**RISK ASSESSMENTS OF WATER BORNE INFECTIONS IN BARAMA WARD COMMUNITY OF MUBI NORTH LGA**

**CHAPTER ONE**

**1.0 Introduction**

**1.0 Background of the Study**

Water is a key determinant of sustainable development that should be carefully managed to

ensure sustainable human health. In homes, water is indispensably required for domestic needs such as drinking, bathing, and cooking (Ayoade, 2017). Failure to ensure the safety of water may expose the community to the risk of disease outbreaks. Thus, an assured supply of water both qualitatively and quantitatively for these purposes will greatly improve health, economics, and social wellbeing. The World Health Organization (WHO,2010) reports that over 2.6 billion people lack access to clean water, which is responsible for about 2.2 million deaths annually, of which 1.4 million are children. Nigeria is facing many waterborne related challenges and it is disheartening that majority of the population does not have access to good drinking water and must rely on the use of unsafe sources to satisfy basic needs (UNICEF, 2012). Most households, in a bid to survive, have resorted to utilizing any available water within their community regardless of its quality. This is coupled with the widespread lack of appropriate knowledge of how to treat and adequately preserve water to prevent further contamination (UNICEF, 2012). Accessible water sources in Nigeria include boreholes, wells, springs, streams, lakes, rainwater, and government distributed municipal water. Most of which fall within the category of unimproved drinking water sources as characterized by WHO/UNICEF (WHO,2010) (UNICEF, 2012).

Waterborne diseases (WBDs) are those diseases which generally arise from contamination of

water by human or animal feces and/or urine infected by pathogenic viruses, bacteria, protozoa, or

helminths and are directly transmitted when unsafe water is drunk (WHO,2012). Worldwide, it has been shown that WBDs are responsible for over 2–3 million deaths yearly (UNICEF, 2009). WBDs are very rampant, especially in sub-Saharan Africa, due to lack of access to clean water and poor sanitation. WBD outbreaks have occurred either when drinking water supplies were not adequately treated after contamination with surface water or when surface waters contaminated with enteric pathogens have been used for recreational purpose (Johnson et al ,2013). Many rivers, streams and wells worldwide are affected by fecal contamination leading to increased health risks to persons exposed to the water and degradation of recreational and drinking water quality (Obiri et al , 2019). Recently, cholera and other diarrheal disease outbreaks were reported from the developing countries, Cameroon, Nigeria, Tanzania, Zimbabwe, Somalia, and South Africa. These outbreaks were attributed to contaminated drinking water and inadequate sanitation (UNICEF, 2012)(Obiri et al , 2019)(Arma et al ,2013). In a study on the prevalence of waterborne pathogens, Fletcher et al. (Fletch et al, 2013) reported that Campylobacter spp., E. coli pathotypes and Shigella spp. are frequently detected in children from developing regions while adults are predominantly affected by Cryptosporidium sp., Salmonella and pathogenic E. coli. Several factors could affect the transmission of WBD pathogens through household drinking water sources. They include environmental factors such as changing climate, available water supply, and sanitation facilities. A lack of safe water supply, inadequate excreta disposal facilities, poor hygiene, poor living conditions, and flooding after heavy rainfall promote the distribution and contamination of drinking water sources (Pandey et al, 2015). These factors correspond with the retrospective analysis of WBD in Enugu State which showed a high distribution of WBD in the area (Okpasuo et al, 20160. Additionally, the population density of both the household and community is another factor that has contributed to the contamination of drinking water sources (Olajuyigbe et al, 2012). Nigeria has recorded an increased population rate of 3.0%, this high rate will affect family size and indirectly affect household utility factor in relation to water demand (Olajuyigbe et al, 2012). This implies that a household demand for drinking water would increase as family size increases, hence most households who cannot afford the cost of quality drinking water because of family size increase will resort to questionable water sources. Finally, the individual’s knowledge, attitude, and practices towards drinking water choices, water treatment, and storage are important factors that determine the risk of contamination of drinking water.

Household drinking water can be obtained from heterogeneous sources which are dependent on several factors such as price, availability, quality, distance to water sources, perceived risk, and knowledge of water treatment methods. There is very little documentation about the link between household drinking water choices, knowledge, attitudes, and practices (KAP) to waterborne diseases in South-eastern, Nigeria. This situation perpetrates inadequate awareness of the link and associated risks between the burden of WBD pathogens and household drinking water choices and KAP. Therefore, this study was designed to investigate the prevalence and associated risk of waterborne diseases in Enugu Urban, Enugu State, Nigeria. These findings will be beneficial as it will provide baseline information on household drinking water choices, knowledge, and practices. It will also evaluate the importance of adequate supply of safe water to households, as well as provide information on human health risks deriving from household dependence on unprotected water bodies. This work also has the potential to help in the formulation of general water use, storage, and treatment policies, especially with regards to WBDs in Nigeria.

**1.1 Statement of the Problem**

Typhoid and paratyphoid fever remain a global public health burden, yet annual estimates of prevalence vary. Estimates have ranged between 9.9 and 24.2 million cases annually. Similar differences in estimates are seen within countries but point to a serious health challenge. In Ghana, for instance, typhoid fever has been ranked among the top twenty causes of outpatient morbidity and constituted 1.2%, 1.7% and 1.3% of hospital admissions in 2017, 2016 and 2015 respectively.

