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Effectiveness of a Diabetes Mellitus and Hypertension-Reducing Intervention Program among Akha Adults in Northern Thailand

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ABSTRACT

Background: Noncommunicable diseases (NCDs) are a major global challenge, especially for those with poor socioeconomic status. Akha is one of the hill tribes living lower than the national poverty line in northern Thailand that is facing problems with NCDs. This study aimed to assess the effectiveness of a diabetes-(DM) and hypertension (HT)-reducing intervention model. **Method:** A community-based experimental design was used to assess the effectiveness of a diabetes (DM) and hypertension (HT)-reducing intervention model. The experiment was conducted in two villages in Akha. In each village, 30 persons aged 30 years and over were randomly selected as key participants. Specific training programs on DM and HT prevention and control, healthy food preparation, and cooking demonstrations were provided, including the promotion of regular exercise between September and December 2019. A validated questionnaire, physical examination (checking both blood pressure and HbA1c), and lipid profile were used as indicators of the study. A model was developed and used as a key intervention. A chi-square and t-test were used to detect a significance level of α=0.05. **Results:** A total of 60 participants were recruited for the study, with 30 in the intervention village and 30 in the control village. Of the participants from the intervention village, 50.0% were female, 43.3% were aged 30–45 years (mean=47.6, SD=9.6), 100.0% were married, 100.0% were Christian, and 90.0% were non-educated, while of the participants from the control village, 50.0% were female, 43.3% were aged 30-45 years (mean= 50.5, SD=10.0), 90.0% were married, 96.7% were Christian, 100.0% were non-educated, and 53.3% were employed daily. The quantity of monosodium glutamate used for cooking (p-value<0.001) and the quantity of cooking oil used during cooking (p-value=0.004) were found to be different between the groups. Comparisons of biomarkers between the control and intervention groups after the intervention showed that triglyceride levels were statistically significant between the groups (p-value=0.048). However, knowledge and attitudes toward DM and HT prevention and care increased. **Conclusion:** The community-based intervention could improve people health especially in reducing lipid levels among Akha hill tribe adults.

Keywords: *Diabetes mellitus, Hypertension, Intervention, Hill tribe, Akha, Adults*

Introduction

Diabetes mellitus (DM) and hypertension (HT) are major non-communicable diseases (NCDs) [1–3]. The World Health Organization (WHO) reported that 41 million people died each year from NCDs, and among those, 15 million were aged between 30–69 years, which are considered premature deaths [4]. A large proportion of premature deaths (85.0%) have been reported in low- and middle-income countries [4]. NCDs are reported globally and require a large amount of medical expenses for care and treatment [5]. Diabetes mellitus (DM) and hypertension (HT) are the most common NCDs [6]. It has also been well-established that DM and HT are major contributors in reducing quality of life (QOL) of both patients and their family members [7,8]. With the current conditions of being diagnosed with these two diseases, treatment will be required for patients' entire lives [5]. An unhealthy diet, low physical activity, and substance use were identified as contributing factors to the disease [4]. Several factors that contribute to the development of DM and HT are well-known, including physical and mental health, as well as other socioeconomic dimensions [9]. The impact it has will be especially

pronounced on people with poor education and low socioeconomic status.

The hill tribe are a group of people who have migrated from South China and settled in Northern Thailand for centuries [10]. As a result of globalization, almost all hill tribe people experience several mixed cultures, including different eating behaviors and lifestyles [11]. Apidechkul [12] reported that the prevalence of HT and DM among Akha people were 46.9% and 8.6%, respectively. Unhealthy food consumption and low physical activity were identified as potential causes of DM and HT. Moreover, high quantities of oil and salt were also detected as contributing factors of DM and HT among hill tribe people living in Northern Thailand [12,13]. Therefore, modifying these behaviors and intervening through specific groups to find the proper model to improve some key indications could be advantageous, and should be explored by public health professionals.

This study aimed to assess the effectiveness of the intervention model implemented in two selected Akha villages.

Methodology

A community-based intervention was used to implement a specific intervention program designed to reduce DM and HT among the adult Akha population. The study settings were chosen in two villages located in Muang District, Chiang Rai Province, Thailand; one intervention village (57 households) and one control village (68 households). The two villages are more than 30 km apart.

