Knowledge And Attitude Of Residents In Abeokuta To Antibiotic Use And Resistance

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Abstract

Antibiotic resistance is a source of concern among healthcare practitioners in Nigeria and around the world. This study therefore was carried out to assess the relationship of the socio-demography of respondents and the knowledge of antibiotic resistance and their attitudes to antibiotic use. Five hundred questionnaires were distributed and received from respondents (100%). The Combination of content analysis of reviewed literature and structured questionnaire purposively distributed was adopted in the study. Descriptive and inferential statistics were used to assess the knowledge of antibiotic resistance, Pearson chi-square was engaged to evaluate whether respondents' age, marital status, education and gender differ in their knowledge of antibiotics. A multiple Bonferroni correction test, P =α/n was further used to determine the significant difference between sociodemographic characteristics and knowledge of antibiotic resistance and antibiotic use. The respondents comprised of 53% males and 47% females from the inferential statistics. A significant chi-square of gender (X^2=13.29, P<0.000) was obtained while the comparison with Bonferroni corrections showed a significant difference between the knowledge scores of male and female respondents. A significant chi-square of X^2=35.62, P<0.002 was obtained for ages of respondents with a Bonferroni correction showing a significant difference between ages 18-29 and 40-49. Non-significant chi-square was obtained for respondents' educational qualification, (χ^2= 1.420, p >0.701.). There was insignificant difference between respondents' educational qualification and age in follow up comparisons. The research showed that age and gender were predictors of antibiotic knowledge of residents while educational qualification was not necessarily a major predictor. It also showed the deficient knowledge of respondents in antibiotic resistance with 319 (63.8%) of the participants not agreeing to bacteria spreading antibiotic resistance. The problem of antibiotic resistance is a global problem and it requires global enlightenment and education on the possible sources, causes and prevention of antibiotic resistance.

Keywords: Resistance, Descriptive-statistics, Inferential-statistics, Bonferroni-correction

Introduction

The management of infectious diseases had been made easier with the use of antibiotics for many years (Chukwu *et al.,* 2020). However, the gains achieved by antibiotics is being threatened by the development of antibiotic resistance in hospitals, communities and ecosystems (Ashley *et al.,* 2011; Chukwu *et al,* 2020). Antibiotic resistance can either be developed by bacteria intrinsically, by absorbing genetic code from other bacteria or through self-mutation (Abushaheen *et al.,* 2020).

Antibiotic resistance (AR) bacteria reduce/remove the efficacy of antibiotics. Its rapid spread and the slow discovery of new antibiotics make antibiotic resistance (AR) the biggest threat to global health (Sivasankar *et al.,* 2023). In 2020, World Health Organisation (WHO) reported high levels of resistance in bacteria according to data reported in eighty-seven countries around the world. This high level of resistance in bacteria caused life-threatening blood stream infections. The Global antimicrobial resistance and use surveillance system (GLASS) reported high levels (about 50%) of resistance in bacteria frequently causing bloodstream infections in hospitals, such as *Klebsiella pneumonia* and *Acinetobacter sp*. Only last-resort antibiotic such as Carbapenems was effective (WHO, 2020). Globally, drug resistance causes death of about 700,000 people per year (CDC, 2018-2023). Misuse and overuse of antibiotics, poor infection prevention and control are factors that aggravate the spread of antibiotic resistance (Chukwu, 2020). In some parts of Nigeria, resistance to specific antibiotics has been reported by some authors and indiscriminate use of antibiotics has also been found among a group of University students (Igbenegbu, 2013). Antibiotics have also been found to be obtained from unauthorised sources without doctor's prescription and non-compliance with the course of antibiotic therapy even when prescribed by a physician. Socio-economic and environmental factors have been associated with the development of antibiotic resistance. Low income and overcrowded living conditions have been linked to high prevalence of drug-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA) (Immergluck *et al.,* 2019). Antibiotics resistance has been found to lead to longer hospital stay, higher medical costs and increased mortality (Weibin Li, 2023). This study aims at drawing insights to the level of awareness of residents of Abeokuta to the problem of antibiotic resistance and their attitude to antibiotic use. The association between the socio-demography of residents, the attitude of residents of Abeokuta towards the use of antibiotics, the socio-demography of residents and their knowledge of antibiotics and antibiotic resistance among the residents of Abeokuta were assessed.

