

Prevalence and Factors Associated with Type 2 Diabetes Mellitus among Middle-Aged and Elderly Lisu Hill tribe People, Northern Thailand: A Cross-sectional Study

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ABSTRACT

Introduction: Type 2 diabetes mellitus (T2DM) is one of the most significant noncommunicable diseases (NCDs), and it is considered a major health threat for humans globally. Hill tribe people live in poor economic conditions, have low educational attainment and are vulnerable to T2DM, particularly the Lisu people, who have unique lifestyles and cooking styles. **Objective:** This study aimed to estimate the prevalence of and determine the factors associated with T2DM among the Lisu people aged 30 years and older in Chiang Rai Province, Thailand. **Methods:** A cross-sectional study was applied to collect information from Lisu participants aged 30 years and older who lived in five randomly selected Lisu villages in Chiang Rai Province. A validated questionnaire was used to collect information, and 5 mL blood specimens were drawn for laboratory testing. Data were collected in May-November 2018. Logistic regression was used to detect associations between variables at a significance level of $\alpha=0.05$. **Results:** A total of 282 Lisu people were recruited into the study; 61.3% were females, 69.5% were aged 40-69 years, and 72.7% were Buddhist. The majority were illiterate (74.1%), agriculturalists (57.4%), and had a family income of less than 50,000 baht per year (70.9%). The total prevalence of T2DM was 18.1%; 8.9% had a medical history of T2DM. Among those who had no medical history of T2DM, 10.1% were detected as new T2DM cases. After adjustments were made for age, sex, income, and marital status, only waistline measurements were found to be associated with T2DM among the Lisu people in Thailand. Those who had been identified as at risk for metabolic complications (≥ 90 cm in males and ≥ 80 cm in females) had a 2.20 time higher likelihood (95%CI=1.16-4.16) of developing T2DM than did those who were normal. **Conclusion:** Effective public health screening for T2DM should be urgently implemented in the Lisu population in Thailand. Moreover, a proper public health intervention for both men and women who have waistline problems should be initiated.

Keywords: Prevalence, associated factors, type 2 DM, Lisu, hill tribe

Introduction

Non-communicable diseases (NCDs) are clearly recognized as the main human health threat in the 21st century, particularly among people with modern lifestyles [1]. These diseases have also emerged as one of the most significant health problems in developing countries [2]. NCDs can lead to many problems, especially with respect to health system expenditures, concerning prevention among those

vulnerable to NCDs and care for those who have already been diagnosed with NCDs. Several studies have demonstrated that not only wealthy persons or those living in modernized areas but also those living in poor economic conditions are at risk of developing NCDs. The World Health Organization (WHO) has reported that more than 41 million people are killed by NCDs each year, and 85.0% of these deaths occurred in low- and middle-income countries. Among these

deaths, 37.0% occurred among those aged 30-69 years, which constitutes premature death [3].

In 2018, approximately 14 million people lived with at least one NCD among the Thai population, and the more than 300,000 deaths caused by NCDs accounted for 73.0% of the total number of deaths in Thailand [4]. The Department of Disease Control in the Ministry of Public Health in Thailand reported that in 2014, Thais lost a total of 14.7 million disability-adjusted life years (DALYs) due to NCDs [5]. Thailand uses more than 2,520 million baht per year of NCD prevention and control, including treatment and care for those who are already diagnosed [6]. There are several risk factors for NCD development, such as smoking [7], alcohol use [8], low engagement in exercise [9], and a high-salt diet [10]. NCDs are not limited to individuals from high economic backgrounds; rather, they are also reported among poor people, such as the hill tribe populations in Thailand [11].

Type 2 diabetes mellitus (T2DM) has been recognized as the leading threat among NCDs in the Thai population [12]. A five-year (2010-2014) study on the morbidity and mortality related to T2DM among the Thai population clearly showed that the number of deaths attributed to T2DM and related conditions increased significantly [13]. Both those who live in urban cities and rural villages are at risk of T2DM in Thailand [14].

