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Research Article

DETERMINING SHORT-TERM ORAL ANTIBIOTICS NON-ADHERENCE AND EXPLORING ITS ASSOCIATED FACTORS AMONG ORANG ASLI POPULATIONS AT KAMPUNG SUNGAI TONGGANG, IPOH, PERAK, MALAYSIA

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ABSTRACT

Objectives: This study aimed to determine the prevalence of non-adherence to short-term oral antibiotics among the Orang Asli community in Kampung Sungai Tonggang, Ipoh, Perak, Malaysia. In addition, it explored the factors contributing to non-adherence and assessed the community's knowledge and attitudes toward antibiotic use.

Methods: A cross-sectional study was conducted among Orang Asli individuals prescribed short-term oral antibiotics. Data were collected through structured interviews, and adherence levels were assessed. Factors associated with non-adherence were analyzed using simple logistic regression. Knowledge and attitudes toward antibiotics were evaluated using a scoring system, with comparisons made based on demographic variables.

Results: The findings revealed that 71.2% of respondents were non-adherent to their antibiotic regimen. Age and gender were significant factors influencing adherence, with male respondents being less likely to adhere (odds radio: 0.117, 95% confidence interval: 0.02–0.60, p=0.010). Knowledge and attitudes toward antibiotic use varied, with 50% of respondents demonstrating good knowledge (K-score ≥13). Literacy status and occupation significantly influenced knowledge levels ($p<0.05$).

Conclusion: Non-adherence to short-term oral antibiotics is prevalent among the Orang Asli community, with demographic and knowledge-related factors playing a role. Targeted educational interventions and culturally appropriate strategies are needed to improve adherence and ensure effective antibiotic use in this population.

Keywords: Antibiotic adherence, Orang Asli community, Knowledge and attitudes, Factors for non-adherence.

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INTRODUCTION

Adherence to prescribed medications, particularly antibiotics, is a critical factor in ensuring successful treatment outcomes and preventing the emergence of antimicrobial resistance (AMR). Non-adherence to short-term oral antibiotics remains a major public health concern, leading to prolonged infections, increased healthcare costs, and the potential spread of resistant bacterial strains [1,2]. Antibiotic adherence is particularly crucial as incomplete courses can lead to treatment failure and the persistence of infections, ultimately exacerbating the global AMR crisis. China reports that approximately 30% of infections are caused by drug-resistant pathogens [3-6]. In Malaysia, A study analyzing data from 2003 to 2008 reported that the national resistance rate for meropenem, a critical antibiotic, increased from slightly below 30% to 50% over the 5-year period [7]. This significant rise underscores the growing challenge of AMR in the country. A 2023 report by the World Health Organization projected that the Western Pacific Region, which includes Malaysia, could witness approximately 5.2 million deaths due to drug-resistant bacterial infections between 2023 and 2030 [8]. Despite extensive studies on medication adherence among various populations, little attention has been given to the indigenous Orang Asli communities in Malaysia, who often face unique healthcare challenges.

Antibiotic adherence is influenced by multiple factors, including patient-related, healthcare system-related, and socioeconomic elements. Patient-related factors encompass forgetfulness, misunderstanding of antibiotic regimens, and misconceptions about antibiotic use. Healthcare system factors include accessibility to healthcare facilities, provider communication, and the availability of medications. Socioeconomic determinants, such as education level, income, and cultural beliefs, also significantly impact adherence behaviors [9,10]. Among marginalized communities like the Orang Asli, these challenges may be more pronounced due to geographical isolation, limited access to healthcare services, and traditional beliefs that might conflict with conventional medical practices.

In Malaysia, a combination of public data from the Department of Orang Asli Development (JAKOA) and data from the Malaysia Statistics Department estimated that the Indigenous Peoples of Malaysia made up 13.7% of the 33 million national population, including Orang Asli in Peninsular Malaysia and Natives from Sabah and Sarawak [11,12]. The Orang Asli, the indigenous people of Peninsular Malaysia, represent one of the most underserved populations in terms of healthcare access and research representation, yet there is a paucity of studies investigating their health behaviors, including antibiotic adherence [13]. Given their limited exposure to modern healthcare and reliance on traditional medicine, it is crucial to explore how these factors contribute to non-adherence to antibiotics. Understanding their perspectives and the barriers they face can provide valuable insights for healthcare providers and policymakers to develop targeted interventions that improve antibiotic adherence and overall health outcomes within this community.

The primary objective of this study was to assess non-adherence to short-term oral antibiotic therapy among the Orang Asli population in Kampung Sungai Tonggang, Ipoh, Perak, Malaysia. In addition, the study aimed to explore the factors contributing to antibiotic non-adherence and evaluate the knowledge and attitudes toward oral antibiotic use within this community. By addressing this gap in research, we hope to contribute to more effective healthcare strategies tailored to indigenous communities. The findings from this study could serve as a foundation for future initiatives aimed at improving medication adherence, enhancing patient education, and ultimately mitigating the risks associated with antibiotic resistance.

