AKENTEN APPIAH MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

FOOD MICROBIOLOGICAL QUALITY AND HYGIENE STANDARD PRACTICES AMONG CATERERS UNDER THE GHANA SCHOOL FEEDING PROGRAMME IN SEKYERE AFRAM PLAINS DISTRICT, GHANA

DANIEL ATANGA

SEPTEMBER

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A thesis submitted to the Department of Public Health Education of the Faculty of Environmental Health and Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development in partial fulfilment of the requirements for the award of a Master of Philosophy degree in Environmental and Occupational Health Education.

SEPTEMBER, 2025

Declaration

Candidate's Declaration

I hereby declare that this thesis is the result of my original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Name: Daniel Atanga

Signature: …… Date: ……...

Supervisors' Declaration

We hereby declare that the thesis's preparation and presentation were supervised per the guidelines on thesis supervision laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

Principal Supervisor's Name: **Rev. Dr. Denis Dekugmen Yar**

Signature: ……. Date: …….....

Co-Supervisor's Name: **Dr. Daniel Tetteh**

Signature: ……. Date: …….....

Abstract

School Feeding Programmes have substantially reduced childhood hunger and improved nutritional outcomes in many countries. This study assessed the microbiological quality of food and the safety practices of handlers under the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District. Sixty food handlers from twelve selected schools participated in the study. The microbial quality of sixty food samples was examined. Results indicated that 51.0% of food samples met acceptable microbiological standards ($\leq 10^3$ CFU/g), while 27.7% exceeded acceptable limits ($>10^5$ CFU/g), suggesting food safety concerns. *Escherichia coli* had the highest mean bacterial load (9.8×10^5 CFU/g), followed by *Staphylococcus aureus*, *Shigella* spp., and *Salmonella* spp., with statistically significant differences among food types ($p < 0.05$). Sanitation and hygiene assessments revealed several challenges, including inadequate water supply (25%), limited use of protective clothing (16.6%), and pest presence (75%). Binary logistic regression analysis showed that the presence of handwashing stations (OR = 0.57, p = 0.046), use of protective clothing (OR = 0.48, p = 0.035), and pest control (OR = 0.40, p = 0.021) significantly influenced food safety compliance. Although 96.7% of handlers demonstrated high environmental hygiene awareness, only 65.0% exhibited good food safety practices. Key barriers to safe food handling included inadequate training (80%), financial constraints (86.6%), and lack of personal protective equipment (91.6%). The findings highlight the need for strengthened training, infrastructural support, and routine monitoring to ensure food safety within the Ghana School Feeding Programme (GSFP).

Acknowledgment

I am grateful to God Almighty, for His protection and guidance while pursuing this degree and for making it possible for me to complete this thesis successfully. I sincerely wish to express my heartfelt appreciation to my supervisors, Rev. Dr. Denis Dekugmen Yar and Dr. Daniel Tetteh as well as my good friend Mr. Samuel Ofori for their assistance, guidance, close meticulous supervision, constructive scholastic criticism, moderation, and correction, which saw me through the successful completion of this thesis.

Dedication

I dedicate this work to my family, most especially my beloved parents Mr. and Mrs. Atanga and my children Bernard Anarfo Amenga-etego, Edna Anarfo Awinigora, Daniel Anarfo Amiwini and Zinaya Anarfo Adinaa for their prayers, support, advice, and encouragement throughout my education and research period. I further dedicate this work to my lovely wife Rosemary Opoku, who have immensely contributed to the success of this research piece in diverse ways.

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Ethical Approval letter

Kwame Nkrumah University of Science and Technology, Kumasi

College of Health Sciences
SCHOOL OF MEDICINE AND DENTISTRY

COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Our Ref: CHREP/AP/187/17 25th March, 2025

Mr. Daniel Atanga
Akenten Appiah-Menka University of Skills
Training and Entrepreneurial Development,
Department of Public Education.
KUMASI-GHANA.

Dear Sir,

LETTER OF APPROVAL

Protocol Title:	***" Food Microbiological Quality and Hygiene Standard Practices among Caterers under the Ghana School Feeding Program in Sekyere Afram Plains District, Ghana"***
Proposed Site:	***Sekyere Afram Plains District.***
Sponsor:	***Self-Sponsored.***
Student:	Mr. Daniel Atanga
Supervisor:	Dr. Dennis Yar

Your submission to the Committee on Human Research, Publications, and Ethics on the above-named protocol refer.

The Committee reviewed the following documents:

- A notification letter of 15th February 2025 from the Ghana Health Service, Sekyere Afram Plains District (study site) indicating approval for the conduct of the study in the District.
- A Completed CHREP Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for one year, renewable after that, from **27th March 2025 to 26th March 2026.** The Committee may, however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you for your application.

Yours faithfully,

Rev. Prof. John Appiah-Poku.
Honorary Secretary
FOR: CHAIRMAN

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Amid a global food crisis where families in many nations are struggling to put food on the table, a new report claims that governments all over the world are becoming more and more convinced that school lunches are a potent and economical approach to guarantee that disadvantaged children receive the nutrition they require (Aope, 2018). According to today's State of School-Feeding Worldwide report from the UN World Food Programmed, nearly four hundred and twenty million children (420,000,000) eat school meals globally. School lunches are a vital safety net for vulnerable children and households at a time when three hundred and forty-five million (345, 000 000) children of which one hundred and forty-five million (145,000 0000) of them are children and teenagers that face crisis levels of hunger (Acheampong, 2014). School feeding Programmes are becoming more widely acknowledged as successful social intervention measures to address malnutrition, fight hunger, and encourage regular school attendance (Lee et al., 2017). These Programmes are essential in promoting enrolment and retention in elementary schools and guaranteeing children access to wholesome meals (Ali & Immanuel, 2017).

In many countries, School Feeding Programmes have significantly reduced childhood hunger and enhanced nutritional outcomes. These Programmes lessen the burden of food insecurity for students, especially those from low-income households, by serving meals regularly (Meleko et al., 2015). Children's general health and well-being are improved, and their cognitive development and academic achievement are enhanced.

The School Feeding Programmes strongly induce parents to enrol their children regularly. A study noted that providing a daily meal motivates parents to prioritize their children's education, increasing enrolment and decreasing dropout rates (Meleko et al., 2015). This, in turn, promotes social growth and educational accomplishment in a positive loop within communities. School feeding Programmes alleviate hunger and malnutrition in the short term and have long-term positive effects on society. Nations build social stability and economic prosperity in the future by investing in the health and education of their children (Acheampong, 2014). The benefits of school meals go beyond helping specific children and instead focus on broader community development, such as increased human capital, less poverty, and enhanced nutrition.

The programme is a multimodal strategy for tackling intricate socioeconomic issues, including hunger, malnutrition, and educational inequity. It addresses students' fundamental nutritional needs and promotes educational attainment and access, fostering societies' overall growth and advancement (Garayoa et al., 2014). The Ghana School Feeding Programme (GSFP) began in 2005 and appeared to be a quick-win strategy for preventing hunger and school dropouts (Annoh, 2019). In some public schools financed by the government, this programme provides students one hot, nourishing meal daily (Owusu-Kwarteng et al., 2020). In many developing countries, School Feeding Programmes (SFP) combat short-term hunger and undernourishment of learners from impoverished communities by providing free meals in schools (Palupi et al., 2024). It is evident that in many developing countries, the vast majority of schools offering SFP meals are located in rural communities and informal settlements where most schools lack basic resources such as portable drinking water, sanitation and hygiene facilities, and a constant electricity supply (Ayim et al., 2024). The health of the children’s, as well as the safety of the food items utilized in meal preparation, and

the hygienic conditions the products go through before they reach these children's plates, should all be taken into consideration because sanitation is a major problem in many African countries (Subramaniam et al., 2023). Foodborne diseases pose a significant health threat within schools worldwide, affecting millions of students and educators each year and disrupting educational activities (Palupi et al., 2024). As educational institutions strive to provide safe and healthy environments for learning, understanding the prevalence and impact of foodborne illnesses in schools is crucial for implementing effective prevention and control measures (Ayim et al., 2024).

Across the globe, schools are primarily concerned with food safety and hygiene. These problems might range from a lack of resources and infrastructure to different degrees of adherence to food safety laws (Liguori et al., 2024). Schools are particularly vulnerable to foodborne illnesses due to improper food handling procedures, inadequate sanitation facilities, and restricted access to clean water (Alves et al., 2021). The World Health Organization (WHO) states that more than 200 diseases are transmitted by food, and the vast majority of the population will contract a foodborne disease at some point in their lifetime (Faour-Klingbeil et al., 2016). Unhygienic practices during food preparation, handling and storage create the conditions that allow the proliferation and transmission of disease-causing organisms such as bacteria, viruses and other foodborne pathogens.

Lack of awareness, insufficient training, and a poor attitude toward sanitation and hygiene are the key contributors to the development of foodborne infections (FBDs), which threaten global health (Amaiach et al., 2023). Despite significant sanitation and food safety advancements, the food supply chain contamination risk remains. Foodborne outbreaks are a possibility with major social and economic repercussions when meals prepared and served by the catering industry are involved, especially when

vulnerable consumers are implicated. World Food Safety Day, 2023, stated that unsafe food is a global concern that causes 600 million foodborne illnesses and 420,000 deaths yearly, with children under five years accounting for 30% of these fatalities (Mohammed, 2020). Similarly, the World Health Organization (WHO) also estimates that unsafe food consumption annually leads to the loss of 33 million healthy years of life worldwide, though this figure may be underestimated (Lee et al., 2017).

African schools have unique difficulties maintaining food safety and cleanliness because of several issues, including a lack of strict food safety laws, inadequate infrastructure, and scarce resources (Liguori et al., 2024). Foodborne illness risk is further increased in school environments by improper food handling procedures, poor sanitation facilities, and restricted access to clean water (Faour-Klingbeil et al., 2016). Recent sources, including data from the World Health Organization (WHO), suggest that Africa experiences an estimated 135 million cases of foodborne diseases (FBD) and 180,000 FBD-related deaths every year (Lupattelli et al., 2022). Like many other African nations, Ghana faces particular difficulties maintaining food safety and cleanliness because of several issues, including a lack of strict food safety legislation, inadequate infrastructure, and scarce resources (Annoh, 2019). The absence of basic food handling practices, poor sanitation facilities, and restricted access to clean water increase the risk of foodborne infections in school environments (Ayerakwa, 2017). To address foodborne illnesses in Ghanaian schools, a comprehensive strategy involving cooperation between public health organizations, education authorities, and local communities is needed. Some potential strategies include enforcing stringent food safety regulations in school cafeterias, regularly inspecting food handling procedures, and educating staff and students about hygiene (Acheampong, 2014).

The Sekyere Afram Plains District, situated in the north-eastern part of the Ashanti region, is grappling with severe poverty and deprivation, lacking essential social amenities, and is endemic to many neglected tropical diseases (NTDS). This challenging environment heightens the risk of foodborne disease outbreaks within its schools. Due to its status as one of the poorest districts, access to sanitation, clean water, and adequate food handling facilities is limited. Consequently, schools may face heightened vulnerability to foodborne illnesses, potentially jeopardizing the health and well-being of students. Within Sekyere Afram Plains, schoolchildren are a particularly vulnerable demographic to the threat of foodborne infections. The combination of poor sanitation practices, limited access to portable drinking water, and inadequate cooking and storage facilities increases the danger of food contamination in school settings. As a result, pupils in Sekyere Afram Plains (SAP) are more likely to contract foodborne infections, posing a substantial risk to their health and well-being.

However, the GSFP lacks a comprehensive system to verify the quality and safety of meals provided to enrolled children. This is due to the higher number of meals prepared and served to more pupils daily. The current study seeks to determine whether the district's school feeding programme meals are microbial infestation-free and safe because any outbreak can affect a higher number of children.

1.2 Problem Statement

Foodborne diseases are still a major health problem in many developing countries. Poor hygiene, unsafe food handling, and weak supervision often lead to contamination of cooked food (Abebe et al., 2020; Makinde et al., 2021). In Ghana, several studies have reported harmful bacteria such as *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus* in ready-to-eat foods. These problems are usually linked to poor sanitation, lack of clean water, and low knowledge of food safety among food handlers (Ayamah et al., 2021; Christiana Cudjoe et al., 2022; Monney et al., 2014). These issues are especially worrying for school feeding programmes, where large numbers of children depend on daily meals.

The Ghana School Feeding Programme (GSFP) aims to improve child nutrition and increase school attendance. However, ensuring the microbial safety of meals under the GSFP continues to be a challenge. Many caterers work in difficult conditions. They often face problems such as limited access to clean water, poor kitchen structures, poor waste management, and weak temperature control during cooking and storage (Adane et al., 2018; Amaiach et al., 2023). Studies in Ghana and other African countries also show that some food handlers do not have enough training in food safety, and this affects how they prepare and serve food (Gyebi et al., 2021; Lee et al., 2017).

