ENSIGN GLOBAL UNIVERSITY

KPONG, EASTERN REGION, GHANA

FACULTY OF PUBLIC HEALTH

DEPARTMENT OF COMMUNITY HEALTH

ASSESSING THE FACTORS INFLUENCING AWARENESS OF THE ONE HEALTH APPROACH TO ANTIMICROBIAL RESISTANCE: A CASE STUDY AMONG SENIOR HIGH SCHOOL STUDENTS IN THE LOWER MANYA KROBO MUNICIPALITY, EASTERN REGION OF GHANA

BY

PRISCILLA EDEM DZAKPASU

NOVEMBER, 2025

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NOVEMBER, 2025

DECLARATION

I, Priscilla Edem Dzakpasu declare that the content of this work is the outcome of my own research and has not been presented for any degree anywhere, with the exception of the use of elements from published sources that have been recognized and properly cited.

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(Head of Academic Program)	Signature	Date

DEDICATION

This thesis is dedicated to all Senior High School students in Ghana whose curiosity and enthusiasm for learning continue to inspire hope for a healthier, more informed generation. Your engagement and awareness is vital in the fight against antimicrobial resistance.

I also dedicate this work to every teacher, health educator, and public health professional who tirelessly promote knowledge on the responsible use of antibiotics and the importance of the One Health approach.

Finally, to my family, mentors, and friends, your prayers, encouragement, and unwavering support have been my strength throughout this journey. This accomplishment is a reflection of your love and faith in me.

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ABSTRACT

Background: Antimicrobial resistance (AMR) remains one of the most critical global public health threats, with growing concern over its spread across human, animal, and environmental domains. The One Health Approach (OHA) emphasizes the interconnectedness of these sectors in addressing AMR. However, awareness of OHA among young people, who represent future health stewards, remains poorly documented in Ghana. This study assessed the factors influencing awareness of AMR and the One Health Approach among Senior High School (SHS) students in the Lower Manya Krobo Municipality, Eastern Region of Ghana.

Methodology: A cross-sectional study was conducted among 394 science students randomly selected from four Senior High Schools in the municipality. The study adopted a quantitative cross-sectional design, targeting SHS students aged 15–19 years. A multistage stratified random sampling approach was used to select 394 participants. Data was collected using a structured, self-administered questionnaire adapted from validated tools, focusing on students' knowledge of antibiotics and AMR, misconceptions, and information sources. Data was entered using KoboCollect and analyzed with SPSS V2.0.

Descriptive statistics summarized demographic characteristics and awareness levels, while Chi-square tests and multivariate logistic regression identified associations between socio-demographic factors and awareness levels. Statistical significance was set at $p < 0.05$.

Results: The findings revealed that awareness of AMR was moderate, with 66% of respondents demonstrating moderate to good knowledge, while 34% had poor awareness. In contrast, awareness of the One Health Approach was strikingly low (16.3%). Male students were more likely to have good AMR awareness compared to females (AOR = 2.24, $p = 0.006$). Socioeconomic status and religion were also significant predictors, with students from higher-

income backgrounds and Christian faiths demonstrating better awareness ($p < 0.05$). No significant associations were found for age, ethnicity, or location. Although AMR knowledge was positively associated with awareness of the One Health Approach, the relationship was not statistically significant ($p = 0.209$), indicating limited translation of AMR knowledge into holistic understanding.

Conclusion:

The study highlights moderate awareness of AMR but poor understanding of the One Health framework among SHS science students. Gender, religion, and socioeconomic status significantly influenced AMR awareness, while One Health understanding remained uniformly low across demographic groups. These findings underscore the urgent need to integrate AMR and One Health education into the Senior High School science curriculum. Strengthening teacher capacity and leveraging digital platforms identified as key information sources could enhance sustained youth engagement. Collaboration among the Ghana Education Service (GES), the District Health Directorate, and NGOs is recommended to promote One Health literacy as part of Ghana's broader National Action Plan on Antimicrobial Resistance.

Keywords: Antimicrobial Resistance, One Health Approach, Awareness, Senior High School Students, Ghana, Lower Manya Krobo Municipality.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Antimicrobial resistance (AMR) represents one of the most critical public health challenges of the 21st century, posing a serious threat to global health, food security, and sustainable development (World Health Organization, 2020). It occurs when microorganisms (bacteria, viruses, fungi, and parasites) develop mechanisms that enable them to survive exposure to antimicrobial drugs designed to eliminate them (World Health Organization, 2020).

As a result, infections that were once easily treatable with antibiotics and other antimicrobials become more difficult, expensive, and sometimes impossible to cure (World Health Organization, 2020). The World Health Organization (WHO) classifies AMR as one of the top ten global public health threats, warning that it could compromise the effective treatment of numerous infectious diseases and significantly undermine advances in modern medicine (‘Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report 2021’, 2021).

The development of AMR is driven by a combination of biological, behavioral, and systemic factors (World Health Organization, 2021). Chief among them are the overuse and misuse of antimicrobials in both humans and animals, poor infection prevention and control practices, lack of access to timely and accurate diagnostics, and gaps in public education about proper antimicrobial use (Klein et al., 2018). Antibiotics, for instance, are frequently used inappropriately, prescribed when not needed, taken in incorrect doses or durations, or accessed without prescriptions. These practices create selective pressure, allowing resistant organisms to thrive while susceptible ones are eliminated (O’Neill, 2016).

Globally, AMR is already having measurable impacts on health systems (World Health Organization, 2021) Infections caused by resistant organisms such as methicillin-resistant *Staphylococcus aureus* (MRSA), multidrug-resistant *Mycobacterium tuberculosis*, and extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriaceae* are increasing in prevalence and complexity (Cassini *et al.*, 2019). Treating these infections often requires more expensive or toxic alternatives, increases hospital stays, and reduces the effectiveness of medical interventions that rely on antibiotics, including surgeries, chemotherapy, and organ transplants (OECD, 2018).

Although AMR is a global phenomenon, its consequences are unevenly distributed (Murray et al., 2022). Low- and middle-income countries (LMICs), especially in sub-Saharan Africa, bear a disproportionate burden due to weaker healthcare infrastructure, limited regulatory enforcement, and access to antibiotics without prescriptions (Tadesse et al., 2017). In these contexts, antibiotics are often sold over-the-counter by informal vendors, and self-medication is a widespread practice (Afari-Asiedu et al., 2021).Moreover, public health literacy around antimicrobial use tends to be low, leading to misconceptions and misuse that further accelerate the resistance crisis (Ocan *et al.*, 2015).

By 2050, antimicrobial resistance (AMR) is projected to cause up to 10 million deaths annually worldwide if effective interventions are not implemented (O'Neill, 2016). Like many other African nations, Ghana has reported the emergence of resistant bacterial strains and developed a National Action Plan on Antimicrobial Use and Resistance (2017–2021) to address the growing threat (Ministry of Health, Ghana, 2017).Evidence from a study conducted across 2 teaching hospitals, 7 regional hospitals, and 2 district hospitals in the country revealed alarmingly high levels of multidrug resistance among common pathogens such as *Streptococcus*, *Salmonella*, and *E. coli*, with resistance rates reaching up to 78.7% (Newman et al., 2003).

Moreover, in Ghana, evidence indicates that many infectious microorganisms are no longer responding to commonly used, potent, and easily accessible antibiotics within the health system. This trend contributes to rising morbidity and mortality (NAP, 2017). Addressing this challenge has become a global priority for the World Health Organization (WHO). In 2015, the World Health Assembly (WHA) endorsed a Global Action Plan to combat antimicrobial resistance (AMR) within the framework of a One Health strategy (EMRO.WHO, 2022), recognizing the interconnectedness of humans, animals, plants, and the environment in the spread of AMR (Collignon & McEwen, 2019).

Following the WHA's call, Ghana developed its own National Action Plan for Antimicrobial Use and Resistance (2017–2021). The first strategic pillar of this plan *"Improve Awareness and Understanding of Antimicrobial Resistance through Effective Communication, Education, and training"* was designed to enhance knowledge and foster responsible antibiotic use. To achieve this, Ghana implemented initiatives in four key areas:

1. Promoting continuous public education in collaboration with all stakeholders under the One Health framework.
2. Partnering with the Ministry of Health and educational institutions to integrate antibiotic-related content into school curricula.
3. Encouraging responsible antibiotic use through sustained awareness campaigns across sectors.
4. Strengthening collaboration between the Ministries of Food and Agriculture, Fisheries and Aquaculture Development, and relevant educational institutions to embed antimicrobial use (AMU) and AMR concepts into teaching and training programs (NAP, 2017).

This study, therefore, focuses on assessing the level of awareness of AMR and the One Health approach among Senior High School (SHS) students in the Lower Manya Greater Accra Region of Ghana. This is crucial in that these students represent future prescribers and custodians of antimicrobial agents who will, in turn, educate their future patients and their families on proper usage. Evaluating their knowledge and awareness of AMR and the One Health is therefore critical in shaping educational interventions that will promote antimicrobial stewardship from a One Health approach.

At a biological level, antimicrobial resistance is defined as the inherited or acquired ability of microorganisms to withstand the action of antimicrobial drugs to the extent that treatment becomes ineffective, thereby allowing resistant organisms to persist and spread. Bacteria develop resistance through multiple biochemical mechanisms, including: (1) enzymatic modification or destruction of the drug; (2) alteration of the drug's target site; (3) mimicking or overproducing the target site; (4) reducing drug penetration into the cell; and (5) eliminating the drug via efflux pumps. Many bacterial species employ more than one of these mechanisms, complicating treatment and accelerating the spread of resistance.

The One Health approach recognizes that human health is closely linked to the health of animals and the shared environment. Although the concept is not new, it has gained increasing importance in recent years due to changing interactions among people, animals, plants, and ecosystems. One Health is a collaborative, multisector, and transdisciplinary framework that seeks to achieve optimal health outcomes by integrating efforts across human, animal, and environmental health sectors at local, national, and international levels.

The relevance of One Health is underscored by the fact that an estimated six out of every ten infectious diseases affecting humans are zoonotic in origin, transmitted directly or indirectly from

animals (WHO, 2017). By fostering cooperation across multiple disciplines, the One Health approach seeks to:

1. Prevent zoonotic disease outbreaks in humans and animals;
2. Strengthen food security and safety;
3. Reduce antimicrobial resistance and improve both human and animal health;
4. Enhance global health security; and
5. Support biodiversity conservation and ecosystem sustainability.

In this way, the One Health framework provides an integrated pathway for achieving the highest possible health outcomes for people, animals, plants, and the environment.

Within this context, the present study seeks to assess the factors influencing awareness of the One Health approach to antimicrobial resistance (AMR) among Senior High School (SHS) science students in the Lower Manya Krobo Municipality in the Eastern Region of Ghana.

1.2 Problem Statement

Antimicrobial resistance (AMR) is a growing global health crisis that threatens effective treatment and prevention of infectious diseases caused by bacteria, viruses, fungi, and parasites. In 2019, bacterial AMR was associated with an estimated 4.95 million deaths, of which 1.27 million were directly attributable to resistant infections, and projections suggest up to 10 million annual deaths by 2050 if left unchecked (Murray et al., 2022a; O'Neill, 2016). Beyond mortality, AMR increases healthcare costs, prolongs illness, and jeopardizes essential medical procedures such as organ transplantation, chemotherapy, and caesarean sections (WHO, 2021).

While high-income countries report significant impacts, with 13 AMR-attributable deaths per 100,000 populations (NIH, 2022), the burden is most severe in sub-Saharan Africa, where

structural health system limitations intensify risks. The region recorded 27.3 deaths per 100,000 attributable to AMR the highest globally with some countries such as the Central African Republic and Lesotho reporting mortality above 200 per 100,000 (Murray et al., 2022b).

Antimicrobial resistance (AMR), which is a concern to human, animal, and environmental health when bacteria develop it, can be conveyed through animals. Owing to its complexity, it is essential to examine it from a variety of perspectives in order to frame it in the context of the One-Health Approach (Velazquez-Meza et al., 2022). The One-Health method is centered on the collaborative work of several disciplines that come up with the best solutions for the wellbeing of people, animals, and the environment.

The drivers of AMR are multifaceted, spanning human, animal, and environmental health. In many African countries, self-medication and unregulated access to antibiotics are major contributors. A review across 19 African nations found self-medication rates ranging from 12.1% to 93.9%, with West Africa recording the highest prevalence (70.1%) (Yeika et al., 2021). Additionally, up to 63.4% of pharmacies dispense antibiotics without prescriptions, and the circulation of substandard or falsified drugs may account for as many as 500,000 deaths annually (Li et al., 2023; The Guardian, 2024). In livestock farming, antimicrobials are also widely misused for growth promotion and prophylaxis. In Ghana, nearly all commercial poultry farms in the Ashanti Region (~97%) report routine antimicrobial use, including for growth promotion, while about 43% of domestic farms use antibiotics regularly, often without veterinary oversight (Donkor et al., 2022). Similarly, over 60% of *E. coli* isolates from healthy pigs in the Greater Accra Region were resistant to tetracycline, reflecting heavy exposure to antimicrobials despite farmers not explicitly reporting their use for feed supplementation (Salifu et al., 2022). These practices, combined with poor

storage and disposal of veterinary drugs, create pathways for resistant organisms to spread across humans, animals, and the environment.

