

## Knowledge of antimicrobial resistance and associated factors among healthcare workers at a tertiary hospital in Monrovia, Liberia: a facility-based cross-sectional study

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**Abstract: Background:** Globally, healthcare systems are currently facing significant challenges in terms of antibiotic resistance. Healthcare workers actively participate in the process of prescribing and administering antibiotics. Our objective was to examine the level of knowledge regarding antibiotic use and antibiotic resistance among healthcare workers working in a tertiary hospital located in Monrovia, Liberia. **Methods:** A hospital-based cross-sectional survey was carried out, and study participants were selected via convenient sampling. Statistical analysis was performed via Epidemiological Information (Epi-Info) 7.2.5.0 after the data were entered into Microsoft Excel 2016. **Results:** Sixty-one (61) health workers ranging in age from 20--60 years were included in the study. The mean age of the study participants was 29.6 years ( $\pm 5$ , range = 27--32), with males accounting for 19 (31.1%) of the participants and 42 (68.9%) females. The majority of participants, 38 (62.3%), reported that they never had AMR training before, and only 27 (44.3%) said that antibiotics are used to treat bacterial infections. Being female (aOR: 0.45; 95% CI: 0.21--0.96) and having a high school diploma (aOR: 11.2; 95% CI: 3.94--35.1) were significantly associated with knowledge of AMR. There was no statistically significant correlation between age or discipline and the general level of awareness of antimicrobial resistance (AMR). **Conclusion:** The results of this study suggest that healthcare workers' knowledge of antimicrobial resistance (AMR) is generally moderate. For healthcare workers to effectively support efforts aimed at preventing antibiotic resistance, their knowledge of antibiotic usage and antimicrobial resistance (AMR) must be increased. This evidence serves as a baseline for larger studies to provide information and awareness of AMR among healthcare workers.

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**Keywords:** Knowledge; Antimicrobial resistance; Healthcare workers; Liberia

### What is already known

- HCWs are an important source of information for patients, as they are related to antibiotic use and the prevention AMR.
- Inadequate knowledge, poor attitudes and poor practices by HCWs can significantly negatively affect the control of antimicrobial resistance.

### What this study adds

- This study offers evidence regarding knowledge and awareness of antibiotic use in Liberia, which has remained largely inaccessible.
- The overall knowledge of HCWs regarding antibiotic use and antimicrobial resistance was inadequate
- There is a pressing need for antibiotic use and AMR awareness for HCWs in

health facilities in Monrovia, Montserrado County.

### Introduction

Since their introduction, antibiotics have been used routinely for managing infections and have improved the management of infectious diseases, resulting in reduced morbidity and mortality(1). Recent data, however, point to a significant issue for public health because of the rise in antibiotic resistance(2,3). The World Health Organization (WHO) has identified antimicrobial resistance (AMR) as among the top 10 global public health challenges to mankind(4). Approximately 700,000 people die each year as a result of infections with antibiotic-resistant organisms, according to estimates(5,6). On the basis of economic projections, these infections will result in 10 million annual deaths by the year 2050 and have a global economic impact of more than USD 1 trillion by the year 2030(5,7,8). Although AMR affects all countries,

the impact is disproportionately greater in low- and middle-income nations than in high-income nations(9). Owing to the high rate of disease, inappropriate antimicrobial use, easy access to over-the-counter antibiotics, and dearth of clinical microbiology facilities for antimicrobial susceptibility testing, the challenge of antimicrobial resistance is complex in low-income countries(2,10). AMR has substantially impeded the ability to treat diseases such as tuberculosis and pneumonia, manage newborn diseases, and deliver vital therapies such as chemotherapy and surgery(11,12). People with severe illnesses are usually affected by AMR, and they frequently need antibiotic treatment. Typically, these patients receive care in healthcare centers where they often interact with other patients and staff members. As a result, there is an increased likelihood of resistance developing and then spreading both within and between patients(13,14).

Uncontrolled use of antibiotics is thought to be a major contributor to the emergence of bacteria that are resistant to antibiotics in health facilities, resulting in and causing difficulties in treating patients(15–19). Inadequate training, knowledge, attitudes, prescribing practices, interactions between patients and doctors, and drug marketing are the main causes of the inappropriate use of antibiotics among healthcare workers (HCWs) (20). They play a direct role in the prescription and usage of antibiotics and might comply with improper patient requests or engage in improper practices, both of which increase the risk of developing antibiotic resistance(19,21,22). Promoting awareness and providing information on responsible antimicrobial use may help healthcare providers make better judgments(23,24).