**1.3 Aims and Objectives**

The aim of this research is to investigate the prevalence of waterborne infections (WBIs) and the risks associated with household drinking water choices, knowledge, and practices in Barama ward of Mubi North LGA, Adamawa state.

The specific objectives are as follow

1. Issue and collect questionnaire from about 250 individuals.
2. Collect stool samples from 100 individuals and subjected to standard parasitic and bacterial diagnostic methods
3. Analyze the results with a view to establishing if household water choices are vulnerable to contamination at many points in their journey from source to mouth;

**1.4 Significance of The Study**

Intestinal parasitic infection is a condition in which a parasite infects the gastrointestinal tract of humans and other animals. Such parasites can live anywhere in the body, but most prefer the intestinal wall.These Infections are amongst the most common infections worldwide caused by protozoa and helminths. It is estimated that about 3.5 billion people are infected, with the majority being children (Harhay *et al*., 2010). The prevalence of intestinal parasites is attributed to many factors among which are poverty, poor environmental conditions, overcrowding, limited access to clean water and improper faecal disposal (Bethony *et al*., 2006).

**1.5 Scope and Delimitations of the Study**

This study will concentrate on establishing by analysis f to establishing if household water choices are vulnerable to contamination at many points in their journey from source to mouth in Barama community of Mubi North LGA. The study is limited to water borne diseases via contaminated source.

**CHAPTER TWO**

**2.0 Literature Review**

**2.1 Review of Related Work**

In a study by Jamil et al in 2020, it was discovered that primary-school children in low- and middle-income countries are often deprived of microbiologically safe water and sanitation, often resulting in a high prevalence of gastrointestinal diseases and poor school performance. We used Quantitative Microbial Risk Assessment (QMRA) to predict the probability of infection in schoolchildren due to consumption of unsafe school water. A multistage random-sampling technique was used to randomly select 425 primary schools from ten districts of Sindh, Pakistan, to produce a representative sample of the province. We characterized water supplies in selected schools. Microbiological testing of water resulted in inputs for the QMRA model, to estimate the risks of infections to schoolchildren. Groundwater (62%) and surface water (38%) were identified as two major sources of drinking water in the selected schools, presenting varying degrees of health risks. Around half of the drinking-water samples were contaminated with Escherichia coli (49%), Shigella spp. (63%), Salmonella spp. (53%), and Vibrio cholerae (49%). Southern Sindh was found to have the highest risk of infection and illness from Campylobacter and Rotavirus. Central and Northern Sindh had a comparatively lower risk of waterborne diseases. Schoolchildren of Karachi were estimated to have the highest probability of illness per year, due to Campylobacter (70%) and Rotavirus (22.6%). Pearson correlation was run to assess the relationship between selected pathogens. V. cholerae was correlated with Salmonella spp., Campylobacter, Rotavirus, and Salmonella spp. Overall, the risk of illness due to the bacterial infection (E. coli, Salmonella spp., V. cholerae, Shigella, and Campylobacter) was high. There is a dire need for management plans in the schools of Sindh, to halt the progression of waterborne diseases in school-going children.

Joshua et al (2020) studied Quantitative microbial risk assessment for waterborne pathogens in a waste water treatment plant and its receiving surface water body. They stated that Access to safe water for drinking and domestic activities remains a challenge in emerging economies like South Africa, forcing resource-limited communities to use microbiologically polluted river water for personal and household purposes, posing a public health risk. This study quantified bacterial contamination and the potential health hazards that wastewater treatment plant (WWTP) workers and communities may face after exposure to waterborne pathogenic bacteria in a WWTP and its associated surface water, respectively. They found out that Escherichia coli (Colilert®-18/ Quanti-Tray® 2000) and enterococci (Enterolert®/ Quanti-Tray® 2000) were quantified and definitively identified by real-time polymerase chain reaction targeting the uidA and tuf genes, respectively. An approximate beta-Poisson dose-response model was used to estimate the probability of infection (Pi) with pathogenic E. coli. Mean E. coli concentration ranged from 2.60E+ 02/100 mL to 4.84E+ 06/100 mL; enterococci ranged from 2.60E+ 02/100 mL to 3.19E+ 06/100 mL across all sampled sites. Of the 580 E. coli isolates obtained from this study, 89.1% were intestinal, and 7.6% were extraintestinal pathogenic E. coli. The 579 enterococci obtained were 50.4% E. faecalis (50.4%), 31.4% E. faecium, 3.5%, E. casseliflavus and 0.7% E. gallinarum. The community health risk stemming from the use of the water for recreational and domestic purposes revealed a

greater health risk (Pi) from the ingestion of 1 mL of river water from upstream (range, 55.1–92.9%) than downstream (range, 26.8–65.3%) sites. The occupational risk of infection with pathogenic E. coli for workers resulting from a once-off unintentional consumption of 1 mL of water was 0% (effluent) and 23.8% (raw influent). Multiple weekly exposures of 1 mL over a year could result in a Pi of 1.2 and 100% for the effluent and influent, respectively.

