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Empowering Nurses as Key Players in the Regional Fight Against Antimicrobial Resistance

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ABSTRACT

This study explores the differences in knowledge, attitude, and practice (KAP) across gender, experience, residence, and ethnicity among 316 nurses. Understanding these variations is essential to tailor effective interventions that promote better knowledge acquisition and application in the long battle against antimicrobial resistance. A cross-sectional study was conducted with 316 participants (89 males, 227 females) to assess KAP metrics. Data were analyzed using incidence rate ratios (IRR) to explore relationships between demographic factors and KAP scores. Correlation analyses were performed to determine the strength of relationships between knowledge, attitude, and practice across various subgroups, including gender, residence (rural/urban), experience levels, and ethnicity. Significant gender differences were found, with females scoring higher in knowledge (IRR=1.03, p=0.024) and attitude (IRR=1.03, p=0.030) than males. Urban participants had significantly higher knowledge scores than rural participants (IRR=1.19, p<0.001). Experience levels also impacted knowledge, with participants having 3-6 years of experience showing lower scores than those with over ten years of experience (IRR=0.89, p<0.001). Attitude positively correlated with knowledge and practice (p<0.05). The findings reveal notable disparities in KAP across gender, experience, and residence. Females and urban participants demonstrate higher knowledge and attitude, while experience correlates with greater knowledge. Interventions should target rural areas and less experienced individuals and focus on improving attitudes to drive better knowledge and practice outcomes. Tailored educational programs addressing these disparities are recommended for more equitable KAP improvements.

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1. INTRODUCTION

Antimicrobial resistance (AMR) represents a significant global health challenge, with an increasing burden affecting human and animal health. The World Health Organization (WHO) has identified AMR as a critical public health issue, estimating that around 700,000 deaths occur annually due to resistant infections, a figure projected to rise to 10 million by 2050 if no effective interventions are implemented [1]. The relationship between antibiotic consumption and resistance is well-documented, with rising levels of antibiotic use correlating with increased resistance rates across various pathogens [2]. This trend is particularly alarming in low- and middle-income countries (LMICs), where healthcare systems often struggle to implement effective surveillance and

control measures [2, 3]. Antimicrobial resistance (AMR) in Indonesia has emerged as a critical public health issue, exacerbated by various factors, including inappropriate antibiotic use, limited access to healthcare, and inadequate regulatory frameworks.

The country has witnessed a significant rise in antimicrobial resistance, particularly among common pathogens such as Escherichia coli and Klebsiella pneumonia, which are responsible for a substantial burden of infections [4, 5]. A systematic review highlighted the urgent need to optimize antibiotic use in Indonesia, emphasizing the role of antimicrobial stewardship programs to combat the rising resistance rates [4]. Nurses play a pivotal role in the battle against AMR, mainly through their involvement in antimicrobial stewardship programs (ASPs). Despite their critical position, nurses often face barriers such as inadequate training and education, which limit their effectiveness in stewardship activities [6, 7]. Given their frontline role in administering medications and monitoring patient conditions, their involvement is crucial to improving antibiotic prescribing practices [8].

This study aims to evaluate nurses' knowledge, attitude, practice (KAP), and sociodemographic factors in combating AMR, highlighting the importance of their role in antimicrobial stewardship programs (ASP). Specifically, we hypothesize that sociodemographic factors influence the nurse's KAP, and this study aims to provide a comprehensive trigger to enhance the role of nurses in the battle against AMR.

2. RESEARCH METHOD

This study used a cross-sectional quantitative design to examine socio-demographic factors related to knowledge, attitudes, and practices among nurses toward antimicrobial resistance issues. The research was conducted between January 1 and August 31, 2024, across multiple collaborations in Indonesia. The study targeted active nurses working across various healthcare settings in Indonesia. Three hundred sixteen participants were recruited using an online questionnaire distributed through professional nursing networks and institutional collaborations. The inclusion criteria required participants to be licensed nurses actively engaged in clinical practice. A convenience sampling method was used to recruit nurses from different regions, healthcare settings (e.g., hospitals, clinics, community health centers), and experience levels. The sample size 316 was sufficient to perform the necessary statistical analyses, ensuring adequate power to detect significant differences in knowledge, attitudes, and practices related to antimicrobial resistance (AMR).

