Antibiotic resistance among the Lahu hill tribe people in northern Thailand: a cross-sectional study

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Research

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Abstract

Background

Antibiotic resistance is often reported and is of major concern as a public health problem. The hill tribe people in Thailand are considered populations vulnerable to antibiotic resistance due to their poor economic and educational status. The study aimed to estimate the prevalence of, the factors associated with, and the major species of bacteria involved in antibiotic drug resistance among the Lahu hill tribe people in northern Thailand.

Methods

A cross-sectional study was conducted to gather information from participants between March and September 2019. A validated questionnaire was used for data collection. Participants who presented an illness related to infectious diseases were eligible to participate in the study and were asked to obtain specific specimens. Antibiotic susceptibility was tested by the Kirbey-Bauer disk diffusion test. Chi-square tests and logistic regression were used to detect the associations between variables at the significance level of $\alpha = 0.05$.

Results

A total of 240 participants were recruited into the study; 70.4% were females, 25.4% were aged 30–40 years. More than half worked in the agricultural sector (55.4%) and had an education level of less than primary school (45.8%). The majority had urinary tract infections (67.9%) with two major pathogenic species of the infection: *Escherichia coli* (12.8%) and *Enterobacter cloacae* (8.0%). The prevalence of antibiotic resistance was 16.0%. *Escherichia coli and Klebsiella pneumoniae* species were found to have multidrug resistance that was greater than that of other species, while ampicillin was found to have the greatest drug resistance. In the multivariate model, it was found that those who had poor knowledge of antibiotic use had a 2.56-fold greater chance (95% CI = 1.09–5.32) of having antibiotic resistance than did those who had good knowledge of antibiotic use, and those who had poor antibiotic use behaviors had a 1.79-fold greater chance (95% CI = 1.06–4.80) of having antibiotic resistance than did those who had good antibiotic use behaviors.

Conclusion

Effective public health interventions are urgently needed to reduce antibiotic drug resistance among the Lahu people by improving their knowledge and skills regarding the proper use of antibiotics and eventually minimizing antibiotic resistance.

Background

Antibiotic resistance is a recently emerging global threat to human health [1]. Most antibiotic drugs become ineffective for a particular treatment and increase all medical expenses, from longer stays at a health institute to the use of drugs. As a result, the morbidity and mortality rates attributable to this problem have been rising every year [1, 2]. The World Health Organization (WHO) has also reported that some kinds of human diseases have become unresponsive to treatment, such as pneumonia, tuberculosis, gonorrhea, and salmonella. Antibiotic resistance is also caused by misuse and by an accelerated food production process, particularly that of animal products [1]. People in developing countries are more vulnerable to antibiotic resistance than are those living in developed countries due to poor education and poor access to standard medical services [3]. To date, the problem of antibiotic resistance does not persist only in health institutes, but it is also present in people living in a community, especially in a community located far away from the city and among people with a poor educational level and economic status [4]. The World Health Organization reported that the major causes of antibiotic resistance were accelerated by the misuse and overuse of antibiotics, as well as poor infection prevention and control [1].

The Ministry of Public Health in Thailand [5] reported that at least 88,000 antibiotic resistance cases were reported each year, and 40.0% died. Moreover, more than 40,000 million Thai baht, or 0.6% of the GDP, were spent to address this problem. In 2016, Thailand launched a 5-year national strategic plan to reduce antimicrobial resistance (NSP-AMR:2017–2021) aimed at reducing antibiotic misuse by enhancing public awareness and reducing antibiotic resistance in the Thai population [6, 7]. Commonly, Thai people are able to access antibiotics without prescriptions, such as through buying drugs from private drugstores or pharmacies, including from a small grocery in a community [8]. Moreover, self-medication is a common health behavior in Thai individuals [9]. Pumtong et al. [10] reported that a lack of knowledge and misunderstandings about antibiotics were important factors in the misuse of antibiotics among Thai people, particularly those living in remote areas.