To address this, Ghana developed the National Action Plan on Antimicrobial Use and Resistance (2017–2021), which emphasized awareness creation through education and training (NAP, 2017). However, studies show that AMR awareness remains low among the general public, with adolescents particularly overlooked (Donkor & Badoe, 2014; Afari-Asiedu et al., 2021). Ghana's plan acknowledged the importance of public engagement but struggled to effectively reach young people, especially in non-metropolitan areas (Hein et al., 2022). This gap is critical, as Senior High School (SHS) science students represent the future workforce of prescribers, veterinarians, agriculturists, and policymakers whose attitudes and practices will shape antimicrobial stewardship. Evidence from other settings demonstrates that early education on AMR improves responsible antibiotic use among adolescents (McNulty et al., 2019; Ashiru-Oredope et al., 2021).

Without targeted educational strategies, the limited awareness of AMR and the One Health approach among SHS students may undermine Ghana's and global efforts to combat AMR. It is therefore necessary to assess the factors influencing awareness among SHS science students in the Lower Manya Krobo Municipality to inform curriculum development, policy, and long-term stewardship interventions.

1.3 Rationale of the study

Antimicrobial resistance (AMR) is a cross-cutting challenge that links human, animal, and environmental health. The inappropriate and excessive use of antimicrobial agents in one domain inevitably impacts the others within a shared ecosystem (Velazquez-Meza et al., 2022). In sub-Saharan Africa, studies consistently report high rates of self-medication with antibiotics, largely

driven by unrestricted access and limited public awareness. These practices accelerate the spread of resistant pathogens and weaken the effectiveness of available treatments (Li et al., 2023; Vicar et al., 2023).

Ghana subsequently adapted this into its National Action Plan on Antimicrobial Use and Resistance (2017–2021**)**, with a central pillar focused on improving awareness and understanding of AMR through effective communication, training, and integration of prudent antimicrobial use into educational curricula (NAP, 2017). The One Health approach highlighted in both plans acknowledges the interconnectedness of people, animals, plants, and the environment, and promotes multisectoral action to safeguard antimicrobial effectiveness (Collignon & McEwen, 2019).

Despite these strategies, a critical gap persists in Ghana.Limited empirical evidence on AMR and One Health awareness among adolescents. While hospital stewardship programs and public awareness campaigns have been implemented, they rarely target young people. In the Lower Manya Krobo Municipality, for example, the antimicrobial stewardship team at Atua Government Hospital has engaged in community education since 2021, yet secondary school students have not been systematically included in these efforts. This is concerning because adolescents, particularly Senior High School (SHS) science students, represent the future generation of prescribers, veterinarians, agriculturists, and policymakers. Their awareness and attitudes will play a pivotal role in shaping responsible antimicrobial use in Ghana.

This study therefore seeks to assess the level of awareness of AMR and the One Health approach among SHS science students in the Lower Manya Krobo Municipality. The Lower Manya Krobo Municipality in the Eastern Region of Ghana provides a relevant case study for this research. The area represents a typical Ghanaian district where health, agriculture, and environmental

interactions converge, making it an appropriate setting to assess awareness of AMR and the One Health approach. Understanding the factors that influence awareness among SHS students in this municipality will provide valuable insights for designing targeted educational strategies. Establishing baseline knowledge in this population will not only guide the design of age-appropriate educational interventions and support curriculum developers but also guide NGOs, and policymakers in tailoring strategies that resonate with adolescents. Furthermore, the findings will contribute to Ghana's national AMR response by providing youth-specific evidence essential for monitoring and evaluating the impact of school-based interventions. By addressing this knowledge gap, the study will help foster a culture of antimicrobial stewardship early in life, strengthening both national and global efforts to combat AMR within the One Health framework.

1.4 Conceptual Framework

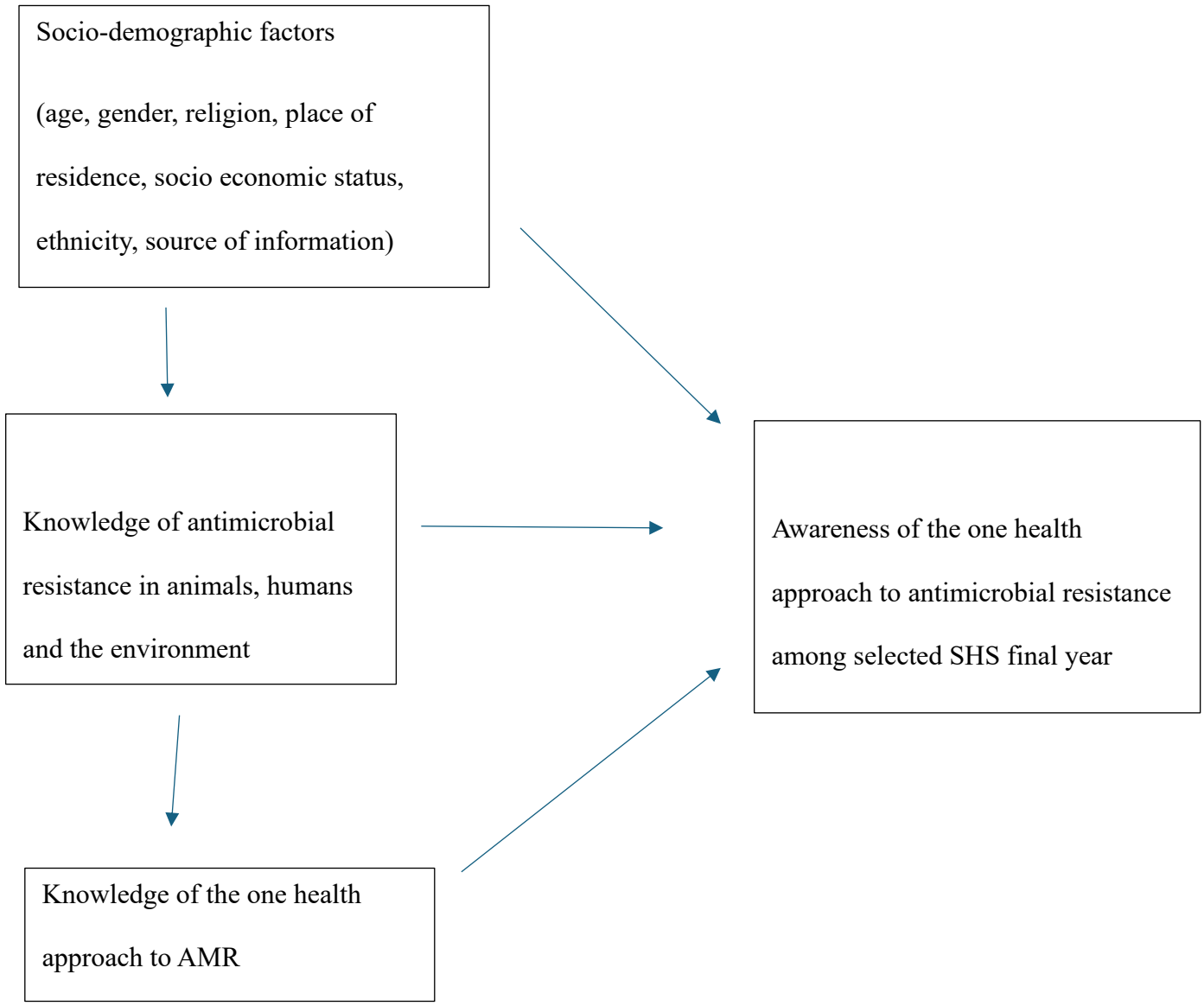

Figure 1.1 Conceptual framework of antimicrobial resistance (Karen Gyasi 2022)

The conceptual framework above represents factors influencing awareness of the One Health approach to antimicrobial resistance (AMR). Three main factors namely socio-demographic, Knowledge of antimicrobial resistance in animals, humans and the environment and Knowledge

of the one health approach to AMR have been identified to influence awareness of one health approach to antimicrobial resistance.

Socio–demographic characteristics such as age, gender, program of study, economic status, primary source of information is expected to directly affect individuals' exposure to information and behaviors related to antimicrobial use. These, in turn, may shape knowledge and awareness of AMR and also their knowledge of the One health approach to antimicrobial resistance.

Also, these three factors identified further influences an individual's awareness of the one health approach in combating AMR in humans.

1.5 Research Questions

1. What are students' awareness level of antimicrobial resistance and its current trend?

2. What is the awareness level of students on one health approach to antimicrobial resistance?

3. What factors influence the students' awareness of the One Health approach to antimicrobial resistance?

1.6 General Objective

To assess the factors influencing the awareness of the One Health Approach to antimicrobial resistance among Senior High School students in the Lower Manya Krobo Municipality in Eastern Region, Ghana.

Specific Objectives

1. To assess students' awareness level of antimicrobial resistance and it current trends.

2. To evaluate students' awareness of One Health Approach to antimicrobial resistance.

3. To determine the socio demographic factors (e.g sex, age, gender, program of study) that influence students' understanding of the One Health Approach to antimicrobial resistance.

1.8 Profile of the Study Area

The Lower Manya Krobo Municipal District, situated within Ghana's Eastern Region, spans approximately 316 km², about 8.1% of the region's total land area of 18,310 km². According to the 2021 Population and Housing Census, the district's population stands at 121,478, comprising 56,662 males and 64,816 females (Ghana Districts, 2024).

Age structure data highlight a youthful population: approximately 30.8% (24,139 individuals) are aged 0–9 years, and 23.6% (28,624 individuals) fall within the 10–19 age bracket. Those aged 15–64 make up a majority at 64%, with only about 5.7% aged 65 and above. Urban–rural distribution shows that 75.3% of residents live in urban areas (91,503 people), with the remaining 24.7% (29,975 people) in rural localities. In terms of literacy for individuals aged 11 and above, 75,599 are literate, while 19,006 are not. The ethnic composition is predominantly Ga-Dangme (87,608), followed by Akan (7,378) and Ewe (21,092) groups (GSS, 2021).

These demographic characteristics indicate a vibrant, youthful and semi-urban district with high literacy rates and dynamic population growth. This makes Lower Manya Krobo an ideal study site.

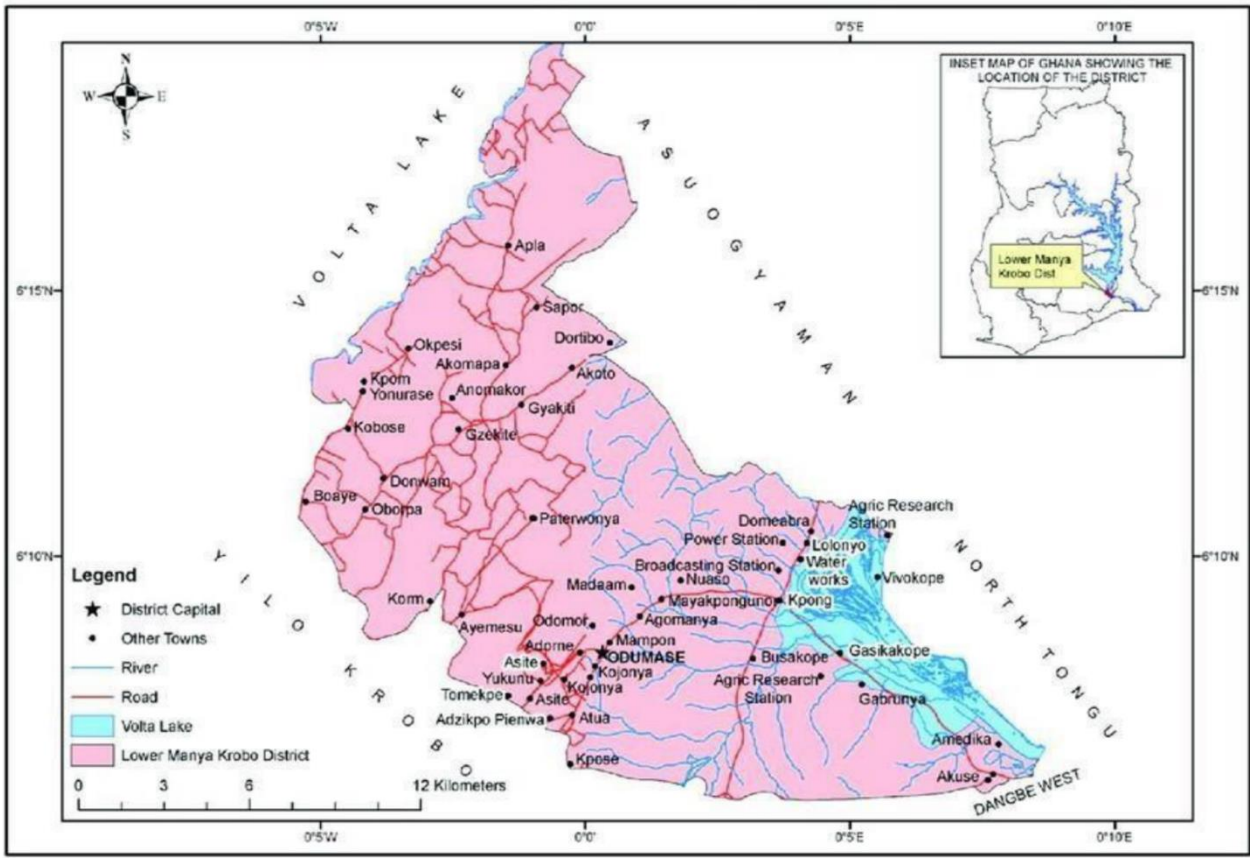

Figure 1.2 Map of the lower Manya Krobo municipal area

1.9 Scope of the Study

This study focused on final-year Senior High School students in selected schools within the Lower Manya Krobo Municipality in the Eastern Region of Ghana. Conducted between 1st July and 30th September 2025, it examined students' demographic characteristics, as well as their level of awareness and knowledge of antimicrobial resistance (AMR) and the One Health Approach. Special emphasis was placed on antibiotic resistance, given its frequent misuse and abuse as a key driver of AMR. The study concludes with recommendations to strengthen awareness and promote responsible antimicrobial use among students, thereby supporting the integration of the One Health Approach into local and national AMR strategies.