Methods

The study was conducted between April and July 2022. Five hundred questionnaires (500) were distributed and five hundred (100%) were retrieved after the informed consent of the participants. The combination of content analysis of reviewed literature and structured questionnaire distributed randomly among residents in a purposively selected area of Abeokuta was adopted in the study. The questionnaire was divided into two sections. Section A gathered the demographic information which included age, educational qualification, marital status and gender while section B was divided into three parts: i. the knowledge of the use of antibiotics and antibiotic resistance; ii. assessing the predictor of the knowledge of antibiotic resistance and; iii. the attitude of residents towards the use of antibiotics.

The preamble research question that guided knowledge on the use of antibiotics and antibiotic resistance study was "*What is the knowledge of antibiotics use and antibiotic resistance among residents in Abeokuta, Ogun State*?" Fourteen questions were utilized to evaluate knowledge

related to antibiotic use and resistance. A knowledge score was determined by calculating the number of correct answers to these 14 questions. Chi-square test was conducted to evaluate the difference between groups in their knowledge of antibiotics, whether groups (Marital status, Education, Age, and Gender) differed in their knowledge of antibiotics.

Statistical Analysis

Statistical analysis was done using IBM SPSS version 23.0. Descriptive and inferential statistics were used for responses. Descriptive and inferential statistics were done to assess the knowledge of antibiotic resistance among residents of Abeokuta. Chi-square test was conducted to evaluate whether the socio-demographic groups (marital status, educational qualification, age and gender) differ in their knowledge of antibiotic use and antibiotic resistance. A multiple comparison Bonferroni correction test, p-value=α/n was used to further determine the significant difference between the socio-demographic characteristics and the knowledge of antibiotic resistance. A Phi (φ) test was conducted to evaluate the strength of the relationship between antibiotic knowledge and attitudes regarding antibiotic use.

Results

This study examined these variables (knowledge and attitude) among residents in Abeokuta, Ogun State. Fig.1 shows that 34.9% of the participants are "between" 30-39 years, 30.0% of the participants are "between" 18-29 years, 21.4% of the participants are "between" 40-49 years, 6.2% of the participants are "between" 50-59 years and 3% of the participants are above 60. The Mean age and standard deviation of the participants are (μ= 35.6, ± = 10.87) which falls between 30-39 year intervals. Fig. 2 shows that males comprised a larger portion of the group at 52.6 %, whereas 47.4 % were females. Fig. 3 shows that out of the 500 participants 44% are single, 36.4 % are married and 19.6 % are divorced. Fig. 4 shows the educational background of the respondents, 35.8 % of the participants are NCE/ND Holder or students, 48.2 % of the participants are Bachelor degree holder or Higher National Diploma holder, 10 % are holders of master degree /PhD holder and 6.0 % are others (secondary school certificate and primary leaving certificates holders) Fig. 5 shows that 75.6 % did not have any chronic disease, while 19.4 % had a chronic disease and 5.0 % were not aware if they had a chronic disease.

