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Influence of behavioral and genetic variables on the prevalence of type 2 diabetes mellitus in middle-aged monks of Thailand

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ABSTRACT

Diabetes mellitus (DM) and its associated complications present a major health problem for the Thai people, including Buddhist monks. This study aimed to identify the influence of behavioural and genetic variables on the prevalence of type 2 diabetes mellitus in middle-aged monks of Thailand. The study analyzed data from the health data centre of the Department of Public Health, Thailand, focusing on middle-aged monks in 76 provinces across 12 regions. The study recruited 6,408 Thai monks who met inclusion and exclusion criteria between October 2015-November 2019. Multivariable analysis was performed using a generalized linear mixed model, with adjusted odds ratios and 95% confidence intervals reported at a significance level of 0.05. Our study found that among the middle-aged monks of Thailand, 7.12% (95% CI: 6.49-7.78) had diabetes mellitus out of a total of 6,408. The results of our multivariable analysis showed that the following factors were associated with diabetes mellitus in monks of Thailand: respondents' body mass index (BMI) ≥30 kg/m2 (AOR=4.26, 95% CI: 3.08-5.90, p-value <0.001), respondents with a family history of DM (AOR=3.37, 95% CI: 2.52-4.81, p-value<0.001), and respondent's age ranges of 55-59 (AOR=2.87, 95% CI: 2.26-3.84, p-value<0.001), respectively. Diabetes millatus is significantly associated with the respondents who were obese, aged, and had a family history of DM. Therefore, a regular DM screening program as well as a timely health monitoring system for monks will enhance the diabetes control program in reducing the DM burden in Thailand.

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1. INTRODUCTION

Diabetes mellitus (DM) is one of the serious chronic metabolic diseases caused by either insufficient production of insulin or ineffective utilisation of the insulin produced by the body. Globally, it was estimated that diabetes prevalence in 2021 was 10.5% (537 million people), rising to 643 million by 2030 and 783 million by 2045 [1]. The majority is type 2 (T2), which accounts for more than 95% of people with diabetes, and around 8.5% of DM cases were found among those aged 18 years and older in 2014 [2]. Approximately millions of DM patients are living in developing and underdeveloped countries between the ages of 20 and 79 [3]. In 2019, approximately 1.5 million people died due to DM. Constant shifts in behaviours led to a health-risk transition, including epidemiological and health transitions with falling infectious diseases, reduced childhood mortality, and increases in non-communicable diseases such as type 2 diabetes mellitus (T2DM) [4]–[7].

The Buddhist monk, as one of the Triple Gem (Rattana Tri) elements, plays an important role in the inheritance and propagation of Buddhism in sustainable and wide manner. Thus, the health care of monks is one way to maintain Buddhism. Throughout the years, health problems among monks in Thailand have been discovered. Particularly, monks in urban areas have the same lifestyle as urban people, who need a fast and convenient lifestyle [8]. This fast and convenient lifestyle often leads to unhealthy habits such as poor diet and lack of exercise. As a result, monks in urban areas may face higher risks of developing health issues such as obesity, diabetes, and cardiovascular diseases. It is crucial to address these health problems among monks to ensure their well-being and ability to continue their important role in propagating Buddhis.

In addition, making food offerings from the people may not be appropriate and sufficient for the monks' health. These problems result from a public lack of knowledge or misunderstandings [9], [10]. For these reasons, an increasing number of monks tend to develop non-communicable diseases each year. Simultaneously, the majority of chronic diseases result from consuming behaviours. Many studies found that the consumption behaviour of a monk mostly consisted of a high-carbohydrate and low-protein diet [11]. Besides that, the monks could not choose their own food. They will just have food provided by people. Nowadays, people tend to give delicacies to monks, which can cause chronic diseases among them such as diabetes, hypertension, and heart disease [11].

The prevalence of DM in Thailand was approximately 8.31% (95% CI; 7.71 to 8.93) among adults >15 years, with a higher prevalence in females 9.6% (95% CI; 8.9 to 10.4) than in males 6.5% (95% CI; 5.62 to 7.42). Thailand had more than 45,159,163 cases of diabetes in 2024, with an 7.71% prevalence among adults [12]–[14]. In Thailand, based on the data from the fifth Thai National Health Examination Survey (NHES V), the prevalence of metabolic syndrome among Thai males who were at least 15 years and older was 24.9% [15]. For monks, the prevalence of metabolic syndrome ranged from 13% to 20.83% [5], [16].