1.10 Organization of the Report

This report is organized into six chapters, preceded by the preliminary sections, including the table of contents, list of figures and tables, definitions of key terms, and an abstract summarizing the scope, objectives, methods, findings, and conclusions. Chapter One introduces the study by presenting the background, problem statement, rationale, conceptual framework, research questions, objectives, and scope. Chapter Two reviews relevant literature related to the study objectives. Chapter Three outlines the methodology, covering the study area, research design, population, sampling, variables, data collection tools, analysis procedures, ethical considerations, and study limitations. Chapter Four presents the results of the data analysis, supported with tables and figures. Chapter Five discusses the findings in relation to the research questions and existing literature, while Chapter Six concludes the study and provides recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Antimicrobial Agents

Antimicrobial agents are substances, whether natural, semi-synthetic, or synthetic, that inhibit or kill microorganisms such as bacteria, viruses, fungi, or protozoa (FAO, 2019). They are widely applied in human medicine, agriculture, veterinary practice, food production, and environmental sanitation (Mathew et al., 2022). The major categories include antibiotics, antivirals, antifungals, antiparasitics, antiseptics, and disinfectants (Ventola, 2015).

Among these, antibiotics remain the most commonly used and most significant group because of their critical role in treating bacterial infections (Klein et al., 2018). However, the extensive and often inappropriate use of antimicrobials in human health, animal production, and crop farming has created widespread selective pressure, accelerating the emergence of antimicrobial resistance (AMR) (WHO, 2021). Inappropriate usage of antimicrobials includes self-medication, over-prescription, growth promotion in animals, and disposal of drug residues into the environment (Ocan et al., 2015).

The misuse of antimicrobial agents in one sector has consequences for others, demonstrating why their regulation cannot be separated across human, animal, and environmental health systems (Collignon and McEwen, 2019). It is within this recognition that the One Health approach has become central to AMR discourse, acknowledging the interconnectedness of health outcomes across species and ecosystems.

2.2 Antibiotics

Antibiotics are a specific subset of antimicrobial agents that act against bacterial infections either by killing the bacteria (bactericidal) or inhibiting their growth (bacteriostatic) (FAO, 2019). Their discovery and widespread application throughout the 20th century revolutionised medicine, contributing to major declines in mortality from bacterial diseases (Podolsky, 2018). However, the overuse and inappropriate use of antibiotics has increasingly undermined their effectiveness, making stewardship essential (Cassini et al., 2019).

To guide stewardship and optimize antibiotic use, the World Health Organization developed the AWaRe classification in 2017, subsequently revised in 2019, 2021, and 2023 (WHO, 2023). This framework groups antibiotics into three categories: Access, Watch, and Reserve. The Access group includes first- or second-line agents that are effective, affordable, and have a lower risk of resistance development, such as amoxicillin and chloramphenicol.

The Watch group comprises antibiotics with a higher resistance potential, including fluoroquinolones such as ciprofloxacin, which are recommended only for specific indications. Finally, the Reserve group represents last-resort drugs such as colistin and fosfomycin, reserved for the treatment of multidrug-resistant infections (WHO, 2020).

This classification is not only technical but also strategic: it provides a global stewardship target that at least 60% of national antibiotic consumption should derive from the *Access* category (Sharland et al., 2019). Countries that have applied this framework report improved stewardship, reduced inappropriate prescribing, and more effective monitoring of antibiotic consumption patterns (Hernández et al., 2023). For Ghana, where antibiotic access remains largely unregulated

in both formal and informal outlets, adopting AWaRe principles is particularly important for containing resistance (Jimah, Fenny and Ogunseitan, 2020).

2.3 Use and Misuse of Antibiotics in Humans

The misuse of antibiotics in humans remains one of the leading drivers of antimicrobial resistance globally. Key practices that contribute to this include self-medication, incomplete courses of treatment, inappropriate prescribing by clinicians, and poor infection prevention and control measures in healthcare facilities (Owusu-Ofori et al., 2021). These behaviours are especially prevalent in low- and middle-income countries (LMICs), where weak regulatory systems and easy over-the-counter access to antibiotics compound the challenge (Ocan et al., 2015).

Studies show that self-medication with antibiotics is particularly widespread in Africa. A systematic review and meta-analysis covering 19 African countries reported self-medication rates ranging from 12.1% to 93.9%, with West Africa recording the highest prevalence (Yeika et al., 2021). In Ghana, research indicates that between 40–70% of antibiotics are acquired without prescription, often from community pharmacies or informal drug sellers (Ahiabu et al., 2018). Such practices lead to inappropriate drug selection, incorrect dosages, and premature discontinuation of treatment, all of which increase the risk of resistant bacterial strains emerging (Opoku et al., 2023).

Evidence from higher education institutions further demonstrates significant knowledge gaps among young adults. A study in Ethiopia among paramedical students found that while most participants recognized AMR as a serious public health issue, only 45% demonstrated good knowledge of antibiotic use (Seid and Hussen, 2018). Similarly, Jimah, Fenny and Ogunseitan (2020) reported that 63% of respondents in Ghanaian communities were unaware of antibiotic

resistance altogether. These findings highlight the importance of targeted interventions, especially in adolescents and young adults, to address misconceptions and promote responsible antibiotic use.

2.4 Antibiotic Use and Resistance in Animals

The use of antibiotics in animals represents another critical pathway for the development and spread of antimicrobial resistance. Food-producing animals are frequently treated with antibiotics not only for therapeutic purposes but also for prophylaxis and growth promotion (Tang et al., 2017). Estimates suggest that nearly 73% of all antimicrobials sold globally are used in livestock production (Van Boeckel et al., 2019). In Ghana and other African countries, antibiotics such as tetracyclines and penicillin are routinely added to animal feed at sub-therapeutic levels to increase productivity and reduce mortality (Turkson, 2009; Sekyere, 2014).

This practice has been linked to the emergence of resistant bacteria in animals that can be transferred to humans through direct contact, the food chain, or environmental contamination. For instance, Escherichia coli resistant to third-generation cephalosporins has been reported in poultry populations, with genetic resistance mechanisms such as extended-spectrum beta-lactamases (ESBLs) transferable to human pathogens (Bennani et al., 2020). The Netherlands provides a clear example of how reducing antibiotic use in food animals can yield positive outcomes. After the prohibition of certain cephalosporins in hatcheries in 2010, cefotaxime resistance in broilers decreased from over 20% in 2007 to 2.9% by 2014 (Bennani et al., 2020).

A systematic review by Tang et al. (2017) further demonstrated that reducing antimicrobial use in livestock led to a 15% overall reduction in bacterial resistance and up to 32% reduction in multidrug resistance. These findings underscore the importance of stewardship interventions in the

veterinary sector. However, African countries face particular challenges in this regard due to weak veterinary regulatory systems, unmonitored antibiotic sales, and poor enforcement of existing policies (Hein et al., 2022).

Veterinary students and practitioners in sub-Saharan Africa have also been shown to possess limited knowledge of antimicrobial stewardship. A survey across Nigeria, South Africa, and Sudan found that only 36.3% of veterinary students felt confident in their ability to select appropriate antimicrobial agents for specific animal cases (Odetokun et al., 2019). In Ghana, Turkson (2009) highlighted poor farm-level practices, such as inappropriate drug storage and unsafe disposal of veterinary medicines, further compounding the risk of resistance.

The One Health perspective emphasises that antibiotic misuse in animals is inseparably linked to human and environmental health. Resistant pathogens originating in livestock can be transmitted to humans through meat, milk, and eggs, while animal waste introduces resistance genes into the environment (FAO, 2019). Without stringent regulation and education, the animal sector will remain a significant driver of resistance in Ghana, highlighting the urgent need for integrated interventions that target farmers, veterinarians, and policy-makers.

2.5 Antibiotic Use and Resistance in the Environment

The environment plays a pivotal role in the evolution, persistence, and spread of antimicrobial resistance (AMR). Increasingly, researchers have recognised the environment not just as a passive reservoir but as an active driver in the dissemination of resistance genes (Bengtsson-Palme, Kristiansson and Larsson, 2018). Soil, rivers, sewage, and agricultural fields all contain diverse microbial communities that harbour naturally occurring resistance genes, which may transfer horizontally to pathogenic bacteria (Nijsingh, Munthe and Larsson, 2019).

One major pathway is the release of antibiotics and their metabolites into water bodies through pharmaceutical effluents, hospital wastewater, and agricultural runoff. Low-level antibiotic residues in rivers or soil exert selective pressure on microbial populations, favouring resistant strains even at concentrations far below clinical doses (FAO, 2019). This phenomenon is concerning because sub-inhibitory concentrations of antimicrobials have been shown to accelerate the horizontal transfer of resistance genes between environmental bacteria and pathogens (Larsson et al., 2018).

Agricultural practices also contribute significantly to environmental AMR. Manure from livestock treated with antibiotics is widely used as fertilizer, leading to the dissemination of resistant bacteria and genes into soils and crops. Studies have detected multi-drug resistant *E. coli* and other resistant organisms in vegetables irrigated with contaminated water or grown in manure-enriched soil (Manyi-Loh et al., 2018). This route poses direct risks to humans as fresh produce is often consumed raw, allowing resistant organisms to bypass cooking and food-processing barriers.

In Ghana and other LMICs, weak waste management systems heighten these risks. Poor regulation of pharmaceutical effluents and limited capacity for wastewater treatment mean antibiotics frequently enter natural water systems unchecked (Sekyere, 2014). The WHO (2021) has emphasised that tackling AMR requires environmental monitoring alongside human and animal health surveillance.

Recent evidence underscores the scale of the problem: a global survey detected antibiotic residues in rivers across 72 countries, with concentrations exceeding safe thresholds in nearly 65% of sites tested (Wilkinson et al., 2019). Such findings highlight the need for environmental stewardship policies, including stricter regulation of pharmaceutical industries, improved sanitation infrastructure, and sustainable farming practices.

From a One Health perspective, the environment serves as a critical interface where human, animal, and ecological systems converge. Resistant genes circulating in soil and water can re-enter human populations through food, drinking water, and recreational exposure, making environmental interventions indispensable for AMR containment (Collignon and McEwen, 2019).

2.6 Antimicrobial Resistance (AMR)

Antimicrobial resistance (AMR) is defined as the ability of microorganisms including bacteria, viruses, parasites, and fungi, to withstand drugs that once killed them or inhibited their growth (Collignon, 2017). While resistance can emerge naturally through mutations or gene exchange, it has been drastically accelerated by inappropriate antimicrobial use across human, animal, and environmental domains (Castro-Sánchez et al., 2016).

The scale of the AMR crisis is alarming. In 2019, bacterial AMR was linked to an estimated 4.95 million deaths worldwide, of which 1.27 million were directly attributable (Murray et al., 2022). Sub-Saharan Africa bears the highest mortality rates, with over 27 deaths per 100,000 attributable to resistant infections, compared to 13 per 100,000 in high-income countries (IHME, 2023). Beyond mortality, AMR prolongs illness, increases treatment costs, and undermines modern medical procedures such as surgeries, cancer chemotherapy, and organ transplantation (WHO, 2021).

Drivers of AMR: Multiple factors drive resistance. Over prescription and inappropriate use of antibiotics in healthcare remain major contributors (Owusu-Ofori et al., 2021). Self-medication and over-the-counter sales, particularly in LMICs, add to the burden (Opoku et al., 2023). In the veterinary sector, routine prophylactic and growth-promoting antibiotic use in livestock sustains selection pressure, while environmental contamination spreads resistant genes beyond clinical

settings (Van Boeckel et al., 2019). Globalization, including international trade and travel, further facilitates the rapid dissemination of resistant pathogens across borders (Pokharel, Raut and Adhikari, 2019).

Educational and Public Awareness Gaps: One of the less addressed but critical contributors to AMR is low public awareness. A WHO (2015) multi-country survey revealed that over 60% of respondents believed antibiotics could treat viral infections such as influenza, underscoring the persistence of misconceptions. In Ghana, Jimah, Fenny and Ogunseitan (2020) found that 63% of community respondents were unaware of antibiotic resistance. Adolescents, in particular, are under-researched yet represent a group highly susceptible to misinformation through peers, media, and unregulated drug vendors. Addressing these gaps through school-based education has been recommended in both global and national AMR action plans (Hein et al., 2022).

AMR as a One Health Issue: The recognition of AMR as a One Health issue reflects its interconnected nature. Resistant organisms emerge in one sector and readily cross into others: for example, resistant *Salmonella* and *E. coli* in livestock can infect humans through food chains, while hospital waste carrying resistant bacteria contaminates rivers that irrigate crops (Bengtsson-Palme et al., 2018). This complexity necessitates cross-sectoral collaboration, integrating medical, veterinary, agricultural, and environmental policies.

Future Projections and Urgency: Without urgent action, AMR is projected to cause 10 million deaths annually by 2050, surpassing cancer as the leading cause of mortality (O'Neill, 2016). Economically, it may cost the world up to US$100 trillion in lost output by mid-century (World Bank, 2016). Such projections underline the urgent need for awareness campaigns, responsible prescribing, investment in new antimicrobials, and effective stewardship programmes.