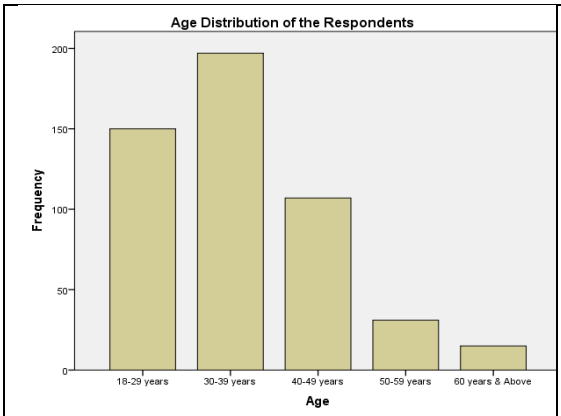

Fig 1: Bar chart for Age distribution of the respondents

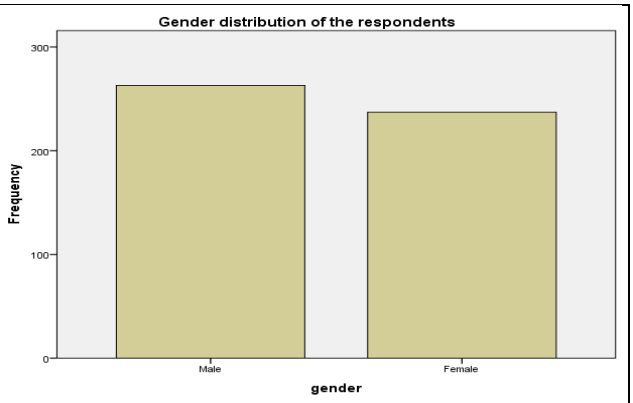

Fig. 2 Bar chart for Gender distribution of the respondents

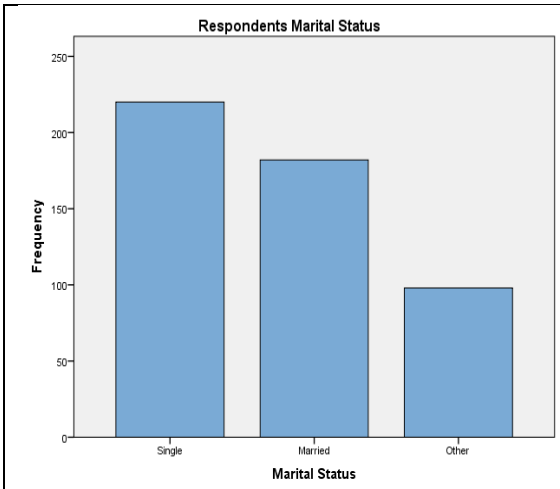

Fig 3: Respondent's marital status

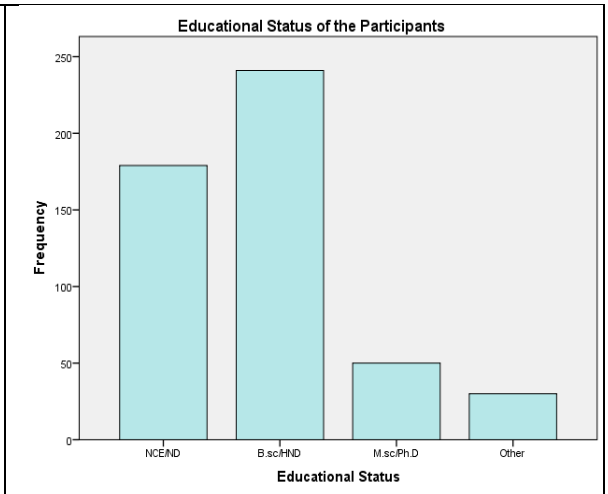

Fig 4: Respondent's Educational status

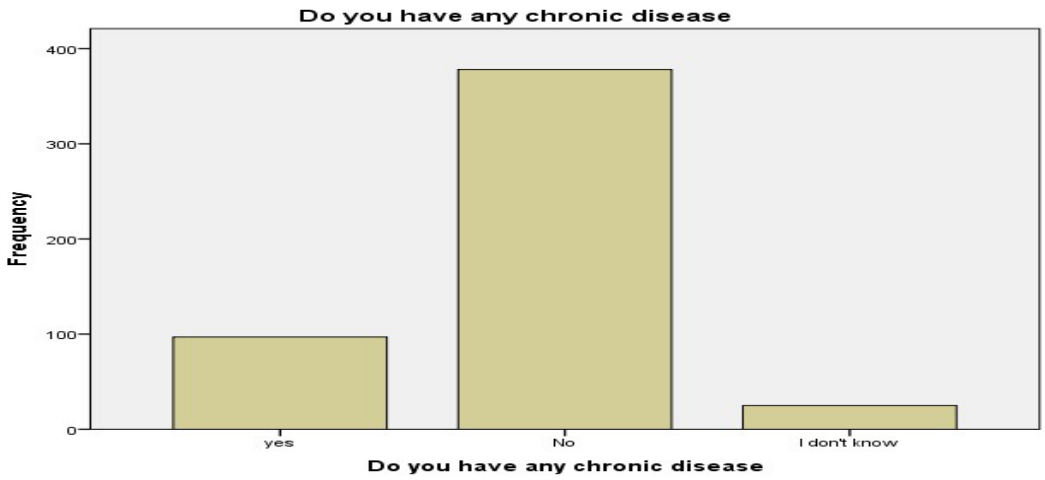

Fig 5: Health status of the participants on chronic diseases

Table 1 shows that large proportion of the respondents (98.0%) had heard about antibiotics but not necessarily how to use it while only 2.0% stated that they were unaware of the word 'antibiotics'. Only 26.8% of the participants had previous exposure to information on antibiotic resistance with more than half (73.2%) having no prior exposure to antibiotic resistance education. Regarding antibiotic use, 77.0% of the participants had used an antibiotic in the past, while the last antibiotic use being six months or more prior to completing the survey having the highest percentage (33.6%). The majority of respondents (92.2%) were not using antibiotics at the time of the study. When asked about the names of the antibiotics that the respondents were familiar with, 15.8% were familiar with penicillin, 15.4%, 11.8% and 8.6% were familiar with