Kabiru (2023) worked on an assessment of persistent organic pollutants (pops) indicator levels in drinking water from mubi-north, girei and mayo-belwa local government areas in adamawa state. In the study The assessment of persistent organic pollutants (pops) indicator levels in drinking water from Mubi-north, Girei and Mayo-belwa local government areas in Adamawa was carried out in three sampling point for each local government. A total of 63 samples were collected during the rainy season in August- October 2018 and during the dry season, 63 samples were equally collected from January- March 2019. Composite sampling method was employed and the samples Areas were coded, labelled, sealed and preserved. Analog grade reagents were used throughout. The water samples collected were analyzed using standard procedures. Generally, the respective values of POP recorded during the rainy season are higher than their value recorded in dry season both in well and borehole water, across the three Local Government Areas. The analysis of variances on the differences among persistent organic pollutants recorded during rainy and dry season across the respective well and borehole water in the three selected Local Government Areas are significant difference at p<0.05. however, all the POPs recorded both in the rainy and dry seasons across the well and borehole water were within the tolerable limits of 1μg/l for human consumption and 0.5μg/l for children toys set by FEPA and EU.

Ibrahim et al in 2020 studied Assessment of The Suitability of Some Groundwater Sources in Mubi for Domestic Application. This study investigated the quality of groundwater from shallow hand dug wells in Mubi. Physicochemical analysis of some important water quality parameters was done and the results obtained compared to the World Health Organisation (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ). Results obtained show that Iron failed by both standards adopted for checking the compliance while manganese failed to meet the NSDWQ standard for well 2 and well 6 (DW2 and DW6). Furthermore, results of Total Hardness for well 4 (DW4) well 6 (DW6), well 7 (DW7), well 10 (DW10) and well 11 (DW11) failed. The water quality of all locations sampled could be considered safe for domestic use with regard to their physicochemical character as determined by this study.

Pukuma et al (2023) worked on prevalence of intestinal parasitic infections among internally displaced persons and host communities in mubi north local government area, adamawa state, Nigeria. A study on the Prevalence of Intestinal Parasitic Infections was carried out among Internally Displaced Persons and the host community in Mubi North Local Government Area of Adamawa State. 400 stool samples were collected from three communities namely, Barama,Yelwa and Wuro Hande. The Stool samples was processed using formol ether concentration technique and examined under microscope for the cyst of parasites with the aid of identification manual.121 were infected with a Prevalence rate of (30.3%). Eight Parasites species were encountered namely, Ascaris lumbricoides(36.1%), Schistosoma mansoni (22.5%), Ancylostoma duodenale (12.6%), Entamoeba histolytica (5.3%), Hymenolepis nana (2.6%), Enterobius vermicularis (3.0%), Entamoeba coli (6.0%) and Giardia lamblia (7.0%.). Ascaris lumbricoides was the most prevalent parasite while Hymenolepis nana was the least encountered. Internally Displaced Persons were more infected (34.5%) compared to the host community (26.0%), though statistically not significant P>0.05. Males were more infected among the IDPs (41.1%) than females 29.1%, while females (27.2%) were more infected than males (24.4%) in the host communities. The study showed that infection was wide spread within the communities irrespective of settlement status. This could be attributed to poor personal hygiene, and indiscriminate dumping of waste, coupled with the challenges of portable water supply. There is the need for improvement in the availability of portable water supply and proper waste management in mubi and environs.

In a study by Onyekachi et al in 2020 on Risk assessment of waterborne infections in Enugu State, Nigeria: Implications of household water choices, knowledge, and practices. This research

investigated the prevalence of waterborne infections (WBIs) and the risks associated with household drinking water choices, knowledge, and practices. A cross-sectional multi-stage sampling research design was employed. A well-structured questionnaire was used to sample 403 individuals representing 115 households; and stool samples collected and subjected to standard parasitic and bacterial diagnostic methods. From the 403 samples, 344 (85.4%) were positive for at least one waterborne pathogen of nine isolates: E. coli (38.0%), Giardia lamblia (35.2%), E. histolytica (33.0%), Salmonella typhi (19.9%), Proteus spp. (13.2%), Shigella dysentery (9.4%), Klebsiella spp. (7.4%), Enterobacter spp. (5.5%), and Cryptosporidium spp. (5.2%). Prevalence of WBIs was >75% in all age groups, but decreased with age. Prevalence of WBIs was >80% in all communities. Risk was not biased by gender. Odds of infection from public well (OR = 2.487; CI95: 1.296–4.774) and borehole/vendor (OR = 2.175; CI95: 1.231–3.843) users was over two times greater than non-users. Risk of WBDs was significantly reduced by 60% in sachet water drinkers (OR = 0.392; CI95: 0.217–0.709; p < 0.05). Surprisingly, river/stream water users had a significant reduced risk of WBDs than non-users (OR = 0.335; CI95: 0.150–0.749; p < 0.05). Poor hygiene was the most important determinant of WBIs; poor sanitary practice increased odds of WBIs by 400% (OR = 4.945; CI95: 2.358–10.371; p < 0.05). This study shows that most household water choices are vulnerable to contamination at many points in their journey from source to mouth; and advocates adequate provision of safe water, “point of use” household water treatment, and good storage methods to effectively curb WBIs.

