FOOD SAFETY AND HYGIENE CONDITIONS IN SELECTED PUBLIC SECONDARY SCHOOLS WITH BOARDING FACILITIES IN IBADAN, NIGERIA

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CERTIFICATION

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DEDICATION

This work is dedicated to GOD Almighty with whom all things are possible

and

To Dr. Gbaruko B.C, a course mate who died in a ghastly motor accident during the course of the programme. May his soul rest in perfect peace.

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Imam

ABSTRACT

Cases of food contamination and poisoning in boarding schools have been reported in Nigeria. Although researches have been carried out on food safety in Nigerian schools, not many studies were conducted in boarding schools despite the health implications of consuming unsafe food. This study was designed to assess the food safety and hygiene conditions in selected Public Secondary Schools with Boarding Facilities(PSSBF) in Ibadan, Nigeria.

Stratified random sampling technique was used to select five out of ten PSSBF in Ibadan. A semi-structured interviewer administered questionnaire was used to elicit information on Knowledge, Attitude and Practice (KAP) of food safety and hygiene among 59 food handlers. A 40, 24 and 30 point scales was used to assess the food handlers KAP respectively. Food hazards and sanitary conditions were assessed by direct observation using a 30-item checklist. Forty-two food samples were collected immediately after cooking from kitchens and dining halls of schools. Food holding temperature was measured by inserting thermocouple in the mid region of the food samples. Borehole, well and Tap water samples used for dish-washing, cooking and drinking were collected from the schools. Food and water samples were assessed for bacteria using pour plate and multiple tube method and results expressed in cfu/g and cfu/ml respectively. Values obtained from analysis of food and water samples were compared with United States Food and Drug Administration (USFDA) and Standard Organization of Nigeria (SON) respectively. Descriptive statistics, Chi-square test, t-test and ANOVA were used for data analysis at $p=0.05$

Mean age of food handlers was 34.5±10.1 years. Mean Knowledge Attitude and Practice scores on food safety was 26.9±4.9, 13.4±3.2 and 21.9±3.8 respectively. Objects observed in food sampled were artificial finger nails, drug capsules, and tiny metals. Toilet facilities in the schools were in poor sanitary conditions with no running water. The mean temperature at holding for food samples in ^{o}C were: rice (57.4±4.6), “moi-moi” (57.1±5.9), “akamu” (34.3±1.5), vegetable-soup (59.0±6.7) and yam-porridge (63.4±3.6). There was a significant difference between temperature at holding for all food compared to the USFDA standard. The types and loads of bacteria isolated from the food samples were *Escherichia coli* ($4.4x10^{8}$), fecal coliform (5.1×10^{8}), *Staphylococcus aureus* (*(*$1.2x10^{8}$) and *Bacillus cereus* ($8.4x10^{8}$) cfu/g. These were significantly higher than USFDA standard for food safety. Mean total coliform of 18 and

16cfu/100ml were obtained for cooking and drinking water respectively. Total coliform for cooking and drinking water exceeded SON water safety level.

The level of food and water contamination in the schools was high. Although the food handlers have average knowledge of food safety and hygiene, the hygiene condition of food surroundings and toilets was poor. Therefore, there is need for hygiene education, training on food safety and regular monitoring in boarding secondary schools.

Keywords: Boarding schools, Food handlers, Food hazards, Hygiene practices, Food safety.

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ACRONYMS

ASFSA	American School Food Services Association
CDC	Centre for Disease Control
CDCP	Centre for Disease Control and Protection
FAO	Food and Agricultural Organization
FDA	Food and Drug Administration
GAO	Government Accountability office
GCI	Government College Ibadan
GSS	Global salmonella surveillance
HACCP	Hazard Analysis Critical Control Points
ICMSF	International Commission on Microbiological Specification for Food
ISI	International School Ibadan
KAP	Knowledge Attitude and Practices
MMWR	Morbidity and Mortality Weekly Report
MPN	Most probable number
NAFDAC	National Agency for Food and Drug Administration and Control
QSI	Queens School Ibadan
SLGS	St Luis Grammar School
SON	Standard Organization of Nigeria
UKDH	United Kingdom Department of Health
UNICEF	United Nation Children's Fund
UNFPA	United Nations Population Fund
USFDA	United States Food Drug Administration
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Unsafe food has been a human health problem for long, and cases of food borne illness occur daily. Although, governments all over the world are doing their best to improve the safety of the food supply, the occurrence of food borne disease remains a significant health issue in both developed and developing countries. As most of these cases are not reported, the true dimension of the problem is unknown (WHO, 2002). Millions of people become ill and many die due to consumption of unsafe food and water. Up to one third of the population of developed countries are affected by food borne illness each year (FAO &WHO, 2002). In recent times, concerns about safety of food have replaced those of the quantity of food. Many feel that such concerns are products of our convenience but the basic truth is that the majority of disease and contaminations of man and animals are from food we consume. .It has been estimated that each year 1.8 million people die as a result of diarrheal diseases and most of these cases can be attributed to contaminated food or water. Each weekday, millions of American students eat meals prepared and served at school (Burghardt *et al*, 1995).

Food safety and hygiene condition is essentially important most especially in the situation where food is cooked in large quantities that involve large numbers of food handlers. A good example is boarding school. The consolidation of small food processing operation to larger one e.g. restaurants, boarding schools, hotels etc, may contribute to an increase in food borne disease.

Food safety is an important part of providing school children with acceptable, safe, and nutritious meals. There is evidence that improvements is needed in the area of food safety in schools, thus the goal of the school food service program is to serve meals that are acceptable, safe, and nutritious (Neill, 1980).

There are incidences of food borne diseases in Nigerian schools. However, the epidemiological data of these outbreaks is either often unavailable or the incidence of contamination is grossly underreported. In 1994, a class of medical students of the University of Lagos, Nigeria came down with a strange illness after consuming a dinner of freshly made salad which was

inadvertently contaminated with salmonella (Tribune, 1994). Lack of knowledge of food safety, poor personal hygiene, and poor storage practices common with food handles in the boarding school is of great concern. Thus, unsafe environment poses many hazards to food preparation. The hygienic quality of prepared food can be assured if basic food safety principles are observed (Ehiri *et al*, 2001)

Poor housekeeping, poor personal hygiene and more specifically hand hygiene can compromise food safety and it is significant risk factors in the transmission of food-borne pathogens (Kilgore *et al* 1996). The slightest food handling mistake by just one person or just one stage of food preparation may affect large number of people and may result in massive food disease outbreak. Hence, hygienic quality of prepared food can be assured if basic food safety principles are observed (Ehiri *et al*, 2001).

Microorganisms are essential components of our environment and they are ubiquitous in the environment. They are in the air, food, water and soil, on the surface of objects such as cooking utensils, as well as in/on our bodies (skin, head, mouth, hand etc). Microorganisms live in, on and with man and animals. Ordinarily, microorganisms are of no threat to healthy humans while some are quite beneficial.

There is an estimated 2 million death in children worldwide due to the consumption of unsafe food (Koepke *et al*, 2008, Miller *et al*, 2008). Chemicals, heavy metals, parasites, fungi, viruses and bacteria can make food unsafe and cause food borne illness. However, bacteria related food poisoning is the most common, but less than 20 of the many thousands of different bacteria actually are the culprits. More than 90 percent of the cases of food poisoning each year are caused by Staphylococcus aureus, Salmonella, Clostridium perfringens, Campylobacter, Listeria monocytogenes, Vibrio parahaemolyticus, Bacillus cereus, Entero-pathogenic Escherichia coli, proteus (WHO, 2004). These bacteria are commonly found on raw foods like salads, eggs, beef, vegetables, cheese, ice cream, unpasteurized milk, fish, fresh fruits, canned foods, mushrooms etc(Noah, 2009, Fry *et al*, 2005).

Food contamination can occur in any stage of food preparation, transportation, distribution and storage. It is however essential to protect the school food from microbial, physical, chemical and all other forms of contamination. The involvement of E coli in several cases of food poisoning suggested that this organism rather than fecal coliform group should be used as an indicator of sanitary quality. Microbiological standards in most developed countries rely on total coliform and E.coli as markers for enteric organisms.(Karatz *et al*, 1999). Many developing countries suffer from either chronic shortages of fresh water or pollution of readily accessible water sources (Lehloesa and Muyima, 2000). According to United Nation Children's Fund (UNICEF) report, about 800 million people in Africa and Asia are living without access to safe drinking water. This has exposed many people to various diseases. (Tanwir *et al*, 2003).

The World Health Organization defines a health-promoting school as one that constantly strengthens its capacity as health setting for living, learning and working (WHO, 1999). Thus the goal of school food safety monitoring is to keep food wholesome. It is important that boarding school children have portable water to drink, adequate water for hygiene, adequate sanitation facilities, safe food and safe clean environment.

Environmental challenges and opportunities vary considerably among schools across countries and within communities around the world. Food environment refers to all entity micro or macro that comes in contact with food. These items can directly or indirectly influence wholesomeness of the food .These environmental factors therefore must be in a clean condition or in acceptable limits at all times. The food environment include bacteria, cooking utensils, food handlers, food storage facilities, food temperature, food plates, spoons, toilet, kitchen , water used for cooking.

The food temperature plays very significant role in determining the wholesomeness of the food consumed in the boarding schools and good temperature control is essential to keep foods safe. Products such as prepared ready-to-eat foods, cooked food, smoked meat or fish, and certain dairy products must, by law, be kept hot or chilled until they are served to the students in the boarding schools. If not, harmful bacteria could grow or toxins (poisons) could form in the food and make the student and staff ill. Foods that are taken chilled should be held at 8°C (46°F) or below while those eaten hot should be held above 63°C (145°F). Research have shown that the factors most commonly associated with food borne illness outbreaks include food purchases

from unsafe sources; inadequate cooking or reheating; holding at room temperature in advance service; cross-contamination from other foods or food contact surfaces; poor personal hygiene; or improper food handling practices (Richards *et al*, 1993; Martin *et al*, 1986)

According to WHO (2002), it is important to have an understanding of the interaction of prevailing food safety beliefs, knowledge and practices of food handlers in order to minimize food borne disease. A good knowledge towards food safety among food handlers and the effective practices of such knowledge in food handling are important in ensuring the safe production of food in any catering operations like the boarding school food department (Mortlock *et al*, 1999). Studies emphasized the need for training and education of public food handlers in hygiene measures due to their lack of knowledge on microbiological food hazards, temperature ranges of refrigerators, cross contamination and personal hygiene (Bas *et al*. 2004)

1.2 Statement of Problem

Many researches on food safety in schools have been carried out in Nigeria but there are not many food safety research carried out in structured school environment like the boarding schools. This may be due to the little priority given by the health decision –makers to issues relating to school health system and food safety.

A little over 600 food borne disease outbreaks in American schools were reported to the Centre for Disease Control between 1973 and 1999 (McCabe-Sellers and Beattie, 2004; Flanigan, 2006). This figure is worrisome, more so that most food outbreaks in schools are grossly underreported. This situation is of great concern in Nigeria schools considering the fact that few cases of outbreaks of food borne illnesses are reported by the health authorities.

In April 2008, about two hundred students at Doma Government Secondary School for Girls were hospitalized for several days and treated for diarrhea after consuming beans meal (Vanguard, Nigeria, 2008). Also in 1993, an entire class of medical students of the University of Lagos Nigeria contracted a strange illness after consuming a dinner of freshly made salad that was inadvertently contaminated with salmonella (Nigerian Tribune, 1994).

Several cases of bacterial food poisoning were reported within the student community of Ambrose Ali University, Ekpoma Nigeria. The researcher later isolated microorganisms causing food poisoning like B cereus, proteus, and Staph aureus. The study also reported the major unhygienic practices observed among the food handlers such as poor care of immediate cleaning and failure to wear covering apron (Oni *et al*; 2010).

In 1998, research showed that infants, elderly and institutionalized adolescents such as students in the boarding schools, some of whom are under emotional and psychological stress as a result of academic rigor and absence from family members are at higher risk of food and water borne diseases even at low doses of enterotoxigenic strains of microorganisms (Nataro *et al*; 1998).

Vendors who prepared food well in advance (over 4 hours) were found to practice food re-heating more than those who prepared food within 4 hrs and there are serious health implications when food are not stored or taken within certain safe temperatures. This study underscores the fact that the school food vendors and handlers may not have been complying with food holding time and temperature regulations (Musa and Akande, 2003).

In 2010, studies showed that less than 20% food handlers had a good level of knowledge, attitude and practice on food sanitation while 80% of the food handlers need to improve knowledge, attitude and practice towards choosing low quality raw materials, using cloths to clean utensils, storing ready-to-eat foods in cabinets to protect them from pests or vectors control . It was found that there was a significant relation between knowledge and practice of food handlers. This study emphasize the significance of Knowledge, Attitude and Practice of food handlers towards ensuring food safety in boarding schools (Thidarat *et al*; 2011).

In Zaria, studies were carried out on food safety in boarding secondary schools using HACCP. The study discovered that the lack of good personal hygiene of the food handlers may compromise safety of foods served in boarding schools (Oranusi *et al*; 2007), while the researcher in Abeokuta, Nigeria who worked on the microbiological quality and safety of ready to eat food sold in secondary schools reported a high level of microbial contamination of the food and attributed this to poor hygiene practices among the food handlers in the secondary schools (Mejayi, 2011).

More recently, an outbreak of salmonella strain contamination of tomato, spinach and cabbage in United State of America resulted in several illnesses and death. This was blamed on the handling process in some of the many stages of preparation of the vegetable produce. This indeed is of serious public health concern (CDC,2012).Food borne disease outbreak is a common phenomenon, the fact that it is seldom reported does not make it less important, it only increases the vulnerability of students and staff in boarding schools and the entire populace to the untoward consequence of such outbreak. Therefore, the food safety and hygiene conditions of food prepared in boarding school are often implicated when food disease outbreak occurs.

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1.3 Rationale for the study

The increasing incidence of food borne disease in Nigerian secondary schools necessitates a study like this. Although, previous studies attempted to assess food safety in schools, not many studies were conducted in boarding secondary schools.

Chemicals, heavy metals, parasites, fungi, viruses and bacteria can make food and water unsafe for consumption and may lead to food borne disease outbreak. Bacteria related food contamination is the most common, hence this study would provide information on the common bacteria that are found in school menu and also determine the microbiological quality and the safety of food in the boarding schools .

Unsafe environment poses many hazards to food preparation; however the hygienic quality of prepared food can be achieved if basic food safety principles are observed (Ehiri, 2001). Food temperature, dining hall environment and food preparation area are some of the important food environments that could make food consumed unsafe, thus the study will provide information on the temperature at which food is being held for consumption, KAP of food handlers on food safety and sanitary condition of toilets, dinning and kitchen in the food preparation areas.

More research on food handling practices, sanitary and hygiene conditions of food handlers in boarding schools will not only increase awareness on food safety but also enhance optimal sanitary environment and overall food safety in the boarding schools.

1.4 BROAD OBJECTIVE OF THE STUDY

The broad objective of the study was to assess food safety and hygiene conditions in selected Public Secondary Schools with Boarding Facilities in Ibadan.

1.5 SPECIFIC OBJECTIVES OF THE STUDY

The specific objectives of this study were to:

1. Identify the sanitary conditions of selected Public Secondary Schools with Boarding Facilities in Ibadan
2. Assess the microbiological quality of food and water used in food preparation in the selected Public Secondary Schools with Boarding Facilities in Ibadan.
3. Determine the mean holding temperature of foods served in the selected Public Secondary Schools with Boarding Facilities in Ibadan
4. Assess the knowledge; determine attitudes and practices of food handlers on food safety and hygiene in Selected Public Secondary Schools with Boarding Facilities in Ibadan
5. Identify the joint relationship between the holding temperature and the microbial count in food.

CHAPTER TWO

LITERATURE REVIEW

This chapter is a review of available literature particularly in Nigeria, Africa and other parts of the world. It involves all aspects of food safety and hygiene, microbiological contamination of food, food handlers, Knowledge, Attitude and Practices of food handlers and food safety assessment.

2.1 Food

Food is life. In Abraham Maslow's hierarchy of needs, the most important need after life is the requirement for food. The American psychologist could not have been more accurate in his conceptualization of a "hierarchy of human needs." Food is any substance consumed to provide nutritional support to the body. It is usually of plant or animal origin, and contains essential nutrients such as carbohydrates, proteins, fat, vitamins and mineral. Food is usually ingested by an organism and assimilated by the organism's cells in order to produce energy, maintain life and stimulate growth.

Food can also be described as every article manufactured, sold, or represented for use as food or drink for human consumption, or any item that enters into or is used in the composition, preparation, or preservation of any food or drink. Food and drink include confectionery and chewing substances and their respective ingredients (Food Act, 1983)

Like many other developing countries, Nigeria faces the challenge of providing adequate food supply for its teeming population. Towards this end, policies and programmes aimed at boosting agricultural and food production are being actively promoted, but the issue of food safety still poses a more daunting challenge. Therefore, Nigeria has to contend with the problem of food-borne diseases with its attendant social, economic and health costs.

Food has been identified globally as not only a biological need but also as an economic and political weapon. It is constantly a potential source of socio-political problems in communities and nations. Therefore, it is pertinent to have an assurance that food consumed is adequate, nutritious, good quality and wholesome.

2.2 Food Safety

Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent food borne illness. This can also be described as a condition achieved by series of actions including processing, handling storage and preparation aimed at ensuring that all food are safe as possible, reducing health hazards and preventing food poisoning and food-borne illness.

The goal of food safety monitoring is to keep food wholesome. This involves the protection of food supply from microbial, chemical (i.e. rancidity, browning) and physical (i.e. drying out, infestation) hazards or contamination that may occur during all stages of food production, harvesting, processing, transporting, distributing, preparation and storing (WHO, 2002).

Food safety is an important part of providing acceptable, safe, and nutritious meals. The goal of the school foodservice program is to serve meals that are acceptable, safe, and nutritious (Neill, 1980). Food safety certification of employees and implementation of a Hazard Analysis Critical Control Point (HACCP) program are two ways to achieve these goals (Giampaoli, 2002). The food safety certification process was initiated to establish minimum standards of food safety practices and provides information necessary to train employees in food safety and implement a food safety system. Strengthening food safety measures in schools would better protect students and school staff from outbreaks of food borne illness (Almanza, 2003).

While food safety is considered to be an important issue in school food service, there have been several recent outbreaks of food borne illness in schools and research shows that good sanitation procedures and efficient food-handling practices are not always followed in school meal programs (Sukyung and Sneed, 2003). Food safety has always been a concern in school food service, and the recent emphasis on Hazard Analysis of Critical Control Point (HACCP) programs has increased awareness of food-handling practices in schools. In developing a quality model for school food service, food quality was included as an integral part of food safety and was described as food that is selected, prepared, and served in a way that retains the natural flavor , identity, nutritious state of the food and free of unsafe bacteriological or chemical contamination (Gilmore and Dana ,1998).

There is rising concern for food safety as it relates to all phases of food production and preparation from “farm to fork." The growing importance of food safety in schools is evident with the recent adoption of the following food safety position statement by the American School Food Service Association (ASFSA, 1999). The ASFSA initiates and support collaborative efforts to ensure that schools develop food safety systems so that students have safe food in schools."

More recent school estimates suggest that there were 292 outbreaks between the years of 1990 and 1999, causing 16,232 students to become ill as a result of food borne illness and that the number of reported outbreaks actually has increased on an average by 10% per year . It should be noted that there was a change in surveillance methodology beginning in 1998 that might account for higher numbers of incidents. Most commonly identified microorganisms for illness outbreaks connected to school foods were salmonella and Norwalk-like viruses and as a result, it has been suggested that USFDA take actions to better ensure the safety of school foods (GAO, 2002). The safety and integrity of food prepared for consumption in boarding schools can be maintained if food handlers effectively wash hand before touching any food related objects, food surfaces and equipments are well cleaned, food are thoroughly cooked, food handlers maintain good and standard personal hygiene, adequate cooking and reheating are maintained, effective temperature control of hot and cold food are ensured, food are adequately stored and food handlers endeavor to report illness as soon as they fall ill. In order to ensure food prepared in the schools are safe at all times, every person that is involved one way or the other with food preparation must abide with the following rules to safe food. These involves keeping a clean environment, separating raw and cooked food, thorough cooking, keeping food at safe temperatures and the use of safe water and raw materials at all time (WHO, 2006).

2.3 Food-Handling Practices in Schools

Food quality is multidimensional, and is defined by nutritional, aesthetic, and microbiological aspects of the food. For food to be of good quality, all three aspects must be present and maintained through excellent food handling practices. A high level of food safety results from appropriate food handling practices by food handlers. Several studies of food-handling practices in school food service indicate that there are areas of concern that need to be addressed

(Blakeslee & Penner, 1999; FDA, 2004; Giampaoli, Cluskey, & Sneed, 2002; Gilmore & Dana, 1998).