Irrational medication use in Liberia is related to systemic issues such as the high frequency of use of expired medications and insufficient numbers of trained healthcare providers. In many cases, health facility dispensaries may also be inadequately maintained, and personnel may not be aware; therefore, they may not consult the standard treatment guidelines and essential medicine list when prescribing(25). In this study, we assessed the knowledge of HCWs regarding antibiotic use and AMR at the Eternal Love Winning Africa (ELWA) Hospital from January to March 2023. Specifically, this study sought to determine overall knowledge of antibiotic use and AMR and to identify associations between HCWs' knowledge of AMR and demographic characteristics. Given that there is limited evidence on AMR among HCWs in Liberia, this study could be used as a baseline for researchers to fill the gaps in AMR challenges in healthcare in Liberia. Hence, we

assessed HCWs' knowledge of AMR and associated factors at ELWA Hospital from January to March 2023.

## **Methods**

### ***Study setting and design***

This facility-based cross-sectional study was conducted to assess HCWs' knowledge of antibiotic use and AMR at the Eternal Love Winning Africa (ELWA) Hospital in Montserrado County, Liberia, from January to March 2023. ELWA Hospital is a private hospital and one of the country's major tertiary care facilities, with approximately 120 beds (26). Institutions serve a significant proportion of the people in Montserrado County, which is the country's only urban county and hosts most healthcare facilities and diagnostic services, such as hospitals, laboratories and pharmacies.

### ***Study population and sample size***

HCWs working in various departments of nursing, pharmacy, medicine, laboratory, and midwifery at ELWA Hospital composed the study population. Convenience sampling was employed to select study participants on the basis of their availability during the study period, resulting in a total sample size of 68.

### ***Inclusion and Exclusion Criteria***

All HCWs in the departments of nursing, pharmacy, medicine, laboratory, and midwifery at ELWA Hospital who were available during the period of data collection and agreed to be interviewed were included in the study. HCWs who were unwilling or on leave were excluded.

### ***Data collection***

Study data were collected via a semistructured, self-administered questionnaire, which was developed on the basis of one used in previous studies but modified for this purpose(27–29). The questionnaire included questions about the sociodemographic characteristics of the participants and their knowledge of antibiotic use and AMR. The questionnaires were distributed to medical workers who worked both day and night shifts. Two nurses who work in the hospital provided assistance to the study team with the distribution and collection of the surveys.

### ***Data Measurement Techniques***

The assessment of knowledge was conducted through the use of five questions. Responses that indicated "Yes" were awarded a score of 3, responses that indicated "I do not know" were awarded a score of 2, and responses that indicated "No" were awarded a score of 1, with a total score of 13. Scores greater than 70% were considered good knowledge, and scores less than 70% were considered poor knowledge (30).

This study's dependent variable was AMR knowledge, whereas potential independent variables included age,

sex, level of education, field of discipline, and self-medication with antibiotics.

#### **Study variables**

The dependent variable was knowledge of AMR, while the potential independent variables were age, sex, education level, field of discipline, practice of self-medication and use of antibiotics.

#### **Statistical analysis**

The data for the study were entered and cleaned via Microsoft Excel 2016, and any inconsistencies or errors in the data were identified and rectified. Epidemiological information (Epi-Info) 7.2.5.0 was used for further analysis. The researchers conducted descriptive data analyses, which involved examining frequencies and percentages. The use of inferential analysis was employed to examine potential correlations between variables and the level of AMR knowledge among HCWs. The threshold for determining statistically significant differences was established at a significance level of  $p < 0.05$ .

#### **Results**

##### ***Demographic characteristics of the study participants***

Among the 68 HCWs who met the eligibility criteria during the study period, 61 (89.7%) fully participated in the study. The remaining 7 (10.3%) could not fully participate, mainly because of a lack of time. The mean age of the study participants was 29.6 years ( $\pm 5$ , range = 27–32). Males accounted for 19 (31.1%) of the participants, whereas 42 (68.9%) were females. The majority of the participants were nurses (36, 59%), followed by pharmacists (8, 13.1%), doctors (7, 11.4%), laboratory technicians (6, 9.8%) and midwives (4, 6.5%). With respect to academic qualifications, 28 (45.9%) participants were high school diploma holders, 22 (36%) were bachelor's degree holders, and 11 (18%) were master's degree holders (Table 1).

