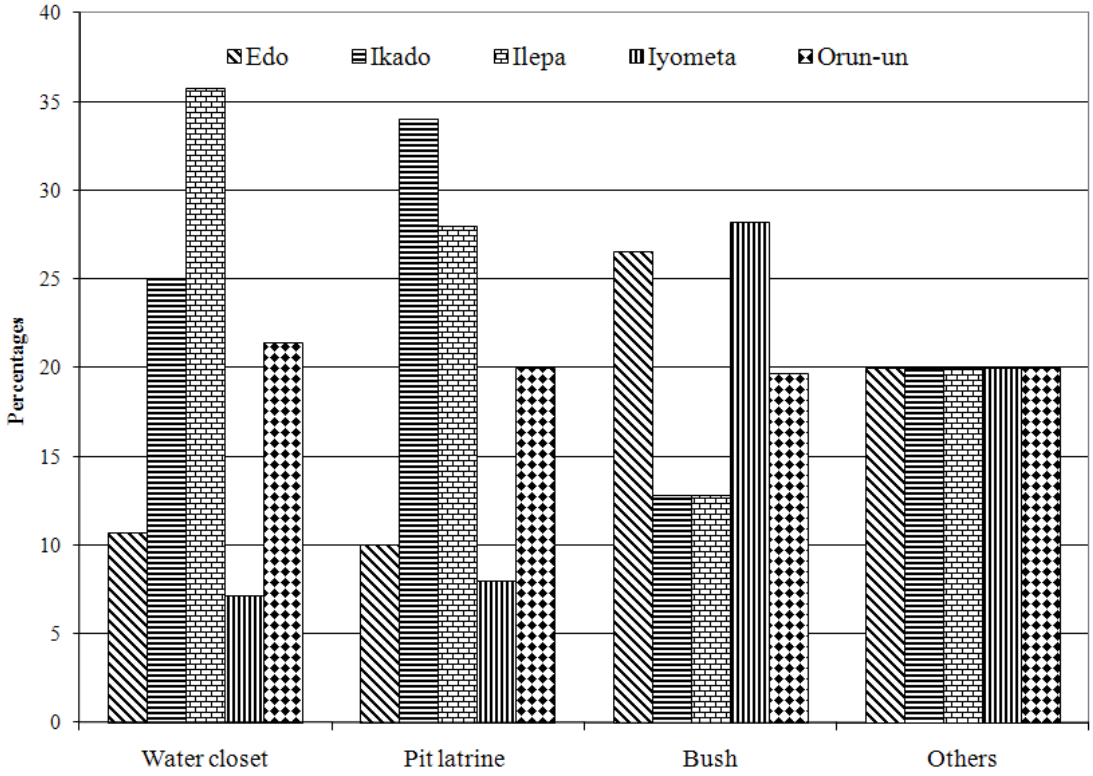

Figure 6. Sanitary system in each community.

these, residents trek long distance and spend much of their time before getting appreciable quantity of domestic water. The result of regression analysis revealed that average household water consumption per day was found to be inversely related to distance of water sources in all communities ($p < 0.05$). Figure 6 revealed the different types of toiletry systems. Ilepa community accounts for the highest (35.7%) population of households using water closet while Iyometa recorded the lowest (7.1%); the highest and lowest households population using pit latrine are recorded at Ikado (34.0%) and Iyometa (8.0%) respectively. Iyometa accounts for the highest (28.2%) households that claimed the use of bush while each at Ikado and Ilepa each account 12.8% (lowest). In each community, 20.0% of their households' population claimed the use of other sources which include streams, drainage channels, open places, abandoned building (Figures 6 and 7).

Access to legal dumpsite is virtually not in existence in the area. On the average, 55% of the households have access to illegal dumpsite around their houses, while 45% disposed their waste/refuse indiscriminately in the area. This varies amongst the five communities. Of the 110 respondents having access to dumpsite in Ikare - Akoko, 47.3, 38.2, 11.8 and 2.7% covered distances of less than 100 m, 100 to 500 m, 500 to 1 km and over 1 km respectively from their home to dumpsite location. In Ikare – Akoko, households disposed waste water through septic tank, drainage channel, bare surface and other means (e.g. street roads). The result reveals that 52% (highest) of households' population disposed their waste water through bare surface while 3% (lowest) disposed their waste water through septic tank. These varied amongst the communities (Figure 8). No household claimed the use of septic tank at Edo, Iyometa and Orun-un communities. The major contribution by government on improved sanitary environment was the monitoring and supervision of monthly sanitation program and as well creating public awareness on households' hygiene through Health Inspection Officers/Personnel (Figure 9).

Population and diarrhea incidences

The result revealed that 62.5% of the respondents in Ikare – Akoko had suffered from diarrhea attack before while 37.5% claimed not to have experienced diarrhea attack. The cause(s) were attributed to the environment, poverty, water, unknown and others such as witchcraft and spell. Households' perception on the causes varies

Figure 7. State of unsanitary environment in Ikare – Akoko.