However, some agencies in both the public and private sectors, as well as various organisations, have implemented health promotion for monks as a group of people with difficulties in accessing healthcare and the actions to provide correct knowledge and understandings about the health of monks in all sectors for better health among monks in urban areas. There are still limited studies being conducted to identify the fators associated with DM among middle-aged monks of Thailand. Therefore, this present study aimed to explore the influence of behavioural and genetic variables on the prevalence of type 2 diabetes mellitus in middle-aged monks of Thailand. The result of this study explores ways to prevent DM among Thai monks, and policymakers will enhance screening program for them.

2. METHOD

2.1. Study design

This cross-sectional analytical study used the data set from the recods of 43 standing healthcare folders of the health data centre (HDC) of the Ministry of Public Health Thailand. Thai middle-aged monks residing in all 12 regions, which consisted of 76 provinces in Thailand, were selected as the study population. A total of 6,408 sample size have been calculated by assuming the power of the test using a sample size calculation formula for logistic regression [17]. The inclusion creitria were thai monks aged 45 yeras and older had complted data on type 2 DM.

2.2. Data collection

Face to face interview was concucted by using a semi-structured questionnaire to assess the prevalence and factors associated with DM among the middle-aged monks of Thailand. The questionnaire was prepared in English and subsequently translated into Thai. In addition, the validity of the questionnaire was checked by three experts. The dependent variable of this study was type 2 diabetes mellitus (having type 2 diabetes mellitus or not having type 2 diabetes mellitus). Having type 2 diabetes mellitus was categorised as coding 1, whereas coding 0 represents that you do not have type 2 diabetes mellitus. The independent variables were sociodemographic factors (age, educational attainment), area of temple, family history of DM, and risk behaviours including body mass index (BMI), smoking, and drinking alcohol.

2.3. Statistical analysis

Statistics analysis was performed using STATA 18 (College Station, Texas 77845 USA, Copyright Khon Kaen University). For the bivariate analysis simple logistic regression was carried out to determine the correlation between one dependent variable and one independent variable, regardless of the impact of the rest of the variables reporting crude odds ratio (crude OR or OR) and 95% CI. The multivariable analysis was performed using generalized liner mixed model by including all independent variables into the model by assigning a p-value for entry (Pe) of 0.25, a p-value for removal (Pr)>Pe, and eliminating variables that do not relate to the model by the backward elimination method. Finally, we have tested the goodness of fit and reported each variable's adjusted OR (AOR) and 95% CI at the 0.05 significance level (α=0.05).

2.4. Ethical approval

The researcher submitted a proposal to Center for Ethics in Human Research, Khon Kaen University and has been approved under ethical exemption (HE632256). Participants were informed of the study's goals, expected outcomes, and the right to leave at any time. Each participant was assured that their information would be kept confidential and that participating posed no risk.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Description of the study population

This present study had 6,408 participants in total. An average age of Thai monks was 52.05 (±4.28) years old. Almost half of the participants had completed elementary school. Furthermore, the majority of participants (92.88%) had a family history of diabetes as shown in Table 1.

Table 1. Socio-demographic of middle-aged monks in Thailand (n=6,408)

Characteristics	Number (n)	Percentage (%)
1. Age (Years old)		
45-49	2,063	32.19
50-54	2,174	33.93
55-59	2,171	33.88
Mean±SD	52.05±4.28	
Median (Min: Max)	52(45:59)	
2. Educational attainment		
No formal education	227	3.54
Pre-elementary school	181	2.82
Elementary school	3,265	50.95
Secondary school	1,826	28.50
Certificate of technical vocation/High vocational certificate	398	6.21
Bachelor degrees	415	6.48
Postgraduate/Doctor degree	96	1.50
3. Family history of diabetes		
Yes	6,133	92.88
No	275	7.12
4. Smoking		
Never	5,814	90.73
Occasionally	84	1.31
Often	41	0.64
Always	469	7.32
5. Drinking alcohol		
Never	6,195	96.68
Occasionally	73	1.14
Often	27	0.42
Always	113	1.76
6. Body mass index (kg/m^2)		
<18.5	376	5.87
18.5-22.9	2,938	45.85
23.0-24.9	1,462	22.82
25.0-29.9	1,293	20.18
≥30	339	5.28
Mean ±SD	23.34±3.67	
Median (Minium: Maximum)	22.86(13.38:50)	
7. Waist circumference (cm)		
Normal	5,308	82.83
Higher than standard	1,100	17.17
Mean ±SD	82.87±8.68	
Median (Minium: Maximum)	82 (30:130)	
8. Area of the temple		
Rural	5,303	82.76
Urban	1,105	17.24

Table 2 showed that the prevalence of diabetes mellitus was 7.12% (95% CI: 6.49-7.78) among middle aged monks of Thailand. According to a regional comparison of DM prevalence, 10.67% (7.54-14.53) of cases are found in Northern (Health region 2). Similarly, 8.30% (6.43–10.49) of DM cases are seen in the central region (Health region 6). Furthermore, perveances of DM among monks have been found in the Northeast (6.91%) and South (9.82%) regions as shown in Table 3.