##### ***Knowledge of AMR among study participants***

Table 2 shows that the majority of the 38 (62.3%) reported that they had never previously had training about AMR. Among the 61 total participants, 37 (60.7%) and 41 (67.2%) responded that antibiotics are effective in treating viral infections and malaria, respectively. Up to 40 (65.6%) also reported that antibiotics are effective in treating the common cold, and only 27 (44.3%) reported that antibiotics are used to treat bacterial infections.

##### ***Knowledge of AMR and its associations with demographic characteristics***

An examination of the relationships between sociodemographic characteristics and knowledge of AMR among the study participants revealed that being female ( $P = 0.026$ ), being a nurse ( $P = 0.017$ ), being a

doctor ( $P = <0.001$ ) and having a high school diploma ( $P = <0.001$ ) were significantly associated with AMR. However, in the multivariable logistic regression analysis, only being female (aOR: 0.45; 95% CI: 0.21–0.96) and having a high school diploma (aOR: 11.2; 95% CI: 3.94–35.1) remained significantly associated with knowledge of AMR (Table 3).

#### **Discussion**

HCWs play a crucial role in preventing the development and spread of AMR by educating patients and minimizing the spread of infections in healthcare settings, especially when treating infections by prescribing, dispensing, and administering antibiotics(31,32). The objective of this study was to assess the level of knowledge regarding antibiotic resistance and its related aspects among HCWs. Our study has several significant findings.

This study revealed that factors such as male sex, a higher level of education, familiarity with the classification of over-the-counter medications, and discipline were identified as significant contributors to a strong understanding of antimicrobial resistance. Several prior studies have revealed that factors such as male sex, work experience, a lower number of working hours per week, and a history of antibiotic intake are influential elements in the development of a strong understanding of AMR(33–35). In a previous study, factors such as differences in education and training as well as professional responsibility for managing and treating infections between professional groups were also associated with knowledge of AMR; consequently, medical doctors achieved the highest scores(36,37). In their study, Hayat *et al.* (2020) reported statistically significant correlations between age, years of experience, and knowledge pertaining to AMR. Research has also shown that nurses with a master's degree have a more favorable disposition toward mitigating AMR. However, it is worth noting that no statistically significant association was observed between awareness of AMR and training in that study. This highlights the necessity of formulating inventive strategies and techniques to educate HCWs to promote the proper utilization of antibiotics and prevent the emergence of antimicrobial resistance.

The majority of participants (61%) reported that the irrational use of antibiotics could accelerate the emergence of antibiotic resistance. This result is marginally lower than those of other studies conducted in Namibia and Ethiopia, where up to 78.3% and 72%, respectively, of respondents believed that overuse of antibiotics could result in antibiotic resistance. While this is a positive finding, up to 37 (38%) of the participants said that the improper use of antibiotics does not hasten the development of antibiotic

resistance(38–40). This is indeed concerning because, in many cases, some HCWs are responsible for prescribing medications to patients, and the risk for the irrational prescription of antibiotics may exist.

According to the findings of our study, HCWs have a moderate level of knowledge of AMR. Similar findings were reported by Balliram *et al.* in 2021 in South Africa, who noted that pharmacists and nurses exhibited deficiencies in their knowledge, attitudes, and practices regarding AMR. These findings are also consistent with those reported in Nepal, which suggests that HCWs have a moderate level of knowledge, attitudes, and practices related to AMR(41). This finding indicates that further engagement with HCWs needs to take place at a level that not only raises awareness and increases knowledge but also brings about behavior change and an understanding of how to support wider AMR stewardship within their working environment.

This study has several limitations, the most significant of which is its relatively small sample size, which is restricted to healthcare employees at a single health facility. Therefore, it may be difficult to generalize our findings to the entirety of the country. When respondents were asked to fill out the questionnaire, social desirability bias could have taken place. In this study, we placed strong emphasis on maintaining complete confidentiality for all of the respondents to minimize this bias.

