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Moderate Knowledge, Negative Attitudes and Suboptimal Practices Regarding Antibiotic Use in a Rural South African Community

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Abstract

Background: The inappropriate use of antibiotics contributes to the development and spread of antibiotic resistance. Community education plays an important role in mitigating this threat; however, community-derived data required to inform the co-creation of solutions and development of awareness packages remain limited. This study assessed knowledge, attitudes, and practices (KAP) regarding antibiotic use in a community participating in a longitudinal enteric antibiotic resistance research project to inform targeted community interventions. **Methods:** This cross-sectional study included 917 residents of nine villages in a rural community in Limpopo Province, South Africa. Data on antibiotic use and resistance were collected using a structured questionnaire comprising closed-ended items and two open-ended questions. The four-point Likert-scale responses were scored based on appropriateness, with possible scores ranging from 0 to 14 for knowledge, 0 to 7 for attitudes and 0 to 5 for practice. Quantitative data were analysed using descriptive statistics, bivariate and multivariable logistic regression, while qualitative responses were analysed thematically. **Results**: The median age of participants was 34 years (IQR: 22), and the majority were females (61.5%), unemployed (67.0%), single (69.1%) and had less than Grade 12 education (60.0%). The mean percentage KAP scores were 67.9 ± 9.3%, 27.3 ± 22.5%, and 61.9 ± 11.0%, respectively. Most participants had moderate knowledge (82.9%), negative attitudes (83.8%) and suboptimal practices (83.2%). Major knowledge misconceptions concerned the effectiveness of antibiotics against viruses and most coughs and colds. More than 70% expressed inappropriate attitudes towards obtaining antibiotics without a prescription or from relatives or friends, keeping antibiotics for future use, and stopping treatment when they felt better. Notable inappropriate practices included obtaining antibiotics based on the experiences of family or friends (77.8%) and stopping the medication when symptoms disappear (94.7%). Unemployed participants had higher odds of having at least moderate knowledge compared to the employed (aOR = 1.48, 95% CI: 1.02–2.14), those aged ≥50 years had lower odds of a positive attitude than those aged

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16–24 years (aOR = 0.35, 95% CI: 0.19–0.68), and participants with less than Grade 12 education had lower odds of good practice than those with Grade 12 education (aOR = 0.62, 95% CI: 0.42–0.91). Positive attitudes were associated with higher odds of good antibiotic-use practice than negative attitudes (aOR = 2.21, 95% CI: 1.46–3.34). Qualitative findings supported the quantitative results by revealing perceptions of antibiotic effectiveness alongside persistent misconceptions, including beliefs that antibiotics treat viral infections or should be used frequently. **Conclusions**: Although participants demonstrated moderate overall knowledge, important misconceptions coexisted with predominantly negative attitudes and poor reported practices. These findings identify priority areas for subsequent responsive dialogues with stakeholders to co-create locally appropriate community antimicrobial stewardship interventions.

Keywords: antibiotic use; antibiotic resistance; knowledge; attitudes and practices (KAP); rural community; South Africa

1. Introduction

The continued emergence and transmission of antibiotic resistance pose a global health crisis that threatens gains in the management of bacterial infections. Inappropriate use of antibiotics remains a major driver of resistance [1]. In South Africa, antibiotic resistance is compounded by high burdens of infectious diseases, including infections such as tuberculosis, which require prolonged antibiotic therapy, and HIV/AIDS, where antibiotics are also commonly prescribed as prophylaxis depending on the stage of the disease [2].

An individual's knowledge, attitudes and practices (KAP) regarding antibiotic use and resistance can influence how antibiotics are obtained and used. Assessing community KAP can therefore inform the development of awareness packages that address misconceptions and behaviours contributing to inappropriate antibiotic use. Studies in Latin America, Asia and Africa have identified recurring misconceptions, including beliefs that antibiotics treat viral infections, influenza, coughs and colds [3–5]. Non-prescription access, self-medication and discontinuation when symptoms improve have also been reported, with evidence from Colombia, Kuwait and Romania demonstrating inappropriate antibiotic use across diverse settings [3,6,7].

Evidence from African countries highlights significant gaps in antibiotic resistance stewardship, characterised by widespread self-medication, limited awareness, and inadequate knowledge, attitudes, and practices that may contribute to inappropriate antibiotic use [8–10]. Studies from low- and middle-income countries (LMICs) have also reported variation in knowledge, attitudes and practices regarding antibiotic use across different populations and settings [5,11–17]. Associations between antibiotic-use-related KAP and factors such as education, income and place of residence further indicate variations that may occur between populations [4,12,18], highlighting the importance of understanding local contexts when designing interventions. Consequently, findings from other countries and communities provide valuable background but require consideration of the local context when developing interventions.