The intervention program was carefully designed based on prior scientific and medical information. The sample size was calculated according to the standard sample size calculation for comparison between the two groups when the endpoint was quantitative data, and is given as follows:

$$n = 2SD^2 (Z_{\alpha/2}+Z_{\beta})^2/d^2 \quad [14],$$

where SD is the standard deviation from the previous study, which was 0.2 [15]; $Z_{\alpha/2}$ was a type-I error at 95% confidence interval (CI), which was 5.0%; Z_{β} was 0.84 at 80% power of the test; d was the effect side or the difference between means,which was 0.6 [15], and 27.8 participants were needed in each group. After accounting for any error and loss to follow-up (10.0%), 30 participants were required for the analysis.

Questionnaires were administered and 5 mL blood samples were obtained as the research instruments. The questionnaire consisted of five parts. In part one, 10 blank spaces regarding weight, height, lipid profiles, and HbA1c, among others, were included. In part two, 15 questions were used to collect general information, such as age, sex, education, occupation, and so on. In part three, 10 questions were provided to analyze individuals' behaviors, such as smoking, alcohol use, and opium use, among others. In part four, 20 questions were used to detect the patients' knowledge related to DM prevention and control. In part five, 20 questions were used to detect the patients' attitudes toward HT prevention and control.

The validity and reliability of the questionnaire were assessed before use. The item-objective congruence (IOC) method was used to assess validity. By doing the IOC, three experts in the field were invited to score each item of the questions. Questions wherein respondents scored less than 0.5 were excluded from the set of the questionnaire, while those scored between 0.5 and above were revised and put into the set of the questionnaire. Afterwards, the questionnaire was administered to 10 selected people who had similar characteristics to the participants. After doing so, the questionnaire was observed for its feasibility, understandability, and order or sequence of the question. Finally, Cronbach's alpha was calculated to determine its reliability for parts four and five, which were found to be 0.77 and 0.71, respectively. Access to the two villages was granted by district government officers. Thirty people aged ≥30 years were randomly selected from each village. However, the intervention was implemented in all people living in the intervention village, but only selected people were detected according to the indicators of the study. Those who had a poor disease stage and were also unable to provide information for any reason were excluded from the study.

A total of 30 participants from each village were recruited randomly from the list of people who met the inclusion and exclusion criteria for living in a certain village; 15 participants were selected from males, and another 15 participants were selected among females. In both villages, the selected participants were asked to complete the questionnaire, and 5 mL blood specimens collected before the program were administered to the intervention village. Blood specimens were transferred to the Mae Fah Laung Medical Laboratory Center for analysis.

During the intervention, all people living in the intervention village were invited to participate in the program. In the control village, all the people adhered to their original daily lifestyle until the end of the program, and they were provided the same intervention. The questionnaire was collected from participants living in both villages at the beginning of the intervention. Analysis knowledge and attitudes as well as blood specimen collection was performed twice, during before and after the intervention, on the 60 selected participants in the intervention and control villages. All participants were provided with information and consumed nothing orally 12 h before blood sample collection.

The intervention village in this study was applied from our previous cross-sectional study, which reported that poor physical activities and high lipid

profiles, including a high volume of oil and salt in cooking practices, were associated with DM and HT among hill tribe people [13]. The designed intervention programs were focused on providing knowledge about DM and HT and their prevention and controls three times, including healthy cooking practices, with a 2-week gap between. There were equipment to play several kinds of sports, such as badminton, table tennis, football, takraw, and volleyball. Five people were selected to be the leader of a sport to motivate people to play a sport every day. Specific designed forms for recording participation activities in sports were created and used to collect data. A group aerobic exercise program was developed and implemented in the village. Three demonstrations and contests of healthy cooking practices were demonstrated in the intervention village. During the intervention, three nutritionists were invited to demonstrate healthy food cooking practices for the villagers. Regular checking of body weight and blood pressure were performed by village health volunteers. The intervention lasted three months, between September and December 2019.

The questionnaires were coded into Excel sheets. Before transferring for the analysis, data were checked for missing data and errors. Data were analyzed using R (R 4.00, 2020) for analysis. Descriptive data analysis was performed properly, and categorical data were presented as percentages, while continuous data were presented as means and standard deviations. The chi-square test and t-test were used to detect the different proportions and means between groups at a significance level of α=0.05. The pair t-test was used to assess the different means within group, while the independent t-test was used to assess the different means between groups.