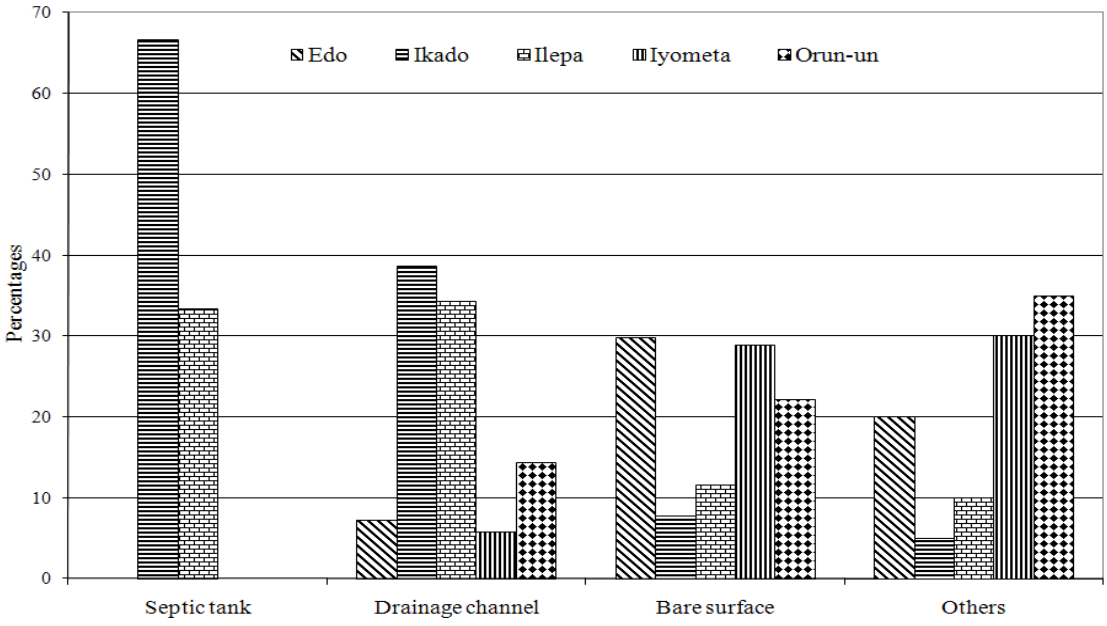

Figure 8. Method of disposing waste water in each community.

from one community to the other. For instance, perception on environment as the cause of diarrhea shows that Ilepa had 35.7% as the highest while Ikado and Orun-un had 7.1% each as the lowest (Figure 10). A total of 27.5% of the respondents associated diarrhea symptoms with vomiting. On the other hand, 7, 50 and 8% associated the symptoms with fever, dysentery and others such as cold (Figure 11). The symptoms are being observed daily, twice a week, weekly, monthly and occasionally. Occasionally and daily were noted as the

Figure 9. Public awareness campaign before monthly sanitation day in Ikare – Akoko.

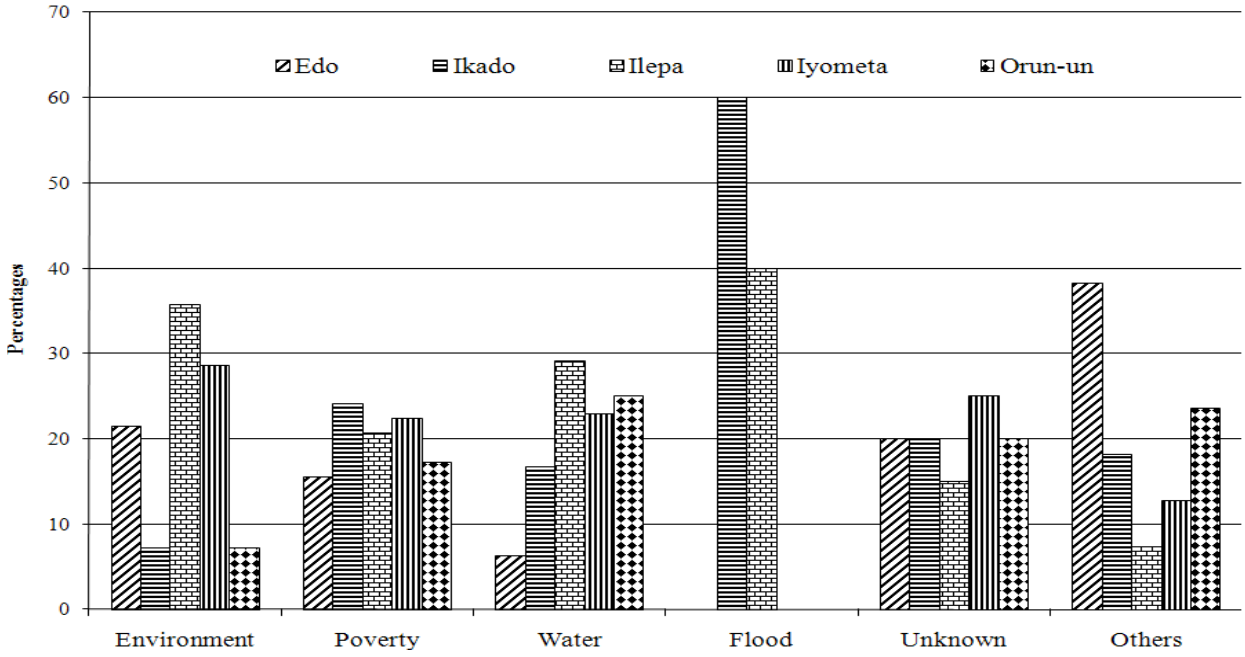

Figure 10. Causes of diarrhea in each community.

highest (62%) and lowest (1%) respectively. Of the 200 respondents in all communities, 59% claimed to have been diagnosed for other disease symptoms such as cholera, typhoid, gastro-intestinal diseases among others while 41% said they have not.

