FACTORS ASSOCIATED WITH TYPE 2 DIABETES MELLITUS AMONG THE ELDERLY HILL TRIBE POPULATION IN THAILAND

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Abstract. Type 2 diabetes mellitus (T2DM) is a common chronic disease among the elderly and a major public health problem in Thailand. There are many risk factors for developing T2DM but little data is available about these factors among the elderly hill tribe population in Thailand. Therefore, we aimed to determine the prevalence of these risk factors among this population in Chiang Rai Province, Thailand. We conducted an analytic cross-sectional survey among hill tribe subjects aged ≥ 60 years in Chiang Rai Province. Each subject was asked to complete a questionnaire. A physical health examination was done by a physician, and 5 ml blood specimen was drawn and examined for lipid profile and fasting glucose level. Logistic regression analysis was used to detect associations between variables and the presence of diabetes. A total of 793 subjects from 61 vilages were recruited into the study. Fifty-one point seven percent were aged 60-69 years (mean=70, SD=7.57), 49.6% were males, 71.5% were Buddhists, and 6.1% had no Thai identification card. After controlling for confounding factors, four variables were significantly associated with T2DM: a) being a member of some hill tribes: Lahu, Yao, Karen, and Lisu had a 3.00 times (95%CI: 1.37-6.63), 3.19 times (95%CI: 1.45-6.99), 4.75 times (95%CI: 2.22-10.15), and 2.71 times (95%CI: 1.22-6.03), respectively greater risk of having T2DM than members of the Akha tribe; b) those who exercised regularly had a 2.46 times (95%CI: 1.31-4.57) greater risk of having T2DM than those who did not; c) those who had hypertension (OR_{adj}=1.93, 95%CI: 1.29-2.91) had a 2.08 times (95%CI:1.31-4.57) greater risk of having T2DM than those who did not; d) and those who had an elevated triglyceride level >200 mg/dl had a 1.99 times (95%CI:1.27-3.11) greater risk of having T2DM than those who had a triglyceride level <200 mg/dl. These data can inform diabetes prevention programs among the study population, which are needed.

Keywords: type 2 diabetes mellitus, elderly, hill tribe, Thailand

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INTRODUCTION

A sedentary lifestyle and an unhealthy diet have become common in rural Thailand, increasing the risk of this population for developing type 2 diabetes mellitus (T2DM). T2DM is common

among the elderly (WHO, 2016a). In 2014, the World Health Organization (WHO) estimated there were 422 million people worldwide living with DM, an increase from 108 million in 1980 (WHO, 2016a). The number of T2DM cases is increasing worldwide (CDC, 2016) including in Thailand (WHO, 2016b). Many factors may be influencing this upward trend, such as globalization, increasing finances, and changes in diet. The prevalence of T2DM among the general population in the United Kingdom, aged 0-99 years old, increased from 2000 (2.39%) to 2013 (5.32%) (Sharma *et al*, 2016).

In 2015, the Ministry of Public Health, Thailand, reported the prevalence of T2DM among people aged ≥60 years was 1,032.50/100,000 population (Ministry of Public Health Thailand, 2015). In 2015, there were 4 million cases of T2DM in Thailand (International Diabetes Federation, 2015). The prevalence of T2DM in Thailand was estimated to be 8% among all adults, and 15% among adults aged >60 years old in 2015 (International Diabetes Federation, 2015). The morbidity rate among people with T2DM in Thailand was 1,726.43 per 100,000 population in 2015 (Bureau of Epidemiology, 2015). In 2014, the Ministry of Social Development and Human Security, Thailand predicted the incidence of T2DM would double from 2014 to 2025 in Thailand (Ministry of Social Development and Human Security Thailand, 2014). The Chiang Rai Provincial Public Health Office, Thailand, reported the mortality rate of diabetes mellitus in Chiang Rai Province increased from 9.60 per 100,000 population in 2013 to 14.74 per 100,000 population in 2015 (Chiang Rai Provincial Public Health Office, 2016).