All procedures and instruments for the study were approved by the Human Ethics Committee of Mae Fah Laung University (IRB No. REH-61009). Participants were provided with all essential information, including the process of conducting research before obtaining informed consent.

Results

A total of 60 participants were recruited into the study: 30 in the intervention village and 30 in the control village.

Characteristics of the participants from the intervention village: 50.0% were female, 43.3% were aged 30–45 years (mean= 47.6, SD=9.6), 100.0% were married, 100.0% were Christian, 90.0% were non-educated, 56.7% were agriculturalist, 43.3% had family annual income less than 50,000 baht, 66.7% were overweight, 23.3% could not speak Thai, and 6.7% could not understand Thai (Table 1).

Table 1. General characteristics of participants

Characteristics	Intervention n (%)	Control n (%)	χ^2	p-value
Total	**30 (100.0)**	**30 (100.0)**	**N/A**	**N/A**
Sex				
Male	15 (50.0)	15 (50.0)	0.00	1.000
Female	15 (50.0)	15 (50.0)		
Age (years)				
30–45	13 (43.3)	13 (43.3)		
46–60	14 (46.6)	11 (36.6)	1.36	0.506
> 60	3 (10.1)	6 (20.1)		
Mean = 47.6, S.D. = 9.6, min = 32, max = 66 for intervention				
Mean = 50.8, S.D. = 10.0, min = 38, max = 68 for control				
Marital status				
Married	30 (100.0)	27 (90.0)	3.15	0.075
Ever married	0 (0.0)	3 (10.0)		
Religion				
Christen	30 (100.0)	29 (96.7)	1.01	0.313
Buddhist	0 (0.0)	1 (3.3)		
Education				
No education	27 (90.0)	30 (100.0)		
Primary school	2 (6.7)	0 (0.0)	3.15	0.206
High School	1 (3.3)	0 (0.0)		
Occupation				
Unemployed	0 (0.0)	10 (33.4)		
Agriculturist	17 (56.6)	4 (13.3)	20.97	0.001*
Trade	2 (6.7)	0 (0.0)		
Daily employed	11(36.7)	16 (53.3)		
Annual family income (baht)				
≤50,000	13 (43.3)	26 (87.7)		
≥ 50,001-100,000	17 (56.7)	4 (13.3)	12.38	<0.001*
Debt				
No	15 (50.0)	17 (56.7)	0.26	0.604
Yes	15 (50.0)	13 (43.3)		
Number of family member (persons)				
≤4	9 (30.0)	13 (33.3)	1.14	0.284
≥5	21 (70.0)	17 (56.7)		
Living with				
Spouse	28 (93.3)	25 (83.3)	1.45	0.227
Child	2 (6.7)	5 (16.7)		
Body mass index (BMI)				
Underweight (≤18.5)	1 (3.3)	0 (0.0)		
Normal (18.51–22.99)	9 (30.0)	11 (36.7)	1.22	0.541
Overweight (≥23)	20 (66.7)	19 (63.3)		
Checking DM status in previous year				
No	15 (50.0)	14 (46.7)	0.06	0.796
Yes	15 (50.0)	16 (53.3)		
Checking HT status in previous year				
No	13 (43.3)	10 (33.3)	0.63	0.425
Yes	17 (56.7)	20 (66.7)		
DM history of father				
Yes	1 (3.3)	0 (0.0)		
No	27 (90.0)	29 (96.7)	1.40	0.495
Do not know	2 (6.7)	1 (3.3)		
HT history of father				
Yes	1 (3.3)	1 (3.4)		
No	27 (90.0)	28 (93.3)	0.35	0.838
Do not know	2 (6.7)	1 (3.3)		
DM history of mother				
Yes	5 (16.7)	1 (3.4)		
No	23(76.6)	28 (93.3)	3.49	0.174
Do not know	2 (6.7)	1 (3.3)		
HT history of mother				
Yes	9 (30.0)	1 (3.4)		
No	19 (63.3)	28 (93.3)	8.45	0.014*
Do not know	2 (6.7)	1 (3.3)		
Ability in speaking skill				
No	7 (23.3)	4 (13.3)		
Few	8 (26.7)	17 (56.7)	5.55	0.062
Yes	15 (50.0)	9 (30.0)		
Ability in listening skill				
No	2 (6.7)	3 (10.0)		
Few	16 (53.3)	15 (50.0)	0.23	0.890
Yes	12 (40.0)	12 (40.0)		

