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Full Length Research

Knowledge and Perceived Health Risks Associated with Heavy Metals Contamination in Groundwater – A Case Study of Sagamu Local Government Area, Ogun State, Nigeria

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This study assesses the level of knowledge of household representatives on heavy metals toxicity and the perceived health risks associated with drinking heavy metals contaminated groundwater by residents in Sagamu Local Government Area (LGA) of Ogun State, Nigeria. The study employed a cross-sectional descriptive survey using interviewed administered semi-structured questionnaire to elicit personal information, information on water source, common health complaints and knowledge of respondents on heavy metals toxicity. Four hundred (400) participants were selected by systematic sampling across the fifteen (15) political wards in Sagamu LGA. Findings from the study showed that the overall mean age of the respondents was 44±1.3 years and majority (74.8%) was secondary school holders. Borehole takes 89.3% of water supply in the communities. The common ailments reported were frequent stooling (7.8%), still birth (2.5%), children with stunted growth (2.0%) and 0.5% cases of death from cancer. Majority (92.8%) of the respondents had poor knowledge of heavy metal toxicity. The study recommends public health education with proper treatment and monitoring of groundwater by the government.

Key words: Heavy metals toxicity, Groundwater, Knowledge level, Health effects, Boreholes.

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INTRODUCTION

There has been a growing concern about the problem posed to health by a number of heavy metals especially when their concentration exceeds the maximum permissible levels in the environment.

Currently, much attention is on heavy metals pollutants in water which have potential to cause cancer, cumulative toxicity and other deleterious effect on human health on longtime exposure (Park, 2001). Water is consequential for cell metabolism. Man's continuous existence on planet earth depends to a large extent on availability and accessibility to good quality water. Water is a pivotal resource upon which transportation, recreation, agriculture, industry and domestic activities rely upon (Awomeso et al., 2010). Water source can be classified into two categories namely: (1) surface water such as rivers, lakes, ponds, ocean, stream, rain water, ocean (natural sources) and (2) groundwater such as borehole, spring, and wells (McMurry and Fay, 2004). Water has unique chemical features owning to its polar nature and presence of hydrogen bond in its constituent which make it a universal solvent (WHO, 2007). Naturally, water does not exist in pure form as it is infiltrated by pollutants from the environment (Mendie, 2005).

The term heavy metal refers to a collection of metals and metalloids that have atomic weight between 63.546 and 200.590 and a specific gravity greater than 4.0 i.e., at least 5 times denser than water. They are present as particulate, colloidal or dissolved substances in water (Nriagu, 1989; Garbarino et al., 1997; Lenntech, 2004) with their occurrence in water bodies being either of natural origin (for example, leachate from ore deposit, products of volcanic extrusion and eroded mineral within sediments) or of anthropogenic origin such as mining, industrial/domestic effluent, solid waste disposal, harbour channel dredging (Marcovecchio et al., 2007). Exposure to heavy metals is potentially inimical particularly for those that did not perform any significant physiological function in body metabolism. Chronic exposure to metals and their compounds can cause dys-regulation of cellular pathways leading to subsequent toxicity (Fitsanakis and Aschner, 2005). The core problem with heavy metals is that they tend to bio-accumulate in the body. The primary tissues targeted by heavy metals contamination are: the liver, kidneys, bowel, brain, nervous system, spleen and eyes. The health problem caused by heavy metal poison is believed to be a global one. While some countries have been able to identify the magnitude of the problem and have already made efforts to put it under control; Nigeria and most other African countries (particularly the underdeveloped ones) are yet to identify the extent of the problem it poses to health, not to talk of even controlling it (Okareh et al., 2018). The utilization of groundwater as sources of water supplies for individual, family and municipal purposes is as old as the existence of man. It continues to gain prominence due to failure of government to secure municipal water distribution system for all the communities through the pipe-borne supplies. The significance of groundwater supplies became more prominent in most parts of developing countries during and after UNICEF promoted drinking water and sanitation programme, (which spanned in the 1980s) in which borehole/tube wells and hand dug well were provided for the supply of clean water for the use of many people in underserved areas of the world. About 50% of Americans, especially rural American rely on groundwater for drinking (Maas et al., 2005) and about 97% of the 125 million people in Bangladesh depend on one form of well or the other as source of water supply (Talukder et al., 1998). In the US, drinking water from groundwater source account for 14 - 20% of total lead exposure (Maas et al., 2005). A primary challenge for most people living in third world countries is access to good quality drinking water. In Africa and Asia, most urban cities utilize surface water however millions of residents in the peri-urban areas and rural settings solely rely on groundwater source. (Obiri-Danso et al., 2009). Most of the mortality and morbidity in the rural communities and major cities with dense population are due to pollution of water bodies. In a bid to alleviate the problem of water shortage, especially in most urban centers, attention have diverted towards hand-dug-wells for groundwater supply (Christian Aid, 2010; Gbadebo and Akinhanmi, 2010). Water sources, including groundwater, contain heavy or trace metals in concentrations depending on geology and contamination from varying anthropogenic sources. Although many heavy metals are of bio-importance to humans, most of them cause bio-toxicity at high/lethal dose. Heavy metals are released into the ecosystem through natural phenomena and anthropogenic activities viz., agriculture, transportation, mining and waste disposal (Kamarudin et al., 2009).