In the Sekyere Afram Plains District, these risks may be even higher because of rural infrastructure challenges. Yet, there is very little research on the actual microbiological quality of meals served under the GSFP in this district. There is also limited information on whether GSFP caterers follow proper hygiene and safety practices. This lack of data makes it difficult for local authorities, environmental health officers, and GSFP managers to identify problems and design effective solutions. Some caterers may lack protective clothing such as gloves and aprons. Some work in kitchens with poor

ventilation, unsafe storage, or pest infestation. Irregular monitoring and the absence of routine microbiological testing make the situation more serious (Aope, 2018; Azanaw et al., 2019; Dela et al., 2023). These conditions expose schoolchildren to harmful bacteria that can cause diarrhoea, stomach pain, typhoid fever and cholera which can result to absenteeism, and poor school performance. Because of these problems, there is an urgent need to assess the microbiological quality of GSFP meals and the hygiene practices of caterers in the Sekyere Afram Plains District. Collecting this evidence will help identify the main challenges, guide the design of better food safety interventions, and ensure that the meals served to children are safe, nutritious, and free from harmful microorganisms.

1.3 Rationale/Justification

The Ghana School Feeding Programme (GSFP) aims to reduce hunger and improve the academic performance of school-age children. However, a major concern remains regarding the microbiological safety of meals prepared by caterers, as poor food handling practices can expose children to preventable health risks. This study is therefore justified for several important reasons. First, the microbiological quality of school meals has a direct impact on children's health and well-being. Unsafe food or poor hygiene practices can lead to foodborne infections, which are harmful to children because their immune systems are still developing.

Evaluating the hygiene practices of GSFP caterers is therefore critical to safeguarding the health of pupils who depend on these daily meals. Second, foodborne illnesses and poor nutrition can negatively affect children's learning ability, concentration, and school attendance. Ensuring that meals under the GSFP meet microbiological and hygiene standards supports not only child health but also educational outcomes. Safe and nutritious food strengthens children physically and enhances their overall school

performance. The long-term success of the GSFP relies on its ability to consistently deliver safe, nutritious, and hygienically prepared meals. Assessing caterers' food handling and hygiene practices helps identify existing gaps and areas needing improvement. Strengthening these areas improves the programme's effectiveness and supports its sustainability, while also providing a model that other school feeding initiatives in Ghana can follow.

Also, foodborne diseases create economic burdens for households, communities, and health systems. When children fall ill, families face treatment costs and schools experience productivity losses due to absenteeism. Promoting strong food safety practices among GSFP caterers helps prevent these avoidable costs, making food safety not only a public health priority but also a sound economic strategy. Finally, Ghana has established food safety standards to guide food preparation and protect consumers. Assessing whether GSFP caterers comply with these regulations helps maintain public trust in the programme and ensures accountability among stakeholders. Compliance also demonstrates the commitment of caterers to delivering meals that are both safe and beneficial to schoolchildren.

1.4 Research Questions

The following research questions are posed in this study.

1. What is the microbiological quality of the food served under the GSFP in the district?
2. What is the sanitation and hygiene situation in the GSFP beneficiary schools in the district?
3. What is the knowledge level of cooks or caterers on food safety in GSFP in the district?

4. What are some of the inherent barriers confronting food safety issues under the GSFP in the district?

1.5 Study Objectives

The main aim of this study was to assess the food microbiological quality and evaluate the adherence to hygiene standard practices among caterers operating under the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District.

1.4.1 Specific objectives

Specifically, this study sought to;

1. Determine the microbiological quality of food served to pupils under the Ghana School Feeding Programme (GSFP)
2. Assess the sanitation and hygienic conditions under which food is prepared and served to pupils under the GSFP
3. Determine food safety knowledge and practices among caterers or cooks in the school feeding programme.
4. Evaluate the barriers associated with food safety issues among food handlers in school feeding Programmes (GSFP).

1.6 Significance of the study

For Ghanaian children in school, the Ghana School Feeding Programme (GSFP) is a ray of hope, providing them with daily hot meals to fight hunger and boost academic performance. The GSFP, which was established in 2005, has proven critical in boosting beneficiaries' academic performance and increasing school attendance. However, this programme's effectiveness and results heavily rely on its caterers' constant provision of

healthy meals. In the Sekyere Afram Plains District of Ghana, this study explores the crucial relevance of evaluating food microbiological quality and hygiene standards practices among caterers participating in the GSFP.

1.7 Scope of the Study

This study investigated the microbiological quality of food and the hygiene practices of caterers working under the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District. It covered various stages of the food supply chain, including procurement, transportation, storage, preparation, and distribution. The research assessed caterers' adherence to hygiene standards and national food safety regulations through observations and laboratory analyses of food samples for harmful microorganisms. It also incorporated the views of school authorities, pupils, and other stakeholders to provide a clearer understanding of the situation. The study identified key challenges that caterers faced in maintaining proper hygiene and proposed practical recommendations to improve food safety practices. Ultimately, the findings were intended to guide policy decisions and enhance the overall quality and safety of the GSFP in the district and potentially beyond.

1.8 Study Limitation

This study faced several limitations. Firstly, the cross-sectional design captures only a snapshot of the conditions during the data collection period, limiting the ability to assess seasonal variations in food hygiene and microbiological quality. Secondly, reliance on self-reported practices by food handlers introduces potential social desirability bias, as respondents may have over-reported favourable behaviours. Logistical challenges, such as difficulties accessing remote schools and ensuring prompt transportation of food

samples under cold conditions, could have affected sample integrity. Despite these limitations, the study applied methodological triangulation and strict laboratory protocols to enhance the credibility and reliability of findings.

1.9 Organization of the Thesis

The thesis is organized into six chapters to provide a structured and comprehensive analysis of the research topic. Chapter One introduces the study by presenting the background, problem statement, rationale, research objectives and questions, significance, scope, and limitations. Chapter Two reviews existing literature on food microbiological quality, hygiene practices, school feeding Programmes, and theoretical frameworks relevant to food safety. Chapter Three outlines the methodology, including the study design, area, population, sampling techniques, data collection methods, microbiological testing procedures, and ethical considerations. Chapter Four presents and interprets the study findings, focusing on microbial quality of food, hygiene practices, food safety knowledge, and challenges encountered by caterers under the Ghana School Feeding Programme. Chapter Five discusses the results concerning previous studies, highlighting implications for public health and policy. Finally, Chapter Six concludes the study by summarizing the key findings and providing recommendations to improve food safety and hygiene practices among Sekyere Afram Plains District caterers.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

School Feeding Programmes (SFPs) have gained considerable prominence across developing countries as key interventions for promoting child health, education, and social protection. By providing nutritious meals to school-aged children, these Programmes aim to address malnutrition, increase school enrolment and attendance, and reduce dropout rates, particularly among vulnerable populations. In the context of food provision within schools, the safety and hygiene of food become critical public health concerns. Inadequate hygiene practices, unsanitary food preparation conditions, and contamination can compromise the intended nutritional benefits and pose serious health risks to children. Therefore, food safety and hygiene are essential to effective School Feeding Programmes.

The relationship between food safety, nutrition, and child health is well established. Unsafe food can lead to foodborne illnesses, contributing to malnutrition, absenteeism, and poor academic performance among school children. As such, safeguarding the microbiological quality of food and ensuring proper hygiene practices are imperative in enhancing the overall impact of school feeding initiatives. The Ghana School Feeding Programme (GSFP), launched in 2005, aims to improve school enrolment and attendance while enhancing domestic food production and ensuring food security. This review explores relevant literature on food microbiological quality and hygiene practices within the GSFP framework, emphasizing implications for child health and programme sustainability.

2.2. Historical Background of Ghana School Feeding Programme (GSFP)

The Ghana School Feeding Programme (GSFP) was established in 2005 as a flagship government initiative to achieve multiple social and developmental goals. This programme represents a remarkable response to the challenge of child hunger, malnutrition, and its detrimental effects on educational outcomes in Ghana (Ghana School Feeding Programme, Impact on Child Nutrition, 2022). The overarching goal of the GSFP is to enhance school attendance and performance by providing daily meals to schoolchildren, particularly those in rural and vulnerable communities (Global Delivery Initiative, 2020).

The GSFP's historical evolution has been accompanied by a growing body of research to assess its impact and effectiveness. Numerous studies have examined various aspects of the programme, including its nutritional outcomes, educational effects, and socioeconomic implications (GSFP, 2019). While the GSFP has achieved notable successes in improving school attendance and child nutrition, it has also faced challenges, particularly related to food safety and hygiene practices within the programme's implementation (Alamneh et al., 2022).

2.3 Food Safety and Hygiene Practices

This entails assessing the protocols and processes to ensure food is safely handled, stored, prepared, and served within School Feeding Programmes. Studies following established food safety criteria, such as those provided by the Ghana Food and Drugs Authority (GFDA), is critical to reducing foodborne illness risk. Effective food safety practices, such as proper handwashing, raw and cooked food separation, and appropriate cooking temperatures, are critical for reducing microbial contamination

(Meleko et al., 2015). Ensuring food safety and maintaining high standards of hygiene in school meal programmes are fundamental components of public health and safety. Providing nutritious meals to schoolchildren carries with it the responsibility of safeguarding their health and well-being through stringent food safety measures (Lee et al., 2017).

In Ghana, like many other countries, School Feeding Programmes are an integral part of the educational system, aimed at providing students with nutritious meals to support their growth and learning (Food Safety Guide for Schools, 2021). However, ensuring the safety and hygiene of food served in these programmes is paramount to preventing foodborne illnesses and promoting students' overall health.

2.4. The Significance of Food Safety and Hygiene in School Feeding

Promoting Health and Well-Being, School Feeding Programmes (SFP) are essential for many students, often serving as their primary source of nutrition. Proper food safety and hygiene practices help prevent foodborne illnesses and ensure that the meals provided are safe to consume (Adane et al., 2018). This, in turn, promotes the health and well-being of students, reducing absenteeism due to sickness. Children are particularly at risk from foodborne illnesses for several reasons. This includes children being less likely to practice good hygiene of their own accord, and their immune systems being less well developed, meaning illnesses can be more severe. Allergies can also be more common in children than in adults. It has also been proven that missed school time significantly negatively affects examination and general educational attainment outcomes (Santana et al., 2019).

2.5. Reducing Foodborne Illnesses

Unsanitary food handling and storage can lead to foodborne illnesses. Foodborne illnesses can be severe, and in some cases, they can even lead to long-term health complications. By adhering to strict food safety and hygiene standards, the risk of foodborne illnesses is minimized, protecting the students. Foodborne illnesses can be reduced by ensuring (Acheampong, 2014)

i. Rigorous Food Safety Training:

Comprehensive training Programmes for food handlers are essential to instils proper food safety practices. Kitchen staff and volunteers should undergo regular training sessions covering food handling techniques, hygiene practices, and sanitation procedures. By ensuring that personnel are well-equipped with the necessary knowledge and skills, schools can minimize the risk of foodborne contamination (Garayoa et al., 2014).

ii. Strict Adherence to Hygiene Practices:

Maintaining high personal and environmental hygiene standards is paramount in preventing foodborne illnesses. Thorough handwashing before and after handling food and regular sanitization of kitchen surfaces, utensils, and equipment should be prioritized. Enforcing strict personal hygiene standards, such as using protective gear like gloves and hairnets, further reduces the likelihood of contamination (Ali & Immanuel, 2017).

iii. Temperature Control:

Proper temperature control is critical at every stage of food handling, from storage to cooking (Annor & Baiden, 2011). Monitoring and recording the temperatures of storage facilities, refrigerators, and freezers helps ensure food is stored at safe temperatures to prevent bacterial growth. Additionally, employing food thermometers during cooking and reheating processes ensures that foods reach the appropriate internal temperatures, mitigating the risk of foodborne pathogens (Subramaniam et al., 2023: Santana et al., 2019).

iii. Hazard Analysis and Critical Control Points (HACCP):

HACCP is a systematic approach that identifies potential hazards, establishes critical control points, and implements measures to monitor and control these points throughout the food production (Amaiach et al., 2023). Implementing HACCP principles enables schools to systematically identify and address potential food safety hazards. By conducting regular assessments and developing HACCP plans tailored to School Feeding Programmes, schools can establish effective control measures at critical stages of food production. Engaging certified food safety professionals enhances the effectiveness of HACCP implementation and ensures continuous improvement in food safety practices (Dinçoğlu et al., 2025).

V. Source Verification and Quality Assurance:

Establishing partnerships with reputable suppliers and vendors is essential in maintaining the safety and quality of food ingredients. Regular food delivery vehicles and storage facility inspections help verify compliance with food safety regulations. Moreover, implementing quality assurance protocols ensures the freshness and safety

of incoming food items, thereby minimizing the risk of contamination (Palupi et al., 2024).

iv. Allergen Management:

Given the prevalence of food allergies among students, effective allergen management is imperative in school feeding Programmes. Maintaining accurate records of food ingredients and allergen information facilitates accommodation for students with specific dietary needs (Martínez-Tomé et al., 2020). Implementing procedures to prevent cross-contact between allergenic and non-allergenic foods and raising awareness among staff and students about the risks associated with food allergies promote a safer dining environment (Lee et al., 2017).

v. Regular Monitoring and Evaluation:

Continuous monitoring and evaluation of food safety practices are essential to identify areas for improvement and ensure compliance with established protocols. Regular inspections and audits of kitchen facilities, food preparation areas, and serving stations help maintain high food safety standards. Soliciting stakeholder feedback allows schools to address concerns promptly and adapt their practices to evolving needs and challenges (Mohammed, 2020).