***** Significance level at α = 0.05

Characteristics of the participants from the control village: 50.0% were female, 43.3% were aged 30-45 years (mean= 50.5, SD=10.0), 90.0% were married, 96.7% were Christian, 100.0% were non-educated, 53.3% were employed daily, 87.7% had family annual income less than 50,000 baht, 63.3% were overweight, 13.3% could not speak Thai, and 10.0% could not understand Thai (Table 1).

Three variables were found to be different between groups: occupation (p-value=0.001), annual family income (p-value<0.001), and HT history of mothers (p-value=0.014) (Table 1).

Among people living in the intervention village, 26.7% smoked, 30,0% used alcohol, 76.6% did not exercise, 96.7% used moderate to high quantities of salt while cooking, and 100.0% used cooking oil in moderate to high quantities while practicing (Table 2).

Among those who lived in the control village, 16.7% smoked, 26.7% used alcohol, 80.0% did not exercise, 93.3% used moderate to high quantity of salt while cooking, 83.3% used moderate to high monosodium glutamate, and 70.0% used cooking oil in moderate to high quantities while practicing (Table 2).

Two variables were found to be statistically different between groups: the quantity of monosodium glutamate used for cooking (p-value <0.001), and the quantity of cooking oil used during cooking (p-value=0.004) (Table 2).

Table 2. Health behaviors among the participants

Health behaviors	Intervention n (%)	Control n (%)	χ^2	p-value
Smoking				
No	22 (73.3)	25 (83.3)	0.88	0.347
Yes	8 (26.7)	5 (16.7)		
Alcohol use				
No	21 (70.0)	22 (73.3)	0.08	0.774
Yes	9 (30.0)	8 (26.7)		
Opium use				
No	29 (96.7)	29 (96.7)	0.00	1.000
Yes	1 (3.3)	1 (3.3)		
Methamphetamine use				
No	30 (100.0)	30 (100.0)	N/A	N/A
Yes	0 (0.0)	0 (0.0)		
Glue use				
No	30 (100.0)	30 (100.0)	N/A	N/A
Yes	0 (0.0)	0 (0.0)		
Heroin use				
No	30 (100.0)	30 (100.0)	N/A	N/A
Yes	0 (0.0)	0 (0.0)		
Exercise				
No	23 (76.6)	24 (80.0)	0.13	0.935
Sometime	5 (16.7)	4 (13.3)		
Regular	2 (6.7)	2 (6.7)		
Quantity of salt for cooking				
High	11 (36.7)	7 (23.3)	3.55	0.169
Moderate	18 (60.0)	18 (60.0)		
Low	1 (3.3)	5 (16.7)		
Quantity of monosodium glutamate for cooking				
High	1 (3.3)	12 (40.0)	15.03	<0.001*
Moderate	24 (80.0)	13 (43.3)		
Low	1 (16.7)	5 (16.7)		
Quantity of oils for cooking				
High	5 (16.6)	3 (10.0)	10.63	0.004*
Moderate	25 (83.4)	18 (60.0)		
Low	0 (0.0)	9 (30.0)		

* Significance level at $\alpha = 0.05$

Regarding the comparison of biomarkers before and after the intervention among participants in the intervention group, no biomarker was found to be different. On the other hand, two biomarkers were found to have a statistically significant difference between the two measurements: triglycerides (p-value=0.027) and LDL-C (p-value=0.005) (Table 3).