T2DM not only affects the patient but the family members as well. In terms of financial cost, a T2DM patient in Thailand has been estimated to pay 1,172 Baht (USD40) per visit to the outpatient department, and 10,217 Baht (USD340) per admission at a public hospital (Institute of Medical Research and Technology Assessment, 2014). T2DM patients need regular medical attention, resulting in a major financial burden to the patient and society. Identifying risk factors for developing T2DM is important to inform T2DM prevention programs.

In northern Thailand there are 6 main hill tribe groups: Akha, Lahu, Karen, Yao, Hmong, and Lisu (The Hill Tribe Welfare and Development Center, 2013). In 2016, the WHO estimated there were nearly 2.5 million hill tribe people living in Thailand; 45% live in Chiang Rai Province (WHO, 2016b). Most hill tribe villages are in remote locations. They have different cultures, languages, beliefs, and life styles. Socio-demographics and economic changes have resulted an increased risk for developing T2DM. Younger members of the hill tribe leave the village and go to the city to study and work, leaving the elderly at their home. However, some tribes have been found to be more adaptable to change, such as the Akha people (Apidechkul *et al*, 2016).

There is little data regarding health behavior among elderly hill tribe members. Part of this is because many elderly hill tribe members do not speak, read or write Thai. A study among the Akha elderly population found only a small portion of studied subjects could speak and understand Thai and this causes problems accessing healthcare (Apidechkul *et al*, 2016).

In this study we aimed to assess the prevalence of and factors assocaited with T2DM among elderly hill tribe members living in Chaing Rai Province, Thailand.

MATERIALS AND METHODS

Study design and study sites

We conducted a cross sectional study to determine factors associated with T2DM among elderly hill tribe members in Chiang Rai Province, Thailand. Study villages were randomly selected from a list of the hill tribe villages. The study was conducted in 13 districts: Mueang, Mae Fa Laung, Mae Suai, Wiang Pa Pao, Doi Luang, Chiang Saen, Chiang Khong, Wiang Kaen, Mae Chan, Phaya Mengrai, Khun Tan, Thoeng, and Wiang Chai.

Study subjects

In 2016, there were 649 hill tribe villages in Chiang Rai Province: 243 Ahka, 35 Lisu, 36 Karen, 56 Hmong, 63 Yao and 216 Lahu. The total hill tribe population in these 649 villages was 221,418; 35,427 of them were classified as elderly (aged ≥60 years). (The Hill Tribe Welfare and Development Center, 2013). The community headman was contacted and asked for permission to conduct the study. A list of eligible participants from each village was obtained and 13 people from each village were randomly selected and asked to participate. After obtaining informed consent the subjects were included in the study. All hill tribe members aged≥ 60 years who identified themselves as being one of the six main hill tribes mentioned previously were eligible for the study. The sample size for our study was calculated based on a previous study from the International Diabetes Federation (2015) which reported a prevalence of T2DM of 15%; we used a power of 80% and an error of 0.05. Assuming a total of 130 subjects per hill tribe and 6 hill tribes studied, gives us a total of 780 subjects needed for the study. Study subjects aged ≥60 years based on their Thai ID card or who answered verbally what their age were included in the study. Exclusion criteria were subjects with severe T2DM or with other serious conditions or diseases were excluded from the study.

Research instrument and other exams

A questionnaire, physical examination and 5 ml blood specimen were used as research instruments. The questionnaire was developed from a relevant literature review and from conducting in-depth interviews with 4 persons from each tribe (two males and two females**).** Information from both these sources was pooled and reviewed by the research team. Then, a 48-item three-part questionnaire was developed. The three parts were: a) general information consisting questions about age, sex, tribe, education level and income level; b) health behavior questions asked about smoking, drinking, exercise, weight, height and blood pressure; c) clinical information questions asked about past health history, diseases, symptoms and current health status.