Participants voluntarily completed the online survey, which captured sociodemographic information and their knowledge, attitudes, and practices regarding AMR. Data were analyzed using descriptive and inferential statistics in R-studio with respective packages [9-12]. Descriptive statistics, such as means and percentages, were used to summarize the nurses's sociodemographic characteristics and KAP responses to the survey questions. To examine differences between groups, Chi-square tests, and Mann-Whitney U tests were employed for categorical and non-parametric data, respectively. Multivariate regression analysis was used to identify factors significantly associated with KAP. The results were reported with p-values to determine statistical significance, with $p < 0.05$ considered statistically significant.

3. RESULTS AND DISCUSSIONS

3.1. Participants Characteristics

A total of 316 participants were analyzed, comprising 28% males and 72% females, as displayed in Table 1. There were no significant age differences between the groups. Most participants had over ten years of experience, with 49% of males and 43% of females falling into this category. Most participants resided in urban areas, though residence did not significantly influence other variables. A significant difference was found in the ethnicity distribution, with more females from Western Indonesia than males. In contrast, a more substantial proportion of males were from Eastern Indonesia compared to females. Religious distribution was diverse; though the most prominent group adhered to Islam, no significant differences were found in religious distribution between genders. Regarding knowledge, attitude, and practice, significant gender differences were observed. Females had higher knowledge, attitude, and practice scores than males (all p-values < .001).

The study revealed significant gender differences in ethnicity, knowledge, attitude, and practice. Notably, females scored higher in knowledge, attitude, and practice metrics, which suggests possible gender-based differences in the approach to these aspects. This finding may reflect broader societal roles or educational access differences between men and women. The significant variation in ethnicity distribution, especially in Western and Eastern Indonesia, highlights the importance of cultural background in shaping responses. This aspect warrants further investigation into how regional differences influence behavior and practices. Regional differences significantly influence behaviors and practices related to antimicrobial resistance (AMR) across various healthcare settings. These differences can be attributed to many factors, including sociocultural, environmental, and economic conditions, which shape healthcare professionals' knowledge, attitudes, and practices regarding antibiotic use [13]. For instance, a systematic review conducted in Africa revealed that disparities in access to healthcare and education contribute to varying levels of awareness and understanding of AMR among different populations [13]. This highlights the need for tailored educational interventions considering local contexts to combat AMR effectively. This shown in **Table 1**.

Table 1. Participant's Characteristics (n=316)

Variable	N	Male N = 89[1]	Female N = 227[1]	p-value[2]
AGE	316	40 (30, 50)	38 (30, 47)	0.5
EXPERIENCE	316			0.3
<3 years		7 (7.9%)	11 (4.8%)	
3-6 years		18 (20%)	46 (20%)	
6-10 years		20 (22%)	72 (32%)	
>10 years		44 (49%)	98 (43%)	
RESIDENCE	316			0.2
Rural		30 (34%)	60 (26%)	
Urban		59 (66%)	167 (74%)	
ETHNICITY	316			0.048*
Javanese-Sundanese		57 (64%)	138 (61%)	
Others		3 (3.4%)	22 (9.7%)	
Eastern Indonesia		15 (17%)	20 (8.8%)	
Western Indonesia		14 (16%)	47 (21%)	
RELIGION	316			0.3
Islam		57 (64%)	119 (52%)	
Others		8 (9.0%)	30 (13%)	
Hinduism		4 (4.5%)	20 (8.8%)	
Buddhism		5 (5.6%)	24 (11%)	
Catholicism		6 (6.7%)	14 (6.2%)	
Protestantism		9 (10%)	20 (8.8%)	
KNOWLEDGE	316	80 (70, 85)	85 (75, 90)	<0.001***
ATTITUDE	316	75 (75, 80)	80 (75, 85)	<0.001***
PRACTICE	316	70 (60, 75)	75 (65, 80)	0.005**

[1]n (%); Median (Q1, Q3)

[2]*p<0.05; **p<0.01; ***p<0.001

3.2. Knowledge, Attitude, and Practices on Antimicrobial Resistance

The correlation analysis across gender, settlement, working experience, and ethnicity (**Figure 1** and **Figure 2**) shows varied relationships between knowledge, attitude, and practice (KAP). Gender and Settlement: In females, there were stronger positive correlations between knowledge and attitude and between attitude and practice than in males. Urban participants showed higher correlations between knowledge, attitude, and practice than rural participants, particularly with attitude strongly correlated with practice and knowledge. Working Experience: Participants with 6-10 years of experience showed the strongest correlation between knowledge and attitude, while those with more than 10 years of expertise exhibited a similar pattern. Conversely, those with less than three years of experience showed a weaker correlation between KAP metrics, suggesting that more experienced individuals might develop a stronger alignment between knowledge and practice. Ethnicity: The Javanese-Sundanese ethnic group had the strongest correlation between attitude and practice. In contrast, participants from Eastern Indonesia showed weaker correlations between knowledge, attitude, and practice, suggesting that geographic or cultural factors may influence these variables.