The hill tribe people are a group of individuals who migrated from South China over two centuries into Thailand and who are currently living below Thailand's poverty line of 2,667 baht/person/month [15]. There are six main groups: the Akha, Lahu, Hmong, Yao, Karen, and Lisu. The Lisu is known as the smallest group among the hill tribes in Thailand [16]. Since they have a culture and lifestyle similar to those of the Chinese population, they consume many animal oils for cooking. Meanwhile, in their adaptation to Thai culture, they consume a large amount of salt and monosodium glutamate in their everyday diet. However, a large proportion of the Lisu still have low levels of education and live in poor economic conditions [17]. Given these multiple risk conditions for the Lisu in Thailand, the study aimed to estimate the prevalence of and determine factors associated with T2DM among the Lisu people aged 30 years and older.

Methods

A cross-sectional study design was used to elicit information from the participants. Participants were the Lisu people who lived in Chiang Rai Province. Those aged 30 years and older were eligible for the study. However, people who had been diagnosed with type 1 diabetes, who could not provide essential information regarding the study protocol and who could not identify themselves as the Lisu were excluded from the study. In 2018, there were 35 Lisu villages in Chiang Rai Province. Five (5) villages were

randomly selected as study settings. People who lived in the selected villages and who met the inclusion criteria were invited to participate in the study.

The sample size was calculated by the standard method [18] for a cross-sectional design, with $p=0.23$ [5], $q=0.77$, and $e=0.05$; therefore, 265 participants were required for the analysis.

A validated questionnaire was used to collect data from the participants. The questionnaire was divided into 4 parts. Part one (7 questions) was used to collect the general information of the participants. Part two (16 questions) was used to collect participants' behaviors that were related to T2DM development. Part three (40 questions) was used to collect data on knowledge and attitudes on T2DM prevention and control. Four items were used to collect laboratory results, including lipid profiles and HbA1c.

The questionnaire was tested and improved for validity and reliability before use. Three experts in relevant fields were asked to determine the validity of the questionnaire through the so-called item-objective congruence (IOC) technique. A pilot test was administered to 12 participants with similar characteristics from the Mae Fah Laung district, Chiang Rai province. In the pilot test, the feasibility and the sequence of the questions were evaluated. Moreover, the reliability was tested for the 10 questions on knowledge and for another 10 questions on attitudes regarding the prevention and control for T2DM, with an overall Cronbach's alpha of 0.73.

Several measurements were used in the study. First, stress was assessed with the standard questionnaire used for stress assessment, which was developed by the Department of Mental Health, Thailand. It is composed of five questions, with 4 ranked response options for each item (0-3) [19]. Those scored 0-4 were classified as low stress, 5-9 as moderate stress, and 10 or more as high stress. Second, body mass index (BMI) was classified into three categories: ≤ 18.5 kg/m² was underweight, 18.51-22.99 kg/m² was normal, and ≥ 23 kg/m² was overweight. Third, waistline measurements for males were classified into two categories: <90 cm was normal, and ≥ 90 cm was over the standard cutoff. Fourth, waistline measurements for females were classified into two categories: <80 cm was normal, and ≥ 80 cm was over the standard cutoff. Fifth, total cholesterol was classified into two categories: ≤ 199 mg/dL was normal, and ≥ 200 mg/dL was high. Sixth, triglycerides were classified into two categories: ≤ 149 mg/dL was normal, and ≥ 150 mg/dL was high. Seventh, high-density lipoprotein (HDL) cholesterol for males was classified into two categories: <40 mg/dL was low, and ≥ 40 mg/dL was normal. Eighth, high-density lipoprotein (HDL) cholesterol for females was classified into two categories: <50 mg/dL was low, and ≥ 50 mg/dL was normal. Ninth, low-density lipoprotein (LDL) cholesterol was grouped into two categories: <100 mg/dL was normal, and ≥ 100 mg/dL was high. Tenth,

the waist-to-hip ratio for males was classified into two categories: ≤ 0.90 was normal, and > 0.90 was obese. Eleventh, the waist-to-hip ratio for females was classified into two categories: ≤ 0.85 was normal, and > 0.85 was obese. Finally, glycated hemoglobin, or hemoglobin A1C (HbA1c), was classified into three categories: < 6.0 was normal, 6.0-6.4 indicated prediabetes, and ≥ 6.5 was classified as T2DM.