The questionnaire was validated by three external experts using the Index of Item Objective Congruence (IOC) method before use. A pilot test was done six times among a similar population at Mae Chan District. The objective of the pilot test was to determine the feasibility and possibility for gathering the information from the subjects.

A physical examination form was developed and used to guide the physical examination performed by a licensed physician. A review of systems was also performed at the time of the physical examination. A 5 ml blood specimen was drawn from each subject after fasting over night for at least 8 hours.

Those already under treatment for T2DM were presumed to have T2DM. Others were diagnosed to have T2DM

Table 1
General characteristics of study subjects.

Characteristics	Number (%)	Characteristics	Number (%)
Total	793 (100.0)	Marital status	
Sex		Single	15 (1.9)
Male	393 (49.6)	Married	524 (66.8)
Female	400 (50.4)	Divorce	20 (2.5)
Thai ID card		Widow	226 (28.8)
Yes	745 (93.9)	Number of family members living together	
No	48 (6.1)	1	40 (5.0)
Tribe		2	116 (14.6)
Akha	130 (16.4)	3-5	301 (38.0)
Lahu	133 (16.8)	6	336 (42.4)
Hmong	140 (17.6)	Number of children	
Yao	130 (16.4)	None	24 (3.0)
Karen	130 (16.4)	1-2	145 (18.3)
Lisu	130 (16.4)	3-5	377 (47.6)
Age in years		6-10	235 (29.6)
60-69	410 (51.7)	≥ 11	12 (1.5)
70-79	279 (35.2)	Occupation	
≥80	104 (13.1)	Unemployed (Retired)	499 (62.9)
Religion		Farmer	252 (31.8)
Buddhism	567 (71.5)	Merchant	11 (1.4)
Christianity	225 (28.4)	Labor	19 (2.4)
Islam	1 (0.1)	Other	12 (1.5)
Education level		Income (Baht/month)	
None	739 (93.8)	0	69 (8.7)
Primary School	41 (5.2)	≤5,000	707 (89.2)
High School	8 (1.0)	≥5,001	17 (2.1)
Living with		Debt (Baht)	
Child	559 (70.5)	0	673 (84.9)
Cousin	12 (1.5)	≤5,000	14 (1.8)
Spouse	174 (21.9)	5,001-10,000	11 (1.4)
Alone	48 (6.1)	10,001-50,000	58 (7.3)
		≥50,001	37 (4.6)

using the following criteria: a) a fasting blood sugar ≥126 mg/dl (Chamberlain *et al*, 2016), and b) having no previous history of type 1 diabetes mellitus. Those who had been diagnosed as DM previously and on treatment, having fasting blood sugar ≥126 mg/dl were defined as uncontrollable of blood sugar.

Data collection and analysis

The subjects were asked to complete the questionnaire, have a physical examination and provide a fasting blood sample. Data were coded and entered into Microsoft Excel 2010 and analysis was done using SPSS (version 20; IBM, Armonk, NY). Means, percentages, and standard deviations (SD) were used to present the characteristics of the subjects. Logistic regression analysis was used to identify associations between variables

Table 2
Prevalence of type 2 diabetes mellitus among study subjects.

Characteristics	Number	(%)
T2DM by medical evidence		
Yes	75	(9.5)
No	718	(90.5)
Fasting blood sugar (T2DM diagnosed previously)		
High	7	(9.3)
Normal	67	(89.3)
(Missing = 1, 1.4%)		
Fasting blood sugar (not previously diagnosed with T2DM)		
High	55	(7.7)
Normal	645	(89.8)
(Missing = 18, 2.6%)		
Total with T2DM		
Yes	130	(16.8)
No	645	(83.2)

T2DM, type 2 diabetes mellitus.

and T2DM. Significance was set at α=0.10 for simple logistic regression analysis and α=0.05 for multiple logistic regression analysis.