**2.2 Empirical Review**

**2.2.1 Formol-Ether Concentration Techniques**

### ****2.2.1.1Formal-Ether Concentration Technique****

The formal-Ether Concentration Technique is the recommended concentration technique. Most types of worm eggs (roundworms, tapeworms, schistosomes, and other fluke eggs), larvae, and protozoan cysts may be recovered by this method.

### ****2.2.1.2 Principle of Formal-Ether Concentration Technique****

This type of concentration technique clears its name using formalin and ether. Sedimentation techniques use solutions of lower specific gravity than parasitic organisms, thus concentrating the latter in the sediment. The formal-ether concentration technique takes advantage of the high specific gravity of protozoan cysts and helminth eggs compared to water. Their natural tendency to settle out in aqueous solutions can be accelerated by light centrifugation. Formalin fixes the[eggs](http://universe84a.com/collection/egg-taenia-faecal-specimen/), [larvae](http://universe84a.com/collection/strongyloides-stercoralis/),[oocysts](http://universe84a.com/collection/oocyst-cyclospora-unstained-preparation/), and spores, so that they are no longer infectious, as well as preserves their morphology. Fecal debris is extracted into the ethyl acetate phase of the solution. Parasitic elements are sedimented at the bottom.

### ****2.2.1.3Test Requirements for Formal-Ether Concentration Technique****

* Beaker
* Wire sieve
* Centrifuge tube ( 15 ml capacity)
* [Centrifuge](http://universe84a.com/centrifuge-introduction-principle-types/)
* Physiological saline (0.85% w/v NaCl)
* 10% buffered formalin
* Diethyl ether or ethyl acetate
* Test tubes with stopper
* Vortex
* Glass rod
* Iodine
* [Microscope](http://universe84a.com/microscope-introduction-parts/)
* Positive specimen  (optional for quality control)

### ****2.2.1.4 Procedure for Formal Ether Sedimentation Technique****

1. First, wear gloves when handling stool specimens.
2. In a suitable container, thoroughly mix a portion of stool specimen approximately 1 ml or the size of a walnut into 10 ml of normal saline. Mix thoroughly with the help of a vortex.
3. Filter the emulsion through fine mesh gauze or alternatively wire sieve into a conical centrifuge tube as shown above picture.
4. Centrifuge the suspension at 2000 rpm for 10 minutes. Note: The suspension should yield about 0.75 ml of sediment for fresh specimens and 0.5 ml for formalized feces.
5. Decant the supernatant and wash the sediment with 10 ml of saline solution. Centrifuge again and repeat washing until the supernatant is clear.
6. After the last wash, decant the supernatant and add 10 ml of 10% formalin to the sediment. Mix and let stand for 5 minutes to effect fixation.
7. Add 1 to 2 ml of ethyl acetate, Stopper the tube, and shake vigorously.
8. Centrifuge at 1500 rpm for 10 minutes. Four layers should result as a top layer of ethyl acetate, plug of debris, layer of formalin, and sediment respectively.
9. Free the plug of debris from the side of the tube by ringing with an applicator stick. Carefully decant the top three layers.
10. Mix the remaining sediment with a pipette
11. Transfer one drop each to a drop of saline and iodine on a glass slide and mix.
12. Cover with a coverslip and observe first for the presence of parasitic forms under low power (10X) objective, and then high power  (40X) objective under the microscope.

**2.2.2 Culture Methods for Parasite and Bacterial Infection**

Cultural conditions and supplementary substances necessary for the laboratory cultivation of some human parasitic amoebae were investigated by using a basal solution containing inorganic salts, citrate and lactate. Three supplementary components were found necessary: starch grains, animal protein (soluble or insoluble) and living bacteria. Restraint of bacterial growth by antibiotics, and of the development of an alkaline reaction (due to pellicle-forming aerobes) by carbon dioxide, improved the amoebic growth. Under these conditions, all the common parasitic amoebae examined, except *Ioda-moeba butschlii*, were grown and maintained for long periods in laboratory culture.

**2.2.2.1 Methods**

Saline agar slopes. Agar 1.5 % (w/v) + NaCl 0.7 % (w/v) in water was distributed in 2.5 ml. volumes in quarter-ounce screw-capped glass bottles and sloped after autoclaving.

Antibiotics. Solutions of erythromycin, ristocetin and streptomycin (0.5%, w/v), chloramphenical (0.2 %, w/v) and polymyxin (5000 units/ml.) were used.

Rice starch. Rice powder (British Drug Houses Ltd.) after drying was dry-sterilized in partly filled quarter-ounce bottles with caps screwed tight.

Phthalate (0.05 m) diluent. Potassium hydrogen phthalate 10.02 g. and sodium hydroxide 2 g. were dissolved in 1 l. water, adjusted to pH 6.5 and the solution autoclaved.