The incidence of cancer of various organs of the body has been on the increase in Nigeria over the

years. In Olabisi Onabanjo Teaching Hospital, Sagamu (a health facility located in the study area), there have been many cancers of various cases whose origin could neither be traced nor explained and many people may have died of unreported cases traceable to high heavy metal–rich drinking water (Okareh et al., 2018). There is, therefore, a need for a study of this phenomenon with a view to assess the knowledge of the household representatives on toxic nature of heavy metals and the perceived health risks associated with drinking such contaminated groundwater among residents in Sagamu Local Government Area of Ogun State, Nigeria.

METHODOLOGY

Study Design

The study is a descriptive survey involving the use of interviewed administered semi-structured questionnaire to elicit personal information and main source(s) of drinking water supplies, including common health complaints of the households.

Study Location and Population

The study area includes seven selected communities (Ogijo, Kamalo, Eweruku, Ita Sanni, Likosi, Sabo 1 and Sabo 11) in Sagamu Local Government Area, Ogun State as illustrated in Appendix I. The Local Government was established on 23rd September, 1991. It is bounded by Odogbolu Local Government to the East, Ikenne Local Government to the North, Obafemi-Owode Local Government to the West and Lagos State to the South respectively. The Local Government Area is named after its headquarters, Sagamu. Sagamu is located within southwest Nigeria. Its farthest points on the top left is 6 50 42.59N/ 3 28 20.67E, farthest point top right is 6 57 26.83N/ 3 36 36.09E. Lower left 6 38 57.35N/ 3 26 37.56E and lower right 6 41 05.34N/ 3 40 55.18E. The local government has an area of 614 km^2 with a population estimated 253,421 according to the 2006 national population census. Sagamu Local Government Area is a Cosmopolitan Area that is divided into fifteen political wards. These include ward 1 – Oko, Epe and Itunle 1; ward 2 – Oko, Epe and Itunla II; ward 3 Aiyegbami Ijoku; ward 4 – Sabo 1; ward 5 – Sabo II; wards 6 – Itunsoku Oyebayo; ward 7 – Ijagba; ward 8 – Latawa; ward 9 – Odelemo; ward 10 – Ogijo/Likosi; ward 11 – Surulere; ward 12 – Isote; ward 13 – Simawa; ward 14 – Agbowa; ward 15 - Ibido/Itun-alara. The selected wards of interest for these studies are Sabo 1, Sabo II and Ogijo/Likosi. They were chosen because of the indiscriminate waste disposal practices and high industrial activities in these communities. The industries in the study area are oil and gas depot and mostly metal, iron steel and battery lead recycling companies.

Sample size determination

The sample size for this study was calculated using the Leslie Kish formula such that the results obtained were within 95% confidence interval. A total of 400 respondents participated in the study.

Sampling Procedure

A three stage multi-sampling procedure was carried out. Fifteen wards were identified from the local government area. Of the fifteen wards, 3 wards were purposively selected based on the high industrial activities and indiscriminate waste disposal practice. Of the fifteen wards, 3 wards were purposively selected based on high industrial activities and indiscriminate waste disposal practices, a practice predisposing heavy metal pollution of the environment. Of the seven communities, households were selected using systematic sampling method. This involves randomly selecting a household and sampling every next n^{th} = 3rd houses i.e. 1^{st}, 4^{th}, 7^{th}…….. .