METHODS

This was a descriptive, cross-sectional survey conducted between September to October 2024 among the Orang Asli (Indigenous people) population at Kampung Orang Asli Sungai Tonggang, Ipoh, Perak, Malaysia.

Study setting

This study was conducted at Kampung Orang Asli Sungai Tonggang, Ipoh, Perak, Malaysia. This was a cross-sectional study, and the study was conducted through an investigator-administered questionnaire method. According to the Malaysian Census Report (2022), it was reported a population size of 120 (Adults only) people was reported at Kampung Sungai Tonggang, Ipoh, Perak. The Raosoft calculator estimated a 92-respondent sample size (95% confidence interval [CI], 5% margin of error). To account for incomplete data, a minimum of 102 participants was required.

Sample size, precision, and analytic power

This study was designed a priori for descriptive precision (estimating knowledge and attitudes toward antibiotic use, as well as the prevalence of non-adherence to short-term oral antibiotics) using a 5% margin of error at 95% confidence, based on the known adult population. The Raosoft calculator indicated a target sample size of n=92. In practice, all individuals who fulfilled the pre-specified inclusion criteria during the recruitment period were invited and successfully enrolled, yielding a final sample of n=52.

For n=52, the half-width of a 95% CI for a proportion near 0.50 is ~13–14% (narrower after applying finite-population correction). Accordingly, all descriptive estimates, including the prevalence of non-adherence, are reported with 95% CI.

Because the study's primary aim was descriptive, multivariable regression was specified as exploratory. With n=52 and a limited, theory-guided set of predictors, the study has adequate power only to detect medium or larger effects (e.g., Cohen's $f^2 \approx 0.20–0.25$ for linear models with 3–5 predictors). Regression results are therefore interpreted as hypothesis-generating.

Ethical consideration

This study was approved by the Joint Ethics Committee of the University. The study was performed in accordance with the Declaration of Helsinki, as revised in Washington in 2013. The ethical approval for this research was obtained by the Institutional Joint Research Ethics Committee of the University (JREC/July 2024/373) and Jabatan Kemajuan Orang Asli, Kementerian Kemajuan Desa dan Willayah, JAKOA.PP.R.004 JLD 8 (18).

Eligibility

Participants recruited for this study were permanent residents of Kampung Sungai Tonggang, Ipoh, Perak, Malaysia, aged 18 years or older, of Orang Asli ethnicity, and had taken short-term oral antibiotic therapy (3–14 days) at least once in the past year. Individuals with incomplete questionnaire data or those who were not permanent residents of Kampung Sungai Tonggang were excluded from the study.

Questionnaire (data collection tool)

The questionnaire used in this study was an adapted instrument that underwent face and content validation by a panel of experts in the field. It comprised three sections: demographics, knowledge and attitudes toward antibiotic use, and reasons for antibiotic non-adherence. The demographics section collected information on respondents' age, gender, occupation, literacy status, educational background, and religion. The knowledge and attitudes toward antibiotic use section was scored based on correct responses, with each correct answer receiving a score of 1, leading to a maximum possible score of 16.

The scoring system for the knowledge and attitudes section followed Bloom's cutoff points: A K-score of 13 or higher indicated good knowledge and attitude, a score between 10 and 12 was categorized as moderate, and a score below 10 was classified as poor [14,15].

Statistical analysis

In this study, statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 28.0 software. Descriptive statistics such as mean, median, standard deviation, interquartile range, minimum, and maximum were used to summarize continuous variables. Counts and percentages were used to summarize categorical variables. Data were analyzed for normality by looking at its skewness and kurtosis. Data were considered to be normally distributed when the value obtained for skewness was within the range from −1 to 1 and kurtosis was in the range from −3 to 3. For outcome measures of continuous data, a paired t-test was used for within-group comparison and an unpaired t-test for between-group comparison if data were normally distributed. Whereas the Wilcoxon signed-rank test was to be used if data were not normally distributed. The Mann–Whitney U test would have been used for between-groups comparison if the data were not normally distributed. The Chi-square (χ^2) test or Fisher's exact test was used to analyze dichotomous data. Binary logistic regression analysis was used to determine the predictors for non-adherence to short-term oral antibiotics. Differences were considered statistically significant if 2-tailed tests were estimated at a $p<0.05$.

There were no missing data for the variables analyzed in this study. All participants provided complete responses to the questionnaire and demographic items; hence, no data imputation or case exclusion was required.