Permission to access to the villages was granted by the district government office. Villages were randomly selected from the list of Lisu hill tribe villages [20]. Selected village headmen were contacted to provide information regarding the research project. Participants who met the study criteria were contacted five days prior date of collecting data. At the date of data collection, participants were asked to obtain the informed consent form before physical examination, blood specimen collection, and completion of the questionnaire. The entire process of data collection lasted 30 minutes for each participant. Data collection was conducted between May and November 2018. The data from questionnaires were double-entered into an Excel spreadsheet before they were transferred to SPSS version 24 (SPSS, Chicago, IL) for data analysis. Both categorical and continuous data were sufficiently descriptive to present the general characteristics of the participants in terms of percentages, means, and SDs. Logistic regression was used to identify factors associated with T2DM at the significance level $\alpha=0.05$.

Table 1 General characteristics of participants.

Characteristic	n	%
Total	282	100.0
Sex		
Male	109	38.7
Female	173	61.3
Age (years)		
30-39	46	16.3
40-49	61	21.6
50-59	69	24.5
60-69	66	23.4
70-79	33	11.7
≥ 80	7	2.5
Religion		
Buddhism	205	72.7
Other (Christianity and Islam)	77	27.3
Education		
Illiterate	209	74.1
Primary school	36	12.8
Secondary school	36	12.8
High school	1	0.4
Occupation		
Unemployed	70	24.8
Agriculturalist	162	57.4
Other	50	17.7
Family income per year (baht)		
$\leq 50,000$	200	70.9
50,001-100,001	68	24.1
$\geq 100,001$	14	5.0
Debt		
No	220	78.0
Yes	62	22.0
Marital status		
Single	9	3.2
Married	221	78.4
Other	52	18.4
Family member (person)		
0-4	149	52.8
5-8	113	40.1
≥ 9	20	7.1
Living situation		
Alone	13	4.6
With spouse	183	64.9
With child	61	21.6
With relative	25	8.9

Results

Two hundred and eighty-two (282) participants were recruited into the study. The majority were females (61.3%), married (78.4%), aged 40-69 years (69.5%), Buddhist (72.7%), and illiterate (72.7%). The majority of participants worked as agriculturalists (57.4%), followed by unemployed individuals (24.8%), and 70.9% had an income of less than 50,000 baht/family/year (Table 1).

According to a medical history and laboratory results, less than half (46.5%) had been screened for DM within the previous year, and a large proportion reported that they did not know their parents' diabetes status. The majority of participants (both men and women) were overweight (59.6%) and had a larger-than normal waistline (51.1%). A large proportion of participants had noteworthy lipid profiles: 42.6% had a high level of triglycerides, and 67.4% had a high level of LDL cholesterol. Twenty-eight participants (9.9%) had HbA1C levels greater than 6.4% (Table 2).

There were 25 participants (8.9%) who were diagnosed with T2DM before the study began, and nobody could control their blood glucose properly. Among those who did not report a history of T2DM, 10.1% were new T2DM cases based on their HbA1c levels. Therefore, the total T2DM prevalence was 18.1%. Moreover, 56.0% had a low level of knowledge

Table 2 Medical history and laboratory results.