Method and Instrument for Data collection

Data were collected using a pre-tested structured interviewer administered questionnaire. The components of the questionnaire were categorized into four sections namely: demographic information**;** information on water supply: health status information; and knowledge of respondents on heavy metal toxicity

Validity and Reliability of the Instrument

The internal consistency of the questionnaire was

also checked with the use of Chronbach's Alpha Coefficient Analysis in Statistical Package for Social Science (SPSS) software for the reliability and the result greater than 0.5 is said to be reliable. The alpha-coefficient for the pre-test was 0.76.

Data Management and Analysis

Data derived from questionnaire were entered into a computer using the Statistical Package for Social Sciences (SPSS) version 17. The use of frequency tables, percentages, chart presentation and descriptive statistics (mean and standard deviation) were utilised for results presentation.

Ethical Consideration

A letter of introduction was collected from the Department of Public Health to the Chairman Sagamu Local Government Area before the commencement of the study. Letter of approval and access to the communities were obtained from the local government. The aim and the objectives of the research were elucidated to all the participants. The right to privacy and anonymity of the people in the communities were fully observed by the researchers and respondents were assured that information provided would be used for research only.

RESULTS

Respondents' Demographic Characteristics

Table 1 shows the demographic characteristic of the respondents. A total of 400 respondents were interviewed in the study. The majority (50.5%) was aged 36 - 45 which only 1.8% fell into 55 years above. The mean age of the entire interviewed population was 44±1.3 years. There were 295 men (73.8%) and 105 women (26.3%). The sex ratio was in favour of males 2.8:1.0. The respondents came from the three main ethnic groups in Nigeria and others were sub-ethnic group and some non–Nigerian. There was Yoruba preponderance as they constituted 83.8% of the study population. Majority of the respondents interviewed were landlord (63%) while landlady was 42%.

Moreover, Table 1 depicted the socio-demographic status of respondents. It revealed that most respondents were traders and housewives (46.8%), followed by artisan (31.3%) while civil servants constitute only 20.3%. Majority of respondents are secondary school holders (74.8%), while only 7.2% have tertiary education as depicted in Figure 1.

Information on Water Supply

Table 2 presents information on water supply. Borehole takes 89.2% of water supply in the communities while 10.8% of the respondents in the communities obtained their water supply from Hand-dug-well as illustrated in Figure 2. In Table 2, about 79% of respondents drink from the groundwater source while 21% use sachet water as source of their drinking water. As depicted in Figure 3, majority 258(81.6%) of the respondents do not treat/purify their water before drinking, while 18.4% used one form of purification or the other before drinking the groundwater source: sedimentation (9.2%), boiling (4.4%), addition of alum (2.2%) and chlorination (2.5%). Most of them (58.3%) do not have idea of the estimated depth of their groundwater source. Most of them (54.5%) believe that borehole is less harmful, that is why they are not treating it.

Information on Health Status

Table 3 reveals information on respondents' health status. Majority of the respondents (86.3%) did not experience ailments in the last six months. The respondents only heard of 2.5% children born dead (still birth) in the last 12 months and 2.0% children manifested poor growth. Only 0.5% death due to cancer was reported.

Respondents' Knowledge on Heavy Metals Toxicity

Table 4 shows the knowledge of respondents on heavy metal toxicity. The knowledge of respondents on toxic nature of heavy metals was very low (92.8%). Only 1.8% had good knowledge on heavy metal problems.

Scoring of Respondents' Knowledge

Figure 4 shows the respondent's knowledge scoring. Majority of the respondents 371(93.0%) have poor knowledge about toxic nature of heavy metals. About

Table 1. Respondents' Demographic Characteristics.