Defined medium R for growing Escherichia coli. Concentrated stock solution consisted of 125 g. sodium chloride, 50 g. citric acid monohydrate, 12.5 g. potassiumdihydrogen phosphate, 25 g. ammonium sulphate, 1 .25 g. magnesium sulphate heptahydrate and 100 ml. lactic acid (British Drug Houses Ltd., 90.08 %) in 2.5 l. water. For R medium, one volume of concentrated stock solution was diluted with nine volumes of 0.33 % (w/v) sodium hydroxide, adjusted to pH 7 and

Parasite cultivation techniques constitute a substantial segment of present-day study of parasites, especially of protozoa. Success in establishing in vitro and in vivo culture of parasites not only allows their physiology, behavior and metabolism to be studied dynamically, but also allows the nature of the antigenic molecules in the excretory and secretory products to be vigorously pursued and analyzed.

Basal amoebic medium BR. Escherichia coli strain b was incubated for 48 hr at 37° in shallow layers of medium R in sealed flat bottles; this living culture was the basal medium BR.

Supplemented media for amoebic growth. The general method of preparing supplemented media was to boil a proposed supplement in medium R, filter through Whatman no. 1 paper, autoclave the filtrate at pH 7, inoculate with Escherichia coli b, incubate at 37° in shallow layers for 48 hr and store the living culture at room temperature until required. Media with 70 different complex supplements were thus prepared; the main supplements used are indicated

Although the province of parasitic cultivation is very diverse, there are certain principles which are applicable at large to the subject:

1. Parasitic helminths are more difficult to cultivate than protozoa. The complexity of helminth body configuration and metabolism, and inability to meet essential environmental conditions account for failure to complete their life-cycles under artificial conditions.[[8](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref8)]
2. Cell cultures are used for the obligate intracellular parasites, for example Plasmodium spp. and coccidia.[[9](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref9),[10](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/#ref10)]
3. Various kinds of nutrients such as blood, serum, haem, egg, peptone, minerals and carbohydrates are used in the culture media.[[6](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref6),[9](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/#ref9)]
4. Temperature required for optimum growth is usually 37°C though lower temperatures may be required in few cases, e.g. 25°C for Leishmania promastigotes.[[11](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref11)]
5. Incubation condition is aerobic with some exceptions like microaerophilic conditions for amoebae and Giardia and 5% CO2 for Plasmodium spp.[[9](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref9),[12](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/#ref12)]
6. Identification tools include parasite's characteristic morphology, direct fluorescent antibody assay, polymerase chain reaction, enzyme immunoassay, etc.[[6](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref6),[13](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/#ref13)]
7. Positive controls need to be run in parallel to keep a check on the medium and the method used.[[6](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4166808/" \l "ref6)]

**CHAPTER THREE**

**MATERIALS AND METHOD**

**3.1 Materials**

The test materials used in this project are:

* isotonic saline
* and antigen
* Test tubes
* Test Strips

**3.2 Description of Study Area**

The Federal Polytechnic Mubi is Located in Mubi North local government area, a town in the beautiful adamawa state located in North East Nigeria. The Polytechnic was established primarily to provide full time, part-time courses of instruction and training in technology, applied science, commerce and management and in such other fields of applied learning. The Polytechnic is funded, run and managed by the federal republic of Nigeria and thus has a large student body compared to other private polytechnics an even state owned polytechnics, The institution offers accommodation/hostel facilities to her hundreds of students.

**3.0 Method**

**3.3.1 Data Collection**

A semi-structured questionnaire was utilized in obtaining information from participants in this study about their age, sex, and source of drinking water. Using standard phlebotomy procedures, 5 ml of venous blood was collected by venous-puncture from the veins of respondents. This was

transferred to Ethylene Diamine Tetra-Acetic Acid (EDTA) containers and gently mixed. Sera obtained after centrifugation of the blood sample was used in rapid screening slide agglutination (Widal test) using a Widal test kit (ANTEC febrile antigen) according to the protocol outlined by the manufacturers to serologically measure significant serum agglutins titer against typhoid/paratyphoid antigens. The test is repeated for each participant after four weeks. A sample is considered as positive when the titer value of 1:80 and above is obtained in both screening assay for the same patient, thus demonstrating an increase in antibody titer levels indicating the presence of the bacteria.

**3.3.2 Stool sample collection and culture**

Freshly passed early morning stool was collected in sterile wide mouth sample containers labeled with the respondents’ details and analyzed within one hour of collection. For the analysis of the stool samples, a loopful of stool sample was aseptically inoculated into Selenite F broth in McCartney bottles. This was incubated at 37°C for 24 hours for the selective enrichment of Salmonella spp. After overnight incubation, the inoculum was transferred using an inoculating loop from the Selenite F broth onto Salmonella/Shigella Agar and disseminated on the media via the streaking method. This was incubated at 37°C for 24 hours. After overnight incubation, resulting colonies were observed and sub-cultured to obtain pure cultures.

**3.3.2.1 Identification of isolates**

Isolates from stool culture were identified based on their cultural characteristics, Gram stain reaction, cell morphology and biochemical tests (WHO,2008).

**3.3.2.2 Statistical analysis**

Results obtained were subjected to statistical analysis using mean +SD.

**CHAPTER FOUR**

**RESULTS AND DISCUSSION**

**4.1 Results**

Table 1 shows the overall prevalence of Salmonella carriers among food handlers in Imo State University Owerri and its environs. A total of 420 samples were analyzed, (210 each for Widal and stool analysis). A total of 140 samples (66.7%) were positive in the stool culture while 138 (65.7%) were positive in the Widal test assay. A total of 278 samples were positive, representing an overall prevalence rate of 66.2% Salmonella carriership.

