ENSIGN GLOBAL COLLEGE
KPONG, EASTERN REGION, GHANA
DEPARTMENT OF COMMUNITY HEALTH

FACTORS INFLUENCING AWARENESS OF THE ONE-HEALTH APPROACH TO ANTIMICROBIAL RESISTANCE: A CASE STUDY AMONGST SELECTED SHS FINAL YEAR STUDENTS IN THE GREATER ACCRA REGION OF GHANA

BY

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DECLARATION

I, Felix Edward Yao Tsakpo, 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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DEDICATION

This work is dedicated to God for his unfailing love and unfailing grace that have enabled me to pursue my Master's degree and for guiding me successfully through the program.

I also thank my beloved Miss Millicent Moyaka, relatives, and friends for their unending encouragement and support in getting me to this stage in my life.

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DEFINITION OF TERMS

Antimicrobial resistance refers to "the resistance of bacteria, viral, parasite, and fungal pathogens to antimicrobial treatments that were previously successful for treating illnesses" (Collignon, 2017).

One Health is an approach that recognizes that the health of people is closely connected to the health of animals and our shared environment.

Antimicrobials are compounds that "kill or inhibit the growth of microorganisms, such as bacteria, viruses, protozoa, and fungi," whether they are "natural, semi-synthetic, or synthetic in origin" (FAO, 2019).

Antibiotics, also known as antibacterials, antifungals, antivirals, and antiprotozoal agents, are examples of antimicrobial substances.

ABBREVIATIONS

AMR- Antimicrobial resistance

AMU- Antimicrobial Use

AMs- Antimicrobials

AOR - Adjusted Odd Ratio

CI-Confidence Interval

CSOs- Civil Society Organizations

FPAs-Food-Producing Animals

GES- Ghana Education Service

MOH- Ministry of Health

NAP- National Action Plan

OHA- One- Health Approach

OR- Odd Ratio

SHS-Senior High School

UNEP- United Nation Environment Programme

WHA- World Health Assembly

WHO- World Health Organization

ABSTRACT

Background: Antimicrobial resistance is getting worse, endangering the practice of modern medicine worldwide. Antibiotic resistance is a result of widespread antibiotic usage and abuse in human and animal health. Local and international action is needed to stop the development of resistant germs in these industries, and it must start with raising awareness, especially among students. The aim of the study is to determine the parameters impacting final-year SHS students' knowledge of the One Health Approach to Antimicrobial Resistance. **Methodology:** The research involved 202 students who were 16 years of age or older and was conducted as a quantitative cross-sectional study between 8th and 30th of August, 2023. The information was entered into Microsoft Excel and exported to SPSS for descriptive and inferential analysis. Frequencies and percentages were utilized in descriptive statistics, whereas Chi-squared and logistic regressions were used in inferential statistics. For statistical significance, a p-value of 0.05 or lower was required. The relationship between the independent and dependent variables using logistic regression and the results are presented as odds ratio with 95% confidence interval. **Results:** Approximately 18 % and 11.9 % (out of 202 respondents) were aware of the terms 'Antimicrobial resistance' and the 'One-Health Approach respectively. The program of study [AOR=0.233 95% CI =0.075-0.726] with the p value of [0.012] Based on the results, it appears that the program of study had substantial impact on students' knowledge of AMR and the OH approach to AMR. **Conclusion:** The programs of study were found to have an impact on people's awareness of the One-Health Approach. AMR and OH components were not fully in the curricula of students studying science and agricultural science, therefore it should be included.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Antimicrobial resistance (AMR) is a significant global health issue that poses a serious threat to people's health worldwide by jeopardizing population health and the ability to prevent and treat a variety of infectious diseases (Hay et al., 2018). AMR, an umbrella term, refers to "the resistance of bacteria, viral, parasite, and fungal pathogens to antimicrobial treatments that were previously successful for treating illnesses" (Collignon, 2017).

It was estimated that "4.95 million (3.62-6.57) deaths were associated with bacterial AMR in 2019" (Murray et al., 2022b) and that "10 million people will die of infectious diseases globally due to AMR related incidences by 2050" (Murray et al., 2022a). Bacterial antimicrobial resistance "has emerged as one of the leading public health threats of the 21st century" (OMS, 2017).

It is also estimated that by 2050, 10 million people will die of infectious diseases due to AMR related incidences globally (OMS, 2017). Ghana, like many other African countries, has reported the presence of resistant bacterial strains (NAP, 2017). A study in “2 teaching, 7 regional and 2 district hospitals in Ghana revealed that very common microbes such as streptococci, salmonella, and E. coli showed very high levels of multiple drug resistance, some as high as 78.7%” (NAP, 2017).

In addition, evidence in Ghana also suggests that many infectious microbes are not responding to conventional, potent and easily accessible antibiotics in the health system leading to increased morbidity and mortality (NAP, 2017).

A significant priority for the World Health Organization is combating AMR (WHO, 2022). The World Health Assembly (WHA) decided on a Global Plan of Action to combat AMR (EMRO.WHO, 2022) in the context of a One-Health strategy in 2015 to address the threat that AMR poses.

Considering any problem from a One-Health viewpoint emphasizes how people, domestic and wild animals, plants, and our environment interact (Collignon and McEwen, 2019). The National Action Plan for Antimicrobial Use and Resistance, 2017–2021, was created by Ghana in response to the WHA's request for member states to create their own Action Plans.

The Action Plan's first pillar, "Improve Awareness and Understanding of Antimicrobial Resistance through Effective Communication, Education and Training," aims to do just that. Ghana's strategies and initiatives with reference to this pillar focused on four (4) areas.

These include collaboration with all stakeholders for continuous education to promote the responsible use of antibiotics among the general public in the spirit of the "one-health" approach," cooperation between the Ministry of Health and educational institutions to incorporate information about antibiotics into their curricula, and collaboration with all parties involved for ongoing education to encourage the general public's responsible use of antibiotics in the spirit of the "one-health" approach; and a partnership between the Ministries of Food and

Agriculture, Fisheries and Aquaculture Development and pertinent educational institutions to create and incorporate concepts of AMU and AMR into their curricula (NAP, 2017).

The focus of this study among final year SHS students in Greater Region of Ghana is to determine their level of awareness on antimicrobial resistance and the One Health Approach. This is important because as future prescribers and handlers of antimicrobial agents, they will educate their clients on the proper use of these agents; thus, their awareness of this concept is important. Understanding the student's level of awareness on the concept of AMR and the One-Health approach will help inform educational strategies targeted at instilling in them a culture of antimicrobial stewardship from a One- Health perspective.

Antimicrobial resistance (AMR) is defined as the inherited or acquired ability of a microorganism to stop the antimicrobial drug from working against it to the extent that it cannot be used any longer in plants, and the available drugs used to treat microbial infections become less effective or ineffective and lead to the persistence and spread of the resistant organisms causing infections.

The bacteria overcome the effects of antimicrobial drugs (such as antibiotics) through five main biochemical mechanisms of resistance. These include enzymatic modification or destruction of the antibiotic; modification of the antibiotic target site; mimicking the antibiotic target with similar biochemical functions or overproduction of the antibiotic target; decreasing the antibiotic penetration; and elimination of the antibiotic from the cell by efflux pumps. Bacteria may have multiple resistance mechanisms.

The "One Health" idea was put forth to convey the notion that animal and human healths are intertwined and dependent on the sustainability of the ecosystems in which they coexist.

It aims to reaffirm the notion that people and animals are both susceptible to certain diseases and environmental risks.

One Health is an approach that recognizes that the health of people is closely connected to the health of animals and our shared environment.

One Health is not new, but it has become more important in recent years. This is because many factors have changed interactions between people, animals, plants, and our environment.

With the aim of obtaining the best possible health outcomes while acknowledging the connections between people, animals, and the common environment, one health is a collaborative, multisectoral, and trans disciplinary approach.

To attain the optimal health for people, animals, and our environment, "One Health" aims to promote the cooperative efforts of numerous disciplines working locally, nationally, and internationally.

Because 6 out of every 10 infectious diseases that affect humans are transferred by animals, the "One Health" approach is crucial.

The One Health strategy can:

1. Avoid zoonotic disease outbreaks in both humans and animals.
2. Boost food security and safety.
3. Decrease illnesses that are resistant to antibiotics and enhance both human and animal health.
4. Ensure the security of world health.
5. Ensure conservation and biodiversity.

One Health approach can produce the highest health results for people, animals, and plants in a shared environment by encouraging collaboration across all sectors.

In this regard, the study seeks to assess the factors influencing the awareness of the One- Health approach to antimicrobial resistance among selected SHS Science final year students in the Greater Accra Region of Ghana as a case study.

1.2 Problem Statement

Globally, antimicrobial resistance has an impact on public health. Most bacteria that formerly responded well to different antibiotic classes and caused serious illness have lately developed resistance (Collignon and McEwen.2019). At the same time, there are not enough scientific breakthroughs in the pipeline for novel antimicrobials, vaccines, and antibiotic alternatives for use in people, plants, and animals. (Bryan-Wilson,2016).

If strong steps are not taken, new types of antibiotic resistance can easily cross international borders and spread between nations and continents in the age of globalization (Lahsoune, 2007). Antibiotics are most at risk, but antivirals, antifungal, and antiparasitic are all in danger (Collignon and McEwen, 2019).

Moreover, estimations from 2050 suggest that 10 million people could perish from infectious diseases annually as a result of antibiotic resistance (O'Neill, 2016).

In low- and middle-income nations, individuals and healthcare systems must deal with a significant burden caused by antimicrobial resistance (AMR).

One of the health issues facing the globe today that best illustrates the One - Health concept is antimicrobial resistance. The One-Health method is centered on the cooperative work of several disciplines that come up with the best solutions for the wellbeing of people, animals, and the

environment. Due to the careless, illogical, and excessive use of antimicrobials (antibiotics) in various areas, AMR is linked to these three (3) components (Velazquez-Meza et al., 2022).

Bacteria develop resistance genes and mobile genetic elements that can move to other bacteria of the same or different species under the pressure of antimicrobial selection (Velazquez-Meza et al., 2022). 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).

If antibiotic resistance is not addressed seriously and with great care, more people will experience treatment failure or succumb to illnesses. Surgery, including Cesarean sections, hip replacement, cancer chemotherapy, and organ transplantation will all become riskier medical procedures (WHO, 2021).

A comprehensive analysis on the global burden of bacterial antimicrobial resistance undertaken in 2019 by Murray et al. estimated that 4.95 million fatalities were related to bacterial antimicrobial resistance (Murray et al., 2022b). Also, it is predicted that by 2050, 10 million people may perish from infectious diseases as a result of antibiotic resistance (O'Neill, 2016).