RESULTS

A total of 113 residents of Kampung Sungai Tonggang, Ipoh, Perak, Malaysia, were assessed for eligibility to participate in the study. Participants were screened based on predefined inclusion criteria. Eligible participants were then further screened based on their history of antibiotic use. Only those who had taken short-term oral antibiotic therapy (3–14 days) at least once in the past year were included. Residents who had not taken antibiotics in the past year were excluded. Following the screening process, a total of 52 participants met the eligibility criteria and were recruited for the study. As shown in Fig. 1, data collection was conducted using a validated questionnaire, which assessed demographic details, knowledge, attitudes, and reasons for antibiotic non-adherence. The collected data were then analyzed using SPSS Statistics version 28 (IBM) to determine patterns of antibiotic adherence and associated factors within the study population.

Participants demographics

Demographics of participants are summarized in Table 1. A total of 52 respondents participated in the study, with 44.2% (n=23) being male and 55.8% (n=29) female. The mean age of the participants was 29.85±9.13 years. In terms of monthly household income, the majority (67.3%) reported earning less than RM 1,500, while 26.9% had an income between RM 1,500 and RM 3,000. A small proportion (5.8%) reported earning more than RM 3,000. All respondents identified as Muslims. Regarding educational background, 11.5% had no formal education, 26.9% completed primary education, and the majority (61.6%) had attained secondary education. With respect to literacy status, 94.2% of respondents were able to read and write,

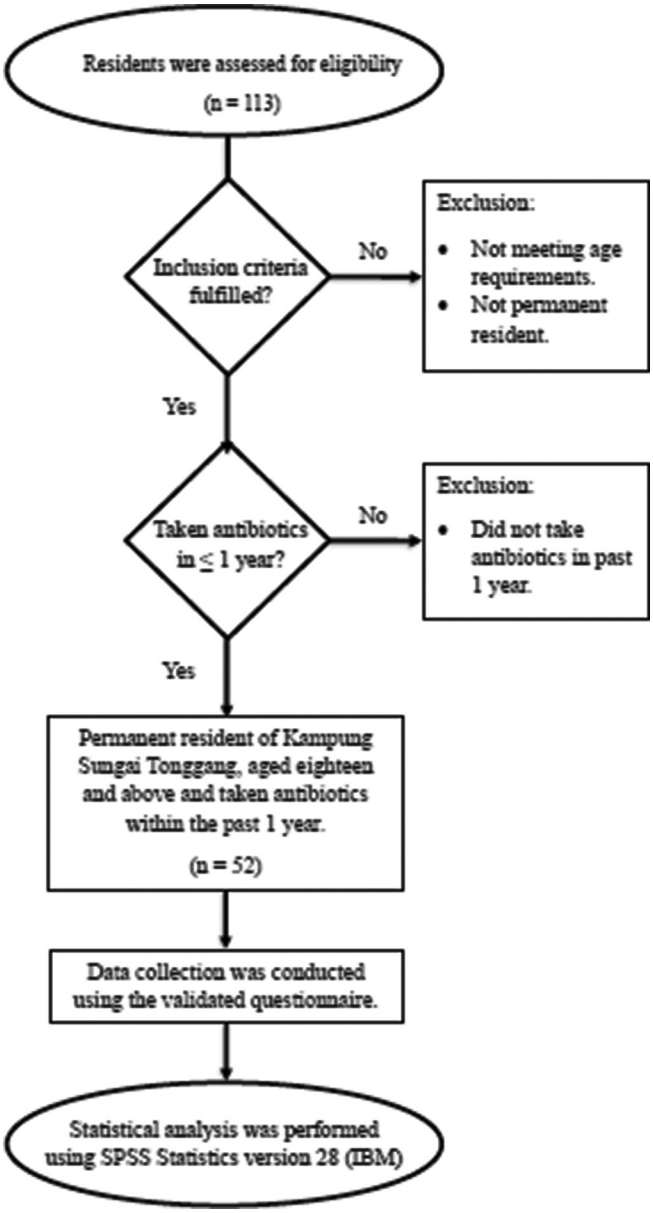

Fig. 1: The flow of the study

while 5.8% were unable to do so. Marital status data indicated that 94.2% of respondents were married, whereas only 5.8% were single. Occupationally, 5.8% were employed in the private sector, 11.5% worked in government positions, 28.8% were self-employed, and the largest proportion (53.9%) identified as homemakers.

Patients' adherence with antimicrobial therapy

Table 2 presents the prevalence of non-adherence within the study sample, along with the factors associated with short-term oral antibiotic non-adherence, analyzed using simple logistic regression. This study identified that only 15 respondents (28.8%) adhered to their antibiotic therapy, while 37 respondents (71.2%) were non-adherent.