Ninety three (that is 46.5%) of the respondents claimed that they have visited hospital/clinic when they observed diarrhea symptoms. On the other hand, 47% claimed that they do not visit hospital/clinic for treatment while 6.5% did not disclose their information (Figure 12). The perception of households on health care services revealed that 4.5, 45.5, 39.5 and 10.5% of the total respondents rated health care services as excellent, good, fair and poor respectively. In Ikare – Akoko, 23, 13.5, 12 and 25% of the respondents claimed that their household members visit state hospital, primary health centre, private hospital and traditional healing homes respectively for diarrhea treatment. The outcome of the treatment shows that 21.7% of the 97 household members that had total cure are from Orun-un, 20.6% are from Iyometa, and 19.6% each was from Edo and Ikado while the least 18.5% was from Ilepa. The outcome also varies with partial cure and no cure amongst the communities (Figure 13). The respondents attributed diarrhea spread agents to flies, air, environmental condition, unknown factors and other agents such as witchcraft are noted as diarrhea spread agents in Ikare – Akoko. For instance, 22.7, 21.2 and 19.7% reside at Ilepa, Ikado and Iyometa respectively while 18.2% each reside at Edo and Orun-un communities. The results also vary for air environmental

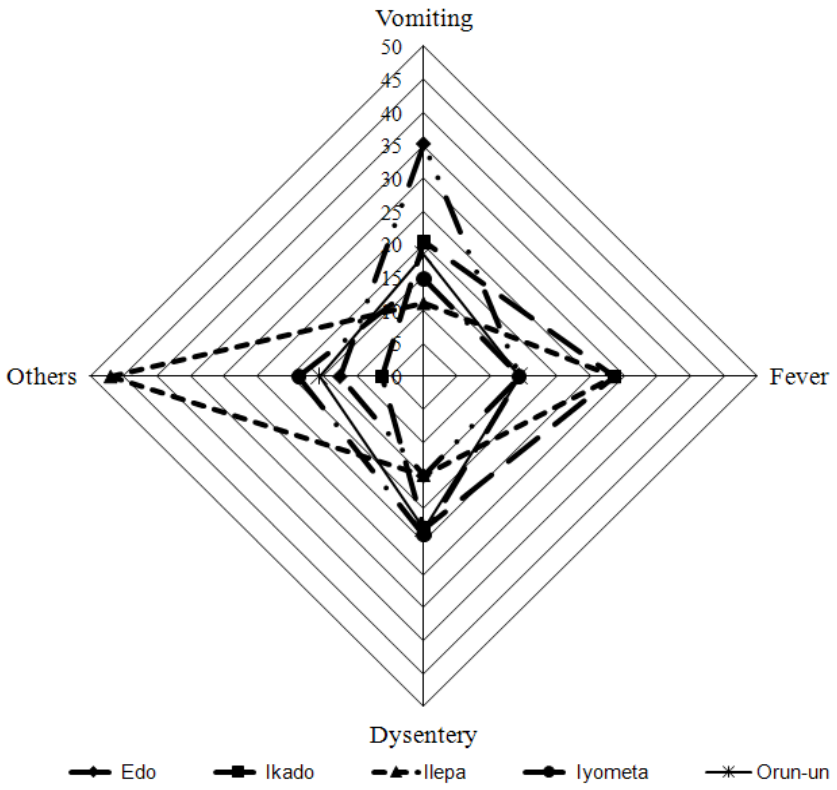

Figure 11. Diarrhea symptoms in each community.