In South Africa, research among patients attending public and private healthcare services has identified misconceptions that antibiotics treat viral infections and that the human body becomes resistant to antibiotics. Antibiotic self-medication reports have also been documented among patients and pregnant women attending a tertiary hospital [19,20]. These studies provide important local evidence, but their healthcare-attending populations may differ from the broader rural community, particularly in low-socioeconomic settings. Global estimates indicate that antibacterials dispensed in community settings account for

approximately 85–95% of total human consumption [21], making community-level KAP central to efforts aimed at mitigating antimicrobial resistance.

The World Health Organization (WHO) Global Action Plan on antimicrobial resistance (AMR) and the South African Antimicrobial Resistance National Strategy Framework identify improving awareness and understanding of AMR through effective communication, education, and training as a core strategic objective [22,23].

However, the need for locally relevant community-level evidence hampers effective implementation. This study seeks to address this gap by assessing the KAP of a rural community in Limpopo Province, South Africa, that is also participating in a community-based, prospective birth cohort gut resistome study. The findings will provide baseline evidence for responsive dialogues with community members and other stakeholders, facilitating the co-production of context-specific educational interventions that promote appropriate antibiotic use.

2. Results

2.1. Characteristics of the Study Population

A total of 917 participants with complete KAP responses were included in the quantitative analysis. The median age was 34 years (IQR: 22), and over half of the participants were aged 25–49 years (55.5%). The majority were females (61.5%), unemployed (67.0%), and single (69.1%). Educational attainment was generally low, with 60% having less than a Grade 12 education. Nearly all the participants (96.1%) reported a gross monthly income of ≤R10,000. The participants were predominantly Christian (90.5%), African (99.9%), and of Vhavenda ethnicity (95.7%). A subset (8.8%) comprised mothers participating in the prospective mother–infant cohort study on community enteric antibiotic resistance (Table 1).

Table 1. Sociodemographic characteristics of study participants (N = 917).

Variable	Category	n	%
Age (years) Median = 34 years (IQR: 22)	<25	209	22.8
	25–49	509	55.5
	≥50	199	21.7
Gender	Female	564	61.5
	Male	353	38.5
Employment	Employed	303	33.0
	Unemployed	614	67.0
Marital status	Single	634	69.1
	Married	269	29.3
	Divorced	7	0.8
	Separated	7	0.8
Highest level of education	<Grade 12	550	60.0
	Grade 12	263	28.7
	Tertiary	104	11.3
Gross monthly income	≤R10,000	881	96.1
	>R10,000	36	3.9
Religion	Christianity	830	90.5
	Traditional African religion	67	7.3
	Islam	4	0.4
	Other	16	1.7

Table 1. *Cont.*

Variable	Category	n	%
Race	African	916	99.9
	Coloured	1	0.1
Ethnicity	Venda	878	95.7
	Tsonga	15	1.6
	Zulu	4	0.4
	Pedi	1	0.1
	Sotho	1	0.1
	Other	18	2.0
Participation in the mother–child cohort study	Yes	81	8.8
	No	836	91.2

2.2. Community Knowledge on Antibiotic Use and Resistance

Table 2 presents the frequencies and proportions of participants' responses to knowledge statements. Agreement with positively framed statements exceeded 89% for most items. Overall, participants demonstrated strong knowledge of the basic functions and consequences of antibiotic use, with correct responses exceeding 89% for most items (Table 2). Despite these encouraging findings, important misconceptions remained. Only 8.3%, 6.0%, and 6.1% correctly identified (disagreed or strongly disagreed) that antibiotics do not speed recovery from most coughs and colds, do not work against most coughs and colds, and are ineffective against viruses, respectively. Furthermore, a total of 94.9% (68.6% agree and 26.3% strongly agree) incorrectly believed that humans, rather than bacteria, become resistant to antibiotics, indicating confusion between bacterial resistance and human immunity.

Table 2. Distribution of participants' knowledge responses on antibiotic use and resistance (N = 917).

Item	Statement	Strongly Disagree, n (%)	Disagree n (%)	Agree, n (%)	Strongly Agree n (%)
K1	I know the difference between antibiotics and other medications.	24 (2.6)	76 (8.3)	553 (60.3)	264 (28.8)
K2	Different antibiotics are needed to cure different diseases.	8 (0.9)	60 (6.5)	592 (64.6)	257 (28.0)
K3	Antibiotics are effective against bacteria.	6 (0.7)	54 (5.9)	609 (66.4)	248 (27.0)
K4	Antibiotics can kill the bacteria that normally live on the skin and in the gut.	6 (0.7)	37 (4.0)	622 (67.8)	252 (27.5)
K5	Antibiotics speed up recovery from most coughs and colds. *	13 (1.4)	63 (6.9)	496 (54.1)	345 (37.6)
K6	Antibiotics work on most coughs and colds. *	7 (0.8)	48 (5.2)	511 (55.7)	351 (38.3)
K7	Antibiotics are effective against viruses. *	9 (1.0)	47 (5.1)	583 (63.6)	278 (30.3)
K8	If you get side effects during antibiotic treatment, you should stop taking them as soon as possible.	16 (1.7)	55 (6.0)	532 (58.0)	314 (34.2)
K9	If you get some kind of skin reaction when using an antibiotic, you should not use the same antibiotic again.	11 (1.2)	31 (3.4)	578 (63.0)	297 (32.4)