Amoxicillin, Doxycycline and Augmentin respectively. Study's participants mentioned they were most likely to get antibiotics from pharmacist (42.6%), doctors (34.2%) while 13.4% did not disclose their source of antibiotics.

Table 1. Attitude to antibiotic Use

Attitude to Antibiotic use	**Response Options**	**N= 500**	**Percent %**
Current Antibiotics Use	Yes	33	6.6
	No	461	92.2
	Don't Know	6	1.2
Previous Antibiotic Use	Yes	385	77.0
	No	89	17.8
	Don't Know	26	5.2
Antibio1ic Information	Yes	490	98.0

	No	5	1.0
	Don't Know	5	1.0
Antibiotic Resistance Information	Yes	131	26.2
	No	313	62.6
	Don't Know	56	11.2
Names of Antibiotic Provided	Not provided	173	34.6
	Penicillin	79	15.8
	Amoxicillin	72	14.4
	Doxycycline / Tetracycline	59	11.8
	Ampicillin	28	5.6
	Ciprofloxacin	34	6.8
	Septrin (co-trimoxazole)	12	2.4
	Augmentin	43	8.6
Last Antibiotic Use	Not applicable	16	3.2
	< 6months	10	2.0
	> 6months	168	33.6
	> 12months	94	18.8
	> 2years	93	18.6
	> 5years	119	23.8
Antibiotic Sources	Not provided	67	13.4
	Pharmacy	213	42.6
	Doctor	171	34.2
	Hospital/clinic	40	8.0
	Dentist	9	1.8
Source of Antibiotic Resistance Education	Not provided/not exposed to antibiotic resistance campaign	366	73.2
	Pamphlet	10	2.0
	Internet e.g. Facebook	35	7.0
	Television	26	5.2
	School/educational institution	20	4.0
	Doctor	16	3.2
	Pharmacy	27	5.4