2.6. Meeting Nutritional Goals

School Feeding Programmes are designed to provide students with balanced and nutritious meals. Ensuring food safety and hygiene helps maintain the nutritional value of these meals, ensuring that students receive the essential nutrients they need for proper growth and development (Kokkinakis & Fragkiadakis, 2017).

2.7. Quality Assurance

Quality assurance measures are intended to preserve the freshness, nutritional quality, and safety of food supplied in School Feeding Programmes (Palupi et al., 2024). According to the literature implementing rigorous quality control measures, such as routine inspections of food supply and adhering to expiration dates, is crucial for guaranteeing food quality. Furthermore, monitoring food storage facility temperatures and doing frequent microbiological tests can aid in the identification and mitigation of potential dangers (Makinde et al., 2021). Parents and guardians entrust the school system with the responsibility of feeding their children. When schools uphold high food safety and hygiene standards, it builds trust and confidence in the meal programmes, encouraging more students to participate (Nkosi & Tabit, 2021). The safety of school meals can be ensured by employing the following strategies;

i. Training and Education

School staff, including cooks and cafeteria workers, should receive training on food safety and hygiene practices (Adane et al., 2018). This training should cover topics such as proper handwashing, safe food storage, and the prevention of cross-contamination.

ii. Regular Inspection and Monitoring

The Ghana Education Service and relevant health authorities conduct regular inspections of school kitchens and cafeterias to ensure compliance with food safety standards (Wafula et al., 2022). Monitoring and enforcing hygiene regulations are essential for maintaining high standards.

iii. Safe Food Handling

Cooks and food handling personnel must follow best practices for food handling, including cooking food to the right temperature, proper storage, and avoiding the use of expired ingredients (Liguori et al., 2024).

iv. Hygienic Infrastructure

Schools should provide appropriate infrastructure for food preparation, storage, and serving. This includes clean and well-maintained kitchen facilities and equipment (Ofoedu et al., 2021). Adequate ventilation systems are essential for maintaining air quality and reducing the danger of cross-contamination. Furthermore, efficient waste management methods should be implemented to dispose of food waste and other materials in a sanitary manner, limiting the possibility of pests and odours (Abebe et al., 2020).

v. Global and National Food Safety Regulations

Regulatory oversight and enforcement methods are critical for ensuring compliance with established standards. Resource constraints, inadequate training, and a lack of awareness among food handlers can hinder practical enforcement efforts (Madoroba et al., 2021). Internationally and nationally, governments and organizations have established comprehensive regulations and standards to guide food safety practices within various contexts, including school meal programmes (Sosah & Donkor, 2025). These regulations emphasize the importance of ensuring that food is free from contaminants and pathogens that may pose health risks to consumers (Fung et al., 2018).

2.8. Microbial Contamination

This characteristic aims to identify the kinds of bacteria present in Ghanaian school meals and the possible health hazards they pose (Petruzzelli et al., 2018). Relevant literature suggests that viruses like *norovirus*, fungi like *Aspergillus spp*., and bacteria like *Salmonella* and *Escherichia coli* are among the most common microbiological pollutants encountered in such situations. Research shows these pollutants frequently come from poor food handling techniques, tainted water sources, or insufficient sanitation protocols (Sagoo et al., 2003).

i. Escherichia coli (E. coli)

Escherichia coli (*E. coli*) is a bacterium commonly found in the gut of humans and warm-blooded animals (Garayoa et al., 2014). Most strains of *E. coli* are harmless. Some strains, however, such as Shiga toxin-producing *E. coli* (STEC), can cause severe foodborne disease. It is transmitted to humans primarily through consuming contaminated foods, such as raw or undercooked ground meat products, raw milk, and contaminated raw vegetables and sprouts (Kapeleka et al., 2020). *E. coli* is a standard indicator of faecal contamination and can cause foodborne illnesses. Testing for *E. coli* can provide insights into the safety of food items (Balali et al., 2020).

ii. Salmonella

Salmonella is a group of bacteria that can cause gastrointestinal illness and fever, called salmonellosis. *Salmonella* can be spread by food handlers who do not wash their hands and/or the surfaces and tools they use between food preparation steps, and when people eat raw or undercooked foods (Aope, 2018). *Salmonella* can also spread from animals to people. People with direct contact with certain animals, including poultry and reptiles, can spread the bacteria from the animals to food if they do not practice proper

hand-washing hygiene before handling food. Pets can also spread the bacteria within the home environment if they eat food contaminated with *Salmonella*. *Salmonella* is a pathogenic bacterium commonly associated with foodborne illnesses. Testing for *Salmonella* can identify potential contamination and assess food safety (Garayoa et al., 2014).

iii. ***Listeria***

Listeria monocytogenes (*L. monocytogenes*) is a species of pathogenic (disease-causing) bacteria that can be found in moist environments, soil, water, decaying vegetation and animals, and can survive and even grow under refrigeration and other food preservation measures (Legnani et al., 2004). When people eat food contaminated with *L. monocytogenes*, they may develop listeriosis. *Listeria monocytogenes* is linked to raw, unpasteurized milk and cheeses, ice cream, raw or processed vegetables, raw or processed fruits, raw or undercooked poultry, sausages, hot dogs, deli meats, and raw or smoked fish and other seafood. Testing for Listeria helps evaluate the presence of harmful microorganisms (Ayerakwa, 2017).

iv. Staphylococcus aureus

Staphylococcus food poisoning is a gastrointestinal illness caused by eating foods contaminated with toxins produced by *Staphylococcus aureus* (*S. aureus*). *S. aureus* is a common foodborne pathogen (Kokkinakis & Fragkiadakis, 2007). People who carry *Staphylococcus* can contaminate food if they do not wash their hands before touching it. If food is contaminated with Staphylococcus, the bacteria can multiply in the food and produce toxins that can make people ill (Lupattelli et al., 2022). *Staphylococcus* bacteria are killed by cooking, but the toxins are not destroyed and can still cause

illness. Foods not cooked after handling, such as sliced meats, puddings, pastries, and sandwiches, are hazardous if contaminated with *Staphylococcus*. Food contaminated with *Staphylococcus* toxin may not smell foul or look spoiled. Testing for *S. aureus* helps assess the safety of food items, particularly those that are temperature-sensitive (Santana et al., 2019).

v. ***Bacillus***

Bacillus cereus (*B. cereus*) is a facultatively anaerobic, toxin-producing Gram-positive bacterium found in soil, vegetation, and food. It commonly causes intestinal illnesses with nausea, vomiting, and diarrhoea (Abebe et al., 2020). *B. cereus* is an aerobic spore-forming bacterium widely distributed in the environment and foods such as rice, meat, and vegetables (Makinde et al., 2020). Food poisoning usually occurs when food is inadequately refrigerated after cooking, allowing *B. cereus* populations to reach $>10^6$ cells/g (Petruzzelli et al., 2018). Outbreaks have been linked to rice dishes, custards, soups, and vegetables (Faour-Klingbeil et al., 2016). The spores of *Bacillus* spp. are resistant to heat, desiccation, and chemicals, allowing survival during food processing (Jeinie et al., 2015). Proper cooking, reheating, and food storage are essential in preventing contamination (Ali & Immanuel, 2017).

vi. ***Proteus spp.***

Proteus species are Gram-negative, non-spore-forming rods belonging to the family *Enterobacteriaceae* (Adigun et al., 2021). They are common in soil, water, plants, and animal faeces and are frequent contaminants of meats and seafood (Ofoedu et al., 2021). *Proteus mirabilis* and *P. vulgaris* are the most prevalent species associated with food spoilage and infections (Makinde et al., 2021). At 17–22 °C,

Proteus can dominate as a spoiler in crustacean meats and eggs (Balali et al., 2020). The bacterium forms biofilms on food processing surfaces, making it difficult to remove without effective cleaning (Alves et al., 2021). Proper sanitation and maintaining low storage temperatures are key to preventing its proliferation (Nkosi & Tabit, 2021).

vi. Enterococci

Enterococcus species are Gram-positive, catalase-negative cocci occurring singly or in chains and are widely distributed in the environment, particularly in the gastrointestinal tracts of humans and animals (Azanaw et al., 2019). *E. faecalis* and *E. faecium* are of food safety concern due to their heat resistance and ability to survive pasteurization temperatures (Adane et al., 2018). They are used as indicators of process hygiene and food quality, especially in salted and fermented foods *(Jevšnik & Raspor, 2021).* Their persistence in food-processing environments highlights the need for strict sanitation practices to minimize contamination (Legnani et al., 2004).

ix. ***Pseudomonas spp.***

Pseudomonas species are aerobic, motile, Gram-negative bacteria widely found in soil, water, plants, and animals (Owusu-Kwarteng et al., 2020). They are major contributors to food spoilage, particularly in refrigerated foods such as meat, milk, and seafood (Madoroba et al., 2021). Although most *Pseudomonas* strains are non-pathogenic and even beneficial for biodegradation processes (Wafula et al., 2022), *P. aeruginosa* is a well-known opportunistic pathogen that can cause infections in immunocompromised individuals (Ahmad et al., 2021). Preventing *Pseudomonas* contamination requires maintaining low storage temperatures and regular disinfection of processing environments (Dinçoğlu et al., 2025).

x. ***Vibrio***

Vibrio species are Gram-negative, rod-shaped bacteria commonly associated with marine environments and seafood (Teklemariam et al., 2023). They pose major public health risks, especially when seafood is eaten raw or undercooked (Ovuru et al., 2024). Contact with contaminated seafood or fluids can also cause infection through open wounds (Christiana Cudjoe et al., 2022). Regular monitoring of seafood for *Vibrio* contamination and adherence to proper cooking and handling practices are critical to preventing outbreaks (Thwala et al., 2021).

2.9. Food Microbiological Assessment

Microbiological analysis of food products uses biological, biochemical, molecular or chemical methods to detect, identify or enumerate microorganisms in a material (e.g., food, drink, environmental or clinical sample). It is often applied to disease-causing and spoilage microorganisms (Microbiological Analysis and Testing at Campden BRI, 2022).

Central to food safety is the microbiological quality of the food served. In food, harmful microorganisms, such as bacteria, fungi, and pathogens, can lead to foodborne illnesses with potentially severe consequences. Within school meal Programmes, assessing the microbiological quality of food is critical to prevent outbreaks of foodborne diseases and ensure schoolchildren's well-being .The microbiological assessment in this study covered two main aspects: microbiological quality and safety indicators (Meleko et al., 2015).

i. Determination of microbiological quality:

This strategic test determines the total viable microbial count of the food sample. It involves assessing the presence, types, and levels of microorganisms in the food. This is crucial for ensuring food safety and shelf-life stability and determining specific details about the food's microbial quality (Annor & Baiden, 2011). Determination of safety indicators involves assessing various factors to ensure that food is free from hazards and risks that could harm consumers. This test involves food analysis and testing samples for various pathogens found in foods, including *Enterobacteria*, *Enterococci*, coliforms, *E. coli*, and *Pseudomonas* spp. *Clostridia*, *Salmonella*, *Bacillus spp*, *Staphylococcus*, lactic acid bacteria, *Listeria*, and *Proteus spp* (Martínez-Tomé et al., 2020).

ii. Total Viable Plate Count (TVPC)

Total Viable Plate Count (TVPC) is a microbiological method used to assess the total number of viable bacteria in a food sample (Muriuki, 2020). This method involves counting all the colonies that develop on a culture medium under specific incubation conditions, typically at 30-37°C for 24-48 hours (Osafo et al., 2022). The colonies that form represent individual bacterial cells in the sample. The TVPC is expressed as colony-forming units per gram *(CFU/g)* or per millilitre *(CFU/mL)* of the food sample (Adesiyun et al., 2020). It provides an overall indication of the microbial load in the food product, reflecting both desirable microorganisms (lactic acid bacteria in fermented foods) and potentially harmful bacteria (Balali et al., 2020). While the TVPC is a helpful indicator of food hygiene and quality, it does not provide information about the specific types of bacteria present or their pathogenicity. Therefore, it is often

combined with other microbiological tests to assess food safety comprehensively (Makinde et al., 2020).

iii. Coliform Count

The coliform count is a hygienic indicator, and a high coliform count generally indicates unsanitary conditions or poor hygiene practices during or after food production (Owusu-Kwarteng et al., 2020). Testing for total coliform is not intended to detect faecal contamination, but rather to reflect general hygiene during food production or handling and the quality of the measures used to minimize bacterial contamination. Coliforms do not necessarily mean that pathogens are present, but their detection in food indicates a risk of foodborne illness. The level of coliforms only reflects the general hygienic conditions during food production or handling. This test helps assess the sanitation and hygiene practices in food preparation (Sosah & Donkor, 2025).

iv. Aerobic Plate Count (APC)

The Aerobic Plate Count (APC) estimates viable microorganisms in test samples or products. Test results determine the number of aerobic mesophilic bacteria. It is primarily used to check the microbiological quality of test samples to avoid public health concerns caused by microbial contamination (Thwala et al., 2021). The test results indicate the major hygiene issues, quality of raw material, storage conditions, and shelf life of the product or anticipated changes due to enzyme degradation. APC is a general microbial test that measures the total count of aerobic bacteria in a sample. It provides insights into the overall microbiological quality of food (Kaptchouang Tchatchouang et al., 2020).

v. Foodborne Pathogen PCR Testing

A real-time PCR test duplicates and analyses specific DNA sequences. In food analysis, PCR tests are used in many applications, e.g., for the detection of pathogenic microorganisms, for allergen identification, for the detection of genetically modified organisms (GMO) or the identification of animal species (Sosah & Donkor, 2025). PCR tests offer many advantages: They are particular, sensitive, robust, rapid, reliable, and can be automated. Polymerase Chain Reaction (PCR) testing can be used to detect specific foodborne pathogens like *Campylobacter*, *Clostridium perfringens*, and others (Adigun et al., 2021).