Situational analysis studies for Ghana suggest that AMR is a problem and that the majority of antibiotics used in the healthcare system are ineffective against a wide range of infectious diseases (NAP, 2017). Antibiotics are used in animal husbandry to prevent and treat disease. Sub therapeutic antibiotic dosages are used to encourage animal growth. According to studies, antibiotics like penicillin and tetracycline are used in pigs and poultry to promote growth and prevent sickness. The research also uncovered dangerous practices in farm storage and disposal

of these medicines. Due to the fact that these antibiotics are also used on humans, the possibility of microbial resistance is increased (Turkson, 2009; Sekyere, 2014; Agga et al., 2015).

The study seeks to assess the factors influencing the awareness of the One- Health approach to antimicrobial resistance among selected SHS Science final year students in the Greater Accra Region of Ghana as a case study.

1.3 Rationale of the study

Inappropriate use of antimicrobial drugs in one area will have an impact on the other in an ecosystem where interactions between people, animals, and the environment exist. The rate of rising antimicrobial resistance is a result of this improper use

The One Health Approach is emphasized in Ghana's Action Plan on AMR, which was adapted from the Global Action Plan to combat antimicrobial resistance.

It emphasizes increasing awareness of antimicrobial resistance through ongoing education to encourage the responsible use of antibiotics among the general public; incorporating the responsible use of antibiotics into the curricula of students who pursue science in the senior high schools in Ghana.

The Global Action Plan on combating Antimicrobial Resistance, which Ghana's Action Plan on AMR was adapted from, emphasizes as one of its strategies to increase awareness of antimicrobial resistance through ongoing education to promote the responsible use of antibiotics among the general public in accordance with the One-Health Approach; incorporate the prudent use of antibiotics into the curricula of training institutions for professionals in human, animal, plant, and (NAP, 2017).

The focus of this study among final year students at the Amasaman Senior High Technical School, St. Johns Grammar Senior High School and Kwabenya Community Senior High School in the Greater Accra Region of Ghana students is to determine their level of awareness on antimicrobial resistance and the One Health Approach.

AMR continues to pose a serious danger to the treatment of bacterial illnesses everywhere, but especially in countries with low and intermediate incomes like Ghana. The threat posed by AMR compounds the already high prevalence of bacterial infections in these environments and the limited availability of effective diagnostics, particularly at intermediate and peripheral levels of the health system.

The results of this study will serve as the basis for evidence-based assessments that will assist Ghana's plan for combating antibiotic resistance.

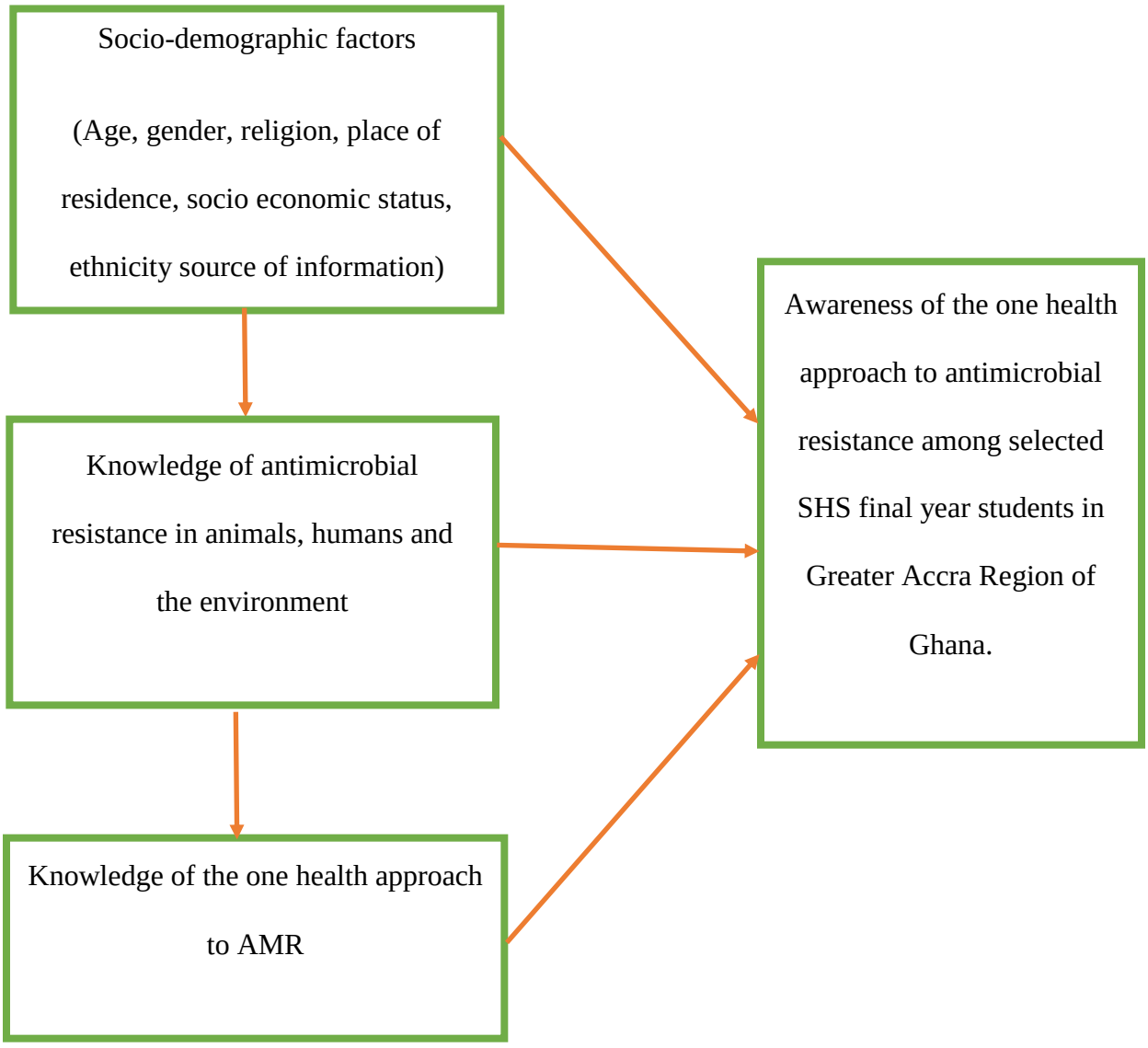


Figure 1. Conceptual Framework

Conceptual framework of antimicrobial resistance (Karen Gyasi 2022).

The conceptual framework above shows the factors that influence awareness of one health approach to antimicrobial resistance. Three factors have been identified to influence awareness of one health approach to antimicrobial resistance.

First and foremost, socio demographic factors such as age, gender, program of study, socio economic position, ethnicity, primary source of antimicrobials could contribute to antimicrobial resistance.

Furthermore, these social demographic factors influence one's knowledge of antimicrobial resistance and the One Health Approach to antimicrobial resistance in humans, animals and the environment.

In addition, the awareness of one health approach can influence one's understanding of antimicrobial resistance

1.4 General Objectives

To assess the factors influencing the awareness of the One Health Approach to antimicrobial resistance among selected Senior High Schools final year students in Greater Accra Region of Ghana.

1.5 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.

1.6 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?

1.7 Profile of Area of Study

Geographically and legally a part of the Eastern Region in 1960, Greater Accra was known at the time as the Accra Capital District.

The Greater Accra Region comprises 3,245 square kilometers, or 1.4% of Ghana's total geographical area, making it the smallest of the 16 administrative regions in terms of area. With 4,010,054 inhabitants in 2010, or 15.4% of Ghana's total population, it is the second most populous region after the Ashanti Region in terms of population.

Greater Accra Region has 29 districts. Adenta Municipal, Ledzokuku Municipal, Ada East, ShaiOsudoku, Ada West, Ningo/Prampram, La Dade-Kotopon, La-NkwantanangMadina, Ga East, Ayawaso West, Ga South Municipal, Ga West Municipal, Ga Central Municipal, Tema West Municipal, Ashaiman Municipal, KponeKatamanso, Ablekuma Central Municipal, KorleKlottey Municipal, Ablekuma North Municipal, Ayawaso North Municipal, Ayawaso East

Municipal, Okaikwei North Municipal, Ga North Municipal, WeijaGbawe Municipal, Krowor Municipal, Tema Metropolitan, Ablekuma West Municipal, Ayawaso Central Municipal and Accra Metropolis.(gtarcc.gov.gh)

The Ghana Education Service (GES) was established, as part of the Public Service of Ghana, in 1974 by NRCD 247 and was subsequently amended by NRCD 252, 357 and SMCD 63. Under the fourth Republican Constitution of Ghana, these earlier legislations have been amended by Acts of Parliament, including Act 506 (1994) and Act 778 (2008). The GES is governed by a fifteen-member Council called the GES (https://ges.gov.gh/about-us/).

Greater Accra Region has forty-four second circle institutions (senior high and technical schools).

But this research was focused on selected Senior High Schools that are science based schools.

i. Amasaman Senior High and Technical School in the Ga West Municipal.
ii. St. John Grammar Senior High School Ga North Municipal
iii. Kwabenya Community Senior High School in Ga East Municipal.

Brief history of St. John Grammar Senior High School.

The name of the school is St. John's Grammar Senior High School. It was established on 16th May, 1954 by the late Mr. John Hayford Mensah with the guidance of Mr. P.K.K Quaidoo, Nana EssilfieBondzie, Mr. Charles Ocansey and S.M. Arko.

It is a mixed school, it is a coeducational and a boarding institution which began and accommodated in temporary structures at Kokomelemele, a suburb of Accra.

Besides the traditional subjects, French, Latin and Greek were taught in the school, hence the name Grammar School. Its present location is Achimota, on the Accra-Nsawam road.