Ethical considerations

This study and the instruments were approved by the Ethics Committee for Human Research, Mae Fah Laung University, Chiang Rai, Thailand (No. REH-58087). All subjects were given a small gift to show appreciation for their participation after finishing the interview.

RESULTS

A total of 793 hill tribe subjects from 61 villages in Chiang Rai Province were recruited into the study. The mean (SD) age was 70 (±7.6) years (range: 60-100). Fifty-one point seven percent were aged 60-69 years and 35.2% were aged 70-79 years. Fifty point four percent were female, 93.9% had a Thai ID card, 71.5% were Buddhists, 93.8% were illiterate, 66.8% lived with their spouse, and 62.9% were unemployed (retired) (Table 1).

The overall prevalence of T2DM in the study population was 16.8%. Of these 9.5% had a previous history of T2DM and was on treatment. Nine point three percent of subjects who were on treatment had inadequate blood sugar control. Seven point seven percent of subjects who had not previously been diagnosed with T2DM had a fasting blood sugar level >126 mg/dl (Table 2).

Simple logistic regression analysis revealed 7 variables significantly associated with T2DM among the study subjects: tribe, smoking, drinking alcohol, exercise, body mass index (BMI), history of hypertension, and triglyceride level.

Being a member of the Lahu tribe had a 2.58 times (90%CI: 1.37-4.85) greater risk of having T2DM than being a member of the Akha tribe. Being a member of the Yao tribe had a 2.91 times (90%CI: 1.54-5.48) greater risk of having T2DM than being a

member of the Akha tribe. Being a member of the Karen tribe had a 3.80 times (90%CI: 2.06-7.03) greater risk of having T2DM than being a member of the Akha tribe, and being a member of the Lisu tribe had a 2.81 times (90%CI:1.14-4.13) greater risk of having T2DM than being a member of the Akha tribe (Table 3).

Subjects who had previously smoked and quit smoking had a 1.53 times (90%CI: 1.04-2.24) greater risk of having T2DM than who never smoked. Those who drank alcohol had a 1.58 times (90%CI: 1.04-2.42) greater risk of having T2DM than those who did not. Those who exercised regularly had a 2.04 times (90%CI: 1.16-3.59) greater risk of T2DM than those who did not. Those who were overweight had a 1.65 times (90%CI: 1.14-2.37) greater risk of having T2DM than those who had a normal weight. Those who had a history of hypertension had a 2.33 times (90%CI: 1.69-3.23) greater risk of having T2DM than those who did not. Those who had a high triglyceride level had a 1.84 times (90%CI: 1.29-2.63) greater risk of having T2DM than those with a normal triglyceride level (Table 3).

On multiple logistic regression analysis four variables were significantly associated with T2DM: tribe, exercise, history of hypertension and high triglyceride level. Those who were member of the Karen, Yao, Lahu or Lisu tribe were significantly more likely than members of the Akha tribe of having T2D: (OR_{adj}=4.75, 95%CI: 2.22-10.15; OR_{adj}=3.19, 95%CI: 1.45-6.99; OR_{adj}=3.00, 95%CI: 1.37-6.63; OR_{adj}=2.71, 95%CI: 1.22-6.03, respectively). Those who exercised regularly had a 2.46 times (95%CI: 1.31-4.57) greater risk of having T2DM than those who did not. Those who had hypertension had a 1.93 times (95%CI: 1.29-2.91) greater risk of having T2DM than those who did not. Those who had a high triglyceride level had a 1.99 times (95%CI: 1.27-3.11) greater risk of having T2DM than those who had a normal level of triglyceride level (Table 4).