Chiang Rai Province is located in northern Thailand and has long borders with neighboring countries such as Myanmar and Laos PDR. Many groups of hill tribe people live along the borders. Most hill tribe people have migrated from South China over many decades to settle in the remote and mountainous areas in northern Thailand. The hill tribe in Thailand has six main groups: Akah, Lahu, Homh, Yao, Karen, and Lisu [11]. The Lahu is the second-largest group among the hill tribe people in Thailand [12]; they usually live in the highlands [13]. The Lahu people have their own culture, language and lifestyle [13, 14] and have very low literacy due to limited access to Thailand's educational system. Given their low family economic status, the Lahu people do not have many choices for access to medicines when they experience health problems. Buying drugs, especially antibiotics, from a small grocery in a community is the most familiar and available option for them.

Material And Methods

The aim

This study aimed to estimate the prevalence of and factors associated with major species of bacteria resisting antibiotics in the Lahu hill tribe people in northern Thailand.

Study design

A cross-sectional study was applied to gather the information from the participants.

Study setting

The study settings were three Lahu villages from Wiang Pa Pao District, Chiang Rai Province, Thailand. The study settings are located 126 kilometers (km) away from the center of Chiang Rai Province.

Study population

Lahu people aged 15 years and older who lived in the three selected villages and who presented signs or symptoms of an infection within the previous 12 months comprised the study population.

Eligible criteria

Lahu hill tribe people who had signs and symptoms of infections of the respiratory tract, gastrointestinal tract, or urinary tract within the previous 12 months met the inclusion criteria of the study. Those who could not provide essential information regarding the study protocol were excluded from the study. All participants were asked to obtain a suitable specimen (stool, sputum, urine) according to their illness presentation.

Study sample

Epi-Info™ was used to calculate the sample size of the study; $Z_{0.05} = 1.96$, $P = 0.77$ [15], $Q = 0.23$, $e = 0.05$, $1\text{-}\beta = 0.8$, and 207 participants were needed. With the addition of 20.0% of the sample size for any errors in the process of the study, 240 participants were required for the analysis.

Materials and measurements

A questionnaire was developed from the literature review regarding the behaviors of antibiotic use and laboratory testing on antibiotic resistance. The questionnaire consisted of seven parts. In part one, 6 questions were used to collect sociodemographic characteristics, such as sex, age, highest education level, and marital status. In part two, 9 questions were used to collect data on the experiences of antibiotic use within the past 12 months, such as the source of antibiotic assessment, frequency, reason for taking antibiotics, and source of antibiotic knowledge. In part three, 10 questions were used to collect knowledge on infectious diseases. Those who scored 60.0% and over were defined as having good knowledge. Those who had scores of 59.0% and lower were defined as having poor knowledge. In part four, 10 questions were used to assess knowledge of antibiotic use in daily life. Those who scored 60.0% and over were defined as having good knowledge. Those who had scores of 59.0% and lower were defined as having poor knowledge. In part five, 10 questions were used to detect attitudes on antibiotic use. Those who scored 60.0% and over were defined as having a good attitude. Those who had scores of 59.0% and lower were defined as having a poor attitude. In part six, 25 questions were used to collect information on antibiotic use behaviors. The last part (part 7) was used for collecting village information, including basic health information from the heath center in the community.

The quality of the questionnaire was validated by three steps. First, the content was validated by the item-objective congruence (IOC) method by five relevant experts: two medical doctors, an epidemiologist, a pharmacist, and a community nurse. The experts provided comments on the questions and a score. Questions that were scored less than 0.5 were excluded from the questionnaire set, those that were scored 0.5–0.7 were revised according to the comments, and questions that were scored greater than 0.7 were included in the questionnaire set. In the second step, a pilot was executed to detect the reliability and feasibility of the questionnaire among 15 samples who had characteristics similar to those of the study samples in Mae Suai District (district near Wiang Pa Pao District), Chiang Rai Province, Thailand. The overall reliability of parts three, four, and five were found to be 0.77, 0.78, and 0.78, respectively. In the last step, the questionnaire was revised and piloted again for 15 additional participants who had characteristics similar to those of the study samples.