Household income and occupation were excluded from OR calculations because of sparse multi-category distributions (including zero cells) that led to unstable or non-estimable coefficients. Fisher's exact test was not applied because it does not generate adjusted ORs and, for r×c tables, provides only a p-value for association without a meaningful single OR Factors associated with non-adherence to short-term oral antibiotics among the study population (Refer to Table 3).

Table 1: Demographics of respondents

Demographics	Frequency (n [%])	p-value
Gender		
Male	23 (44.2)	0.417
Female	29 (55.8)	
Age in years*	29.85±9.127	
Monthly household income (RM)		
<1,500	35 (67.3)	<0.001
1,500–2,000	14 (26.9)	
>3,000	3 (5.8)	
Religion		
Islam	52 (100)	
Educational background		
No educational background	6 (11.5)	<0.001
Primary education	14 (26.9)	
Secondary education	32 (61.6)	
Literacy status		
Able to read and write	49 (94.2)	<0.001
Unable to read and write	3 (5.8)	
Marital status		
Single	3 (5.8)	<0.001
Married	49 (94.2)	
Occupation		
Private sector employees	3 (5.8)	<0.001
Government employee	6 (11.5)	
Self-employed	15 (28.8)	
Homemaker	28 (53.9)	

N: Number of respondents, RM: Malaysian Ringgit. The values were expressed as mean±standard deviation* and counts (percentages over column total)

Age and gender

Age was found to be a statistically significant factor influencing adherence, with a crude odds ratio (OR) of 0.754 (95% CI: 0.61, 0.93) and a p=0.007, indicating that younger respondents were more likely to adhere to their antibiotic therapy compared to older individuals.

Gender also played a significant role in adherence, with male respondents demonstrating lower adherence rates compared to females. Only 13.3% of males adhered to their antibiotic regimen, while 56.8% were non-adherent. The crude OR for males was 0.117 (95% CI: 0.02, 0.60) with a p=0.010, suggesting that males were significantly less likely to adhere to their prescribed antibiotics compared to females, who served as the reference group.

Household income

Household income was categorized into three groups: less than RM 1,500, RM 1,500–2,000, and more than RM 3,000. The majority of non-adherent respondents (62.2%) had a household income below RM 1,500, followed by 29.7% in the RM 1,500–2,000 range. However, due to the limitations of simple logistic regression, household income was not included in the odds ratio calculation.

Educational background

Education level was examined as a potential factor affecting adherence. Respondents with no formal education had an OR of 4.33 (95% CI: 0.70, 27.01), while those with primary education had an OR of 3.25 (95% CI: 0.82, 12.94) compared to those with secondary education (reference category). Despite these differences, the association was not statistically significant (p=0.134), indicating that education level alone may not be a strong determinant of adherence.

Occupation

The majority of adherent respondents were housewives (80.0% of all adherent participants), whereas non-adherence was more common among self-employed individuals (32.4%) and government employees (16.3%). However, due to the limited sample size in some occupational categories, logistic regression could not be applied to this variable.

Table 2: Reasons for non-adherence antibiotics

Reasons for antibiotics non-adherence prompt	Response (n [%])	
	Yes	No
Unaware of the consequences of taking antimicrobial drugs without the doctor's advice.	21 (40.4)	31 (59.6)
Take too many drug varieties, forget correct order and dosage.	27 (51.9)	25 (48.1)
Pharmacists or dispensers do not specify the administration method and dose.	12 (23.1)	40 (76.9)
The smell and the shape of the drugs is difficult to accept.	30 (57.7)	22 (42.3)
Fear of adverse effects caused by long-term use (i.e. causing kidney damage).	24 (46.2)	28 (53.8)
Too busy studying or working.	33 (63.5)	19 (36.5)
Drug prices are too high to afford.	21 (40.4)	31 (59.6)
Do not know the exact effect of the drugs prescribed by the doctor.	33 (63.5)	19 (36.5)
Inadequate knowledge about the illness and take the drugs passively.	41 (78.8)	11 (21.2)
Lack of confidence in young doctors.	18 (34.6)	34 (65.4)
Lack of confidence in antibiotics given.	12 (23.1)	40 (76.9)
Drug manuals are too technical to understand.	12 (23.1)	40 (76.9)
The prescribed doses are difficult to comply with (such as the need to break the tablet into 2 pieces).	18 (34.6)	34 (65.4)
Too worried about the adverse effects described in the drug manual.	12 (23.1)	40 (76.9)
Do not need to continue treatment once the condition improves.	27 (51.9)	25 (48.1)
Patients consider that their condition does not require medication and that they will recover by themselves.	6 (11.5)	46 (88.5)
Preference for secret recipe or food therapy or traditional remedies.	18 (34.6)	34 (65.4)
Too many drug varieties (polypharmacy).	12 (23.1)	40 (76.9)

N: Number of respondents. The values were represented as counts (percentages over row total)

Table 3: Factors associated with non-adherence of short-term oral antibiotics using simple logistic regression