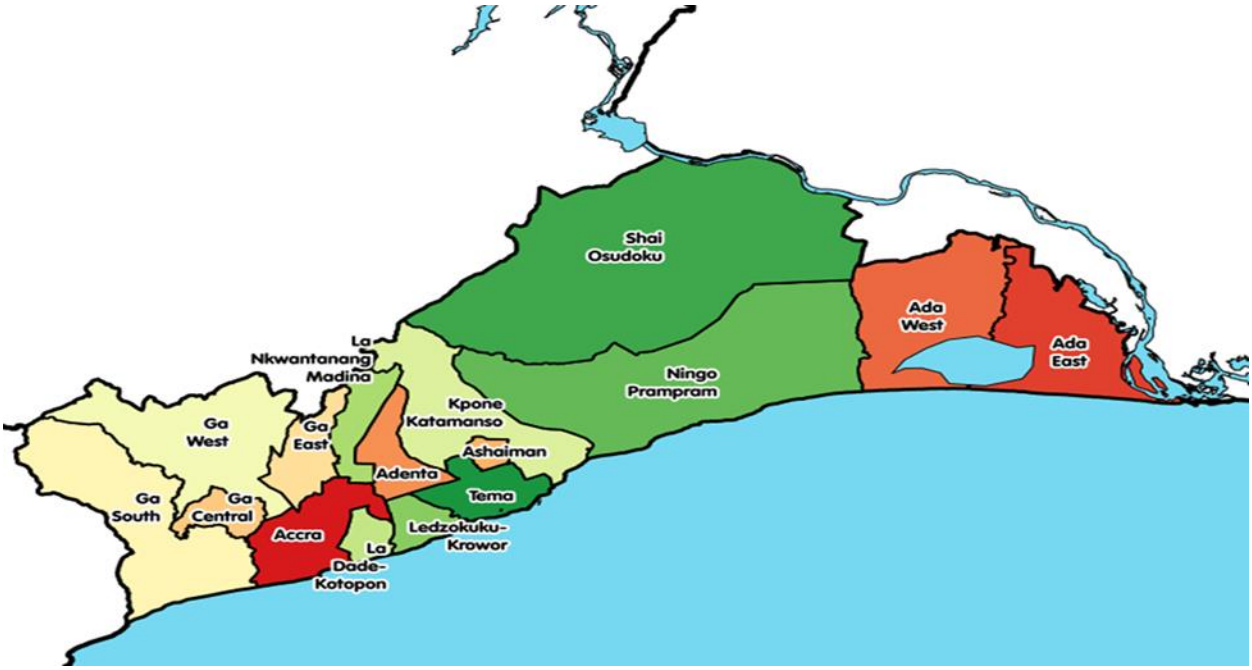
Brief history of Amasaman Senior High Technical School

Amasaman Senior High Technical School was established in 1991.With a pioneering class of fifty (50), which boys were thirty-five and the girls were fifteen (15) and a permanent staff of five.

Brief history of Kwabenya Community Senior High School

It is located on main the Kwabenya Atomic Road, adjacent to ECG office.It the only public senior high school in the Ga East Municipal. It is a mix school and has 66 employees, of which 54 are teachers and the rest 12 are support staff.

Map of Greater Accra Ghana Statistical Service 2017.



Map 1. Map of Greater Accra Ghana

1.8 Scope of Study

The scope of the study was set to include final year SHS students from the Amasaman Senior High School, St. John Grammar Senior High School and Kwabenya Community Senior High School of Greater Accra Region of Ghana. The study was conducted from the 8th March to the 30th of August 2023. It looked into the demographics of the participants, their level of awareness and knowledge of AMR and the One- Health Approach. Much emphasis was placed on antibiotic resistance as its misuse and abuse is prominent in the field of AMR. The report concludes with some recommendations based on the findings to advance awareness of the One- Health Approach to AMR amongst students.

1.9 Organization of Report

The report was organized into six (6) main chapters: Introduction, Literature Review, Methodology, Results, Discussions, Conclusions and Recommendations. This was preceded by detailed contents including a list of figures, tables, definition of terms and the abstract which described briefly the scope, objectives of the study, methodology, findings and conclusion.

Chapter one introduced the background information of the study: the problem statement, the rationale of the study, the conceptual framework, the research questions, the general objective, the specific objectives and the scope of the study. Chapter Two which is the literature review presented similar studies associated with the objectives of the study.

Chapter Three outlined the methodology which comprised the study area, the research methods and design, data collection techniques and tools, study population, study variables, sampling, pre-testing, data handling, data analysis, ethical considerations, limitations of study.

Chapter Four, the results section, provided a summary of the variables as well as the results based on the key variables of the study from data analysis. These results are represented in tables. Chapter Five discussed the results based on the research questions by comparing them with literature. Finally, Chapter Six outlined the conclusion and recommendations of the stud

CHAPTER TWO

LITERATURE REVIEW

2.1Antimicrobial Agents

Antimicrobials are compounds that "kill or inhibit the growth of microorganisms, such as bacteria, viruses, protozoa, and fungi," whether they are "natural, semi-synthetic, or synthetic in origin" (FAO, 2019). Antibiotics, also known as antibacterials, antifungals, antivirals, and antiprotozoal agents, are examples of antimicrobial substances. These substances are employed not just on humans but also on animals and agricultural products.

According to the study "Antimicrobial resistance in Ghana: a review of the literature" by Antwi-Agyei et al. (2019), antimicrobial resistance is a significant issue in Ghana. According to the report, Ghana's most typical sources of antibiotic resistance are:

1. Improper use of medications.
2. Bad hygiene.
3. Lack of knowledge regarding antibiotic resistance.

The WHO (2018) report "The role of education in preventing antimicrobial resistance" found that education is crucial for combating antimicrobial resistance. According to the study, education can alter attitudes and behaviors that contribute to antimicrobial resistance, increase knowledge of proper antibiotic usage, and promote awareness of antimicrobial resistance.

The World Bank (2016) determined that there is a large economic cost associated with antibiotic resistance in its report, "The Economic Burden of Antimicrobial Resistance." According to the study, the annual cost of antibiotic resistance ranges from $1.3 trillion to $3.9 trillion.

The health of people and the nation as a whole may suffer significantly if senior high school students in Ghana do not study One Health and AMR. It is crucial to educate children about these critical concerns so that they can make wise health decisions and contribute to the prevention of the spread of antibiotic resistance.

2.2 Antibiotics

According to FAO (2019), "antibiotics are antimicrobial agents that can kill or inhibit the growth of another organism and are naturally produced by bacteria or fungi."

Antibiotics are divided by the WHO into three (3) categories. "Access Watch and Reserve groups" (also known as the "AWaRe" classification of antibiotics) are the categories. The Access group is made up of first- or second-choice antibiotics that provide the best therapeutic result while lowering the risk of resistance. Examples include Chloramphenicol and Amoxicillin &Clavulanic Acid.

The Watch groups are additionally first- or second-choice antibiotics, which are solely suggested for a restricted and/or constrained range of infectious disorders. Since they are more likely to be targets of antibiotic resistance, these antibiotics are given priority in stewardship programs and monitoring. Ciprofloxacin, as an illustration.

Antibiotics that fall under the Reserve category are those that are only used as a last resort in cases of multi-drug resistant (MDR) bacteria causing life-threatening illnesses.

In order to maintain their effectiveness, these antibiotics must be carefully tracked and given top priority as targets of stewardship programs. Colistin and Fosfomycin are two examples (WHO, 2020). The 'AWaRe' classification of antibiotics seeks to increase antibiotic use through good stewardship to prevent the further establishment and spread of antimicrobial resistance.

2.2.1The Use and Misuse of Antibiotics in Humans

The majority of antibiotics face the prospect of losing some of their prior potency globally. This pattern has been linked to excessive and inappropriate use of antibiotics, including self-medication, incomplete antibiotic delivery, excessive antibiotic prescription by doctors, and improper infection control in healthcare facilities(Owusu-Ofori et al., 2021).

To ensure the responsible use of antibiotics, knowledge about AMR is required. Nearly 96% of the participants believed that antimicrobial resistance is a catastrophic and preventable public problem, but about half of the participants (55%) had a poor level of knowledge, according to research done among paramedic students in Gondar, Ethiopia, on their attitudes and knowledge regarding AMR (Seid and Hussen, 2018). According to Jimah, Fenny, and Ogunseitan (2020), 252 out of 400 respondents (or 63%) in their study on public knowledge, attitudes, and practices in a few selected villages in Ghana were "respondents were unaware of antibiotic resistance."

Additionally, a study on the topic of "assessment of knowledge, awareness of antimicrobial resistance and appropriate antibiotic use among healthcare students in a Nigerian University" found that 506 participants, or 58.4%, had strong knowledge of the topic. According to logistic regression, students in the third and sixth years showed increased knowledge of antimicrobial resistance, with an AOR of 9.29 and a 95% confidence interval of (3.7-22.96) (Akande-Sholabi and Ajamu, 2021).

2.2.2 Antibiotic (Antimicrobial) Use and Resistance in Animals

Animals reared for food are also treated with antimicrobials that are closely similar to, or even the same antimicrobials used in humans. The WHO defines food-producing animals (FPA) as "all terrestrial and aquatic animals (that is, includes aquaculture) used to produce food" (2021).

According to Boeckel et al. (2019), "73% of all antimicrobials sold on Earth are used in animals raised for food". More antimicrobials are frequently employed to maintain health and boost productivity as a result of the rise in demand for animal protein. Antimicrobials are utilized in animals at high levels to cure and prevent disease in exposed animals (Turkson, 2009). In order to promote growth, avoid disease, increase feed conversion, boost reproductive performance, and lower morbidity and mortality, antimicrobials are added to animal feed at sub-therapeutic doses (Turkson, 2009; WHO, 2017).

Evidence reveals a connection between the amount of antibiotics used in animals and the emergence of animal antimicrobial resistance (AMR).

According to Bennani et al. (2020), "E.coli resistance to cefotaxime, a third generation cephalosporin, increased after 2003 in broilers in the Netherlands, reaching a level of more than 20% in 2007. This resistance prevalence decreased sharply after the use of ceftiofur, a third generation cephalosporin, was banned in hatcheries in 2010, to reach a level of 2.9% in 2014.

Additionally, "due to a government policy to reduce antimicrobial use (AMU) after the country had been identified as one of the highest consumers of antimicrobials (AMs) among EU countries in 2007, antibiotic use in food-producing animals (FPAs) has been reduced considerably in the Netherlands in recent years. According to Bennani et al. (2020), "between 2007 and 2013, there was a 63% decrease in AMU in animals, from 565 tonnes per year to 217 tonnes per year. Tang et al. (2017) looked into the correlations between limiting the use of AMs in FPAs and AMR in these animals and humans in a recent systematic review.

The findings demonstrated that AMR in bacteria was decreased by interventions to alleviate AMU in animals, "with an overall reduction in AMR by about 15% and multi-drug resistant (MDR) bacteria between 24% and 32%" (Bennani et al., 2020).

According to the World Health Organization (2017), the use of antimicrobials in animals raised for food has the potential to "select for and spread antimicrobial resistant bacteria in food-producing animals, their wastes, and their surrounding environment." Animals can transfer resistant bacteria to humans through food and other sources. To reduce the usage of antibiotics, veterinarians must be aware of this trend.