Demographic	Frequency	Percentage (%)
Age Group		
20 – 35	95	23.8
36 – 45	202	50.5
46 – 55	96	24.0
>55	7	1.8
Total	400	100.0
Gender		
Male	295	73.8
Female	105	26.3
Total	400	100.0
Ethnic		
Yoruba	335	83.8
Igbo	44	11.0
Hausa & others	21	5.3
Total	400	100.0
Position of respondents in the household		
Landlord	168	42.0
Landlady	84	21.0
Tenant	148	37.0
Total	400	100
Occupation		
Civil servant	81	20.3
Artisan	125	31.3
Farming	7	1.8
Others (Trader / House wife)	187	46.8
Total	400	100
How long (in years) have you been living here?		
2	58	14.5
3	57	14.2
4	86	21.5
5	42	10.5
6	58	14.5
7	44	11.0
8	32	8.0
9	7	1.8
10	16	4.0
Total	400	100.0

22(5.0%) have fair knowledge while only 7(2.0) have good knowledge about heavy metals toxicity.

DISCUSSION

Water sources have been put under intense pressure by population explosion in both developed and third world nations, through pollution by various anthropogenic activities such as agriculture, mining, industry, and by environmental change (WHO, 2010). As population increases and economy advancement proceeds at an alarming rate, more especially in developing nations, the urgency for metals needs would rise and likewise the propensity for environmental contamination. This definitely will have

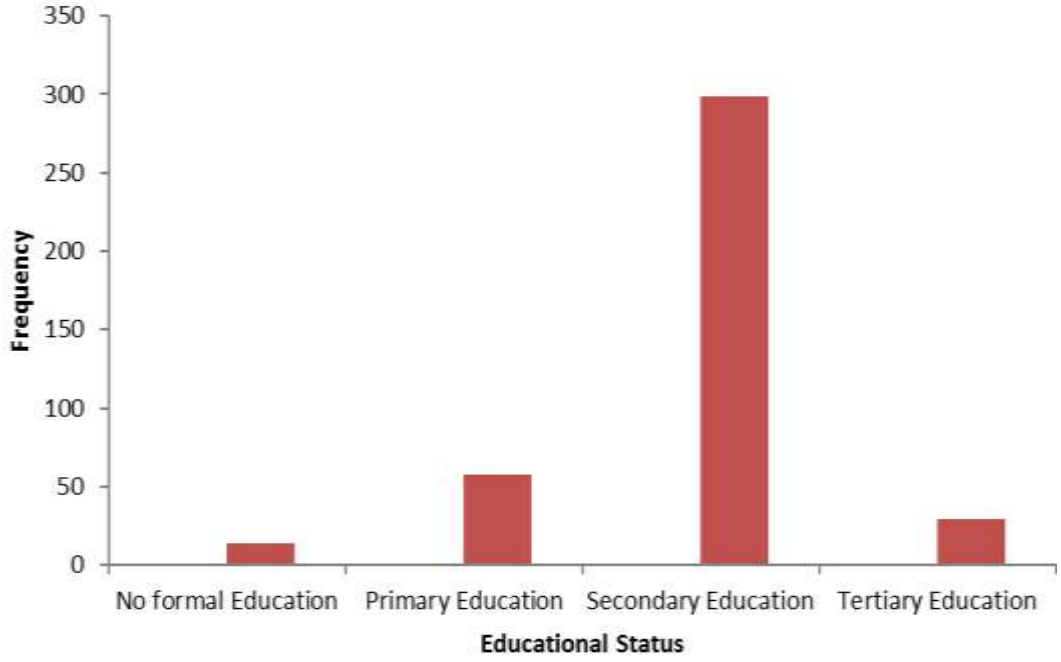

Figure 1. Respondents' education status in various communities within Sagamu LGA, Ogun state, Nigeria.

Table 2. Information on Water Supply.

Variable	Frequency	Percentage (%)
Do you drink from the ground water source?		
Yes	316	79.0
No	84	21.0
Total	400	100.0
Your source of drinking water		
Sachet	84	21.0
Other source	316	79.0
Total	400	100.0
When was your ground water source dug in years?		
2	28	7.0
3	28	7.0
4	71	17.8
5	35	8.8
6	8	2.0
7	15	3.8
8	8	2.0
9	8	2.0
10	8	2.0
No idea	191	47.8
Total	400	100.0

serious consequences for human and environmental quality (David and Joel, 2004).

The findings from this study revealed that, the general mean age of respondents from the various

Table 2. Continued.