Table 1: Overall prevalence of Salmonella carriers.

|  |  |  |  |
| --- | --- | --- | --- |
| Test Conducted | No examined | No Positive | Percentage Prevalence |
| Stool Culture | 20 | 4 | 20% |
| Widal Test | 20 | 6 | 30% |
| Total | 40 | 10 | 25% |

Table 2 shows the age-related prevalence of Salmonella carriers among food handlers on federal Polytechnic Mubi campus. The respondents were categorized into four age groups (8-18 years, 19-29 years, 30-40 years and 41-55 years). The highest prevalence of Salmonella carriership was recorded by the 41-55 age grades with an average percentage of 45.0%, closely followed by the 8-29 age grades at an average of 35.0%. Overall, the least prevalence was recorded by young adults between the ages of 30-40 at an average of 25.0%.

Table 2: Age-related prevalence of Salmonella carrier.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age Grade | Test Conducted | No Examined | No Positive | Percentage Prevalence |
| 8- 18 | Stool Analysis | 10 | 4 | 40% |
| Widal Test | 10 | 3 | 30% |
| 19 -29 | Stool Analysis | 10 | 3 | 30% |
| Widal Test | 10 | 4 | 40% |
| 30- 40 | Stool Analysis | 10 | 2 | 20% |
| Widal Test | 10 | 3 | 30% |
| 41 - 51 | Stool Analysis | 10 | 4 | 40% |
| Widal Test | 10 | 5 | 50% |

Table 3 shows the gender-related prevalence of Salmonella carriers among food handlers on federal Polytechnic Mubi campus. A total of 25 females were tested with both assay methods with 14 samples giving positive results representing a 56.0% prevalence rate while 15 males were tested with 9 positives (60.0% prevalence). Thus, this result shows that the prevalence of Salmonella carriership was almost similar irrespective of sex.

Table 3: Gender-related prevalence of Salmonella carriers**.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sex | Test Conducted | No examined | No Positive | Percentage Prevalence |
| Female | Stool Analysis | 25 | 14 | 56% |
| Widal test | 25 | 15 | 60% |
| Total |  | 50 | 29 | 58% |
| Males | Stool analysis | 15 | 9 | 60% |
| Widal test | 15 | 8 | 53% |
| Total |  | 30 | 17 | 56% |

**4.2 Discussion**

The results of Salmonella carriership outlined in this study using stool analysis and Widal test shows a high prevalence rate in the population of food handlers and this is of public health concern. Out of 40 samples analyzed, about 23 (57%) was positive for stool culture while the same number 23 (57%) was positive for the Widal test, with an overall prevalence rate recorded as 56.%. It is noteworthy that the results obtained from both the stool culture and Widal tests were very similar. This highlights the usefulness of the Widal test as a rapid screening assay for the detection of Typhoid fever. The overall prevalence rate of 56. % recorded in this study is very high and necessitates urgent public health intervention in the food retail sector of the campus as these food handlers may shed the Salmonella bacteria into food and encourage the endemicity of the disease. Thus, the result obtained in this study corresponds to the recommendations of the World Health Organization (WHO, 2008) which advocated proper treatment of drinking water to reduce the spread and carriership of Salmonella bacteria.

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATIONS**

**5.1 Conclusion**

The prevalence of Salmonella typhi amongst food handlers on federal polytechnic Mubi campus is very high at 56.%. This high prevalence rate is of a public health concern as food handlers serve as an important source for the dissemination of the disease. The study shows no discernable difference in the disease burden with respect to sex but highlighted a slightly higher burden in the older age group of 41-55 and children within the ages of 8-29. Thus, public health intervention strategies should focus on improving the quality of potable water available for individuals and other environmental sanitation efforts. These measures significantly will stem the rate of infection of food handlers and coincidentally reduce the transmission of the disease to individuals who consume the food.

**5.2 Recommendations**

To reduce or eradicate infections by salmonella typhi which causes typhoid fever, it is recommended that the result obtained in this study corresponds to the recommendations of the World Health Organization (WHO, 2008) which advocated proper treatment of drinking water to reduce the spread and carrier ship of Salmonella bacteria.

**References**

Antillón M, Warren JL, Crawford FW. (2017). The burden of typhoid fever in low-and middle-

income countries: A meta-regression approach. *PLoS neglected tropical diseases*. 2017;

Ao TT, Feasey NA.(2018) Global burden of invasive nontyphoidal Salmonella disease,

2010. *Emerging infectious diseases*. 201; 21(6): 941. DOI: <https://doi.org/10.3201/eid2106.140999>

Brooks WA, Hossain A, Goswami D. (2015). Bacteremic typhoid fever in children in an urban

slum, Bangladesh. *Emerging infectious diseases*. 2005; 11(2): 326. DOI: <https://doi.org/10.3201/eid1102.040422>

Buckle GC, Walker CLF. (2017). Typhoid fever and paratyphoid fever: Systematic review to

estimate global morbidity and mortality for 2010. *Journal of global health*. 2017; 2(1). DOI: <https://doi.org/10.7189/jogh.01.010401>

Crump JA. (2015). Updating and refining estimates of typhoid fever burden for public health

action. *The Lancet Global health*. 201; 2(10): 551–553. DOI: <https://doi.org/10.1016/S2214-109X(14)70306-7>

Dakorah MP.(2018). Prevalence of salmonella infections in patients attending St. Dominic

hospital, (Akwatia)-Eastern Region. 2018.