Table 2 shows knowledge of people on antibiotics use. The mean knowledge score was 10.3 (SD=3.6), and the median was 11.0. Inadequate and adequate knowledge was defined as a total knowledge score of 0-7 and 8-14, respectively. A large proportion (63.4%) of respondents knew that viruses cause the majority of colds and coughs. About 38.8% of participants correctly disagreed by saying no with the statement that antibiotics work on most sore throats and 69.8% of respondents correctly answered no to the question about using antibiotics to treat coughs and colds. Over half (76.8%) did not know that antibiotics can kill bacteria that normally live on the skin and in the gut. Some of the respondents (74.6%) had correct knowledge of the meaning of antibiotic resistance. Some of the respondents were also misinformed regarding the reduced effectiveness of treatment, if the full course of antibiotic treatment was not completed and the potential to spread antibiotic-resistant bacteria. A surprising finding from the respondent's responses was the misunderstanding of how antibiotic resistance happens. Although 74.6% of the participants correctly agreed by saying yes to the statement, if antibiotics are taken for a long time, bacteria can become resistant. About 66% of the respondents incorrectly agreed by saying yes to the statement, if antibiotics are used less than the prescribed dose bacteria become less resistant. This may indicate that the respondents do not understand the concept of antibiotic resistance. Both prolonged antibiotic use and using less than the prescribed doses of antibiotics can be classified as antibiotic misuse, and antibiotic resistance can result from any form of inappropriate antibiotic use.

Table 2: Antibiotic Knowledge among the Public in Abeokuta

	Questions Assessing Antibiotic Knowledge	**Correct Response N=500 (%)**	**Incorrect Response N=500 (%)**
1	I can differentiate between a bacterial and viral infection	292 (58.4%)	208 (41.6%)
2	Viruses cause most cold and cough	317 (63.4%)	183 (36.6%)
3	Only with doctor prescription, antibiotics can be used	349 (69.8%)	151 (30.2%)
4	Antibiotics are effective for most sore throat	194 (38.8%)	306 (61.2%)
5	Antibiotics can kill bacteria	398 (79.6%)	102 (20.4%)
6	Bacteria that live normally on the skin and in the guts are good for the health	384 (76.8%)	116 (23.2%)
7	Antibiotic resistance means that bacteria will not be killed by antibiotics	358 (71.6%)	142(28.4%)
8	Infections caused by antibiotic resistant bacteria cannot be easily cured or cannot be cured	430 (86.0%)	70 (14.0%)

9	If antibiotics are taken for a long period of time, bacteria become resistant to antibiotics	373 (74.6%)	127 (25.4%)
10	If antibiotics are taken less than the prescribed dose, bacteria become less resistant to antibiotics	170 (34%)	330 (66.0%)
11	If twice the prescribed dose of antibiotics is taken, the effects of antibiotics are more rapid	333 (66.6%)	167(33.4%)
12	The prescribed dose and duration of antibiotics can be terminated if the symptoms improve	293 (58.6%)	207 (41.4%)
13	Antibiotic resistance can spread between bacteria	181 (36.2%)	319 (63.8%)
14	Antibiotics have no side effect	306 (61.2%)	194 (38.8%)

Overall score on knowledge	
Mean score of knowledge (mean ± SD)	10.3 ± 3.6
Knowledge rating *Low level of knowledge (n (%))*	110 (22.00)
High level of knowledge (n (%))	390(78.00)

Table 3 showed that out of 263 male respondents, 222 (84.4%) of them had high level of knowledge on antibiotics and of the 237 female respondents, 168 (70.9%) of them had high level of knowledge on antibiotic usage.

A significant chi-square was obtained for Gender, (χ^2= 13.29, p < 0.000). Follow up pairwise comparisons using Bonferroni correction found significant differences between the Male and Female respondent's level of knowledge.

Table 3: Cross tabulation Table between Gender and Knowledge level

gender * KNV Cross-tabulation

	Knowledge Level		**Total**
	Low	High	
Male count	41		
% within	15.6%		263
Female count		222	100.0%
% within		84.4%	
Gender count	69	168	237
% within	29.1%	70.9%	100.0%
Total	110	390	500
% within	22.0%	78.0%	100.0%

Table 4 shows a significant difference in chi-square obtained within the Age groups, (χ^2= 35.62, p < 0.002). Follow up pairwise comparisons using Bonferroni correction, found significant

differences between 18-29 and 40-49 in their knowledge of antibiotics (more inadequate antibiotic knowledge in 40-49, more adequate antibiotic knowledge in 18 – 29) = (χ^2=9.49, p < 0.002). Also between 18 – 29 and 50 and above (more adequate antibiotic knowledge in 18 – 29, more inadequate knowledge in 50 and above age) (χ^2= 8.66, p <0.003.)