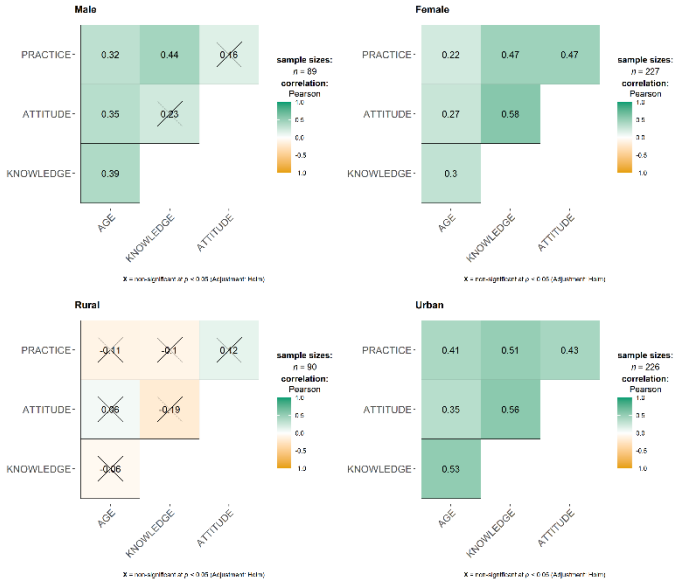

Figure 1. The KAP Correlation Analysis Across Gender and Settlement

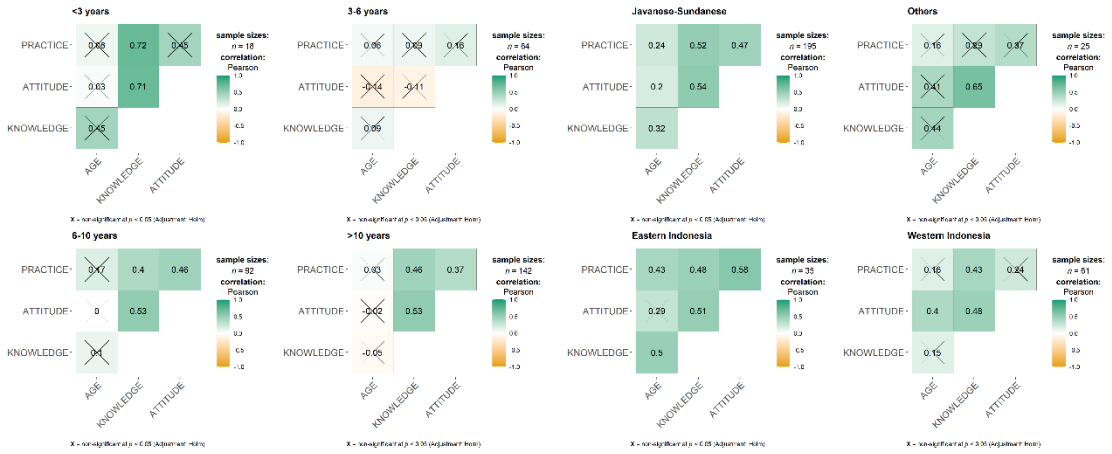

Figure 2. The KAP Correlation Analysis Across Working Experience and Tribe

The correlation analysis highlights significant differences in the relationship between knowledge, attitude, and practice across different demographic and experiential groups. Females and urban residents showed stronger relationships between these variables than males and rural participants. This suggests that females and those living in urban areas may have more consistent application of knowledge into practice, possibly due to greater access to resources or education. Ethnic differences also played a role, with participants from Eastern Indonesia showing weaker correlations, perhaps indicating less access to knowledge or differing cultural practices that may affect how knowledge and attitude translate into practice. The relationship between demographic factors, such as gender and urban residency, and the consistent application of knowledge regarding antimicrobial resistance (AMR) is significant.