In sum, AMR is a multifaceted crisis with devastating health, social, and economic consequences. For Ghana, where antibiotic misuse and weak regulatory systems persist, the challenge is compounded by lo

2.7 One Health Approach

The One Health (OH) approach is increasingly recognised as the cornerstone of global strategies to address antimicrobial resistance (AMR). It refers to the integrated effort of multiple disciplines working at local, national, and global levels to achieve optimal health outcomes by recognising the interconnection between people, animals, plants, and their shared environment (Kahn, 2017). Unlike traditional approaches that separate human health from veterinary or environmental health, OH emphasizes collaboration across these domains to tackle complex health threats that transcend species boundaries. Components of the One Health Approach include;

1. **Human Health**: focuses on the appropriate use of antimicrobials in healthcare settings, improved infection prevention and control, and public education about antibiotic stewardship. Misuse in hospitals and self-medication in communities create strong selective pressures for resistant bacteria (Opoku et al., 2023).

2. **Animal Health**: addresses the widespread use of antimicrobials in livestock, aquaculture, and veterinary medicine. More than 70% of global antibiotic sales are used in food-producing animals, often for growth promotion rather than treatment (Van Boeckel et al., 2019). Resistant organisms from animals, such as *E. coli* and *Salmonella*, can spread to humans through food chains or direct contact.

3. **Environmental Health**: recognizes that water bodies, soils, and ecosystems are critical reservoirs and transmission routes for resistant organisms and genes. Waste from hospitals,

pharmaceutical industries, and agriculture introduces antibiotic residues and resistant bacteria into rivers and soils, which can then re-enter human populations through food or drinking water (Bengtsson-Palme, Kristiansson and Larsson, 2018).

These three pillars are connected by cross-sectoral collaboration and knowledge-sharing mechanisms that ensure data on AMR surveillance, drug use, and emerging risks are integrated across health systems (Zinsstag et al., 2011).

2.7 One Health and AMR

The relevance of One Health to AMR is particularly striking. Resistance does not remain confined to one sector. Misuse of antibiotics in livestock or aquaculture can foster resistant strains that contaminate food and spread to humans. Similarly, antibiotics released into rivers and soils can drive environmental resistance that eventually transfers to human pathogens through horizontal gene transfer (Larsson et al., 2018). The One Health approach therefore provides a holistic way of addressing these feedback loops, ensuring that interventions in one domain are not undermined by neglect in another.

2.8 The Global Action Plan on AMR

Recognizing AMR as a global health emergency, the World Health Organization (WHO), in collaboration with the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE), launched the Global Action Plan (GAP) on Antimicrobial Resistance in 2015 (WHO, 2015). The GAP provides a strategic framework for member states to develop national policies and align global responses to the growing resistance crisis.

The plan is built on five key objectives. The first is to improve awareness and understanding of AMR through effective communication, education, and training. Public awareness remains uneven

globally, with significant misconceptions persisting, such as the belief that antibiotics can cure viral infections (WHO, 2015). Educational interventions, particularly in LMICs, are thus central to this objective.

The second objective focuses on strengthening the knowledge and evidence base through surveillance and research. Robust surveillance systems such as the Global Antimicrobial Resistance and Use Surveillance System (GLASS) are designed to monitor resistance trends across countries (WHO, 2021). However, many LMICs, including Ghana, face challenges of weak laboratory infrastructure and limited technical capacity (Hein et al., 2022).

The third objective aims to reduce infection incidence through improved sanitation, hygiene, and infection prevention measures. Evidence shows that enhancing water, sanitation, and hygiene (WASH) infrastructure can significantly curb the spread of resistant infections in both healthcare and community settings (Collignon and McEwen, 2019).

The fourth objective emphasizes optimizing antimicrobial use in human and animal health. This is operationalized through frameworks like the AWaRe classification of antibiotics, which guide stewardship efforts to ensure rational use of medicines (WHO, 2023).

Finally, the fifth objective seeks sustainable investment in the development of new drugs, diagnostics, and vaccines. With few new antibiotic classes developed in recent decades, the GAP stresses the need for incentivizing pharmaceutical innovation while ensuring equitable access (OECD, 2018).

Since its adoption, the Global Action Plan has been a benchmark for countries in designing national strategies. Yet progress has been uneven, with implementation gaps particularly pronounced in LMICs. Ghana's National Action Plan (2017–2021) adapted the Global Action Plan but faced

challenges of financing, coordination, and enforcement (Hein et al., 2022). Despite these constraints, the Global Action Plan remains a cornerstone of global efforts, highlighting AMR as not merely a biomedical challenge but a socio-economic and ecological issue requiring collective responsibility.

2.9 The Ghana National Action Plan on AMR

Ghana's response to the growing antimicrobial resistance (AMR) crisis has been framed within the National Action Plan (NAP) on Antimicrobial Resistance 2017–2021, which was developed in line with the Global Action Plan (GAP) of the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (OIE). The NAP reflects Ghana's commitment to situating AMR within a One Health (OH) perspective, acknowledging that the misuse of antimicrobials in humans, animals, and agriculture, combined with weak regulatory and surveillance systems, creates an environment conducive to resistance (Hein et al., 2022).

Strategic Priorities of the National Action Plan

The Ghanaian NAP adapted the GAP's five overarching objectives but contextualized them to reflect national realities. The first objective emphasizes improving awareness and understanding of AMR through effective communication, education, and training. This objective recognizes that public awareness of AMR remains critically low, with studies reporting high levels of self-medication and misconceptions about antibiotic use in Ghana (Jimah, Fenny and Ogunseitan, 2020; Opoku et al., 2023). The second objective prioritizes strengthening knowledge and evidence through surveillance and research. This has led to the establishment of sentinel sites for laboratory-

based AMR monitoring, although coverage remains patchy due to infrastructural limitations (Yevutsey et al., 2017).

The third objective focuses on reducing the incidence of infections through improved hygiene, sanitation, and infection prevention and control (IPC) measures. Ghana's recurrent cholera and diarrhoea disease outbreaks underscore the importance of IPC as a complementary strategy to reduce unnecessary antimicrobial use (WHO, 2021). The fourth objective calls for optimizing the use of antimicrobial medicines in human and animal health. Efforts here include introducing stewardship programmes in hospitals and revising treatment guidelines to reduce inappropriate prescribing (Otieku et al., 2023). Finally, the fifth objective is to secure sustainable investment in new medicines, diagnostics, and vaccines. However, funding constraints have made this the least advanced area, as most interventions rely on donor support rather than sustainable domestic financing (Hein et al., 2022).

2.10 One Health Integration in the Ghanaian NAP

The Ghanaian NAP is significant because it explicitly adopts a One Health framework. It acknowledges that resistance is not only a medical problem but also one driven by agricultural and environmental practices. Antibiotics are commonly used in poultry and aquaculture in Ghana to promote growth and prevent infections, often with little veterinary oversight (Turkson, 2009; Sekyere, 2014). Surveillance capacity within veterinary and environmental sectors remains weak, and cross-ministerial collaboration has been limited (Hein et al., 2022). The Ghana National Action Plan (2017–2021) embraced OH principles, but its evaluation highlighted gaps in coordination, infrastructure, and curriculum integration.The GNAP therefore mandates collaboration between the Ministry of Health, the Ministry of Food and Agriculture, the Fisheries Commission, and the Environmental Protection Agency to ensure coordinated stewardship across sectors. Yet,

evaluations of the National Action Plan reveal gaps in its one health implementation. For example, while stewardship programmes in hospitals have received some investment, veterinary and environmental surveillance have lagged due to weak infrastructure and lack of political prioritization (Hein et al., 2022). This imbalance risks undermining the one health principle, as interventions in one domain may be negated by inaction in others.

2.11 Challenges in Implementation

Despite its ambitious scope, the Ghanaian NAP has faced several challenges. Firstly, limited financing has restricted the rollout of planned interventions, with many activities dependent on external donors (Hein et al., 2022). Secondly, fragmentation across sectors has hindered coordination. Ministries and agencies often operate in silos, with weak data sharing and communication. Thirdly, weak enforcement of regulations remains a persistent challenge. Antibiotics continue to be sold over the counter in pharmacies and chemical shops despite legislation requiring prescriptions (Opoku et al., 2023). Finally, there is a gap in public and youth engagement. While adult populations have been targeted through public campaigns, little has been done to integrate AMR and OH concepts into school curricula or youth programmes.

2.12 Conclusion

In summary, the Ghana National Action Plan represents a major step forward in aligning national strategies with global AMR priorities. Its adoption of a one health framework reflects recognition of the multisectoral drivers of resistance. However, gaps in implementation, particularly around financing, veterinary and environmental surveillance, and youth engagement remain significant. The GNAP's emphasis on awareness creation and education makes this study particularly timely. By investigating the awareness of AMR and one health among Senior High School (SHS) students,

this research directly contributes to one of the plan's central pillars. Adolescents are a critical demographic, representing both future health professionals and everyday users of antibiotics. Their current level of knowledge influences not only personal behaviour but also the broader culture of antimicrobial use in Ghana. Evidence from other contexts has shown that introducing AMR education early can improve antibiotic stewardship practices and foster a generation more committed to responsible use (Newitt et al., 2017).

This study, by focusing on SHS students' awareness of AMR through a one health lens, addresses a critical blind spot in the National Action Plan and provides evidence that can inform future AMR policy decisions.

CHAPTER THREE

METHODOLOGY

3.1 Study Design

This study employed a descriptive cross-sectional design using quantitative methods to assess the awareness, knowledge, and misconceptions about antimicrobial resistance (AMR) among Senior High School students. The cross-sectional design is appropriate for capturing data at a single point in time and is cost-effective and suitable for school-based surveys.

3.2 Study Site

The study was conducted amongst Senior High School science students within the Lower Manya Krobo Municipal District of the Eastern Region of Ghana. The municipality is semi-urban, with a youthful population and high literacy levels. These characteristics make it an ideal location for studying awareness and misconceptions about AMR among adolescents, who represent a crucial target group for public health education.

3.3 Study Population

The target population will consist of science students attending Senior High Schools in the Lower Manya Krobo District.

Inclusion Criteria

2nd and final year Senior High science students in selected schools within the Lower Manya Krobo District.

Exclusion Criteria

First year students and non-science students will be excluded from the study

3.4 Study Site

The Lower Manya Krobo Municipal District, situated within Ghana's Eastern Region, spans approximately 316 km², about 8.1% of the region's total land area of 18,310 km². According to the 2021 Population and Housing Census, the district's population stands at 121,478, comprising 56,662 males and 64,816 females (Ghana Districts, 2024). These demographic characteristics indicate a vibrant, youthful and semi-urban district with high literacy rates and dynamic population growth. This makes Lower Manya Krobo an ideal study site.

3. 4.1 Dependent variables

1.Awareness of AMR

2.Awareness of the One- Health Approach

Independent variables

Socio- demographic factors: age, program of study, ethnicity, religion, place of residence, primary source of news/information.

Economic factors: Socio-economic class.

3.5 Sample Size

The sample size will be calculated using Cochran's formula:

$$n = \frac{Z^2 \times pq}{e^2}$$

Where:

- n = sample size
- Z = z-score for 95% confidence level = 1.96
- p = Estimated proportion of students with good AMR knowledge = 37% (Jimah, Fenny and Ogunseitan, 2020)
- q = (Proportion with poor AMR knowledge)1 − p = 0.63
- e = margin of error = 0.05

$$n = \frac{(1.96)^2 \times (0.37 \times 0.63)}{(0.05)^2} \cong 358$$

To accommodate for a potential non-response rate of 10%, the final adjusted sample size will be: 394

3.6.1 Sampling Procedure

A multistage sampling approach was employed to select participants for this study.

Stage 1: stratified selection of schools

All Senior High Schools in the Lower Manya Municipality were first grouped into two strata based on public and private schools. From each stratum, a proportionate number of schools were randomly selected using simple random sampling. This approach ensures both public and private schools are fully represented in the study.

Stage 2: Selection of students

Finally, respondents were selected using simple random sampling from class registers to ensure equal representation and reduce selection bias. The number of students drawn from each school

will be proportionate to the total student population of the school to ensure equitable representation. Eligible students who provided informed assent were enrolled and administered the questionnaire by trained data collectors.

3.7 Data Collection Methods and Instruments

Data was collected using an adapted and modified structured, self-administered questionnaire employing close ended questions. The questionnaire was extracted from the literature reviewed and designed to reflect the specific objectives of the study (Sakeena *et al.*, 2019; Shahpawee *et al.*, 2020).

The questions contained in the questionnaire focused on socio- demographic factors, awareness of antibiotic (antimicrobial) resistance and awareness of the One- Health Approach.

The questionnaire included multiple-choice, and true/false items. It was administered in English with assistance from trained research assistants to clarify questions as needed.

3.8 Pre-testing

The questionnaire was pre-tested among 40 students from in Yilo Krobo Senior High School to assess clarity, flow, and cultural appropriateness. Feedback from the pre-test will inform revisions to ensure the instrument is valid and easy to understand.

3.9 Data Handling

Completed questionnaires were checked for completeness each day and securely stored. Data was entered electronically using KoboCollect and exported to Microsoft Excel and SPSS version 2.0 for analysis. Access to digital data will be restricted to the research team and project supervisor

using password-protected devices. All data will be anonymized to ensure confidentiality. Data will be stored for a maximum of 5 years before being destroyed.