All participants were asked to collect suitable specimens according to their illness. Each individual was asked for one specimen. All specimens were transferred to the Mengrai Laboratory Center, Chiang Rai, Thailand, on the same day. The Kirbey-Bauer disk diffusion test, based on the Clinical and Laboratory Standards Institute (CLSI) Guidelines, was used to detect antibiotic resistance.

Study procedure

Permission to access villages was granted by the district public health officer. Village headmen were contacted three days before having a small meeting. All information regarding the study was provided to the village headmen and village health volunteers. Before the date of data collection, all village members who met the eligible criteria were informed about the study protocols and invited to participate in the study. At the date of data collection, all participants were asked to obtain an informed consent form before data collection. For participants younger than 18 years old, informed consent forms were also obtained from their parents before data collection. The questionnaire was completed with the help of 15 village health volunteers (five persons in each village) who were fluent both the Thai and Lahu languages. They were trained for six hours on the content of the study, including a questionnaire, to clarify their understanding of and familiarize them with the full content of the questionnaire. The interviews lasted 25 minutes in each. Specimens were collected by licensed medical technicians from a hospital.

Laboratory work

All 240 participants were asked to collect specimens; 61 participants had sputum collected, 173 participants had urine collected, and 6 participants had stool collected. Specimens were kept and transferred for laboratory work at Chiang Rai city on the same day. Different specimens were placed on a specific plate before incubation at 35°C for 24 hrs. Afterwards, the colonies were observed for the detection of pathogenic typing. Sensitivity to antibiotics was detected by the Kirbey-Bauer disc diffusion test to determine antibiotic resistance.

Statistical analysis

Data were double-entered into Excel spreadsheets and were checked for any errors before being transferred into SPSS version 24 (SPSS, Chicago, IL) for further analysis. Descriptive statistics were used to describe the participants' characteristics in both categorical and continuous data. Chi-square tests and logistic regressions were used to identify the factors associated with antibiotic resistance among the participants at the significance level of $\alpha = 0.05$. In the logistic regression steps, the Hosmer-Lemeshow chi-square test was used to assess the overall model prediction before and after the variables were included into the model. The fitness of the model was determined by the Cox-Snell R^2 and Nagelkerke R^2 before the results were interpreted.

Results

Three villages were selected for the study: 69 households in the first village (344 people), 153 households (746 people) in the second village, and 177 households (775 people) in the last village. The locations are approximately 42 km from Wiang Pa Pao District, Chiang Rai Province, Thailand. A health center is located 8 km from the first village and requires 20 minutes of driving by motorcycle, 11 km from the second village and 45 minutes of driving by motorcycle, and 18 km from the third village and 60 minutes of driving by motorcycle (Fig. 1). The distance from the health center to a district hospital is 28 km, requiring 30 minutes to travel by car. Moreover, an hour is required to travel from the district hospital to the provincial hospital (tertiary hospital) by car. There are approximately 6–8 members in each household in a Lahu family. The majority of the Lahu people were Buddhist (83.0%), and traditional crops such as corn, beans, and rice were planted, with an annual income of 60,000-120,000 baht per family. They did not have livestock and did not use antibiotics in animals.

The health center is responsible for 14 hill tribe villages, encompassing a total population of 9,632 people (4,815 males, 4,817 females). There are 9 public health staff members: two nurses, two public health professionals, and 5 other health professionals. Three different antibiotics were available at the health center: amoxicillin, roxithromycin, and dicloxacillin. The top five infectious diseases reported from the health center between January and December 2019 were 1) diarrhea, 2) pyrexia, 3) dengue fever, 4) conjunctivitis, and 5) hand, foot and mouth disease. The top three infectious diseases among the people living in the selected villages were 1) diarrhea, 2) common cold, and 3) cystitis.