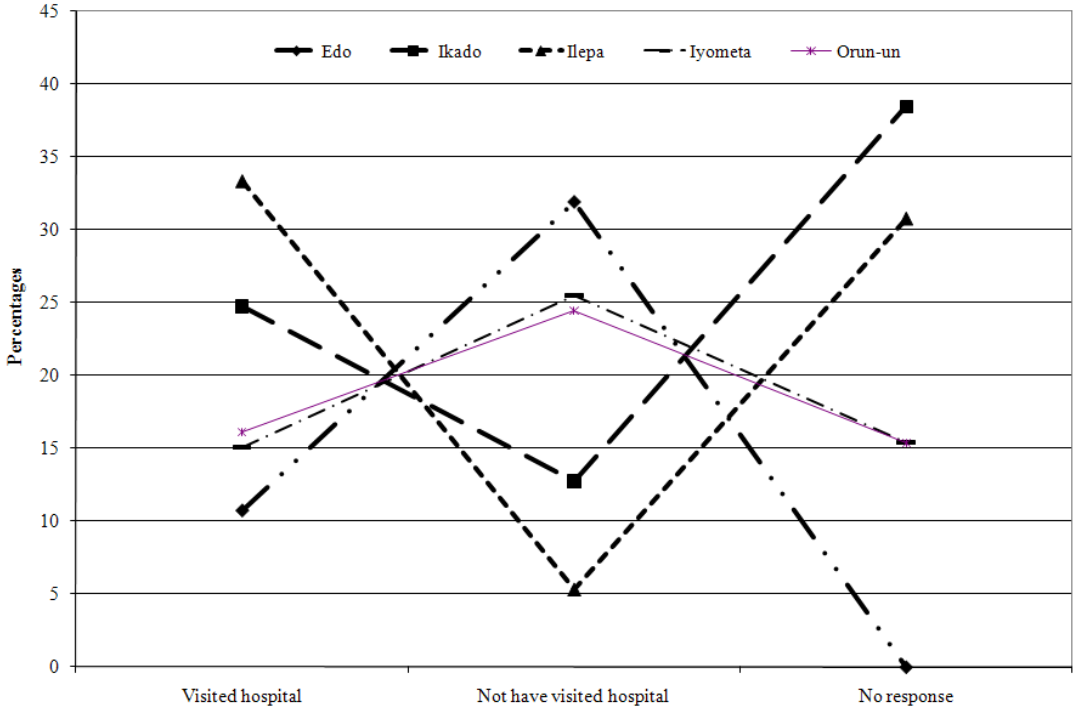

Figure 12. Visiting hospital as a result of diarrhea in each community.

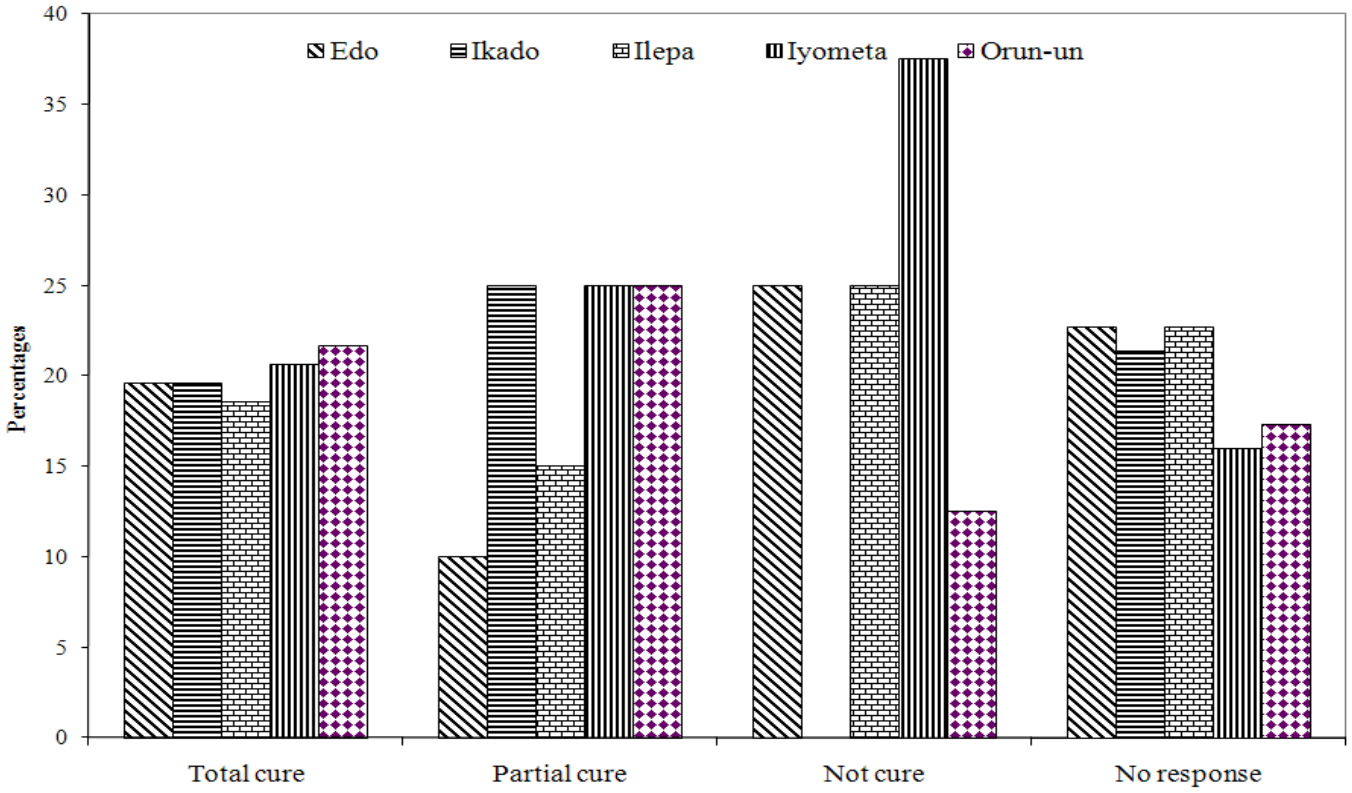

Figure 13. Diarrhea treatment in each community.

condition, unknown factors and other agents (Figure 14).

Figure 15 revealed the attitude and perception of respondents on pond water. In summary, 16.5% of the respondents in Ikare – Akoko argued that they use pond water because there is no alternative; 16% use pond to complement other sources such as pipe borne water, boreholes and wells that are not sufficient. The majority (32.5%) use pond water as a result of the traditions/ customs value attached to it. On the other hand, 17 and 18% use pond water based on its quality and reliability respectively. In respect to traditions/customs, the indigenes claimed that aside from drinking and other domestic purposes, pond water serve as divine protection particularly on the new born babies. The respondents argued further that pond water is a natural fluid medicine that cures fever and spiritual diseases such as spell.