Only 36.3% (n = 123) of the students in a multi-country survey conducted in Nigeria, South Africa, and Sudan on the Knowledge, Attitudes, and Perceptions Associated with Antimicrobial Stewardship in Veterinary Students revealed a "overall, poor perceptions and knowledge of Antimicrobial Stewardship among the Countries and Only 36.3% (n = 123) of the students were Confident in their ability to choose the ideal antimicrobial agents for a specific patient/group of animals"

In a related study, "of the 426 respondents, 60% received knowledge scores below average and >87% requested more education on clinical use and prescriptions prior to graduation, monitored antimicrobial drug dispensing, conducted AMR research, and confirmed the relationship between human, animal, and environmental health. According to Odetokun et al. (2019), "less than 25% of respondents were aware of antimicrobial stewardship and global efforts/organizations addressing AMR. +

2.2.3 Antibiotic (Antimicrobial) Use and Resistance in the Environment

According to Bengtsson-palme, Kristiansson, and Larsson (2018), the environment "is an important component for the transmission of resistant bacteria and in the emergence of resistant pathogens." and its significance as a source and a means of resistance transmission is coming into greater focus. Natural microbial resistance can be found in soil, water, and other ecosystems. In soil and water, bacteria "naturally possess a huge diversity of resistance genes" (FAO, 2019), which "over time are transferred horizontally to pathogens" (Nijsingh, Munthe, and Larsson, 2019). A person can come into contact with resistant genes through drinking water, eating, or even just being outside.

The introduction of antibiotics and other antimicrobial substances into the environment can promote the evolution of bacteria that are resistant to treatment. As much as or even more than clinical levels of antibiotics and disinfectants are released into the environment by some pharmaceutical corporations (FAO, 2019). "However, compared to levels found in a clinic or in raw industrial effluent, antibiotic concentrations in most effluents, surface waters, and soil habitats may be 1,000 times lower. The contamination with low concentrations is particularly significant because it can select for resistance while yet being too low to kill exposed bacteria (FAO, 2019).

Additionally, agricultural waste like animal dung introduces antibiotics into the ecosystem. Despite the fact that some antibiotics are neutralized, others are still in effect and put pressure on soil bacteria to evolve (FAO, 2019).

Antibiotic resistance is a global health concern, not only in clinical settings but also in the environment. The extensive use of antibiotics in human medicine, veterinary medicine, and

agriculture has led to the release of antibiotics and resistant bacteria into various environmental compartments, such as soil, water, and air.

2.2.4 Antibiotic (Antimicrobial) Use in Plants

In the words of FAO (2019), "Bacteria and fungi cause significant plant disease and production losses worldwide." Plant infections are managed with the help of some antimicrobials used in human and veterinary medicine (such as streptomycin).

Fresh fruits and vegetables might "serve as a source of dietary exposure to antimicrobial-resistant bacteria" because they are typically consumed raw or with little preparation (FAO, 2019). Direct soil contact with edible plant parts and soil splash can both lead to contamination with these hardy micro biomes, which, when swallowed, can cause food-borne illnesses. It is unclear how much antimicrobial use (AMU) specifically is driving the development of AMR in plant pathogens, soil organisms, spoilage organisms, non-pathogenic contaminants, and zoonotic agents present on foods of plant origin. However, extensive use and misuse of antimicrobials drives the development and transmission of AMR (FAO, 2019).

2.2.5 Antimicrobial Resistance (AMR)

According to Collignon (2017), AMR is "the resistance of bacterial, viral, parasitic, and fungal microorganisms to antimicrobial drugs that were previously effective for treating infections."

According to the Australian government (2017), resistance can arise naturally when germs activate specific built-in defense mechanisms, undergo self-preservation mutations, or take up resistant genes from other bacteria.

AMR has been accelerated by the inappropriate use of antibiotics and is influenced by a number of factors, some of which include suboptimal and excessive antimicrobial prescription rates and

insufficient adherence to advised practices, such as finishing antibiotic courses (Castro-Sánchez et al., 2016).

According to the literature, senior high schools in Ghana must teach about antimicrobial resistance for a number of reasons: The "Review on Antimicrobial Resistance," popularly known as the "O'Neill Report," was commissioned by the UK government in 2014 and is a piece of literature that highlights the significance of teaching AMR in schools. The paper stresses the importance of comprehensive AMR education at all societal levels, particularly in schools, in order to combat the growing threat of antimicrobial resistance.

Reasons for teaching about AMR in schools:

Public Health Awareness: Antimicrobial resistance education for high school students aids in raising awareness of the potential repercussions of excessive and improper antibiotic use. The World Health Organization (WHO) study "Antibiotic Resistance: Multi-Country Public Awareness Survey" highlights the importance of educating the public, especially young people, on the effects of antibiotic resistance so that they can make wise decisions (T.J. Brown,S.M.Deeks, et al.,2016).

Responsible Antibiotic Use: Teaching AMR encourages responsible antibiotic use to stop the evolution of drug-resistant bacteria. A 2015 study that was highlighted in "The Lancet Infectious Diseases" shows that teaching students about proper antibiotic usage can reduce the amount of unneeded antibiotic prescriptions (T.J. Brown,J. R.Watt et al., 2015).

Sustainable Healthcare: The effectiveness of healthcare systems around the world is threatened by AMR. Ghana can help create a generation that values and supports sustainable healthcare practices by teaching high school students about AMR. An article titled "High School Students'

Knowledge and Attitudes about Antibiotics" that was published in "PLOS ONE" demonstrates the beneficial effects of educational interventions on knowledge and attitudes (Kwame Awuah-Faisal I. B. Mohammed et al., 2019).

Interdisciplinary Learning: Teaching about AMR provides an opportunity for interdisciplinary learning, combining elements of biology, health, chemistry, and social sciences. This approach aligns with modern education goals and encourages students to understand complex health issues from various angles. The "Infection Control & Hospital Epidemiology" journal's article "An Antibiotic Awareness Week Infection Prevention Education Campaign: A Multicenter Evaluation" demonstrates the effectiveness of interdisciplinary education in raising awareness (Erin M. O'Connor**,**Heidi L. Larson,Shannon E. Everhart,et al.,2018).

Global Citizenship: Understanding AMR equips students with knowledge about global health challenges and their role as responsible citizens. This perspective is highlighted in UNESCO's report "Global Citizenship Education: Preparing learners for the challenges of the 21st century," which emphasizes the importance of addressing global issues in education (Moeller, C., Ruitenberg, C., & Hicks, D. (2014).

Future Health Professionals: Some high school students may become future healthcare professionals. Teaching them about AMR fosters a foundation of knowledge that they can build upon during their higher education and professional careers. A study in the "Journal of Antimicrobial Chemotherapy" titled "An Educational Campaign on Antibiotics and Bacterial Resistance in Primary Care" discusses the role of education in preparing future healthcare professionals.(Newitt, S., Anthierens, S., Coenen et al.,2017).

Incorporating AMR education into senior high schools in Ghana aligns with global efforts to combat antimicrobial resistance. The mentioned literature supports the idea that such education can enhance public awareness, promote responsible antibiotic use, contribute to sustainable healthcare, offer interdisciplinary learning opportunities, nurture global citizenship, and prepare future healthcare professionals

2.2.6 Current trends in AMR

The One-Health approach, which combines the human, animal, and environmental sectors in a multidisciplinary, cross-sectoral collaboration to combat AMR, is currently popular throughout the world (Pokharel, Raut, and Adhikari, 2019).

This approach takes into account the political, economic, sociological, technological, ecological, and industrial factors that contribute to AMR.

Antimicrobial resistance may also cause 10 million deaths annually by the year 2050, according to estimates (O'Neill, 2016). If antibiotic resistance is not addressed seriously and with great care, more people will experience treatment failure or succumb to illnesses. Surgery, including cesarean sections, hip replacement, cancer chemotherapy, and organ transplantation will all become riskier medical operations in the future (WHO, 2021).

2.3 One- Health Approach

One-Health (OH) is described as "the collaborative effort of multiple health science professions, together with their related disciplines and institutions—working locally, nationally, and globally—to attain optimal health for people, domestic animals, wildlife, plants, and our environment" (Kahn, 2017).

In the early years of the twenty-first century, the idea of OH was acknowledged as a new health policy, initially to control dangers from developing diseases.

The idea of OH is not brand-new. Calvin Schwabbe introduced the phrase "one-medicine" in the 20th century to denote the "similarity between human and animal medicine and their mutual benefits" (Valeix, 2018).

The idea of the OH gained traction after the SARS epidemic in 2003 and the Avian Influenza pandemic between 2005 and 2007 when the "need for more multifaceted approaches in zoonoses research, policy, and management was widely recognized" (Valeix, 2018). According to Zinsstag et al. (2011), "the term 'one medicine,' having a rather clinical connotation reflects inadequately the interactions between human and animal healths that reach far beyond individual clinical issues and include ecology, public health, and broader societal dimensions." When it comes to ensuring the health and well-being of people, animals, and the environment, OH goes above and beyond; it embraces both human and animal health as well as environmental health. It also emphasizes the idea that, as human population grows, climate change has an impact, pollution levels rise, and the earth's resources are depleted, health disciplines and other disciplines must cooperate (Kahn, 2017).

Because antimicrobials are used in all sectors (animals, people, and the environment), and because all sectors have resistance, AMR is essentially an OH issue. Animals, people, and the environment are all susceptible to the resistance.

Interventions that can be used in various sectors should be created and implemented in order to lessen reservoirs and spread between sectors in order to address AMR. Ghana created a

comprehensive plan called the National Action Plan (NAP) on AMR for 2017–2021 in accordance with the WHO approach for battling AMR.

In the plan, Ghana highlighted areas such as strengthening knowledge and evidence through national surveillance and research and the enhancement of laboratory services for culture and sensitivity testing, as well as reducing the incidence of infections through improved and effective sanitary practices.

One Health approaches in Ghana need improvement within the veterinary services, there is ineffective surveillance of antibiotic use due to a lack of the necessary infrastructure, there is a lack of coordination between telecommunication systems used by the different stakeholders, and there is a lack of research, according to a study conducted to assess the success of the implementation and identify some shortcomings of the Ghanaian NAP (2017-2021) after its rollout.

The study also showed that Ghana as a nation lacks an organization or government department with a clear mandate to pursue OH; regulations for the procurement and dispensing of antibiotics are not sufficiently enforced; and there are financial limitations in the NAP's implementation.

It was discovered that AMR was discussed in courses on infection and illness management but

had not been included as a separate module in training, teaching, or research.

However, a study respondent noted that although antimicrobial stewardship and the pharmacist's role in the containment of AMR had been included at various undergraduate and graduate levels in the field of pharmacy, these concepts also needed to be clearly outlined in the curricula for

students majoring in veterinary medicine, medicine, dentistry, and laboratory science (Hein et al., 2022).