3.10 Statistical Analysis

Descriptive statistics (frequencies, means, and percentages) was used to summarize demographic characteristics, AMR and One Health Approah knowledge levels. Respondents' socio-demographic factors; age, gender, program of study, religion, place of residence, socio economic status, ethnicity and primary source of information were analyzed firstly using simple proportions (frequencies and percentages). Microsoft Excel was used to score the responses and clean data. Data was analyzed using SPSS V2.0. Three (3) categories were generated using Bloom cut off point. Scores between 80- 100% were categorized as good, 60-79% moderate and scores less than 60% graded as poor for the two dependent variables. Chi- squared tests and cross tabulations were used to determine associations between the socio demographic factors and the level of awareness of AMR. Multivariable Logistic regression models were used to test for the strength of association between the socio- demographic factors and the level of awareness of AMR and the socio- demographic factors and the One- Health Approach to AMR. A confidence interval of 95 % was used to show significant relations between the dependent and independent variables ($p<0.05$).

3.10 Ethical Considerations

Ethical issues related to the study were addressed by the following:

Ethical clearance: Ethical clearance will be first sought from the Ensign Institutional Review Board. Administrative approval will also be sought from GES.

Privacy/ Confidentiality: Participants will be assured of confidentiality and privacy to respond to the questions. In order to assure the respondents of the privacy of information, they will not be asked to provide their names, telephone numbers and house addresses.

Voluntary withdrawal: Participants will be assured that participation in this research is entirely voluntary. They are free to withdraw consent and discontinue participation in the study at any time.

3.11 Limitations of Study

A limitation of the study included;

- The study exceeded the minimum calculated sample size (358) by surveying 394 respondents, it was limited in scope to science students from four randomly selected Senior High Schools in the Lower Manya Krobo Municipality.
- The findings may not be generalizable to all SHS students in Ghana or even to non-science students within the same municipality.
- Students could have given desirable answers to the question posed with regards to the Socioeconomic status and may not be a true reflection of the socioeconomic status of their parents.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the empirical findings of the study in a structured manner. It begins with a descriptive analysis of the socio-demographic characteristics of the participants, including age, gender, programme of study, academic performance, religion, and place of residence. These characteristics provide the necessary context for interpreting subsequent results on awareness and knowledge.

The chapter then examines the level of awareness of antimicrobial resistance (AMR) among participants. This section highlights the extent to which students have been exposed to the concept of AMR, their understanding of its causes and implications, and their awareness of key initiatives such as Ghana's National Action Plan and the principles of antibiotic stewardship. In addition, participants' global knowledge of AMR and antibiotic resistance is explored to provide insight into the broader scope of their understanding.

The chapter further reports findings on awareness and perceptions of the

The final section presents the results of multivariate analyses, specifically logistic regression models, which examine the association between socio-demographic characteristics and awareness of AMR. The findings are expressed in terms of odds ratios to facilitate interpretation of the relative influence of these predictors. The next section begins with a description of the socio-demographic characteristics of the participants.

4.2 Socio-Demographic Characteristics of the Participants

The questionnaire was completed by 393 students. From Table 4.1, majority of respondents (68.2%) were less than 18 years old, while 31.8% were above 18 years. Most participants were female (75.1%) and enrolled in General Science programmes (89.3%), with only 10.7% in Agricultural Science. Christianity was the predominant religion (81.7%), followed by Islam (15.8%) and Traditional beliefs (2.5%). In terms of socio-economic status, most students belonged to the middle class (69.7%), with smaller proportions in the low (15.3%) and high classes (15.0%). Ethnically, respondents were mainly Akan (31.6%), Ewe (26.5%), Krobo (17.8%), and others (17.8%), with Ga-Adangbe representing 6.4%. The internet was the most common primary source of information (64.1%), followed by TV (20.4%), radio (9.9%), and newspapers (5.1%), while social media contributed the least (0.5%). In terms of location, the majority resided in urban areas (59.5%), with smaller proportions in rural (21.6%) and peri-urban (18.8%) areas. The characteristics of the respondents are represented in Table .4.1

Table 4.1 Summary of the Socio-Demographic Characteristics of the Participants. (n=393)

Variables	Categories	Frequency	Percentage
Age	Less than 18years	268	68.19
	More than 18years	125	31.81
Gender	Male	98	24.94
	Female	295	75.06
Programme	General science	351	89.31
	Agricultural science	42	10.69
Religion	Christianity	321	81.68
	Islam	62	15.78

	Traditional	10	2.54
Socio-economic status	Low class	60	15.27
	Middle class	274	69.72
	High class	59	15.01
Ethnicity	Akan	124	31.55
	Ga-Adangbe	25	6.36
	Krobo	70	17.81
	Ewe	104	26.46
	Others	70	17.81
Primary source of information	Internet	252	64.12
	Social media	2	0.51
	Newspaper	20	5.09
	Radio	39	9.92
	TV	80	20.36
Location	Rural	85	21.63
	Peri-Urban	74	18.83
	Urban	234	59.54

4.3 Awareness of AMR among students

The findings represented in table 4.2 indicates that out of the 167 participants that responded to this section, 78.5% responded correctly, the difference between an antibiotic and an antimicrobial. 28.8 % of the respondents could not tell that scientists have enough antibiotics under development. More than half the respondents 57.5% answered correctly that AMR will be the leading cause of death by 2050 if measures are not put in place. 6.0 % answered correctly that Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well. Most respondents (74.3% and 74.9%, respectively) correctly acknowledged that most infections are becoming increasingly resistant to antibiotics and that resistant bacteria are difficult to treat. 65.3% agreed that Antibiotic resistance is an issue that can affect them and their family. 58.7 % of the respondents answered correctly that Antibiotic resistance is not just an issue in other countries but also in Ghana. 64.1 % of the respondents indicated that antibiotic resistance is only a problem for people who take antibiotics regularly. 40.1 % responded correctly that bacteria which are resistant could be spread from person to person. 59.3% correctly agreed that antibiotic resistant infections could make medical procedures like surgery, organ transplantation, and cancer treatment much more dangerous. The responses are represented in Table 4.2.

Table 4.2 Summary of Awareness of AMR (n=167)

Question/statements	**Correct N(%)**	**Incorrect N(%)**
What is the difference between an antimicrobial and an antibiotic?	131(78.45)	36(21.55)
Globally, do scientists have enough antibiotics under development at the moment to keep up with the problem of antibiotic resistance?	48(28.75)	130(71.25)

Antimicrobial resistance will be the leading cause of death in humans by 2050, if current trends continue.	96(57.49)	71(42.51)
Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well.	10(5.98)	157(94.01)
Many infections are becoming increasingly resistant to antibiotics.	124(74.25)	43(25.75)
If bacteria are resistant to antibiotics, it can be very difficult or impossible to treat the infection they cause.	125(74.85)	42(25.15)
Antibiotic resistance is an issue that could affect me or my family.	109(65.27)	58(34.73)
Antibiotic resistance is an issue in other countries but not here in Ghana.	98(58.68)	69(41.32)
Antibiotic resistance is only a problem for people who take antibiotics regularly.	60(35.93)	107(64.07)
Bacteria which are resistant to antibiotics can spread from person to person.	67(40.12)	100(59.88)
Antibiotic-resistant infections could make medical procedures like surgery, organ transplantation, and cancer treatment much more dangerous.	99(59.28)	68(40.72)

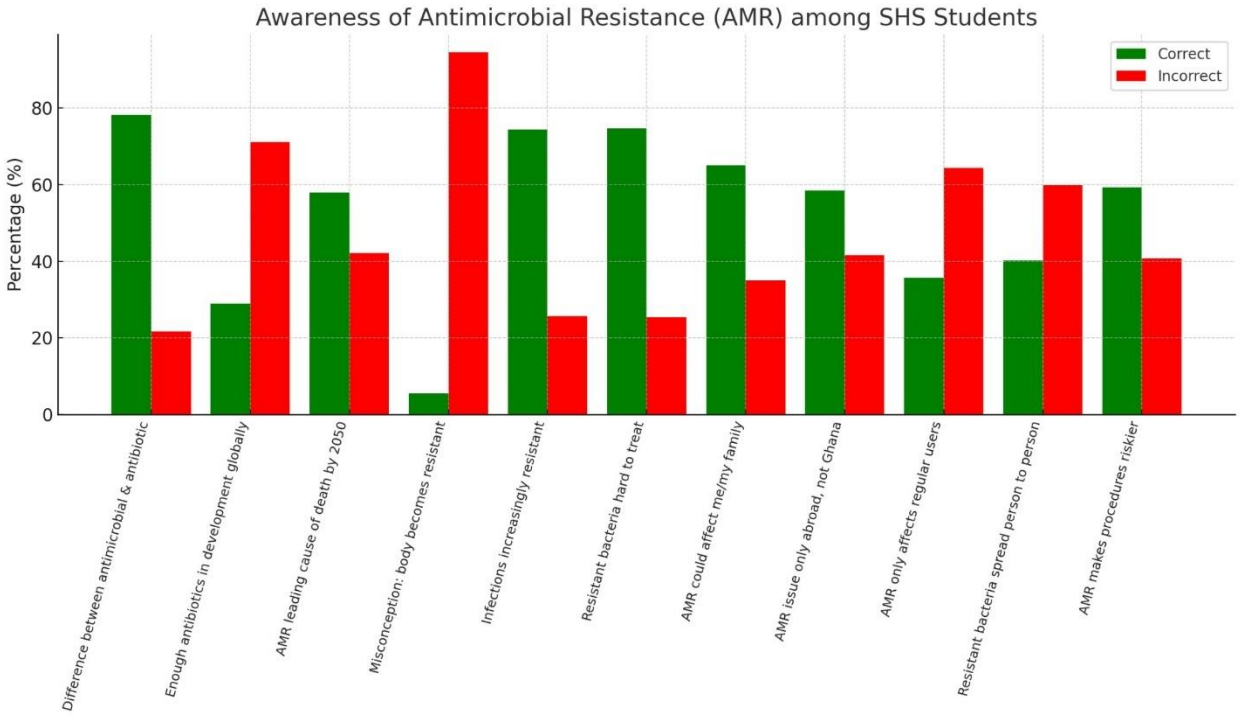

Figure 4.3 Graph showing the Awareness of Antimicrobial Resistance (AMR) among SHS Students

4.4 Awareness of the One-Health Approach to AMR among students

The results in Table 4.3 below indicates majority of respondents (62.5%) recognized that antibiotic resistance poses an increasing global threat to both human and animal health. Similarly, 60.9% correctly acknowledged the misuse of antibiotics by veterinary practitioners contributes significantly in driving antibiotic resistance in animals a bnd humans, while 53.1% recognized the contribution of farmers' misuse of antibiotics across plants, animals, and humans. two-thirds (67.1%) correctly agreed that the inappropriate use of antibiotics in food-producing animals significantly contributes to resistant human pathogens. However, 45.3% agreed that the improper disposal of antibiotics can contribute to resistance in plants, animals, and humans.

32.8% of the respondents correctly identified One Health as the only comprehensive way to address AMR, and 79.7% recognized that it emphasizes the interconnectedness of people, animals,

plants, and their environment. More than half of the respondents (54.7%) correctly agreed that the One Health Approach can protect global health security while improving food safety and security.

Table 4.3 Summary of Awareness of the One-Health Approach to AMR (n=64)

Questions/ Statements	Correct N(%)	Incorrect N(%)
Antibiotic resistance is an increasing global threat to human and animal health.	40(62.50)	24(37.50)
The misuse of antibiotics by veterinary practitioners contributes significantly to antibiotic resistance in both animals and humans.	39(60.94)	25(39.06)
The misuse of antibiotics by farmers contributes significantly to antibiotic resistance in plants, animals and humans.	33(53.12)	31(46.88.)
The inappropriate use of antibiotics in food-producing animals significantly contributes to antibiotic resistance in human pathogens.	43(67.19)	21(32.81)
Improper disposal of unused/excess antibiotics into the open environment can contribute to antibiotic resistance in plants, animals and humans.	29(45.31)	35(54.69)
The One- Health Approach is the only way to address antimicrobial resistance.	21(32.81)	50(67.18)
The One- Health Approach does not recognize the interconnection between people, animals, plants and their shared environment. These various sectors are independent of each other and should be targeted independently.	51(79.69)	13(20.31)
The One- Health Approach can protect global health security as well as improve food safety and security.	35(54.69)	29(45.31)

4.5 Association between demographic characteristics and awareness of antimicrobial resistance

Bloom's cut-off point classification as described by Feleke, Wale and Yirsaw **(2021)** was used to grade the level of awareness; poor, moderate and good. 19 students representing 11.4 % had a good knowledge of AMR scoring between 80-100%. 54 students (32.3%) had moderate score; ranging from 60- 79 %. 94 (56.3%) students had poor knowledge of AMR.

Pearson`s Chi squared showed that most variables had no statistically significant association with awareness levels ($p > 0.05$), except for gender ($p = 0.01$). Male students demonstrated relatively higher levels of good awareness (29.2%) compared to females (8.4%). Age, programme of study, religion, socio-economic status, ethnicity, source of information, and location did not show significant associations with AMR awareness.