Food quality model for school foodservice operations was developed and tested. In this process, these researchers conducted observations in eight school kitchens in Iowa and Minnesota, reviewing food receiving practices, food production sanitation steps, and food-handling techniques. Many sanitation practices were good, including clean uniforms, short and unpolished fingernails, appropriate use of utensils/gloves for handling food, sanitizing of work surfaces, and the thawing of foods. Researchers did observe that hand washing was infrequent, hair restraints were not used, and jewelry was not limited to watch and wedding band. They also observed that food handlers made use of reusable towels to dry dishes/utensils in some kitchens. These findings are consistent with observations of food-handling practices in subsequent research studies Gilmore and Dana (1998).

A study was conducted to develop baseline data on the risk factors for Foodborne illness in retail foodservice operations, including schools, hospitals, nursing homes, restaurants, and retail food stores. Overall, elementary schools were in 80% compliance for the items observed. Improper holding and time/temperature relationships were the area with the lowest compliance (60.5%) and personal hygiene was next at 74.2% compliance. For cold foods, 45% of schools did not hold them at a cold enough temperature. Improper or inadequate hand washing was seen at 36% of those schools that were out of compliance for personal hygiene, while 27% of the schools did not take steps to prevent hand contamination (FDA, 2000).

Employees in 15 school districts in the Silicon Valley, California was observed by researchers, it was found that proper hand washing techniques were often not used, that the majority of employees did not wear hair restraints, and that employees were observed eating and drinking in the kitchens. Some food storage practices were inappropriate, such as boxes being stored on the floor, raw meats stored above other food items, and inadequate labeling and dating of food in storage. Sanitizing issues, such as not checking temperature/sanitizer concentrations and not using sanitizing agents on food contact surfaces, also were identified (Giampaoli, Cluskey, and Sneed, 2002).

In a study of 40 Iowa school districts, several food-handling issues were identified. About one-third of the observed employees either did not wash their hands frequently enough nor use appropriate hand washing techniques. Food temperature was not taken and in instances when these were taken, the temperatures were not recorded. Calibrated thermometers often were not used (and employees often were not aware of calibration procedures). Researchers checked temperatures of both hot and cold food items at the time of service and found more problems with appropriate cold food temperatures than hot food temperatures, which is consistent with the FDA study (2000).

In a study of five boarding secondary schools in Zaria Nigeria, researchers revealed some factors that could contribute to contamination of foods prepared in boarding schools. The factors such as improperly washed utensils and equipments, poor hygiene, dirty environment and the presence of animals in the cooking environment. The major hazards associated with foods prepared in the studied schools were inadequate (5 - 10 min) time/temperature exposure of foods (akamu, tuwo, eba), extensive handling of foods by cooks after preparation, leaving cooked foods open till served to students and the presence of toxigenic strains of *B. cereus* and *E. coli*. The cooking temperatures of foods examined in this study reached levels capable of destroying many vegetative forms of food borne pathogens. However, a concentration of organisms ranging from 2-5log10 cfu/g survived in the foods after cooking (Oranusi *et al*, 2007).

2.4 Food safety in school

From 1973 through 1997, States and Local Health Departments reported 604 outbreaks of food borne disease in American schools such as primary, secondary, colleges and universities. The median number of school outbreaks annually was 25. The most commonly reported food preparation practices that contributed to the school-related outbreaks were improper food storage, inappropriate holding temperatures and food contaminated by a food handlers

The three most commonly identified etiologic agents for food borne disease as a result of food contamination in schools were *Salmonella, S. aureus* and *C. perfringens (*Daniels, 2002).

Several outbreaks in schools have been attributed to contamination of food by food-handlers who worked while ill (Quiroz *et al* 2000), or had poor personal hygiene (Daniels, 2000., Holmberg *et al*, 1984). In a review of reported food borne outbreaks in school, 57% of outbreaks were

attributed to likely contamination by food-handlers. The adoption of a work policy that includes paid leave for food handlers with gastroenteritis would probably increase compliance with illness related work exclusion policies. Training and certifying all food handlers in school cafeterias in specific techniques, such as good personal hygiene, adequate hand washing, proper cooling and reheating of foods and methods of preventing cross-contamination between cooked and raw foods, would also likely reduce the incidence of food borne disease outbreaks (Manning , 1994). Furthermore, food handlers could be important reservoirs for pathogenic bacteria in boarding schools, increased time/temperature exposure of foods and strict control of mishandling of food during preparation and dispensing is highly recommended for prevention of contamination.

2.5 Food Poisoning

Food poisoning is very likely to occur in boarding schools when foods are not hygienically handled. Food poisoning is described as the unacceptable contamination (of a biological, chemical, or physical nature), unacceptable microbial growth, or unacceptable survival of microorganisms in food (WHO, 2000).

The food contamination state that may occur in boarding schools is categorized into:

- **Food-borne illness:** Food Borne Illnesses occur in boarding school due to the ingestion of contaminating microbial pathogens (i.e., bacteria, mold, and viruses), chemicals, parasites, or from naturally occurring toxins or poisons. Bacterial food borne disease is of two major types viz: Infection and intoxication
- **Food-borne Infection:** Food prepared may be contaminated by live pathogens that grow and multiply inside the intestinal tract of animals and man or are passed to other organs (e.g *Salmonella enteritidis, Campylobacter jejuni, Listeria monocytogene*). These pathogens may find their way into food if hygiene procedure is compromised
- **Food-borne Intoxication:** Illness caused by ingestion of food containing toxin (metabolic byproduct) that was formed and excreted into the food as a result of pathogenic microbial growth. e.g. *Clostridium botulinium, Staphyloccccus aureus*

A failure of hygiene standard in any stage of food preparation could cause food poisoning. Harmful bacteria that cause food poisoning can spread very easily, so it is important to ensure that contamination is prevented. Food poisoning can lead to serious illness, or even death,

especially among the very young, the very old and ill people, who are particularly at risk from food poisoning

There are four main defenses against the growth and spread of bacteria:

1. Ensuring food areas are clean and good standards of personal hygiene are maintained
2. Cooking foods thoroughly
3. Keeping foods at the right temperature
4. Preventing cross-contamination

2.6 Knowledge, Attitude and Practice on Food Safety

A Knowledge Attitude and Practices survey is a representative study of a specific population to collect information on what is known, believed and done in relation to food safety. The KAP constitute a triad of interactive factors characterized by dynamism and unique interdependence. The triad of knowledge, attitude and practice in combination governs all aspects of life in human societies, and all three pillars together make up the dynamic system of life itself. It is pertinent to have an understanding of the interaction on prevailing food safety beliefs, knowledge and practices of food handlers in order to minimize food borne outbreaks (WHO, 2000).

Knowledge is the capacity to acquire, retain and use information; a mixture of comprehension, experience, discernment and skill. The possession of knowledge requires complementarities between two basic ingredients: the concept through which an object is thought of at all, this requiring intellect; and the perception by which the concept is acquired, this requiring power of sense. The nature of knowledge rests on the different modes of acquisition of ideas: perception, imagination, memory, judgment, abstraction and reasoning. Knowledge criteria center on the sense that allows us to distinguish between right and wrong. Thus education is the prerequisite of knowledge. There was general agreement revealed from several authors as good levels of knowledge towards food safety among food handlers and the effective practices of such knowledge in food handling were imperative in ensuring the safe production of food in any catering operations (Mortlock *et al*,1999).

A recent study on the KAP on food safety in Indian schools showed that about 50- 70%, of the respondents' food handlers in the school do not know that diarrhea, abdominal pain, nausea and

vomiting may be a symptom of food-borne disease' When asked on storage of food, 75% reported to leave the cooked food at room temperature and only 29.4% of them consumed the stored food after thorough heating (Sudershan *et al*, 2009). Among the food handlers, 13.0%, 18.5% and 15.2% (n=92) had a good level of knowledge, attitude and practice respectively on food safety. From statistical analysis, there was a significant relation between food safety knowledge and food safety practice and between food safety attitude and food safety practice.

Attitude refers to inclinations to react in a certain way to certain situations; to see and interpret events according to certain predispositions; or to organize opinions into coherent and interrelated structures. Howes *et al*, (1996) indicate the correlation of positive behavior, attitudes and continued education of food handlers towards the maintenance of safe food handling practices. On the other hand, Bas *et al.* (2004) in their study found that the attitude scores of the food handlers toward food borne diseases prevention and control was poor (44.2 ± 13.2) and practice scores were very low (48.4 ± 8.8). According to Howes *et al*. (1996), a study in the USA showed that approximately 97.0% of foods borne outbreaks were due to improper food handling practices in food service. Previous reports indicate that beside poor hand and surface hygiene, lack in personal hygiene among food handlers was also one of the most commonly reported practices that gave rise to food borne illness (Collins, 1997). This shows that if food handlers take serious note on the cleanliness of their hand, body and clothing, this will help in preventing incidence of cross-contamination from occurring (Sneed *et al*. 2006)

Practice is the application of rules and knowledge that leads to action. Good practice is an art that is linked to the progress of knowledge and technology and is executed in an ethical manner. According to Howes *et al*. (1996), a study in the USA showed that approximately 97.0% of food borne outbreaks was due to improper food handling practices. Previous reports indicate that besides poor hand and surface hygiene, lack of personal hygiene amongst food handlers was also one of the most commonly reported practices that gave rise to food borne illness (Collins ,1997). This shows that if food handlers take serious note on the cleanliness of their hands, bodies and clothing's, incidence of cross-contamination will be reduced.

2.7 Environmental Sanitation

The term “environmental sanitation” has been given various interpretations in different countries and at different times. In its most restrictive sense, sanitation has been equated with the safe disposal of human excrement. In many cases, it is used to cover the handling by the community of the water supply and the disposal of sewage and refuse. But in recent years, it has been increasingly used to denote the control, generally, of those elements in the environment that affect or may affect human health. It has also been defined as an adjustment of the environment for the prevention of disease. Environmental sanitation include various sanitary conditions like (1) clean and safe water supply, (2) clean and safe ambient air, (3) efficient and safe animal, human, and industrial waste disposal, (4) protection of food from biological and chemical contaminants, and (5) adequate housing in clean and safe surroundings also called environmental hygiene (WHO, 1953).

Access to basic or adequate sanitation is vital for human health, while having a safe, convenient and private place to defecate is essential for human dignity. Adequate sanitation refers to the use of a “sanitary facility” in a dwelling or immediate vicinity. A sanitary facility is a unit for the disposal of human excreta that isolates feces from contact with people, animals, crops and water sources. The basic sanitation is the lowest-cost option for securing sustainable access to safe, hygienic and convenient facilities and services for excreta and sullage disposal that provide privacy and dignity while ensuring a clean and healthy living environment both at home and in the neighborhood of users.” This definition captures the relationship between sanitation and human health and highlights that dignity and privacy are important elements of basic sanitation, as these promote the use of sanitary facilities (WHO, 2009).

2.8 Education

Education means learning knowledge, skills, and attitudes. The most important of these is learning how to learn. Learning means deciding about your own lifestyle. Education can be divided into formal, Non formal and Informal.

2.8.1 Formal Education

Formal education is the hierarchically structured, chronologically graded educational system running from primary school through the university and including, in addition to general academic studies, a variety of specialized programs and institutions for full-time technical and professional training (Coombs *et al*, 1973). Formal education is properly associated with school but it is not a limiting factor in the employment of food handlers in the boarding schools. Formal education refers to the structured educational system provided by the state. In most countries, the formal education system is state-supported and state-operated. In some countries, the state allows and certifies private systems which provide a comparable education **(** Etling, 1993)

2.8.2 Non Formal Education (NFE)

Non formal education is described as any intentional and systematic educational enterprise (usually outside of traditional schooling) in which content is adapted to the unique needs of the students (or unique situations) in order to maximize learning and minimize other elements which often occupy formal school teachers (i.e. taking roll, enforcing discipline, writing reports, supervising study hall, etc.). Non formal education is more learner-centered than most formal education. Learners can leave anytime they are not motivated. Food handlers can obtain education on food safety non- formally.

The NFE tends to emphasize a cafeteria curriculum of options and choices rather than the prescribed, sequential curriculum found in schools. In NFE, human relationships are more informal in which the roles of teachers and students are less rigid than in schools where student teacher and administrator roles are hierarchical and seldom change in the short term. Non Formal Education focuses on practical skills and knowledge while schools often focus on information which may have delayed application. Overall, NFE has a lower level of structure (Kleis *et al*, 1973). Most typically, the term or phrase non-formal education is used to refer to adult literacy and continuing education for adults

2.8.3 Informal Education

Informal Education deals with everyday experiences which are not planned or organized. This is also refers to as incidental learning. When these experiences are interpreted or explained by

elders or peers they constitute informal education (Kleis *et al*, 1973). Many food handlers obtained education on food safety through informal and/ or formal education.

2.9 Food Hygiene

Hygiene deals with the promotion and preservation of health while food hygiene is all conditions that measure the safety and suitability of food at all stages of food chain. (WHO, 2006) Food hygiene can also be described as the conditions and practices that serve to promote or preserve health. Good food hygiene by food handlers is essential to ensure that the foods prepared in boarding schools are safe. Poor hygiene procedures can put the students and staff of the schools at risk. To achieve good food hygiene, food handlers need to consider these actions during the entire food process, from the moment the raw food ingredients are purchased to the final stage before it is consumed.

2.9.1 Nigerian Policy on Food Hygiene and Safety

The Government of Nigeria launched the National Policy on Food Hygiene and Safety in year 2000 as an integral part of the Nigerian National Health Policy, in recognition of food safety as an important factor for achieving high level of health for all Nigerians, The overall goal of the food hygiene and safety policy is the attainment of high level of food hygiene and safety practices which will promote health, control food-borne diseases, minimize and finally eliminate the risk of diseases related to poor food hygiene and safety. The policy seeks to stimulate and promote legislations concerning food in areas of production, storage, handling, processing, preservation, trade, transportation and marketing. It also seeks to improve the quality of healthcare through ensuring that all food consumed in Nigeria, whether imported or exported are wholesome, nutritious, free from contaminants and accessible to the consumers at affordable price. Implementation of the policy is aimed at addressing the unsatisfactory level of food hygiene and safety practices which to a large extent is responsible for the prevalence of food-borne diseases in Nigeria (Omotayo, 2002).

2.9.2 National Legislations on food Safety

The main national legislations relating to food safety include the following:

1. The Public Health Laws (1917) now known as Public Health Ordinance Cap 164 of 1958;
2. The Food and Drugs Decree, No. 35 of 1974;
3. The Standards Organization of Nigeria Decree, No. 56 of 1971;
4. The Animal Disease Control Decree, No. 10 of 1988;
5. The Marketing of Breast Milk substitute Decree, No. 41 of 1990.
6. The National Agency for Food and Drugs Administration and Control (NAFDAC) Decree No. 15 of 1993.

The following government organization and agencies are responsible for regulating and monitoring food safety standards and practices

1. Federal Ministry of Health
2. National Agency for Food and Drug Administration and Control (NAFDAC)
3. Standards Organization of Nigeria (SON)
4. National Codex Committee
5. Federal Ministry of Agriculture
6. States and Local Governments.

2.9.3 The Federal Ministry of Health

Federal Ministry of Health has the responsibility for formulating national policies, guidelines and regulations on food hygiene and safety as well as the monitoring of their implementation. It is also responsible for establishing guidelines for the requirements for the nutritive value of food, and monitoring of food environments and handlers, control of food borne disease, the quality of public water supply as well as national and international matters relating to food.

2.9.4 National Agency for Food and Drug Administration and Control (NAFDAC)

National Agency for Food and Drug Administration and Control is the parastatal under the Federal Ministry of Health, charged with the responsibility for the regulation and control of imported and locally processed foods and bottled water, at the Federal and State levels of the

government. The agency is involved in controlling the sales and use of foods and to ensure that foods and food ingredients used in the boarding secondary schools are wholesome and free of any form of contaminations physical, chemical or microbiological (NAFDAC, 2005).

2.10 Boarding School

It is difficult to know the exact time that the first boarding school was established. However, the practice of fostering children with other families so that they could learn is very long standing, with records going back thousands of years.

A boarding school is a residential school. Students live in dormitories or resident halls on the school's premises. A boarding school can be described as a school where students are lodged, fed as well as taught. Students living in the dormitories are supervised by members of the school's staff. The boarding school is usually a fee-charging school where some or all pupils not only study, but also live with their fellow students and possibly teachers during term time.

Students at boarding schools take their meals in a dining hall. The word 'boarding' in this sense means to provide food and lodging. It is also a school which provides board and lodging as well as tuition, thus students may go home at weekends or between terms depending on the school regulation. Boarding schools offer an inclusive approach to education. Students learn, live, exercise and play together in a communal setting under adult supervision. (Bamford, 1967)

The amount of time students spend in boarding school varies considerably from one year to twelve or more years. Boarding school pupils may spend the majority of their childhood and adolescent life away from their parents, although pupils return home during the holidays. In United States, schools generally comprise grades seven through twelve, with most covering the High School years. In Nigeria, boarding school mostly starts from secondary school year one to six, predominantly children between the ages of 11 to 17 years. However, in Britain, children as young as 5 to 9 years of age are sending to boarding schools (Power, 2007).

Most societies decline to make boarding school the preferred option for the upbringing of their children except in former British colonies in India, Nigeria and other African colonies of Great Britain. This is because children may be spending significant parts of their early life in what may be seen as total institution and possibly experiencing social detachment. (Goffman, 1948)

2.11 School Health

Health is created by caring for oneself and others by being able to make decisions and have control over one's life circumstance and by ensuring that the society one lives creates condition that allow the attainment of health by all members. The boarding school is an extraordinary setting through which student's health can be improved. Boarding school provides the opportunity to achieving significant health and educational benefits. The promotion of children health is recognized at the international level as an important means of influencing health behavior. The school health has been an important goal of the World Health Organization and other international agencies and this has gained significant momentum in recent years (WHO, 1999).

School students deserve to inherit a safer and healthier world. It is very important that the school environment is safeguarded. It is equally important that students have clean water to drink, safe food to eat, adequate sanitary facilities, adequate water to use for hygiene, clean air to breathe and safe place to learn and play (WHO, 2003). One of the identified strategies to provide young people with required knowledge, skill and enabling environment for the development of their psychological competence is to provide relevant information and education.

There are different categories of schools in Nigeria. There are Nursery, Primary, secondary and tertiary schools; and about 70% of the schools in Nigeria are owned and financed by the government (both State and Federal government). Problems associated with the educational system in Nigeria include the deterioration of the quality of education and inequitable distribution of facilities nationwide (UNFPA, 1998)

The school environment in most public secondary schools in Nigeria, especially in urban communities is generally dirty and in deplorable condition which is not conducive to learning and which is also a potential risk to the food and water consumed by the students and teaching staff. Many schools do not have dependable sanitary facilities and adequate waste management system. Many boarding secondary schools lack adequate facilities to properly dispose waste gathered from the cleaning activities of the students. Udoh (1996) examined the status of health Education in Nigeria and noted that there is no organized health education in public school

system. The curriculum of teaching and learning of health information over the years shows that the content and methods used concentrate primarily on health information rather than participation and behavior change among students (Oladimeji and Fabiy, 1993).

2.12 Health- Promoting School

The World Health Organization, through the School Health Initiative, promotes the concept of Health-Promoting School. A Health-Promoting School can be described as a school that is constantly strengthening its capacity as a healthy setting for living, working and learning. This is achieved by:

1. Implementing policies and practices that respect an individual's well-being and dignity, and provide multiple opportunities for success and acknowledge good efforts.
2. Striving to improve the health of school personnel, students as well as the community members.
3. Fostering health and learning with all the measures at its disposal.
4. Striving to provide a healthy environment, school health education and school health services along with school/community projects and outreach, health promotion programmes for the members of staff, nutrition and food safety program, opportunities for physical education and recreation as well as programmes for counseling, social support and mental health promotion.
5. Engaging health and education officials, teachers, students, parents, health providers and community leaders in order to make the school a healthy place.

Infectious disease carried by food and water are examples of risks student and school personnel face at school throughout the world. A school provides for every student an environment that is physically safe, emotionally secured and psychologically enabling. It also provides protection from biological, physical and chemical risks that may threaten student's health (WHO, 2006).

2.13 Food Related Health problems in School

It was estimated that nearly 5,500 children die each day from bacteria in food, thus unsafe foods remain an important public health problem in boarding schools. In developing countries, polluted

environments, lack of safe water supply and poor sanitation increase the probability of food contamination. Most food borne disease outbreaks are as a result of improper food handling, food contamination by equipment, contamination by individuals, cross contamination, use of contaminated raw food ingredients, use of food containing natural toxins and addition of toxic chemicals (WHO, 2003).

2.14 Water and Sanitation

The global Water Supply and Sanitation Assessment reported that 2.4billon people globally did not have access to any type of improved sanitation facilities (WHO, 2009). Also, about one sixth of the global population lack access to adequate drinking water. An estimated 5.3 billion people, or 83% of the world's population, had access to water from an improved source in 2004. While this is a significant increase from 1990, when the proportion was 78%, the rate of increase has just barely kept up with population growth. As a result, the proportion of people without access to improved water sources has not substantially decreased. An estimated 1.1 billion people, roughly one-sixth of the world's population, still do not have access to improved drinking water. Out of these people, 84% live in rural areas. The global population without access to improved drinking water is largely concentrated in three regions: Sub-Saharan Africa (322million), Eastern Asia (302 million) and South Asia (226 million). Overall, the coverage of improved drinking water is above 78% in all regions of the world, except Sub-Saharan Africa and Oceania, where the coverage levels are 56 % (WHO, 2007).