The One Health philosophy highlights how intimately related the health of people, animals, and the environments are to one another and to other aspects of the ecosystem. There are many advantages to teaching the One Health method in senior high schools in Ghana, including building a more thorough understanding of health, encouraging multidisciplinary thinking, and addressing the issue of new infectious diseases. Key arguments from the body of research supporting the inclusion of the One Health approach in Ghanaian senior high school curricula are as follows:

Comprehensive Understanding of Health: With the understanding that human health is closely linked to the health of animals and the environment, the One Health approach encourages students to view health holistically. Understanding these links can result in more successful illness preventive and management efforts, according to a study by (Gibbs et al., 2013).

Interdisciplinary Thinking: One Health education encourages multidisciplinary thinking, which is essential for tackling challenging global health issues. The One Health strategy promotes cooperation amongst fields like medicine, veterinary science, environment, and public health, according to a review by (Zinsstag et al. 2011).

Emerging Infectious Diseases: The One Health strategy is even more important when new infectious illnesses become a greater danger. The genesis of diseases is influenced by environmental changes and interactions among people, animals, and pathogens, according to a study by Jones et al. (2008). One Health education can help students better comprehend these dynamics and potential illness pathways.

Environmental Conservation: The One Health strategy places a strong emphasis on the value of environmental sustainability. One Health education can empower children to become environmental stewards, helping to preserve biodiversity and prevent environmental damage, according to a report by the United Nations Environment Programme (UNEP).

Food Security and Safety: Food safety and security are intertwined with one health. Students' comprehension of how agricultural methods, animal health, and food production affect human well-being can be improved by teaching the One Health idea. An investigation by Rüegg et al. (2015) shows the value of the One Health strategy in combating food borne illnesses.

Social and Economic Implications: The One Health strategy also affects society and the economy. A 2013 essay by Rabinowitz et al. emphasizes the connections between health systems and economy across species and ecosystems. Students who learn about these relationships can gain a more thorough understanding of how society functions.

Global Health Preparedness: The World Health Organization (WHO) recognizes the value of One Health in preparing for global health emergencies. One Health education can help create a generation of students who are ready to handle public health emergencies that call for interdisciplinary cooperation.

The One Health method can give students in senior high schools in Ghana a broader perspective on health and empower them to become informed, accountable citizens who contribute to the welfare of their communities and the global community.

2.4 The Global Action Plan on AMR

AMR is a global problem that seriously endangers the general public's health. The Food and Agriculture Organization (FAO) and the World Health Organization for Animal Health (OIE) worked with the WHO to develop a comprehensive action plan in May 2015 to address the growing issue of resistance to antibiotics and other antimicrobials. The "Global Action Plan" was given to this.

In order to "ensure continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality assured, used in a responsible manner, and accessible to all who need them" (WHO, 2015).

The five main pillars or objectives outlined in the “Global Action Plan” are to;

1. Improve awareness and understanding of antimicrobial resistance through effective communication, education and training.
2. Strengthen the knowledge and evidence base through surveillance and research.
3. Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures.
4. Optimize the use of antimicrobial medicines in human and animal health.
5. Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions (Collignon and McEwen, 2019).

2.5 The Ghana National Action Plan on AMR

Ghana has modified the Global Action Plan on Antimicrobial Resistance's antimicrobial resistance (AMR) policy. The AMR policy was created to raise knowledge and comprehension of antimicrobial resistance by effective communication, education, and training that shows how the wellbeing of people and animals is linked to the health of the ecosystems in which they live (NAP, 2017).

The five (5) strategic objectives were modified for Ghana's AMR Policy, which also created strategic interventions and actions for each goal. Its five-year rollout schedule was set to start in 2017 and end in 2021.

2.6 The Ghana National Action Plan on AMR- Strategic Objective 1

Strategic objective one (1) focuses on improving awareness and understanding of antimicrobial resistance through effective communication, education and training with a sub objective of increasing national awareness. Strategic intervention one states that, "there shall be collaboration between stakeholders including CSOs and the media for continuous education to promote the responsible use of antimicrobials amongst the general public in the spirit of the 'one –health approach".

Activities geared towards this intervention include "engaging CSOs and the media to educate the public; develop information, education and communication materials for targeted groups; educate the public in order to promote the responsible use of antimicrobials among the general population and review the public education campaign for optimized impact.

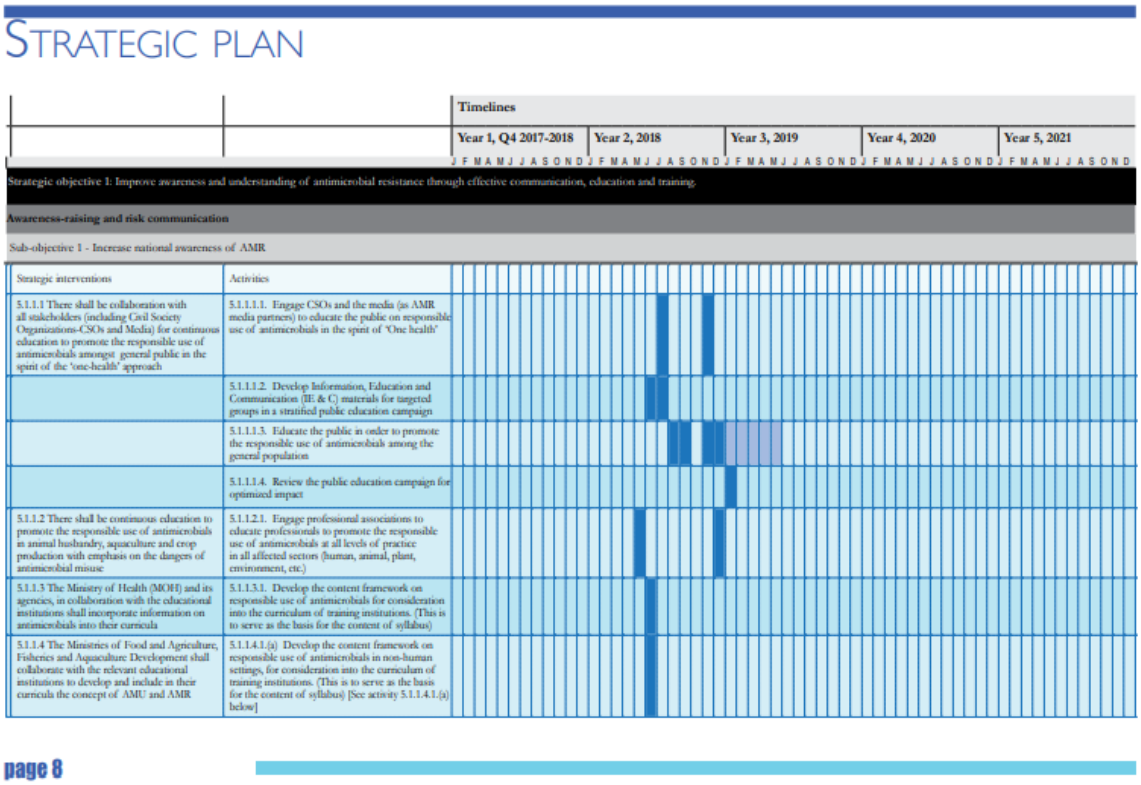
Intervention two (2) focused on "continuous education to promote the responsible use of antimicrobials in animal husbandry, aquaculture and crop production with emphasis on the

dangers of antimicrobial misuse". Activities to support this intervention include engaging professional associations and groups to educate professionals to promote the responsible use of antimicrobials at all levels of practice in all the affected sectors (human, animal, plant, environment, etc.)

Intervention three (3) targeted the Ministry of Health (MOH) and its agencies, stating that the Ministry and its agencies "shall in collaboration with the educational institutions incorporate information on antimicrobials into their curricula. To implement this, a content framework on responsible use of antimicrobials for consideration into the curriculum of training institutions shall be developed. This is to serve as the basis for the content of syllabus in the educational institutions.

Intervention four (4) focused on the Ministries of Food and Agriculture, Fisheries and Aquaculture Development collaborating with the relevant educational institutions to develop and include in their curricula the concept of AMU and AMR. Activities to support this intervention included developing the content framework on responsible use of antimicrobials in non-human settings, for consideration into the curriculum of training institutions. This is to serve as the basis for the content of syllabus; incorporate content on responsible use of antimicrobials into the curriculum of training institutions for professionals in all affected sectors (human, animal, plant, environment etc.) (*NAP*, 2017).

This is shown in Figure 2.



STRATEGIC PLAN

		Timelines				
		Year 1, Q4 2017-2018	Year 2, 2018	Year 3, 2019	Year 4, 2020	Year 5, 2021
		J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
Strategic objective 1: Improve awareness and understanding of antimicrobial resistance through effective communication, education and training.						
Awareness-raising and risk communication						
Sub-objective 1 - Increase national awareness of AMR						
Strategic interventions	Activities					
5.1.1.1 There shall be collaboration with all stakeholders (including Civil Society Organizations-CSOs and Media) for continuous education to promote the responsible use of antimicrobials amongst general public in the spirit of the 'one-health' approach	5.1.1.1.1. Engage CSOs and the media (as AMR media partners) to educate the public on responsible use of antimicrobials in the spirit of 'One health'					
	5.1.1.1.2. Develop Information, Education and Communication (IE & C) materials for targeted groups in a stratified public education campaign					
	5.1.1.1.3. Educate the public in order to promote the responsible use of antimicrobials among the general population					
	5.1.1.1.4. Review the public education campaign for optimized impact					
5.1.1.2 There shall be continuous education to promote the responsible use of antimicrobials in animal husbandry, aquaculture and crop production with emphasis on the dangers of antimicrobial misuse	5.1.1.2.1. Engage professional associations to educate professionals to promote the responsible use of antimicrobials at all levels of practice in all affected sectors (human, animal, plant, environment, etc.)					
5.1.1.3 The Ministry of Health (MOH) and its agencies, in collaboration with the educational institutions shall incorporate information on antimicrobials into their curricula	5.1.1.3.1. Develop the content framework on responsible use of antimicrobials for consideration into the curriculum of training institutions. (This is to serve as the basis for the content of syllabus)					
5.1.1.4 The Ministries of Food and Agriculture, Fisheries and Aquaculture Development shall collaborate with the relevant educational institutions to develop and include in their curricula the concept of AMU and AMR	5.1.1.4.1.(a) Develop the content framework on responsible use of antimicrobials in non-human settings, for consideration into the curriculum of training institutions. (This is to serve as the basis for the content of syllabus) [See activity 5.1.1.4.1.(a) below]					

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Figure 2. Strategic Objective 1 of Ghana's Action Plan on AMR

CHAPTER THREE

METHODOLOGY

3.1 Research Methods and Design

The research design was a descriptive cross-sectional study among some selected SHS final year students in the Greater Accra Region of Ghana. This study adopted quantitative methods to estimate the factors influencing awareness of the One- Health approach to AMR. A structured questionnaire was used to collect data on awareness of AMR and the One-Health Approach.