Suggestion and way forward for habitable sanitary environment

Various suggestions were made on what could be done to eradicate diarrhea in Ikare - Akoko. On average, 55.4% of the total sampled population suggested health campaign awareness, environmental sanitation and effective drug administration; 0.5% suggested that the only solution is to conciliate the witches/wizard and god of the land. The remaining 44.1% suggested that government, international organizations e.g. WHO, health based NGOs, communities and individuals should be responsible for eradication of diarrhea in Ikare – Akoko and Nigeria at large.

Linkage between bacteriological result of unsafe surface water and clinical specimen

The quality assessment results show that bacteriological concentration varied spatially over the study area. Based on the zero tolerance level for coliforms, all sampled ponds were of poor quality (EPA, 1995). *E. coli, Salmonella* spp. *and Shigella* species were the noted isolated pathogens found in the sampled ponds. Nevertheless, the isolated pathogen indicates either positive (+) or negative (-) Grams and also varied among the sampled ponds (Table 1). Of the total fifty (50) clinical specimens analysed, thirty (30) and twenty (20) were collected from under five children and adult respectively. The results of bacteriological analysis confirmed positive for some clinical specimens collected in the area (Table 2).

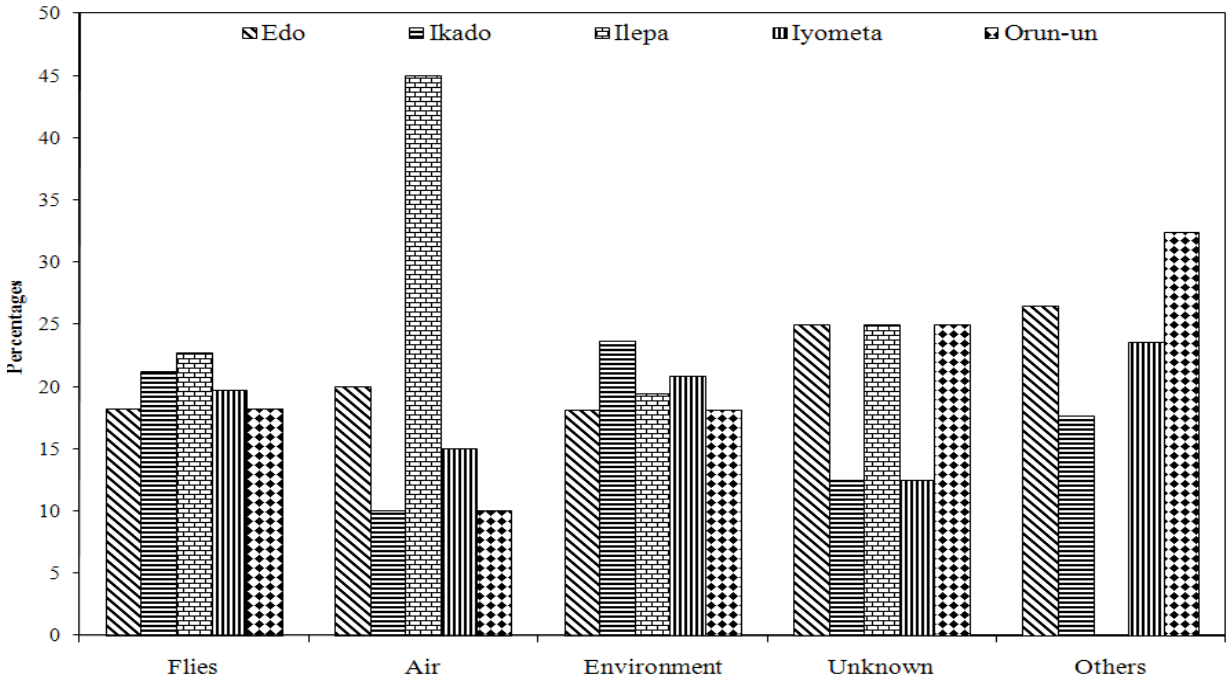

Figure 14. Diarrhea spread agents in each community.