Table 4.4 Chi-square of Association between demographic characteristics and awareness of antimicrobial resistance

Variables	Categories	Poor N(%)	Moderate N(%)	Good N(%)	p-value
Age	Less than 18years	76(59.8)	39(30.7)	12(9.4)	.187
	More than 18years	18(45.0)	15(37.5)	7(17.5)	
Gender	Male	10(41.7)	7(29.2)	7(29.2)	0.01
	Female	84(58.7)	47(32.9)	12(8.4)	
Programme	General science	85(54.8)	53(34.2%)	17(11.0)	.180
	Agricultural science	9(75.0)	1(8.3%)	2(16.7%)	
Religion	Christianity	84(56.4)	48(32.2)	17(11.4)	.930
	Islam	9(52.9)	6(36.3)	2(11.8)	
	Traditional	1(100.0)	0(0.0)	0(0.0)	

Socio-economic status	Low class	4(50.0)	3(37.5)	1(12.5)	.445
	Middle class	69(53.5)	43(33.3)	17(13.2)	
	High class	21(70.0)	8(26.7)	1(3.3)	
Ethnicity	Akan	27(47.4)	26(45.6)	4(7.0)	.242
	Ga-Adangbe	2(50.0)	2(50.0)	0(0.0)	
	Krobo	19(57.6)	9(27.3)	5(15.2)	
	Ewe	25(58.1)	12(27.9)	6(14.0)	
	Others	21(70.0)	5(16.7)	4(13.3)	
Primary source of information	Internet	62(56.4)	34(30.9)	14(12.7)	0.63
	Social media	0(0.0)	2(100.0)	0(0.0)	
	Newspaper	6(100.00)	0(0.0)	0(0.0)	
	Radio	8(61.5)	2(15.4)	3(23.1)	
	TV	18(50.0)	16(44.4)	2(5.6)	
Location	Rural	12(48.0)	9(36.0)	4(16.0)	.481
	Peri-Urban	21(63.0)	11(33.3)	1(3.0)	
	Urban	61(56.3)	54(32.3)	19(11.4)	

4.6 Association between demographic characteristics and awareness of the One-Health Approach

Bloom's cut-off point classification as described by Feleke, Wale and Yirsaw (2021) was used to grade the level of knowledge; poor, moderate and good. 35 students representing 59.7 % had a poor awareness of OHA scoring less than 60 %. 19 students (29.7%) had moderate score; ranging from 60- 79 %. 10 students (15.6 %) had good knowledge of OHA.

According to Pearson's Chi squared test, there was no relationship between the students' knowledge level and their age, gender, religion, or place of residence. There was also no relationship between their socioeconomic status, program of study and their main source of information as all p values >0.05

Table 4.5 Chi-square of Association between demographic characteristics and awareness of the One-Health Approach

Variables	Category	Poor N(%)	Moderate N(%)	Good N(%)	p-value
Age	Less than 18years	21(46.7)	16(35.6%)	8(17.8)	.136
	More than 18years	14(73.7)	3(15.8)	2(10.5)	
Gender	Male	7(70.0)	2(20.0)	1(10.0)	.570
	Female	28(51.9)	17(31.5)	9(16.7)	
Programme	General science	33(55.0)	19(31.7)	8(13.3)	.105
	Agricultural science	2(50.0)	0(0.0)	2(50.0)	
Religion	Christianity	32(54.2)	17(28.8)	10(16.9)	.586
	Islam	3(60.0)	2(40.0)	0(0.0)	
	Traditional	--	--	--	
Socio-economic status	Low class	3(70.0)	1(25.0)	0(0.0)	.275
	Middle class	24(48.0)	16(32.0)	10(20.0)	
	High class	8(80.0)	2(20.0)	0(0.0)	
Ethnicity	Akan	11(50.0)	9(40.9)	2(9.1)	.238
	Ga-Adangbe	2(66.7)	0(0.0)	1(33.3)	
	Krobo	5(38.5)	3(23.1)	5(38.5)	
	Ewe	13(68.4)	5(26.3)	1(5.3)	
	Others	4(57.1)	2(28.6)	1(14.3)	

Primary source of information	Internet	26(60.5)	12(27.9)	5(11.6)	.547
	Social media	0(0.0)	1(100.0)	0(0.0)	
	Newspaper	1(50.0)	0(0.0)	1(50.0)	
	Radio	3(60.0)	1(20.0)	1(20.0)	
	TV	5(38.5)	5(38.5)	3(23.1)	
Location	Rural	6(66.7)	1(11.1)	2(22.2)	.678
	Peri-Urban	7(46.7)	5(33.3)	33(20.0)	
	Urban	22(55.0)	13(32.5)	5(12.5)	

4.7 Association between awareness (knowledge) of AMR and the awareness (knowledge) of One- Health Approach (OHA)

Bloom's cut-off point classification as described by Feleke, Wale and Yirsaw (2021) was used to grade the level of knowledge of AMR and One Health Approach. The cross-tabulation showed that students with poor AMR awareness largely demonstrated poor OHA awareness (61.9%). Conversely, those with good AMR awareness had higher proportions in moderate (45.5%) and good (27.3%) OHA awareness categories. However, Pearson's Chi-square test revealed that this association was not statistically significant ($p = 0.209$).

Table 6 Chi-square of Association between awareness (knowledge) of AMR and the awareness (knowledge) of One- Health Approach (OHA)

Awareness of the One- Health Approach					
Variable		Poor n (%)	Moderate n(%)	Good n(%)	p-value
Awareness of AMR	Poor	13(61.9)	7(33.3)	1(4.8)	.209
	Moderate	10(55.6)	4(22.2)	4(22.2)	
	Good	3(27.3)	5(45.5)	3(27.3)	

4.8 Relationship between knowledge of AMR and demographic characteristics

The multivariate logistic regression model examined socio-demographic predictors of AMR awareness**.** Gender showed a significant association, with male students being more than twice as likely to have good AMR awareness compared to females (AOR = 2.24, p = 0.006). Religion was also significant, with Muslim students less likely to report good awareness than Christians (AOR = 0.45, p = 0.017). Socioeconomic status strongly predicted awareness; students from middle (AOR = 4.98, p < 0.001) and high socioeconomic classes (AOR = 5.01, p = 0.002) were significantly more likely to demonstrate good awareness compared to those from low socioeconomic backgrounds. Programme of study showed no statistically significant effect, though Agricultural Science students were less likely to be aware of AMR compared to General Science students (AOR = 0.49, p = 0.07). Other factors, including age, ethnicity, source of information, and location, did not show statistically significant associations (p > 0.05).

Table 7 Logistic regression of socio-demographic predictors of AMR Awareness

Predictor	AOR	95% CI for AOR	p-value
Age			
18years or less	1	1	1
More than 18years	0.73	[-0.83 - 0.21]	0.235
Gender			
Female	1	1	1
Male	2.24	[0.23 - 1.38]	0.006 **
Programme of Study			
General Science	1	1	1
Agricultural Science	0.49	[-1.47 - 0.05]	0.07

Religion			
Christianity	1	1	1
Islam	0.45	[-1.46 – (-0.14]	0.017*
Traditional	0.42	[-2.37 - 0.61]	0.247
Socioeconomic status			
Low	1	1	1
Middle	4.98	[0.74 - 2.48]	< .001***
High	5.01	[0.62 - 2.61]	0.002**
Ethnicity			
Akan	1	1	1
Ga-Adangbe	0.33	[-2.23 - 0.01]	0.051
Krobo	1.16	[-0.51 - 0.80]	0.659
Ewe	1.20	[-0.40 - 0.77]	0.534
Others	1.22	[-0.47 - 0.86]	0.563
Primary Source of Information			
Internet	1	1	1
Social media	$1.10\times10^{+6}$	[-1208.00 - 1235.82]	0.982
Newspaper	0.42	[-1.94 - 0.21]	0.114
Radio	1.09	[-0.77 - 0.95]	0.838
TV	1.12	[-0.46 - 0.68]	0.703
Location			
Rural	1	1	1
Peri-Urban	1.76	[-0.18 - 1.31]	0.134
Urban	1.57	[-0.18 - 1.08]	0.159

4.9 Relationship between knowledge of One-Health Approach and demographic characteristics

Table 4.8 above presents the adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for the socio-demographic predictors of awareness of the One Health Approach (OHA). The regression model showed that none of the socio-demographic predictors were statistically significant (all p-values > 0.05). However, Gender approached statistical significance, with male students almost twice as likely to demonstrate awareness of the One Health Approach compared to females (AOR = 2.18, p = 0.055), although this did not reach statistical significance. Similarly, students identifying as Muslim appeared less likely to have good awareness compared to Christians (AOR = 0.35, p = 0.061). Age, programme of study, socioeconomic status, ethnicity, source of information, and location were not significantly associated with OHA awareness.

Table 4.8 Logistic regression of socio-demographic predictors of One Health Approach

Predictor	AOR	95% CI for AOR	p-value
Age			
18years or less	1	1	1
More than 18years	1.36	[-0.35 - 0.97]	0.359
Gender			
Female	1	1	1
Male	2.184	[-0.02 - 1.58]	0.055
Programme of Study			
General Science	1	1	1
Agricultural Science	0.37	[-2.26 - 0.26]	0.119
Religion			

Christianity	1	1	1
Islam	0.35	[-2.12 - 0.05]	0.061
Traditional	2.06	[-0.99 - 2.43]	0.409
Socioeconomic status			
Low	1	1	1
Middle	1.90	[-0.43 -1.71]	0.239
High	2.26	[-0.42 - 2.05]	0.195
Ethnicity			
Akan	1	1	1
Ga-Adangbe	0.97	[-1.26 - 1.20]	0.959
Krobo	0.73	[-1.17 - 0.54]	0.464
Ewe	1.32	[-0.42 - 0.98]	0.434
Others	0.73	[-1.23 - 0.60]	0.500
Primary Source of Information			
Internet	1	1	1
Social media	5.00	[-1.23 - 4.45]	0.267
Newspaper	0.58	[-2.11 - 1.03]	0.502
Radio	0.45	[-2.14 - 0.52]	0.234
TV	1.23	[-0.48 - 0.88]	0.557
Location			
Rural	1	1	1
Peri-Urban	1.86	[-0.30 - 1.53]	0.184
Urban	0.93	[-0.90 - 0.75]	0.860

CHAPTER FIVE

DISCUSSION

5.1 Introduction

The aim of this study was to assess the factors influencing Senior High students' awareness of the One Health approach to antimicrobial resistance (AMR). The discussion presented in this chapter interprets the findings.

5.2 Awareness of AMR and current trends

Out of 393 respondents, a third of them 131 (78.3%) correctly distinguished between antimicrobials and antibiotics, suggesting that foundational definitions are fairly well understood, likely due to their inclusion in science curricula. However, more complex AMR knowledge was lacking. For instance, only 28.8% knew that insufficient antibiotics are currently in development to keep pace with resistance, reflecting limited awareness of global scientific and policy challenges. Similar trends have been observed in Nigeria, where students displayed better understanding of basic definitions than of broader AMR dynamics (Aworh et al., 2020).

Also, more than half (57.5%) correctly recognized that AMR could become the leading cause of death by 2050 if unchecked, indicating some awareness of the seriousness of the threat. However, misconceptions were evident, as 94 % incorrectly believed that antibiotic resistance occurs when the body becomes resistant to antibiotics, rather than bacteria. This misconception is consistent with global evidence showing that misunderstanding the mechanism of resistance is one of the most common gaps in public knowledge (McCullough et al., 2016; WHO, 2021).

Positively,74.3% acknowledged that many infections are becoming resistant, and 74.9% understood that resistant bacteria are difficult or impossible to treat. Similarly, 65.2% recognized

AMR could affect them or their families, reflecting positive risk perception. however, 41.5% believed resistance was not a problem in Ghana highlighting the common misconception that AMR is mainly a foreign or Western problem a barrier also identified in prior studies in sub-Saharan Africa (Chokshi et al., 2019). This suggests that although students are aware of AMR as a global health issue, many still perceive it as a distant or abstract problem rather than an immediate risk to their own health and communities suggestive of limited personal risk perception, which is a critical barrier to behaviour change. According to the Health Belief Model, individuals are less likely to adopt preventive actions such as avoiding misuse of antibiotics or supporting stewardship initiatives if they do not see themselves as directly vulnerable (Rosenstock, 1974; Champion & Skinner, 2008). For Ghana, this means that even with general awareness campaigns, students may not translate knowledge into practice unless communication strategies make the risks of AMR tangible and personally relevant.

Other misconceptions were equally concerning. Approximately, 35.9% of the respondents thought AMR only affects people who take antibiotics regularly and only 40.1% understood that resistant bacteria can spread between people. These beliefs underestimate the transmissibility of AMR and its broader community impact, potentially weakening adherence to preventive behaviours like hygiene and vaccination. Furthermore, while 59.3% recognized that resistant infections make medical procedures riskier, this leaves many unaware of the systemic risks posed to surgery, organ transplantation, or cancer treatment. International surveys show similar gaps, where people acknowledge antibiotic misuse but underestimate how AMR threatens modern medicine (Ahmed et al., 2024; CDC, 2025). Evidence from a nationwide survey conducted in Nigeria by Chukwu et al. (2020) identified widespread misconceptions about antibiotics and antimicrobial stewardship, despite high levels of antibiotic use.

Using Bloom's cut-off point as applied by Feleke, Wale and Yirsaw (2021) to categorize levels of awareness as poor, moderate, and good, this study found that out of the 167 respondents who reported having heard of AMR, 19 students (11.4%) demonstrated good knowledge (scores between 80–100%), 54 students (32.3%) had moderate knowledge (scores between 60–79%), while 94 students (56.3%) exhibited poor knowledge of AMR. These findings mirror global trends where AMR has consistently been highlighted as a top-tier public health threat, yet public understanding continues to lag behind scientific and policy recognition (WHO, 2023; Ahmed et al., 2024).