Table 2. *Cont.*

Item	Statement	Strongly Disagree, n (%)	Disagree n (%)	Agree, n (%)	Strongly Agree n (%)
K10	Antibiotics can cause imbalance in the body's own bacterial flora.	19 (2.1)	52 (5.7)	588 (64.1)	258 (28.1)
K11	The unnecessary use of antibiotics can increase the resistance of bacteria to them.	22 (2.4)	57 (6.2)	523 (57.0)	315 (34.4)
K12	Resistance to antibiotics is a worldwide problem.	15 (1.6)	57 (6.2)	561 (61.2)	284 (31.0)
K13	The use of antibiotics among animals can reduce the effectiveness of antibiotics among humans.	29 (3.2)	55 (6.0)	580 (63.2)	253 (27.6)
K14	Humans can be resistant to antibiotics. *	23 (2.5)	24 (2.6)	629 (68.6)	241 (26.3)

* Negatively framed items; disagreement or strong disagreement indicates appropriateness.

2.3. Community Attitudes on Antibiotic Use and Resistance

Attitudes regarding appropriate antibiotic use were considerably less favourable (Table 3). Although 71.1% were in agreement that they would always complete an antibiotic course even after feeling better, fewer than one-third demonstrated appropriate attitudes by rejecting inappropriate means of accessing antibiotics, such as obtaining antibiotics from relatives or friends (29.7%), preferring to purchase antibiotics without a prescription (28.7%), keeping antibiotics for future use (24.2%), or stopping treatment prematurely once symptoms subside (18.3%). There were particularly concerning attitudes towards the misuse of antibiotics for viral infections: only 9.7% and 9.4% rejected a preference for antibiotics for a cough lasting more than a week and for a sore throat, respectively (Table 3).

Table 3. Distribution of responses to attitude items (N = 917).

Item	Statement	Strongly Disagree, n (%)	Disagree n (%)	Agree n (%)	Strongly Agree, n (%)
A1	I always complete the course of treatment with antibiotics, even if I feel better.	85 (9.3)	180 (19.6)	444 (48.4)	208 (22.7)
A2	It is good to be able to get antibiotics from relatives or friends without having to see a medical doctor. *	82 (8.9)	190 (20.7)	459 (50.1)	186 (20.3)
A3	I prefer to be able to buy antibiotics from the pharmacy without a prescription. *	69 (7.5)	194 (21.2)	492 (53.7)	162 (17.7)
A4	I prefer to keep antibiotics at home in case there may be a need for them later. *	54 (5.9)	168 (18.3)	520 (56.7)	175 (19.1)
A5	If I feel better after a few days, I sometimes stop taking my antibiotics before completing the course. *	42 (4.6)	126 (13.7)	530 (57.8)	219 (23.9)
A6	I prefer to use an antibiotic if I have a cough for more than a week. *	23 (2.5)	66 (7.2)	569 (62.1)	259 (28.2)

Table 3. *Cont.*

Item	Statement	Strongly Disagree, n (%)	Disagree n (%)	Agree n (%)	Strongly Agree, n (%)
A7	When I have a sore throat, I prefer to use an antibiotic. *	24 (2.6)	62 (6.8)	601 (65.5)	230 (25.1)

* Negatively framed items; disagreement or strong disagreement indicates positive attitude.

2.4. Community Practices Regarding Antibiotic Use

Agreement or strong agreement with seeking pharmacists' advice, consulting healthcare professionals about suspected side effects and keeping antibiotics with their explanatory inserts ranged from 91.3% to 95.5%. However, major inappropriate practices included buying antibiotics based on family or friends' experiences (77.8%) and stopping the medication once symptoms disappeared (94.7%) (Table 4).

Table 4. Distribution of responses to practice items (N = 917).

Item	Statement	Strongly Disagree, n (%)	Disagree n (%)	Agree n (%)	Strongly Agree n (%)
P1	I ask the pharmacist in detail about the antibiotics I have bought.	24 (2.6)	56 (6.1)	652 (71.1)	185 (20.2)
P2	I buy antibiotics based on the experiences of family and friends *.	46 (5.0)	158 (17.2)	560 (61.1)	153 (16.7)
P3	If I suspect side effects of the antibiotics, I consult my doctor or pharmacist.	15 (1.6)	30 (3.3)	622 (67.8)	250 (27.3)
P4	I stop using antibiotics as soon as the symptoms of the illness are no longer present. *	15 (1.6)	34 (3.7)	662 (72.2)	206 (22.5)
P5	I keep antibiotics with its explanatory insert.	11 (1.2)	30 (3.3)	653 (71.2)	223 (24.3)

* Negatively framed items; disagreement or strong disagreement indicates appropriateness.