Water presumed to be safe may be contaminated with chemical or microbiological contaminants and the safety of water consumed is assessed in terms of water quality. Access to basic or adequate sanitation is vital for students and staff in boarding schools, while having a safe, convenient and private place to defecate is essential for each school. Adequate sanitation refers to the use of a "sanitary facility" in a dwelling or immediate vicinity of the schools. A sanitary facility is a unit for the disposal of human excreta that isolates feces from contact with people, animals, crops and water sources.

A much broader definition of basic sanitation that focused on the links between access to sanitation and human health was proposed by the World Summit on sustainable Development (WSSD).

Basic sanitation was defined as the lowest cost option for securing sustainable access to safe, hygienic and convenient facilities and services for excreta and sullage disposal that provide privacy and dignity while ensuring a clean and healthful living environment both at home and in the neighborhood of users. This definition captures the relationship between sanitation and human health and highlights that dignity and privacy are important elements of basic sanitation, as these promote the use of sanitary facilities (WHO, 2002).

2.15 Water quality

The bacteriological quality of drinking water significantly declines after collection in many settings. The extent of contamination after water collection in schools varies considerably, but is proportionately greater where fecal and total coliform counts in source water are low. Low quality water exposes students and staff of boarding schools to a variety of food and water borne diseases.

The assessment of Microbiological quality of water involve one or more of the following three bacteria indicators: (1) total coliform which are Gram-negative bacteria that ferment lactose at 35–37°C within 24–48 h; (2) fecal thermo-tolerant coliform which are a subset of total coliform bacteria that ferment lactose at 44–45°C and (3) E. coli which are exclusively fecal in origin, are a sub-group of the fecal coliform that produce the enzyme B-galactosidase and not urease. Microbiological contamination of water between source and point-of-use is widespread and often significant. The World Health Organization guidelines state that none of these bacteria should be detectable in a 100-ml water sample (WHO, 1997). Out of these bacteria, E. coli are regarded as the most reliable indicator of fecal contamination and total coliform as the least reliable indicator. A separate analysis was performed for each of the three indicator organisms because their abundance in water and their origins may be different. For example, total coliform are known to originate from decaying vegetation whereas *E. coli* are not and consequently patterns of contamination may vary between the three types of organisms. Furthermore, total coliform are more numerous than fecal coliform, which are more numerous than E. coli and so bacteria

counts vary for each indicator. 'High' and 'low' bacteria count studies are analyzed separately because the method of assessing the change in water quality was different for these two types of study.(Mazengia *et al*, 2002).

2.16 Safety of Food and Water

The body needs constant supply of clean water and a range of safe and nutritious foods to function properly. Without these, humans cannot survive. Similarly, clean and safe boarding school environments with adequate sanitation protect students from degrading surroundings that can cause disease and death.

According to the World Health Organization, "safe water" is water that does not pose any significant risk to health over a lifetime of consumption. Safe water is suitable for domestic use, is free of objectionable tastes and odors and is available in sufficient quantities for hygiene purposes. Similarly, "safe food" is defined as food that will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. The Codex Alimentarius defines "hazard" as a biological, chemical or physical agent with the potential to cause adverse health effect. For students and staff of boarding schools to be safe, both food and water should not contain any biological, chemical or physical agents at concentrations directly detrimental to health. Safe food is achieved when all conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain are present and being applied.

This understanding of safe food and water takes into account the varying vulnerabilities that may occur as people move through different stages of the life-cycle. For example, infants and young children, as well as the elderly, are more vulnerable to the effects of unsafe food and water often suffering greater adverse consequences compared to young or middle-aged adults. Students who are malnourished or living in boarding school facility with unsanitary conditions are also more vulnerable than those who are well-nourished and/or living in boarding school with hygienic conditions

2.17 Food handlers

A food handler is defined as any person who handles or prepares food and drinks whether unwrapped or packaged (UKDH, 1997). Therefore, the cook, food servers and food janitors that work in the school kitchen can all be described as food handlers. Food is handled by the food handlers in the boarding schools. The food handler may be a cook, food server or food janitor.

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Food handlers in the course of their normal routine work come into contact with uncovered food that is not intended for their personal use. . A food handler can broadly be described as any person involved in the processing, production, manufacturing, packaging, preparation, sale or serving of any food stuff, including water and beverages. Food handlers are often implicated when there is food safety compromise or in case of any other food borne illnesses. The most commonly reported food preparation practices that contributed to school-related outbreaks were improper food storage and holding temperatures and food contaminated by a food handler and despite an increase in the number of food handlers receiving food hygiene training, a high proportion of food poisoning outbreaks still occurred as a result of poor food handling practices

The personal hygiene of food handlers is an essential determinant of the overall safety of food in the boarding school. Food handlers are meant to be well-groomed and demonstrate high personal cleanliness. They must wear appropriate hair restraints and should be encouraged to wash hands thoroughly with warm soapy water before commencing the cooking or handling of foods. Effective hand washing involves the use of warm water and liquid soap. A good lather is worked up at least for 20 seconds, while ensuring that wrist, hand, finger, thumb, finger nail and in between the finger nail are all thoroughly washed. The soap is rinsed off the entire hand and dried thoroughly using disposable towels or hot- air dryer and never use apron. Food handlers should never use food preparation sinks for hand washing. Food handler with the following conditions will require a medical treatment and subsequent certification by medical personnel before being allowed to handle food. The health conditions are:

- Chronic suppurative conditions, e.g. otitis media with drum perforation;
- Chronic bronchitis with productive, purulent sputum
- Widespread chronic skin conditions, such as psoriasis or eczema which makes skin cleansing difficult and are often associated with secondary infection.

2.18 Bacteria food contaminants

Bacterial infection and poisoning which result from the ingestion of bacteria contaminated food is commonly referred to as food borne illness.

A more accurate term would be food borne bacterial illness or disease. Most types of "food poisoning" are strictly not poisoning even though in the final analysis, the symptoms may be indistinguishable from poisoning. Most food poisoning are really infectious which is the illness caused by the multiplication of pathogenic microorganism in the living host particularly the gastro intestinal tract. The term poisoning is applied to these illnesses and is recognized as such by the general public because of the acute or the severity of the symptoms i.e. the disease occurs suddenly and in most cases is of short duration. The food borne bacterial illness is strictly the ingestion of toxin. Most food borne diseases are enteric in nature i.e. the initial early symptoms are some form of gastro intestinal tract disturbance such as nausea, vomiting, abdominal pain/, cramp or diarrhea.

2.19 Sources of pathogenic Bacteria

There are five major sources of bacteria causing food borne illness.

- Fecal matters and /or urine infected human and animal not only those showing symptoms but also active asymptomatic carriers
- Nasal and throat discharges of sick individuals asymptomatic carriers
- Infection of body surfaces of food handlers head and arm
- Infected soils, mud, surfaces, waters, dust etc
- Sea water, marine materials and marine life.

In most food borne diseases, the food serves only as a vehicle of transmission, the final link in the chain of infection. The food product not only permits the survival of the pathogen, it may also provide a suitable medium for the rapid proliferation of the microorganism and the production of toxins as in case of exotoxin producing organisms. The degree to which these parameters are made possible by the infected food products may determine the final infectiousness of those products, the severity of the symptoms and the extent of outbreak or epidemic e.g. cholera causing organisms (*Vibro cholera*) in acid foods and survives only a few

days in many other types of food products. Thus the outbreak of cholera may not occur when only those types of food are affected (Felsenfeld, 1965)

The Majority of Cases of Food Poisoning are due to Bacterial contamination. The microorganisms often implicated include:

2.20 Bacillus Cereus

Bacillus cereus is a spore –forming, gram positive organism. While it is aerobic, it is also facultative anaerobic. It is a relatively large, long and rod shaped organism. *B cereus* is found primarily in soil, dust, water and food products (Highton and Hobbs, 1972).

All types of food products may be contaminated by B. cereus. Outbreak involving large numbers of cases have been reported in several European countries. For example, in Hungary betwee1960 and 1966, *B cereus* ranked third among the most common causes of gastroenteritis. The low incidence in United States may be attributed to little attention given to the microorganism. 3% of dry foods obtained from retail outlets in Madison, Wisconsin, contained the organism at levels of 100 to 4000 cells/g (Kim and Goepfert, 1971)

The isolation of *B. cereus* from all the cooked food samples is of concern. This could be explained by the ubiquitous distribution of this organism and its ability to form endospores (Mckillip, 2000). The presence of *B. cereus* in food could be attributed to the methods of processing the grains (drying on inadequately clean floors count of the food was higher than counts of the food before heat treatment. According to Wogu *et al* (2011), four bacteria were isolated from ready to eat rice sold in Benin City Nigeria. These are: *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumonia*. *Bacillus cereus,* which is mainly associated with food poisoning because of its ability to produce toxins, was present in 37.5% of samples, alongside *E. coli*. Also, oranusi *et al* (2007) observed that the hazards associated with foods prepared in the schools studied were the inadequate (5 - 10 min) time/temperature exposure of foods (akamu, tuwo, eba), extensive handling of foods by cooks after preparation, leaving cooked foods open till served to students and the presence of toxigenic strains of *B. cereus* and *E. coli*.

The International Commission on Microbiological Specification for Food (ICMSF) 2002 suggested the acceptable limit for *B. cereus* in food to be 3 log10cells/g, with 4log10/g as tolerable and above 6log10/g as above the acceptable limit. The optimum growth temperatures for B. cereus are 30 to 35°C (Breed *et al*.1957). The maximum temperature permitting growth is between 40°C and 50°C depending on the strain (Kim and Goepfert, 1971)

The minimum temperature permitting growth of *B cereus* in food is between 10°C to 12°C (Larkin and Stokes, 1966). . Heat may influence the germination of *B. cereus* by the direct effect on the spores and effect on medium (Davies and Wilkinson, 1973)

2.21 Staphylococcus aureus

The staphylococci are ubiquitous in the environment. They are found in the air, water, sewage, and fecal matters. The skin of human and animals, mucus membrane of the nose and throat are the principal habitat of these organisms. *Staphylococcus aureus* seems to be commonly found in nasal passage of human particularly in hospital workers and patients whose incident rate may be as high as 60-80%(MacDougall *et al*, 2005)

Human are the most important single source of staphylococcus contaminant of food products. Food handlers are probably the most important single source of staphylococcus contaminated foodstuffs. For example, sources of staphylococcus in several cases of serious and widespread outbreak of food poisoning in England were constantly traced to persons involved in preparation of contaminated stuffs In most cases, persons involved in food disease outbreaks were active nose and hand carrier. The carriers disperse staphylococcus to their surroundings from the nose and especially the skin (Hobbs *et al*, 1968).

The role of food handlers in the contamination of food products is illustrated by the outbreak of staphylococcus food poisoning in Colorado USA. In this particular outbreak, Greek spaghetti dispensed in vending machine was the vehicle. Meat used for the dish was handled by an employee with blisters and bandage on his hand which was shown to carry a couagulase positive staph aureus phase 85. This strain was also present in the Greek spaghetti in the vending machine and the raw meat used in the preparation. Type D enterotoxin was found in the food even though staph. aureus phase type 85 produced only type A enterotoxins. This is an indication that at the

time of the outbreak, the strain had overgrown the original strain which produced type D enterotoxins (CDC, 2000). The staphylococcal aureus infection is a staphylococcal food poisoning caused by enterotoxin producing strain of staphylococcus aureus. This is one of the common food borne illnesses and the leading cause of food poison in Ambrose Ali University of Nigeria and it's environ.(Oni *et al*, 2010)

2.22 Escherichia coli

Escherichia coli is a type of bacteria commonly found in the human intestinal tract and in human feces. It is used as a marker to indicate the contamination of water or food with human feces, and hence the potential dangers that might accompany the presence of human feces in our food and water supply. This *E. coli* is only one of several mutant varieties of bacteria that are both pathogenic (disease causing) and antibiotic-resistant.

As early as the mid-1950's, antibiotics were being fed to farm animals for the purpose of faster weight gain with less feed. The effectiveness of antibiotics for this purpose has never been proven while this procedure was not for the purpose of disease control. Outbreaks of *E. coli* 0157; H7 began occurring in the US in 1982 and have been happening since then at even more alarming rates.

2.23 Coliform Bacteria

The coliform bacteria group consists of several genera of bacteria belonging to the family enterobateriaceae. The bacteria are mostly harmless and live in soil, water and the digestive system of animals. Fecal coliform bacteria, which belong to this group, are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. If a large number of fecal coliform bacteria (over 200 colonies/100 milliliters (ml) of water sample) are found in water, it is possible that pathogenic (disease- or illness-causing) organisms are also present in the water. Fecal coliform by themselves are usually not pathogenic; they are indicator organisms, which means they may indicate the presence of other pathogenic bacteria.

2.24 Food Safety Practices of Food Handlers

Musa *et al,* (2003) investigated Food hygiene practices of food vendors in secondary schools in Ilorin Nigeria. The researcher observed that the major unhygienic practices observed among the food handlers were poor care of used utensils, use of previously used water for washing and cleaning, lack of covering apron among the food handlers and lack of wash hand basin for immediate cleaning. Only 85(46%) of the respondents used soap and water to clean their utensils while the rest 100(54%) used unhygienic methods to clean their utensils. It was observed that the food handlers who used soap and water for cleaning, vended food at locations that were relatively closer to water source, compared to other food handlers who used other methods to clean their utensils. Unkempt fingernails, skin lesions and poor food protection from flies were some of the food contaminating risk factors observed in the study

Mejayi, H (2011) investigated the microbiological quality of foods sold in secondary schools in Abeokuta, Ogun state, Nigeria and indicated that students are prone to food borne diseases due to high levels of food contaminations in the secondary schools studied. The researcher attributed the high level of microbial contamination to the absence of regulation and guidelines for food handlers on food hygiene practices. The researcher further suggested that the microbial contamination may have been introduced by the food handlers through various unhygienic practices.

Ekwenye *et al,* (2005) reported that most food handlers had undertaken formal food hygiene training; however, many who had no food hygiene training still handled food . On-going supervision and pre-training support was lacking and this limits the effectiveness of the food hygiene training. The researcher further suggested that there are evidence for a causal link between hand washing and risk of infection from the food prepared by food handlers and that subjective norm is the most significant influence on food handler' intention to perform safe food handling practices regardless of the training status of the food handlers.

Oranusi *et al,* (2007) evaluated food safety in boarding schools in Zaria, Nigeria, using the HACCP system. The researcher observed that all the foods (akamu, eba, tuwo and vegetable soup) attained cooking temperatures of 60 – 100°C which was capable of destroying vegetative

forms of food borne pathogens. However, B. *cereus*, *Staphylococcus aureus* and coliforms were isolated in the cooked foods. The researcher further suggested that high level initial contamination associated with raw foods, food ingredients, food contact surfaces, food handlers and inadequate cleaning of food utensils call for concern..

CHAPTER THREE

METHODOLOGY

3.1 Study Design

This is a cross sectional study. The study has laboratory, survey and observation components. It involved the assessment of food temperature, bacteria in food and water samples. Also, questionnaire, observation checklist and in-depth interview were used to assess food safety and hygiene conditions in selected public secondary schools in Ibadan

3.2 Description of Study Area

The study was carried out in the city of Ibadan, capital of Oyo State, Nigeria. Ibadan is located in the South -west region of Nigeria. Ibadan is approximately 120km from Lagos, the former capital of Nigeria which is the transit point between the coastal area and the Northern region. Ibadan came in to being in 1929 and served as a war camp for warriors coming from Ile- Ife, Oyo and Ijebu (Falola, 1984). It is located near the forest grassland, boundary of south-western Nigeria on longitude 35 East of Greenwich Meridian and Latitude 7□ 23 North of the equator at a distance of about 145km North- east of Lagos (Ayeni, 1982). The total area of Ibadan covers approximately 103.8sq.km. As at 2010, Ibadan city is divided into eleven local government areas out of which Ibadan South East, Ibadan South West, Ibadan North, Ibadan North East, and Ibadan North West are located in the core of the city while Akinyele, Ona-ara, Lagelu, Egbeda and Oluyole are the local government areas around the city. Ibadan North Local Government Area has a population of 306, 795 with 153,039 males and 153,756 females and her people are predominantly of the Yoruba ethnic group. Many other Nigerian ethnic groups are also resident in Ibadan which is largely cosmopolitan (Ayeni, 1982).

There are more than 100 secondary schools and over 300 primary schools in Ibadan. There are about fourteen functioning Boarding secondary schools in Ibadan of which about twelve are public schools owned by the government.

3.3 Sampling Methods

To ensure adequate representation of all schools with boarding facility in Ibadan, a list of all boarding schools in Ibadan was obtained from Oyo State Ministry of Education. There were fourteen public secondary schools that were officially identified to have a boarding facility. Of this number, only twelve schools physically have boarding facilities. Using stratified random sampling, twelve schools were grouped into three strata based on the location of the public schools in the three Ibadan zonal areas followed by a simple random sampling method to randomly select five public boarding secondary schools after which the sixth school selected declined participation.

The selected five public secondary schools are:

1. St Louis Grammar School Mokola, Ibadan (SLGS)
2. Command Secondary School Bodigbo Ibadan (CSS)
3. The International School, University of Ibadan (ISI)
4. Queen School Apata, Ibadan (QSI)
5. Government College , Ibadan (GCI)

3.4 Data Collection Procedure

3.4.1 Study Population

The study population comprised all the 59 food handlers in the selected Public Secondary Schools with Boarding Facilities

3.4.2 Sample Size

The total population of food handlers in all the selected five public secondary schools with boarding facilities in Ibadan was used for this study.

3.4.3 Inclusion Criteria

- Public secondary schools in Ibadan with boarding facilities
- Food handlers in public secondary schools in Ibadan with boarding facilities.

3.4.4 Exclusion Criteria

- Food handler in the selected schools that is not willing to participate.
- Private boarding secondary schools in Ibadan.
- Public secondary schools in Ibadan without boarding facilities

3.5 Materials and Methods

3.5.1 Food sample collection

The plan was to collect 2 food samples of each food, however, it was realized that some schools do not have certain food type in there menu. Hence, forty two cooked food samples were collected from the PSSBF: Two samples of cooked rice was collected from each school, except QSI; 2 samples of yam porridge was collected from each school except CSS; 2 samples each of *akamu and moi moi* were collected from each school except ISI and 2 samples of vegetable soup was collected from the five schools. Each school selected for survey was visited periodically during the 3 months of the study (February to April, 2009).

All samples were collected in sterile sample bottles containing sterile 0.1% peptone water using sterile metal spoons. *Moi moi* and *akamu* were collected in the morning during breakfast, while vegetable soup, rice and yam porridge were collected during lunch. Time between sample collection and analysis did not exceed 6 hours. The food samples were placed in a light-proof insulated box containing ice-packs to ensure rapid cooling. The samples were kept in the dark. Food samples were tested for coliform, *Bacillus cereus*, *Staphylococcus aureus* and *Escherichia coli*. The food preparation areas for the five selected schools were observed. Time of food holding i.e. from the time foods were dished to the time they were eventually eaten was recorded. Food temperatures were taken during holding just before consumption. This was done by inserting a thermocouple into the central region of the food being served. The duration of food holding was recorded using stop clock. The microbial analysis of food samples was carried out following standard methods.

3.5.2 Water sample collection

Two water samples were taken from different locations in each of the five schools. Samples were collected from Tap connected to Borehole, Well, drinking water container and washing water bowl. Water samples were poured into sterile sample bottles with screw caps. Time between sample collection and analysis did not exceed 6 hours. Water samples were placed in a light proof insulated box containing ice-packs to ensure rapid cooling. The samples were kept in the dark. Water analysis was mainly bacteriological involving detection of coliform. Physical parameters such as color, odor, taste and smell of water samples were also determined. Microbial analysis of water samples was carried out following standard methods.

3.5.3 Microbiological analysis of food samples

Ten grams or 10 ml of food samples were homogenized with 90 ml of 0.1% peptone water in screw capped flasks by means of horizontal and vertical agitation for few minutes. Serial dilutions of 10^{-2} were prepared for enumeration. Aliquots of 0.2 ml of the serial dilutions of the food samples were spread on duplicate plates using a sterile glass rod into Nutrient Agar, Manitol salt agar and MacConkey agar and then incubated at 37°C for 24 h except for the coliform in which incubation was at 37 ºC and 44ºC for 24 h. After the incubation time, the different culture plates were examined for microbial growth. Sub-cultures were made, to obtain discrete colonies, and different morphological tests were performed on the colonies, which were then stored in a slant at 4°C for further biochemical investigations, in order to identify microorganisms in the isolate. This technique was used for the enumeration of fecal coliform, *and Bacillus, and Staphylococcus counts* on various media like nutrient agar, mansitol salt agar, and MacConkey agar. The colony count was reported as colony forming units per gram of food sample (cfu/g).