A report indicates that females and individuals living in urban areas tend to exhibit a more consistent application of knowledge into practice, which can be attributed to greater access to educational resources and healthcare services [14]. Urban areas often have better healthcare infrastructure, facilitating more effective dissemination of information regarding AMR and appropriate antibiotic use [15]. For instance, a study conducted in Western Greece found that healthcare workers' knowledge about antibiotic use and resistance was influenced by their access to educational resources, which were more readily available in urban settings [14]. This aligns with findings from other regions where urban healthcare workers demonstrated a higher awareness and understanding of AMR than their rural counterparts [16]. The availability of training programs and workshops in

urban areas enhances the capacity of healthcare professionals to implement appropriate antimicrobial stewardship practices [4].

Moreover, gender differences also play a role in applying knowledge to practice. Studies have shown that female healthcare workers often exhibit more positive attitudes towards antibiotic stewardship and are more likely to engage in practices that reduce the risk of AMR [17]. This trend may be linked to differences in educational backgrounds and professional experiences, which can influence their approach to patient care and antibiotic prescribing [17]. In contrast, individuals in rural areas may face barriers such as limited access to healthcare education and resources, which can hinder their ability to apply knowledge effectively [16]. A study in Indonesia highlighted that healthcare workers in rural settings often had less exposure to training on antimicrobial stewardship, leading to gaps in knowledge and practice [18]. This discrepancy emphasizes the need for targeted educational interventions that address healthcare professionals' specific challenges in rural areas.

Furthermore, the socioeconomic context of urban versus rural settings can influence antibiotic prescribing behaviors. In urban areas, healthcare systems may have more robust antimicrobial stewardship programs, which can lead to more rational prescribing practices [19]. Conversely, in rural areas, the lack of such programs may contribute to higher rates of inappropriate antibiotic use, exacerbating the AMR crisis [20]. Among different experience levels, participants with 6-10 years of experience demonstrated the strongest correlation between knowledge, attitude, and practice. This may suggest that a moderate amount of professional experience is optimal for aligning knowledge and practical behavior. Less experienced individuals may still develop their understanding, while those with more than ten years may have reached a plateau in their learning curve. We performed multivariate analysis (table 2) to analyze the incidence rate ratio (IRR) of knowledge, attitude, and practice (KAP), revealing several significant findings.

Females showed a significantly higher incidence rate ratio for both knowledge and attitude compared to males. However, no significant differences were found in practice between genders. Participants with 3-6 years of experience had significantly lower knowledge IRR than those with more than ten years of experience, suggesting less experienced individuals might be at a disadvantage in knowledge acquisition. No significant differences were found in attitude or practice across experience levels. Urban participants had significantly higher knowledge IRR than rural participants, indicating a strong urban-rural divide in terms of knowledge. No significant differences in knowledge, attitude, or practice were found across ethnicities or religious groups. Attitude and Practice Correlation: Attitude was significantly associated with knowledge and practice, suggesting that an improvement in attitude is closely linked to both knowledge and practical application.

Table 2 highlights several important aspects of KAP. Females were found to have higher knowledge and attitude scores compared to males. This suggests that gender shapes how information is processed and applied, potentially due to social, educational, or behavioral factors. However, the lack of significant differences in practice might indicate that knowledge and attitude do not always directly translate into behavior, particularly for males. Participants with less experience (3-6 years) had significantly lower knowledge scores than those with over ten years of experience. This suggests that knowledge accumulation is linked to time spent in the field, reflecting the importance of professional exposure and continued education. Several publications indicate that as nurses gain more experience, their knowledge base expands, which in turn enhances their clinical competence and ability to provide high-quality care [21]. For instance, a study by Sun et al. demonstrated that nurses' attitudes and practices regarding pressure ulcer prevention improved significantly with increased years of working experience, suggesting that accumulated knowledge directly influences their clinical performance [21].

This finding underscores the critical role that practical experience plays in shaping nursing competencies. Moreover, knowledge accumulation is supported by the notion that experienced nurses are essential for mentoring and training novice nurses. Farkhani et al. highlighted that experienced nurses actively participate in knowledge sharing and succession planning, which is vital for fostering a culture of continuous learning within healthcare settings [22]. This mentorship benefits the new nurses and reinforces the knowledge and skills of experienced nurses, creating a cycle of professional development that enhances overall care quality [22]. The significant association between attitude and knowledge and practice emphasizes the importance of fostering positive attitudes toward learning and application. Improving attitude may serve as a lever to enhance knowledge acquisition and practical behavior.