## Conclusion

The findings of this study fill an essential evidence gap in the evaluation of the level of knowledge of AMR among HCWs in Liberia. According to these findings, HCWs need to increase their understanding of antibiotic usage and AMR to successfully contribute to initiatives for the prevention of antibiotic resistance. In the context of the research setting, the study supplies baseline data that may be used to build a program that can improve the knowledge of HCWs.

## Data availability

The analysis includes all relevant data. The datasets used in this work may be obtained from the corresponding author upon satisfactory request.

## List of abbreviations

AMR: Antimicrobial Resistance

CDC: Centers for Disease Control and Prevention

CI: Confidence Interval

COVID: Coronavirus Disease

ELWA: Eternal Love Winning Christ

ESAC: European Surveillance of Antimicrobial Consumption

EU: European Union

IRB: Institutional Review Board

KAP: Knowledge, Attitude and Practice

UL: University of Liberia

USD: United States Dollars

WHO: World health Organization

**Table 1: Demographic characteristics of the study population (n = 61)**

Variable	Categories	Frequency	Percent
Age (years)	Mean = 29.6 ( $\pm$ 5.31)	Min = 20, Max = 60	
	20 – 30	8	13.1
	31 – 40	23	37.7
	41 – 50	17	27.8
	51 – 60	12	19.6
Sex	Male	19	31.1
	Female	42	68.9
Highest academic qualification	High school diploma	28	45.9
	Bachelor's	22	36
	Master's	11	18
Field of discipline	Nurses	36	59
	Pharmacists	8	13.1
	Doctors	7	11.4
	Laboratory technicians	6	9.8

Midwives

4

6.5

**TABLE 2: Overall knowledge of antibiotic use and AMR among study participants (n = 61)**

Variable	Categories	Frequency	Percent
Practice of self-medication	Yes	24	39.3
	No	37	60.7
Have been trained about AMR	Yes	23	37.7
	No	38	62.3
Ever heard of antimicrobial resistance	Yes	35	57.3
	No	26	43
Antibiotics can be used to treat viral infections	Yes	37	60.6
	No	24	39.3
Antibiotics are used to treat bacterial infections	Yes	35	57.4
	No	26	42.6
	Yes	20	32.8
	No	41	67.2

**Table 3: Association between healthcare workers' knowledge of AMR and demographic characteristics**

Variables	Categories	Knowledge		P value	AOR (95% CI)	P value
		Good (%)	Poor (%)			
<b>Sex</b>	Female	19 (45.2)	23 (54.8)	<b>0.026</b>	0.45 (0.21 – 0.96)	<b>0.046</b>
	Male	12(63.2)	7(36.8)	<0.748	1.65 (0.41 – 0.96)	0.618
<b>Field of Discipline</b>	Nurses	20(55.5)	16(44.4)	<b>0.017</b>	1.27 (0.52 – 2.12)	0.646
	Pharmacists	4(50)	4(50)	0.615	1.26 (0.54– 2.94)	0.801
	Midwives	4(57.1)	3(42.9)	0.730	1.12 (0.45 – 2.74)	0.417
	Doctors	5(83.3)	1(16.7)	<b>&lt;0.001</b>	1.45 (0.70 – 3.04)	0.300
	Laboratory Technicians	2(50)	2(50)	0.783	1.23 (0.64 – 2.63)	0.503
<b>Level of education</b>	High School Diploma	10(35.7)	18(64.3)	<b>&lt;0.001</b>	11.2 (3.94 - 35.1)	<b>&lt;0.001</b>
	Bachelor's	16(72.7)	6(27.2)	0.471	1.25 (0.62 – 2.12)	0.428
	Master's	9(81.8)	2(18.1)	0.294	1.42 (0.31 – 0.98)	0.501

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#### Authors' contributions

VT conceived this work and coordinated the data collection. He also contributed to writing the methods section of this manuscript. BMF served as a technical research advisor for this project and led in the writing of all sections of this manuscript. BIS served as the project lead and supervisor. He also performed final revisions and edits to this manuscript.

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#### Ethical considerations

Written informed consent was obtained from each participant, and ethical approval for this study was obtained from the University of Liberia Institutional Review Board (UL-IRB/JCT-CH/66/'23).

#### Consent for publication

All authors have reviewed and approved the final version and agree to its publication.

#### Competing interests

The authors declare that they have no competing interests.

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