3.5.4 Microbiological analysis of water samples

3.5.5 Water Analysis Using Pour Plate Method

- 1ml of water sample was added to15-20ml of sterile nutrient agar; this was swirled gently and allows settling.
- The plate was then inverted and incubated at 35±0.5°C for 24-48±3 hours

- The number of colonies on the agar plate was counted afterwards. This was expressed as the number per ml of sample. According to the WHO (1997) standards, the Total coliform, Fecal coliform and E. coli should be absent from drinking water

3.5.6 Detection and Enumeration of Coliform Organisms

The coliform organism was detected by multiple-tube fermentation or MPN Technique. This was carried out in 2 stages:

- The presumptive tests
- The confirmatory tests

3.5.7 Multiple tube method

In this method, a measured sub-sample 10ml is diluted with 100ml of sterile growth medium and an aliquot of 10ml is then decanted into each of ten tubes. These are then diluted again and the process repeated. At the end of 5 dilutions, a total of 50 tubes covering a dilution range of 1:10 through to 1: 10000 were obtained. The tubes were then incubated at37 ºC for 24 h and at the end of the process the number of tubes with growth was counted for each dilution. Statistical tables were then used to derive the concentration of organisms in the original sample. Indicator medium which changes colour when acid forming species are present was used. A tiny inverted tube was used to catch any gas produced. The production of gas at 37 ºC was a strong indication of the presence of *Escherichia coli.*

3.5.8 Procedure for presumptive test

- A 1:10 dilution of each water samples collected was made
- Each of the 5 sterile test tubes and 5ml of the medium (MacConkey broth) with a code for the sample with the date and dilution was labeled
- 10 mls were measured and diluted into 11-20 test tubes or mar Cartney bottles containing sterile MacConkey broth (double and single strength) and Durham tubes using sterile pipettes.
- Water was mixed thoroughly to expel gas in the Durham tubes
- This was incubated at 37°C for 18-24 hours.

- The number of positive tubes (those with gas production and color change) were counted after incubation for 24 hours for each dilution.
- A consecutive series of 3 ten-fold dilutions which shows some positive and negative reactions were selected.
- The result was reported in terms of the most probable Number (MPN) of the total coliform present in 100ml of water sample estimated from the MacCrandy's statistical table.

Plate 3.1: Microbial analysis of water using Multiple Tube Method

3.5.9 Procedure for Confirmed test

- The content of each of the positive tube was sub cultured into peptone water in a test tube using an inoculating loop
- These were incubated in incubator at 44°C for 18-24 hours
- After the incubation, about 2 drops of kovac's reagent was added using Pasteur's pipette. A ring brown solution at the upper layer of test tube is indicative of a positive reaction and then a probable presence of E. coli.

3.5.10 Quality assurance and Quality control Procedures

- Investigator's hand and that of other laboratory assistances was thoroughly washed before commencing work in the laboratory
- The work was carried out in a dust-free and draught-free part of the laboratory. The bench used was cleaned and swab down with ethanol just before work starts
- Care was taken to ensure that top of the bottles containing sterile medium or diluents, those used for sample collection and the top or bottom half of sterile pipette were not carelessly touched.
- When opening a bottle(or test-tube) containing sterile medium or diluents, or one containing the sample, the open neck of the bottle was quickly passed through a Bunsen flame while holding the cap of the bottle
- Pipette was carried out by hand pipette suction pump.

The water samples were analyzed by standard plate count using the pour plate method.

3.6 Survey Methods

3.6.1 Questionnaire

A structured interviewer administered questionnaire as shown in appendix 1 was administered to 59 food handlers in the five secondary schools studied. The questionnaire as shown was divided into four major sections for ease of administration. The sections are the socio demographic data of food handlers, Education on food safety and hygiene, environmental parameters related to food safety and knowledge, attitude and practice of food handlers on food safety. The questionnaire was pre-tested on 10% respondent similar to the study population in another

boarding school and validated before being administered to each food handler. A Face-to-face interview was conducted in English and Yoruba (the language widely spoken in the study area) to ensure good understanding. Written and signed informed consent was sought from each respondent. The purpose of the study was explained to each participant that the information provided will be kept confidential and that the participation is voluntary.

i. **Section A: Socio-demographic information**

This was used to collect personal data such as age, sex, marital status and ethnicity from the respondents

ii. **Training and Education on food safety**

This section was designed to collect data on the educational status and training the food handlers pertaining to food safety and food handlers' health certification with respect to safety of food in schools

iii. **Environment and food safety**

This section obtained data on environmental parameters that may affect food safety one way or the other. Here, data on food environment, food, water and environmental sanitation, food handlers' hygiene practices were collected

iv. **Knowledge Attitude and practice of food handlers**

This section collects information on knowledge of food handlers on food safety and hygiene , their attitude towards food safety practices, data on food handling practices, , food holding and. storage temperatures. Forty, 24 and 30 –point scales were used to assess food handlers' knowledge, attitude and practice with mean scores >19>11>and >14 categorized as good respectively.

3.6.2 Onsite Observation

An observation checklist was used to examine the schools' environment as it relates to the safety of food and water consumed in the schools. The checklist was also used to assess the kitchen, dining hall, Water supply facilities, refuse disposal facilities, excreta disposal facilities, sanitary and hygiene conditions of these facilities, safety and hygiene practices of the food handlers as

shown in appendix 2. The hygiene conditions of the kitchens, toilets and dinning of the boarding schools were assessed by direct observation using 30-item checklist with mean scores of ≥70%, 50-69%, 40-49% and <40% categorized as excellent, good, fair and poor hygiene conditions respectively.

3.6.3 In Depth Interview (IDI)

An in depth interview was conducted with the school Nurse and the heads of the food services of the 5 selected boarding secondary schools using an In Depth Interview Guide (as shown in appendix 3). Entry was made into the schools by first meeting with the principal of each school, who then introduced the researcher to the school 'Nurse or Head of food services. An average of 15 minutes interview was conducted to elicit information on food safety and hygiene, food handlers training and food borne disease outbreak. Prior to the interview, full disclosure of the nature of the study was given to the participants with emphasis on the voluntariness of participation and the confidentiality of the information they will be giving.

Plate 3.2: Food handlers in action without wearing protective apron and head covering

Plate 3.3: Food handlers exposed to smoke and heat from firewood method of food preparation

Plate 3.4: Food is unhygenically served in an open food container

3.6.4 Statistical analysis and Data management`

The qualitative data obtained from the onsite observation and observation checklist were summarized while the quantitative data obtained through questionnaire, microbiological analysis of food and water, food holding temperature were recorded and analyzed with Statistical Package for Social Sciences(SPSS) version15 while a coding guide was utilized to facilitate data entry. The quantitative data were first summarized with descriptive statistics such as mean, mode and standard deviations while inferential analysis such as the independent samples t-test and chi-square were used to test for the significant difference and significance of association respectively. The degree of freedom or levels of significance were also stated. Data analysis results are presented in charts, tables and figures in result section.

CHAPTER FOUR

RESULTS

This chapter presents the description of demographic characteristics of food handlers, food handling practices, food training, and knowledge attitude and practices on food safety, on site observation and sanitary conditions of kitchen, toilet and dining. This is shown by the data from the socio demographic information, food handlers' education on food safety, food holding temperature, environmental sanitation practices and food safety knowledge and practices obtained from the questionnaire survey, observation checklist and In-depth Interview. The results on microbiological analysis of food and water and Mean holding temperatures of food are also presented. The analyses of results were grouped into three sections. The first section assessed food safety practices and KAP of food handlers on food safety; the second section analyzed microbiological growth on food and water and food holding temperature while the third section presents analysis of environmental sanitation and results of in-depth interview.

4.1 Socio-Demographic characteristics of Food Handlers

A total of 59 food handlers: SLGS (8), QSI (9), GCI (6), ISI (19) and CSS (17) participated in this study with 13 (22%) male and 46(78%) female. Those that were married were. 37(62.7%) while 22 (37.3%) were single. Forty-five (76.3%) of food handlers that participated were less than 40 years of age while (2)3.4% were adult of 60 years and above. Fifty one (86.4%) of the food handlers are Christian while 8(13.6%) practice Islamic religion. From the total number of food handlers, 52(88.1%) were cooks while 7(11.9%) were food servers whom although handle food, do not participate in actual cooking of food (Table 4.1). Furthermore, about 38 (64.4%) of the food handlers have secondary education, 5 (8.5%) had tertiary education, while 6(10.2%) of the handlers had no formal education at all (Table 4.1).

Table 4.1: Socio-Demographic Characteristics of the Food Handlers

Factors	Categories	N	%
Gender	Male	13	22
	Female	46	78
Age			
	20-29	19	32.2
	30-39	26	44.1
	40-49	8	13.6
	50-59	4	6.8
	>=60	2	3.4
Marital status	Single	22	37.3
	Married	37	62.7
Religion	Christianity	51	86.4
	Islam	8	13.6
Occupation	Cook	52	88.1
	Cooking staff	7	11.9
Educational status	Non formal	6	10.2
	Primary	15	25.4
	Secondary	33	55.9
	Tertiary	5	8.5

4.2 Food Safety Education and Training

The food handlers are exposed to a form of training at the commencement of employment as food handler and from time to time to keep them abreast of the challenges of food safety. Fifty three (89.9%) of the respondents claimed to have had training on food safety while 6(10.2%) food handlers did not have any form of food training. Of the food handlers that reported to have had food training, 14(26.4%) had on the job training, 6(11.3%) had formal health training with a proof of certificate, 24(45.3%) had informal training on food safety with no certificate, while 9(17.0%) had only attended special food safety training organized by their employers. (Table 4.2)

Table 4.2: Food safety Education and training of food handlers

	Categories	N (%)
Received food safety training	Yes	53 (89.9)
	No	6 (10.2)
Types of training	On the job training	14 (26.4)
	Formal health training with certificate	6 (11.3)
	Informal health training without certificate	24 (45.3)
	Special training organized by employer	9 (17.0)

4.3 Medical Examination of food handlers

Fifty-two (88.1%) of food handlers claimed to have undergone pre-employment medical examination and certified medically fit to take a job as food handlers while 11.9% did not undergo medical examination before commencing work as food handlers . Thirty six (61.0%) of food handlers claimed to have undergone routine on the job medical examination to certify them medically fit to handle food for consumption while 39.0% never had routine medical examination while on the job.(Table 4.3). However, no medical report certifying any of the food handlers was seen.

4.4 Environmental features

4.4.1 Water Supply

The major source of water for drinking, cooking and general cleaning in the selected boarding schools was borehole with 55(93.2%) of food handlers claiming to have only borehole water in the schools, 2 (3.4%) of respondents claimed to have only tap water while 2 (3.4%) of food handlers claimed to use well water only for their drinking, cooking and general cleaning of food preparation areas. (Table 4.4)

Table 4.3: Medical Examination of Food Handlers

Variables	Categories	N (%)
Pre-employment medical examination	Yes	52 (88.1)
	No	7 (11.9)
On the job medical examination	Yes	36 (61.0)
	No	23 (39.0)
Certification by qualified medical personnel	Yes	52 (88.1)
	No	7 (11.9)

Table 4.4.: Water facilities in the schools

Facilities	Available	Not available
	N (%)	N (%)
Borehole	55 (93.2)	4 (6.8)
Tap	2 (3.4)	27(46.6)
Well	2 (3.4)	27 (46.6)

4.4.2 Sewage and Refuse Disposal Methods in Schools

The toilet facilities food handlers' use in the five selected schools was poorly maintained and grossly inadequate. The toilet environment was full of flies and offensive odor. The 5 schools had poor sanitary conditions with no running water or effective excreta disposal system. Majority of the respondents reported that toilet facilities in their school were inadequate while food handlers at Government College Ibadan had no toilet facility and so they defecated in the nearby bush.

The five schools claimed to have 3 main refuse was disposal types: Refuse was disposed in open field, dump site and pit. Although refuse disposal in the majority of the schools were inadequate, Thirty- four (57.6%) of respondents said they dump their refuse in open field, 3(5.1%) claimed to deposit waste in a dump site while 22 (37.3%) of respondents dump their solid waste into pits provided by the schools. Also, there are different types of excreta disposal methods in the schools. Forty- five (76.3%) food handlers claimed to use pour flush, 6(10.2%) use septic tank, 1(1.7%) use pit latrine while 7(11.9%) defecate in the open and throw into bush.(Table 4.5)

Table 4.5: Sewage and refuse disposal facilities in the schools

	Facilities	N (%)
Sewage	Pit latrine	1(1.7)
	Septic tank	6(10.2)
	Pour flush	45 (76.3)
	Throw into bush	7 (11.9)
Refuse disposal	Dumping in open field	34 (57.6)
	Dumping in a pit	25 (42.4)

4.4.3 Access to water source, sewage and refuse disposal facilities

Twelve(20.3%) food handlers reported that they walked 3 minutes(0.3km) or more in order to fetch water for drinking and cooking while 47(79.7) of respondent said they walked less than 3 minutes(0.3km) to obtain water for cooking, drinking and general cleaning for food preparation.

Forty- one(69.5%) of the food handlers claimed to walk less than 2 minutes(0.2km) to the excreta disposal facility while 18(30.5%) reported to work more than 2 minutes(0.2km) to access excreta disposal facility. Also, 17(28.8%) of food handlers reported walking less than 2(0.2km) minutes to get to the refuse disposal point, 35 (59.3%) said they walked between 2 - 5minutes(0.3km) while 7 (11.9%) walked more than 5 minutes(0.5km) just to dump the refuse.(Table 4.6)

Table 4.6: Access to water source, sewage and refuse disposal facilities

Facilities	Walking distance		N (%)
	Min	km	
Water	<3minutes	< 0.3	47 (79.7)
	≥3minutes	≥ 0.3	12 (20.3)
Sewage	<2minutes	< 0.2	41 (69.5)
	≥2 minutes	≥0.2	18 (30.5)
Refuse	<2minutes	<0.2	17 (28.8)
	2-5 minutes	0.3	35 (59.3)
	>5minutes	>0.5	7 (11.9)

4.5 Domestic animals in cooking area

The major sources of microbial contamination in food are human being and animals Thus 18 (30.5%) of the food handlers reported having domestic animals like goat, chicken, sheep ,cat etc around the food preparation areas , while 41(69.5%) claimed to have no domestic animals around the food preparation areas.(Table 4.7)

4.6 Pest control

Pest control methods are mostly introduced in schools to protect food from insects, bugs, and vermin and maintain the safety of food in the schools. Forty–seven (83%) of the food handlers said chemical method of pest control such as the use of insecticide was predominantly used, 9(15%) believed mechanical method such as setting rat trap is mostly used and only 1(2%) of food handlers said the school mostly employs physical methods of pest control such as killing ants and insects with broom.. (Figure 4.1)

4.7 Food Storage

The results revealed that 45(76.3%) of the respondents claimed that raw food are stored away from food preparation area while 14(23.7%) said the raw foods are stored in the kitchen. With regards to storage of raw and cooked food, 39(66.1%) of respondents reported that they stored raw and cooked food separately, however, 20(33.9%) of food handlers said they usually store raw and cooked food together. (Table 4.8**)**

4.8 Cooking Methods

The cleanliness of food preparation area, environmental friendliness and possible level of pollution depend on the method of cooking adopted by the school. Forty (68%) of respondents said the schools utilize firewood for cooking while 19(32. %) said the schools use bottled gas for cooking. (Figure 4.2)

Table 4.7: Domestic animals in the food preparation area

Categories		%
Domestic animals present	18	30.5
Domestic animals absent	41	69.5
Total	**59**	**100.0**

The domestic animals include cats, sheep, chicken, goats, cattle, sheep,

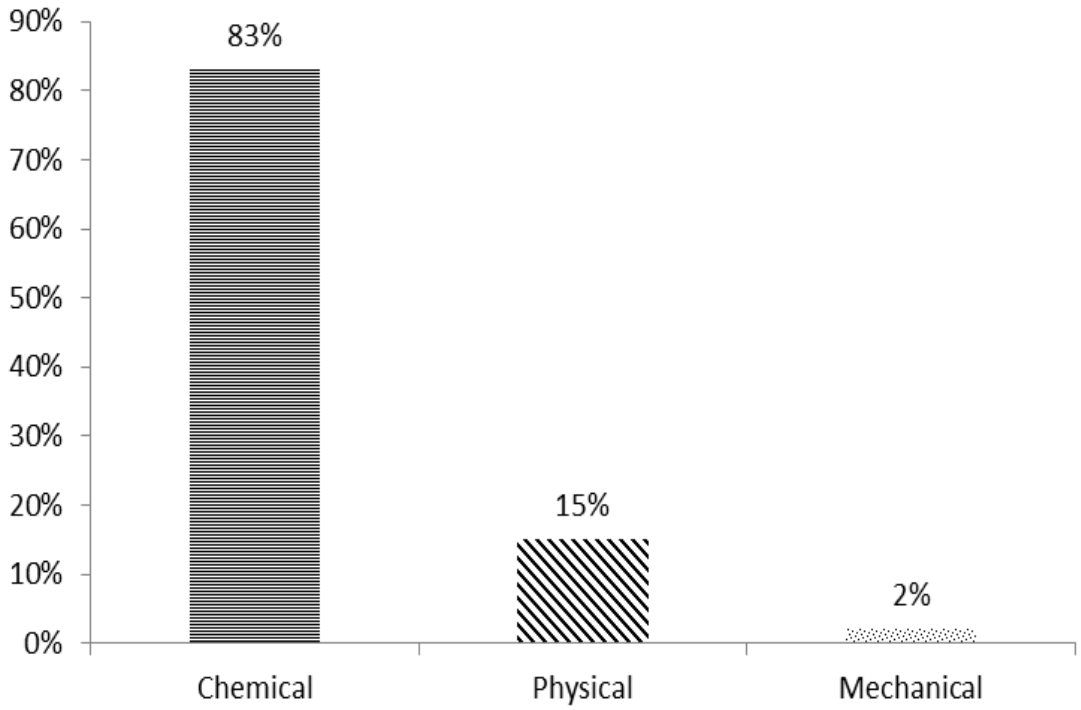

Figure 4.1 Methods of pest control in schools

Table 4.8: Food preparation and storage

	Categories	N	%
Food preparation place(kitchen) is separated from	Yes	45	76.3
Storage place(store)	No	14	23.7
Raw food are stored separately from cooked food	Yes	39	66.1
	No	20	33.9

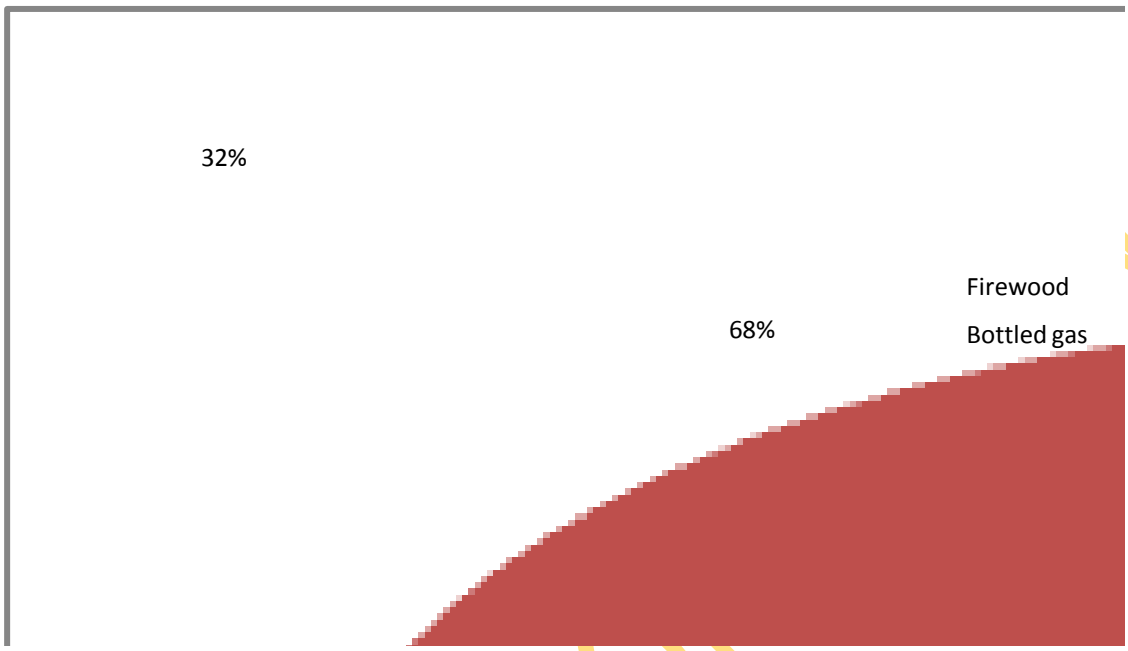

Figure 4.2 Methods of cooking in schools

4.9 Food holding temperature

Majority of the foods prepared in the five boarding schools attained temperatures of boiling or near boiling of 60 – 100°C, thus no serious food temperature breach was recorded. However, Akamu seems to have an average holding temperature of less than 50°C. The mean holding temperatures in degree centigrade for all foods in each school were: SLGS (51.9±9.9), CSS (51.2±12.0), and ISI (64.8±5.5), QSI (48.9 ±12.7 and GCI (55.2±10.0) with the total mean food holding temperature of 54.6 ±11.4 (Table 4.9).