The study has several limitations. First, the sample size for some demographic subgroups (such as ethnicities and certain religious groups) was relatively small, limiting the ability to detect significant differences across these categories. Additionally, the study's cross-sectional design prevents causal conclusions from being drawn regarding the relationships between knowledge, attitude, and practice. Second, the study did not account for other potential confounding variables such as education level, socioeconomic status, and workplace-specific factors that could influence KAP outcomes. Future studies would benefit from including a more comprehensive array of demographic variables to fully understand the factors influencing KAP. Further research is needed to explore the reasons behind the observed gender and urban-rural differences in knowledge and attitude. Additionally, longitudinal studies could help clarify how experience influences knowledge accumulation and whether interventions to improve attitudes could lead to sustained improvements in practice.

Finally, exploring interventions tailored for rural areas or less experienced individuals may help address the knowledge gaps identified in this study.

Table 2. Multivariate Analysis for The KAP and Demographics Factors

Variable	Knowledge				Attitude				Practice			
	N	IRR[1]	SE[1]	p-value[2]	N	IRR[1]	SE[1]	p-value[2]	N	IRR[1]	SE[1]	p-value[2]
GENDER	316				316				316			
Male		—	—			—	—			—	—	
Female		1.03	0.015	0.024*		1.03	0.015	0.030*		1.02	0.016	0.2
AGE	316	1.00	0.002	0.7	316	1.00	0.002	0.5	316	1.00	0.002	0.2
EXPERIENCE	316				316				316			
<3 years		—	—			—	—			—	—	
3-6 years		0.89	0.032	<0.001***		1.00	0.033	>0.9		0.95	0.035	0.13
6-10 years		1.00	0.036	>0.9		1.05	0.036	0.14		0.95	0.038	0.2
>10 years		1.03	0.053	0.6		1.08	0.053	0.14		0.94	0.057	0.3
RESIDENCE	316				316				316			
Rural		—	—			—	—			—	—	
Urban		1.19	0.017	<0.001***		1.03	0.021	0.13		1.03	0.022	0.2
ETHNICITY	316				316				316			
Javanese-Sundanese		—	—			—	—			—	—	
Others		1.02	0.024	0.5		0.99	0.024	0.8		0.98	0.026	0.4
Eastern Indonesia		1.00	0.021	0.9		1.01	0.021	0.8		1.03	0.022	0.2
Western Indonesia		1.00	0.016	0.9		1.00	0.017	0.9		1.00	0.018	0.9
RELIGION	316				316				316			
Islam		—	—			—	—			—	—	
Others		0.98	0.020	0.4		1.02	0.020	0.4		1.03	0.021	0.2
Hinduism		0.99	0.025	0.7		1.03	0.024	0.2		1.02	0.026	0.4
Buddhism		0.99	0.023	0.5		1.01	0.023	0.6		1.01	0.024	0.6
Catholicism		0.99	0.027	0.7		1.01	0.027	0.7		1.02	0.028	0.5
Protestantism		1.00	0.023	>0.9		1.00	0.023	0.9		1.01	0.024	0.6
ATTITUDE	316	1.00	0.001	0.037*					316	1.00	0.001	<0.001***
PRACTICE	316	1.00	0.001	0.020*	316	1.00	0.001	0.014*				
KNOWLEDGE					316	1.00	0.001	0.025*	316	1.00	0.001	<0.001***

[1]IRR = Incidence Rate Ratio, SE = Standard Error [2]*p<0.05; **p<0.01; ***p<0.001

4. CONCLUSIONS

This study highlights significant gender differences in knowledge and attitude, with females scoring higher than males, underscoring the urban-rural divide in knowledge acquisition. Additionally, individuals with more professional experience demonstrated higher knowledge levels, indicating the importance of continued learning. The strong link between attitude and knowledge and practice suggests that fostering positive attitudes can drive better outcomes in knowledge application. To bridge the identified gaps, it is recommended to implement targeted educational programs, especially for rural areas and less experienced professionals. Gender-sensitive strategies should be developed to ensure that both males and females benefit equally from knowledge improvement initiatives. Additionally, interventions that aim to improve attitudes toward learning and practical application should be prioritized, as they can potentially enhance knowledge acquisition and behavioral outcomes in practice. Long-term studies should be conducted to measure the effectiveness of these interventions over time.

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