Table 2. Prevalence of type 2 diabetes mellitus among the middle-aged monks in Thailand (n=6,408)

Diabetes Mellitus Type 2	Number (n)	Percentage (%)	95%CI of Prevalence of DM
Yes	456	7.12	6.49-7.78
No	5,952	92.88	92.23-93.50

Table 3. Health region wise prevalence of type 2 diabetes mellitus cases among the middle-aged monks in Thailand, (n=6,408)

Regional health	Prevalence of DM			95%CI of prevalence of DM
	Total cases	Number of DM cases (n)	Percentage of DM (%)	
North				
Health region 1	624	60	9.62	7.41-12.20
Health region 2	328	35	10.67	7.54-14.53
Central				
Health region 3	514	31	6.03	4.13-8.45
Health region 4	510	36	7.06	4.99-9.64
Health region 5	782	58	7.42	5.68-9.49
Health region 6	759	63	8.30	6.43-10.49
Northeast				
Health region 7	589	35	5.94	4.17-8.17
Health region 8	752	52	6.91	5.218.97
Health region 9	741	34	4.59	3.20-6.35
Health region 10	552	38	6.88	4.92-9.33
South				
Health region 11	145	3	2.07	4.29-5.93
Health region 12	112	11	9.82	5.01-16.89

3.1.2. Bivariate analysis

In our bivariate analysis, monks aged 50-54 and 55-59 were found to be associated with DM with OR 1.80, 95% CI: 1.36-2.37, p-value <0.001, and OR 2.78, 95% CI: 2.15-3.62, p-value <0.001, respectively. Similarly, those who had family history of DM (OR 3.85, 95% CI: 2.81-5.27, p-value <0.001) and respondents' BMI ranges of 23-24.9 kg/m^2 (OR=1.55, 95% CI: 1.21-2.00, p-value <0.001), 25-29.9 kg/m^2 (OR=1.87, 95% CI: 1.46-2.39, p-value <0.001), and BMI ≥30 kg/m^2 (OR=4.30, 95% CI: 3.13-5.90, P-value <0.001), respectively as shown in Table 4.

3.1.3. Multivariable analysis

The analysis between independent factors and the prevalence of DM among Thai monks on the basis of GLMM has been described in Table 5. According to our findings, respondents who had a family history of having diabetes (AOR 3.37, 95% CI 2.52-4.81, p-value <0.001) and increased BMI ≥30 kg/m^2 (AOR 4.26, 95% CI 3.08-5.90, p-value <0.001) were found to be significantly associated with DM. In addition, the elderly monks age groups of 50-54 (AOR 1.81, 95% CI 1.37–2.40, p-value <0.001) and 55-59 (AOR 2.87, 95% CI 2.26-3.84, p-value <0.001) were also associated with T2DM as shown in Table 5.

3.2. Discussion

This present study has been described the circumstantial threads which led by the threatening non-communicable disease i.e. diabetes miletus among the Thai monks. It has been observed that 7.12% of the Thai monks were suffering from DM which is slightly lower than that of the overall prevalence of DM in Thailand [18]–[20]. In our setting, this present study revealed that a substantial correlation between type 2 diabetes (which has been linked to obesity with a BMI of ≥30 kg/m^2) and eating behaviour and an unbalanced lifestyle, as has been noted in numerous other studies [21]–[23]. A number of epidemiological studies have indicated a steady rise in the prevalence of type 2 diabetes among individuals who are obese [7], [24]. Obesity is a significant independent and modifiable risk factor for the disease. Of the well-known risk factors for diabetes, obesity (BMI ≥30 kg/m^2) is one of the most significant and influential risk factors. Numerous studies have shown a close correlation between obesity and the onset of diabetes. Studies have indicated that those with higher body weight, especially in the abdomen, have higher insulin resistance and may find it more difficult to effectively manage their diabetes [9], [25].