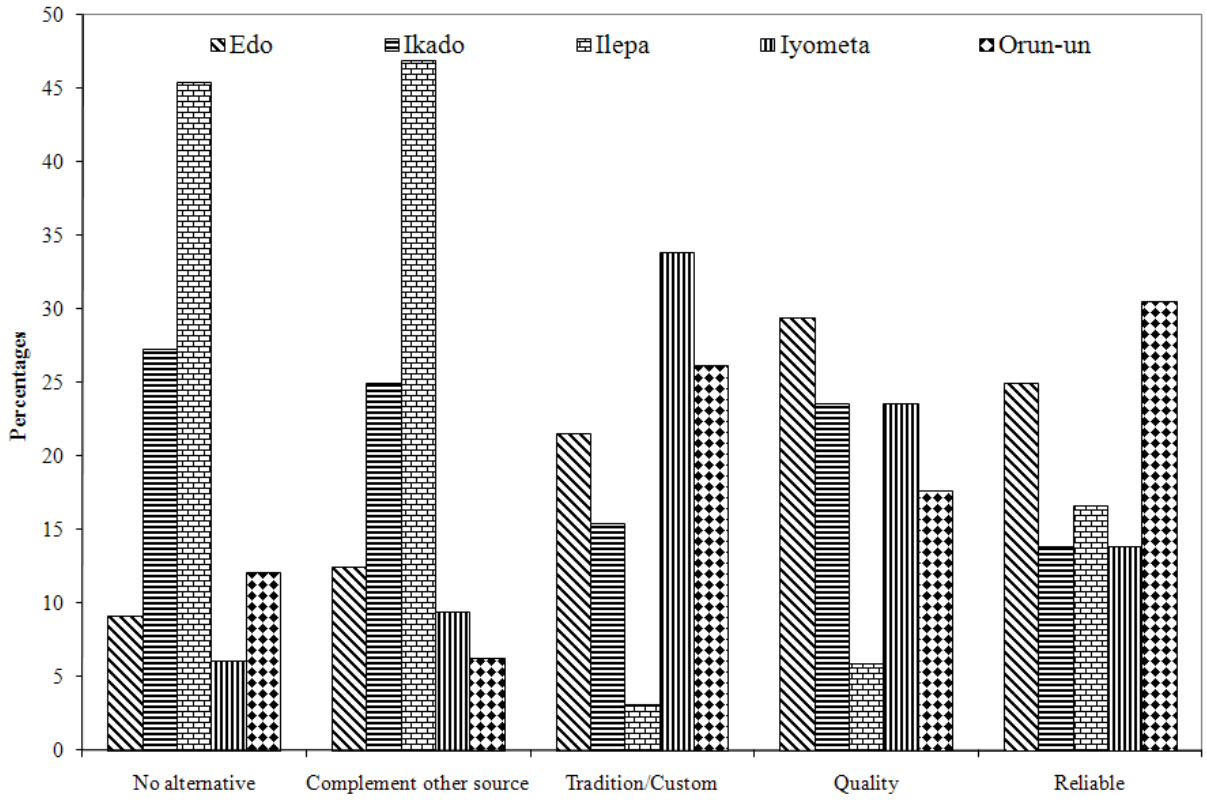

Figure 15. Attitude and perception on surface pond water in each community.

Table 1. Bacteriological result of sampled ponds.

S/N	Communities	Pond name	Ecol	Salm	Shig
1	Edo	Omiidu	+	+	-
		Gurusi	+	-	+
		Isunpaye	+	+	+
2	Ikado1	Alapoti	+	-	+
		Isayen	+	+	+
3	Ilepa	Agbo Ilepa	+	-	-
4	Iyometa	Isun	+	+	+
		Arungiya	+	+	+
5	Orun-un	Oroki	+	-	+
		Adangbara	+	+	+
Total positive			10	6	8

Ecol = Escherichia coli, Salm = Salmonella and Shig = Shigella.

Table 2. Stool samples analysis results.

Communities	Age	Sex	Ecol	Salm	Shig
Edo	< 5	F	1+	1+	3+
		M	4+	3+	3+
	Adult	F	2+	2+	
		M	1+	1+	1+
	Total Positive		*8*+	*7*+	*7*+
Ikado	< 5	F	3+	2+	2+
		M	2+	3+	3+
	Adult	F	2+	1+	2+
		M	1+	2+	1+
	Total Positive		*8*+	*8*+	*8*+
Ilepa	< 5	F	3+	2+	3+
		M	2+	3+	3+
	Adult	F	1+		1+
		M	1+	1+	1+
	Total Positive		*7*+	*6*+	*8*+
Iyometa	< 5	F	3+	2+	3+
		M	3+	3+	3+
	Adult	F	2+	2+	1+
		M	1+	1+	2+
	Total Positive		*9*+	*8*+	*9*+
Orun-un	< 5	F	3+	2+	3+
		M	3+	3+	2+
	Adult	F	2+	1+	1+
		M	2+	1+	1+
	Total Positive		*10*+	*7*+	*7*+
Grand Total positive			42	36	39

Ecol= Escherichia coli, Salm = Salmonella and Shig = Shigella.

Table 3. Stool samples analysis results.

Communities	Age	Sex	Ecol	Salm	Shig
Edo	< 5	F	1+	1+	3+
		M	4+	3+	3+
	Adult	F	2+	2+	
		M	1+	1+	1+
	Total Positive		8+	7+	7+
Ikado	< 5	F	3+	2+	2+
		M	2+	3+	3+
	Adult	F	2+	1+	2+
		M	1+	2+	1+
	Total Positive		8+	8+	8+
Ilepa	< 5	F	3+	2+	3+
		M	2+	3+	3+
	Adult	F	1+		1+
		M	1+	1+	1+
	Total Positive		7+	6+	8+
Iyometa	< 5	F	3+	2+	3+
		M	3+	3+	3+
	Adult	F	2+	2+	1+
		M	1+	1+	2+
	Total Positive		9+	8+	9+
Orun-un	< 5	F	3+	2+	3+
		M	3+	3+	2+
	Adult	F	2+	1+	1+
		M	2+	1+	1+
	Total Positive		10+	7+	7+
Grand total positive			**42**	**36**	**39**

Ecol= *Escherichia Coli*, *Salm* = *Salmonella* and *Shig* = *Shigella.*

Of the 30 children sampled, 90, 80, and 93%, were *E. coli, Salmonella and Shigella* positive respectively. On the average, male children are more vulnerable to diarrhea in the area. Table 2 revealed that 14 of 27 children positive to *E. coli* were males. In the case of *Salmonella,* 15 of 24 positive children were males while 17 of 24 children positive to *Shigella* were males. In the case of adults, more female were vulnerable as indicated in Table 3. For instance, result revealed that 9 of 15 examined adults that were positive to *E. coli* were female. Of the 12 adults' positive to Salmonella, 7 were female while 6 of 11 adults positive to Shigella were female. The results varied from one community to another (Table 2).