The data was analyzed using descriptive statistics and inferential statistics such as chi-square and logistic regression.

3.1.1 Study Site

The study was undertaken at the Amasaman SHS, St. John Grammar SHS and Kwabenya Community SHS in the Greater Accra Region of Ghana.

3.2 Data Collection Techniques and Tools

A modified structured questionnaire employing close ended questions was used for this study. 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). Data collection was done by self-administration of the questionnaire. The questionnaire is attached as an appendix.

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

3.3 Study Population

Students in their last year at Ghana's Greater Accra Region's Amasaman Senior High Technical School, St. Johns Grammar Senior High School, and Kwabenya Community Senior High School made up the study's target group. This field is crucial to the One Health Approach (animals, humans and the environment).

3.3.1 Inclusion criteria

Final-year science and agriculture students at the Amasaman Senior High Technical School, St. Johns Grammar Senior High School, and Kwabenya Community Senior High School

3.3.2 Exclusion criteria

Students who are not in their final year (general science and agriculture science) at the Amasaman Senior High Technical School, St. Johns Grammar Senior High School, and Kwabenya Community Senior High School.

3.3.3 Study Variables

Dependent Variables

i. Awareness of AMR
ii. 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.

3.4 Sampling

For the study, the whole population of science and final-year students from the Amasaman Senior High Technical School, St. Johns Grammar Senior High School, and Kwabenya Community Senior High School were employed.

As a result, there was no and the Census method will be used.

The census method is a statistical enumeration technique that involves studying the entire population.

Table 1.0 Student Populations by Schools

Department	Population
Amasaman SHS	40
St. John Grammar SHS	120
Kwabenya Comm.SHS	42
TOTAL	202

Pre-testing

Twenty (20) West Africa Senior High School students in their last year participated in pre-test the survey's questionnaires. The main study did not contain the results from the pretesting. The purpose of the pre-test was to gauge how well the participants comprehend the questions. Appropriate revisions were made to the questionnaire where necessary before actual data collection.

3.5 Data handling

The modified structured questionnaire was used to gather data on the topic under study (factors influencing the One-Health Approach to antimicrobial resistance amongst some selected final years SHS students in Greater Accra Region of Ghana). The questionnaires were screened for completeness and errors. The data was entered using Microsoft Excel. The original was used as the primary source data. The principal investigator was responsible for data cleaning and management. Data was stored on Google Drive, and backed-up on an external hard drive.

3.6 Analyzing Data

Data collected was analyzed using SPSS version 20 a statistical software tool. SPSS 20 was used for cleaning, emerging and analyzing the responses from the completed questionnaires. The data was cleaned by running frequencies of inconsistently coded data prior to the analysis. Respondents' socio-demographic factors; age, gender, program of study, religion, place of resistance, socio economic status, ethnicity and primary source of information were analyzed firstly using simple proportions (frequencies and percentages).

Chi- squared tests and cross tabulations were used to determine associations between the socio demographic factors and the level of awareness of AMR and the One- Health Approach to AMR.

Microsoft Excel was used to score the responses and expressed as percentages. 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.

Multivariable logistic regression was 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 ($p<0.05$).

3.7 Ethical Consideration

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

Ethical clearance: Ethical clearance was first sought from the Ensign Institutional Review Board. Administrative approval was also sought from Amasaman SHS, St. John Grammar SHS and Kwabenya Community SHS.

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

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

3.8 Limitations of Study

A limitation of the study included;

1. The number of respondents for the study was relatively small, which may affect the power of inference to the larger population.
2. Students could have given desirable answers to the question posed with regards to the program of study.
3. SES and may not be a true reflection of the SES of their parents

CHAPTER FOUR

RESULTS

4.0 Introduction

Based on the study's aims, this chapter provides analysis and a thorough summary of the findings. In this study, final-year science students of selected Senior High Schools in Greater Accra Region of Ghana were asked to rate the elements that influence their knowledge of the One-Health Approach to antibiotic resistance. The study specifically aimed to gauge students' knowledge of current trends in antimicrobial resistance, assess students' knowledge of the One-Health Approach to antimicrobial resistance, and identify the variables affecting students' knowledge of antimicrobial resistance and the One-Health Approach to antimicrobial resistance.

There are three strata in this section. The students' demographic features are described in section one using descriptive statistics. Analysis of the awareness of AMR is presented in Section two. The analysis on One-Health Approach to AMR awareness is presented in Section three.

4.2 Demographic Characteristics of Respondents

All of the survey participants were chosen from selected Senior High Schools in Greater Accra Region of Ghana. Through the distribution of questionnaires, data was acquired. Two hundred and two students from the three (3) selected Senior High Schools in Greater Accra Region of Ghana responded to the questionnaire. According to Table 4.0, there were 55.9% male respondents and 44.1% female respondents. Christians were reportedly represented by 70.3%.

The majority of survey participants belonged to the socioeconomic low class. Rural areas were home to 55.0% of people. The majority of respondents (55.1%) identified as Akan, Ewe (16.3%),

Ga-Dangbe (20.8%), and other ethnic groupings (11.4). 41.6% of the respondents said they mostly rely on the Television for information

4.3 Awareness of Antibiotic (Antimicrobial) Resistance

The difference between an antibiotic and an antimicrobial was correctly identified by 17.3% of the 202 respondents in this section. Approximately, 84.2% of respondents were unable to determine if scientists were working on enough antibiotics. If no action is taken, AMR will be the primary cause of death by 2050, according to 15.8% of respondents. 15.3% of respondents correctly identified the cause of antibiotic resistance as a body's resistance to antibiotics, which causes them to lose some of their effectiveness. 14.4% of respondents believed that most infections are getting more difficult to treat with medicines. 13.9% concurred that antibiotic resistance is a problem that they and their family may have to deal with.

Table 4.1 displays the traits of the respondents. 14.4% of respondents correctly stated that antibiotic resistance is a problem in Ghana as well as other nations. According to 13.4% of survey participants, antibiotic resistance only affects those who take antibiotics often.

14.4% of respondents correctly identified the possibility of bacterial resistance spreading from person to person. 14.9% of respondents said that antibiotic resistance could increase the risk of medical procedures like surgery, organ transplantation, and cancer therapy.

Table 1. Socio Demographic Characteristics (n=202)

Variable	Frequency (n)	Percentage (%)
Age		
Young adults (16-19)	122	60.4
Adults (20-24)	80	39.6
Gender		
Male	113	55.9
Female	89	44.1
Program of Study		
General Science	172	85.1
Agricultural Science	30	14.9
Religion		
Christianity	142	70.3
Islam	36	17.8
Traditional	23	11.4
Others	1	.5
Socio-economic status		
Low class	96	47.5
Middle class	67	33.2
High class	39	19.3
Ethnicity		
Akan	104	51.5
Ga-Dangme	42	20.8
Ewe	33	16.3

Others	23	11.4
Primary Source of information		
Television	84	41.6
Newspaper	31	15.3
Radio	16	7.9
Internet	71	35.1
Location		
Rural	111	55.0
Peri-Urban	30	14.9
Urban	61	30.2
Career		
Scientist	70	34.7
Nurse	43	21.3
Doctor	41	20.3
Pharmacist	14	6.9
Veterinary doctor	15	7.4
Others	19	9.4

Table: 2 Showing the responses received

Statement/ Question	Correct Answer, n(%)	Incorrect Answer n(%)
What is the difference between an antimicrobial and an antibiotic?	35 (17.3)	167(82.7)
Globally, do scientists have enough antibiotics under development at the moment to keep up with the problem of antibiotic resistance?	32 (15.8)	170(84.2)
Antimicrobial resistance will be the leading cause of death in humans by 2050, if current trends continue.	31 (15.3)	171 (84.7)
Antibiotic resistance occurs when your body becomes resistant to antibiotics and they no longer work as well.	29(14.4)	173(85.6)
Many infections are becoming increasingly resistant to antibiotics.	31 (15.3)	171 (84.7)
If bacteria are resistant to antibiotics, it can be very difficult or impossible to treat the infection they cause.	29(14.4)	173 (85.6)
Antibiotic resistance is an issue that could affect me or my family.	28 (13.8)	174 (86.1)
Antibiotic resistance is an issue in other countries but not here in Ghana.	29 (14.4)	173 (85.6)
Antibiotic resistance is only a problem for people who take antibiotics regularly.	27 (13.4)	175 (86.6)
Bacteria which are resistant to antibiotics can spread from person to person.	29 (14.4)	173 (85.6)
Antibiotic-resistant infections could make medical procedures like surgery, organ transplantation, and cancer treatment much more dangerous.	30 (14.9)	172 (85.6)

4.4 Awareness of the One- Health Approach

Answers to the questions in this section came from 202 respondents. 24 (11.9%) of respondents agreed that antibiotic resistance is a growing global threat to human and animal health; farmers' improper use of antibiotics has a significant negative impact on antibiotic resistance in plants, animals, and people; and improper use of antibiotics in animals used for food has a negative impact on antibiotic resistance in human pathogens. 100% of respondents said that veterinary professionals' improper use of antibiotics has no a substantial impact on antibiotic resistance in both animals and people. 11.9% of the respondents correctly responded to the question about how inappropriate disposal of unneeded or excess antibiotics into the environment can lead to antibiotic resistance in plants, animals, and people.

The One-Health Approach, according to 11.9% of the respondents, is the only strategy for addressing antibiotic resistance. One-Health Approach is acknowledged as recognizing the connections between people, animals, plants, and their shared environment by 10.9% of respondents. These numerous industries are interdependent. 11.9% agreed that the One-Health Approach may improve food safety and security while also defending global health security.

Table 3 Presentation of Results

Statement/ Question	Correct Answer, n (%)	Incorrect Answer, n (%)
Antibiotic resistance is an increasing global threat to human and animal health.	0	202(100)
The misuse of antibiotics by veterinary practitioners contributes significantly to antibiotic resistance in both animals and humans.	0	202 (100)
The misuse of antibiotics by farmers contributes significantly to antibiotic resistance in plants, animals and humans.	0	202(100)
The inappropriate use of antibiotics in food-producing animals significantly contributes to antibiotic resistance in human pathogens.	0	202(100)
Improper disposal of unused/excess antibiotics into the open environment can contribute to antibiotic resistance in plants, animals and humans.	24(11.9)	178 (88.1)
The One- Health Approach is the only way to address antimicrobial resistance.	24 (11.9)	178 (88.1)
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.	22 (10.9)	180 (89.1)
The One- Health Approach can protect global health security as well as improve food safety and security.	24 (11.9)	178 (88.1)

4.5 Association between demographic characteristics awareness of Antimicrobial resistance.

The level of awareness was graded using the Bloom cut-off point (Feleke, Wale, and Yirsaw, 2021); bad, moderate, and good. AMR was well-understood by 26 students, or 12.8% of the class, with scores ranging from 80 to 100%. The scores of 3 pupils (or 1.48% of the class) ranged from 60 to 79%. AMR was poorly understood by 173 (85.6%) pupils.