Table 4. Bivariate analysis of factors associated with type 2 diabetes mellitus among the middle-aged monks in Thailand, using generalized linear mixed model GLMM (n=6,408)

Factors	Number (n)	% of DM	Crude OR	95%CI	P-value
1. Age (Years old)					<0.001*
45-49	2,063	3.97	1	1	
50-54	2,174	6.90	1.80	1.36-2.37	
55-59	2,171	10.32	2.78	2.15-3.62	
2. Educational attainment					
Secondary school-postgraduate/Doctor degree	2,735	7.06	1	1	0.954
No formal education pre-elementary school	408	7.11	0.99	0.66-1.50	
Elementary School	3,265	7.14	1.03	0.84-1.26	
3. Family history of diabetes					<0.001*
No	6,133	6.52	1	1	
Yes	275	20.36	3.85	2.81-5.27	
4. Smoking					0.606
No	5,814	6.57	1	1	
Yes	594	7.17	1.09	0.77-1.54	
5. Body mass index (kg/m^2)					<0.001*
<22.9	3,314	4.98	1	1	
23.0-24.9	1,462	7.59	1.55	1.21-2.00	
25.0-29.9	1,293	9.05	1.87	1.46-2.39	
≥30	339	18.58	4.30	3.13-5.90	
6. Area of the temple					0.460
Urban	1,105	6.61	1	1	
Rural	5,303	7.22	1.10	0.85-1.43	

* p-value <0.05 significance level

Table 5. Multivariable analysis of factors associated with type 2 diabetes mellitus among the middle-aged monks in Thailand, using GLMM (n=6,408)

Factors	Number (n)	% of DM	Crude OR	Adj. OR	95%CI	P-value
1. Age (Years old)						<0.001*
45-49	2,063	3.97	1	1	1	
50-54	2,174	6.90	1.79	1.81	1.37-2.40	
55-59	2,171	10.32	2.78	2.87	2.26-3.84	
2. Family history of diabetes						<0.001*
No	6,133	6.52	1	1	1	
Yes	275	20.36	3.66	3.37	2.52-4.81	
3. Body mass index (kg/m^2)						<0.001*
<22.9	3,314	4.98	1	1	1	
23.0-24.9	1,462	7.59	1.55	1.52	1.18-1.96	
25.0-29.9	1,293	9.05	1.87	1.76	1.37-2.27	
≥30	339	18.58	4.30	4.26	3.08-5.90	

* p-value<0.05 significance level

Our finding that recognized risk factors accounted for family history-associated risks to varying degrees also suggests that the aetiology of the risk varies throughout family members. Strong risk factors for type 2 diabetes in monks include anthropometric traits including BMI inherited lifestyle choices [11], [26], [27]. A substantial amount of the family history association may be mediated by genetic factors, as evidenced by previous studies of adoptees who showed no increased risk of T2DM from a family history of diabetes in their adoptive parents but a sustained increase in risk when their biological parents had the disease [28]–[30].

Similarly, this study showed that type 2 diabetes was more common in the 55 to 59 age range, which is consistent with several studies conducted on older adults that found a substantial correlation between type 2 diabetes and age 55 [29], [31], [32]. One possible explanation for this could be that middle-aged individuals consume large amounts of food and exercise less because they are preoccupied with home duties and employment, which limits their opportunities for self-care and seeking medical attention [8], [26], [33]. Therefore, one of the worldwide health concerns is determining the early detection of diabetes, particularly in monks, so that policymakers may develop an appropriate program for DM screening and improve Thailand's program for DM control.

3.2.1. Strength and limitations of the study

This study's design has been focused on secondary analysis, which is one of its limitations. In contrast to primary analysis, the researcher in secondary analysis must accept the method of data collection and the data "as it is". The researcher can't design the study based on the questions to be answered. Similarly,

the researcher designs questions based on the availability of the data. Regardless of this limitation, secondary analysis of the HDC of the Ministry of Public Health Thailand permitted the researcher to use data from a large sample in a laborious national study.

4. CONCLUSION

This current study revealed that the prevalence of DM is significantly higher among middle-aged Thai monks. In addition, DM is significantly associated with the respondents who were obese, aged, and had a family history of DM. Hence, with this present study, we can claim that behavioural and genetic variables are one of the major predictors of DM among monks in Thailand. Therefore, a regular DM screening program as well as a timely health monitoring system for monks will enhance the diabetes control program, reducing the DM burden in Thailand. Lifestyle factors and genetic risk are significant contributors to diabetes onset. So, future studies should explore gene-environment interactions and understand how lifestyle factors contribute to epigenetic changes in genetic risk expression over the lifespan.

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