Table 4: Cross tabulation Table between Age of the Respondents and level of Knowledge

Age		**Level of Knowledge**		**Total**
		Low	**High**	
18-29 years	Count	17	133	150
	% within Age	11.3%	88.7%	100.0%
30-39 years	Count	37	160	197
	% within Age	18.8%	81.2%	100.0%
40-49 years	Count	36	71	107
	% within Age	33.6%	66.4%	100.0%
50-59 years	Count	16	15	31
	% within Age	51.6%	48.4%	100.0%
30-39 years	Count	4	11	15
	% within Age	26.7%	73.3%	100.0%
60 years & Above	Count	110	390	500
	% within Age	22.0%	78.0%	100.0%

Table 5 shows that non-significant chi-square was obtained for Marital Status, (χ^2= 2.112, p >0.348.). Follow up pairwise comparisons using Bonferroni correction found significant differences between single and married in their knowledge of antibiotics (more adequate antibiotic knowledge in married, more inadequate antibiotic knowledge in single).

Table 5: Cross-tabulation Table between Respondents Marital Status and level of Knowledge Marital Status

		KNV		Total
		Low	High	
Single	Count	55	165	220
	% within Marital Status	25.0%	75.0%	100.0%
Married	Count	35	147	182
	% within Marital Status	19.2%	80.8%	100.0%
Other	Count	20	78	98

	% within Marital Status	20.4%	79.6%	100.0%
Total	Count	110	390	500
	% within Marital Status	22.0%	78.0%	100.0%

Table 6 shows that non-significant chi-square was obtained for respondents educational Status, (χ^2= 1.420, p >0.701.). Follow up pairwise comparisons using Bonferroni correction found insignificant differences between respondents' educational qualification

Table 6: Cross-tabulation Table between Respondents Education Status and level of Knowledge

Educational Level * Level of Knowledge Crosstabulation

			KNV		Total
			Low	High	
Educational Level	NCE/ND	Count	40	139	179
		% within Educational Level	22.3%	77.7%	100.0%
	B.Sc/HND	Count	55	186	241
		% within Educational Level	22.8%	77.2%	100.0%
	M.Sc/Ph.D	Count	11	39	50
		% within Educational Level	22.0%	78.0%	100.0%
	Other	Count	4	26	30
		% within Educational Level	13.3%	86.7%	100.0%
Total		Count	110	390	500
		% within Educational Level	22.0%	78.0%	100.0%

Table 7 shows the mean attitude score was 7.2 (SD 2.4), and the median was 8. Poor and good antibiotic attitudes were defined as a total attitude score of 0-7 and 8-11, respectively. About 35.2% of the participants expected antibiotics to be prescribed if they suffer from common cold symptoms while 29.2% respondents said that they requested antibiotics to prevent cold symptoms from getting worse. Some of the participants (15.2%) said they had taken unconsumed antibiotics from previously filled prescriptions without first consulting a doctor, and 20.4% of respondents stopped taking antibiotic courses when they felt better. Additionally, 24.8% of respondents confirmed that

they stock antibiotics at home in case of an emergency and 36.8% were aware of which of the prescribed drugs was an antibiotic when they take cold medications

Table 7: Antibiotic attitude among the Public in Abeokuta, Ogun State.