According to the results from the questionnaire, the majority of the participants were females (70.4%), aged 30–40 years (25.4%), and married (82.9%). More than half worked in the agricultural sector (55.4%) and had poor education, which was less than primary school (45.8%) (Table 1).

Table 1
General characteristic of participants.

Characteristic	n	%
Total	240	100.0
Sex	71	29.6
Male	169	70.4
Female		
Age (years)	10	4.2
10–20	40	16.7
21–30	61	25.4
30–40	59	24.6
41–50	22	9.2
51–60	35	14.6
61–70	13	5.4
> 70		
Mean = 43.5, SD = 15.3, Min = 17, Max = 98		
Education	110	45.8
No education	110	45.8
Primary school	14	5.8
High school	6	2.5
Vocational certificate and higher		
Occupation	23	9.6
Unemployed	133	55.4
Agriculturalist worker	67	29.9
Employee	17	7.1
Commercial		
Married status	20	8.3
Single	199	82.9
Married	21	8.8
Ever married		
Underlying disease*	193	80.4
No	47	19.6
Yes *	*23*	
Hypertension (n = 47)	*13*	
Gastritis(n = 47)	*12*	
Diabetes mellitus(n = 47)	*4*	
Chronic renal failure(n = 47)	*3*	
Asthma(n = 47)	*2*	
Coronary heart disease(n = 47)		
* Some participants had more than one list of a disease.		

Urinary tract infectious diseases accounted for the largest group of infections in the past 12 months (67.9%), with 163 cases of urinary tract infection. A community health center (28.8%) was the favored location of healthcare services for the participants, followed by a district hospital (24.6%) and a drugstore or village grocery (21.7%). The top three sources of antibiotic use were district hospitals (51.7%), drugstores or village groceries (27.9%), and private medical clinics (22.5%). Most of these sources showed good knowledge of infectious diseases (82.9%), while knowledge of and attitudes toward antibiotics and practices were poor (66.2%, 51.2%, and 64.6%, respectively). More than half of the participants received information about infectious diseases and antibiotics from health care professionals (Table 2).

Table 2
History of illness and access medical services.

Factors	n	%
Total	240	100.0
History of illness 12 months prior*	163	67.9
Urinary tract infection (n = 240)	135	56.3
Respiratory tract infection (n = 240)	81	33.8
Gastrointestinal tract infection (n = 240)		
First priority on access a medical care while having health problem	69	28.8
Community health center	59	24.6
District hospital	52	21.7
Drugstore	39	16.3
Village grocery	13	5.4
Private clinic	4	1.7
Using leftover drugs	3	1.3
Using drugs from family member		
Frequency of antibiotic use 12 months prior (times)	153	63.8
1	58	24.2
2	29	12.1
≥3		
Source of getting antibiotics*	124	51.7
District hospital (n = 240)	67	27.9
Drugstore (n = 240)	54	22.5
Private medical clinic (n = 240)	38	15.8
Private nurse clinic (n = 240)	16	6.7
Health center (n = 240)	10	4.2
Tertiary hospital (n = 240)	2	0.8
Family member or neighborhood (n = 240)		
Reasons for taking antibiotics*	167	69.6
Wish to get better from an illness (n = 240)	151	62.9
Doctor or health care professional prescribed (n = 240)	77	32.1
Protect severity of illness (n = 240)		
Ever receiving information on infectious diseases	64	26.7
No	176	73.3
Yes		
Source of information about infectious disease *	129	53.8
Health care professional (n = 240)	74	30.8
Village health volunteer (n = 240)	70	29.2
Community leader (n = 240)	66	25.5
Television, radio (n = 240)		
Received information on antibiotics	62	25.8
No	178	74.2
Yes		