The findings of this study also revealed very low awareness of Ghana's National Action Plan (NAP) on AMR (15.3%) and antimicrobial stewardship (18.7%), underscoring a critical gap between policy frameworks and community-level knowledge. The World Health Organization (WHO, 2025) notes that even in countries with established NAPs, dissemination efforts rarely reach younger audiences, leaving students and the general public poorly informed about AMR policies and stewardship practices.

Within Ghana, similar gaps have been documented among health sciences students, who often exhibit partial understanding of AMR concepts but limited knowledge of stewardship principles and appropriate antibiotic use (Sefah et al., 2022). Overall, adolescent awareness of AMR in this study was partial, students grasped basic definitions but demonstrated weak understanding of transmission dynamics, stewardship, and systemic risks. Persistent misconceptions about how resistance develops and whether it is a problem within Ghana remain major barriers to effective engagement.

Targeted initiatives, such as the Youth Ambassador Programme implemented by Dr. Amenyo Stella Adadevoh Health Trust (DRASA) in collaboration with the WHO, have demonstrated that

school-based interventions can significantly improve student awareness when AMR education is contextualized and delivered through relatable, age-appropriate content (WHO AFRO/DRASA, 2019; DRASA, 2022). These findings align with this study, where "class/teachers" emerged as the primary source of AMR knowledge (53.9%), emphasizing that formal teaching channels remain the most effective means of information transfer in this population. This highlights the urgent need to integrate AMR education into school curricula and strengthen teacher-led initiatives. Without such deliberate interventions, adolescents may continue to underestimate both their personal vulnerability and the broader public health implications of AMR, ultimately undermining national and global stewardship efforts.

5.3 Awareness of the One Health Approach (OHA) to AMR

The study revealed a generally low awareness of the One Health Approach (OHA) among students, with only 64 (16.3%) out of 393 respondents indicating familiarity with the concept. This aligns with global findings that, although OHA has gained prominence within policy and academic circles, its understanding among the general public particularly students remain limited (Bonfoh et al., 2021; WHO, 2022).

Among those familiar with the One Health approach, 40 (62.2%) recognized that antimicrobial resistance (AMR) poses a growing global threat to both humans and animals, and 39 (60.9%) agreed that antibiotic misuse by veterinary practitioners contributes to resistance in both species. Similarly, 34 (53.1%) understood that the misuse of antibiotics by farmers contributes to resistance across plants, animals, and humans, while 43 (67.1%) recognized that the inappropriate use of antibiotics in food-producing animals contributes to resistance in human pathogens. These findings indicate that students were aware of some connections between antibiotic use in agriculture, veterinary practice, and human health.

Fewer than half of respondents, 29 (45.3%), acknowledged that improper disposal of antibiotics into the environment could spread resistance across humans, animals, and plants. This reflects a limited understanding of the environmental dimension of One Health, similar to findings from Ethiopia and Kenya, where AMR is often viewed primarily as a clinical or farming issue (Seid & Hussen, 2018; Ocan et al., 2021).

Overall understanding of One Health was modest. Only 21 (32.8%) agreed that the One Health Approach is the best strategy to address AMR, suggesting limited appreciation of cross-sector collaboration. However, 43 (79.7%) rejected the misconception that human, animal, plant, and environmental health operate independently, and 35 (54.7%) recognized that the approach enhances global health security and food safety. These results are consistent with evidence indicating that while individuals may understand aspects of AMR, the holistic One Health framework is seldom effectively communicated to the public (McEwen & Collignon, 2019; WHO, 2023). In Ghana, research shows that even health science students possess only partial knowledge of AMR and limited understanding of One Health principles (Sefah et al., 2022).

In summary, students demonstrated partial awareness of One Health concepts. most could connect human and animal health but had difficulty recognizing the environmental and integrative aspects of the framework. This gap likely reflects the absence of One Health content within the Senior High School (SHS) science curriculum. Although Ghana's National Action Plan on Antimicrobial Resistance (2017–2021) explicitly adopts the One Health framework (Ministry of Health, 2017), dissemination has largely been restricted to professional and institutional settings. There is therefore an urgent need for the Ghana Education Service (GES) to incorporate One Health education into the SHS curriculum. Equipping teachers with the skills and materials to teach the interconnections between human behaviour, agriculture, environmental health, and antimicrobial

resistance is essential for developing a generation capable of adopting a holistic understanding of AMR prevention and control.

5.4 Factors influencing awareness of the One- Health Approach to AMR

The Chi-square test results indicated that gender was the only variable significantly associated with AMR awareness. However, the multivariate logistic regression analysis provided a deeper understanding by showing that gender, religion, and socioeconomic status remained significant predictors when controlling for other factors.

Gender emerged as a strong predictor, with male students more than twice as likely to demonstrate good AMR awareness compared to females (AOR = 2.24, $p = 0.006$). This aligns with studies from Ghana and Ethiopia, where gender disparities in AMR knowledge were attributed to unequal access to health information and differing roles in household health decision-making. For example, Afari-Asiedu et al. (2021) found that men in rural Ghana were more likely than women to access information on antibiotic use and make healthcare decisions. Similarly, Seid and Hussen (2018) observed that Ethiopian male paramedical students exhibited higher AMR knowledge scores due to greater exposure to digital and academic learning resources. However, this trend is not universal. In European school-based antibiotic education programmes, female students have been shown to demonstrate higher awareness and engagement with infection prevention and antibiotic use topics (McNulty et al., 2019). Conversely, Donkor and Newman (2019) found no significant gender differences in AMR awareness among the Ghanaian population, indicating that gender-based disparities may be context-specific and influenced by sociocultural norms, educational access, and exposure to health information rather than inherent knowledge differences.

Socioeconomic status was another strong predictor of AMR awareness. Students from middle-income (AOR = 4.98, $p < 0.001$) and high-income households (AOR = 5.01, $p = 0.002$) were significantly more likely to have good knowledge compared to those from low-income backgrounds. This finding is consistent with WHO (2021), which notes that individuals from higher socioeconomic groups often have better access to education, digital resources, and health information campaigns.

Religion also showed a statistically significant relationship with AMR awareness, with Muslim students less likely to demonstrate good awareness than Christians (AOR = 0.45, $p = 0.017$). While religion itself is unlikely to be a direct cause, this disparity may reflect differences in educational opportunities or exposure to AMR-related messages within specific community networks or schools.

Other demographic factors including age, ethnicity, programme of study, location, and primary source of information did not show statistically significant associations ($p > 0.05$). This supports WHO's (2019) position that access to reliable information is often a stronger determinant of AMR awareness than demographic variables. Although Agricultural Science students displayed slightly lower awareness than General Science students (AOR = 0.49, $p = 0.07$), the difference was not statistically significant, possibly reflecting differences in curriculum emphasis rather than capability.

By combining the Chi-square and logistic regression analyses, the study provides a more robust understanding of predictors of AMR awareness. The Chi-square test revealed the initial associations, while the logistic regression quantified their relative influence, identifying gender, religion, and socioeconomic status as the key determinants of awareness among SHS science students in the Lower Manya Krobo Municipality.

Overall, the study revealed that while students demonstrated moderate awareness of antimicrobial resistance (AMR), their understanding of the One Health Approach (OHA) remained limited. Although most students could identify basic AMR concepts such as distinguishing between antimicrobials and antibiotics and recognizing the dangers of resistant infections critical misconceptions persisted regarding how resistance develops, spreads, and links human, animal, and environmental health. Demographic analysis showed that gender, religion, and socioeconomic status significantly influenced AMR awareness, whereas OHA awareness did not differ significantly across demographic groups, suggesting that gaps in understanding are widespread rather than confined to specific populations. These findings mirror those from other low- and middle-income countries, where basic knowledge of AMR tends to be stronger than awareness of its systemic, cross-sectoral dimensions (Afari-Asiedu et al., 2021; Seid & Hussen, 2018; McEwen & Collignon, 2019).

The association between AMR knowledge and One Health awareness was positive but not statistically significant ($p = 0.209$), implying that knowledge of AMR does not automatically translate into awareness of its broader One Health implications. This aligns with global findings that AMR education often focuses narrowly on clinical or human health dimensions, neglecting environmental and agricultural perspectives (McCullough et al., 2016; WHO, 2021).

Collectively, these findings underscore the urgent need to strengthen antimicrobial resistance (AMR) education within Ghana's Senior High School system. The Ghana Education Service (GES) should prioritize the integration of AMR and One Health concepts into the science curriculum to ensure that students develop not only definitional knowledge but also a deeper understanding of the interconnections between human behaviour, animal health, agricultural practices, environmental stewardship, and antimicrobial resistance. Equipping teachers with the

necessary knowledge, pedagogical skills, and teaching resources is equally essential to make these complex concepts accessible and relatable to students. Without such curricular integration, the One Health Approach will continue to exist as an abstract policy framework rather than a practical, lived understanding capable of shaping responsible attitudes and behaviours among future generations. Furthermore, as identified in this study, leveraging the internet as a key source of information presents a valuable opportunity for sustained youth engagement in AMR awareness. These initiatives would directly advance the objectives of Ghana's National Action Plan on Antimicrobial Use and Resistance (GHS, 2017), which emphasizes education, awareness creation, and the adoption of a One Health approach as critical pillars in combating antimicrobial resistance effectively.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Introduction

This chapter presents an overview of the study, summarizing the main findings and drawing conclusions in relation to the study objectives. It also provides recommendations for policy, education, and future research. The study assessed the factors influencing awareness of the One Health Approach (OHA) to Antimicrobial Resistance (AMR) among Senior High School (SHS) science students in the Lower Manya Krobo Municipality of Ghana. Specifically, it examined students' knowledge of AMR and its current trends, assessed their awareness of the One Health Approach, and explored the socio-demographic factors influencing this awareness.

A descriptive cross-sectional design was adopted, and quantitative data were collected from 394 SHS science students using a structured questionnaire. Microsoft excel was used to enter the data which was then exported for analysis into SPSS version 2.0. The data were analyzed using descriptive and inferential statistics including Chi-square tests and multivariate logistic regression, with significance set at $p < 0.05$.

6.2 Conclusion

The findings revealed that awareness of AMR and the One Health Approach among SHS students was generally low, with notable misconceptions across both areas. While (167/393) 42.5% of the respondents demonstrated some understanding of basic AMR concepts, deeper knowledge, particularly regarding its transmission dynamics and broader health implications, remained limited. Awareness of the One Health Approach was even lower (16.3%), with many students

failing to recognize the interconnectedness of human, animal, and environmental aspects embodied in the One Health concept.

Gender, religion, and socioeconomic status were found to significantly influence AMR awareness, with male students and those from higher socioeconomic backgrounds exhibiting better knowledge. However, these factors were not significantly associated with awareness of the One Health Approach, suggesting that the gap in understanding is widespread and not limited to specific demographic groups. The results further indicated that students with higher AMR knowledge were more likely to have moderate or good awareness of OHA, though this relationship was not statistically significant ($p = 0.209$). This finding suggests that familiarity with AMR alone does not ensure comprehension of its broader One Health implications.

Overall, the study concludes that while the concept of AMR is moderately understood among SHS science students, the One Health Approach remains poorly appreciated and insufficiently understood. This gap underscores the need to incorporate One Health education into the secondary school curriculum and strengthen public health messaging that highlights the interconnection between human, animal, and environmental health. Integrating One Health education into formal curricula and youth-focused communication strategies will not only enhance students' understanding but also build a generation equipped to contribute to national and global efforts in combating antimicrobial resistance.

6.3 Recommendations

Based on the study findings, the following recommendations are made:

1. The Ghana Education Service (GES) should fully incorporate antimicrobial resistance and the One Health Approach into the SHS science curriculum, ensuring students

understand not only basic definitions but also transmission pathways, stewardship principles, and community-level implications.

2. Future studies should employ mixed-method approaches (quantitative and qualitative) to explore not only the level of knowledge but also the underlying perceptions, attitudes, and behavioral drivers influencing awareness of AMR and OHA.

3. While this study focused on SHS students, further research should assess the awareness of AMR and OHA among the general public, healthcare, environmental and agricultural practitioners, who play critical roles in stewardship and policy implementation.

4. Gender was significantly associated with awareness of AMR and not OH. Further research should be done to determine the extent gender has on an individual's level of awareness of the One-Health Approach to AMR.

5. Beyond classroom interventions, community and media-based awareness campaigns should be scaled up by the District Health Directorate, NGOs and stakeholders to correct misconceptions and make the risks of AMR more tangible and personally relevant to young people and their families.

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APPENDICES

APPENDIX I: INFORMED CONSENT FORM

GENERAL INFORMATION ABOUT THE RESEARCH

I am Dzakpasu Edem Priscilla, a Master of Public Health candidate at Ensign Global College, Kpong. I am conducting a research study titled: **"**Assessing the Awareness of Antimicrobial Resistance among Senior High School Students in Lower Manya Krobo Municipality, in the Eastern Region of Ghana**."** You have been selected to participate in this study because you are a student in a Senior High School in this district.

The aim of this study is to understand students' level of awareness, knowledge, and misconceptions about antimicrobial resistance (AMR), and to find out where they get their information about AMR. You will be asked to answer a questionnaire by choosing the answers that best describe your views and experiences.Completing the questionnaire will take approximately 15 to 25 minutes of your time. Your answers will be used only for academic purposes.