Table 3. Comparisons of biomarkers before and after intervention among the intervention and control

Biomarker	n	Mean	SD	t	df	p-value
Intervention						
HbA1c (%)						
Before	30	5.05	1.05	-0.47	29	0.640
After	30	4.95	0.44			
Triglyceride (mg/dL)						
Before	30	159.73	202.89	-0.28	29	0.780
After	30	149.03	78.82			
Total cholesterol (mg/dL)						
Before	30	196.47	34.75	1.06	29	0.296
After	30	206.70	42.51			
LDL-C (mg/dL)						
Before	30	128.90	32.76	-1.69	29	0.101
After	30	116.60	35.35			
HDL –C (mg/dL)						
Before	30	46.07	7.88	1.95	29	0.061
After	30	49.77	9.17			
Control						
HbA1c (%)						
Before	30	5.03	1.67	-0.17	29	0.865
After	30	5.01	1.32			
Triglyceride (mg/dL)						
Before	30	164.37	111.58	2.32	29	0.027*
After	30	199.23	111.16			
Total cholesterol (mg/dL)						
Before	30	208.55	34.24	-0.01	29	0.991
After	30	208.43	38.25			
LDL-C (mg/dL)						
Before	30	132.00	38.66	-3.00	29	0.005*
After	30	115.77	32.54			
HDL –C (mg/dL)						
Before	30	50.70	10.19	0.21	29	0.835
After	30	51.20	9.38			

* Significance level at $\alpha = 0.05$

With regards to the comparison of knowledge and attitudes toward DM and HT prevention and control among the participants in the intervention, two items were found to be statistically significant: attitudes toward DM prevention and care (p-value=0.033), and knowledge about HT prevention and control (p-value=0.038) (Table 4). However, no statistical significance was found when the knowledge and attitudes toward DM and HT prevention and control among the participants in the control group were compared (Table 4).

Table 4. Comparison of knowledge and attitudes about DM and HT before and after intervention among intervention and control

Knowledge and Attitude	n	Mean	SD	t	df	p-value
Intervention						
Knowledge about DM prevention and care						
Before	30	4.03	1.49	1.49	29	0.146
After	30	4.60	2.15			
Attitude towards DM prevention and care						
Before	30	3.43	1.95	2.24	29	0.033*
After	30	4.23	2.04			
Knowledge about HT prevention and care						
Before	30	3.40	2.69	2.17	29	0.038*
After	30	4.66	2.24			
Attitudes towards HT prevention and care						
Before	30	4.56	2.02	0.38	29	0.702
After	30	4.70	2.07			
Control						
Knowledge about DM prevention and care						
Before	30	4.40	1.49	-0.70	29	0.485
After	30	4.13	1.07			
Attitudes toward DM prevention and care						
Before	30	3.40	1.10	0.12	29	0.902
After	30	3.43	1.27			
Knowledge about HT prevention and care						
Before	30	3.80	1.60	0.67	29	0.504
After	30	4.03	1.40			
Attitudes toward HT prevention and care						
Before	30	3.83	2.22	0.75	29	0.941
After	30	3.86	1.35			

* Significance level at $\alpha = 0.05$

There were no significant differences in biomarkers between the control and intervention groups before the intervention. However, post-intervention triglyceride values between both groups were significantly different (p-value=0.048) (Table 5). However, no statistical difference was detected in biomarkers, knowledge, and attitudes toward DM and HT prevention and care between the groups both before and after intervention (Table 5).

Discussion

The Akha people are of low socioeconomic status. A large proportion of participants never attended school and are overweight, one-fourth smoked and use alcohol. A large proportion use a high volume of salt, monosodium glutamate, and cooking oil in daily cooking practices [16]. After intervention, the biomarkers among the intervention decreased, while the control of some biomarkers increased. Knowledge and attitudes increased significantly among the intervention groups, but not among the control groups. Triglyceride levels were significantly decreased after intervention between the intervention and control groups.

Table 5. Comparisons of biomarkers and knowledge and attitudes about DM and HT before and after intervention between intervention and control

Item	Before		After	
	t	p-value	t	p-value
Biomarkers				
HbA1c (%)				
Control	0.46	0.963	-0.22	0.825
Intervention				
Triglyceride (mg/dL)				
Control	-0.11	0.913	-2.01	0.048*
Intervention				
Total cholesterol (mg/dL)				
Control	-1.35	0.182	-0.16	0.869
Intervention				
LDL-C (mg/dL)				
Control	-0.33	0.739	0.95	0.925
Intervention				
HDL–C (mg/dL)				
Control	-1.96	0.054	-0.59	0.552
Intervention				
Knowledge about DM prevention and care				
Control	-0.94	0.347	1.06	0.294
Intervention				
Attitudes toward DM prevention and care				
Control	0.81	0.936	1.81	0.074
Intervention				
Knowledge about HT prevention and care				
Control	-0.69	0.488	1.30	0.196
Intervention				
Attitudes toward HT prevention and care				
Control	1.33	0.188	1.84	0.070
Intervention				