Factors	n	%
Source of information about antibiotics*	150	62.5
Health care professional (n = 240)	83	34.6
Village health volunteer (n = 240)	76	31.7
Community leader announcement (n = 240)	62	25.8
Television or radio broadcasting (n = 240)		
Knowledge on infectious diseases	41	17.1
Poor	199	82.9
Good		
Knowledge regarding antibiotic use	159	66.2
Poor	81	33.8
Good		
Attitudes regarding antibiotic use	123	51.2
Poor	117	48.8
Good		
Behavior regarding antibiotic use	155	64.6
Poor	85	35.4
Good		

According the comparisons between those who had drug resistance and those who did not, only knowledge regarding antibiotic use was found to be statistically significant (p-value = 0.034). However, two other variables (age and antibiotic use behaviors) were found to have marginally significant differences between groups (Table 3).

Table 3
Factors correlation with antibiotic resistance.

Factors	Resistance		No resistance		χ²	p-value
	n	%	n	%		
Total	**30**	**12.5**	**210**	**87.5**	**N/A**	**N/A**
Age (years)	20	66.7	172	81.9	3.81	0.051
< 60	10	33.3	38	18.1		
≥ 60 years						
Education	18	60.0	92	43.8	2.77	0.096
No	12	40.0	118	56.2		
Yes						
Receiving antibiotic information	8	26.7	54	25.7	0.01	0.911
No	22	73.3	156	74.3		
Yes						
Knowledge on infectious diseases	6	20.0	35	16.7	0.20	0.650
Poor	24	80.0	175	83.3		
Good						
Knowledge regarding antibiotic use	25	83.3	134	63.8	4.47	0.034*
Poor	5	16.7	76	36.2		
Good						
Attitudes regarding antibiotic use	19	63.3	104	49.5	2.00	0.157
Poor	11	36.7	106	50.5		
Good						
Behaviors on antibiotic use	24	80.0	131	62.4	3.56	0.059
Poor	6	20.0	79	37.6		
Good						
Frequency of antibiotic use 12 months prior (time)	22	73.3	131	62.4	1.36	0.243
1	8	26.7	79	37.6		
≥ 2						
* Significant level at α = 0.05						

Of 240 specimens (participants), 187 samples were found to contain bacterial species, including normal flora. Fifty-five specimens were found to have more than 3 bacterial species, and only 30 samples were found to have drug resistance. The top-five bacterial species were detected in the specimens: *Escherichia coli* (12.8%*), Enterobacter cloacae* (8.0%), *Klebsiella pneumoniae* (4.3%), *Enterococcus faecalis* (4.3%), and *Staphylococcus coagulase negative* (4.3%). The prevalence of antibiotic resistance was 16.0%. *Klebsiella pneumoniae* resisted ampicillin, cefazolin, cefoxitin, ciprofloxacin, levofloxacin and trimethoprim-sulfamethoxazole (TMP-SMX), while *Escherichia coli* demonstrated resistance to ampicillin, amoxicillin-clavulanate, gentamycin, ciprofloxacin, levofloxacin and TMP-SMX. Ampicillin was found to have the highest resistance rate among the pathogenic bacteria, followed by cefoxitin, cefazolin, amoxicillin-clavulanate, and TMP-SMX (Table 4).

Table 4
Types of bacterial infection and antibiotic resistance (n = 30).

Antibiotic **Bacterial species**	**Amount** **of infection**	**Ampicillin**	**TMP-SMX**	**Penicillin**	**Amoxicillin + Clavulanic acid**	**Cefoxitin**	**Cefazolin**	**Doxy cycline**	**Gentamycin**	**Cipro foxacin**	**Levofloxacin**
Escherichia coli	7	6	6		1				2	1	1
Enterobacter cloacae	3	4			4	4	1				
Klebsiella pneumoniae	7	7	1			1	1			1	1
Staphylococcus coagulase negative	3			3				1			
Salmonella spp.	1	1	1	1						1	1
Citrobactor Freundii	1	2			1	1	1				
Enterococcus faecalis	3							3	1		
Staphylococcus aureus	2			2				1			
Klebsiella aerogenes	1	1			1	1	1				
Proteus mirabilis	1	1	1	1					1		
Streptococus agalactiae	1	1									
Citrobacter koseri	1	1									
Klebsiella oxytoca	1	1									
Total		25	9	7	7	7	4	4	4	3	3
* 1 person could infect more than one type bacterial species and antibiotics											