The result also revealed that in all the schools, mean holding temperatures of food in degree centigrade were: Rice (57.4±4.6), moi-moi (57.1±5.9), "akamu" (34.3±1.5), vegetable-soup (59.0±6.7) and Yam-porridge (63.4±3.6). The average temperature at which akamu was consumed in all the five boarding schools was below the recommended food temperature of hot ready- to- eat food. (Table 4.9.1) There is a significant difference between food holding temperature among the five boarding schools ($P<0.05$). Also it was shown that there is significant difference between the foods holding temperature in all schools and the USFDA standards ($P<0.05$) (Tables 4.9.2).

Table 4.9: Mean holding temperature of foods in the schools

School	Mean	Std. Deviation
SLGS	51.9	9.9
CSS	51.2	12.0
ISI	64.8	5.5
QSI	48.9	12.7
GCI	55.2	10.0
Total	54.6	11.4

Table 4.9.1: Mean holding temperature of each food in the schools.

School	Food Temp(°C)				
	Rice	Akamu	Moin-moin	Vegetable soup	Yam porridge
SLGS	65	43	64	61	68
CSS	64	36	57	60	-
ISI	60	-	-	68	69
QSI	-	28	57	56	66
GCI	62	30	58	58	68
Total	57.4±4.6	34.3±1.5	57.1±5.9),	59.0±6.7	63.4±3.6

Table 4.9.2 Mean difference between the foods holding temperature in all schools and the USFDA standard

Variables	Mean (˚C)	95% confidence interval		T	p value
		Lower	upper		
Mean temperature	54.5	3.72051	7.18426	6.216	0.000
Standard temperature	60.0				

4.10 Food holding time

The mean holding time which is the time between food preparation and the actual consumption of food is a very crucial determinant of food safety. The result revealed that there was no serious food holding time breach in all the five schools studied since none of the school held food for more than 3hours before consumption. The mean food holding time in minutes for each food prepared in the 5 schools were: Rice(36min.3sec) akamu(,43.5min) moi moi(36min), vegetable soup(41min),and yam pouridge(30min.5sec). St Luis Grammer School Mokola had a significant higher food holding time (48min) than all other schools and surprisingly the same school had the lowest food holding time(27min) recorded. Majority of the food prepared in the five boarding schools were consumed within 27min to 1hour after preparation hence no serious time – temperature breach was recorded. (Table 4.10)

Table 4.10: Mean food holding time in schools

School	Food holding time(min)				
	Rice	Akamu	Moin-moin	Vegetable soup	Yam porridge
SLGS	45	48	45	45	27
CSS	35	40	30	40	-
ISI	30	-	-	40	30
QSI	-	46	35	40	35
GCI	35	40	40	40	30
Mean holding time	36.3	43.5	37.5	41	30.5

4.11 Microbial Quality of food and water

The microbiological analysis of water samples collected from the schools showed the presence of Total coliform, fecal coliform and *E.coli* while the microbial analysis of food samples indicated the presence of *B.cereus, E.coli, Staph aureus and fecal coliform*.

4.12 Microbial Quality of cooked food

Table 4.12 shows the mean microbial count of food prepared in five selected Secondary Schools with boarding facilities in Ibadan. The results show that the yam porridge prepared in Queen School had B. cereus count of 5.2×10^8 cfug-1 which is higher than that observed in other schools. However; B cereus was not detected in yam porridge prepared in International School. B cereus was not detected in the rice, moi moi and vegetable soup prepared at Government College Ibadan. The results also revealed that the vegetable soup prepared at Queens School had the highest count of B. cereus (5.1×10^8), Staph aureus (0.5×10^9), E.coli (4.0×10^8) and Fecal coliform (5.2×10^8) all in cfug-1 .

In all the schools, rice had the lowest number of microbial count. Fecal coliform (5.0×10^8 cfug1) recorded the highest microbial count found in rice while staph aureus was not detected in all the rice prepared in the five schools. The fecal coliform count of Akamu at CSS (5.1×10^8), QSI (5.1×10^8) and GCI (5.0×10^8) were very similar. However, Fecal coliform was not observed in akamu at ISI and SLGS.

The E. coli count in Akamu was highest for GCI (7.5×10^8), followed by QSI (4.6×10^8) with the least count of 3.7×10^8 cfug-1 recorded in SLGS. Staph aureus was not detected in moi moi prepared in SLGS, QSS and GCI, likewise no growth of E. coli was detected in moi moi prepared in STLG, CSS and GCI. Apart from the B. cereus found in the vegetable soup (4×10^8cfug-1), no other food samples tested positive for B.cereus in ISI. However, QSI recorded the highest microbial counts of B.cereus (1.8×10^9), Staph aureus (1.4×10^9), E.coli (, 7.5×10^8) and Fecal coliform (5.3×10^8)in all the foods prepared in the five boarding schools. (Table 4.11.1)

Table 4.11: Microbial load of foods prepared in selected public secondary schools with boarding facilities in Ibadan

Organism	School	Rice (cfug-1)	Akamu (cfug-1)	Moin-moin (cfug-1)	Vegetable soup (cfug-1)	Yam porridge (cfug-1)
B cereus	SLGS	3.1×10^{8}	1.4×10^{9}	4.7×10^{8}	1.4×10^{9}	3.4×10^{8}
	CSS	3.6×10^{8}	1.5×10^{9}	2.0×10^{8}	5.0×10^{8}	NT
	ISI	ND	NT	NT	4×10^{8}	ND
	QSI	NT	1.8×10^{9}	4.3×10^{8}	5.1×10^{8}	5.2×10^{8}
	GCI	ND	1.5×10^{9}	ND	ND	1.8×10^{9}
Staph aureus	SLGS	ND	NT	ND	ND	5×10^{3}
	CSS	ND	ND	NT	1.5×10^{8}	NT
	ISI	ND	NT	NT	1.3×10^{8}	ND
	QSI	NT	2.3×10^{8}	ND	0.5×10^{9}	1.4×10^{9}
	GCI	-ND	1.6×10^{8}	ND	ND	1.0×10^{8}
E.coli	SLGS	ND	3.7×10^{8}	ND	3.7×10^{8}	3.1×10^{8}
	CSS	2.2×10^{8}	4.0×10^{8}	ND	2.7×10^{8}	NT
	ISI	ND	NT	NT	2.3×10^{8}	ND
	QSI	NT	7.5×10^{8}	3.9×10^{8}	4.0×10^{8}	4.3×10^{8}
	GCI	ND	4.6×10^{8}	ND	1.2×10^{7}	ND
Feacal coliform	SLGS	ND	4.9×10^{8}	4.8×10^{8}	5.1×10^{8}	ND
	CSS	5.0×10^{8}	5.1×10^{8}	Nd	4.9×10^{8}	NT
	ISI	ND	NT	NT	ND	ND
	QSI	NT	5.1×10^{8}	4.8×10^{8}	5.2×10^{8}	5.3×10^{8}
	GCI	5.1×10^{8}	5.0×10^{8}	Nd	ND	5.3×10^{8}

ND = Organism not Detected; NT = Organism not Tested

4.13 Microbial quality of water

According to the WHO and SON standard limits for water safety level, Total Coliform and E. coli should be absent in drinking water (WHO, 1997). The drinking water samples collected from SLGS had Total and fecal coliform of 11 and 10 MPN/100mls respectively. These values are higher than the permissible limits although the E.coli value was within the permissible limits. At QSI, the drinking and cooking water samples had E. coli values of 2 and 4 MPN/100mls respectively. This values are higher than the acceptable limits hence the water is not safe for consumption. Total and fecal coliform of 20 and 9MPN/100mls respectively for drinking water collected from CSS were higher than the recommended limits; E. coli was not present in the water. The drinking water in CSS was however less polluted compared to the QSI with drinking water of 20, 9 and 2 MPN/100mls for Total, fecal coliform and e. coli respectively.

Drinking water samples at GCI was the most polluted of the drinking water in all the schools with the Total and fecal coliform values of 23 MPN/100mls, while ISI recorded the lowest total and fecal coliform contamination in drinking water of 6 and 4 MPN/100 respectively. This lower contamination of drinking water may be due to the fact that water was boiled, filtered and then dispensed through a potable water dispenser at ISI. (Table 4.12)

Going by the results obtained in all five schools, it was shown that the drinking water in all the schools were unsafe for consumption because virtually all the water samples contained fecal coliform and total coliform and some also had E.coli above the limits recommended by SON and WHO. Although, none of the drinking water in the five boarding schools was safe for consumption, the cooking water could still be used since it would eventually reach the boiling temperature and thus make the food safe for consumption.

Table 4.12: Microbial quality of water in selected public secondary schools with boarding facilities in Ibadan

Schools	Water samples	Total coliform (MPN/100mls)	Fecal Coliform (MPN/100mls)	E.coli (MPN/100mls)
SLGS	Borehole water for cooking	18	17	Nil
	Drinking water	11	10	Nil
	Water for washing	23	18	6
CSS	Borehole water for cooking	13	9`	Nil
	Water for drinking	20	9	Nil
	Water for washing	21	19	3
ISI	Borehole water for cooking	19	17	1
	Water for washing	26	15	5
	Boiled & filtered borehole water for Drinking through water dispenser	6	4	Nil
QSI	Borehole water for cooking	23	15	4
	Water for drinking	20	9	2
	Water for washing	27	21	6
GCI	Well water for cooking	17	17	3
	Water for drinking	23	23	3
	Water for washing	35	18	11

4.14 Knowledge Attitude and Practice on food safety

The analysis of the questionnaire results show that the mean KAP scores of food handlers on food safety was 26.9±4.9, 13.4±3.2 and 21.9±3.8 out of total score of 40, 24 and 30 respectively. Among the food handlers, 78%, 5% and 83% had a good Knowledge, attitude and practices on safe food storage respectively while 22%, 95% and 17% of food handlers need improvement on their knowledge, attitude and practice on food storage respectively. From the statistical analysis, there was a significant relationship between knowledge and practice on safe food storage and between attitude and practice on safe food storage ($p<0.05$) (Table 4.13).

The result also showed that among food handlers, 73%, 19% and 48% had a good knowledge, attitude and practices on hand wash respectively while 27%, 81%, 52% of food handlers need improvement on their Knowledge, attitude and practices respectively on hand washing . In addition, there was no significant relationship between food safety knowledge and practice on hand washing and between food safety attitude and practice of hand washing among the food handlers. (Table 4.14)

Furthermore, 34%, 37% and 36% of food handlers had a good level of knowledge, Attitude and Practices respectively on food storage temperature , while 66%, 63%, 64% of food handlers need improvement on their knowledge, attitude and practices on food safety temperature. Also, there was no significant relationship between food safety knowledge and practice on food temperature and between food safety attitude and practice on food temperature among food handlers. (Table 4.15)

Table 4.13: KAP of food handlers on food storage

Indicators	N (%)
Knowledge of food storage	
Good	46(78)
Needs improvement	13(22)
Attitude on food storage	
Good	3(5)
Needs improvement	56(95)
Food storage practice	
Good	49(83)
Needs improvement	10(17)

Table 4.14: KAP of food handlers on hand washing

Indicators	N (%)
Knowledge of hand washing	
Good	43(73)
Needs improvement	16(27)
Attitude on hand washing	
Good	11(19)
Needs improvement	48(81)
Hand washing practice	
Good	28(48)
Needs improvement	31(52)

Table 4.15: KAP of food handlers on food temperature

Indicators	N (%)
Knowledge of food temperature	
Good	20(34)
Needs improvement	39(66)
Attitude on food temperature	
Good	22(37)
Needs improvement	37(63)
Food temperature practice	
Good	21(36)
Needs improvement	38(64)

4.15 Knowledge of food safety in relation to Sex, Marital Status, Level of Education and Age of Food Handlers

According to the results, 8(62%) of male and 24(52%) of female food handlers had good food safety knowledge, while 5(38%) of male and 22(48%) of female food handlers had poor knowledge of food safety.(Table 4.17) Also, 12(55%) of single and 20(54%) of married food handlers had good knowledge of food safety while 10(45%) of single and 17(46%) of married food handlers had poor knowledge of food safety (n=59)(Table 4.16). Result also shows that 4(80%), 19(58%), 7(47%), and 2(33%) of food handlers with tertiary, secondary primary and no formal education respectively had good knowledge of food safety while 1(20%), 14(42%), 8(53%) and 4(67%) of food handlers with tertiary, secondary , primary and no formal education respectively had poor knowledge of food safety.(Table 4.16).The result showed that 18(54%), 11(55%), 3(60%) and none (0%) of food handlers within the age range 20-34,35-49,50-64 and 65-79 respectively had good knowledge of food safety education, while 15(46%), 9(45%), 2(40%), and 1(100%) of food handlers within the age range 20-34,35-49,50-64 and 65-79 respectively had poor knowledge of food safety education(Table 4.16)

Table 4.16: Knowledge of food safety in relation to Sex, Marital Status , Level of Education and Age of Food Handlers

	Knowledge of food safety			p-value
	Poor	Good	Total	
	n (%)	n (%)	N (%)	
Sex				
Male	5 (38)	8 (62)	13(100)	0.550
Female	22(48)	24(52)	46(100)	
Marital status				
Single	10(45)	12(55)	22(100)	0.971
Married	17(46)	20(54)	37(100)	
Level education				
None	4(67)	2(33)	6(100)	0.409
Primary	8(53)	7(47)	15(100)	
Secondary	14(42)	19(58)	33(100)	
Tertiary	1(20)	4(80)	5(100)	
Age				
20-34	15(46)	18 (54)	33(100)	0.739
35-49	9(45)	11(55)	20(100)	
50-64	2(40)	3(60)	5(100)	
65-79	1(100)	0	1(100)	

4.16 Food Safety Attitude in relation to Sex, Marital Status, Level of Education and Age of Food handlers

The result shows that 5(38.5%) of male and 25(54.3%) of female food handlers had good attitude on food safety while 8(61.5%) of male and 21(45.7%) of female food handlers had poor attitude on food safety.(Table 4.17) Also, 12(54.5%) of single and 30(81.1%) of married food handlers had good attitude on food safety while 10(45.4%) of single and 7(18.9%) of married food handlers had poor food safety attitude.(Table 4.17) The result also shows that 33(56%),16(49%) 10(67%), and 3(50%) of food handlers with tertiary, secondary , primary and no formal education respectively had good attitude on food safety, while 26(44%) , 17(51%), 5(33.3%) and 3(50%) of food handlers with tertiary, secondary , primary and no formal education respectively had poor food safety attitude.(Table 4.17). Considering the age of food handlers with respect to the food safety attitude, 16(49%), 13(65%), 4(80%) and none (0%) of food handlers within the age range 20-34,35-49,50-64 and 65-79 years respectively had good attitude on food safety , while 17(51.5%), 7(35%), 1(20%), and 1(100%) of food handlers within the age range 20-34,35-49,50-64 and 65-79 years respectively had poor food safety attitude.(Table 4.17)

Table 4.17: Food safety Attitude in Relation to Sex, Marital Status, Level of Education and Age of Food Handlers

	Food safety practice			p-value
	Poor	Good	Total	
	N (%)	N (%)	N (%)	
Sex				
Male	8(61.5)	5(38.5)	13(100)	0.351
Female	21(45.7)	25(54.3)	46(100)	
Marital status				
Single	10(45.4)	12(54.5)	22(100)	0.148
Married	7(18.9)	30(81.1)	37(100)	
Level of Education				
None	3(50)	3(50)	6(100)	0.439
Primary	5(33)	10(67)	15(100)	
Secondary	17(51)	16(49)	33(100)	
Tertiary	26(44)	33(56)	59(100)	
Age				
20-34	17(51)	16(49)	33(100)	0.278
35-49	7(35)	13(65)	20(100)	
50-64	1(20)	4(80)	5(100)	
65-79	1(100)	0(0)	1(100)	

4.17 Food safety Practices in relation to Sex, Marital Status, Level of Education and Age of Food Handlers

The results revealed that, 10(77%) of male and 29(63%) of female food handlers had good food safety practices, while 3(23%) of male and 17(37%) of female food handlers had poor food safety practice.(Table 4.18) Also, 12(55%) of single and 27(73%) of married food handlers had good food safety practice while 10(45%) of single and 10(27%) of married food handlers had poor food safety practice.(Table 4.18) It can also be deduced from the result that 5(100%), 19(58%), 9(60%), and 6(100%) of food handlers with tertiary, secondary, primary and no formal education respectively had good practice on food safety, while none (0%), 14(42.4%), 6(40%) and none (0%) of food handlers with tertiary, secondary, primary and no formal education respectively had poor food safety practice(Table 4.18). Lastly, considering age of food handlers with respect to the food safety practices, 17(51%), 16(80%), 5(100%) and 1(100%) of food handlers within the age range 20-34,35-49,50-64 and 65-79 years had good food safety practice , while 16(49%) and 4(20%) of food handlers within the age range 20-34 and 35-49 had poor food safety practice.(Table 4.18)

Table 4.18: Food safety practice in relation to Sex, Marital Status, Level of Education and Age of Food Handlers

Variable	Food safety practice			p-value
	Poor	Good	Total	
	n (%)	n (%)	N (%)	
Sex				
Male	3 (23)	10 (77)	13 (100)	0.351
Female	17 (37)	29 (63)	46 (100)	
Marital status				
Single	10(45)	12(55)	22(100)	0.148
Married	10(27)	27(73)	37(100)	
Level of Education				
None	0	6(100)	6(100)	0.073
Primary	6(40)	9(60)	15(100)	
Secondary	14(42)	19(58)	33(100)	
Tertiary	0	5(100)	5(100)	
Age				
20-34	16(49)	17(51)	33(100)	0.047
35-49	4(20)	16(80)	20(100)	
50-64	0	5(100)	5(100)	
65-79	0	1(100)	1(100)	

4.18 On-site Observations on Hygiene and Sanitary Conditions of Schools

The schools' kitchen, toilet, dining hall and personal hygiene of food handlers are essential parts of the school food environment, and they all play vital roles in the integrity and safety of the food consumed in the boarding schools. It was difficult to rate the sanitary conditions of schools' kitchens and dining as good or bad due to lack of standard grading tools and/or reference materials. However, this study selected a few variables to rate the sanitary conditions of boarding schools in Ibadan as follows: floor repair condition, infestation of flies, toilet availability, cleanliness, availability of hand washing place in the lavatories, physical condition of solid waste storage containers, and availability of clean piped water supply.

4.19 Sanitary/Hygiene Conditions of the Kitchens in Schools

Food preparation was primarily carried out in an open kitchen for all the selected schools, only ISI had a closed type kitchen. All other schools prepared food in an open kitchen. This gives easy access to flying insects such as houseflies, rodents like rats and domestic animals like chickens, goats etc. Some schools like the CSS, QSI and GCI use the kitchen for storing worn out materials, food handlers personal belongings, unused cooking utensils etc. As a result, the kitchen environment in most schools was generally dirty with poor sanitary conditions.

The proximity of the schools kitchen to the toilet facility is of great concern. Most of the schools toilets except SLGS were situated close to the kitchen. This is of serious environmental health implications more so that majority of them except ISI had open kitchen which gives easy access to the flow of bacteria, insects, vermin and other food contaminants. Furthermore, with the exception of ISI, none of the schools had piped water in the kitchen, hence water was fetched at a distance and brought to the kitchen in open containers like bowls and buckets.

Visible smoke deposits were seen on the walls and roofs of kitchens in most schools except ISI. This may be because ISI is the only school that uses the liquefied gas method of cooking while other schools use firewood for cooking. The solid waste receptacles at the kitchen were not properly secured(Table 4.19)

Table 4.19 Sanitary/Hygiene Conditions of Kitchens in Schools

Environmental Health indicators of the kitchen	Schools				
	SLGS	CSS	ISI	QSI	GCI
Food is prepared inside the kitchen	Yes	Yes	Yes	Yes	Yes’
A closed type kitchen is present	No	No	Yes’	No	No
Kitchen is used to store worn out materials, firewood etc	No’	Yes	No’	Yes	Yes
Kitchen’s interior is dirty and unkempt	No’	Yes	No	Yes	Yes
Domestic animals seen in and around the kitchen	Yes	No	No’	No’	Yes
Kitchen infested with rats	Yes	Yes	Yes	Yes	Yes
Kitchen is just by the toilets or latrine	No’	Yes	Yes	Yes	Yes
Piped water available in the kitchen	No	No	Yes’	No	No
Hand washing facility available	Yes’	No	Yes’	Yes’	No
Bowls and/or buckets are used for dish washing	Yes	Yes	No’	Yes	Yes
Dish washing sink available	Yes’	No	Yes’	Yes’	No
Runny pipe water available in the kitchen	No	No	Yes’	No	No
Presence of visible smoke particles on the walls	Yes	Yes	No’	Yes	Yes
Presence of insect vectors e.g. cockroaches, houseflies.	Yes	Yes	Yes	Yes	Yes

Kitchen Floors	Concrete'	Plain earth	Concrete'	Concrete/Plain earth	Concrete/Plain earth
Window that could be open (an average of 10% of the floor area)	No window	No window	Yes'	No window	No window
Good floor repair condition	Yes'	No	Yes'	No	No
Good wall and ceiling repair condition	Yes'	Yes'	Yes'	No	No
Clean walls and kitchen	Yes'	No	Yes'	No	No
Adequate ventilation	Yes'	Yes'	Yes'	Yes'	Yes'
Adequate lightning	Yes'	Yes'	Yes'	Yes'	Yes'
Kitchen floor is clean	Yes'	No	Yes'	No	No
Solid waste storage receptacle is properly secured	No	No	Yes'	No	No
Total %	57%	17%	83%	26%	13%
	Good	Poor	Excellent	poor	Poor

Key:
Excellent (≥70%), Good (50-69%), Fair (40-49%), Poor (<40%).