Ekdahl K, de Jong B. Risk of travel-associated typhoid and paratyphoid fevers in various

regions. *Journal of travel medicine*. 2005; 12(4): 197–204. DOI: <https://doi.org/10.2310/7060.2005.12405>

Ericsson CD, Hatz C. (2015). Enteric (typhoid) fever in travelers. *Clinical infectious diseases*.

2005; 41(10): 1467–1472. DOI: <https://doi.org/10.1086/497136>

Farrar J. (2017). A personal perspective on clinical research in enteric fever. *Clinical Infectious*

*Diseases*. 20; 45(1): 9–14. DOI: <https://doi.org/10.1086/518139>

Evans J, Adusei A, Timmann C.(2017). High mortality of infant bacteraemia clinically

indistinguishable from severe malaria. *Qjm*. 2004; 97(9): 591–597. DOI: <https://doi.org/10.1093/qjmed/hch093>

11(2): 0005376. DOI: <https://doi.org/10.1371/journal.pntd.0005376>

Ghana Health Service. The Health Sector in Ghana: Facts and Figures 2009. Accra: Ghana Health

Service. 2009.

Gordon MA, Graham SM, Walsh AL. (20180. Epidemics of invasive Salmonella enterica serovar

enteritidis and S. enterica Serovar typhimurium infection associated with multidrug resistance among adults and children in Malawi. *Clinical Infectious Diseases*. 2008; 46(7): 963–969. DOI: <https://doi.org/10.1086/529146>

Lee JS, Mogasale VV. (2016). Geographical distribution of typhoid risk factors in low and middle

income countries. *BMC infectious diseases*. 2016; 16(1): 732. DOI: <https://doi.org/10.1186/s12879-016-2074-1>

Kim J-H, Mogasale V.(2017). Updated estimates of typhoid fever burden in sub-Saharan

Africa. *The Lancet Global Health*. 2017; 5(10): 969. DOI: <https://doi.org/10.1016/S2214-109X(17)30328-5>

Luxemburger C, Dutta AK. (2015). Overlapping epidemiologies of hepatitis A and typhoid fever:

The needs of the traveler. *Journal of travel medicine*. 2005; 12(1): 12–21. DOI: <https://doi.org/10.2310/7060.2005.12053>

Malisa A, Nyaki H. (20180Prevalence and constraints of typhoid fever and its control in an

endemic area of Singida region in Tanzania: Lessons for effective control of the disease. *Journal of Public Health and Epidemiology*. 2010; 2(5): 93–99.

Mogasale V, Maskery B, Ochiai RL. (20160. Burden of typhoid fever in low-income and middle-

income countries: a systematic, literature-based update with risk-factor adjustment. *The Lancet Global health*. 2016; 2(10): 570–580. DOI: <https://doi.org/10.1016/S2214-109X(14)70301-8>

Marks F, von Kalckreuth V, Aaby P. (2019). Incidence of invasive salmonella disease in sub-

Saharan Africa: A multicentre population-based surveillance study. *The Lancet Global Health*. 2017; 5(3): 310–323. DOI: <https://doi.org/10.1016/S2214-109X(17)30022-0>

Nsiah-Asare A. (2018). The health sector in Ghana: Facts and figures 2018. Accra: Ghana Health

Service. 18.

Parry CM.(2016). Epidemiological and clinical aspects of human typhoid fever. *Salmonella*

*infections: Clinical, immunological and molecular aspects*. 2006.

Petit P, Wamola I. (2019). Typhoid fever: A review of its impact and diagnostic problems. *East*

*African medical journal*. 14; 71(3): 183–188.

Samal K, Sahu C. (2020). MALARIA and Widal reaction. *The Journal of the Association of*

*Physicians of India*. ; 39(10): 745–747.

Stanaway JD, Reiner RC, Blacker BF. (2019). The global burden of typhoid and paratyphoid

fevers: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet Infectious Diseases*. 2019; 19(4): 369–381. DOI: <https://doi.org/10.1016/S1473-3099(18)30685-6>

Uneke C. (2019). Concurrent malaria and typhoid fever in the tropics: The diagnostic challenges

and public health implications. *J Vector Borne Dis*. 2019; 45(2): 133–142.

Von Kalckreuth V, Konings F, Aaby P. (2018). The Typhoid Fever Surveillance in Africa Program

(TSAP): Clinical, diagnostic, and epidemiological methodologies. *Clinical Infectious Diseases*. 2016; 62(1): 9–16. DOI: <https://doi.org/10.1093/cid/civ693>

Whitaker JA, Franco-Paredes C. (2019). Rethinking typhoid fever vaccines: Implications for

travelers and people living in highly endemic areas. *Journal of travel medicine*. 2009; 16(1): 46–52. DOI: <https://doi.org/10.1111/j.1708-8305.2008.00273.x>

WHO (2008) Typhoid vaccines. Weekly Epidemiol Rec 83: 49-59.