Two variables were found to be associated with antibiotic drug resistance among the Lahu people: knowledge and behaviors regarding antibiotic drug resistance. In the multivariate model, these two variables remained associated with antibiotic resistance, including knowledge and behaviors regarding antibiotic resistance. Those who had poor knowledge reading antibiotic use had a 2.56-fold greater chance (95% CI = 1.09–5.32) of having antibiotic resistance than did those who had good knowledge of antibiotic use. Those who had poor antibiotic use behaviors had a 1.79-fold greater chance (95% CI = 1.06–4.80) of having antibiotic resistance than did those who had good antibiotic use behaviors (Table 5).

Table 5
Factors associated with antibiotic resistance in univariate and multivariate analyses.

Factors	Drug-resistance (n = 30)		No drug-resistance (n = 210)		OR	95% CI	p-value	OR_{adj}	95% CI	p-value
	n	%	n	%						
Total	30	12.5	210	87.5	N/A	N/A	N/A	N/A	N/A	
Age (years)										
< 60	20	66.6	172	81.9	1.00	0.98–5.22	0.056			
≥ 60	10	33.3	38	18.1	2.26					
Education										
No	18	60.0	92	43.8	1.92	0.88–4.19	0.100			
Yes	12	40.0	118	56.2	1.00					
Received antibiotic information										
No	8	26.7	54	25.7	1.05	0.44–2.49	0.911			
Yes	22	73.3	156	74.3	1.00					
Knowledge on infectious diseases										
Poor	6	20.0	35	16.7	1.25	0.48–3.28	0.651			
Good	24	80.0	175	83.3	1.00					
Knowledge regarding antibiotic use										
Poor	25	83.3	134	63.81	2.8	1.04–7.71	0.041*	2.56	1.09–5.32	0.048*
Good	5	16.7	76	36.2	1.00			1.00		
Attitudes regarding antibiotic use										
Poor	19	63.3	104	49.5	1.76	0.80–3.88	0.161			
Good	11	36.7	106	50.5	1.00					
Behavior regarding antibiotic use										
Poor	24	80.0	131	62.4	2.41	1.02–6.16	0.046*	1.79	1.06–4.80	0.041*
Good	6	20.0	79	37.6	1.00			1.00		
Frequency of antibiotic use last 12 month (time)										
1	22	73.3	131	62.4	1.00	0.25–1.41	0.24			
≥ 2	8	26.7	79	37.6	0.60					
* Significant level at α = 0.05										

Discussion

The Lahu villages were located far away from a health center, while the Lahu people lived with low education and poor family economic status. They were facing several infectious diseases that required antibiotic treatment. A few lists of antibiotic drugs were available in community health centers where trained health professionals were working. Almost one-third of the Lahu people were practicing self-prescription by buying drugs from private pharmacies or village groceries. Urinary tract infections accounted for the greatest proportion of infectious diseases among the Lahu people. Two-thirds had poor knowledge and poor behaviors regarding antibiotic drug use, and more than half had poor attitudes towards antibiotic use. The prevalence of antibiotic resistance was 16.0%. *Klebsiella pneumoniae* showed resistance to ampicillin, cefazolin, cefoxitin, ciprofloxacin, levofloxacin and TMP-SMX, while *Escherichia coli* demonstrated resistance to ampicillin, amoxicillin-clavulanate, gentamycin, ciprofloxacin, levofloxacin and TMP-SMX. Ampicillin was found to have the highest resistance rate among the pathogenic bacteria, followed by cefoxitin, cefazolin, amoxicillin-clavulanate, and TMP-SMX. Poor knowledge and behaviors related to using antibiotic drugs were associated with antibiotic drug resistance among the Lahu people.