Variable	Respondents adhered to oral antibiotics Mean (SD)/n (%)	Respondents did not adhere to oral antibiotics Mean (SD)/N (%)	Crude OR (95% CI)	p-value
Age (year)	15 (28.8)	37 (71.2)	0.754 (0.61, 0.93)	0.007
Gender				
Male	2 (13.3)	21 (56.8)	0.117 (0.02, 0.60)	0.010
Female	13 (86.7)	16 (43.2)	1.00 (Ref)	
Household income				
<1,500	12 (80.0)	23 (62.2)	--	NA*
1,500–2,000	3 (20.0)	11 (29.7)	--	
>3,000	0 (0.0)	3 (8.1)	--	
Educational background				
No education	3 (20.0)	3 (8.1)	4.33 (0.70, 27.01)	0.134
Primary	6 (40.0)	8 (21.6)	3.25 (0.82, 12.94)	
Secondary	6 (40.0)	26 (70.3)	1.00 (Ref)	
Occupation				
Private sector	0 (0.0)	3 (8.1)	--	NA*
Government employee	0 (0.0)	6 (16.3)	--	
Self-employed	3 (20.0)	12 (32.4)	--	
Housewife	12 (80.0)	16 (43.2)	--	

Note *The assumptions of simple logistic regression were not met, there must be at least two cases for each category of the dependent. SD: Standard deviation, OR: Odds ratio, 95% CI: 95% confidence interval

The findings suggest that age and gender were the most significant predictors of antibiotic adherence, with younger individuals and female respondents demonstrating better adherence. While factors such as household income, educational background, and occupation showed trends toward influencing adherence, their statistical significance could not be confirmed within this study due to sample size limitations.

Reasons for non-adherence to antimicrobial therapy

Table 2 presents the various reasons cited by respondents for non-adherence to short-term oral antibiotic therapy. The most frequently reported factor contributing to non-adherence was inadequate knowledge about the illness and passive consumption of antibiotics, with 78.8% (n=41) of respondents admitting to taking antibiotics without fully understanding their illness or the necessity of completing the course.

A significant proportion (63.5%) of respondents stated that they were too busy with studies or work, making it difficult to adhere to their prescribed antibiotic regimen. Similarly, 63.5% also expressed a lack of understanding of the exact effects of the prescribed antibiotics, highlighting the need for better patient education. In addition, 51.9% of respondents reported forgetting the correct order or dosage due to the consumption of multiple medications, further contributing to non-adherence.

Concerns about medication properties and side effects also played a role, with 57.7% of respondents indicating that they found the smell or shape of the medication difficult to tolerate. Furthermore, 46.2% of respondents were afraid of long-term adverse effects, such as kidney damage. 40.4% stated that they were unaware of the consequences of taking antibiotics without a doctor's advice, demonstrating a lack of awareness regarding AMR and the dangers of misuse.

Other factors contributing to non-adherence included a lack of confidence in young doctors (34.6%), mistrust in antibiotics (23.1%), and perceived difficulty in following prescribed doses (34.6%), particularly when splitting tablets. In addition, 34.6% of respondents preferred traditional remedies or food therapy over conventional antibiotic treatment, indicating cultural beliefs influencing adherence.

A small proportion (11.5%) of respondents believed that their condition would improve without medication, reinforcing misconceptions about

antibiotic necessity. Finally, 23.1% cited polypharmacy (taking too many medications simultaneously) as a reason for not adhering to their antibiotic regimen.

Knowledge and attitudes toward oral antibiotic (Refer to Table 4)

The knowledge and attitudes toward oral antibiotics are tabulated in Table 4. The overall knowledge and attitudes toward short-term oral antimicrobial therapy were assessed using a knowledge score (K-score) classification. Among the respondents, 50.0% demonstrated good knowledge (K-score ≥13), while 26.9% exhibited moderate knowledge (K-score 10–12), and 23.1% had poor knowledge (K-score 0–10).

Knowledge and attitudes by gender

The distribution of knowledge scores by gender revealed that an equal proportion of male and female respondents (50% each) had good knowledge of antibiotics. Similarly, 26.9% of both genders had moderate knowledge, while a higher percentage of females (75%) compared to males (25%) fell into the poor knowledge category. However, the association between gender and antibiotic knowledge was not statistically significant (p=0.311).

Knowledge and attitudes by monthly household income

When analyzed based on monthly household income, respondents earning below RM1500 had the highest proportion of good knowledge (65.4%), followed by those in the RM1500–RM2000 (23.1%) and those earning above RM3000 (11.5%). Moderate knowledge levels were predominantly seen in the lower-income group (85.7%), while all respondents from the highest income group had at least moderate knowledge. However, this association did not reach statistical significance (p=0.107).