Characteristic	n	%
History of diabetes screening within the previous year		
No	151	53.5
Yes	131	46.5
Father's history of diabetes		
Yes	14	5.0
No	161	57.1
Unknown	107	37.9
Mother's history of diabetes		
Yes	12	4.3
No	167	59.2
Unknown	103	36.5
Body mass index (BMI)		
Normal (< 18.5 - 22.99)	94	33.3
Under standard (≤ 18.5)	50	7.1
Overweight (≥ 23)	168	59.6
Waistline		
Normal (< 90 cm in males, and < 80 cm in females)	138	48.9
Risk of metabolic complication (≥ 90 cm in males and ≥ 80 cm in females)	144	51.1
Total cholesterol (mg/dL)		
Normal (≤ 199)	176	62.4
High (≥ 200)	106	37.6
Triglycerides (mg/dL)		
Normal (≤ 149)	162	57.4
High (≥ 150)	120	42.6
HDL cholesterol		
Low (< 40 mg/dL for males, and < 50 mg/dL for females)	154	54.6
Normal (≥ 40 mg/dL for males, and ≥ 50 mg/dL for females)	128	45.4
LDL cholesterol (mg/dL)		
Normal (< 100)	92	32.6
High (≥ 100)	190	67.4
Waist-to-hip ratio		
Normal	157	55.7
Risk	125	44.3
HbA1c (%)		
Normal (< 6.0)	231	81.9
Risk for diabetes (6.0- 6.4)	23	8.2
High/diabetes (≥ 6.5)	28	9.9

regarding diabetes prevention and care, and 74.5% had

negative attitudes toward diabetes prevention and control (Table 3).

Table 3 T2DM among the participants.

T2DM	n	%
Type 2 diabetes mellitus from medical history		
Yes	25	8.9
No	257	91.1
Medical history and control of blood glucose		
Yes	0	0.0
No	25	100.0
Type 2 diabetes mellitus from HbA1c with no medical history (new cases)		
Yes	26	10.1
No	231	89.9
Total diabetes mellitus		
Yes	51	18.1
No	231	81.9
Knowledge of diabetes prevention and control		
Low	158	56.0
Moderate	51	18.1
High	73	25.9
Attitudes toward diabetes prevention and control		
Negative	210	74.5
Neutral	56	19.9
Positive	16	5.7

One-third smoked (30.9%), and used alcohol (26.2%). More than half (53.9%) reported that they did not exercise daily. A large proportion reported the use of salt (85.8% used moderate to high levels), monosodium glutamate (84.4% used moderate to high levels), and oil (82.6% used moderate to high levels) in their cooking. A total of 15.6% of the participants had a moderate to high level of stress (Table 4).

Table 4 Risk behaviors of participants.

Behaviors	n	%
Smoking		
No	195	69.1
Yes	87	30.9
Alcohol use		
No	208	73.8
Yes	74	26.2
Opium use		
No	275	97.5
Yes	7	2.5
Methamphetamine use		
No	278	98.6
Yes	4	1.4
Exercise		
No	152	53.9
Sometimes	92	32.6
Everyday	38	13.5
Salt for daily cooking		
Little	40	14.2
Moderate	151	53.5
High	91	32.3
Monosodium glutamate in daily cooking		
Little	44	15.6
Moderate	134	47.5
High	104	36.9
Oil for cooking		
Little	49	17.4
Moderate	162	57.4
High	71	25.2
Stress (ST-5)		
Low	238	84.4
Moderate	38	13.5
High	6	2.1

In the univariate model, five (5) variables were found to be associated with T2DM among the Lisu in Chiang Rai Province, Thailand: sex, oil use in cooking, stress, waistline measurement, and triglycerides. Compared to males, females had a 1.65 time greater likelihood (95%CI=1.01-3.18) of having T2DM. Those who used larger amounts of cooking oil had a 1.99 time greater likelihood (95%CI=1.16-2.55) of developing T2DM than those who used smaller amounts of oil in their cooking. Those who had high levels of stress had a 2.40 time greater likelihood (95%CI=1.19-3.56) of developing T2DM than those who had low stress levels. Those who had been categorized as at risk for metabolic complications based on waistline indicators had a 2.20 time greater likelihood (95%CI=1.16-4.16) of developing T2DM than those with a normal waistline. Those who had a high level of triglycerides had a 1.67 time greater likelihood (95%CI=1.09-3.07) of developing T2DM than those who had a normal level (Table 5).