4.20 Sanitary/Hygiene Conditions of the Toilets in Schools

Food handlers at CSS, ISI and SLGS use septic tank type of toilet, while those at QSI utilize pit latrines. There was no toilet facility available for the food handlers at GCI hence the food handlers made use of the surrounding bush for defecation. None of the schools had piped water available in the toilets however; all except GCI made use of mobile water container which could be refilled when needed.

The toilet floor of all the schools except ISI was water flooded, none of the schools had washing fluid available in the toilet, hygiene conditions of toilets in all the schools was generally bad while food handlers at ISI, GCI and CSS use toilets as storage for worn out materials, old items and food handlers' clothing. (Table 4.20)

Table 4.20 Sanitary/Hygiene Conditions of Toilets in Schools

Environmental Health indicators of the toilets	Schools				
	SLGS	**CSS**	**ISI**	**QSI**	**GCI**
Types of toilet available	Septic tank	Septic tank	Septic tank	Pit latrine	None
Piped water available in toilet	No	No	No	No	No
Mobile water container with water for sanitary cleansing present	Yes	Yes	Yes	Yes	No
Toilet floor is water flooded	Yes	Yes	No	Yes	No
Toilet also stores worn out materials, clothes and old items	No	Yes	Yes	Yes	No
Toilet's general hygiene condition	Bad	Bad	Bad	Bad	Bad
Hand washing fluids available	No	No	No	No	No
TOTAL (%)	43%	29%	43%	29%	29%
	Fair	Poor	Fair	Poor	Poor

Key:

Excellent (≥70%), Good (50-69%), Fair (40-49%), Poor (<40%).

4.21 Sanitary/Hygiene Conditions of the Dining in Schools

All the five schools had dining hall which can sit all students at once except CSS and SLGS where the students had to take meal in batches because of limited space. The floor and walls at QSI, CSS and GCI are dirty while parts of the roof of dining at GCI and QSI had already fallen off. There was adequate ventilation in the dinning of most schools with walls and ceiling in good conditions except for GCI and QSI. (Table 4.21)

Table 4.21 Sanitary/Hygiene Conditions of Dining in Schools

Environmental Health indicators of the dining hall	Schools SLGS	CSS	ISI	QSI	GCI
Dining hall available	Yes	Yes	Yes	Yes	Yes
Dining hall sit all students at meal time	No	No	Yes	Yes	Yes
Floor and walls are dirty	No’	Yes	No	Yes	Yes
Parts of the roof is falling off	No’	No	No	Yes	Yes
Unwashed plates and food remnants littered the floor	No	Yes	No	Yes	Yes
Walls in good condition	Yes	Yes	Yes	No	No
Ceiling in good condition	Yes	Yes	Yes	No	No
Adequate ventilation	No	Yes	Yes	Yes	Yes
Chairs and tables in good condition	Yes	Yes	Yes	Yes	No
Total (%)	78%	67%	100%	44%	33%
	V good	Good	Excellent	Fair	Poor

Key:
Excellent (≥70%), Good (50-69%), Fair (40-49%), Poor (<40%).

4.22 Personal Hygiene of Food Handlers in Schools

About 50% of food handlers at SLGS and QSI, 90% at ISI, less than 10% at CSS and none at GCI were seen wearing protective head covering during food handling. About 50% of food handlers at SLGS and QSI, 70% at ISI, and none from GCI wear safety apron. Food handlers were seen with untrimmed long nails, conspicuous ring and other hand ornaments and less than 50% of the food handlers at ISI, CSS, GCI and QSI washed hands before cooking. About 50% of food handlers at QSI sneeze without hand washing. Almost every food handler at SLGS washed hands before food preparation. This was however different at CSS, ISI and GCI where food handlers forgot to wash hands before starting food preparation.

Although few food handlers were seen picking nose during food preparation, this unhygienic practice was common with food handlers at SLGS and GCI with 50% of food handlers pick nose without hand washing during food preparation. The nose picking practice was however not observed with food handlers at CSS and QSI. None of the food handlers at SLGS and QSI kept long untrimmed nails while more food handlers about 33% at GCI and 25% at CSS had long fingernails and 8% of handlers at CSS had dirty fingernails (**Table 4.32)**

Table 4.22 Personal Hygiene of Food Handlers in Schools

Personal Hygiene of Food Handlers	Schools				
	SLGS	CSS	ISI	QSI	GCI
% of food handlers with protective head covering	50	<10	>90	50	0
% of food handlers that wash hands before cooking at meal preparation time	100	26	32	50	33
% of Food handlers that sneeze without hand washing	0	17	5	50	30
% of handlers that pick nose or cough without hand washing	50	0	4	0	50
% of food handlers wearing protective work gown (Apron)	50	6	70	50	0
food handlers gown	Clean	Unclean	Clean	Unclean	Unclean
	100	0	100	0	0
% of food handlers that wear rings and other finger ornaments	50	28	15	50	33
% of food handlers with Untrimmed fingernails	0	25	8	0	33
Total (%)	50	14	37	31	22
	Good	V. poor	Poor	Poor	Poor

Key:

Excellent (≥70%), Good (50-69%), Fair (40-49%), Poor (<40%).

4.23 Relationship between holding temperature and microbial load in food

Table 4.33 shows the correlation analysis between holding temperature and microbial loads in foods for each organism. The analysis shows that microbial load of E coli in food had significantly fair but inverse relationship with the holding temperature ($p<0.05$). However, there was no significant relationship between food holding temperature and microbial count of B cereus, Staph. aureus and fecal coliform in the selected foods studied.

Table 4.23 Food holding temperature and microbial loads in food

Organism	Correlation coefficient	p-value
B. aeurus	-0.340	0.131
Staph. aureus	-0.085	0.729
E-coli	-0.519*	0.016
Fecal Coliform	-0.202	0.380

*Correlation is significant at p<0.05

4.24 Findings from In-depth Interviews with School Nurses and Head of Food Departments

All interviewees acknowledged the possibility of food hazard occurring in the schools. Many of the respondents reported not having food safety training manual. However, the schools follow food safety management measure and control stipulated by the school management board. Furthermore, majority of the respondents claimed that they do regular random monitoring and checks to ensure that food handlers comply with basic food safety principles.

Interviewees claimed that there were written and documented policy and procedures for visitors (vendors, teachers, students, etc) to the kitchen and dining areas. However, they equally admitted that these procedures may not have been followed by food handlers at all times

Some of the interviewee claimed that there was a documented orientation program on food safety for new employees; however, the interviewer was not shown any of these documents. Majority of the interviewee said that there was no documented orientation program on food safety nor was there an on-going training program on food safety. A statement of one of the respondents goes thus: "*We expect any food handler we employed to have known the basics of food preparation and cooking*."

All interviewees reported that pre-employment medical certification was a requirement to work as cook and food servers in the schools. They were however not strict as to the certification by medical personnel as long as the applicant is experienced to do the job and looks physically fit. Most of the respondent did not have records of pre- employment medical certification of the food handlers. They said, "*It is the responsibilities of the various hospitals that these medical tests were carried out to keep such records"*. According to the respondents, on the job routine medical examination was however almost nonexistent.

Most of the respondents reported that there is no minimum training or education an employee must acquire to work as food handler. According to some of the respondents, "*Cooks are employed based on their experience in cooking, and not training or education on cooking"*

Most interviewees reported cough, malaria, headache, abdominal upset and general fatigue as the common illness reported amongst the food handlers. According to one the respondents, "*Malaria, abdominal pain, diarrhea, cough and headache are illnesses frequently reported by boarding students and boarding staff"*

A majority of the respondents reported that cases of food borne diseases are rare; they however admitted that two or more students do occasionally come down with certain illnesses like diarrhea, vomiting, abdominal pain, fever etc., but they believed these are just isolated cases. In such instances, students are taken to the nearest government hospital for treatment. In the words of one of the respondents, "*This illness is just as a result of the student overeating and not a food related illness"*. Only one respondent acknowledged remembering a previous food related illness of a group of students after consuming bean soup called "*gbegiri*" but the interviewer was not privileged to see the documentation of how this particular incidence was handled.

The interviewees claimed that their schools have control measures in place to prevent possible food related diseases. They said that food handlers always wash their hands before cooking and that the food handlers are enforced to wear neat apron, cover their heads, maintain trimmed nails and ensure good personal hygiene.

CHAPTER FIVE

DISCUSSION

This chapter considers the results of the questionnaire survey used to obtain information on the knowledge, attitude and practices, socio- demographic characteristics, food safety education and hygiene practices of food handlers. The chapter also presents the implications of results obtained for mean holding temperatures, food holding time, microbiological quality of water used for food preparation, drinking, and microbiological quality of food samples collected in the five selected boarding schools in Ibadan. Information on the sanitary condition of the dining hall, kitchen, toilet and hygiene practices of food handlers in the five selected boarding schools were also highlighted.

5.1 Socio-demographic characteristics of food handlers

According to the findings of this study, some socio-demographic characteristics of the food handlers in the selected schools vary significantly. Some of the characteristics include age, gender, marital status, level of education and experience. Majority of food handlers are women. An earlier study had reported that females are more informed about appropriate food preparation and handling than men (Roseman *et al*, 2006). Although there was no significant difference between educational status of food handlers and KAP on food safety in this study, similar studies had suggested that educated food handler shave often recognized the importance of food safety and younger food handlers have shown greatest need for additional food safety education (Bruhn *et al.,* 1999; Rimal *et al*., 2001). Findings of this study indicated that about 65% of food handlers attained a secondary school education and this is similar to other study that reported high level of literacy with 64% food handlers with secondary school education (Tan *et al*, 2012)

Ekwenye *et al* 2005 earlier observed food safety knowledge was significantly higher among food handlers with higher educational level and among younger staff and those attending continuing educational course about food hygiene while very few food handlers had participated in formal training in food hygiene.

5.2 Microbiological Quality of Food Samples

According to the FDA and WHO, the maximum permissible limits of fecal coliform, staph aureus and Bacillus cereus in cooked ready to eat food are ≥10, ≥ 10^2 and ≥10^4 cfu/g respectively. However, *E.coli* should be absent in cooked food (WHO, 1994).The microbiological analysis of food samples revealed that the bacterial isolate from all food samples collected in the five boarding schools were *B. cereus, S. aureus, E.coli,* and Coliform. This finding is similar to previous reports by Nichols *et al*. (1999) and Mensah *et al*. (2002) in which *B. cereus* and *E. coli* were the prevalent bacteria isolates isolated from food in their respective studies.

Although, the cooking temperatures of foods examined in this study reached levels capable of destroying many vegetative forms of food borne pathogens, the quantity of organisms ranging from 2.0×10^8 to 1.8×10^9cfu/g either survived in the foods after cooking or were introduced externally after cooking This may represent the group of heat resistant spore former and/or post process contaminants (Inabo *et al*., 2000; Ehiri *et al*., 2001). The food contamination could also have come from improper personal hygiene of cooks or dirty cooking utensils (Vivek et al., 1995) The *B.cereus* count of 2.0×10^8 to 1.8×10^9 cfu/g recorded for cooked foods from all the schools could have been initially introduced from the raw foods and food ingredients or due to large number of vegetative cells that contaminated food ingredients (Obuekwe and Ogbimi, 1989). The isolation of *B. cereus* from all the cooked food samples in SLGS is of concern. This may be explained by the ubiquitous distribution of this organism and its ability to form endospores (Mckillip, 2000) or probably due to the unhygienic practices of the food handlers.

The result shows that the yam porridge prepared at GCI had higher *B. cereus* count than other schools however; *B cereus* was not detected in yam porridge prepared in ISI neither was it detected in the rice, *moin moin* and vegetable soup prepared at GCI. This high level of *B cereus* contamination in yam porridge at GCI could be attributed to initial contamination of food ingredients used in this particular school or post process contamination after the yam porridge preparation

The result also reveals that the vegetable soup prepared at QSI had the highest count of *B. cereus, Staph aureus, E.coli* and fecal coliform than vegetable soup prepared in other schools. This result may however suggest the possibility of microbial exposure at the school either from the ingredients used in food preparation or from food handling practices, since the highest level of microbial exposure for the aforementioned food was observed at QSI than from other schools.

Microbial contamination of cooked rice was the lowest in all the schools compared to bacterial contamination of other foods. Also, F. coliform had the highest microbial count in rice while *Staph aureus* was not detected in all the rice prepared in the five schools. The fecal coliform count of Akamu in CSS was similar to that of QSI and GSI but was higher than that in SLGS. Coliform was detected in all the food samples tested for QSI but none was seen in all food samples tested for the ISI. The presence of coliform in the food may have been from improperly cleaned utensils, poor hygiene of food handlers, and the animals within the vicinity (along with their fecal droppings) present in the food preparation environment (Ehiri *et al.,* 2001)

The food safety problem associated with foods prepared among the studied schools were the inadequate time and temperature exposure of akamu, extensive handling of foods by cooks after preparation and the practice of leaving cooked foods uncovered till served to students. The limited time/temperature exposure of 5 - 10 min during Akamu preparation was insufficient to destroy *B. cereus* spores. This result is similar to that obtained by Oranusi *et al*, 2007 in the food safety condition in boarding schools at Zaria.

Furthermore, it was also shown that the *B. cereus isolated* from rice in SLGS and CSS; the *E. coli* found in rice at CSS; and fecal coliform isolated in the rice from CSS and GCI could be traced to post process contamination. This is because rice prepared in majority of the schools was devoid of the microorganisms. This result is similar to Tambekar *et al* (2006) which indicated a high incidence of E.coli in ready to eat food which might have occurred through contamination of cooked food by food handlers due to poor post cooking handling and contaminated cooking utensils. The International Commission on Microbiological Specification for Food suggested the acceptable limit of $\geq 10^4$ for *B. cereus* in food. Based on this, the results obtained from this study indicated that most of the ready-to-eat food samples examined did not meet bacteriological quality standards.

5.3 Microbial quality of water used in food preparation

According to the WHO (1997) standards, the Total coliform, Fecal coliform and E. coli should be absent from drinking water. The results of analysis for microbial quality of water used in the selected schools shows that the fecal coliform and coliform levels were higher than the permissible level in drinking water samples in all the schools. However, *E coli* were not detected in the drinking water samples of ISI, CSS, and SLGS. Fecal coliform, coliform and *E. coli* were all detected in the water used for washing. The high level of coliform contaminants in water may be attributed to the hygiene practices of food handlers and the environmental sanitation in place. The handling of water container can also contribute to the coliform contamination of water. Handlers were seen using the same container for cooking and fetching water while water fetchers were being dropped carelessly on the floor with no safety precautions. This result is similar to that obtained by Adesiyan *et al*,(1983) and Bryan *et al*.(1988) of which both reported that the coliform contamination of well water might have occurred due to the use of unclean water vessels.

Water for washing collected in SLGSI and CSS; contained *E.coli* levels higher than the permissible limits. However, E. coli was absent from drinking and cooking water. The presence of coliform may be attributed to contamination introduced during washing since the same water for washing might have been reused several times before being discarded. Also, the high coliform in water from QSI may be attributed to improper handling procedure as water was fetched in an unhygienic way from the borehole and Well, and then transported in an open container with no safety precautions. This is similar to the inference made by Alabi and Adesiyan (1985) and Ehiri *et al*. (2001). This suggests that the contamination of well and tap water by fecal organisms could be from water storage vessels and from persons collecting the water.

Bacteriological quality of drinking, cooking and washing water samples collected from QSI and GCI revealed that all water samples had bacteria load higher than the permissible limits. Overall, it was shown that cooking water was highly contaminated with coliform while drinking water was also polluted. Therefore, this water was not fit for consumption.

5.4 Mean temperature of food

The temperature danger zone is the temperature range in which microorganisms grow quickly and sometimes reach levels that can make people ill. The temperature between 5°C–57°C was identified as the temperature danger zone(FDA, 2009)

Findings from the results of temperature measurement of food at holding indicates that the majority of schools held food at temperature above 57°C which is the recommended temperature for hot ready to eat food. The mean temperature of individual food is within the recommended standard except for Akamu. International School of University of Ibadan had the highest mean holding food temperature for hot ready to eat food. The result shows that there was a significant difference in the holding temperature among schools and that there was a significant difference in holding temperature in all schools in comparison with the United States Food and Drug Administration (USFDA) standards.

Most food prepared in the five selected Public Secondary Schools with Boarding Facilities reached boiling point at cooking but the limited time/temperature exposure during cooking for some foods like akamu and *moin moin* can be a determining factor in the overall safety of the consumed food.

5.5 Methods of Cooking.

Findings of this study revealed that about 65% of the boarding schools use firewood methods of cooking. This method of cooking results in the creation of carbon monoxide particulate and smog pollution. These can cause a variety of symptoms ranging from headaches and nausea, to potentially life-threatening conditions including cardiovascular and respiratory diseases to the food handlers (Yang, 2011). This method is a major source of potentially climate changes soot in the air. Less than 35% of the schools use bottled gas which is a cleaner and more efficient method of cooking. Thus the US medical studies on health risk have found little to no substantial health and environmental implication beyond the dangers of gas leaks and possible gas explosion during cooking (Westlake, 2009).

5.6 Food handling practices

Findings from observations indicate that some of the schools prepared food overnight and then store it in the refrigerator or cooler for subsequent use. This practice may be responsible for the microbial proliferation which occurs when the bulk rice was stored overnight. This was the common practice at SLGS. For example, rice was usually reheated in the morning many hours later after being cooked. The result is consistent with the study by Mejayi, 2009 on the microbiological quality of ready to eat food sold in secondary school in Abeokuta Ogun State. The study inferred that the occurrence of microbial growth in ready to eat food was as a result of the food handling practices of the food handlers.

Although, cooks were able to maintain temperature high enough to reach the cooking state for moin moin, this temperature may not be maintained long enough to kill all microorganisms present during cooking for the fear of *moi moi* getting burnt. The *moi moi* prepared in majority of the schools were well steamed and held at average temperature of 57of °C and above, in order to prevent multiplication of microbes. Mean holding temperature of 57°C and mean holding time of less than 1 hour was recorded and this food temperature/time condition was adequate to prevent and maintain any possible exposure to microorganisms. However, the results revealed that the microbial contamination of most food samples was still very high. Thus the method of storage during holding is a possible source of bacteria to the foods. The result showed that food from QSI showed a considerable growth of *B cereus, E.coli* and fecal coliform in *moi moi*. This may be because *moi moin* at Queen School was usually dished in large uncovered cooler and the students were expected to equally dish into their individual plates. This multiple handling and transfer process in food handling can encourage considerable level of bacterial contamination. This was consistent with the findings of previous studies on food safety conducted in boarding secondary schools in Zaria (Oranusi *et al*, 2007).

Another major food safety problem associated with food handling practices in the schools was the inadequate time/temperature exposure of Akamu. Ordinarily, decanting of water in the akamu reduces pH which in turn reduces microbial growth. Also,, increasing the time/temperature during cooking should be enough to kill microorganisms. However, the limited time/temperature exposure during the preparation of Akamu at QSI may be insufficient to destroy *B. cereus* spores. The Akamu was not exposed to high temperature to prevent food from

getting burnt and this may possibly explain why there was considerable bacteria growth seen in the Akamu. The result shows that yam porridge prepared at QSI had higher mean colony count of B. cereus than other schools. This could be as a result of contamination by food condiments and other seasoning such as grounded crayfish and pepper that were added to yam at later stage of food preparation. Thus the limited time –temperature exposure may be a factor since there was not enough heat to kill the existing bacteria in the added condiments

5.7 Knowledge Attitude and Practice of Food Handlers on food safety

The results of this investigation indicate that food handlers in the five selected boarding schools in Ibadan have an average knowledge of food safety. However, the result from the observation checklist shows that food handlers may not always put this knowledge into practice. This result is similar to findings on food handlers' knowledge and practice on food safety by Oteri and Ekanem, 1989. Less than 6% of the food handlers had good attitude on food safety storage while about a quarter of the food handlers will need improvement in knowledge on food safety storage.

More than 65% of the food handlers need improvement on knowledge, attitude and practice on food temperature while more than a quarter of the food handlers need to improve their knowledge attitude and practices on hand wash before, during and after food preparation. The finding from this study indicates that about 73% of food handlers have good knowledge of hand washing. However, very few of the few handlers at the boarding schools do practice effective hand washing .This is consistent with the research by Manning (1994) that have earlier shown that 81% of food handlers are aware of the importance of hand wash, but only 2% actually practice thorough hand wash. Furthermore, in this survey, only 34% of the respondents managed to prove that they know the right temperature for storage of hot and cold ready to eat foods. This result is supported by Bas *et al*. (2004) who reported that knowledge of critical temperature of food safety were low amongst studied food handlers. Walker *et al*. (2003) also reported that less than half of 444 respondents' food handlers knew the correct temperature at which hot ready to eat foods should be held.