Knowledge and attitudes by educational background

Education level showed a notable trend, where the majority of those with secondary education (65.4%) had good knowledge, compared

Table 4: Knowledge and attitudes towards short term oral antimicrobial therapy

Overall antibiotics knowledge and attitudes K-score category					
Antibiotics K-score category					**Respondents (n [%])**
Good (≥13)					26 (50.0)
Moderate (10–12)					14 (26.9)
Poor (0–10)					12 (23.1)
Antibiotics knowledge and attitudes score (K-score) category according to gender					
Antibiotics K-score category	**Gender (n [%])**				**p-value**
	Male	**Female**			
Good (≥13)	13 (50)	13 (50)			0.311
Moderate (10–12)	7 (50)	7 (50)			
Poor (0–9)	3 (25)	9 (75)			
Antibiotics knowledge and attitudes score (K-score) category according to monthly household income					
Antibiotics K-score category	**Monthly household income (n [%])**				**p-value**
	<RM1500	**RM1500–RM2000**	**>RM3000**		
Good (≥13)	17 (65.4)	6 (23.1)	3 (11.5)		0.107
Moderate (10–12)	12 (85.7)	2 (14.3)	0 (0)		
Poor (0–9)	6 (50)	6 (50)	0 (0)1		
Antibiotics knowledge and attitudes K-score category according to educational background					
Antibiotics K-score category	**Educational background (n [%])**				**p-value**
	None	**Primary education**	**Secondary education**		
Good (≥13)	3 (11.5)	6 (23.1)	17 (65.4)		0.355
Moderate (10–12)	0 (0)	5 (35.7)	9 (64.3)		
Poor (0–9)	3 (25)	3 (25)	6 (50)		
Antibiotics knowledge and attitudes K-score category according to literacy status					
Antibiotics K-score category	**Literacy status (n [%])**				**p-value**
	Able to read and write	**Unable to read and write**			
Good (≥13)	26 (100)	0 (0)			0.005
Moderate (10–12)	14 (100)	0 (0)			
Poor (0–9)	9 (75)	3 (25)			
Antibiotics knowledge and attitudes K-score category according to occupation					
Antibiotics K-score category	**Occupation (n [%])**				**p-value**
	Private sector employee	**Government employee**	**Self-employed**	**Housewife**	
Good (≥13)	0 (0)	6 (23.1)	6 (23.1)	14 (53.8)	0.011
Moderate (10–12)	3 (21.4)	0 (0)	3 (21.4)	8 (57.1)	
Poor (0–9)	0 (0)	0 (0)	6 (50)	6 (50)	

K-score, knowledge score. N: Number of respondents. The values were presented as counts (percentages over row total). The p values were determined by Pearson Chi-square test. The frequencies with p<0.05 are statistically significantly different

to 23.1% of those with primary education and only 11.5% of those without formal education. Poor knowledge was most prevalent among respondents with no education (25%) and primary education (25%), while it was higher among those with secondary education (50%). However, this association was not statistically significant (p=0.355).

Knowledge and attitudes by literacy status

A statistically significant association was observed between literacy status and antibiotic knowledge (p=0.005). All respondents who were able to read and write had either good or moderate knowledge, while those unable to read and write had a higher proportion of poor knowledge (75%).

Knowledge and attitudes by occupation

Occupation also played a significant role in antibiotic knowledge (p=0.011). Housewives (53.8%) and self-employed individuals (21.4%) had the highest proportion of good knowledge, whereas no respondents from the private sector or government employment achieved a good K-score. Poor knowledge was most evident among self-employed individuals (50%) and those in the private sector (100%).

Overall, the findings indicate that literacy status and occupation significantly influence knowledge and attitudes toward antibiotic use. Meanwhile, factors such as gender, income, and education level did not show statistically significant associations but exhibited notable trends. These insights highlight the importance of targeted educational interventions to improve antibiotic knowledge and adherence among specific demographic groups.

DISCUSSION

The present study assessed non-adherence to short-term oral antibiotic therapy and explored the factors influencing non-adherence among the Orang Asli population in Kampung Sungai Tonggang, Ipoh, Perak, Malaysia. It also examined the knowledge and attitudes towards antibiotic use. The findings provide insights into the determinants of adherence behavior and highlight potential intervention areas.

Non-adherence to antibiotics

The results indicate a high rate of non-adherence to short-term oral antibiotics (71.2%), with age and gender emerging as significant predictors. Younger respondents were more likely to be non-adherent, as shown by the crude OR of 0.754 (95% CI: 0.61, 0.93; p=0.007). This is consistent with findings from studies conducted in rural communities in Malaysia and other low-income populations, where younger individuals were found to be less compliant with prescribed antibiotics due to a lack of perceived severity of illness and a higher tendency to discontinue medication when symptoms subside [16-19].