Estimated depth (in meters) of the groundwater source		
70	7	1.8
80	14	3.5
85	14	3.5
86	7	1.8
87	14	3.5
90	14	3.5
95	7	1.8
100	37	9.3
110	15	3.8
120	24	6.0
175	14	3.5
No idea	233	58.3
Total	400	100.0
If no purification is done which of these bests describe why it is not done		
Borehole/well water is less harmful	218	54.5
No one has ever told me it is necessary to purify borehole water.	45	11.3
It is a waste of time.	65	16.25
I've been drinking it since I was young & nothing happened.	72	18.0
Total	400	100.0

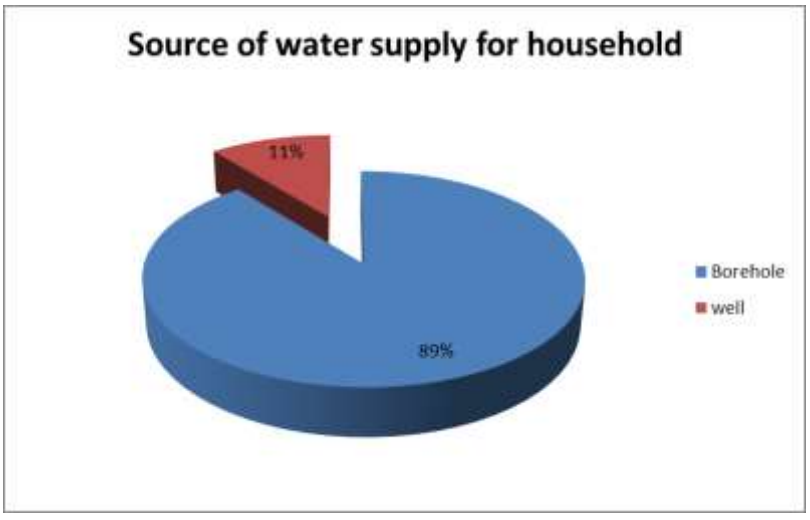

Figure 2. Source of water supply as reported by the households in the study area.

wards in Sagamu Local Government Area (LGA) of Ogun State, Nigeria was 44±1.3 years and the age range was between 36 – 45 years respectively. Majority of the respondents were males and the

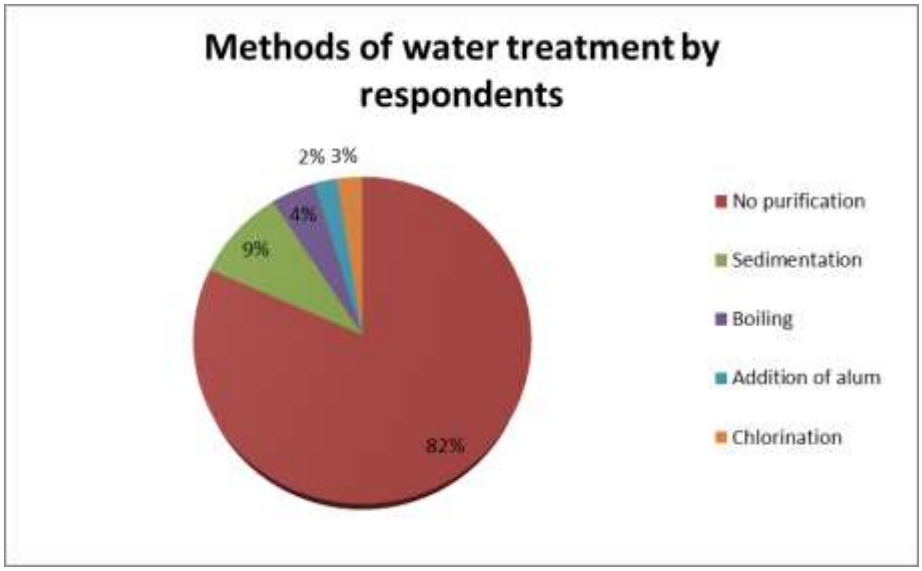

Figure 3. Various methods of treatment of the groundwater source employed by the respondents before drinking.

Table 3. Information on health status.