After adjustments were made for age, sex, income, and marital status in the multivariate model, only waistline measurement was found to be associated with type 2 diabetes among the Lisu tribe in Thailand. Those who had been defined as being at risk for metabolic complications from waistline measurements (≥ 90 cm in males and ≥ 80 cm in females) had a 2.20 time greater chance (95%CI= 1.16-4.16) of developing type 2 diabetes than those who had a normal waistline measurement.

Discussion

The Lisu people in Thailand are have a low level of education and poor economic status. Most of them have unskilled jobs, such as agricultural workers, with low monthly family income. Less than a half were screened for T2DM within the previous year, and a large proportion did not know their parents' T2DM status. The majority are obese and at risk of metabolic complications due to their waistline measurements. Moreover, the Lisu people have high levels of indicators on their lipid profiles, such as high cholesterol and high LDL. The prevalence of T2DM among the Lisu was 18.1%, and among these individuals, 10.1% did not know their diabetes status. The main factor associated with T2DM among the Lisu was obesity or waistline measurement ≥ 90 cm in males and ≥ 80 cm in females.

The World Health Organization (WHO) reported that in 2018, the global prevalence of T2DM among people aged 18 years above was 8.5% [21]. In Thailand, the Ministry of Public Health reported that the prevalence of among people aged 30 years and older was 8.8% in 2018 [22]. Obviously, the Lisu people in northern Thailand have a greater risk of T2DM than the general Thai population or even people living in other regions or countries in the world. There are several risk factors for the development of T2DM among the Lisu people, such as low education and poor

Table 5 Univariate analysis of factors associated with type 2 diabetes mellitus among the Lisu.

Factor	OR	95%CI	p-value
Sex			
Male	1.00		
Female	1.65	1.01-3.18	0.042*
Age (years)			
30-39	1.00		
40-49	0.45	0.15-1.37	0.158
50-59	0.87	0.33-2.26	0.768
60-69	1.11	0.43-2.83	0.832
70-79	1.54	0.54-4.44	0.422
≥ 80	0.69	0.07-6.43	0.741
Religion			
Buddhism	1.00		
Other (Christianity and Islam)	1.59	0.83-3.03	0.159
Occupation			
Unemployed	1.00		
Agriculturalist	0.84	0.41-1.71	0.622
Other	0.88	0.35-2.22	0.784
Income per family per year (baht)			
≤ 50,000	1.00		
50,001-100,000	1.31	0.65-2.63	0.445
≥ 100,001	2.02	0.60-6.84	0.257
Family debt			
No	1.64	0.73-3.70	0.234
Yes	1.00		
Marital status			
Single	1.00		
Married	1.61	0.20-13.25	0.659
Other	2.67	0.30-23.39	0.376
Family member (person)			
0-4	4.79	0.62-37.22	0.134
5-8	4.09	0.62-32.32	0.182
≤ 9	1.00		
Living situation			
Alone	1.00		
With spouse	0.73	0.19-2.82	0.651
With child	0.99	0.24-4.11	0.992
With relative	0.14	0.01-1.50	0.104
Father's history of diabetes			
No	1.00		
Yes	1.75	0.51-5.95	0.372
Unknown	0.83	0.43-1.58	0.563
Mother's history of diabetes			
No	1.00		
Yes	0.81	0.17-3.89	0.794
Unknown	0.75	0.39-1.44	0.382
Smoking			
No	1.00		
Yes	0.82	0.42-1.61	0.562
Alcohol use			
No	1.00		
Yes	1.08	0.55-2.13	0.828