2.9.2. Hygiene Standard Practices

To guarantee food safety, hygiene standards must be strictly adhered to in food handling, preparation, and storage (Nkosi & Mwanza, 2022). These standards encompass handwashing, equipment sanitation, temperature control, and safe food storage (Makinde et al., 2021). Caterers and food handlers within school meal programmes are expected to be well-versed in and compliant with these standards to ensure the safety of the meals they provide (Madoroba et al., 2021). According to (Ofoedu et al., 2021), as compliance with hygiene practices among caterers can vary widely, leading to potential food safety risks.

2.9.3. Challenges and Barriers to Ensuring Food Safety in School Feeding Programmes

Despite the importance of food safety and hygiene within school meal programmes, several challenges and barriers can impede their effective implementation. Understanding these challenges is crucial for devising strategies to enhance food safety practices in such programmes (Curwood et al., 2017). These challenges include funding constraints, inadequate infrastructure and equipment, limited access to local food items, sustainability issues, monitoring and evaluation, and nutritional value of meals.

i. Socioeconomic Factors

One significant challenge is the influence of socioeconomic factors on food safety within school meal programmes. Vulnerable communities and schools with limited resources may face difficulties procuring safe ingredients, maintaining proper kitchen infrastructure, and providing adequate training to caterers (Lee et al., 2017). Research has shown that schools play an integral role in shaping children's dietary behaviours. Socioeconomic disparities can lead to variations in food safety practices and potentially compromise the quality of meals served (Bardin et al, 2020).

ii. Lack of Awareness and training

Another barrier to food safety in school meal programmes is the lack of awareness and training among caterers and food handlers. Many individuals engaged in meal preparation may not have received formal training in food safety practices (Jevšnik & Raspor, 2021). This knowledge gap can result in suboptimal handling, cooking, and food storage, increasing the risk of contamination (Whitworth, 2021).

iii. Resource Constraints

Several factors, like poor food handling and sanitation practices, inadequate food safety training, weak regulatory systems, a lack of financial resources, low educational status, and a lack of knowledge, have been identified as affecting food safety in school meal Programmes (Azanaw et al., 2019). Resource constraints, including limited access to clean water, kitchen space, appropriate cooking equipment, refrigeration and storage facilities, can pose significant challenges to maintaining food safety standards in school meal Programmes. Inadequate resources may hinder caterers' adherence to recommended food safety practices.

iv. Inadequate Regulatory Oversight

Effective regulatory oversight is essential for ensuring food safety within school meal programmes. However, regulatory enforcement and monitoring shortcomings can compromise the effectiveness of food safety measures. Sometimes, a lack of stringent enforcement may lead to non-compliance with food safety regulations. Inadequate regulatory oversight can lead to various issues, including mismanagement of funds, corruption, and the provision of substandard meals to students.

The government and relevant authorities must address these issues to ensure the programme's effectiveness and the well-being of the students they serve. This may involve implementing stricter regulations, improving transparency, and conducting regular audits to prevent misuse of resources and ensure that students receive nutritious meals (Lawson-Lartego & Cohen, 2020). The challenge facing school food service directors is maintaining food safety standards and safe produce handling required to

support student well-being, and managing the operational objectives both fiscally and from a human resources perspective (Curwood et al., 2017).

v. Cultural and Traditional Practices

Cultural and traditional food preparation and handling practices can also impact food safety in School Feeding Programmes. Caterers may follow customary practices that do not align with modern food safety guidelines (Adom, 2018). Balancing cultural preferences with food safety requirements can be a delicate challenge. Understanding these challenges and barriers is essential for identifying areas where interventions are needed to improve food safety practices within School Feeding Programmes. Addressing these challenges is critical not only for the health and well-being of schoolchildren but also for the success and sustainability of such programmes.

2.9.4. Theoretical Framework and Models for Assessing Food Safety

This study presents conceptual models explaining the food hygiene and safety practices culinary students undergo during the culinary internship (Jeinie et al., 2015). Theoretical frameworks and models are pivotal in understanding, assessing, and improving food safety practices within complex systems like the Ghana School Feeding Programme (GSFP). These frameworks provide structured approaches for analysing factors contributing to food safety, such as food handling and sanitation practices, food safety training and education, regulatory systems and financial resources, food systems, Sociocultural and ecological factors and designing interventions to mitigate risks. When assessing food safety in schools, various theoretical frameworks and models can

be applied to ensure a comprehensive evaluation of the food service operations. Here are some theoretical frameworks and models commonly used for assessing food safety in school settings:

i. **Health Belief Model (HBM)**

The Health Belief Model (HBM) is a psychological framework often used to understand and influence health-related behaviours. It posits that individuals' decisions regarding health practices are influenced by their perceived susceptibility to health threats, their perceived severity of health threats, their perceived benefits of taking preventive actions, and their perceived barriers to taking those actions (Wang et al., 2021). Within the GSFP, the HBM can be applied to assess caterers' perceptions of food safety risks and the factors influencing their adherence to food safety practices.

ii. Social Cognitive Theory (SCT)

The Social Cognitive Theory (SCT) emphasizes the role of social influences, observational learning, and self-efficacy in shaping behaviour. Within the context of food safety in school meal Programmes, SCT can be employed to examine how caterers' behaviours are influenced by their social environment, including interactions with colleagues and supervisors (Gordillo & Prescott, 2023). In the context of food safety in schools, SCT can be used to examine how social norms, peer influence, and role-modelling by teachers and cafeteria staff influence students' and staff's food safety practices.

iii. **Trans-Theoretical Model (TTM)**

The Trans-Theoretical Model (TTM) is another valuable framework for assessing food safety practices. It describes stages of behaviour change, including pre-contemplation, contemplation, preparation, action, and maintenance. The transtheoretical model (TTM) describes change not as an individual event but as a series of steps that occur according to a person's motivation (Meleko et al., 2015). The four constructs of TTM are the stages of change, the processes of change, self-efficacy, and decisional balance (Nakabayashi et al., 2020). Understanding where caterers and food handlers fall within these stages can inform interventions to promote food safety awareness and compliance. These theoretical frameworks provide valuable lenses through which to analyse and improve food safety practices within the GSFP. They offer structured approaches to understanding the complex interplay of factors that influence food safety and can guide the development of effective interventions (Ahmad et al., 2021).

iv. Plan-Do-Check-Act (PDCA) Cycle:

The PDCA cycle is a continuous improvement framework that involves planning, implementing, monitoring, and adjusting processes to achieve desired outcomes. In schools' food safety context, the PDCA cycle can systematically assess and improve food safety practices through iterative observation, evaluation, and adjustment (Ofoedu et al., 2021). The PDCA cycle is iterative, meaning that once the fourth step (Act) is completed, the cycle begins again with the planning phase. Through repeated planning, implementation, monitoring, and adjustment cycles, schools can continuously improve their processes, products, and outcomes (Adesiyun et al., 2020; Aworh, 2021).

v. Systems Theory:

Systems theory examines how components within a system interact to achieve a desired outcome (Kapeleka et al., 2020). In the context of food safety in schools, systems theory can be applied to assess the interconnectedness of various factors influencing food safety practices. Systems theory, applied to food safety in schools, is an approach that views the school food system as a complex, interconnected network of various components and processes. It emphasizes understanding the interactions and relationships between these components to improve food safety outcomes.

In the context of food safety in schools, system theory would involve analysing the individual elements of the food system (such as food preparation, storage, and distribution) and the broader context in which these elements operate (Muriuki, 2020). This could include government regulations, school policies, staff training, student behaviour, and community involvement. By applying systems theory to food safety in schools, stakeholders can identify potential points of failure or contamination within the system and implement targeted interventions to address them (Christiana Cudjoe et al., 2022). This holistic approach recognizes that improving food safety requires considering the entire system rather than focusing solely on individual components or processes (Wafula et al., 2022).

2.10 Conceptual Framework

This study is guided by a conceptual framework that integrates several theories to explain the factors influencing the microbiological quality of food served under the Ghana School Feeding Programme (GSFP). The framework draws on established public health and behavioural models such as the Health Belief Model (HBM), the Social Cognitive Theory (SCT), Systems Theory, and the Plan-Do-Check-Act (PDCA) cycle. Together, these models provide a comprehensive understanding of how knowledge, environment, resources, and behaviour interact to determine food safety

outcomes. The framework emphasizes that food safety and quality depend on three interrelated domains: hygiene practices, environmental conditions, and human factors. Hygiene practices include proper handwashing, the use of clean utensils, wearing gloves and aprons, and maintaining personal cleanliness among food handlers. These measures are vital for preventing microbial contamination and ensuring the safety of meals served to children (Adane et al., 2018; Lee et al., 2017). Environmental factors such as kitchen sanitation, waste disposal, and access to clean water are equally critical in controlling contamination pathways and reducing the transmission of foodborne pathogens (Monney et al., 2014; Amaiach et al., 2023).

Human factors include the caterers' knowledge, attitudes, and motivation to adhere to food safety standards. Training, supervision, and resource availability directly influence these behaviours (Gyebi et al., 2021; Annoh, 2019). Barriers such as inadequate facilities, limited access to protective clothing, and lack of regular monitoring often reduce compliance even when handlers are aware of proper hygiene protocols (Aope, 2018; Abebe et al., 2020).

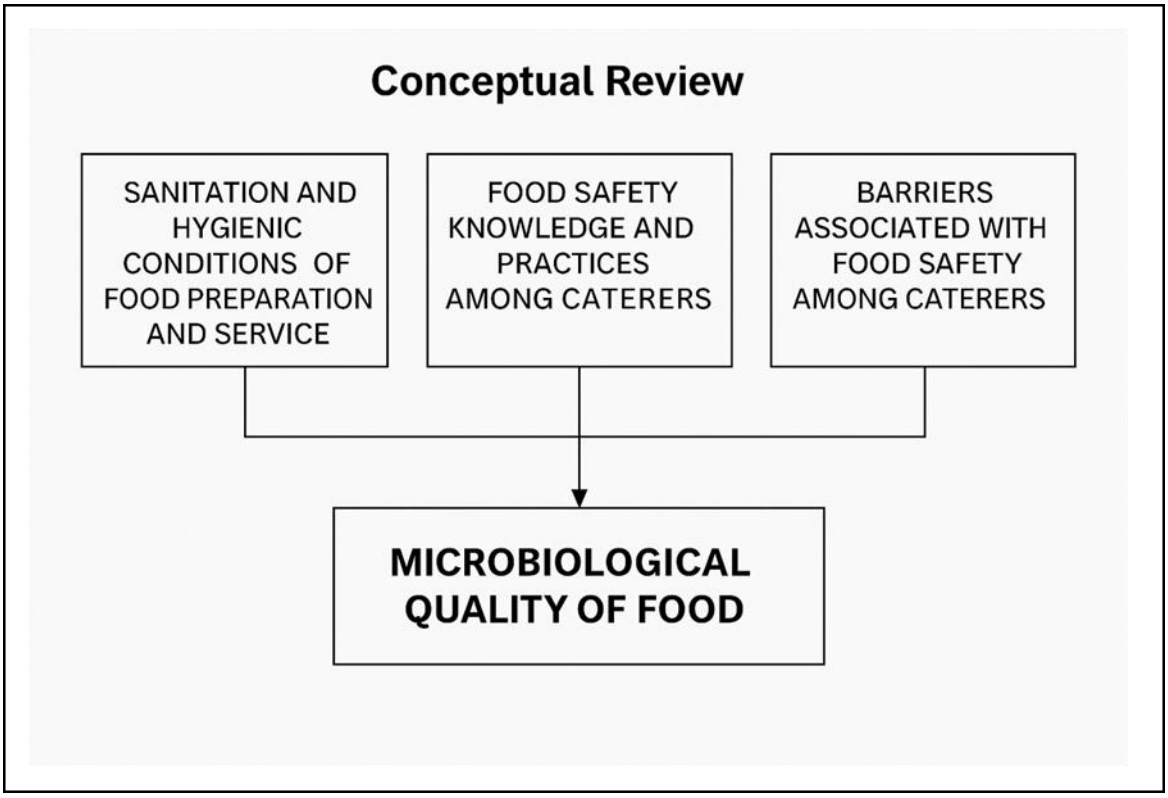

Figure 2 1: Conceptual Framework, Source: Author Constructed, 2025

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Introduction

This chapter outlines the methodological approach adopted to assess the microbiological quality of food and evaluate hygiene practices among caterers under

the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District. It describes the research design, study area, population, sample size, sampling technique, data collection methods, tools and instruments, data analysis techniques, and ethical considerations.