* Significance level at $\alpha = 0.05$

In this study, the specific designed intervention program greatly reduced the risk of developing DM and HT among Akha adults, which manifested as a significant reduction in triglycerides among those in the intervention group compared to the control group. Due to the limitation of a short intervention time, only this biomarker was reported to be significant. Upon closer analysis, other biomarkers, especially lipid profiles, showed decreasing trends compared to the control groups, which showed increasing trends in some markers. Triglyceride levels are greatly affected by food consumption. This could imply that people in the intervention village had good knowledge and attitudes in preparing and cooking healthy food in their daily life after being provided training through the program. Moreover, the program's demonstration of preparing food and cooking practices impacted Akha adults' daily food consumption.

Several studies supported our approach in improving DM and HT among the adult populations by using a community-based intervention, which meant that it required engagement or involvement from all people in a community. A systematic study reported that providing knowledge to people in the community was a significant factor in improving DM, especially when there is community engagement throughout the program, which had a great impact on the desired outcomes [17]. Another systematic review on the effectiveness of a community-based intervention for prevention of type 2 diabetes in low-and middle-income countries demonstrated that a community-based intervention for addressing type 2 DM among adults was important in addressing DM [18]. A community participant program was implemented to improve DM in Thailand, and it was reported that promoting exercise in the community could significantly reduce individuals' BMI and other biomarkers after implementation for three months [19]. Correia et al. [20] reported that the most effective program to address DM and HT was a program that had been implemented by a community member and met the sustainability for control of DM and HT. Pereira et al. [21] reported that providing essential health information regarding DM and HT to people in a community could improve their knowledge on how to maintain their blood glucose and blood pressure. Shirvani et al. [22] also supported their findings after conducting a global systematic review and meta-analysis, showing that community-based educational interventions could be used as a tool or approach to effectively reduce the prevalence of type 2 DM.

A crucial factor influencing the prevalence of DM and HT among the hill tribe was their culture of cooking and dietary pattern. In our previous study [13], which was used as the information base to develop the intervention program in this study, Akha people were found to favor the use of large quantities of cooking oil, salt, and monosodium glutamate when cooking. Then, we used this information to modify their knowledge, attitudes, and practices to promote better practices in preparing food and cooking for themselves and their family members. This was supported by a study in Thailand, which reported that culture and norms were major factors that needed to be addressed to reduce the incidence of DM and HT [23].

This study has some limitations. First, language was one of the critical barriers, especially during educating the participants, wherein some were not able to understand Thai. This challenge was solved by translating all essential information to participants by the village headmen and the village health volunteers who were fluent in Thai. Second, spaces for conduction physical activities in the village is limited, and some of their preferred sports were not conducted, such as football. The location of the intervention village is located at a small place at the top of the hill. However, the aerobic group dance was placed and received the most favor from the participants. Finally, many factors during the intervention could not be controlled for, which is common in community-based interventions. However, the major key characteristics of those who lived in the intervention and control villages did not differ. Moreover, people who lived in both villages were Akha and had the same culture and lifestyle; thus, the impact of the factors that were not controlled for, might not have interfered with the outcome.

At the end of the study, all interventions provided to the intervention village were provided to the people and participants in the control village. The people in the control village were trained on the standard program design, demonstration of healthy food preparation and cooking practices, and sports equipment. This was done to meet the standard for conducting intervention studies in the field.

Conclusion

Providing knowledge through specific training programs, including the demonstration of healthy dietary practices, to the hill tribe who are vulnerable to NCDs, especially DM and HT, can help improve key biomarkers for these diseases. Moreover, encouraging people to exercise by virtue of their own choice is another key factor in reducing the prevalence of DM and HT among the hill tribe. Therefore, having good knowledge through specific and carefully designed programs will improve attitudes toward good health, and practicing healthy food preparation and continuous exercise are expected to reduce the prevalence of DM and HT among hill tribe adults. The intervention program should be promoted among health professionals in the field.

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