	Questions Assessing Antibiotic Knowledge	Appropriate Response N=500 (%)	Inappropriate Response N=500 (%)
1	I expect antibiotics to be prescribed by my doctor if I suffer from common cold symptoms.	324 (64.8%)	176 (35.2%)
2	If I catch a cold, I ask for an antibiotic prescription to prevent my symptoms from getting worse	354 (70.8%)	146 (29.2%)
3	I believe that antibiotics cure my cold faster	289 (57.8%)	211 (42.2%)
4	I save the remaining antibiotics for the next time	424 (84.8%)	76 (15.2%)
5	I stop taking the prescribed antibiotics once I get better	398 (79.6%)	102 (20.4%)
6	I prefer a shot (Injection) to an oral medication if antibiotics are needed	324 (64.8%)	176 (35.2%)
7	I always complete my antibiotics even I feel better	384 (76.8%)	116 (23.2%)
8	Unnecessary use of antibiotics can reduce their efficacy for treatment	184 (36.8%)	316 (63.2%)
9	If my family member is sick I usually give my prescribed antibiotic to them.	384 (76.8%)	116 (23.2%)
10	I normally keep antibiotic stock at home in case of emergency.	376 (75.2%)	124 (24.8%)
11	I take antibiotics according to the instructions on the label.	488 (97.6%)	12 (2.4%)

Discussion

A common practice around the world is the use of antibiotics (Kardas *et al*., 2005). The factors contributing to the problem of antibiotic resistance are many. They range from poor accessibility to drugs, lack of education on drug use and self-medication. There is a general consensus that not only patients can contribute to the spread of antibiotic resistance rather humans, hospitals, food, water and natural ecosystem can also aid the spread (Hernando-Amodo *et al.*, 2020). Ease of access to antibiotics can contribute to antibiotic resistance. Due to uneasy access to drugs at foreign hospitals, Nigerians that travel back home use the opportunity to stock on antibiotics that will not ordinarily be prescribed to them for minor infections abroad, therefore it is a global problem. The

need to curb the inappropriate use of antibiotics has become necessary due to the rise in antibiotic resistance (Ntagiopoulos *et al.,* 2007). It is important to mention that low levels of understanding and misconceptions regarding antibiotic use have been found among lay people from previous studies (Curry *et al.,* 2006; Davey *et al.,* 2002; Eng *et al.,* 2003; Hong *et al.,* 1999).

Over half (76.8%) did not know that antibiotics can kill bacteria that normally live on the skin and in the gut. 74.6% of respondents had correct knowledge of the meaning of antibiotic resistance. Some of the respondents were also misinformed regarding the reduced effectiveness of treatment if the full course of antibiotic treatment was not completed and the potential to spread antibiotic-resistant bacteria. A surprising finding from the respondent's responses was the misunderstanding of how antibiotic resistance happens. Although 74.6% of the participants correctly agreed by saying yes to the statement, if antibiotics are taken for a long-time bacterium can become resistant. About 66% of the respondents incorrectly agreed by saying yes to the statement, if antibiotics are used less than the prescribed dose bacteria become less resistant. This may indicate that the respondents do not understand the concept of antibiotic resistance. Both prolonged antibiotic use and using less than the prescribed doses of antibiotics can be classified as antibiotic misuse, and antibiotic resistance can result from any form of inappropriate antibiotic use.

In this study, education was identified as a major predictor of antibiotic knowledge. Compared with higher and more, respondents with M.Sc./Ph.D education have good knowledge about antibiotics used and antibiotics resistance. The lack of knowledge among those with lower educational level has been stated in other studies conducted in various countries (Andre *et al.,* 2010; Eng *et al.,* 2003; McNulty *et al.,* 2007; McNulty *et al.,* 2007; Oh *et al.,* 2010; Rouusounides et al., 2011; You *et al.,* 2008). Findings also show that respondents with M.sc/Ph.D education were more likely to have a good antibiotic attitude which is similar to the findings from other studies (You *et al.,* 2008; Kim *et al.,* 2011; Oh *et al.,* 2010). A possible reason for this is that individuals with this level of education are usually exposed to a wide variety of information including antibiotic information which consequently influences their attitudes.

From the findings in this study, it was found that respondents who had previous exposure to antibiotic resistance education were more likely to have an adequate antibiotic knowledge and good antibiotic attitude. The results of this study have identified some areas of misconceptions and specific groups to be targeted for intervention. There is a critical need for actions that effectively build the understanding of how and when to take antibiotics and what they should be used for, especially targeting (Chukwu, 2020) groups among whom these misconceptions seem to be most prevalent. Public education campaigns have been shown to be effective in changing attitudes and knowledge about antibiotic use and resistance (Finch *et al.*, 2004; Madle *et al.*, 2004). This further shows the importance of public health education in addressing antibiotic misuse.