Although there was no significant difference between food safety practice and marital status, gender, age and level of education of food handlers studied. From the statistical analysis, It was

found that there was a significant relationship between food safety knowledge and practice of food storage and between attitude and practice of food storage ($p<0.05$). This result was similar to that of Wilcock et al,2004, who found that there was an association between knowledge and current practice of food handlers and that the awareness of food handlers improved their practice.

5.8 Sanitary conditions of kitchen, Dining and Toilet

Going by the On-site observation of the dining, kitchens and toilets in 5 boarding schools, none of the schools passed the total basic requirements of food sanitation. The food preparation vicinity was checked by on-site sanitary observations which took into consideration the kitchen, toilet and dinning (The three vital areas that are in contact with food)

5.8.1 Kitchen Area

A closed type kitchen in which food is prepared in an hygienic environment with running water and good cross ventilation system is what is recommended. However, kitchens in the schools except that of ISI are all makeshift and not well defined as kitchen. Apart from SLGS and ISI, kitchen area of all other schools was dirty, infested with flies and rodents. The kitchens also served as storage for worn out items such as old clothes, cooking utensils and unused electronic appliances. A major problem was the unclean nature of the kitchen and its surrounding in most of the schools. International School Ibadan seems to have a cleaner floor, but the floor was flooded and this exposed handlers to falls and injury. The kitchen floors of other schools were dirty and littered with rappers of food ingredients. Raw foods were kept on the floor and this might have caused bacterial contamination. It was common to see food handlers chatting and laughing while cooking, this exposed the food to bacterial contamination through introduction of germs from the mouth and other parts of the body. It was also observed that majority of the schools had poor environmental sanitation. Government College and QSI did not have waste container and good drainage system. Bowl and buckets used for cooking was also used to fetch water, since none of the school kitchen had running piped water. All the schools except ISI cooked with firewood resulting in black carbon deposits on the kitchens walls and ceiling. The liquefied gas employed by ISI is a cleaner and more efficient method of cooking.

5.8.2 Toilet Facility

All the schools except GCI had toilet that was functional. Although there was a designated toilet at GCI, the toilet had been converted to storage hence food handlers defecate in the nearby bush and use paper or leave for sanitary cleaning. Most toilets in the schools used by the food handlers were littered with dirt, water logged, had no running piped water and no hand washing fluid or soap for sanitary cleaning. A key step in promoting good hygiene is ensuring that there are hand washing stations and toilet facilities available in close proximity (not more than ¼ mile) to the food handlers' station. Mishandling and disregard of hygienic measures on the part of the food handlers using unsanitary toilet may enable pathogenic bacteria to come into contact with food and in some cases survive and multiply in sufficient numbers to cause illness in the consumer(Malugeta *et al*, 2012)

5.8.3 Dinning Facility

Dining was available in all the schools and it was big enough to sit all students at once except for the dining at SLGS that could not sit all the students at once. Dinning floor and walls were dirty while unwashed plates used for previous meal were observed at CSS, GCI and QSI. The dinning wall and ceiling were in good condition at CSS, SLGS and ISI while large portion of the dinning ceiling had fallen off at GCI and QSI. There were good cross ventilation in all the schools dinning except at SLGS which had few tiny windows and poor lightning system. Chairs and tables arrangement was adequate in all schools except GCI where many dining chairs were broken and student were seen sitting on the dining tables.

5.9 Personal Hygiene of Food Handlers

Good personal hygiene is a major quality expected from food handlers. The inadequate personal hygiene observed in food handlers with respect to wearing of clean protective apron, head covering, hand washing, coughing without mouth covering, sneezing at the food area, keeping of long nails, wearing conspicuous ring and ornaments are sources of concern. Food safety can be promoted by educating the food handlers about personal hygiene; therefore, the knowledge of food hygiene must be imparted on the food handlers in order to understand the need to effectively maintain good personal hygiene (Bas et al, 2004).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study set out to evaluate food safety and hygiene conditions in boarding schools using factors and conditions that may directly or indirectly affect safety of food consumed such as food holding temperature; microbiological quality of food and water; sanitary conditions of the kitchen, dining and toilets; knowledge, attitude and practices of food handlers.

Students in the boarding schools like any other group of people have the right to consume safe and wholesome food. Hence effective school food control is very necessary to achieve this. Therefore, ensuring good microbiological quality of food consumed at these schools is very paramount. Findings from this study show that many of the food prepared in the schools are of poor microbiological quality and can be described to be unfit for consumption. The same can be said of the drinking and cooking water which were shown to contain an unacceptably high coliform and sometimes polluted with *E.coli*.

The study also revealed that although, effective food holding temperature were attained for most food in the boarding schools, mean holding temperature of food like Akamu was lower than the minimum temperature 57°C for hot ready to eat food. The limited time –temperature exposure had been implicated for this. The same can also be said of *moi moi* in which steam but not high heat was required to cook at limited time. There was no significant relationship between food holding temperature and microbial count in foods.

It was also discovered that all the boarding schools had toilets with poor hygiene conditions. There was no running water for sanitary cleansing neither were there provisions for wash hand soap to use after defecation. Government College and QSI have kitchen and dining with poor hygiene conditions, CSS had kitchen with poor hygiene condition, while food handlers at GCI could only defecate and urinate in the nearby bush since there was no functional toilet. In general, poor environmental sanitation was discovered in majority of the schools studied. They

do not conform to the guidelines stipulated for school sanitation as contained in the Policy Guidelines on School Sanitation developed by Federal Ministry of Environment.

The study also revealed that the food handlers at the boarding schools had barely average knowledge on food safety. In general, the food handlers showed poor attitude on safe food storage. Majority of the food handlers' exhibit poor food handling practices. Poor hand washing with poor knowledge, attitude and practice on safe food temperature.

6.2 Recommendations

Based on the findings and observation during the course of the study, some of the recommendations emphasize measures that could prevent food contamination and possible food disease outbreak by promoting good hygiene that would ensure safety of food consumed in the boarding schools. This includes but not limited to the following:

1. The activities of the food handlers in boarding schools should be regularly monitored and appropriate corrections should be made by supervisors when food safety procedures are breached
2. Strict hygiene control should be practiced at all time during preparation and dispensing of food to prevent food contamination
3. Oyo State Ministry of Health through the School Health Board should establish a unit that will register, train, educate and re-educate food handlers on food safety and hygiene most importantly in the area of effective and safe food handling and environmental sanitation
4. The Government should support and encourage more scientific research on food safety by providing grants and other useful facilities that will motivate tertiary institutions and relevant agencies in carrying out various researches on food safety.
5. Certain levels of food safety standards and specifications should be established by relevant Government authorities that every boarding school must adhere to when setting up the kitchen and dining hall to protect the students and staff from possible food borne disease outbreak.

6. Environmental and health education programmes should be established to raise awareness on food safety, the causes and prevention in every food processing centers. This will ensure the food handlers are better equipped in the area of food hygiene and environmental sanitation.

REFERENCES

Adesiyan, A.A., Adekeye, J.O., Umoh, J.U., Nadara, J (1983). Studies on well water and possible health risks in Katsina, Nigeria. *J Hygiene* 90:199-204

Alabi, D.A., Adesiyan, A.A (1985). Studies on microbial quality of filtered water in households of a university community in Nigeria. *J Hygiene* 96: 239-248.

Almanza, B.A., Nesmith, M (2003). Food handlers certification regulations in the United States. *Journal of Environmental Health* 16: 45-72.

American School Food Service Association.(1999) Straight from the source: Findings from ASFSA's 1999 operations survey. School Foodservice & Nutrition, 53, 16.

Ayeni, B (1982). Map of land use pattern in Ibadan. Unpublished paper.

Bamford, T.W (1967). Rise of the public schools, a study of boys' public boarding schools in England and Wales from 1837 to the present day.

Bas, M., Ersun, A.S and Kıvanc, G (2004). The evaluation of food hygiene and knowledge, attitudes and practices of food handlers in food businesses in Turkey. *Journal of Food* Control 17: 317-322.

Blakeslee, K.M., Penner, K.P (1999). A case study of a school foodservice cook-chill operation Used to develop a Hazard Analysis Critical Control Point Program. *J Dairy, Food and Environmental Sanitation*, 19, 257-267.

Breed R.S., Murray, E.G.D., and Smith, N.R (1957). Bergeys's Manual of Determinative Bacteriology, 7th ed. Baltimore: The Williams and Wilkins Company.

Bruhn, C. M., Schutz, H. G (1999). Consumer food safety knowledge and practices. *Journal of Food Safety* 19:73-87.

Bryan, F.L(1988). Risks of practices, procedures and processes that lead to out-breaks of food borne diseases. *Journal of Food Protection* 1: 663-673.

.Burghardt, J.A., Gordon, A.R., Fraker, T.M (1995). Meals offered in the national school lunch program and school breakfast program. *Am J Clin Nutr*. 61:187–198.

CDC (1999). Surveillance of food borne disease outbreaks, United States, MMWR surveill sum 45:1-66.

CDC (2000). Preliminary FoodNet data on the incidence of food illness: Selected sites, United States. MMWR 51: 325-329.

CDCP (2012). Multistate outbreak of Shiga toxin-producing Escherichia colio O157:H7 infection linked to organic spinash and spring mix blend. CDC E,coli webpage.

Collins, J.E (1997). Impact of changing consumer lifestyle on the emergence/re-emmergence of foodborne pathogens. Emergence Infection Disease 3:1-13.

Coombs, P.I., Prosser, R.C., and Ahmed, H (1973.). New paths to learning for rural children and youth ICED, New York.

Daniels, N.A (2002). Food borne disease outbreaks in United States schools. Pediatr. *Dis. J.* 21(7): 623-628.

Davies,F.L., Wilkinson, G (1973). Germination of Spores of Bacillus cereus in Milk and Milk Dialysates: Effect of Heat Treatment. *Bacteriol Journal*.62(3) 123-192.

Ehiri, J.E., Azubuike, M.C., Ubbaonu, EC., Ibe, K.M., Ogbonna, M.O (2001).Critical Control Points of complementary food preparation and handling in Eastern Nigeria. Bull. WHO 79: 423-433.

Ekwenye, U.N., Okoro, L.A., Ojimelukwe, P.C., Akaeru, B. and Ogbonnu, P (2005). Comparative evaluation of the bacterocin characteristics of lactic acid bacteria from selected traditional fermented food. *J food science and Tech*. 5(1):1-5.

Etling, A (1993). What is non formal education? *Journal of Agricultural Education*, 72-76.

Falola, T (1984). The political Economy of pre-colonial state: Ibadan, 1830-1900. University of Ile-Ife Press,Ile-Ife.

FAO (2002). Agricultural Statistics; Food and Agricultural Organisation of the United Nations, Rome www.fao.org.

FDA, Center for Food Safety & Applied Nutrition (2000). *Web* page manual: 11http://vm.cfsan.fda.gov/- ~ebam/bam-toc.html

FDA (2004). Food borne pathogenic microorganisms and natural toxins handbook. http://www.fda.gov/dmslfs-toc.htm.

FDA (2009). Food Code :Annex 4-Management of food safety practices-Achieving Active Managerial Control of Foodborne Illness Risk Factors. FDA webpage.

Felsenfeld, O. (1965). Notes on food, beverages and fomites contaminated with vibrio cholera. Bulletin of the World Health Organization, 33(5), 725-734.

Food Act (1983). Definition of food: Malaysian Legislation. Act, 381. The commissioner of Law Revision Malaysia.

Flanigan, B. (2006). The food safety factor. Am. School Board J. 193(6): 1-5.

Fry, A.M et al.(2005). Food borne disease. In GL. Principle and Practice of Infectious Disease, 6th ed, vol.1,pp 1286-130. Philadelphia Elsevier Churchill Livinggstone.

GAO (2002). Continued vigilance needed to ensure safety of school meals. United States Gov Acc Office Pp 5-16.

Giampaoli, J., Cluskey, M., and Sneed, J. (2002). Developing a practical audit tool for assessing employee food-handling practices. *The Journal of Child Nutrition & Management*.

Giampaoli, J., Sneed, J., Cluskey, M., and Koenig, H.F. (2002). School foodservice directors' attitudes and perceived challenges to implementing food safety and HACCP programs. The Journal of Child Nutrition & Management.

Gilmore, S.A., and Dana, J.T. (1998). Food quality model for school food services. The Journal of Child Nutrition & Management, 22, 32-30

Goffman, E(1948). The Role of Status Symbols in Social organization.

http://www.univ.edu/centers/cdclv/ega/documents/eg burgess.pdf.

Highton, P.J., Hobbs, D.G(1972). Penicillin and cellwall synthesis: a study of Bacillus cereus using electron microscopy. *J Bacteriol.*

Hobbs, B.C., Kendall, M., Gilbert, R.J(1968). Use of phenolphthale in diphosphate agar with polymyxin as a selective medium for the isolation and enumeration of coagulase-positive staphylococci from foods. Appl Microbiol. 16(3): 535.

Holmberg, S.D., Harris, J.R., Kay, D.E et al (1984). Foodborne transmission of cholera in Micronesian households Lancet, i: 325-328.

Howes, M., McEwen, S., Griffith, M. and Harris, L (1996). Food handler certification by home study: measuring changes in knowledge and behavior. Dairy Food Environmental Sanitation 3:208-214.

ICMSF (2002). Microorganisms in Foods and Microbiological testing in food safety management. Kluwer Academic / Plenum Publishers,New York, USA.

Inabo, H.I., Ogbadu, L.J., Umoh, V.J., Ameh., J.B. (2000).Microbiological quality of selected marketed condiments. Namoda Techscope J. 4: 20-30.

Kim,H.U., Goepfert, J.M (1971).Enumeration and Identification of Bacillus cereus in food:l.24 Hour Presumptive Test Medium. Appl. Microbiol.1971,22(4):581.

Kleis,J., Lang,L., Mietus, J.R. and Tiapula, F.T.S.(1973). Towards a contextual definition of non-formal education. Nonformal education discussion papers, East Lansing, MI Michigan State University,pp.3-6.

Koepe, et al(2008). Global occurrence of infant botulism, 1976-2006. Pediatrics J. :122(1):73-82

Kratz,J.D., Nyaphisi, M., Mandel, R. and Peterson, E (1999). Quantitative examination of domestic water supply in Lesotho Highland: Water quality sanitation and village health Bull.WHO.77:10.

Larkin,J.M, Stokes, J.L (1966). Isolation of psychrophilic species of Bacillus. *J Bacteriol*. 91(5) 1667-167.

Lehloesa, L. j., Muyima,N.Y.O (2000). Evaluation of the impact of household treatment procedure on the quality of ground water supplies in the rural community of Victoria district eastern cape. Water, 26:28.

MacDougal, C., Powell, J.P., Johnson, C.K., Edmund, M.B., Polk, R.E (2005). Hospital and community flouroquinolones use and resistant in staphylococcus aureus and E.coli in 17 US hospitals. Clin Infect Dis 41(4) 435-440, 2.

Manning, C.K (1994). Food safety knowledge and attitudes of workers from institutional and temporary food service operations. Am Diet Assoc 1994; 94:895–97.

Martin, D.L., Gustafson, T.L., Pelosi J.W., Suarez, L., Pierce, G.V (1986). Contaminated food produce: a common source for two outbreaks of *Shigella* gastroenteritis. *Am J Epidemiol* 1986; 124:299–305.

Mazengia, M.S., Chidavaenzi, M., Bradley, M. et al(2002). Effective and culturally acceptable water storage in Zimbabwe: maintaining the quality of water abstracted from upgraded family wells. *Journal of Environmental Health* 64, 15-18.

McCabe-Sellers, B.J., Beattie, S.E (2004). Food safety: Emerging trends in food borne illness surveillance and prevention. *J. Am. Diet*. Association.104: 1708-1717.

McKillip, J. L. (2000). Prevalence and expression of enterotoxins in *Bacillus cereus* and other *Bacillus* spp., a literature review. *Antonie Van Leeuwenhoek* 77, 393-399.

Mensah, P., Manu, D.Y., Darko, K.O., Ablor- dey, A (2002). Street foods in Accra, Ghana: how safe are they?. Bull WHO 2002; 80: 546-54.

Mejayi, H (2011). Microbiological quality of foods sold in secondary schools in Abeokuta, Ogun State, Nigeria.Int journal of food protection. 12:2-34.

Mulugeta, K., Bayeh, A.(2012). The sanitary conditions of food service establishments and food safety knowledge and practices of food handlers in Bahir dar town.. *Ethiop J Health* Sci. Vol. 22, No.1 pp 28-32.

Miller et al (2008). Global epidemiology of infections due to Shigella,salmonella Serotype Typhi and enterotoxigenic Escherichia coli. Epidemiol infect. ;136(4): 433-5.

Mortlock et al (1999). A national survey of food hygiene training and qualification levels in the UK food industry. International Journal of Environmental Health Research 10: 2 p 111- 123.

Musa, O.I., Akande, T.M (2003). Food hygiene practices of food vendors in secondary schools in Ilorin. Niger Postgrad Med J. 2003 Sep; 10(3):192-6.

NAFDAC (2005). Abc about NAFDAC. Nafdac.gov.ng

Nataro, J.P., Steiner, T., Guerrant, L.R (1998) Enteroaggregative *E. coli*. Emerging Infect. Dis. 3: 459-465.

Neill, C (1980). Safe-n-sensible food safety. School Food Service Journal, 34(7). 44-46.

Nicholas, A.D. et al (1999). Foodborne disease outbreaks in United States schools. Pediatr Infect Dis J, Vol. 21, No. 7:623–628.

Nigeria Tribune (1994). Medical students ends up in hospital after consuming salad. April 12;Pp 7

Noah, N (2009) Food poisoning from raw fruit and vegetables. Introduction Epidemiol. Infect.Mar 2009; 137(3): 305-6.

Obuekwe, C.D., Ogbimi, A.O (1989). Prevalence of *Bacillus cereus* and other Gram- positive bacteria in Nigerian dried food condiments. Nig Food J. 7: 11-19.

Oladimeji, B.A and Fabiyi, A.K (1993). Increasing the Awareness of Safety Measures among Secondary School Pupils: The Ile-Ife Experience. *Nigerian School Health Journal* 8.2:9-19.

Omemu, A M., Aderoju, S.T (2007) Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria

Omotayo, R.K and Denloye, S.A. (2002) The Nigerian experience on food safety regulations FAO/WHO global forum on food safety regulators Marrakesh Morocco.

Oni, V., Oni,A., Esumeh, F. (2010) Prevalence of Bacteria food poison from vegetable salads. *Journal of Nutrition and Wellness*, Vol.10 (2).

Oranusi, S., Galadima, M., Umoh, V. J., Nwanze, P. I (2007). Food safety evaluation in boarding schools in Zaria Nigeria ,using the HACCP system; Academic Journals of Scientific Research and Essay, Vol .2(10), pp. 426-433.

Oteri, T., Ekanem, E.E (1989). Food hygiene behavior among hospital food handlers. J. Public health; 103(3), 153-159.

Pesigan, T.P., Plantilla, J., Rolda, M (1967). Applied studies on the viability of El Tor vibrios and cereus Bull World Health Organ ;37(5); 779-786.

Power,A(2007). Discussion of Trauma at the threshold. The impact of Boarding school on Attachment jn Young Children. In Attachment: New Direction in Psychotherapy and Relational Psychoanalysis, vol 1,No 3, 310-312.

Quiroz, E.S., Bern, C., MacArthur, J.R (2000). An outbreak of cryptosporidiosis linked to a food handler. J Infect Dis ; 181:695–700.

Richards,MS., Rittman, M., Gilbert, T.T(1993). Investigation of a staphylococcal food poisoning outbreak in a centralized school lunch program. Public Health Rep ; 108:765–71.

Rimal, A., Fletcher, S. M., McWatters,K.H., Misra, S.K., and Deodhar, S. (2001). Perception of food safety and changes in food consumption habit: a consumer analysis. International J of Consumer Studies 25(1), 43-52.

Roseman, M., Kurzynske, J. (2006). Food safety perceptions and behaviors of Kentucky food handlers. Journal of Food Protection 69:1412-1421.

Sneed, J., Strohbehn, C., Gilmore, S.A, and Mendonca, A. (2006). Microbiological Evaluation of Food service contact surface in Iowa assisted-living facilities. *Journal of American Dietitians Associations* 104:1722-1724.

SON.(2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard. Pp 8- 9.

Sudershan, R .V., Pratima, R., Kalpagam, P (2009). Food safety research in India: a review, As. *J. Food Ag-Ind*. 2(03), 412-433.

Sukyung, Y., Sneed, J(2003). Implementation of HACCP and Prerequisite programs in school foodservice. J. Amer. Diet. Assn. Vol. 103. No. 1,pp.55-60.

Tambekar, D.H., Hirulkar,N.B., KaLikar, M.V., Patil, YS., Gulhane, S.R.(2006). Prevalence of thermotolerant E. coli in drinking water and its multidrug resistance . Res.J. Microbiol., 1:458-462.