According to Pearson's Chi squared analysis, the students' knowledge level was strongly correlated with their program of study (p= 0.042)but not with the socioeconomic status (p=0.525), and their age, gender, religion, location, or primary information source.

Students in the general science and agricultural science programs demonstrated strong understanding (p=0.042) as students from the low class (p=0.525) do not.

Table 4 Presentation of Results (Awareness Score AMR)

Awareness Score (AMR)					
Characteristics		**Poor**	***Moderate***	**Good**	**p Value**
		n(%)	***n (%)***	**n(%)**	
Age	15-19	101(58.4)	3 (100)	18(69.2)	0.211
	20-25	72(41.6)	0 (.00)	8(30.8)	
Gender	Male	97 (56.1)	2 (66.7)	14(53.8)	0.911
	Female	76(43.9)	1(33.3)	12(46.2)	
Program of Study	General science	151(87.3)	3 (100.)	18 (69.2)	0.042
	Agric science	22 (12.7)	0 (0.0)	8(30.8)	
Religion	Christianity	118 (68.2)	2(66.7)	22 (84.6)	0.680
	Islam	32 (18.5)	1 (33.3)	3 (11.5)	
	Traditional	22 (12.7)	0 (0.0)	1 (3.8)	
	Others	1(0.6)	0 (0.0)	0(0.0)	
Socio-economic status	Low Class	80(46.2)	1 (3.33)	15(57.7)	0.525
	Middle class	59 (34.1)	2 (66.7)	6 (23.1)	
	High class	34(19.7)	0 (0.0)	5 (19.2)	

Ethnicity	Akan	87(50.3)	1 (33.3)	16 (61.5)	0.492
	Ga-Dangme	36 (20.8)	2 (66.7)	4 (15.4)	
	Ewe	29 (16.8)	0 (0.0)	4 (15.4)	
	Others	21 (12.1)	0 (0.0)	2 (7.7)	
Primary source of information	Television	68 (39.3)	1 (33.3)	15 (57.7)	0.551
	Radio	14 (8.1)	2 (34.4)	2 (7.7)	
	Newspaper	26(15.0)	1 (33.3)	4 (15.4)	
Location	Rural	92 (53.2)	1 (33.3)	18 (69.2)	0.221
	Peri-urban	29 (16.8)	0 (0.0)	1 (3.8)	
	Urban	52 (30.1)	2 (66.7)	7 (26.9)	

4.6 Association between demographic characteristics awareness of the One Health Approach.

The level of knowledge was rated as poor, moderate or good using the Bloom cut-off point

(Feleke, Wale, and Yirsaw, 2021). 180 pupils, or 89.1% of the class, scored lower than 60% on the OHA awareness test. 22 students (10.9) received scores in the moderate range (60–79%). OHA was not known by students

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 and their main source of information.

Students from science and agricultural science department had knowledge (p 0.042)

Table 5 Comparison between the demographic characteristics and Awareness of the One-Health Approach.

Awareness Score (One-Health)					
Characteristics		**Poor n(%)**	**Moderate n(%)**	**Good n(%)**	**P-Value**
Age	16-19	108(60)	14(63.3)	0(0.0)	0.742
	20-24	72(40)	8(36.4)	0 (0.0)	
Gender	Male	102(56.7)	11 (50.0)	0(0.0)	0.552
	Female	78 (43.3)	11 (50.0)	(0.0)	
Course of Study	Science	158 (87.8)	14(63.6)	0 (0.0)	0.042
	Agric science	22 (12.2)	8(36.4)	0(0.0)	
Religion	Christianity	124 (68.9)	18 (81.8)	0(0.0)	0.605
	Islam	33(18.3)	13(13.6)	0(0.0)	
	Traditional	22 (12.2)	1(4.5)	0(0.0)	
	Others	1(0.67)	0(0.0)	0(0.0)	
Socio-economic status	Low Class	83 (46.1)	13(59.1)	0(0.0)	0.467
	Middle class	62(34.4)	5 (22.7)	0(0.0)	
	High class	35 (19.4)	4 (18.2)	0 (0.0)	
Ethnicity	Akan	92 (50.6)	13 (59.1)	0(0.0)	0.776
	Ga-Dangme	39 (21.7)	3 (13.6)	0(0.0)	
	Ewe	30 (16.7)	3(13.6)	0 (0.0)	

	Others	20(11.1)	3(13.6)	0(0.0)	
Primary source of information	Television	70 (38.9)	14 (63.6)	0 (0.0)	0.85
	Radio	15 (8.3)	1(4.5)	0(0.0)	
	Internet	68(37.8)	3(713.6)	0(0.0)	
	Newspaper	27(15.0)	1(4.5)	0(0.0)	
Location	Rural	96 (53.3)	15(68.2)	0(0.0)	0.270
	Peri-urban	29 (16.1)	1 (4.5)	0(30.0)	
	Urban	55 (30.6)	6 (27.3)	0(0.0)	

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

There was association between one's understanding of AMR and that of the OHA. The level of knowledge of the students in AMR was linked to the level of knowledge in the OHA, according to Pearson's Chi squared test (p 0.000).

Table 6 Comparison between Awareness of Antimicrobial resistance and Awareness of the One-Health Approach

		Awareness of the One- Health Approach			
Characteristics		**Poor n (%)**	**Moderate n(%)**	**Good n(%)**	**p Value**
Awareness of AMR	Poor	171 (95.5)	1(4.5)	0 (0.0)	**0.000**
	Moderate	4 (1.7)	0(0.0)	0 (0.0)	
	Good	5(2.8)	21 (95.5)	0 (0.0)	

4.8 Relationship between knowledge of AMR and demographic characteristics

The results of the multivariate logistic regression demonstrated how one's academic path affects their knowledge about AMR. Compared to those studying science, and agricultural science students had higher odds of knowing about AMR (OR= 0.233, 95% CI (0.075-0.726) Age, gender, religion, place of residence, socioeconomic level, ethnicity, and the primary information source had no bearing on one's knowledge about or awareness of AMR.

The Table 8 depicted this.

Table 7 Bivariate Logistic regression analysis demographic characteristics with awareness of Antimicrobial resistance.

Characteristics		**AOR (95% CI)**	**p-value**
Age			
	15-19	1.247(0.490 - 3.173)	0.643
	20-25	Ref	
Gender	Female	Ref	
	Male	1.247 (0.490-3.173)	0.643
Course of Study	General science	0.233(0.075-0.726)	0.012
	Agric Science	Ref	
Religion	Christianity	1	
	Islam	2.77 (0.16-47.36)	0.48
	Traditional	1	
	Others	Ref	
Socio-economic status	HighClass0.478(0.031-	0.808(0.0147-4.458)	0.807

	2.554) 0.454		
	Low Class	0.278(0.031-2.534)	0.256
	Middle class		
Ethnicity	Akan	1.743(0.288-10.531)	0.545
	Ga-Dangme	1.367(0.184-10.126)	0.760
	Ewe	1.443 (0.185-11.256)	0.727
	Others	Ref	
Primary source of information	Internet	Ref	
	Radio	3.364(0.764-14.810)	0.109
	Television	2.515(0.489-12.929)	0.269
Location	Rural	1.046(0.237-4.611)	0.953
	Peri-urban	0.278(0.31-2.5334)	0.256
	Urban	Ref	

4.9 Relationship between awareness of OHA and demographic characteristics

The results of the multivariate logistic regression demonstrated how one's OHA knowledge is influenced not by their course of study. Students Science department [OR= 0.233, 95% CI = (0.75-0.726). age, gender, religion, place of residence, socioeconomic position, ethnicity, and the main information source had no effect on one's knowledge of or awareness of OHA.

In Table 9 this was shown

Table 8 Multivariate Logistic regression analysis demographic characteristics with awareness of OHA

Characteristic		AOR (95% CI)	p-value
Age	16-19	Ref	
	20-24	2.537(0.953-6.752)	0.62
Gender	Female	Ref	
	Male	1.247(0.490-3.173)	0.643
Program of Study	General science	0.233(0.75-0.726)	0.012
	Agric science	Ref	
Religion	Christianity	Ref	
	Islam	1.85 (0.05-70.72)	0.74
	Traditional	1	
	Others	1	
Socio-economic status	High class	0.808(0.147-4.458)	0.807
	Low Class	0.806(0.178-3.640)	0.779
	Middle class	Ref	
Ethnicity	Akan	1.743(0.288-10.531)	0.545

	Ga-Dangme	1.367(0.184-10.126)	0.760
	Ewe	1.443(0.185-11.256)	0.727
	Others	Ref	
Primary source of information	Internet	3.364(0.764-14.810)	0.109
	Radio	2.515(0.489-12.929)	0.269
	Television	1.957(0.272-14.084)	0.505
Location	Rural	1.046(0.237-4.611)	0.953
	Peri-urban	0.278(0.31-2.534)	0.256
	Urban	Ref	

CHAPTER FIVE

DISCUSSION

5.0 Introduction

The purpose of this study was to evaluate the variables affecting final-year Science and students' knowledge of the One-Health approach to AMR. The study's results are discussed in this chapter in light of the specified goals.

5.1.1 Awareness of Antibiotic (Antimicrobial) resistance

In all, 32 (18%) of the 202 respondents were aware of the term "antimicrobial resistance," irrespective of the study's focus. “If action is not taken to stop the rising abuse and misuse of antibiotics, 15.8% of the students predicted that AMR will be a major cause of mortality by 2050”. This suggests that students are unaware that by 2050, acute infectious infections will be the primary cause of death since most antibiotics (antimicrobials) will not be as effective as they once were owing to resistance.

In some nations, like Ghana, this could lead to a worsening of the dual burden of infectious and chronic diseases, with more people dying from poorly managed infectious diseases due to inefficient antibiotics.

The statement "Antibiotic resistance is not only a problem for people who take antibiotics regularly" was also accurately cited by about 13.4% of the students. This may indicate that students, who will eventually use and distribute antibiotics, are unaware of the long-term effects of AMR. This suggests that since AMR is a severe public health risk, serious emphasis should be given to it.

According to 14.9 % of respondents, antibiotic-resistant diseases could increase the risk of medical procedures such surgery, organ transplantation, and cancer therapy. Approximately 14.4% of respondents believed that "bacteria which are resistant could be transferred from one person to another." These results imply that students were not aware of the AMR tendencies that are now in effect.