Variable	Frequency	Percentage (%)
Which of these ailments have you experienced in the last six months?		
Frequent watery stooling	31	7.8
Inability to breath well	14	3.5
Skin problem	10	2.5
None	345	86.3
Total	400	100.0
How many cases of children born dead have you heard in this community in the last 12months?		
Born dead	10	2.5
None	390	97.5
Total	400	100.0
How many children in this household have manifested signs of poor growth in the last 12 months?		
Manifested poor growth	8	2.0
None	392	98.0
Total	400	100
How many people in this house died of cancer of any internal organs of the body?		
How many	2	0.5
None	398	99.5
Total	400	100.0

Table 4. Respondents' Knowledge on Heavy Metals Toxicity.

Variable	Frequency	Percentage (%)
Do you know that your ground water source may contain harmful substance?		
Yes	108	27.0
No	160	40.0
Don't know	132	33.0
Total	400	100.0
Drinking water that contains harmful substance and, specifically heavy metals, may cause:		
Mouth odour	15	3.8
Poisoning	79	19.8
Malaria	63	15.8
I don't know	243	60.8
Total	400	100.0
Arsenic exposure in drinking water can cause:		
Stomach ulcer	7	1.8
Typhoid	106	26.5
Skin problem	7	1.8
I don't know	280	70.0
Total	400	100.0
Lead exposure in drinking water can lead to:		
Typhoid	91	22.8
Malaria	14	3.5
I don't know	295	73.8
Total	400	100.1
Cadmium exposure in drinking water can lead to:		
Typhoid	77	19.3
Kidney problem	14	3.5
Don't know	309	77.3
Total	400	100.1
Chromium exposure in drinking water can lead to:		
Typhoid	78	19.5
Liver problem	8	2.0
Malaria	21	5.3
Don't know	293	73.3
Total	400	100.0
Long exposure to heavy metals in drinking water may lead to:		
Typhoid	121	30.3
Cancer	67	16.8
Frequent watery stooling	77	19.3
Don't know	135	33.8
Total	400	100.0

preponderance ethnic group belonged to the Yoruba. This is obviously expected in a study of this nature since it was conducted in the south-western part of Nigeria. The secondary level of education recorded

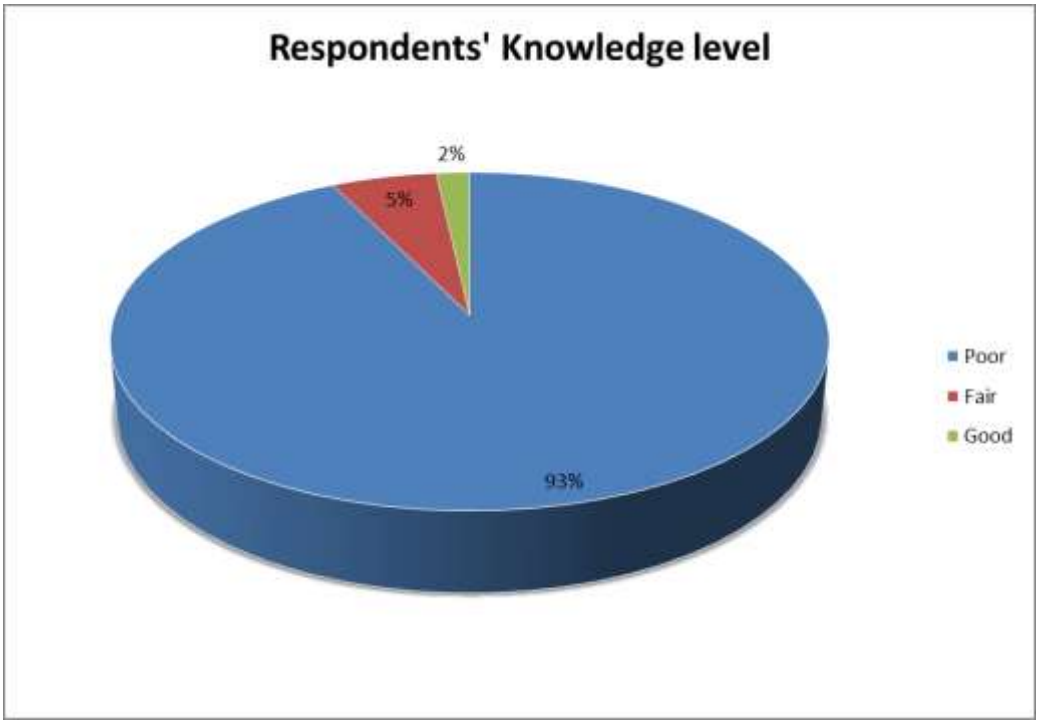

Figure 4: Shows the respondent's knowledge level.