3.2. Study Design

A descriptive cross-sectional research design was employed to assess the current state of food safety, hygiene practices, and microbiological quality of meals served under the GSFP. Quantitative data collection techniques enriched the findings and ensured comprehensive analysis.

3.3 Study Area

The Sekyere Afram Plains District is one of the 261 Metropolitan, Municipal and District Assemblies (MMDAs) in Ghana. It forms part of the 43 MMDAs in the Ashanti Region and has its administrative capital as Drobonso. The Sekyere Afram Plains District Assembly was established in March 2012 through Legislative Instrument (LI) 2114 and was inaugurated on 28th June 2012. The district is located in the Northeastern part of the Ashanti Region between latitudes 00 20’ N and 102’ N and longitudes 60 52’ W and 70 32’ W. The Sekyere Afram Plains District in Ghana is the study site for investigating. School kitchens, food storage facilities and WASH facilities were the principal study sites for the study. To thoroughly investigate the GSFP's operations in the district, the study investigates these sites to evaluate food safety and hygiene methods, ingredient quality, and overall standards within the programme.

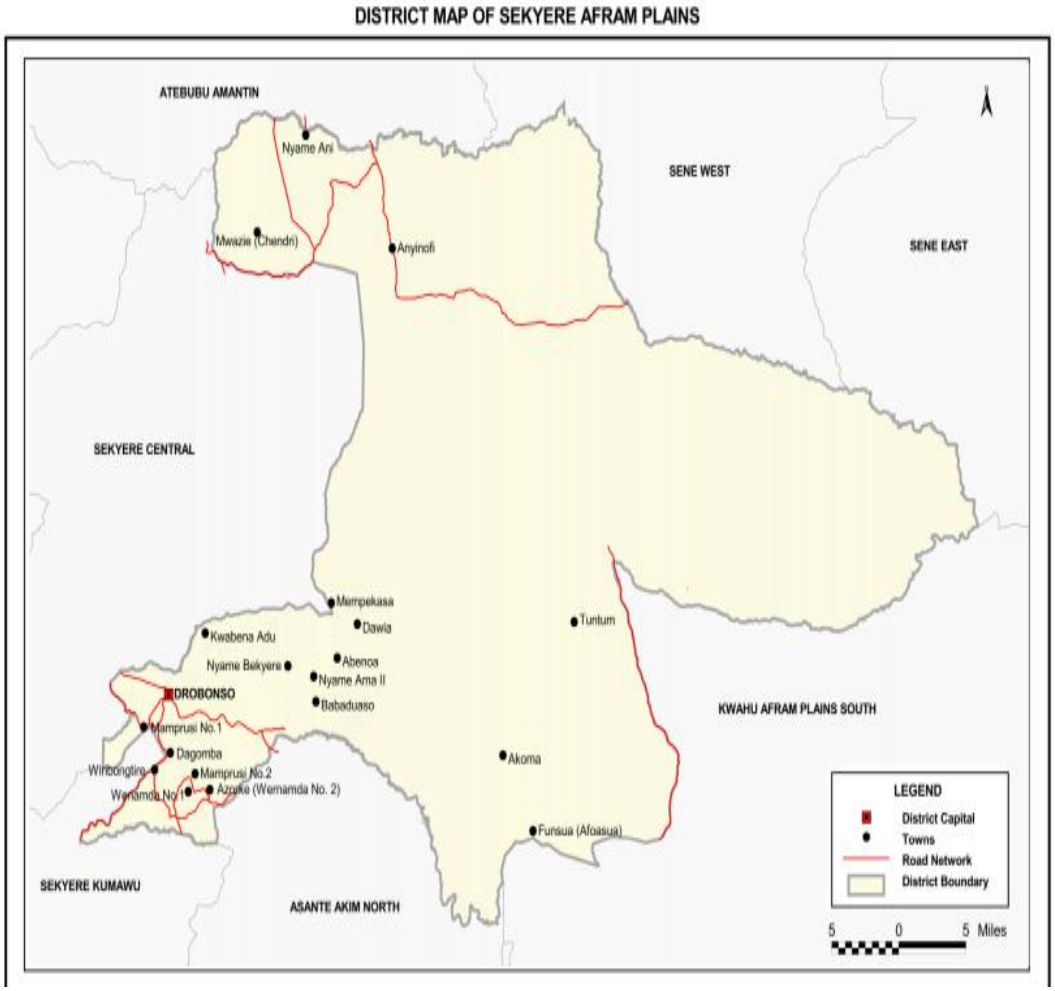

Figure 3.1 Map of Sekyere Afram Plans, Source: Ghana Statistical, Service (2021)

3.4 Target Population

The target population comprised all schools benefiting from the GSFP in the Sekyere Afram Plains District, including headteachers, caterers, food handlers involved in meal preparation and service, and school-based health education programme coordinators (SHEP).

3.5 Sample Size and Sampling Technique

The study employed a census sampling technique to include all 12 public basic schools in the Sekyere Afram Plains District participating in the Ghana School Feeding

Programme (GSFP). This ensured that every school benefiting from the programme was represented in the study. From each of the 12 schools, simple random sampling was used to select five food handlers, including caterers and kitchen assistants, who were actively involved in preparing and serving meals. This method provided an equal chance for each food handler to be selected, reducing selection bias. In total, 60 food handlers (5 from each school × 12 schools) were selected to participate in the survey and observation components (Table 3.1). Additionally, each selected food handler collected one cooked food sample, resulting in 60 food samples for microbiological analysis.

3.6 Data Collection Methods and Instruments

3.6.1 Structured Questionnaire

A structured questionnaire was developed based on the socio-demographic characteristics of caterers and food handlers to assess knowledge, attitudes, and practices related to food hygiene and safety. The questionnaire covered personal hygiene, food storage practices, cooking procedures, cleaning routines, and awareness of foodborne diseases.

Table 3.1: Number of Respondent Selected from GSFP Beneficiary Schools in Sekyere Afram Plains

S/Ns	Name of School	No. of Food Handlers	No. of School-Based SHEPs	No. of Head Teachers	Total
1	Seneso D/A primary	3	1	1	5
2	Adonso St' George's R/C primary	3	1	1	5
3	Abura D/A primary	3	1	1	5
4	Anyinofi SDA Primary	3	1	1	5
5	Apapasu/Saabum D/A primary	3	1	1	5
6	Drobonso Martyrs of Uganda R/C Basic	3	1	1	5
7	Saabrewa D/A primary	3	1	1	5
8	Offe D/A primary	3	1	1	5
9	Hamidu D/A Primary	3	1	1	5
10	Funsua D/A Basic	3	1	1	5
11	Akoma D/A Basic	3	1	1	5
12	Drobonso Presbyterian primary	3	1	1	5
	TOTAL	36	12	12	60

Source: Field Survey, 2025

3.6.2 Observation Checklist

A checklist was also developed and used to document hygiene practices and environmental sanitation during meal preparation and serving. Observations focused on the cleanliness of cooking areas, the use of protective clothing, handwashing behaviour, utensil hygiene, waste disposal methods, and general food handling procedures.

Figure 3.2: Kitchen and Sample Section

3.6.3 Key Informant Interviews

An interview guide was also developed to assess the headteachers and environmental health officers and gather contextual information about programme oversight and implementation. These interviews explored administrative roles, monitoring routines, training Programmes, and institutional challenges enforcing hygiene standards.

3.7 Microbiological Testing

3.7.1 Food Sample Collection

Food samples were collected from 12 GSFP beneficiary schools across the district. Five commonly served meals, Rice, Banku, Kenkey, Waakye, and Jollof, were selected for testing due to their frequency in school menus and diverse preparation methods. A total of 60 food samples were collected, five per school (12 schools × 5 food items). Samples were collected at the point of serving using sterile stainless-steel spoons and containers. Each sample was labelled with the school ID, food type, date, and time of collection.

3.7.2 Sample Transportation

All collected samples were immediately placed in ice-cooled boxes maintained at 4°C to preserve integrity and inhibit microbial proliferation. Within 4 hours of collection, samples were transported to the Akenten Appiah Menka University of Skills Training and Entrepreneurial Development laboratory for analysis.

3.7.3 Laboratory Procedures:

3.7.3.1 *Escherichia coli*

Each food sample (25g) was homogenized in 225 ml of Buffered Peptone Water (BPW), serially diluted, and 0.1 ml inoculated onto MacConkey agar plates. Plates were incubated at 37°C for 24 hours. Colonies exhibiting pink coloration (indicating lactose

fermentation) were further tested using IMViC biochemical tests (Indole, Methyl Red, Voges-Proskauer, and Citrate) for confirmation (Gyebi et al., 2021).

3.7.3.2 *Salmonella spp.*

Identified using Xylose Lysine Deoxycholate (XLD) agar (HiMedia, batch no M031, India). Samples were pre-enriched in BPW for 24 hours, selectively enriched in Rappaport-Vassiliadis broth, and streaked onto XLD plates. Plates were incubated at 37°C for 24 hours. Typical colonies (red with black centres) were sub-cultured on Triple Sugar Iron (TSI) slants (HiMedia, batch no M021) and confirmed via serological tests using polyvalent O and H antisera (Difco Laboratories) (Gyebi et al., 2021).

3.7.3.3 *Staphylococcus aureus*

Cultured using Baird-Parker agar (Oxoid, batch no CM0275) supplemented with egg yolk tellurite. Samples were surface-plated and incubated at 37°C for 24–48 hours. Black shiny colonies with clear zones were tested using catalase, coagulase slide, and tube tests (Oxoid diagnostics kit). Positive isolates were recorded as *Staphylococcus aureus* (Gyebi et al., 2021).

3.7.3.4 *Shigella* spp.

Isolated using XLD agar (same as above). After pre-enrichment in Gram-Negative Broth (GN broth, batch no CM0213, Oxoid), samples were streaked onto XLD and incubated at 37°C for 24 hours. Pale colonies were selected and subjected to biochemical profiling, including motility, urease, and TSI reactions. Results were interpreted using guidelines and acceptable limits established by the Ghana Standards Authority (GSA) and the World Health Organization (WHO) for ready-to-eat meals (Gyebi et al., 2021).

Figure 3.3: Laboratory Section

3.8 Data Analysis

Quantitative data from questionnaires and microbiological testing were entered into SPSS (Statistical Package for the Social Sciences) version 26 for descriptive and inferential analysis. Frequencies, percentages, means, and standard deviations were computed. Cross-tabulations and chi-square tests were conducted to examine associations between variables.

3.9 Validity and Reliability

To ensure validity, public health and food safety experts reviewed the questionnaire and checklists. A pilot study was conducted in two non-participating schools in Sekyere Central in the Ashanti Region to refine the tools. Reliability was ensured through consistent training of data collectors and standardized procedures for microbiological sample collection and testing.

3.10 Ethical Considerations

Ethical clearance was obtained from Committee on Human Research, Publication and Ethics in Kwame Nkrumah University of Science and Technology (CHRPE/AP/187/17). Before data collection, informed consent was secured from all participants. Participation was voluntary, and confidentiality of information was assured. Data were anonymized, and participants were informed of their right to withdraw at any stage without penalty.

3.11 Limitations of the Study

Potential limitations included challenges in accessing remote schools, reliance on self-reported data, which may introduce bias, and logistical constraints in transporting samples for laboratory testing. Measures were taken to mitigate these limitations, including using cool boxes for sample transport and the triangulation of data sources.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

Chapter Four presents and discusses the study's findings on food microbiological quality and hygiene practices among Ghana School Programme (GSFP) caterers in Sekyere Afram Plains District. The results address key objectives, including food safety levels, hygiene conditions, caterers' knowledge and practices, and barriers to food safety. Data were collected through laboratory analysis, questionnaires, observations, and interviews and discussed using quantitative and qualitative approaches.

4.2 Demographic Characteristics

Table 4.1 shows that of the 60 food handlers from 12 selected schools, 46.6% were between 46 and 55 years old, while 26.6% were between 36 and 45 years old. The majority (63.3%) were married, and 20.0% were single; 10.0% had J.H.S. education, while 68.3% had no formal education. The majority of the respondents (46.6%) were Christians, while 41.6% were Muslims; 8.3% had worked with the Ghana School Feeding Programme (GSFP) for less than 5 years, while 73.3% had been in the programme for 1–5 years; 18.3% of food handlers had worked for 6–10 years, under Ghana School Feeding Programme (GSFP).