2.5. Overall Community KAP on Antibiotic Use and Resistance

When participant responses were categorised into adequate (≥80%), moderate (60–79%), and poor (<60%), only 1.6% (n = 15) achieved an adequate knowledge score, while 82.9% (n = 760) had moderate knowledge and 15.5% (n = 142) had poor knowledge. The mean knowledge percentage score was 67.9 ± 9.3%, indicating an overall moderate level of knowledge of antibiotic use and resistance in the community. In contrast, attitudes were largely negative (83.8%, n = 768), and 83.2% (n = 763) had suboptimal practice scores (Table 5).

Table 5. Overall proportion of knowledge, attitude and practice scores related to antibiotic use in the study community (N = 917).

Variable	Mean Percentage Score ±SD	Category	n (%)
Knowledge	67.9 ± 9.3	Adequate Moderate Poor	15 (1.6) 760 (82.9) 142 (15.5)

Table 5. *Cont.*

Variable	Mean Percentage Score ±SD	Category	n (%)
Attitude	27.3 ± 22.5	Positive Negative	149 (16.2) 768 (83.8)
Practice	61.9 ± 11.0	Good Suboptimal	154 (16.8) 763 (83.2)

Mean percentage score = mean of the participants' percentage correct-response scores for each domain.

2.6. Sociodemographic Factors Associated with KAP Outcomes in the Study Community

Because only 1.6% (n = 15) of participants had adequate knowledge, the adequate and moderate categories were combined for regression analysis. The model, therefore, estimated the odds of having at least moderate knowledge compared with poor knowledge. Employment status was independently associated with at least moderate knowledge. After adjustment for marital status, unemployed participants had higher odds of having at least moderate knowledge than employed participants (aOR = 1.48, 95% CI: 1.02–2.14; $p = 0.037$) (Table 6).

Table 6. Sociodemographic factors associated with at least moderate knowledge of antibiotic use (N = 917).

Variable	Category	Crude OR (95% CI)	Overall *p*-Value	Adjusted OR (95% CI)	Adjusted *p*-Value
Age group	16–24 years (Ref) 25–49 years ≥50 years	- 0.99 (0.64–1.54) 1.15 (0.66–1.98)	0.823		
Gender	Female (Ref) Male	- 1.06 (0.73–1.54)	0.755		
Employment status	Employed (Ref) Unemployed	- 1.49 (1.04–2.16)	0.032	- 1.48 (1.02–2.14)	0.037
Marital status	Married (Ref) Not married	- 0.69 (0.46–1.05)	0.084	- 0.70 (0.46–1.07)	0.096
Highest education attained	Grade 12 (Ref) Less than Grade 12 Tertiary level	- 1.10 (0.73–1.66) 0.69 (0.39–1.23)	0.218		
Gross monthly income	>R10,000 (Ref) ≤R10,000	- 0.88 (0.34–2.29)	0.787		
Religion	Christianity (Ref) Other	- 0.79 (0.45–1.41)	0.432		

Ref, reference category.

Age was associated with attitude in the adjusted analysis ($p = 0.005$). Participants aged ≥ 50 years had lower odds of a positive attitude than those aged 16–24 years (aOR = 0.35, 95% CI: 0.19–0.68). Moderate to adequate knowledge was also associated with lower odds of positive attitudes compared with poor knowledge (aOR = 0.40, 95% CI: 0.26–0.61; overall $p < 0.001$) (Table 7).

Table 7. Sociodemographic factors associated with positive attitudes towards antibiotic resistance and use (N = 917).

Variable	Category	Crude OR (95% CI)	Overall *p*-Value	Adjusted OR (95% CI)	Adjusted *p*-Value
Age group	16–24 years (Ref) 25–49 years ≥50 years	- 0.84 (0.56–1.26) 0.32 (0.17–0.59)	<0.001	- 0.86 (0.57–1.30) 0.35 (0.19–0.68)	0.005
Gender	Female (Ref) Male	- 1.21 (0.85–1.72)	0.300		
Employment	Employed (Ref) Unemployed	- 0.82 (0.57–1.18)	0.273		
Marital status	Married (Ref) Not married	- 1.26 (0.84–1.87)	0.262		
Highest education attained	Grade 12 (Ref) Less than Grade 12 Tertiary	- 0.71 (0.48–1.05) 1.49 (0.87–2.57)	0.010	0.85 (0.56–1.29) 1.38 (0.79–2.40)	0.194
Gross monthly income	≤R10,000 (Ref) >R10,000	- 0.80 (0.34–1.85)	– 0.597		
Religion	Christianity (Ref) Other	- 0.57 (0.28–1.16)	0.121	- 0.56 (0.27–1.16)	0.119
Knowledge	Poor (Ref) Moderate to adequate	- 0.40 (0.26–0.61)	<0.001	0.40 (0.26–0.61)	<0.001

Ref, reference category.