Conclusion and Recommendation

It is therefore suggested that a well-planned, organized and structured educational program be undertaken to improve the appropriate use of antibiotics and this will require the concerted action of the medical world in collaboration with patient organization and policymakers.

References

Abushaheen M. A., Muzaheed F. A. J., *et al.*, (2020) Antimicrobial resistance, mechanisms and its clinical significance. *Diseases Monitoring*. 66(6):1009-71.

Ashley E. A., Lubell Y., White N.J. & Turner P. (2011) Antimicrobial susceptibility of bacterial isolates from community acquired infections in sub-Saharan Africa and Asian low and middle income countries. *Tropical Medical International Health*; 16(9):1167–79.

Africa Center for Disease Control (2018) Africa CDC framework for antimicrobial resistance, 2018-2023. Available from http://www.africacdc.org/resources/strategic-framework/strategic-framework/africa-cdc-amrframework-eng/detail

Chukwu E. E., Oladele D. A., Awoderu O. B., Afocha E. E., Lawal R. G., Abdus-salam I., Ogunsola F. T. & Audu R. A. (2020) A national survey of public awareness of antimicrobial resistance in Nigeria. *Antimicrobial Resistance and Infection Control*, 9:72

Ghebremedhin B., Olugbosi M.O., Raji A. M., Layer F., Bakare R. A., Konig B. & Konig W. (2009). Emergence of a community-associated methicillin-resistant Staphylococcus aureus strain with a unique resistance profile in southwest Nigeria. *Journal of Clinical Microbiology*; 47(9):2975–80

Global antimicrobial resistance and use surveillance system (GLASS) report: 2022

Hernando-Amado Sara, M. Coque Teresa, Baquero Fernando & Martínez José L. Antibiotic Resistance: Moving From Individual Health Norms to Social Norms in One Health and Global Health. *Frontiers in Microbiology*, 11(7):19

Igbeneghu O. A. (2013) Knowledge and practices in the use of antibiotics among a group of Nigerian university students. *International Journal of Infection Control*; 9(7): 13.

Kim, J., Hanotte, O., Mwai, O. A., Dessie, T., Bashir, S., Diallo, B., et al. (2011). The genome landscape of indigenous African cattle. *Genome Biology*, 18:34.

Lamikanra A., Crowe J. L., Lijek R. S., Odetoyin D. W., Wain J., Aboderin A. O. & Okeke I. N. (2011) Rapid evolution of fluoroquinolone-resistant *Escherichai coli* in Nigeria is temporarily associated with fluoroquinolone use. *BMC Infection Diseases*;11: 312.

McNulty C. A. M., Boyle P., Nichols T., Clappison P. & Davey P. (2007) Don't wear me out—the public's knowledge of and attitudes to antibiotic use. *Journal of Antimicrobial Chemotherapy*; 59:727–38.

Melander E., Jonsson G., & Molstad S. (2000) Frequency of penicillin-resistant pneumococci in children is correlated to community utilization of antibiotics. *Paediatrics Infectious Diseases Journal* ;19(12):1172–7.

Okesola A. O. & Oni A. A. (2009) Antimicrobial resistance among common bacterial pathogens in south western Nigeria. *American-Eurasian Journal Agricultural & Environmental Science*; 5(3):327–30.

Weibin Li, Chaojie Liu, Hung Chak Ho, Lin Shi, Yingchao Zeng, Xinyi Yang, Qixian Huang, Yi Pei, Cunrui Huang, & Lianping Yanga (2023). Association between antibiotic resistance and

increasing ambient temperature in China: An ecological study with nationwide panel data. *The Lancet Regional Health - Western Pacific*; 30: 1006-28

World Health Organization, WHO (2022) Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data. *Geneva* News release.