Conclusions

It was understood that residents of Ikare – Akoko are generally concerned about the unsanitary environment they live and the quality of their domestic water. Notwithstanding, their thinking is far from proffering solution to the menace themselves rather they relied on governments. Even, the wells and ponds owned by community members or clans are not well managed and maintained. From public responses, it was observed that many ill-health incidences have correlated with deteriorating sanitary environment and inadequate safe water supply. Diarrhea was observed as the most occurring gastrointestinal problems among the residents that live around illegal dumpsite, open defecation site, pit latrine and found ponds water inevitable. By comparing the socio-economic status of the residents, the finding reveals that the core traditional areas of Edo, Ilepa, Iyometa and Orun-un communities are more vulnerable to diarrhea disease and more exposed to the danger of unsanitary environment.

The study therefore recommends that governments should provide more safe water sources that are free of faecal contaminants. Governments should ensure that the modern, effective and affordable sanitary facilities

(latrines and sewers) are available for the poor households in no distant future. Proper waste disposal management, water treatment plants and other water supply infrastructure should be upgraded, managed and supervised by well trained personnel. Effective, simple and affordable waste disposal and water treatment methods should be designed and introduced to the residents of Ikare – Akoko. All concerned stakeholders should try as much as possible to improve their effort in ensuring adequate improved sanitary services and install/sink safer water supply sources. Lastly, vulnerable individuals, children in particular, should immediately seek medical attention if diarrhea symptoms are observed before it becomes severe or bloody.

ACKNOWLEDGMENTS

The author would like to thank the Community of Practice Eco-Health for West and Central Africa (COPEH – AOC), Cotonou for funding this research project and IDRC Canada for subsidizing the fund. In appreciation, the author would like to thank the coordinator of COPEH – AOC, Professor Benjamin Fayomi and Professor Ayobami T. Salami of Obafemi Awolowo University, Ile – Ife, Nigeria for supervising this research work.

REFERENCES

Ademiluyi IA, Odugbesan JA (2008). Sustainability and impact of community water supply and sanitation programmes in Nigeria: An overview. Afr. J. Agric. Res., (12): 811-817,

Ajiwe VIE, Nnabuike BO, Onochie CC, Ajobola VO (2000). Surface water pollution by effluents from some industries in Nnewi area, Nigeria, J. Appl. Sci., 3: 1265–1280.

APHA (1998). Standard Methods for the Examination of Water and Wastewater, American Public Health Association (APHA), 20th Edition, Washington DC, pp. 4 – 144

Ayeni AO, Soneye ASO, Balogun II (2009). State of Water Supply Sources and Sanitation in Nigeria: Implications for Muslims in Ikare-Akoko Township. Arab World Geographer, 12(1-2): 95–104.

Bateman OM, Smith S (1991). A comparison of the health effects of water supply and sanitation in urban and rural Guatemala. DHS World Conference August 5-7, 1991. Proceedings II: 1505-1524.

Begum YA, Talukder KA, Nair GB, Qadri F, Sack RB, Svennerholm A (2005). Enterotoxigenic *Escherichia coli* Isolated from Surface Water in Urban and Rural Areas of Bangladesh. J. Clin. Microbiol., 43(7): 3582–3583.

Boadi K, Kuitunen M (2005). Childhood diarrhoeal morbidity in the Accra Metropolitan Area, Ghana: socio-economic, environmental and behavioral risk determinants. J. World Health Popul., pp. 2-13.

Cairncross SU, Blumenthal PK, Moraes L, Tayeh A (1996). The public and domestic domains in the transmission of disease, Trop. Med. Int. Health, 1: 27–34.

Cairncross S (1990). Health impacts in developing countries: new evidence and new prospects. J. Inst. Water Environ. Manage., 4: 571–577.

Cook GC (2001). Influence of diarrhea diseases on Military and Naval campaigns, J. R. Soc. Med., 94: 95 – 97.

Davis J, White G, Damodaron S, Thorsten R (2008). Improving access to water supply and sanitation in urban India: microfinance for water and sanitation infrastructure development. Water Sci. Technol., 58(4): 887-91.

Ekugo EI (1998). Public health and urban sanitation. Environ. News, 5: 7.

FBS (2007). Federal Bureau of Statistics, Federal Republic of Nigeria Official Gazette, States (National and State Provisional Totals 2006 Census) 24: 94.

Graf J, Meierhofer R, Wegelin M, Mosler HJ (2008).Water disinfection and hygiene behaviour in an urban slum in Kenya: impact on childhood diarrhoea and influence of beliefs. Int. J. Environ. Health Res., 18(5): 335-55.