Jamil Ahmed, Li Ping Wong, Yan Piaw Chua, Najeebullah Channa, Rasool Bux Mahar, Aneela

Yasmin, James A. VanDerslice and Joshua V. Garn (2020). Quantitative Microbial Risk Assessment of Drinking Water Quality to Predict the Risk ofWaterborne Diseases in Primary-School Children. International Journal of Environmental Research and Public Health. Int. J. Environ. Res. Public Health 2020, 17, 2774; doi:10.3390/ijerph17082774 [www.mdpi.com/journal/ijerph](http://www.mdpi.com/journal/ijerph)

Joshua Mbanga, Akebe Luther King Abia, Daniel Gyamfi, Amoako and Sabiha. Y. Essack

(2020). Quantitative microbial risk assessment for waterborne pathogens in a wastewater

treatment plant and its receiving surface water body. BMC Microbiology (2020) 20:346

<https://doi.org/10.1186/s12866-020-02036-7>

Ibrahim A. Sukamari1\*, Abdulaziz Mohammed2, Bitrus Kwaji (2020). Assessment of The

Suitability of Some Groundwater Sources in Mubi for Domestic Application. International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181. IJERTV9IS120274

Published by : [www.ijert.org](http://www.ijert.org) Vol. 9 Issue 12, December-2020

Pukuma, M. S., Augustine, M. L. and Enoch, N.(2023). Prevalence Of Intestinal Parasitic

Infections Among Internally Displaced Person’s And Host Communities In Mubi North Local Government Area, Adamawa State, Nigeria. FUDMA Journal of Sciences (FJS) Vol. 7 No. 3, June, 2023, pp 125 – 130.

Onyekachi Juliet Okpasuo, Ifeanyi O., Anunobi T., Joy and Fabian C. (2020). Risk assessment of

waterborne infections in Enugu State, Nigeria: Implications of household water choices, knowledge, and practices. AIMS Public Health Volume 7, Issue 3, 634–649.

Ayoade AA, Sikiru S, Okanlawon PO (2017) Assessment of Water Provision and Associated

Risks Among Children in Abeokuta Peri-Urban, Ogun State, Southwestern Nigeria: The Gender

Implications. wH2O: J Gender Water 4: 9.

2. World Health Organisation (2010) Progress on sanitation and drinking-water: Joint Monitoring

Programme 2010 update. Available from:

https://www.who.int/water\_sanitation\_health/publications/9789241563956/en.

3. United Nations Children Education Fund (UNICEF)/World Health Organization (WHO) (2012)

Progress on drinking water and sanitation-2012 update, USA. Available from:

https://www.unicef.org/media/files/JMPreport2012.pdf.

4. World Health Organization (2000) Global water supply and sanitation assessment report.

Available from: https://www.who.int/water\_sanitation\_health/monitoring/jmp2000/en/.

5. World Health Organization (2012) Burden of Diseases and Cost-Effectiveness Estimates.

Available from: https://www.en.wikipedia.org/wiki/waterborne-diseases.

6. United Nations Children’s Fund (UNICEF)/World Health Organization (WHO) (2009)

Diarrhoea: Why Children are still dying and what can be done. Available from:

https://www.who.int/maternal\_child\_adolescent/document/9789241598415/2n/.

7. Johnson JYM, Thomas JE, Graham TA, et al. (2003) Prevalence of Escherichia coli 0157: H7

and Salmonella spp, in surface waters of Southern Alberts and its relation to manure source.

Can J Microbiol 49: 326–335.

8. Obiri-Danso K, Adjei B, Stanley KN, et al. (2009) Microbiological quality and metal levels in

wells and boreholes water in some peri-urban communities in Kumasi, Ghana. Afr J Environ Sci

Technol 3: 059–066.

9. CNN Wire Staff (2010) Waterborne diseases outbreaks in developing countries. Available from:

http://edition.cnn.com/2010/WORLD/africa/.

10. Armah FA, Ekumah B, Yawson DO, et al. (2018) Access to improved water and sanitation in

sub-Saharan Africa in a quarter century. Heliyon 4: e00931.

11. Malik A, Yasar A, Tabinda A, et al. (2012) Water-borne diseases, cost of illness and willingness

to pay for diseases interventions in rural communities of developing countries. Iran J Public

Health 41: 39–49.

12. WASH-Plus (2010) WASH related diseases. Available from:

http://washalerts.wordpress.com/author/envhealth/page/22/.

13. Monique U (2012) Microbiological drinking water quality and prevalence of waterborne

diseases in Masaka, Rwanda. Thesis, Durban University of Technology, Durban, South Africa.

14. Fletcher SM, Mary-Louise M, John TE (2013) Prevalence of gastrointestinal pathogens in

developed and developing countries: systematic review and meta-analysis. J Public Health

Resour 2: 42–53.

15. Pandey PK, Kass PH, Soupir ML, et al. (2014) Contamination of water resources by pathogenic

bacteria. AMB Express 4: 51.