Educational attainment was associated with practice ($p = 0.049$). Participants with less than Grade 12 education had lower odds of good antibiotic-use practice than those with Grade 12 education (aOR = 0.62, 95% CI: 0.42–0.91). Positive attitudes were associated with higher odds of good practice than negative attitudes (aOR = 2.21, 95% CI: 1.46–3.34; $p < 0.001$). However, knowledge showed no association (Table 8).

Table 8. Sociodemographic factors associated with good antibiotic-use practice (N = 917).

Variable	Category	Crude OR (95% CI)	Overall *p*-Value	Adjusted OR (95% CI)	Adjusted *p*-Value
Age group	16–24 years (Ref) 25–49 years ≥50 years	- 0.88 (0.57–1.34) 0.90 (0.54–1.49)	0.827		
Gender	Female (Ref) Male	- 0.99 (0.69–1.42)	0.959		
Employment	Employed (Ref) Unemployed	- 0.76 (0.53–1.08)	0.128	- 0.80 (0.55–1.16)	0.233
Marital status	Married (Ref) Not married	- 1.01 (0.69–1.47)	0.973		
Highest education attained	Grade 12 (Ref) Less than Grade 12 Tertiary	- 0.59 (0.40–0.86) 0.86 (0.49–1.52)	0.019	- 0.62 (0.42–0.91) 0.78 (0.44–1.40)	0.049
Gross monthly income	≤R10,000 (Ref) >R10,000	- 1.26 (0.48–3.30)	0.635		

Table 8. *Cont.*

Variable	Category	Crude OR (95% CI)	Overall *p*-Value	Adjusted OR (95% CI)	Adjusted *p*-Value
Religion	Christianity (Ref)	-			
	Other	1.33 (0.77–2.31)	0.308		
Knowledge	Poor (Ref)	-			
	Moderate to adequate	0.99 (0.62–1.60)	0.970		
Attitude	Negative (Ref)	-			
	Positive	2.23 (1.53–3.46)	<0.001	2.21 (1.46–3.34)	<0.001

Ref, reference category.

2.7. Qualitative Findings

Of the 917 participants, 840 (91.6%) provided a response regarding their general views on antibiotics, while 822 (89.6%) responded to the question on their knowledge of antibiotics. Four thematic groupings emerged: (1) perceived effectiveness of antibiotics, (2) limited conceptual depth regarding appropriate indications, (3) stewardship-related awareness, and (4) misconceptions and inappropriate indications.

Perceived effectiveness of antibiotics as "infection-fighting medicines": Responses commonly described antibiotics as strong medicines that fight or kill bacteria and infections. These statements were generally concise and efficacy-focused. Illustrative responses included: "*They fight infections in the body*", "*Antibiotics kill bacteria*," "*They are strong medicines for infection*", "*They help when you are sick*", and "*They work faster than other medications*." Such responses align with the high proportion of correct quantitative responses regarding antibiotics' effectiveness against bacteria and their role in treating infections.

Limited conceptual depth regarding appropriate indications: Some participants expressed general positivity in their views without detailed explanations, using terms such as *"they are good", "they are helpful"*, or *"they can heal and they are good."* Such responses highlight positive perceptions of antibiotics but suggest limited depth of knowledge about their specific uses or risks.

Awareness of treatment procedures (stewardship-related awareness): Some responses indicated awareness that antibiotics should be obtained through formal healthcare channels and used as directed. Statements such as "*I think you need to go to the hospital for strong antibiotics*", *"you must get them from the clinic"*, "*they are medicines given by doctors"*, and "*you don't purchase without a doctor's prescription*" suggest some stewardship-related awareness of the formal treatment process and are consistent with the high proportions reporting that they sought pharmacists' advice and consulted healthcare professionals about suspected side effects, although overall antibiotic-use practices remained suboptimal.

Misconceptions and inappropriate indications: Some responses reflected conceptual misunderstandings about antibiotic function and appropriate indications, particularly the perceived use of antibiotics for viral infections and illnesses in general. Examples include *"they treat flu", "they cure viruses ", "you use them for cough and cold", "they help with HIV", "help everyone and they are good"* or *"they should be used most of the time."* These misconceptions align directly with the quantitative findings showing very low appropriate responses regarding antibiotics' ineffectiveness against viruses and confusion between bacterial resistance and human immunity.

Vague, unclear or incomplete responses, such as "*they do help*," were grouped as "Other." These responses may reflect limited knowledge or difficulty articulating an understanding of antibiotics.

2.8. Sources of Information About Antibiotics

One question assessed participants' sources of information about antibiotics, with multiple responses permitted. Of the 917 participants, 885 (96.5%) reported at least one source of antibiotic information. Clinics were most frequently reported (n = 524; 57.1% of all participants), followed by doctors (n = 120; 13.1%), radio (n = 98; 10.7%), friends (n = 52; 5.7%) and pharmacies (n = 52; 5.7%). Among participants reporting a source, 860/885 (97.2%) reported one source; 16 (1.8%), five (0.6%), three (0.3%) and one (0.1%) reported two, three, four and eight sources, respectively.