among majority of respondents from Sagamu LGA as well as the high population of artisan/house wives could be ascribed to high level of impoverishment and poor socio-economic status of the communities. Low level of literacy was also reported by Osinusi and Oyejide (1990) among respondents in a poor urban setting in Nigeria.

Majority of households in the seven selected communities depend on borehole and hand-dug well as sources of drinking water. A similar survey conducted by Shittu et al. (2008) reported that in Nigeria, majority of the rural populace do not have access to potable water and therefore, depend on groundwater for domestic use. Abolanle-Azeez et al., (2010) also reported that in Ogun State, borehole and well are common sources of drinking water. The inability of government to make potable water accessible and available to the populace in the rural communities has led to people sourcing for water from other alternative sources like construction of borehole and hand-dug well. This constitutes a looming danger because borehole and hand-dug well are easily polluted by leaking contaminants, heavy metals and microorganisms. When pollutants or their leachates are inadvertently dumped on the soil surface, they percolate through the soil profile and contaminate the aquifer. Majority of the households do not subject their water to any form of treatment before consumption. This might be due to the fact that they had poor knowledge about the toxicity of heavy metals and other contaminants in groundwater: they were only satisfied with the apparent clarity of the water. This corroborated the work of Abolanle-Azeez et al. (2010), who enunciated that majority of households in selected towns in Ogun State were not treating their water. About 1.1 billion of the World's population lack access to potable and quality drinking water supply (WHO, 2007).

Findings from this study revealed that a significant proportion of respondents from the various selected wards in Sagamu LGA, Ogun State, Nigeria reported that they had no health challenges in the last six months. However few people reported frequent intestinal disorders and watery stooling which are symptoms of diarrhea, typhoid fever and other gastrointestinal associated ailments while insignificant proportion of the respondents reported stunted growth, still birth, and cancer within their households. This could be attributed to groundwater contamination by heavy metals pollution from industrial discharge. This hypothesis is further affirmed by the reports of several authors across different states in Nigeria who enunciated the harmful effects of heavy metals in drinking water from

groundwater source on human health such as Jatau et al. (2008) in Kaduna South Industrial Area; Oyekun and Eludoyin (2010) in Ojota Lagos; Yaya and Ahmed (2010) in FCT, Abuja; Laniyan et al. (2010) in Ibadan metropolis; Nwankwoala et al. (2011) in Yenegoa town, Bayelsa; Mile et al. (2013) in Makurdi and sub-urban; and Ocheri et al. (2014).

Assessing people's knowledge on health risks associated with heavy metals pollution is momentous to initiation of educational programmes and public health measures (Ward et al., 1997). The residents in the study communities generally have poor knowledge on the harmful constituents of heavy metals and their toxicity on human health. The poor knowledge observed among respondents in this study could be ascribed to low level of literacy, nature of the communities and lack of exposure to information/educational programmes on heavy metal toxicity. In addition, most of the respondents are indifferent towards the adverse health implication of groundwater contamination by heavy metals. This is in accordance with the report of Cui et al. (2003) who stated that majority of people in rural or poor socio-economic background are not adequately aware or properly informed about the impact of heavy metal contamination in groundwater.

CONCLUSION

The purpose of this study was to assess respondents' knowledge and perceived health risk associated with heavy metals contamination in groundwater in some selected communities in Sagamu Local Government Area, Ogun State, Nigeria. The study revealed that few of the respondents reported diarrhea, stunted growth, still birth and cancer which may be attributed to the heavy metals present in the industrial discharge released into the groundwater bodies. Furthermore, the community residents in the study areas have poor knowledge on heavy metal toxicity and their inimical effects on human health.