Haque R, Mondal D, Kirkpatrick BD, Akther S, Farr BM, Sack RB, Petri WA (2003). Epidemiologic and clinical characteristics of acute diarrhea with emphasis on *Entamoeba histolytica* infections in preschool children in an urban slum Of Dhaka, Bangladesh, Am. J. Trop. Med. Hyg., 69(4): 398–405.

Ifabiyi IP (2000). Water Resources Utilization: Implication on Environmental setting. In: Jimoh H.I and I.P. Ifabiyi(eds), Contemporary Issues in Environmental Studies, Ilorin, Haytee Press and Publishing, pp. 245 - 264.

Jyothi J, Ravish KS, Gopinath D (2011). A Study of Socio-Cultural Factors, Water Quality and Diarrhea in Bangalore the Internet J. Public Health, 1(1) http://www.ispub.com/journal/the_internet_journal_of_public_health/volume1_ nmber_1 (Accessed on 14 June 2011)

Kinge CW, Mbewe M (2010). Characterisation of *Shigella* species isolated from river catchments in the North West province of South Africa, S. Afr. J. Sci., 106(11 – 12): 1 – 4

Knittle MA, Eitzman DV, Baer H (1975). Role of hand contamination of personnel in the epidemiology of Gram-negative nosocomial infections, J. Paediatr., 86: 433–437.

Mahvi AH, Karyab H (2007). Risk Assessment for Microbial Pollution in Drinking Water in Small Community and Relation to Diarrhea Disease. American-Eurasian J. Agric. Environ. Sci., 2(4): 404-406.

Mattila L (1994). Clinical Features and Duration of Traveler's Diarrhea in Relation to Its Etiology. Clin. Infect. Dis., 19: 728-34.

Mikhail IA, Fox E, Haberberger RL, Ahmed MH, Abbatte EA (1990). Epidemiology of bacterial pathogens associated with infectious diarrhea in Djibouti. J. Clin. Microbiol., 28: 956 - 961.

Olorunfemi JF, Odita CO (1998). Land use and solid waste generation in Illorin, Kwara State, Nigeria. Environmentalist., 18: 67–75.

Olugbemiro S, Adebowale AA, Rasheed AG, Olusegun GA (1994). Persistent Diarrhea in Nigerian Children aged less than five years: A Hospital-Based Study, University College Hospital, Ibadan, Nigeria, pp. 1-9.

Olusanya O, Shonukan OO, Ogwo VA (1990). Childhood carriers of *Salmonella* and *Shigella* species in the rural area of Ile-Ife, Nigeria. Ethiop Med. J., 28(20): 49 – 52.

Osumanu IK (2007). Household environmental and behavioural determinants of childhood diarrhea morbidity in the Tamale Metropolitan Area (TMA), Ghana. Danish J. Geogr., 107(1): 59 – 68.

Riddle MS, Sanders JW, Putnam SD, Tribble DR (2006). Incidence, etiology, impact of diarrhea among long-term travelers (US military and similar populations): A systematic review. Am. J. Trop. Med. Hvg., 74(5): 891-900.

Rowland MGM (1985). "Bacterial diarrhoeas: contaminated food and water" In: Diarrhoeal Disease and Malnutrition – a Clinical Update, M Gracey (ed.) Churchill Livingstone, Edinburgh, pp. 47–62.

Sasaki S, Suzuki H, Igarashi K, Tambatamba B, Mulenga P (2008). Spatial analysis of risk factor of cholera outbreak for 2003-2004 in a peri-urban area of Lusaka, Zambia, Am. J. Trop. Med. Hyg., 79(3): 414-21.

Shah MF, Khan R, Kamruzzaman M, Yamasaki S, Ahmad QS, Azim T, Nair GB, Takeda Y, Sack DA (2002). Isolation of *Shigella dysenteriae* Type 1 and S. flexneri Strains from Surface Waters in Bangladesh: Comparative Molecular Analysis of Environmental Shigella Isolates versus Clinical Strains, Appl. Environ Microbiol., 68(8): 3908–3913.

Simon L, Norman R, Nannan N, Thomas E, Bradshaw D (2007). Estimating the burden of disease attributable to unsafe water and lack of sanitation and hygiene in South Africa in 2000. S. Afr. Med. J., 97: 755-762.

Trueman WS, Thornton SA, Wallace MR, Defraites RF, Sanchez JL, Batchelor RA, Rozmajzl PJ, Hanson RK, Echeverria P, Kapikian AZ, Xiang XJ, Estes MK, Burans JP (1995). Diarrheal disease among military personnel during operation restore hope, Somalia, 1992-1993. Am. J. Trop. Med. Hvg., 52(20): 188-193.

Uluocha NO, Ekop G (2002). Nigeria: Geography, In: Osuntokun A; Aworawo D and Masajuwa F (eds), History and Cultures of Nigeria up to AD 2000, Edited by Lagos, Frankad Publishers, pp. 3-19.

WHO (1996). Childhood Diseases in Africa: Fact Sheets. http://www.Who.int/inf-fs/en/fact 109.html pp. 1-6.

Wilunda C, Panza A (2009). Factors Associated With Diarrhea among Children less Than 5 Years Old In Thailand: A Secondary Analysis of Thailand Multiple Indicator Cluster Survey 2006. J. Health Res., 23(suppl): 17-22.