3. Discussion

Understanding community KAP related to antibiotic use and antimicrobial resistance is important for developing effective antimicrobial stewardship interventions. This study provides locally generated evidence to guide subsequent responsive dialogues and the co-creation of contextually appropriate antimicrobial stewardship interventions.

The community demonstrated an overall moderate level of knowledge, with a mean score of 67.9%, which was higher than that (53%) reported in a patient survey of public and private health sectors in South Africa [19]. However, the observation that only 1.6% achieved an adequate knowledge score and that only a small proportion (<10%) of participants correctly recognised that antibiotics neither speed recovery nor are effective for most coughs and colds, nor act against viruses, highlights substantial knowledge gaps and widespread misconceptions. These findings are consistent with reports from South Africa [19,24] and other community-based studies in low- and middle-income countries (LMICs) [4,10,25,26], where limited understanding of antibiotics, inappropriate use and non-prescription dispensing practices have been documented [25,27,28]. The qualitative knowledge responses corroborated the quantitative pattern, as although some participants associated antibiotics with treating infections and killing bacteria, such as "*fight infections in the body*" and "*kill bacteria fast*", the responses demonstrated only basic awareness of antibiotic use. These brief responses offered limited detail on appropriate indications, which may in part mean a lack of conceptual depth, reflecting the higher quantitative classification of knowledge as moderate. Importantly, misconceptions emerged, such as the belief that antibiotics "*should be used most of the time*". Similar misconceptions about antibiotics being a "*cure-all*" have also been documented in other studies [19,25,29], underscoring a global challenge in antibiotic literacy.

Unexpectedly, unemployed participants had higher odds of having at least moderate knowledge than employed participants. A Ugandan study similarly identified occupational status as an important correlate of knowledge; however, self-employed, rather than unemployed, participants had a higher prevalence of good knowledge than employed participants [12]. The association observed in the present study may reflect unmeasured differences in access to health information, contact with healthcare services or participation in community activities.

Attitude was the weakest of the KAP domains, with approximately 84% of participants categorised as having negative attitudes. Despite moderate factual awareness, many participants still expressed negative attitudes that may predispose them to inappropriate antibiotic use, indicating the need for interventions that promote behavioural change. Low positive attitudes towards antibiotic use have also been reported among rural and urban dwellers in Ethiopia [17], and in Tanzanian communities [10], indicating that negative attitudes are widespread.

The open-ended responses provided additional context for the observed quantitative patterns: although some participants expressed positive views, describing antibiotics as "*good*", "*strong pills*", or "*fast to cure a person*", these statements did not fully demonstrate an

understanding of appropriate indications. Thus, positive perceptions of antibiotic effectiveness should not always be interpreted as a positive antibiotic-stewardship attitude. In such a community, overall attitudes toward stewardship require significant improvement. This pattern mirrors findings from other studies, in which antibiotics were viewed as universally beneficial, including infections not caused by bacteria, with limited recognition of the risks of overuse and antimicrobial resistance [16,24,30,31].

Clinics and healthcare professionals were the most frequently reported antibiotic information sources. Although the content, quality and frequency of information received, were not assessed, due to potentially infrequent access to these sources, local radio and suitable digital platforms could complement healthcare-provider-based awareness efforts [32].

Attitudes varied significantly with age, with older participants demonstrating lower odds of positive attitudes. This suggests that age-specific components should be considered when designing stewardship interventions.

Only 16.8% of participants met the predefined good-practice threshold, while 83.2% had suboptimal practice scores. Other community studies have also reported a lag in appropriate antibiotic-use practices [6,24,25]. Importantly, the item-level findings in this study suggest an apparent knowledge–practice gap, such as the disconnect between awareness of formal antibiotic safety procedures and decisions made during treatment. For example, although most participants reported consulting healthcare professionals regarding suspected side effects and seeking pharmacists' advice, purchasing antibiotics based on the experiences of relatives or friends and stopping treatment once symptoms disappeared were also common practices.

Premature discontinuation when symptoms improve may reflect the perception that antibiotics are required only while symptoms are present, rather than an understanding that they should be taken according to professional instructions. Similarly, reliance on the experiences of relatives or friends suggests that socially shared knowledge may sometimes compete with formal healthcare advice, potentially influencing antibiotic-use decisions. The findings indicate that antibiotic-use decisions may be shaped by a combination of healthcare advice, perceived recovery, previous treatment experiences, and social influences. A study by Visschers et al. [33] demonstrated that factors beyond knowledge, particularly social influences, play an important role in shaping antibiotic-use decisions. Systematic reviews have also shown that access to antibiotics without a prescription remains common globally and in sub-Saharan Africa [34,35], with 78% and 69% of antibiotics, respectively, reportedly dispensed without a prescription upon patient request [34,35]. Inappropriate antibiotic use should therefore not be viewed solely as an individual knowledge deficit but also within the broader context of social influence, access to medications and communication with healthcare providers. Consequently, interventions aimed solely at improving knowledge may be insufficient unless they also address these social and behavioural influences. Nevertheless, the self-reported nature of the practice data may have introduced recall and social desirability bias.