Gender differences were also significant, with males being less likely to adhere to antibiotics compared to females (OR=0.117, 95% CI: 0.02, 0.60; p=0.010). Similar findings have been reported in previous studies, where women demonstrated better adherence to medication regimens due to greater health awareness and caregiving responsibilities [20,21]. Our finding that male gender was associated with markedly lower antibiotic adherence (OR=0.117) is consistent with evidence from Malaysia, where Fatokun (2014) reported significantly higher non-compliance among men (56.8%) than women (44%), potentially due to disparities in healthcare-seeking behaviors and exposure to medication counseling [22]. This suggests that gender-specific health education strategies may be beneficial in improving antibiotic adherence among men in the Orang Asli population.

Factors contributing to non-adherence

The primary reasons for non-adherence included a lack of knowledge about antibiotics (78.8%), busy schedules (63.5%), and the belief that they did not need to continue treatment once they felt better (51.9%). These findings align with prior research that identified misconceptions about antibiotic use as a major driver of non-adherence, particularly in communities with lower health literacy) [23-25]. Additionally, the fear of adverse effects (46.2%) and difficulties in remembering the correct order and dosage of multiple medications (51.9%) were noted.

A significant portion of respondents (34.6%) preferred traditional remedies over antibiotics, reflecting cultural influences on health behaviors. This preference has also been reported in studies on indigenous communities in Southeast Asia, where traditional medicine is often perceived as more natural and safer than pharmaceuticals [26-28]. This finding aligns with prior work showing high use of traditional and complementary medicine (TCAM) in Malaysia and the region, where herb-based therapies and other local modalities are widely used for both self-care and illness treatment. Drivers include cultural explanatory models of illness, long-standing family and community practices, perceived efficacy and safety of traditional remedies, ease of access, and trust in traditional practitioners. Moreover, ethnographic and health-systems literature describe a process of "healthcare hybridity" in which biomedical and local medical systems interact—patients routinely combine therapies or choose treatments based on cultural scripts and practical considerations rather than biomedical logic alone. These dynamics help explain why good knowledge about antibiotics does not automatically translate into biomedical adherence: people may deliberately use traditional remedies alongside or instead of prescribed antibiotics because of beliefs about cause, expected time to recovery, or previous experience. The public-health implication is that antibiotic stewardship efforts should be culturally sensitive and consider engagement with traditional practitioners and community belief systems; qualitative research (e.g., in-depth interviews or focus groups) is warranted to unpack the specific motivations behind preference for traditional remedies in this population [29]. Addressingthese beliefs through culturally tailored educational interventions may help improve adherence.

Knowledge and attitudes towards antibiotics

The study found that 50.0% of respondents had a good knowledge and attitude score (K-score ≥13), while 23.1% had poor knowledge (K-score ≤10). These findings are comparable to studies conducted in rural Malaysia, which found a substantial proportion of the population with limited antibiotic knowledge, contributing to inappropriate usage and self-medication [30,31].

Our results revealed a notable paradox: nearly 50% of participants had "good" knowledge about antibiotic use, yet 71.2% reported non-adherence. This mirrors findings from a nationwide Malaysian survey, where 56.6% of adults engaged in at least one inappropriate antibiotic practice, most frequently not completing the course despite associations between higher knowledge and fewer misuses [32]. Such discrepancies imply that knowledge alone is not sufficient to ensure correct behavior. Factors such as perceived severity, healthcare access, cultural scripts around self-treatment, or motivational influences may be at play. To unpack these behavioral drivers, future studies should employ qualitative methods (e.g., in-depth interviews or focus groups) that capture the rich, contextual factors that shape antibiotic use decisions.

When analyzed by demographic factors, knowledge scores varied significantly by literacy status (p=0.005) and occupation (p=0.011). Literate individuals demonstrated significantly higher knowledge levels than those unable to read and write, reaffirming the role of education in promoting responsible antibiotic use. Similarly, housewives and self-employed individuals exhibited better knowledge scores than private-sector employees, possibly due to greater exposure to community-based health programs [33].

While gender and monthly household income did not significantly influence antibiotic knowledge (p>0.05), a trend was observed where individuals with higher incomes and higher educational backgrounds had better knowledge scores. These findings are consistent with global studies indicating that socioeconomic status plays a role in health literacy and medication adherence [23,34-36].

Implications for public health and future interventions

The findings underscore the need for targeted health education initiatives focusing on antibiotic adherence, particularly among younger individuals and males. Community-based awareness programs, possibly integrated with traditional healing practices, could enhance acceptance and understanding of antibiotics.

Moreover, pharmacists and healthcare providers should emphasize the importance of completing antibiotic courses during patient consultations, addressing specific concerns such as adverse effects and dosage confusion. Digital health interventions, such as reminder apps or text message alerts, may also help improve adherence rates.