Out of 202 respondents, 1.48% had moderate to good understanding of AMR according to the survey. The results of a study that examined the "Knowledge of AMR among Veterinary Students and their Personal Antibiotic Use Practices in Nigeria" revealed that almost half of the participants (55%) had a poor level of awareness regarding AMR (Seid and Hussen, 2018). This is in contrast to those findings. Seid and Hussen's study, however, was conducted among second to sixth-year veterinary students, whereas this study was conducted among final-year science students in selected senior high schools in Greater Accra Region of Ghana.

Students studying Science and Agricultural science were not well-informed about AMR. Scores using Bloom's cut off. When compared to students in sciences and agricultural science departments were not aware of AMR just few. This can be because of the subject matter were not covered in science and agricultural science whereas 89.1 % had poor knowledge. In a qualitative study that examined the accomplishments and shortcomings of the NAP in Ghana, a respondent on the topic of "AMR-related Teaching, Training, and Research in Academic Institutions" stated that "in Pharmacy, antimicrobial stewardship and the role of Pharmacist in the containment of AMR had been incorporated at different levels, undergraduate, graduate, but these must also be evident in the curricula for students studying.

5.2 Awareness of the One- Health Approach to AMR

Out of the 202, 11.9% acknowledged having heard of the term "One-Health Approach. One-Health Approach awareness was tested among medical interns in a comparable survey, and 40.2% of the 316 participants had never heard of the idea (VarerAkpinar and Durmaz, 2022). The aforementioned study, however, was exclusively intended for medical interns, whereas the current study concentrated on final-year SHS science and agricultural science students.

In their curricula there is no One Health Approach, this may accounted for low level of awareness of the one health approach among science and agricultural science students. We urge the Ghana Education Service to include one health approach in the curricula of science and agricultural science students in senior high school. Since they will be the very people pursing Pharmacy, Veterinary medicine and medicine in the university. This helped them to have solid foundation before entering university for science related courses.

All 202 respondents do not agreed that farmers' improper use of antibiotics significantly contributes to antibiotic resistance in plants, animals, and humans; improper use of antibiotics in animals used for food production significantly contributes to antibiotic resistance in human pathogens, despite the fact that knowledge of the One-Health Approach was low (11.9% out of 202 respondents).

Furthermore, 100% of respondent’s do not agreed that veterinary professionals' improper use of antibiotics had a sizable impact on the development of antibiotic resistance in both humans and animals. The inappropriate disposal of leftover or excess antibiotics into the environment, according to almost 11.9% of respondents, can result in antibiotic resistance in plants, animals, and people. However, the nature of the questionnaire as it was administered was such that it

purposefully elicited full awareness of the "One Health" terminology and, as a result, it's associated understanding. It is likely that the remaining 88.1% students who had not heard of the term "One Health" could have had some idea of the cross-interaction of AMR across the two stakeholder disciplines. Thus, a similar follow-up study may be required to confirm and evaluate the aforementioned premise. However, it is crucial that a majority of the pupils, if not all of them, thoroughly do not comprehend the language and the facts that go along with it.

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

It was clear from the bivariate and multivariate analyses of the socio-demographic factors that there was no significant association between one's level of awareness of AMR and the One Health approach to AMR and one's age, gender, religion, place of residence, ethnicity, or source of information.

The amount of awareness of AMR was not significantly association with one's socioeconomic status (p value=0.807), which is greater than the 0.05 level of significance. This suggests that socioeconomic status might not affect AMR. However, it is important to emphasize that socioeconomic position and awareness of OH were not significantly correlated.

In their curricula they have microbes as a topic they were not having one health approach.

The teachers themselves have low level of knowledge on AMR and OH. The GES should include AMR and OH in their SHS curricula; this is because the SHS students will be the future health workers. When they have it in their curricula it will help them to have strong foundation in AMR and OH.

In addition, one's knowledge of AMR and the One Health approach to AMR were significantly influenced by the course of study, with p 0.042 for both dependent variables.

This suggests that curriculum material on AMR and OH could typically increase people's awareness of these topics. As the right use of antibiotics (antimicrobials) and AMR in the spirit of One-Health are clearly outlined under strategic objective one (1) of Ghana's NAP on AMR, more research can be done to assess the content of courses provided to students.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The study's overview, findings, and suggestions are presented in this chapter. In this study, final-year SHS science and agricultural science students of Greater Accra Region of Ghana were chosen in order to evaluate the factors impacting their knowledge of the One-Health Approach to Antimicrobial Resistance. The study specifically aimed to measure students' knowledge of antimicrobial resistance and its current trends, assess students' knowledge of the One-Health Approach to antimicrobial resistance, and identify the variables that affect students' knowledge of this approach.

Students in their last years of General Science and Agricultural Science participated in the quantitative study. 202 students' responses to questionnaires were used to gather data. Microsoft Excel was used to enter the data, which was then exported for analysis into R version 4.3.0. The data were analyzed using descriptive and inferential statistics. While the inferential statistics used Chi-squared and multivariate logistic analysis, which reported odds ratios and their respective 95% confidence intervals signifying level of precision with a significant alpha value set at 5% (p0.05), the descriptive analysis used frequencies and percentages.

6.2 Conclusions

Based on the study's goals, it is possible to derive the following conclusions. The terms "antimicrobial resistance" and "one-health approach" were each known to 11.9% of respondents (180/202), 88.1% of respondents had no knowledge on AMR and OHA. The study found that people's awareness of AMR was not significantly influenced by their socioeconomic status but

rather programs of study. Additionally, it was discovered that a person's level of knowledge of AMR and the program of study affected how well-versed they were in the One-Health Approach to AMR.

Based on the results, it appears that the program of study had substantial impact on students' knowledge of AMR and the OH approach to AMR.

6.3 Recommendations

1. The core of this study's design was quantitative. In order to further understand the variables that affect students' understanding of the One Health Approach to AMR, future research should use a mixed method that combines quantitative and qualitative techniques.

2. While this study focused on students, more research should be done to determine the general public's (as well as practitioners') degree of awareness of AMR as well as their level of familiarity with the One-Health Approach to AMR.

3. It was discovered that OH Approach and AMR was not fully in the curricula of SHS, we advised that GES should include it fully in the curricula. Future research that evaluates the Science and Agricultural science curricula to find components of AMR may help to clarify this.

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APPENDICES

ETHICALCLEARANCE

Appendix 1. Ethical clearance (Ensign Global College)

ENSIGN GLOBAL
COLLEGE

OUR REF: ENSIGN/IRB/EL/SN-227 April 19, 2023.
YOUR REF:

INSTITUTIONAL REVIEW BOARD SECRETARIAT

Felix Edward Yao Tsakpo
Ensign Global College
Kpong

Dear Felix,

ETHICAL CLEARANCE TO UNDERTAKE POSTGRADUATE RESEARCH

At the General Research Proposals Review Meeting of the *INSTITUTIONAL REVIEW BOARD (IRB)* of Ensign Global College held on Wednesday, April 19, 2023, your research proposal entitled **"Factors Influencing Awareness of the One Health Approach to Antimicrobial Resistance: A Case Study Amongst Selected Senior High School Final Year Science Students in the Greater Accra 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 Acquah-Arhin
IRB Chairperson

P. O. Box AK 136 | Terna Akosombo – Agyaw, Kpong, Eastern Region, Ghana
https://www.ensign.edu.gh +233 245 762 228 irb@ensign.edu.gh

CONSENT FORM

Appendix 2Consent Form

Hello Madam,

My name is, …….I am a student of Ensign Global CollegeKpong. I am conducting research on the Factors Influencing Awareness of the One-Health Approach to Antimicrobial Resistance Amongst Selected SHS Final Year Students in The Greater Accra Region of Ghana.

This is scholarly study that might be applied to the creation of policy. The time you could give me to complete this questionnaire would be greatly appreciated.

AMR is defined as "the emergence of bacterial, viral, parasitic, and fungal germs that are resistant to antimicrobial drugs that were once successful for treating illnesses" (Collignon, 2017).

It is possible for germs to naturally develop resistance by activating certain built-in defense mechanisms, evolving to withstand antibiotics, or acquiring resistant genes from other bacteria (Australian government, 20 Antimicrobial resistance (AMR) has been accelerated by the inappropriate use of antibiotics and is influenced by a number of factors, some of which include suboptimal and excessive antimicrobial prescription rates and insufficient adherence to advised practices, such as finishing antibiotic courses (Castro-Sánchez et al., 2016).

To achieve optimal health for people, domestic animals, wildlife, plants, and our environment, One - Health (OH) is defined as the "collaborative effort of multiple health science professions,

together with their related disciplines and institutions—working locally, nationally, and internationally" (Kahn, 2017)

The goal of this study is to evaluate the factors impacting students' knowledge of the One Health approach to antimicrobial resistance in a sample of senior high school science final year students in the Greater Accra Region of Ghana. Interventions in public health will be informed by the study's findings.

Your involvement in this study will be crucial in assisting us in achieving this objective.

Dear participant,

Please accept my invitation to participate in my study on the factors influencing students' awareness of the One-Health Approach to Antimicrobial Resistance in the Greater Accra Area of Ghana's SHS General Science Final Year. The purpose of this study is to evaluate the elements that affect people's knowledge of the one health approach to antibiotic resistance.

While this study is voluntary, you are free to leave at any moment without incurring any fees or losing any benefits. Your responses will be kept private and anonymous, and no publications or reports will indicate who you are.

Participating in this study carries no known risks, and you might gain from it by helping to understand the factors that affect people's awareness of one health-related approach to antibiotic resistance.

It will take you 10 to 20 minutes to finish the questionnaires. You are giving your informed consent to take part in the study by consenting to take part.

Your anonymity is also assured. Thank you.

Do you have any questions to ask about the interview?

Do you want to partake in it? **YES** ☐ **NO** ☐

ANSWER ANY QUESTIONS AND ADDRESS RESPONDENT'S CONCERNS.

RESPONDENT *AGREES* TO BE INTERVIEWED

1	-- - - - → BEGIN

RESPONDENT *DOES NOT AGREE* TO BE INTERVIEWED

2	- - - - → END

Name of Interviewer _____

Date: _____

RESPONDENT'S SIGNATURE: _____

THUMB PRINT

QUESTIONNAIRE

Appendix 3 Questionnaire

FACTORS INFLUENCING AWARENESS OF THE ONE-HEALTH APPROACH TO ANTIMICROBIAL RESISTANCE: A CASE STUDY AMONGST SELECTED SHS FINAL YEAR STUDENTS IN THE GREATER ACCRA 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