Educational attainment was associated with practice, with participants with less than Grade 12 education having lower odds of good practice than those with Grade 12 education, although tertiary education was not significantly associated with better practice. This association supports attention to educational accessibility when developing interventions; however, it also suggests that formal education alone may not ensure appropriate antibiotic use, as there may be other interacting factors. Positive attitudes were associated with higher odds of good practice, whereas knowledge was not associated with practice. Unexpectedly, participants with at least moderate knowledge had lower odds of positive attitudes. This finding may reflect a disconnect between factual awareness and beliefs regarding appropriate antibiotic use. Although participants demonstrated moderate knowledge of

antibiotic use and resistance, many still endorsed attitudes favouring self-medication, obtaining antibiotics without prescriptions, and using antibiotics for respiratory symptoms. These findings suggest that knowledge alone may be insufficient to promote stewardship-oriented attitudes and behaviours. The strong association between attitudes and practice further indicates that attitude change may be an important target for community-based antimicrobial stewardship interventions.

The internal consistency of the KAP scales was Cronbach's $\alpha = 0.52$ for knowledge and 0.61 for attitudes and practice. Although below 0.70, comparable coefficients of 0.607 and 0.612 were considered acceptable in a medication-safety KAP study [36], while a community antibiotic KAP study reported coefficients of 0.63–0.67 [18]; however, differences in instruments and populations limit direct equivalence. Cronbach's alpha is influenced by item number and interrelatedness [37], which may partly explain the modest coefficients in the attitude and practice domains, particularly the practice domain, which contained only five items. Content heterogeneity within each domain may also have contributed to the lower coefficients, as discussed in previous antibiotic-use research [33]. An exploratory item analysis of KAP identified negative corrected item–total correlations for four knowledge (K5–K7 and K14) and one attitude item (A1), and none for practice (positive corrected item–total correlations range from 0.319 to 0.411). Excluding the negative items increased α to 0.83 for knowledge and 0.79 for attitudes. However, these items were retained to preserve coverage of important misconceptions and attitudes concerning antibiotic use and resistance, recognising that maximising alpha may narrow the content assessed, particularly in knowledge tests [38]. Participants may understand some aspects of antibiotic use while retaining misconceptions or inappropriate attitudes towards others; this heterogeneity, and possibly acquiescent responding, may have contributed to the lower coefficients. Consequently, findings from analyses involving composite KAP scores should be interpreted cautiously.

4. Methodology

4.1. Study Design and Setting

This was a community-based, cross-sectional study conducted in Dzimauli, Limpopo Province of South Africa, from September 2023 to May 2024. The aim was to establish baseline KAP data on antibiotic use important for the co-development of tailored interventions through responsive dialogues. Dzimauli is a low-socioeconomic setting comprising 13 villages [39]. The community was selected because it hosts a prospective mother–child observational study investigating the acquisition of antibiotic-resistant gut bacteria [40], providing additional context for examining community-level KAP related to antibiotic use.

4.2. Sampling and Recruitment

The population of Dzimauli was estimated at about 9000 around the start of the MAL-ED cohort in 2009 [39]. Applying a 2.23% annual growth rate estimate (Thulamela Municipality, 2011–2022) over 14 years projected that the population would reach 12,256 by 2023. The minimum sample size was therefore determined using the single-proportion formula ($n_0 = Z^2p\,(1 - p)/d^2$, with $Z = 1.96$ for 95% confidence, $p = 0.50$ and $d = 0.05$) with finite population correction, assuming 80% data completeness as 466.

A household-based convenience sampling approach through door-to-door visits was used. Fieldworkers visited households in a consecutive manner and invited eligible residents aged ≥16 years to participate. Households were revisited where possible when no one was available at the time of the previous visit. Recruitment continued beyond the minimum target to broaden coverage and to establish baseline KAP data across the surveyed villages, which would ensure that future tailored interventions are responsive to specific needs and contexts. The final analysis included 917 participants with complete

KAP responses. Participants aged ≥18 years provided written informed consent, while those aged 16–17 years provided assent and written consent was obtained from a parent or legal guardian.

4.3. Data Collection

The KAP questionnaire was developed by adapting items from previous studies [6,36] and contextualised. It was pre-tested among 15 community members and revised for clarity. The structured questionnaire included sections covering the sociodemographic information of participants, while the KAP component consisted of 26 closed-ended items (14 knowledge-, 7 attitude-, and 5 practice-related) (Supplementary Material, S1). Participants were also asked to identify their sources of information about antibiotics. Two open-ended questions were also included on general views ("What is your general view about antibiotics?") and on knowledge of antibiotics ("What do you know about antibiotics?"). The first 26 KAP questions were answered using a four-point Likert scale: "strongly disagree", "disagree", "agree" and "strongly agree". Participants were excluded if they reported no prior antibiotic use. A screening question ("Have you ever used antibiotics?") was included within the questionnaire to confirm this inclusion criterion. The questionnaires were administered by trained fieldworkers in English or Tshivenda, the local language of the community, based on each participant's preference.