Factor	OR	95%CI	p-value
Exercise			
No	0.63	0.27-1.50	0.301
Sometimes	0.73	0.29-1.82	0.501
Everyday	1.00		
Salt in daily cooking			
High	0.79	0.31-2.05	0.627
Moderate	0.91	0.38-2.19	0.834
Low	1.00		
Monosodium glutamate in daily cooking			
High	0.88	0.35-2.22	0.785
Moderate	1.08	0.45-2.61	0.858
Low	1.00		
Cooking oil			
High	1.99	1.16-2.55	0.048*
Moderate	0.97	0.42-2.22	0.941
Low	1.00		
Stress (ST-5)			
Low	1.00		
Moderate	1.28	0.55-3.00	0.567
High	2.40	1.19-13.56	0.032*
Knowledge of T2DM prevention and control			
Low	1.00		
Moderate	1.36	0.60-3.08	0.459
High	1.70	0.85-3.40	0.137
Attitudes toward T2DM prevention and control			
Negative	1.00		
Neutral	1.02	0.47-2.20	0.967
Positive	1.56	0.48-5.10	0.463
Body mass index (BMI)			
Normal	1.00		
Underweight	0.44	0.09-2.06	0.296
Overweight	0.86	0.45-1.63	0.639
Waistline			
Normal	1.00		
Risk for metabolic complication	2.20	1.16-4.16	0.015*
Total cholesterol			
Normal	1.00		
High	0.80	0.42-1.51	0.489
Triglycerides			
Normal	1.00		
High	1.67	1.09-3.07	0.049*
HDL cholesterol			
Low	1.36	0.73-2.53	0.329
Normal	1.00		
LDL cholesterol			
Normal	1.00		
High	0.57	0.31-1.07	0.079
Waist-to-hip ratio			
Normal	1.00		
Risk	0.77	0.42-1.44	0.418

*Significant level at $\alpha=0.05$

economic status, and they lack better choices for daily dietary habits. In the final model, even obesity or waistline measurement was found to be associated with T2DM. Several studies have reported that socioeconomic status is associated with T2DM in different populations and in different countries [23-26]. In our study, it was found that waistline measurements ≥ 90 cm in males and ≥ 80 cm in females were associated with T2DM development among the Lisu people aged 30 years and older. This finding is supported by many studies from different settings. A study in China clearly demonstrated the association between waistline measurement and T2DM

development in Jinan city [27]. Two systematic reviews [28, 29] were clearly reported on the association and mechanism of obesity, particularly with high waistline measurements in both sexes, and T2DM development.

There are some limitations to this study. First, the measurements of the amount of oil, salt, and monosodium glutamate used in cooking were limited to participant self-report. We developed tools to demonstrate the use of these materials for cooking, and there were some improvements in the validity and reliability of the measurements. The level of participants' understanding of the Thai language during

the completion of the questionnaire might interfere with the accuracy of their responses to a question, particularly among those older than 50 years of age. At this point, we have helped villagers who were fluent Thai. Finally, according to the question regarding the use of oil, salt, and monosodium glutamate in participants' cooking, most of their lunches were made by other people. Thus, with a lifestyle in which individuals eat lunch outside of the home and family environment, they cannot control for oil, salt, and monosodium glutamate use in food.

Conclusion

The Lisu hill tribe people in Thailand are living in poor economic circumstances and have low levels of education. They also engage in risk behaviors such as smoking, alcohol use, and other substance abuse. Moreover, the Lisu people in Thailand regularly cook with high amounts of salt and oil. More than half of the Lisu people do not exercise regularly, and obesity and metabolic problems, particularly waistline measurements, exceed the standard in both males and females. The prevalence of T2DM among the Lisu people is greater than that among the general Thai population, and a large percentage of the Lisu people do not know their T2DM status. An effective screening test is needed to intervene in this population to clarify the actual magnitude of the problem. Furthermore, an effective public health program to reduce the use of oil in cooking and to encourage the initiation of appropriate and regular exercise should be implemented in Lisu villages.

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