Table 4.1: Demographic Characteristics of Respondents

Demographic Characteristics	Frequency (n=60)	Percentage (%)
Age Group (years)		
18 – 25	3	5.0
26 – 35	8	13.3
36 – 45	16	26.6
46 – 55	28	46.6
56 and above	5	8.3
Marital Status		
Married	38	63.3
Single	12	20.0
Divorced	3	5.0
Widowed	7	11.6
Level of Education		
Non-formal	41	68.3
Primary	13	21.6
Junior High School	6	10.0
Religion		
Christian	28	46.6
Muslim	25	41.6
Traditional/Spiritualist	5	8.3
No Religion	2	3.3
Duration of School's Participation in GSFP		
1 - 5 years	18	30.0
More than 5 years	42	70.0
Years of Experience as a Food Handler		
Less than 1 year	5	8.3
1 - 5 years	44	73.3
6 - 10 years	11	18.3
11 - 15 years	-	-
16 years and above	-	-

Source: (**Field survey, 2025)**

4.3 Microbial Quality of School Meals

Table 4.2 and Figure 4.1 indicate that 51.0% of the food sampled had Acceptable Quality ($\leq 10^3$ CFU/g), 21.3% had Tolerable Quality range ($10^3 – 10^5$ CFU/g), whereas 27.7% of the food samples had Unacceptable Quality ($>10^5$ CFU/g), signifying potential food safety risks.

Table 4.2: Aerobic Colony Count (ACC) Classification of School Meals

ACC Classification	Range (CFU/g)	No. of Samples (n=60)	Percentage (%)
Acceptable Quality	$\leq 10^3$	31	51
Tolerable Quality	$10^3 - 10^5$	13	21.3
Unacceptable Quality	$>10^5$	16	27.7

(Field survey, 2025)

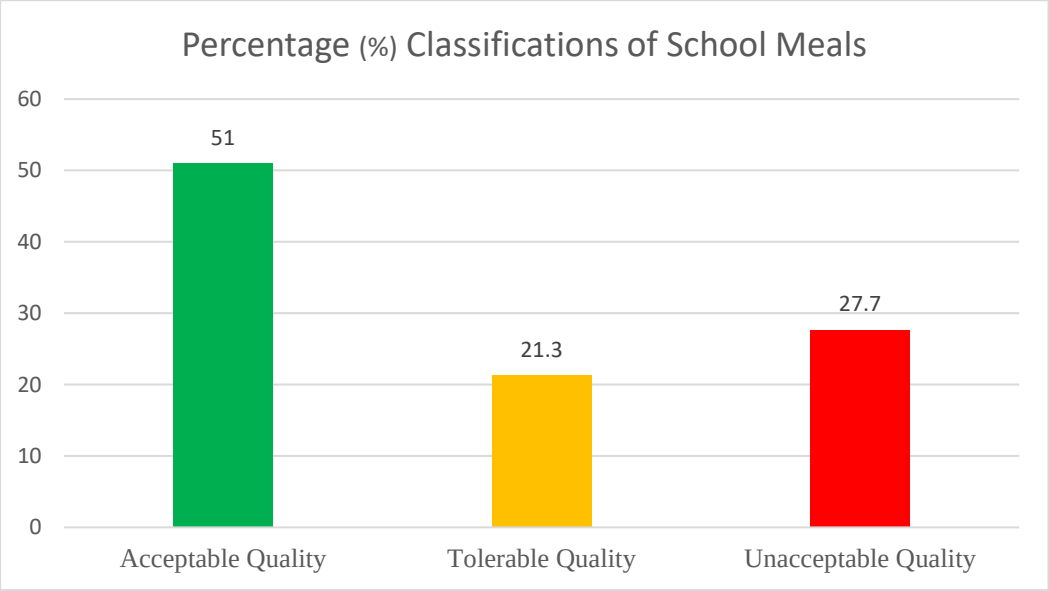

Figure 4 1:Aerobic Colony Count (ACC) Classification of School Meals

4.3.1: Bacterial Contamination in School Meals

Table 4.3 shows varying levels of bacterial contamination in the food samples. *Escherichia coli* recorded the highest mean bacterial load of $9.8 \times 10^5 \pm 2.1 \times 10^5$ CFU/g ($\log_{10}$ mean of 5.99 ± 0.10. *Staphylococcus aureus* had a mean bacterial count of $1.39 \times 10^5 \pm 3.2 \times 10^4$ CFU/g ($\log_{10} = 5.14 \pm 0.09$). *Shigella* spp. and had a mean bacterial load of $1.03 \times 10^4 \pm 2.1 \times 10^3$ CFU/g ($\log_{10} = 4.01 \pm 0.09$), while *Salmonella spp.* recorded $9.5 \times 10^3 \pm 1.8 \times 10^3$ CFU/g ($\log_{10} = 3.98 \pm 0.08$).

Table 2.3: Bacterial Contamination in School Meals

Bacterial Species	Mean CFU/g (± SD)	$\log_{10}$ Mean CFU/g (± SD)
Escherichia coli	$9.8 \times 10^5 \pm 2.1 \times 10^5$	5.99 ± 0.10
Salmonella spp.	$9.5 \times 10^3 \pm 1.8 \times 10^3$	3.98 ± 0.08
Staphylococcus aureus	$1.39 \times 10^5 \pm 3.2 \times 10^4$	5.14 ± 0.09
Shigella spp.	$1.03 \times 10^4 \pm 2.1 \times 10^3$	4.01 ± 0.09

(Field survey, 2025)

4.4.2 Microbiological Quality of Food Served Under the GSFP

Table 4.4 reveal varying levels of bacterial contamination in food served under the Ghana School Feeding Programme (GSFP). *Escherichia coli* was detected in Rice and Stew (3.2×10^5 CFU/g), Kenkey (2.1×10^5 CFU/g), and Waakye (4.5×10^5 CFU/g), with Waakye having the highest contamination ($p = 0.012$). *Salmonella* spp. was present in Rice and Stew (1.8×10^3 CFU/g), Banku (2.5×10^3 CFU/g), Waakye (3.0×10^3 CFU/g), and Jollof Rice (2.2×10^3 CFU/g), with Waakye showing the highest level ($p = 0.045$). *Staphylococcus aureus* was found in Banku (4.7×10^4 CFU/g), Kenkey (3.8×10^4 CFU/g), and Jollof Rice (5.1×10^4 CFU/g), but differences were not significant ($p = 0.089$). *Shigella* spp. was detected in Rice and Stew (2.8×10^3 CFU/g), Banku (3.5×10^3 CFU/g), and Waakye (4.0×10^3 CFU/g) ($p = 0.031$).

Table 4.4: Bacterial levels and Quality of Food Served Under the GSFP

Bacterial Species	Bacterial Count (CFU/g)					
	Rice	**Banku**	**Kenkey**	**Waakye**	**Jollof**	**p-value**
Escherichia coli	3.2×10^{5b}	Absent	2.1×10^{5b}	4.5×10^{5a}	Absent	0.012
Salmonella spp.	1.8×10^{3b}	2.5×10^{3b}	Absent	3.0×10^{3a}	2.2×10^{3b}	0.045
Staphylococcus aureus	Absent	4.7×10^{4a}	3.8×10^{4a}	Absent	5.1×10^{4a}	0.089
Shigella spp.	2.8×10^{3b}	3.5×10^{3b}	Absent	4.0×10^{3a}	Absent	0.031

Different Superscript letters (^{a}, ^{b}) within the same row indicate no significant differences

4.3 Sanitation and Hygienic Conditions under which Food is Prepared and Served

Table 4.5 presents the sanitation and hygiene conditions for preparing and serving food in the study area. Most (75.0%) food is prepared with an unsafe water supply. Meanwhile, 58.3% of the food is prepared with clean cooking utensils, although 16.6% of the cooks in some areas used protective clothing such as gloves and aprons. The fraction (33.3%) of the kitchens had designated handwashing facilities, while 16.6% had soap available. The majority (66.6%) of the cooking environments were clean, but only 25.0% had no pests. An equal proportion (50%) cooking areas had adequate ventilation during food preparation. Meanwhile, 33.3% had separate cooking and serving areas.

Table 4.5: Sanitation and Hygienic practice under which Food is Prepared

Sanitation & Hygiene Indicators	Frequency (n=12)	Percentage (%)
Availability of clean water supply	3	25.0
Presence of handwashing stations	4	33.3
Use of soap for handwashing	2	16.6
Availability of clean cooking utensils	7	58.3
Use of protective clothing (gloves, aprons)	2	16.6
Cleanliness of cooking environment	8	66.6
Proper waste disposal practices	4	33.3
Presence of pests (e.g., rodents, flies)	9	75.0
Food prepared in a well-ventilated area	6	50.0
Availability of separate cooking and serving areas	4	33.3

Source: (Field survey, 2025)

4.3.1 Association between Sanitation and Hygiene Indicators with Food Safety

The presents association between sanitation and hygiene practices and food safety. Having handwashing stations (OR = 0.57, p = 0.046) and using protective clothing like gloves and aprons (OR = 0.48, p = 0.035) had the likelihood for food handlers to ignore hygiene practices. The presence of pests, like rodents or flies (OR = 0.40, p = 0.021) had the reduced odds maintaining good sanitation. Other factors, like the cleanliness of the cooking area (OR = 0.78, p = 0.423) and separate cooking and serving areas (OR = 0.68, p = 0.254), did not show significant results. The use of handwashing stations, protective clothing, and pest control are important for maintaining hygiene in food preparation areas.

Table 4.6: Association between Sanitation and Hygiene Indicators with Food Safety

Sanitation & Hygiene Indicators	Coefficient (β)	Standard Error	Wald Statistic	Odds Ratio (OR)	p-value
Presence of Handwashing Stations	-0.56	0.28	-2	0.57	0.046
Use of Soap for Handwashing	-0.45	0.31	-1.45	0.64	0.147
Availability of Clean Cooking Utensils	-0.33	0.29	-1.14	0.72	0.254
Use of Protective Clothing (Gloves, Aprons)	-0.74	0.35	-2.11	0.48	0.035
Cleanliness of Cooking Environment	-0.24	0.3	-0.8	0.78	0.423
Proper Waste Disposal Practices	-0.51	0.3	-1.7	0.6	0.089
Presence of Pests (e.g., Rodents, Flies)	-0.92	0.4	-2.3	0.4	0.021
Food Prepared in a Well-Ventilated Area	-0.2	0.27	-0.74	0.82	0.461
Availability of Separate Cooking and Serving Areas	-0.38	0.33	-1.14	0.68	0.254

(Field survey, 2025)

4.4 Food Safety Knowledge and Practices among Caterers in the School Feeding Programme

Table 4.7 shows cross-contamination was low at 45.0%, whiles knowledge level was high at 75.0%. 48.3% of respondents agreed that food should be stored properly.

41.7% of respondents reported routinely checking handlers for health issues, while 50.0% of respondents were aware of appropriate reheating temperatures. 55.0% of respondents understood the signs of food poisoning. Additionally, 85.0% acknowledged that soap and water are necessary for safe hands, and 83.3% supported the use of hair restraints. 75% of respondents agreed that jewellery should not be worn while cooking and 63.3% agreed that keeping raw and cooked food separate is crucial.

However, 38.3% indicated that cooks should not taste food with their fingers, with 46.7% felt that handling cooked food with an injured finger is unhygienic.

Table 4.7: Food Safety Knowledge and Practices among Caterers under the GSFP

Food Safety Knowledge & Practices	Frequency (n)	Percentage (%)
Knowledge of foodborne diseases	45	75.0
Knowledge of cross-contamination	27	45.0
Regular handwashing before food handling	32	60.0
Use of clean water for food preparation	28	46.6
Proper food storage practices	29	48.3
Separation of raw and cooked foods	38	63.3
Regular cleaning of kitchen surfaces	36	60.0
Awareness of proper reheating temperatures	30	50.0
Regular health screening of food handlers	25	41.7
Understanding of food poisoning symptoms	33	55.0
Wearing short fingernails during food preparation	57	95.0
Washing hands in between food preparation processes	35	58.3
A chief cook suffering from cold or cough cannot prepare food	45	75.0
Safe hands are those washed with water and soap	51	85.0
A chief cook should wear hair restraints	50	83.3
A cook should not wear jewellery while preparing food	45	75.0
A cook should not taste food using fingers	23	38.3
Using a clean serviette is safer than a kitchen napkin for drying hands	38	63.3
Wearing hand gloves when serving cooked food is necessary	37	61.7
It is unhygienic to handle cooked food with an injured finger	28	46.7

Source: (Field survey, 2025)

4.4 Barriers Associated with Food Safety Issues Among Food Handlers in School Feeding Programmes (GSFP).

Table 4.8 shows the barriers to food safety in GSFP. Most (80.0%) respondents indicated that the common barriers encountered were inadequate food safety training, lack of proper storage facilities (66.7%), and poor waste disposal systems (58.3%). Financial constraints (86.6%) and limited access to clean water (80.0%) were also significant barriers. Overcrowding in cooking areas (41.7%) and a lack of personal protective equipment (91.6%) were identified as additional challenges to maintaining food safety standards.