Limitations

Report bias, clinical outcomes and study design

This study has several limitations. First, adherence and related practices were measured through self-report, which is prone to recall and social desirability biases and may have led to overestimation of adherence rates. Second, the study did not capture clinical outcomes such as treatment failure, recurrence of infection, or AMR rates; hence, the implications of non-adherence on health outcomes and public health remain inferential. Third, the cross-sectional design precludes causal inference. While associations between knowledge, attitudes, and non-adherence were identified, temporal or causal relationships cannot be established. Finally, findings are context-specific, based on adults meeting the inclusion criteria within a defined 2-month collection period, which may limit wider generalizability.

Potential sources of bias

As the study recruited only participants with recent oral antibiotic use who met the inclusion criteria, individuals without recent antibiotic exposure were excluded. This could introduce selection bias, as knowledge, attitudes, and adherence behaviors may differ between antibiotic users and non-users. Therefore, our findings should be interpreted as representative of current or recent antibiotic users, rather than the general adult population. Future studies with broader inclusion criteria are warranted to capture the perspectives of non-users.

Period of study

The study was conducted over a 2-month period (September–October 2024), which may limit temporal generalizability. However, as all individuals who fulfilled the pre-specified inclusion criteria during this period were recruited, the final sample size was sufficient to meet the study's primary aim of descriptive precision. Nevertheless, extending the recruitment window in future studies may help capture a broader range of participant characteristics and account for potential seasonal or temporal variations in antibiotic use and adherence.

Logistic regression analysis

Odds ratios for household income and occupation could not be estimated because of sparse and unbalanced multi-category distributions, including zero cells in some groups. Under these conditions logistic regression produces unstable or non-estimable coefficients. Although Fisher's exact test can be used for 2×2 tables, it is not appropriate for multi-category variables, as it provides only a p-value for association without a meaningful single OR. For this reason, household income and occupation were presented descriptively rather than included in regression analysis.

Another limitation is that we were unable to perform multivariable logistic regression adjusting for potential confounders such as age, gender, and income. With only 52 participants and 15 adherent cases, the events-per-variable threshold for stable multivariable analysis was not met, and several categorical predictors had sparse or zero counts, leading to non-estimable coefficients. As such, only simple logistic regression was performed, and results should be considered exploratory. Future studies with larger samples are required to identify independent predictors of non-adherence

CONCLUSION

The findings revealed a significant proportion of non-adherence, influenced by factors such as age, gender, knowledge, and attitudes towards antibiotic use. Several reasons for non-adherence were identified, including a lack of awareness about antibiotic consequences, difficulties in following prescribed regimens, and concerns about adverse effects. The study also highlighted variations in knowledge and attitudes based on demographic factors such as education, literacy, income, and occupation. These insights emphasize the need for targeted educational interventions and community engagement programs to improve antibiotic adherence and promote rational antibiotic use among the indigenous population. The results align with prior research conducted in similar settings, reinforcing the need for tailored health interventions. Future research should explore culturally tailored strategies to address the unique challenges faced by indigenous communities in medication adherence and exploring behavioral interventions and community-based strategies to promote responsible antibiotic use in indigenous populations.

ETHICAL CONSIDERATION

The principles of the Declaration of Helsinki, revised in 2013 were upheld during this study. The ethical approval for this research was obtained by the institutional joint research ethics committee of the University (JREC/July 2024/373) and Jabatan Kemajuan Orang Asli, Kementerian Kemajuan Desa dan Willayah, JAKOA.PP.R.004 JLD 8 (18).

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to ethical considerations and the confidentiality agreement with Jabatan Kemajuan Orang Asli (JAKOA), access to the data is restricted and may require approval from the relevant authorities.

AUTHORSHIP STATEMENT

All authors contributed equally in the production of this manuscript.

AUTHOR'S CONTRIBUTIONS

Conceptualization: Yen Ping Ng, Darren Kar Wing Lai. Data curation: Yen Ping Ng, Darren Kar Wing Lai. Formal analysis: Yen Ping Ng, Boon Seng Tan. Investigation: Yen Ping Ng, Shu Ying Looi, Jin Yi Choo, Darren Kar Wing Lai. Methodology: Yen Ping Ng, Darren Kar Wing Lai. Supervision: Yen Ping Ng. Project Administration: Yen Ping Ng, Shu Ying Looi, Jin Yi Choo, Darren Kar Wing Lai, Kwok Wen Ng. Validation: Cheng Hoon Yap, Boon Seng Tan, Jing Ng. Writing- Original draft: Yen Ping Ng. Writing- Review and editing: Jing Ng, Kwok Wen Ng, Cheng Hoon Yap

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CONFLICTS OF INTEREST STATEMENT

The authors have no conflict of interest to disclose.

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