In our study, the prevalence of antibiotic resistance was 16.0%, and bacteria from urinary tract infections were the major cause of antibiotic resistance. A report from the Ministry of Public Health in Thailand said that the five most common bacterial species involved in antibiotic resistance were *Escherichia coli, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus* (MRSA) [5]. A community study in Tanzania [16] found that *Escherichia coli* strains were mostly present in infections and antibiotic resistance. In addition, a hospital-based study in Lebanon [17] reported that the frequency of antibiotic resistance was 53.7% (39.9% were multidrug-resistant), and different kinds of pathogenic bacteria that were resistant to different kinds of antibiotics, such as *Escherichia coli* strains, were mostly susceptible to carbapenems and tigecycline, while *Klebsiella* species were mostly susceptible to amikacin and carbapenems. Moreover, a study in Hungary showed that the frequency of prescriptions from clinicians was related to the percentage of antibiotic resistance [18]. In addition, a prospective cohort study demonstrated that several bacterial pathogenic species were resistant to different kinds of antibiotics in the United Kingdom; 43.0% of patients with E. coli were resistant to at least one antibiotic, with the highest resistance to amoxicillin [19].

A study in Kenya [20] showed that several bacteria causing diarrhea were resistant to different kinds of antibiotics, and the misuse and improper dosing of drugs were the major factors contributing to antibiotic resistance. Moreover, a study in the rural hill communities of northeastern India [21] found that several antibiotics had high resistance rates, such as ampicillin (92.0%), ceftazidime (90.0%), and tetracycline (36.0%). The study also reported that the education of participants was strongly associated with antibiotic resistance.

A study on the epidemiology of antibiotic resistance in some selected communities in Thailand found that pathogeneses from upper respiratory tract and digestive tract infections were most common in antibiotic drug resistance [22]. A systemic review of antimicrobial resistance among pathogenic bacteria in Southeast Asia reported pathogenic species resistance to penicillin among the pathogeneses causing respiratory and digestive tract infections [23] which are findings similar to those in our study.

In our findings, we also found that knowledge and misuse antibiotic behaviors were associated with antibiotic resistance among the Lahu hill tribe people. This was supported by a study by Castro-Sánchez et al. [24], which reported that the major significant factor for antibiotic resistance was the misuse of antibiotics in both humans and animals. Moreover, a 5-year analysis on antibiotic resistance was reported even in high-standard hospitals, with several antibiotic resistances found particularly among patients who had a history of misusing antibiotics prior to being admitted to the hospital, especially those who had poor knowledge of antibiotic use [25]. Additionally, a study in Thailand reported that people who had higher educational levels and those with greater wealth were associated with having antibiotic drug resistance [8].

The results from this study confirm that the problem of antibiotic resistance extends into the community, even in remote areas. It reflects a need for the design of an effective strategy at the nationwide level to address the problem, particularly among those who have poor economic and educational status. Moreover, improving access to health centers to obtain antibiotics while requiring their careful and proper use for the treatment of people living in remote areas is critical in Thailand.

A few limitations of the study must be noted, namely, communication with the participants and transportation to the targeted villages. However, we asked the village health volunteers who were fluent both the Thai and Lahu languages to help with communication during the completion of the questionnaire and the collection of specimens.

Conclusion

The Lahu people in Thailand are facing major challenges in their access to standard medical care due to the location of their village, which is far from the city and health center. They are also improperly using antibiotics, which had led them to have several bacterial infections that have eventually become resistant to antibiotics. Poor education and poor behaviors regarding the use of antibiotics are major factors influencing antibiotic resistance among the Lahu people. Public health interventions for improving knowledge and practices regarding the use of antibiotics should be urgently implemented. Moreover, a regulation to prevent untrained health professionals from selling antibiotics, particularly in small groceries in villages, should be developed and implemented to reduce the improper use of antibiotics and minimize antibiotic resistance among the Lahu people in Thailand.