Tan,S.L., Cheng, P.L., Soon,H.K., Ghazali,H. and Mahyudin, N.A(2012). A qualitative study on personal hygiene knowledge and practices among food handlers at selected primary schools in Klangvalley area,Selangor, Malaysia. Int.food Research J.20(1):71-76.

Tanwir, F., saboor,A., Shan, M.H(2003). Water contamination, health hazards and public awareness: A case of the urban Punjab Pakistan. *Int.J.Agric.Biol*., 5: 460-462.

Thidarat, C., Suwat., S, Duangjai, M(2011) Food Safety Knowledge, Attitude and Practice of Food Handlers and Microbiological and Chemical Food Quality Assessment of Food for Monks in Ratchathewi District, Bangkok Asia Journal of Public Health 2:1-8.

Udoh, C.O (1996). The College that is Health Education. An Inaugural Lecture. University of Ibadan.

UKDH(1997) Food handlers fitness to work. www.food.gov.uk

Umoh, V. J., Odoba, M.B.(1999). Safety and quality evaluation of street foods sold in Zaria Nigeria Food Control 1999; 10:9-10. 30.

UNFPA(1998). The State of World Population: The New Generations. United Nation Population Fund, New York.

Vanguard Nigeria (2008). Thirty agrochemical products banned in Nigeria after deaths. May 19; Pp 12.

Vivek, k., William, M.S., Rebecca S.J., Thomas, S.J., James, M.M(1995). Molecular population genetic analysis of S. aureus recovered from cows. J.Clin. Microbiol. 33:376-380.

Walker, E., Pritchard, C., and Forsythe, S.(2003). Food handlers' hygiene knowledge in small food businesses. Food Control, 14(5), 339-343.

Westlake, D (2009). Health Risks of Cooking With Gas. eHow internet j.

WHO (1953). Third European Seminar for Sanitary Engineers on design and operations of septic tanks. Geneva. WHO monograph series no 18.

WHO (1997). Guideline for Drinking Water Quality 2nd edition. Geneva.

WHO(1999). Improving Health through schools: National and International strategies. Geneva

WHO (2000). Food borne Disease: Focus on Health Education. Geneva.

WHO (2002). Food safety and food borne illness. Geneva.

WHO (2002). World Summit on Sustainable Development.(WSSD). Earth summit 2002. Johannesburg.

WHO (2003). Creating an Environment for Emotional and Social Well-Being. An important responsibility of a Health-Promoting and Child Friendly School Education.

WHO ((2004). Global *Salmonella* Surveillance (GSS). http://www.who.int/salmsurvIFAQ/eni.

WHO (2006). Five keys to safe food manual. Department of food safety, zoonoses and food borne diseases. Geneva.

WHO(2007). Public Health and the Environment. Geneva.

WHO (2009). Integrating Poverty and Gender into Health Programmes, a source book for health professionals. Module on water sanitation and food. Geneva.

Wilcock, A., Pun, M., Khanona, J., Aung, M. (2004). Consumer attitudes , knowledge and behavior: a review of food safety issues Trends. Food Sci & Technol; 15: 56-66.

Wogu, M. D., Omoruyi, M. I., Odeh, H. O. and Guobadia, J. N. (2011) Microbial load in ready-to-eat rice sold in Benin City. Journal of Microbiology and Antimicrobials Vol. 3(2), Pp. 29-33.

Yang, S (2011). Wood smoke from cooking fires linked to pneumonia, cognitive impacts. UC Berkely News Centre.

APPENDIX 1

PICTURE GALLERY

Food handler uses same container for food preparation and washing

Food handler dishes food unhygenically with bare hand into open food containers

Food is hygienically served in covered food containers

A school dining is well arranged for the next meal

Kitchen also serves as storage place for firewood and unused cooking materials

A goat is feeding on food ingredients in an open type of kitchen

APPENDIX 2

QUESTIONNAIRE

FOOD SAFETY AND HYGIENE IN BOARDING SECONDARY SCHOOLS IN IBADAN OYO STATE OF NIGERIA USING HAZARD ANALYSIS CRITICAL CONTROL POINT(HACCP) SYSTEM

Dear sir/ma

My name is Imam Muhammed. I am a postgraduate student of the department of Epidemiology, Medical Statistic and Environmental Health, Faculty of Public Health, College of Medicine, University of Ibadan. I am carrying out a study on food safety and hygiene conditions in boarding secondary schools in Ibadan Oyo State. This study is entirely for academic purpose; the findings from this study will be of great benefit to the advancement of knowledge, improvement of safety and hygiene, and reduction of chances of food and water borne diseases in the boarding schools. You have been selected for this study because of the wealth of information that you may provide as a result of your enormous responsibility. Your honest response to the following questions will be greatly appreciated.

It is not compulsory to take part in this study. You may decide not to be involved. If you wish, you may also withdraw from the research at anytime. If you decide to participate, we will like to inform you that whatever information you give to us will be kept secret. It will not be revealed to persons, schools, principal or the school authorities.

Thank you for your cooperation.

I understand all that has been explained above and I am willing to participate in the study

(a) Signature and date…… ……. Or

(b) Thumb print and date…… …… or

(c) Not willing to sign or thumbprint but willing to participate in the study

Please tick the space provided ( ) and date…….

Kindly state the reason for not willing to sign or thumbprint before participating when applicable…….....
.....

……

NOTE: DO NOT WRITE YOUR NAME OR THE NAME OF YOUR SCHOOL ON THIS QUESTIONNAIRE

Instructions

- Answer truthfully
- Fill in the gaps when necessary
- Tick where applicable

SECTION A

SOCIO-DEMOGRAPHIC INFORMATION

1. Serial number ☐☐☐
2. Age (in years) ☐☐☐
3. Sex (a) Male ( ) (b) Female( )
4. Marital status (a) Single( ) (b) Married( ) (c)Separated( ) (d) Divorced( )
5. Religion (a) Christianity ( ) (b) Islamic ( ) (c) Traditional ( ) (d) Others……
6. Occupation (a) Cook ( ) (b) Cooking Staff ( ) (c) Others……
7. Level of Education (a) No formal Education ( ) (b) Primary ( ) (c) Secondary ( ) (d) Tertiary ( )
8. Length of time on the job as food handler ……?

SECTION B

a. FOOD SAFETY AND HYGIENE TRAINING OF FOOD HANDLERS

1. Have you received any form of health education or training on food safety and hygiene?
   (a) Yes ( ) (b) No ( )
2. What type of food safety and hygiene training did you undergo?
   (a) On the job training ( ) (b) Formal health training which you received certificate ( ) (c) Informal health training which you did not receive certificate ( ) (d) Special training organized by your employer ( ) (e) Others please specify……
3. Is Hazard Analysis Critical Control Point system included in your training?
   (a) Yes ( ) (b) No ( )

4. Has the school you work incorporated HACCP in the food service system?
   (a) Yes ( ) (b) No ( )

b. MEDICAL EXAMINATION OF FOOD HANDLERS

1. Did you undergo a pre employment medical examination before starting the job as food handler? (a) Yes ( ) (b) No ( )
2. Have you had any form of medical examination while on the job? (a) Yes ( ) (b) No ( )
3. If yes to question 2, when was the last time you had medical examination? (Please specify in Months) ……..
4. Were you certified by qualified medical personnel to be medically fit to work as food handler? (a) Yes ( ) (b) No ( )

SECTION C

ENVIRONMENT AND FOOD SAFETY

1. What type of domestic water source(s) do you have in the school? You may pick more than one source. (a) Spring ( ) (b) Stream ( ) (c) Well ( ) (d) Borehole ( ) (e) Tap ( ) (f) Pond ( ) (g) Others please specify…….
2. How long will it take you to walk from where you fetch water to the food preparation areas? (a) Less than 3mins ( ) (b) Greater than 3mins ( ) (c) Greater than 5mins( )
3. What method(s) of sewage disposal do you have in the school? You may pick more than one source (a) Pit latrine ( ) (b) Septic tank( ) (c) Pour flush( ) (d) Aqua privy( ) (e) Throw into bush( )
4. What is the walking distance between the sewage disposal point(s) and the food preparation areas? (a) Less than 2mins ( ) (b) Less than 5mins ( ) (c) greater than 5mins ( ) (d) Greater than 10mins( )
5. Do you have domestic animal(s) around the food preparation area?
   (a) Yes ( ) (b) No ( )
6. If yes to Number 5, what type of domestic animal(s) do you have? Please specify……..……
   ….……

7. What method(s) of refuse disposal does your school have? (a) Dumping in open field ( ) (b) Sanitary lands fill ( ) (c) Dumping in a pit ( ) (d)Others, please specify……. (You may pick more than one choice)
8. What is the walking distance between the refuse disposal point(s) and the food preparation area? (a) Less than 2mins ( ) (b) Less than 5mins ( ) (c) greater than 5mins ( ) (d) Greater than 10mins( )
9. Do you have procedures in place for pest control? (a) Yes ( ) (b) No ( )
10. If yes to Number 9, what types of pest control method(s) do you have? Please specify…….
11. Is the food preparation area/kitchen separate from the raw food storage place? (a) Yes ( ) (b) No ( )
12. Are there separate food preparation surfaces for raw and cooked food? (a) Yes ( ) (b) No ( )
13. What types(s) of cooking facilities do you use? You may pick more than one choice. (a) Firewoods ( ) (b) kerosene stove ( ) (c) .Bottled gas ( ) (d) Other, please specify……

SECTION D

KNOWLEDE ATTITUDES AND PRACTICES OF FOOD HANDLERS

KNOWLEDGE

1. Below is a table with list of diseases. Indicate by ticking "True" or "False" for the disease(s) that is (are) food borne in nature. If you are not sure, tick, don't know".

S/N	DISEASES	True	False	Don't know
1	Dysentery			
2	HIV/AIDS			
3	Hepatitis A			
4	Tuberculosis			
5	Diabetics			
6	Typhoid fever			
7	Hypertension			
8	Cholera			

9	Diarrhea			
10	Malaria			
11	Worm infestation			
13	Obesity			

2. State the common symptoms of food borne diseases that you could easily remember?

…… …….. ……..

……. ……. ……..

3. The table below contains a list of statements about food handling practices. Go through the statement carefully and tick whether the statement is True or false. If you are not sure you may tick "Don't know"

	STATEMENTS ON FOOD HANDLING PRACTICES	**True**	**False**	**Don't know**
1	Preparation of food well in advance before serving will not contribute to the likelihood food contamination			
2	Prolong handling of food can contribute to food contamination			
3	Incorrect application of cleaning procedures of equipments e.g. slicing machine, will not increase the risk of food borne disease			
4	Hand washing is only necessary at the end food preparation and not before touching the food			
5	wearing of gloves while handling food reduces the risk of food contamination			
6	Hot, ready to eat food should be maintained at temperature of about 21-30°C			
7	Cold ready to eat food should be maintained at temperature of about 13-16°C			
8	Uncovered long hair and long fingernails of food handlers will not affect the hygiene state of the food			
9	Raw and cooked food must be stored separately			

10	Food handlers are potential source of contamination to food			
11	Infected saliva from a food handler may lead t food borne disease			
12	Hand washing before touching food will help make the food safe for consumption			

4. The table below contains list of diseases that must be reported by food handlers when contracted. Tick to indicate "True" or "False". If you are not sure, tick "Don't know".

S/N	**DISEASES**	**True**	**False**	**Don't know**
1	Diabetes			
2	Ear discharge			
3	Skin infection			
4	Hypertension			
5	Tuberculosis			
6	Cough and cold			
7	HIV/AIDS			
8	Dysentery			
9	Malaria			
10	Diarrhea			
11	Hepatitis A			
12	Sore throat			

ATTITUDES

The table below shows list of statements that describe attitudes toward food hygiene and related issues. Please indicate by ticking "Agree" or "Disagree". You may tick "Uncertain" if you are not sure on what the answer should be.

S/N	STATEMENTS ON ATTITUDES TO FOOD SAFETY	Agree	Disagree	Uncertain
1	Raw food should be kept separate from cooked food to prevent cross contamination			
2	Defrosted food should not be refrozen to avoid food contamination			
3	The use of cap, mask, protective glove and adequate protective clothing cannot reduce the risk of food contamination.			
4	Knowing the temperature food are stored does not reduce the risk of food spoilage			
5	Food products should be dated before storage to prevent spoilage and contamination			
6	Clean overall should be worn occasionally by food handlers while cooking			
7	Food handler can smoke while cooking as long as the cigarette does not fall into the food			
8	Insects and rodent control is an effective way of ensuring food safety			
9	Food handlers with abrasions or cut on hand should not touch unwrapped foods			
10	Liquid soap is better than solid soap for hand washing			
11	You should wipe your hands with your apron after hand washing.			
12	A small refuse bin in the kitchen area is more likely to be removed frequently when full than a bigger bin			

PRACTICEES

1. Do you wash your hand when handling food? (a) Yes ( ) (b) No ( )
2. If yes to question 1, answer the below questions ticking either "Always" "Sometimes" or "Rarely".

   How would you describe your hand washing pattern at the following critical points?

S/N	CRITICAL POINTS	Sometimes	Always	Rarely
1	Before cooking starts			
2	After cooking ends			
3	Before touching unwrapped cooked food			
4	After touching unwrapped cooked food			
5	After sneezing or coughing			
6	After handling the food ingredients			
7	After leaving the kitchen area			
8	When entering the kitchen			
9	Before touching unwrapped raw food			
10	After touching unwrapped raw food			
11	After hand tasting the food			
12	After using the toilet			

3. Do you check the expiration date of food at the point of purchase? (a) Yes ( ) (b) No ( )
4. Below is a table showing the list of various methods of hand washing. Please tick appropriately based on your practice of hand washing.

s/n	Methods of hand washing	Sometimes	Always	Rarely
1	Water			
2	Water and soap			
3	Disposable paper towel			
4	Cloth towel or cloth			
5	Hand drying			

5. Raw and cooked food should be stored : (a) Together ( ) (b) Separate ( ) (c) No particular form of storage ( )
6. Do you regularly check the temperature of the raw food stored? (a) Yes ( ) (b) No ( )
7. If yes to question 6, what instrument(s) do you use to check the food temperature? ……
8. What temperatures do you store chilled foods? .....
9. What temperature do you store cooked or reheated food? ……..
10. Do you clean food preparation areas and surfaces after using them? (a) Yes ( ) (b) No ( )
11. If yes to question 10, at what point(s) do you clean the food preparation area and surface? (a) Before cooking starts only ( ) (b) After cooking ends only ( ) (c) Before and after cooking end ( )
12. Do you prepare food well in advance before serving? (a) Yes ( ) (b) No ( )
13. If yes to question 12, how long do you normally hold the food before serving? Please specify in hours……..
14. Do you prepare food well in advance (greater than 4hrs) before serving? (a) Yes ( ) (b) No ( )
15. Do you reheat your food before serving? (a) Yes ( ) (b) No ( )
16. Do you take some time off work if you are ill or having a particular type of sickness? (a) Yes ( ) (b) No ( )
17. If yes to question 16, which sickness(s) did you contract that you took sometime off work? Please specify…….....
18. Are pest control program in place for the kitchen and dinning area? (a) Yes ( ) (b) No ( )
19. If yes to question 18, what type(s) of pest control method do you use in your school? Please specify……..
20. Do you use personal protective devices when cooking or handling food? (a) Yes ( ) (b) No ( )
21. If yes to question 20, what type(s) of protective device(s) do you use? Please specify……

APPENDIX 3

OBSERVATION CHECKLIST

Observation checklist for determining sanitary conditions of the kitchen, toilet dinning, and hygiene state of the food handlers in the boarding schools

Name of School……

Type of School (single/mixed)

Name of community

Status of community (urban, semi-urban, rural)…….

LGA……

State……

Total Population……

Instruction for filling the form

For each item assessed tick

Yes – If the answer is true

No - If the answer is false

Physical observation of kitchen

Item	Description	Yes	No	Remarks
1	Food is prepared inside the kitchen			
2	A closed type kitchen is present			
3	Kitchen is used to store worn out materials, firewood etc			
4	Kitchen's interior is dirty and unkempt			
5	Domestic animals seen in and around the kitchen			
6	Kitchen infested with rats			
7	Kitchen is just by the toilets or latrine			
8	Piped water available in the kitchen			
9	Hand washing facility available			
10	Bowls and/or buckets are used for dish washing			
11	Dish washing sink available			
12	Runny pipe water available in the kitchen			

13	Presence of visible smoke particles on the walls			
14	Presence of insect vectors e.g. cockroaches, houseflies.			
15	Kitchen Floor is concrete			
16	Window could be open (an average of 10% of the floor area)			
17	Good floor repair condition			
18	Good wall and ceiling repair condition			
19	Clean walls and kitchen			
20	Adequate ventilation			
21	Adequate lightning			
22	Kitchen floor is clean			
23	Solid waste storage receptacle is properly secured			

Physical observation of toilet

Item	Description	Yes	No	Remarks
1	Toilet available			
2	Piped water available in toilet			
3	Mobile water container with water for sanitary cleansing present			
4	Toilet floor is water flooded			
5	Toilet also stores warn out materials clothes and old items			
6	Mobile water container available			
7	Hand washing fluids available			
8	General Hygiene condition			

Physical Observation of Dining

Item	Description	Yes	No	Remarks
1	Dining hall available			
2	Dining hall sit all students at meal time			
3	Floor and walls are dirty			
4	Parts of the roof is falling off			
5	Unwashed plates and food remnants littered the floor			
6	Walls in good condition			
7	Ceiling in good condition			
8	Adequate ventilation			
9	Chairs and tables in good condition			

APPENDIX 4

IN-DEPTH INTERVIEW GUIDE

FOOD SAFE TY AND HYGIENE CONDITIONS IN SELECTED PUBLICBOARDING SECONDARY SCHOOLS IN IBADAN, NIGERIA

A. Introduction

- I am **Imam Muhammed Isiaku**, a postgraduate student of Environmental Health in the Faculty of Public Health, College of Medicine, and University of Ibadan.
- I thank you for accepting to participate in this interview. The interview intends enquire about the food safety and hygiene conditions in selected public boarding secondary schools
- The outcome of this study will be helpful in further improving safety of food and hygiene conditions in the boarding schools.
- With your permission, I will like to use a tape recorder because there is a limit to what I can remember and I do not want to forget the useful information you will provide
- I assure you that what is discussed here will not be used in any way against anyone and all that will be discussed will be kept strictly confidential

B. Questions

1. What are the food safety management procedures or guidelines currently in place in the school?
2. What are procedures for cleaning and sanitizing food equipments and utensils in place and are the food handlers following these procedures?
3. From your own observation, what are the common food related health problems e.g. food poisoning, vomiting, diarrhea etc reported by the students and staff in the school?(Prove for specific types of food related health problems and the severity)
4. In what ways did such food related health problems were managed? (Probe for specific treatment measures and actions taken)
5. How these foods related health problems are documented and reported to the appropriate health authorities?
6. What are the mechanisms put in place to prevent or reduce food related health problems?
7. What are the ways in which such mechanisms are supervised and monitored to ensure compliance by the food handlers?

APPENDIX 5

INFORMED CONSENT FORM

My name is **Imam Muhammed Isiaku**, a student of Environmental Health of the department of Epidemiology, Medicals Statistics and Environmental Health, Faculty of Public Health, Collage of Medicine, University of Ibadan. We are currently carrying out a research in selected Public board schools in Ibadan to enable us assess food safety and hygiene conditions in the schools. We will need to ask you some questions contained in the structured questionnaire. You will be assigned a number with no name written on the form so that you name will never be used in connection with any information you have disclosed.

You are free to take part in this research. You also have the right to withdraw at any given time if you wish to. However, we will greatly appreciate your help in responding to the survey questions by participating in the study

Consent: Now that the study has been explained to me and I fully understand the content of the study process. I am willing to participate in the programme.

…… ……

Signature/Thumbprint of parent/Date **Signature of interviewer/Date**

……..

Signature/Thumbprint of Witness/Date (If required)

APPENDIX 6

IWE IFITONI LETI

Lati Eka Ilera to nri si Ayika'
Ti Ile-Eko Giga'
Yunifasiti ti Ibadan
Ojo keje, osu keji, Odun 2009

Si Ojogbon tabi Omidan,

IWE IFITONI LETI

Oruko mi ni Imam Muhammed Isiaku, Akeko gboye Imo Ijinle tie ka ilera to nrisi eto ayika ti ile-eko giga Yunifasity ti ilu Ibadan. Mo nse iwadi ni pa imoju to onje ati hygiene larin awon ile iwe girama ti ilu Ibadan. Ma fe bere awon ibere nkan tabi meji lowo re, eyi ti mi o ni ko sinu iwe ibere. Mo fid a o loju wipe gbogbo idahun re si awon ibere wonyi ni mo ma se lojo ti ko si nil u sita si enikeni.

Ko pon dan dan fun o lati kopa ninu eto iwadi yi. O si ni eto lati ma ko pa mo lasiko ti o wu o. Sugbon inu mi yio dun ti o ba le kopa ni ibi eto iwadi yi

Ero mi: Nisinsinyi ti o ti salaye lori eto iwadi yi fun mi ti mo sigbo alaye re yekeyeke, emi yo kopa ninu eto na.

……. ……

Ifowosi Olukopa/Ojo(Date) **Ifowosi Olubere/Ojo(Date)**