DISCUSSION

The overall prevalence of T2DM among our study subjects was 16.8%, which is greater than that among the general elderly Thai population of 9.2% (Bureau of Non-communicable Diseases, 2015). The highest prevalences by tribe were 26.4% (Karen), 21.5% (Yao) and 19.5 % (Lahu). This could be due to differences in lifestyle. Lorga *et al* (2013) reported members of the Karen tribe in Thailand had lifestyles that put them at a higher risk for developing chronic non-communicable diseases, such as DM, and most of those study subjects had a low knowledge level about T2DM prevention. Lorga *et al* (2012) reported the prevalence of T2DM among the Karen population to be 16.7%, which is lower than our study. However, we found no published studies of the incidence of T2DM among the Yao and Lahu tribes in Thailand.

Genetics may also contribute to the differences in T2DM prevalences among the various hill tribes. Besaggio *et al* (2007) found a 5-14% variation in mitochondrial DNA among the hill tribe populations in Thailand. Differences in DNA may affect the prevalence of chronic diseases, such as T2DM.

In our study, obesity was associated with T2DM, similar to other studies of the Thai population (Malik *et al*, 2010; Jitnarin *et al*, 2011; Kitayaporn *et al*, 2011; Aekplakorn, 2014; Yue *et al*, 2016).

In our study, subjects who exercised regularly had a greater risk of having T2DM, unlike other studies (Coldberg *et al*, 2010; Kirkman *et al*, 2012; Ferriolli *et al*, 2014).

Table 3
Simple logistic regression analysis in identifying factors associated with T2DM.

Characteristics	T2DM		OR	90%CI	*p*-value
	Yes	No			
	n (%)	*n* (%)			
Sex					
Male	66 (17.3)	316 (82.7)	1		
Female	64 (16.3)	329 (83.7)	0.93	1.02 - 2.02	0.712
Tribe					
Akha	11 (8.6)	117 (91.4)	1		
Lahu	26 (19.5)	107 (80.5)	2.58	1.37 - 4.85	0.013*
Hmong	11 (8.1)	124 (91.9)	0.94	0.45 - 1.96	0.896
Yao	26 (21.5)	95 (78.5)	2.91	1.54 - 5.48	0.006*
Karen	34 (26.4)	95 (73.6)	3.8	2.06 - 7.03	<0.001*
Lisu	22 (17.1)	107 (82.9)	2.18	1.14 - 4.13	0.046*
Age in years					
60-69	75 (18.8)	324 (81.2)	1		
70-79	39 (14.3)	234 (85.7)	0.72	0.50 - 1.02	0.127
≥80	16 (15.5)	87 (84.5)	0.79	0.48 - 1.30	0.444
Smoking					
No	78 (16.4)	398 (83.6)	1		
Quit	34 (23.1)	113 (76.9)	1.53	1.04 - 2.24	0.064*
Yes	18 (11.8)	134 (88.2)	0.68	0.43 - 1.08	0.177
Drinks alcohol					
No	79 (15.2)	447 (85)	1		
Quit	26 (19.3)	109 (80.7)	1.35	0.89 - 2.03	0.23
Yes	25 (21.9)	89 (78.1)	1.58	1.04 - 2.42	0.072*
Exercise					
No	64 (15)	362 (85)	1		
Yes	21 (26.6)	58 (73.4)	2.04	1.16 - 3.59	0.013*
Highly active physical work	45 (16.7)	225 (83.3)	1.12	0.74 - 1.70	0.584
Body mass index					
Normal	68 (15.1)	381 (84.9)	1		
Underweight	13 (11.4)	101 (88.6)	0.72	0.42 - 1.22	0.311
Overweight	41 (22.8)	139 (77.2)	1.65	1.14 - 2.37	0.023*
Obese	8 (8)	24 (75)	1.86	0.92 - 3.78	0.145
Hypertension					
Yes	60 (25.8)	173 (74.2)	2.33	1.69 - 3.23	<0.001*
No	70 (12.9)	472 (87.1)	1		
Headache					
Yes	35 (16.4)	178 (83.6)	0.96	0.67 - 1.38	0.875
No	95 (16.9)	467 (83.1)	1		
Dizziness					
Yes	44 (18.9)	189 (81.1)	1.23	0.88 - 1.72	0.303
No	86 (15.9)	456 (84.1)	1		

Table 3 (Continued).