Declarations

Availability of data and materials

The raw data available upon reasonable request from the corresponding author.

Consent for publication

Not applicable.

Competing interest

The authors declare that they have no competing interests.

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Author Contributions

SI developed research tools, collected data, interpreted the analysis, drafted and approved the manuscript. TA and PK, collected data, collected blood specimen, analyzed data, approved the manuscript.

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Ethical consideration

The study concept and protocols were approved by the Chiang Rai Provincial Health Office Ethics Committee on Human Research (No. CRPPHO 8/2562), and all participants were asked to obtain informed consent before interviews.

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Figures

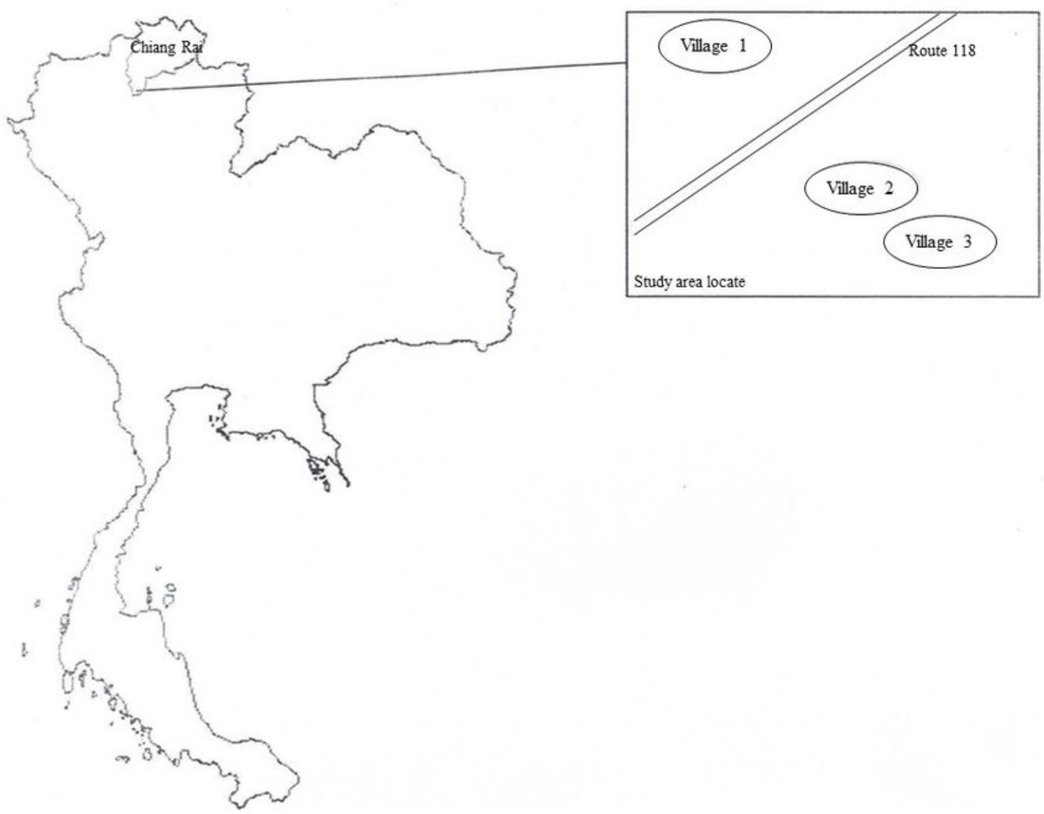

Figure 1

Three Lahu villages under the study setting, located in Wiang Pa Pao District, Chiang Rai province, Thailand. The study settings are located 126 km away from the center of Chiang Rai Province and 42 km from Wiang Pa Pao District. A health center is located 8 km from the first village and, 11 km from the second village, and 18 km from the third village.