Table 4.8: Barriers Associated with Food Safety Issues Among Food Handlers

Food Safety Barriers	Frequency (n)	Percentage (%)
Inadequate training on food safety	48	80.0
Lack of proper storage facilities	40	66.7
Poor waste disposal systems	35	58.3
Limited access to clean water	48	80.0
Financial constraints	52	86.6
Shortage of cooking fuel (e.g., firewood, gas)	28	46.7
Lack of government monitoring and supervision	38	63.3
Overcrowding in cooking areas	25	41.7
Lack of access to personal protective equipment	55	91.6
Poor knowledge of proper food handling	47	78.3

Sources: (Field survey, 2025)

CHAPTER FIVE

DISCUSSION

5.1 Microbiological Quality of Food

The food microbial quality analysis revealed that 51% of food samples met acceptable microbiological standards, whereas 27.7% exceeded safe microbial limits (>10^5 CFU/g), a significant public health risk. *Escherichia coli* exhibited the highest contamination levels, particularly in Waakye, suggesting improper handling, post-cooking contamination, or poor storage practices. Such contamination could also result from inadequate reheating of leftovers, unclean cutting boards, or cross-contamination from raw ingredients during food preparation. Detecting pathogens such as *E. coli*, *Salmonella spp*., *Shigella* spp., and *Staphylococcus aureus* indicates the potential for foodborne illnesses among schoolchildren. Also, Dela et al. (2023) reported that Nigerian public schools have comparable contamination levels in ready-to-eat foods attributable to a lack of standardized food safety protocols. Likewise, Gyebi et al., (2021*),* noted high levels of *Staphylococcus aureus* and *E. coli* in food samples from institutional kitchens in Accra, linking it to improper personal hygiene and poor equipment sanitation.

The high levels of *E. coli* suggest faecal contamination, which may be attributed to inadequate hand hygiene, lack of safe water for washing, or use of contaminated utensils and surfaces. *E. coli* is known to proliferate when food is stored at improper temperatures or left exposed to flies and rodents, common problems in the absence of refrigeration and proper storage. A study by Ayamah et al., (2021), observed similar *E. coli* outbreaks in school meal programmes in India due to inadequate refrigeration and poor food handling techniques.

Salmonella spp. was another notable contaminant, detected in multiple meal types. Its presence may stem from undercooked poultry, contaminated eggs, or unclean vegetables. Improper washing of produce, using contaminated chopping surfaces, and poor kitchen sanitation are potential sources. Recontamination after cooking due to handling with unwashed hands or exposure to contaminated environments further elevates the risk. This finding is consistent with reports by Yar et al. (2020), in Ghana, *Salmonella* contamination was linked to the consumption of inadequately cooked chicken and eggs. Inadequate heat treatment and post-cooking contamination have similarly been cited by Muriuki, (2020), as common causes of *Salmonella* outbreaks in low-resource settings. Nyangena et al. (2020), in Ethiopia also associated *Salmonella* prevalence in ready-to-eat foods with poor vendor hygiene, unsafe food handling, and use of unsafe water. Similarly, studies in Kenyan school kitchens (Ahmad et al., 2021), emphasized the role of broken cold chains and lack of protective clothing as contributory factors.

Shigella spp. was also detected at concerning levels. This pathogen often spreads through direct faecal-oral transmission or by consuming food handled by infected persons who have not properly washed their hands. The presence of *Shigella* in this study may be associated with insufficient access to handwashing facilities, poor toilet hygiene, and contaminated water sources. Similar outbreaks were reported in Tanzanian schools, where students fell ill due to food prepared by handlers with inadequate sanitation access (Kapeleka et al., 2020). In Uganda similarly linked *Shigella* contamination to food environments where soap and water were unavailable for handlers (Grwambi, 2021). Poor maintenance of sanitation facilities and overcrowding in cooking areas can also exacerbate the risk, as Muriuki, (2020) indicated in their study of peri-urban school food systems.

Staphylococcus aureus contamination typically results from improper food handling and poor personal hygiene, such as food handlers touching cooked foods with their bare hands or coughing near food (Nyangena et al., 2020). This bacterium is commonly found on humans' skin, hair, and nasal passages. Its presence here could also suggest lapses in health screening, food safety audits, or training of food handlers. Findings by study confirm that *S. aureus* contamination frequently occurs in settings where handlers fail to use gloves or masks, especially in high-temperature environments where bacteria rapidly proliferate (Abebe et al., 2020; Beshiru et al., 2022; Ovuru et al., 2024). Christiana Cudjoe et al. (2022), also observed high *S. aureus* prevalence in Ghanaian street-vended meals and attributed it to overcrowded cooking spaces, inadequate food storage, and lack of enforced hygiene protocols. Also evidence from Bangladesh linked *S. aureus* outbreaks to repeated touching of ready-to-eat food without handwashing and poor handler health surveillance (Teklemariam et al., 2023).

5.2 Sanitation and Hygiene Conditions

The sanitation assessment showed mixed results. Significant deficits were identified, while some areas had access to clean utensils and relatively clean environments. For instance, only 25% had clean water access, and only 16.6% used protective clothing. Regression analysis confirmed that the presence of handwashing stations and the use of protective clothing significantly improved food hygiene practices. Conversely, the presence of pests had a detrimental effect, indicating a need for enhanced pest control strategies (Wafula et al., 2022). Several underlying factors may contribute to these sanitation gaps. Limited infrastructure investment in rural schools, irregular or seasonal water supply, poor waste management systems, and lack of training materials or incentives for hygiene practices all play critical roles. In many cases, the absence of

government funding for kitchen renovations and hygiene kits (gloves, aprons, disinfectants) increase the challenge (Grwambi, 2021). Also, food handlers are sometimes expected to procure these items out of pocket, which is unsustainable. Cooking spaces that doubled up as classrooms or were situated near latrines or open drainage increased the likelihood of contamination. Cultural norms regarding hand hygiene and limited understanding of foodborne disease transmission may also contribute (Adesiyun et al., 2020).

Studies by Osafo et al. (2022), in Ghana observed that food handlers working in schools with no designated kitchens and poor ventilation tended to overlook essential hygiene practices. This aligns with, who reported high microbial loads in school kitchens that lacked proper sanitation facilities (Kaptchouang Tchatchouang et al., 2020). Moreover, insufficient financial support for protective gear and sanitation supplies, such as gloves and disinfectants, impedes good hygiene behaviours (Adesiyun et al., 2020). In Rwanda, Wafula et al. (2022), similarly found that schools with limited hygiene budgets were prone to sanitation lapses and food contamination. These findings are consistent with a study by Wafula et al. (2022), which emphasized that the absence of basic hygiene infrastructure, such as water and soap, was significantly associated with poor food safety practices in Nigeria's school-feeding initiatives. Similarly, a study by Balali et al. (2020), in Tanzania found that limited budgetary allocations for hygiene infrastructure in public schools resulted in poor sanitation conditions and increased the risk of foodborne diseases (Kapeleka et al., 2020). In South Africa, Balali et al. (2020) also indicate that the absence of ongoing training, low prioritization of food safety, and inconsistent supervision led to weak compliance with hygiene protocols in school kitchens (Teffo & Tabit, 2020).

The implications of these findings are considerable. Persistent sanitation deficits in school food environments increase the likelihood of foodborne illnesses and undermine the broader objectives of school feeding programmes, which aim to improve children's nutrition, health, and school attendance (Aworh, 2021; Christiana Cudjoe et al., 2022; Grwambi, 2021). Unsanitary conditions can discourage students from consuming meals, negate health benefits, and increase school absenteeism due to illness. These issues demands a multi-sectoral response involving the health, education, and local government sectors (Adesiyun et al., 2020). Interventions should include facility upgrades, continuous hygiene education, increased budget allocations for sanitation materials, and institutional accountability mechanisms to ensure sustained improvements (Kaptchouang Tchatchouang et al., 2020; Osafo et al., 2022; Wafula et al., 2022).

5.3 Food Safety Knowledge and Practices

The results indicate that while a majority of food handlers under the GSFP demonstrated some awareness of hygiene protocols, such as handwashing and avoiding jewellery during food preparation, there remain significant knowledge gaps in critical areas like cross-contamination (Christiana Cudjoe et al., 2022), proper food storage, and safe handling of raw meat. These knowledge deficiencies suggest that although there is some degree of awareness, practical understanding and application of food safety principles remain limited. One primary reason for these gaps could be the absence of structured and frequent training programmes (Ovuru et al., 2024). Many caterers rely on informal learning or peer observation rather than formal instruction, which reduces the likelihood of understanding the scientific basis for hygiene standards. As Ahmad et al., (2021) noted, food handlers without structured training are less likely

to adhere to safety protocols, particularly under stressful or resource-limited conditions. Furthermore, training that lacks practical demonstrations or ongoing supervision often fails to translate knowledge into behaviour change (Wafula et al., 2022).

Inadequate emphasis on food safety within national education and vocational curricula also contributes to these issues (Owusu-Kwarteng et al., 2020). Food handlers may not prioritize hygiene, especially without consistent monitoring or penalties for non-compliance. A study by Osafo et al. (2022), in Malaysia found that implementation was poor even when knowledge levels were moderate without external enforcement mechanisms. Similarly, (Kapeleka et al., 2020), found that food safety behaviour among handlers in institutional kitchens improved significantly only when combined with training and regular inspection (Aworh, 2021). Cultural beliefs and traditional cooking practices may conflict with modern food safety standards. In some communities, it is common to reuse cooking water, store leftovers unrefrigerated, or taste food directly with fingers, habits that increase contamination risk (Kaptchouang Tchatchouang et al., 2020). Without culturally sensitive education that addresses these norms, behaviour change is unlikely.

Comparatively, studies across Africa and Asia reinforce these findings. In Kenya, (Teklemariam et al., 2023), reported that less than half of school food vendors could identify signs of food spoilage, and many had never received formal training. In Bangladesh, (Madoroba et al., 2021), noted that although handlers could list food safety rules, their actual practices were poor due to a lack of resources and role models. In Ghana, (Yar et al., 2020), found a mismatch between food safety knowledge and actual hygiene behaviour among institutional food providers, attributing the gap to limited capacity building and oversight (Madoroba et al., 2021). The implications of these findings are significant. Without targeted interventions, the knowledge-practice gap can

contribute to ongoing microbial contamination, foodborne outbreaks, and diminished trust in school meal programmes (Osafo et al., 2022). Strengthening the food safety culture among GSFP handlers will require intensive training, accessible educational materials, periodic refresher sessions, behaviour monitoring, and feedback loops. Interventions should also be context-specific, using local languages, visual aids, and practical demonstrations to ensure inclusiveness and sustainability (Abebe et al., 2020).

4.4 Barriers to Food Safety

The study revealed a range of significant barriers affecting food safety among caterers in the GSFP. These included inadequate training, lack of proper storage facilities, poor waste disposal systems, limited access to clean water, financial constraints, overcrowded cooking areas, and lack of personal protective equipment. These barriers reflect systemic and institutional weaknesses that negatively impact the consistent application of food hygiene practices and adherence to internationally recognized standards such as Hazard Analysis and Critical Control Points (HACCP). One underlying reason is the chronic underfunding of school feeding Programmes in low-income regions. Food handlers often operate with minimal financial support, forcing them to compromise on critical food safety elements such as protective clothing, proper waste disposal, and safe food storage. This observation is congruent with the findings of Adesiyun et al. (2020), who noted that financial constraints among food vendors in Ghana resulted in lower compliance with food safety protocols. Similar economic constraints have been reported by Beshiru et al. (2022), in Uganda, where school meal providers cited funding gaps as a critical barrier to acquiring essential sanitation infrastructure.

Institutional oversight also remains suboptimal. Infrequent or irregular inspections, coupled with weak enforcement mechanisms, limit accountability. Food handlers are seldom monitored or evaluated on hygiene performance, leading to persistent unsafe practices. This finding is supported by Muriuki, (2020), who reported that food safety enforcement in Ethiopian schools was sporadic and largely reactive. In Nigeria, (Teklemariam et al., 2023), found that the absence of structured regulatory frameworks weakened the ability of authorities to ensure compliance with food hygiene standards (Ofoedu et al., 2021). Training-related barriers are equally critical. Although food handlers may receive some initial instruction, the absence of systematic and periodic refresher sessions and limited post-training supervision reduces the long-term retention and practical application of knowledge. This is consistent with Grwambi, (2021), who observed a significant decline in hygiene practices among vendors without regular follow-up. Moreover, language barriers and low literacy rates among food handlers further impair the effectiveness of training materials, especially when they are not adapted to local dialects or designed using visual aids. Madoroba et al. (2021) found that simplified infographics training led to better compliance among food handlers with limited formal education in Zambia.