4.4. Data Analysis

Quantitative data were analysed using IBM SPSS Statistics, version 28. The internal consistency was assessed using Cronbach's alpha. Cronbach's alpha was 0.52 for the 14 knowledge items, 0.61 for the seven attitude items and 0.61 for the five practice items, indicating modest internal consistency. Frequencies and proportions were calculated for each of the four Likert response categories.

To determine the community's overall knowledge, attitudes and practices towards antibiotic use, responses were further summarised following a previous KAP study [28]. Each correct or appropriate response ("agree" or "strongly agree" for positively framed statements, and "disagree" or "strongly disagree" for negatively framed statements) received a score of 1, whereas each incorrect or inappropriate response received a score of 0. For each participant, item scores were summed within each domain, giving possible totals of 0–14 for knowledge, 0–7 for attitude and 0–5 for practice. Each total was also expressed as a percentage of the maximum possible score for that domain: (total score/maximum possible score) × 100. For knowledge, the total scores were classified using modified Bloom's cut-offs as adequate (≥80%; 12–14), moderate (60–79%; 9–11), or poor (<60%; 0–8). Following Awad and Aboud [6], attitudes were classified as positive (4–7) or negative (0–3). Practice was classified as good (≥80%; 4–5 appropriate responses) or suboptimal (<80%; 0–3 appropriate responses). The mean percentage score (±SD) across all participants was also calculated for each domain.

Bivariable logistic regression was used to determine the associated factors of KAP in the study community. Variables with an overall p-value of ≤0.20 were considered for inclusion in the corresponding multivariable model. Outcomes were at least moderate (moderate to adequate) versus poor knowledge, positive versus negative attitudes, and good versus suboptimal practice. In addition to sociodemographic characteristics, knowledge was examined as a predictor of attitude; knowledge and attitude were examined as predictors of practice. Crude and adjusted odds ratios with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$.

The responses to the two open-ended questions on general views and knowledge of antibiotics were analysed using qualitative content analysis and organised into thematic

groupings. All responses were screened for completeness, and codes were generated inductively. Deductive coding, guided by the literature on community perceptions of antibiotics, was also applied. Related codes were organised into four thematic groupings: (1) perceived effectiveness of antibiotics, (2) conceptual depth limitation regarding appropriate indications, (3) awareness of antibiotic access and treatment procedures, and (4) misconceptions and inappropriate antibiotic use. Vague, unclear, or incomplete statements that could not be confidently assigned under these groupings were classified separately as "Other". Non-responses were treated as missing data.

4.5. Limitations of the Study

The findings of the study should be considered in light of the following limitations. Door-to-door convenience sampling may have under-represented residents frequently away from home, despite revisits, introducing possible selection bias. The cross-sectional design precludes causal inference, and self-reported responses may be affected by recall and social desirability biases, which may inflate knowledge and practice scores. Also, the small proportion with adequate knowledge (1.6%) prevented examination of associations specific to this category. Low internal consistency, particularly in the knowledge items, may have introduced measurement error and misclassification, potentially weakening observed associations; composite scores and classifications should therefore be interpreted with caution. Additionally, findings from this study may not be generalisable to other communities with different sociocultural and socioeconomic characteristics.

5. Conclusions and Recommendations

The community demonstrated moderate overall knowledge of antibiotic use. This finding challenges the assumption that communities with low socioeconomic status and limited formal education inherently have very poor knowledge of antibiotic use. Attitudes were predominantly negative, and most participants had suboptimal practice scores. The study also identified priority areas for community-informed antibiotic-stewardship interventions.

Recommended actions include: (1) strengthening knowledge, addressing negative attitudes and suboptimal practices, and correcting misconceptions about antibiotic use; (2) ensuring that communication is accessible across educational levels and responsive to the needs of older community members; (3) further investigation of the unexpected association between unemployment and knowledge; (4) engaging community members, healthcare professionals and other relevant stakeholders in responsive dialogues to co-create locally appropriate interventions addressing misconceptions, premature treatment discontinuation and socially influenced antibiotic use; and (5) using clinics, healthcare professionals and local radio as potential platforms for supporting the resulting community-informed interventions.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/antibiotics15111082/s1, S1: Questionnaire on Knowledge, attitude and Practice regarding antibiotic use.

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Informed Consent Statement: Written informed consent was obtained from participants aged 18 years or older. Participants aged 16–17 years provided assent, with written informed consent obtained from a parent or legal guardian.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, P.O.B., upon reasonable request.

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Abbreviations

The following abbreviations are used in this manuscript:

AMR	Antimicrobial resistance
HIV/AIDS	Human immunodeficiency virus/acquired immunodeficiency syndrome
KAP	Knowledge, attitudes and practices
LMICs	Low- and middle-income countries
SAMRC	South African Medical Research Council
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

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