Characteristics	T2DM		OR	90%CI	*p*-value
	Yes	No			
	n (%)	*n* (%)			
Joint pain					
Yes	78 (18.5)	343 (81.5)	1.32	0.95 - 1.82	0.155
No	52 (14.7)	302 (85.3)	1		
Numbness					
Yes	35 (17.9)	161 (82.1)	1.1	0.77 - 1.58	0.639
No	95 (16.4)	484 (83.6)	1		
Cholesterol level					
Normal (<199 mg/dl)	90 (17.3)	430 (82.7)	1		
High (≥200 mg/dl)	38 (16.1)	198 (83.9)	0.91	0.64 - 1.29	0.682
Triglyceride level					
Normal (<199 mg/dl)	88 (14.9)	504 (85.1)	1		
High (≥200 mg/dl)	40 (24.4)	124 (75.6)	1.84	1.29 - 2.63	0.004*

* Significant at $\alpha = 0.10$; T2DM, type 2 diabetes mellitus; OR, odds ratio; CI, confidence interval; *n*, number.

Table 4
Multiple logistic regression analysis of factors associated with T2DM.

Characteristics	T2DM		OR	95%CI	*p*-value
	Yes	No			
	n (%)	*n* (%)			
Tribe					
Akha	11 (8.6)	117 (91.4)	1		
Lahu	26 (19.5)	107 (80.5)	3.00	1.37 - 6.63	0.006*
Hmong	11 (8.1)	124 (91.9)	1.08	0.42 - 2.78	0.858
Yao	26 (21.5)	95 (78.5)	3.19	1.45 - 6.99	0.004*
Karen	34 (26.4)	95 (73.6)	4.75	2.22 - 10.15	≤0.001*
Lisu	22 (17.1)	107 (82.9)	2.71	1.22 - 6.03	0.014*
Exercise					
No	64 (15.0)	362 (85.0)	1		
Yes	21 (26.6)	58 (73.4)	2.46	1.31 - 4.57	0.004*
Highly active	45 (16.7)	225 (83.3)	1.11	0.74 - 1.80	0.502
Physical work					
Hypertension					
Yes	60 (25.8)	173 (74.2)	1.93	1.29 - 2.91	0.001*
No	70 (12.9)	472 (87.1)	1		
Triglyceride level					
Normal	88 (14.9)	504 (85.1)	1	1.27 - 3.11	0.002*
High	40 (24.4)	124 (75.6)	1.99		

* Significant at $\alpha = 0.05$; T2DM, type 2 diabetes mellitus; OR, odds ratio; CI, confidence interval.

This unexpected finding could be a result of the cross sectional study design. In cross sectional studies, independent (risk factors) and dependent (fasting plasma glucose) variables are evaluated at the same time (Hordem *et al*, 2012). In our study, many of subjects had already been diagnosed with T2DM. Those subjects may already have been advised to exercise by medical staff.

In our study, hypertension was associated with T2DM similar to other studies (Daskalopulou *et al*, 2015; Cryer *et al*, 2016). T2DM is also a risk factor for developing hypertension in the elderly (Mussa *et al*, 2016; Ahmad *et al*, 2016).

The American Diabetes Association reported a high triglyceride level is a major predictor for developing T2DM among obese patients (Russo *et al*, 2016), similar to other studies (Singh *et al*, 2016; Hasegawa *et al*, 2016; Beshara *et al*, 2016; Zheng *et al*, 2016).

In conclusion, in our study, the prevalence of T2DM in the study population was high. The factors significantly associated with T2DM were the tribe, whether they exercised or not, whether they had a history of hypertension or not and whether they had a high triglyceride level or not. Prevention programs need to be developed for the study population taking into consideration these factors in order to reduce the incidence of T2DM. These programs need to be in the language of the study subjects and culturally appropriate.

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