Cultural attitudes and perceptions also contribute to unsafe practices. In many communities, there is a tendency to equate visual cleanliness with microbiological safety, leading to a neglect of more critical yet invisible threats such as bacterial and viral contamination. (Teklemariam et al., 2023) indicate this phenomenon in Accra, where food vendors perceived visibly clean environments as adequately safe, even when microbial analyses indicated otherwise. A similar misconception was identified by Owusu-Kwarteng et al. (2020) in South Africa, where subjective cleanliness often replaced scientific food safety assessments. The implications of these barriers are

multidimensional. First, they compromise the safety and nutritional value of meals served through the GSFP, potentially increasing the risk of foodborne disease outbreaks among vulnerable school-age populations. Second, the persistent recurrence of hygiene failures can undermine parental and community confidence in the programme, potentially reducing school enrolment and participation. Third, poor food safety can disrupt the overall objectives of school feeding programmes, including improving learning outcomes and reducing child malnutrition.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Summary of the key findings

The study assessed the food microbiological quality and hygiene standard practices among caterers under the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District. The findings revealed that a little bit over half (51.0%) of the food samples met acceptable microbiological standards, while 27.7% exceeded the tolerable limits, indicating potential food safety risks. *Escherichia coli* had the highest bacterial load, followed by *Staphylococcus aureus, Shigella* spp., and *Salmonella* spp., with statistically significant variation among different food types.

Sanitation and hygiene assessments showed considerable deficiencies: only 25% of kitchens had access to clean water, and a mere 16.6% of food handlers used protective clothing. Additionally, 75% of kitchens reported the presence of pests, and only 33.3% had designated handwashing stations.

Although 96.7% of food handlers exhibited good awareness of hygiene, only 65.0% demonstrated good food safety practices. Knowledge gaps were observed in areas such as cross-contamination, proper food storage, and personal hygiene. Major barriers to safe food handling included inadequate training (80%), financial constraints (86.6%), lack of personal protective equipment (91.6%), and limited access to clean water (50%).

6.2. Conclusion

This study aimed to assess the microbiological quality of food and evaluate hygiene standard practices among caterers under the Ghana School Feeding Programme (GSFP) in the Sekyere Afram Plains District. The results indicate that a notable proportion (27.7%) of food samples had microbial levels exceeding acceptable limits, particularly contaminated with *Escherichia coli*, *Salmonella* spp., *Shigella* spp., and *Staphylococcus aureus*, raising concerns about food safety risks to pupils. The sanitation and hygiene conditions observed were inadequate, as many food preparation sites lacked essential facilities such as handwashing stations, protective clothing, and proper pest control.

These environmental shortcomings directly affected the overall safety of the food served. Moreover, while some food handlers demonstrated a basic understanding of food safety practices, significant gaps were evident in cross-contamination prevention, food storage, and handling techniques. Lastly, the study revealed several food safety barriers, including insufficient training, inadequate infrastructure, lack of personal protective equipment, and financial constraints. These findings emphasize the need for coordinated efforts at the institutional and individual levels to address food safety challenges within the GSFP.

6.2. Recommendations

To improve food safety in the GSFP, the following recommendations are proposed for both institutions and individual food handlers:

1. GSFP Secretariat

- **i.** **S**hould institutionalize periodic microbial testing of all school meals to ensure compliance with food safety standards.
- **ii.** It should support hygienic food preparation and provide consistent access to clean water, handwashing stations, and proper waste disposal systems.
- **iii.** Should organize regular workshops and refresher courses for food handlers on safe handling, cross-contamination, personal hygiene, and storage practices.
- **iv.** Should ensure the continuous supply of gloves, aprons, hair restraints, and other PPE to all food handlers.
- **v.** Invest in constructing separate cooking and serving areas, pest-proof kitchens, and ventilated environments within school feeding zones.
- **vi.** Allocate sufficient funding, improve supervision, and create feedback mechanisms for caterers to report challenges related to food safety.

2. Caterers

i. Participate in mandatory food safety and hygiene training workshops to improve their knowledge and practices.

ii. Consistently use personal protective equipment such as gloves, aprons, and hair restraints during food preparation and service.

iii. Ensure proper handwashing and utensil sanitation before and during food handling to reduce the risk of contamination.

3. Head Teachers

i. Monitor and supervise food preparation areas regularly to ensure adherence to hygiene protocols by caterers.

ii. Facilitate regular health screening of food handlers in collaboration with local health authorities.

iii. Advocate for school-level food safety committees to support inspection and promote best practices in hygiene and sanitation.

4. Non-Governmental Organizations (NGOs)

i. Provide financial and material support such as clean water storage tanks, soap, and protective clothing for schools under the GSFP.

ii. Organize community sensitization Programmes on food safety, hygiene, and nutrition involving caterers and school stakeholders.

iii. Partner with local authorities to establish school-based food safety monitoring systems and capacity-building initiatives.

5. Future Research

i. Investigate the seasonal variation in microbial contamination of school meals to inform targeted interventions.

ii. Explore the impact of nutrition education on long-term hygiene behaviour among school food handlers.

iii. Assess the cost-effectiveness of food safety interventions implemented in GSFP beneficiary schools.

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Appendix

Questionnaire

Survey Questionnaire on Food Microbiological Quality and Hygiene Standard Practices among Caterers under the Ghana School Feeding Programme in the Sekyere Afram Plains District, Ghana.

I Daniel Atanga, a student of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Mampong, undertaking a study on Food Microbiological Quality and Hygiene Standard Practices among Caterers under the Ghana School Feeding Programme in the Sekyere Afram Plains District, Ghana.

I therefore seek your support by participating in a survey as a respondent and any information you provide will be treated with anonymity and your answers will remain confidential.

FOOD SAFETY IN SCHOOL FEEDING

NO	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
	SOCIO-DEMOGRAPHIC CHARACTERISTICS **I would like to start by asking you a few questions about yourself.**		
Q1	Please tell me your date of birth or your age in years.	|__|__| day |__|__| month |__|__||__|__| year |__|__| age (completed years) Don't know	
Q2	What is your marital status?	Married 1 Single…… 2 Divorce……. 3 Widowed……... 4	

Q3	What is your level of education?	Non-formal……...1 Primary……..…2 J.H.S …….3 S.H.S……..…4 post-secondary/vocational……5 Tertiary…….6	
Q4	What is your religion?	Christian 1 Muslim 2 Traditional/Spiritualist 3 No religion 4 Other's 5	
Q5	How long has your school been participating in the Ghana School Feeding Programme (GSFP)?	Less than 1 year…….1 1-5 years ……...2 More than 5 years …….3	
Q6	How long have you been practicing as a food handler in the school?	Less than 1 year ……..1 1-5 year ……2 6-10 years ……...3	

		11-15 years ……..4 16 years and above ……..6	
	FOOD SAFETY CHECKLIST		
Q7	The school have kitchen	Yes ……. 1 No…… 2	
Q8	If no, where do they prepare the meals	Specify…….	
Q9	The school have a portable source of drinking water on site	Yes ……. 1 No…… 2	
Q10	If no, where do they get water to prepare the meal	Specify…….	
Q11	Employees wear clean and proper uniforms including shoes	Yes ……. 1 No…… 2	
Q12	Effective hair restraints are properly worn	Yes ……. 1 No…… 2	
Q13	Fingernails are short, unpolished, and clean (no artificial nails)	Yes ……. 1 No…… 2	

Q14	Is there a functional handwashing facility available on site	Yes ……..…....1 N ……2	
Q15	If yes, is it stocked with soap, disposable towels, and warm water	Yes …….1 No……2	
Q16	Hands are washed properly, frequently, and at appropriate times.	Yes ……. 1 No…… 2	
Q17	Employees use disposable tissues when coughing or sneezing and then immediately wash their hands.	Yes ……. 1 No…… 2	
Q18	Employees appear in good health	Yes ……. 1 No…… 2	
Q19	Eating, drinking, chewing gum, smoking, or using tobacco are allowed only in designated areas away from preparation, service, storage, and ware washing areas	Yes ……. 1 No…… 2	
Q20	Burns, wounds, sores or scabs, or splints and water-proof	Yes ……. 1	

	bandages on hands are bandaged and completely covered with a food service glove while handling food.	No…… 2	
	FOOD SAFETY KNOWLEDGE		
Q21	Are you familiar with the key principles of food safety and hygiene?	Yes…….1 No……..…. 2	
Q22	If yes, please state some of the key principles of food safety and hygiene that you are aware of	Specify……... ……	
Q23	Have there been any reported foodborne illness incidents or cases concerning the GSFP in your school?	Yes……1 No……...2	
Q24	If yes, briefly describe the incident.	Specify…….	
Q25	Have you been medically screened and cleared to handle food for public consumption?	Yes …….1 No ……...……2	

FOOD PREPARATION Yes /No Corrective Action **Now I would like to ask you questions about food preparation**			
Q26	The internal temperature of the food being cooked is monitored and documented.	Yes ……. 1 No…… 2	
Q27	Food is cooked to the required safe internal temperature for the appropriate time. The temperature is tested with a calibrated food thermometer	Yes ……. 1 No…… 2	
Q28	Clean reusable towels are used only for sanitizing equipment, and surfaces and not for drying hands, utensils, or floor	Yes ……. 1 No…… 2	
Q29	Food is handled with suitable utensils, such as single-use gloves or tongs	Yes …… 1 No …… 2	
Q30	Procedures are in place to prevent cross-contamination.	Yes ……. 1 No…… 2	
Q31	Food equipment utensils, and food contact surfaces are properly washed, rinsed, and sanitized before every use	Yes ……. 1 No…… 2	
	FOOD STORAGE AND DRY STORAGE Yes/ No Corrective Action		

Q32	The school has a storeroom for foodstuff and other ingredients and vegetables	Yes ……. 1 No…… 2	
Q33	If No, where do they store their foodstuff	Specify…….	
Q34	Open bags of food are stored in containers with tight-fitting lids and labelled with the common name	Yes ……. 1 No…… 2	
Q35	There is no bulging or leaking canned goods.	Yes ……. 1 No…… 2	
Q36	All food and paper supplies are stored 6 to 8 inches off the floor	Yes ……. 1 No…… 2	
Q37	All food is labelled with name and received date	Yes ……. 1 No…… 2	
	UTENSILS AND EQUIPMENT **Yes/ No Corrective Action**		
Q38	All small equipment and utensils, including cutting boards and knives, are cleaned and sanitized between use	Yes ……. 1 No…… 2	
Q39	Work surfaces and utensils are clean.	Yes ……. 1 No…… 2	

Q40	Work surfaces are cleaned and sanitized between uses.	Yes ……. 1 No…… 2	
Q41	"Can openers" and racks are clean.	Yes……..…1 No……..… 2	
Q42	Clean utensils are handled in a manner to prevent contamination of areas that will be in direct contact with food or a person's mouth.	Yes ……. 1 No…… 2	
	GARBAGE STORAGE AND DISPOSAL Yes/ No Corrective Action	Yes ……. 1 No…… 2	
Q43	Kitchen garbage bins are clean and kept covered.	Yes ……. 1 No…… 2	
Q44	The dumpsters are clean.	Yes ……. 1 No…… 2	
Q45	The loading dock and area around the dumpster are clean	Yes ……. 1 No…… 2	
Q46	Garbage cans are emptied as necessary	Yes ……. 1 No…… 2	
	PEST CONTROL		

	Yes /No Corrective Action		
Q47	There is evidence of the pest's present	Yes ……. 1 No…… 2	
Q48	There is a regular schedule of pest control by a licensed pest control operator	Yes ……. 1 No…… 2	
Q49	Outside doors have screens, are well-sealed, and are equipped with a self-closing device.	Yes ……. 1 No…… 2	
	Barriers to Food Safety (yes/No)		
Q50	Have you ever encountered any challenges in ensuring food safety practices in your school feeding programme before?	Yes……1 No……2	⇨ ⇨
Q51	If yes, what were some of the challenges you encountered?	Specify…… …… …… ……...	
Q52	Are there any resource constraints (e.g., equipment, cleaning supplies)	Yes …… 1 No…… 2	

	that hinder your ability to maintain food safety standards?		
Q53	What improvements or support would help you overcome the barriers to food safety in the school?	Specify …… ……	
Q54	Are there any challenges related to waste disposal that affect food safety?	Yes ……. 1 No…… 2	
Q55	If yes, how do you manage food waste and refuse? ……		
Q56	Do time constraints or work pressure affect your ability to follow proper food safety procedures?	Yes ……. 1 No…… 2	
Q57	Do you face any challenges in receiving food items from suppliers that impact on food safety?	Yes ……. 1 No…… 2	
Q58	If yes, specify the problem.	…… ……	

Q59	Are there any cultural or traditional practices that conflict with food safety guidelines in your school?	Yes ……. 1 No…… 2	
Q60	If yes, specify the cultural practice.	…… ……	
	Monitoring And Inspection		
Q61	Are there any regulatory or oversight issues that impact your ability to ensure food safety in the school feeding programme?	Yes……1 No…….2	
Q62	If yes, specify the regulation.	……. …….	
Q63	Have you ever received any training or education on food safety practices?	Yes……1 No…….2	
Q64	If yes, how often?	Monthly……1 Quarterly…….2 Yearly……3	

		Never……...4	
Q65	What was the training about?	Specify…….. …… ……	

Plate 1: Selected pictures during the laboratory process

Plate 3: Selected pictures during feeding




Plate 3: Selected School Kitchen from the study Area





Selected pictures of schools of which the study was conducted