BENEFITS AND RISKS OF THE STUDY

There are no physical, psychological, or emotional risks expected in participating in this study. However, you may experience minor inconvenience due to the time required to complete the questionnaire.

There is no direct benefit to you for participating. However, the information you provide will help researchers and health professionals better understand how to educate young people about antimicrobial resistance. This can lead to better public health strategies that benefit you and your community in the long term.

CONFIDENTIALITY

Your responses will remain completely anonymous. Your name or any identifying details will not appear in any report or publication. All data will be stored in a password-protected file and will only be accessible to the researcher and academic supervisors. Results will be reported in a way that ensures individual students cannot be identified.

VOLUNTARY PARTICIPATION AND COMPENSATION

Participation in this study is completely voluntary. You will not be paid for participating, but your time and effort are greatly appreciated. You are free to withdraw from the study at any time without giving a reason and without any penalty. You may also refuse to answer any question you do not feel comfortable with.

If you have any questions about this study at any time, feel free to ask the researcher or your teacher.

_____

Name of Participant

_____

Signature of Participant

_____

Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____

Name of Person who Obtained Consent

_____

Signature of Person Who Obtained Consent

_____

Date

Emergency Contact

Dzakpasu Edem Priscilla

Email: p.edemdzakpasu@gmail.com

Phone; 0554830589

APPENDIX II: ASSENT FORM FOR STUDENTS AGED 15–17 YEARS

Title of Study:

Assessing the Factors Influencing Awareness of the One Health Approach to Antimicrobial Resistance: A Case Study Among Senior High School Students in the Lower Manya Krobo Municipality, Eastern Region of Ghana.

Investigator:

Dzakpasu Edem Priscilla

Master of Public Health Candidate

Ensign Global College, Kpong

Why are we doing this study?

We are doing this study to learn what Senior High School students know about antimicrobial resistance (AMR) and the One Health Approach. This information will help health workers and teachers teach young people how to use antibiotics the right way.

Why have I been invited?

You are being invited because you are a student at a Senior High School in the Lower Manya Krobo Municipality.

What will I be asked to do?

If you agree to take part, we will ask you to fill out a questionnaire. It will ask questions about what you know about antibiotics, how they are used, and how people, animals, and the environment are all connected when it comes to health. It will take about 15 to 25 minutes.

Do I have to take part?

No. You do not have to take part if you don't want to. It's your choice. Even if you say "yes" now, you can change your mind later. No one will be angry with you or punish you.

Will I be hurt or helped by this study?

You will not be hurt. There are no risks to joining. You may not get anything directly from joining, but the information you give will help improve health education for young people in Ghana.

Will my answers be kept private?

Yes. No one will know your answers. Your name will not be written on the questionnaire. Only the researcher and the supervisor will see the answers. Your teachers, classmates, or parents will not know what you said.

Who can I talk to if I have questions?

You can ask the researcher or your teacher if you do not understand anything or want more information.

Do you want to be in the study?

If you want to take part, please write your name and sign below. Your parent or guardian will also be asked to give permission.

STUDENT ASSENT

I have read (or someone has read to me) this form. I understand what the study is about, and I want to take part.

Name of Student: _____

Signature of Student: _____ Date: _____

RESEARCHER DECLARATION

I have explained this study to the student in a language they understand. They had the chance to ask questions and agreed to take part freely.

Name of Person Obtaining Assent: _____

Signature: _____ Date: _____

Emergency Contact

Dzakpasu Edem Priscilla

Email: p.edemdzakpasu@gmail.com

Phone; 0554830589

APPENDIX III: PARENTAL/GUARDIAN CONSENT FORM

Title of Study:

Assessing the Factors Influencing Awareness of the One Health Approach to Antimicrobial Resistance: A Case Study Among Senior High School Students in the Lower Manya Krobo Municipality, Eastern Region of Ghana.

Principal Investigator:

Dzakpasu Edem Priscilla

Master of Public Health Candidate

Ensign Global College, Kpong

Dear Parent/Guardian,

Your child is being invited to participate in a research study. The purpose of this study is to understand what Senior High School (SHS) students know about antimicrobial resistance (AMR) and the One Health Approach, which looks at how the health of humans, animals, and the environment are connected. This study will help improve health education among young people in Ghana.

Your child has been selected because they are a student at a Senior High School in the Lower Manya Krobo Municipality.

What will your child do in this study?

If you allow your child to participate, they will be asked to complete a short questionnaire during school hours. The questionnaire will ask about what they know and think about antibiotics, AMR, and the One Health concept. It will take about 15 to 25 minutes.

Are there any risks?

There are no physical, emotional, or legal risks involved in this study. The only possible inconvenience is the time taken to complete the questionnaire.

Are there any benefits?

Your child may not directly benefit from the study, but the information gathered will help health professionals and educators design better educational programs for students in Ghana.

Confidentiality

Your child's responses will remain strictly confidential. No names or identifying information will be used in any reports or publications. All data will be kept in secure, password-protected files.

Voluntary Participation

Participation is completely voluntary. You may refuse to allow your child to participate, and your child may withdraw from the study at any time without any penalty or consequences.

Who can I contact with questions?

If you have questions about the study, you may contact the researcher or your child's school representative. You may also ask to see the questions being asked before giving permission.

CONSENT STATEMENT

I have read and understood the information above. I give permission for my child to participate in the study.

Name of Child: _____

Name of Parent/Guardian: _____

Signature of Parent/Guardian: _____

Date: _____

RESEARCHER DECLARATION

I have explained the nature and purpose of the study to the parent/guardian in a language they understand. They had the opportunity to ask questions and voluntarily agreed to allow their child to participate.

Name of Person Obtaining Consent: _____

Signature: _____ **Date:** _____

Emergency Contact

Dzakpasu Edem Priscilla

Email:

Phone; 0554830589

APPENDIX IV: QUESTIONNAIRE

Survey Questionnaire: ASSESSING THE FACTORS INFLUENCING AWARENESS OF THE ONE HEALTH APPROACH TO ANTIMICROBIAL RESISTANCE: A CASE STUDY AMONG SENIOR HIGH SCHOOL STUDENTS IN THE LOWER MANYA KROBO MUNICIPALITY, EASTERN REGION OF GHANA.

Instructions: please tick where applicable and provide details where necessary

Section A: Socio- Demographic information

1. Age: ……

2. Gender: a. [ ] [Male b. [ ] Female

3. Program of study

a. [ ] General Science b. [ ] Agriculture science

4. What grade did you score in biology or agricultural science last semester?

a. [ ] A1 b. [ ] B2 c [ ] B3 d. [ ] C4 e. [ ] C5 f. [ ] C6 g. [ ]others (specify) …….

5. What do you intend to be in the future: a. [ ] Scientist b. [ ] Nurses c. [ ] Doctor d. [ ] Pharmacist e. Veterinary doctor f. others (specify)…….……

6. Religion: a. [ ] Christianity b. [ ] Islam c. [ ] Traditional d. Others (specify) …….

7. How would you describe your place or residence when not in school?

a. [ ] Rural b. [ ] Peri-Urban [ ] c. [ ] Urban

8. How would you describe your family of origin in terms of socio-economic standing?

a. [ ] Low class b. [ ] Middle class c. [ ] High class

9. What ethnic group do you belong to?

a. [ ] Akan b. [ ] Ga- Dangme c. [ ] Ewe d. [ ] others (specify) ……..

10 What is your primary source of news/information most of time? (Select one)

a. [ ] Television b. [ ] Newspaper c. [ ] Radio d. [ ] Internet e. Other (specify) ……..

Section B: Awareness of Antibiotic (Antimicrobial) Resistance

11. Have you heard of antimicrobial resistance?

a) [ ] Yes

b) [ ] No (If No skip to Question (Q) 26)

12. If Yes to Q. 10, where did you first hear of antimicrobial resistance from? Select one

a) [ ] In class/ from teachers

b) [ ] From the internet

c) [ ] From social media (e.g., Instagram, Twitter, WhatsAppetc)

d) [ ] Television

e) [ ] Radio

f) [ ] Newspaper

g) Others (specify)……

13. Where do you often hear of antimicrobial resistance? (Select as many as applies)

a) [ ] In class/ from teachers

b) [ ] From the internet

c) [ ] From social media (e.gInstagram, twitter, WhatsAppetc)

d) [ ] Television

e) [ ] Radio

f) [ ] Newspaper

g) Others (specify)……

14. Are you aware of Ghana's National Action Plan on Antimicrobial resistance (2017 – 2021)?

a) [ ] Yes b. [ ] No

K15. Have you heard of the term 'antibiotic stewardship' or 'antimicrobial stewardship'?

a. [ ] Yes b.[ ] No

16. What is the difference between an antimicrobial and an antibiotic? (Select one)

a. [ ] Antibiotics refers to drugs that kill bacteria, whereas antimicrobials incudes drugs that kill viruses, fungi or bacteria

b. [ ] Antibiotics refers only to naturally occurring compounds, it does not include synthetic compounds

c. [ ] There is no difference between an antibiotic and an antimicrobial

d. don't know

17. Globally, do scientists have enough antibiotics under development at the moment to keep up with the problem of antibiotic resistance?

a. [ ] Yes b. [ ] No c. [ ] Don't know

18. Antimicrobial resistance will be the leading cause of death in humans by 2050, if current trends continue?

a. [ ] Yes b. [ ] No c. [ ] Don't know

19. Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well.

a. [ ] Yes b. [ ] No c. [ ] Don't know

20. Many infections are becoming increasingly resistant to antibiotics

a. [ ] Yes b. [ ] No c. [ ] Don't know

21 If bacteria are resistant to antibiotics, it can be very difficult or impossible to treat the infection they cause

a. [ ] Yes b. [ ] No c. [ ] Don't know

22. Antibiotic resistance is an issue that could affect me or my family

a. [ ] Yes b. [ ] No c. [ ] Don't know

23. Antibiotic resistance is an issue in other countries but not here in Ghana

a. [ ] Yes b. [ ] No c. [ ] Don't know

24. Antibiotic resistance is only a problem for people who take antibiotics regularly

a. [ ] Yes b. [ ] No c. [ ] Don't know

25. Bacteria which are resistant to antibiotics can spread from person to person

a. [ ] Yes b. [ ] No c. [ ] Don't know

26. Antibiotic-resistant infections could make medical procedures like surgery, organ transplantation, and cancer treatment much more dangerous

a. [ ] Yes b. [ ] No c. [ ] Don't know

Section C: Awareness of the One-Health Approach to Antibiotic (Antimicrobial) Resistance

27. Have you heard of the One-Health Approach to antimicrobial resistance?

a. [ ] Yes b. [ ] No

If No truncate questionnaire

28. Where did you first hear of the One-Health Approach from?

a. [ ] In class/ fromteachers

b. [ ] From the internet

c. [ ] From social media (e.g., Face book, Instagram, twitter, WhatsApp)

d. [ ] Television

e. [ ] Radio

f. [ ] Newspaper

g. [ ] Never heard of it

h. Others (specify)……

29. I have received formal teaching / lesson in class on the one-health approach to antibiotic (antimicrobial) resistance

a. [ ] Yes b. [ ] No c. [] Don't remember

30. Antibiotic resistance is an increasing global threat to human and animal health

a. [ ] Yes b. [ ] No c. [ ] Do not know

31. The misuse of antibiotics by veterinary practitioners contributes significantly to antibiotic resistance in both animals and humans

a. [ ] Yes b. [ ] No c. [] Do not know

32. The misuse of antibiotics by farmers contributes significantly to antibiotic resistance in plants, animals and humans.

a. [ ] Yes b. [ ] No c. [] Do not know

33. The inappropriate use of antibiotics in food-producing animals significantly contributes to antibiotic resistance in human pathogens

a. [ ] Yes b. [ ] No c.[ ] Don't know

34. Improper disposal of unused/excess antibiotics into the open environment can contribute to antibiotic resistance in plants, animals and humans

a. [ ] Yes b. [ ] No c.[ ] Don't know

35. The One- health approach is the only way to address antimicrobial resistance

a. [ ] Yes b. [ ] No c.[ ] Don't know

36. The One- Health Approach does not recognize the interconnection between people, animals, plants and their shared environment. These various sectors are independent of each other and should be targeted independently.

a. [ ] Yes b. [ ] No c. [] Don't know

37. The One- Health Approach can protect global health security as well as improve food safety and security.

a. [ ] Yes b. [ ] No c. [ ] Don't know

APPENDIX V: ETHICAL CLEARANCE

ENSIGN GLOBAL
UNIVERSITY

OUR REF: ENSIGN/IRB/EL/SN-300/03
YOUR REF:

August 4, 2025

INSTITUTIONAL REVIEW BOARD SECRETARIAT

Priscilla Edem Dzakpasu
Ensign Global University
Kpong.

Dear Priscilla,

ETHICAL CLEARANCE TO UNDERTAKE POSTGRADUATE RESEARCH

At the General Research Proposals Review Meeting of the *INSTITUTIONAL REVIEW BOARD (IRB)* of Ensign Global University held on Friday, August 1, 2025, your research proposal entitled **"Assessing the Factors Influencing Awareness of the One Health Approach to Antimicrobial Resistance: A Case Study Among Senior High School Students in the Lower Manya Krobo Municipality, Eastern Region of Ghana"** was considered.

You have been granted Ethical Clearance to collect data for the said research under academic supervision within the IRB's specified frameworks and guidelines.

We wish you all the best.

Sincerely,

Dr. (Mrs.) Rebecca Acquaah-Arhin
IRB Chairperson

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