Hence, this study recommends that measures to control pollution from the industrial activities should be advocated. Government support for the treatment of groundwater source in this area should be encouraged through health education programmes and provision of facilities. Regular and proper treatment, with monitoring of the groundwater source is also recommended. In addition, provision of potable water from the government should be considered as a good option.

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Conflict of Interest

The authors declare no conflict of interest.

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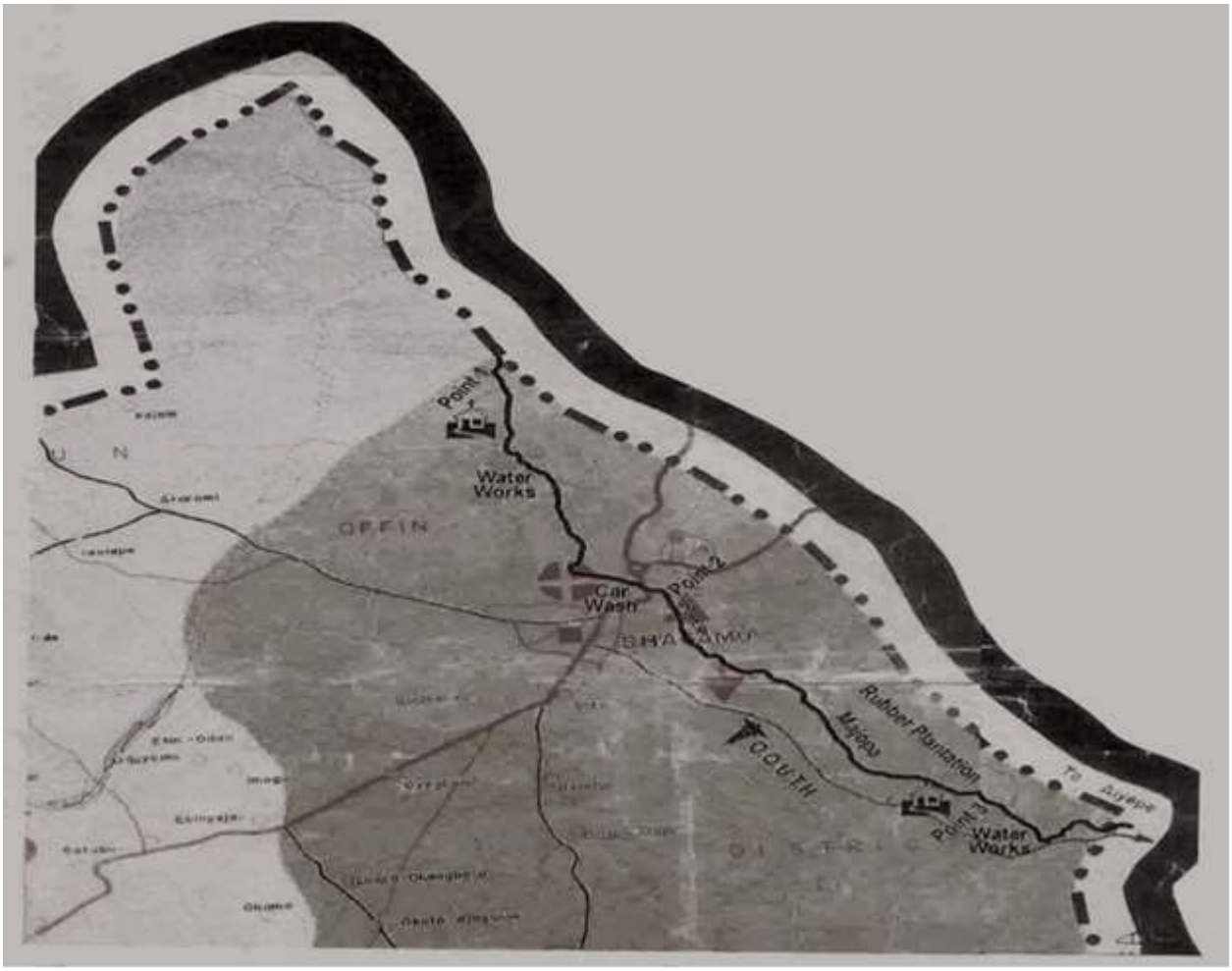
Appendix



Appendix I. Map of Shagamu LGA in Ogun State, Nigeria.