International Journal of Public Health Asia Pacific
Open Access: e-Journal
ISSN: 2822-0587(Online)

Health related factors and prediabetes among middle-aged adults in Mandalay, Myanmar

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ABSTRACT

Background: Prediabetes indicates a higher risk for the development of overt type 2 diabetes mellitus, and an already heightened risk of cardiovascular diseases (CVD). In Myanmar, diabetes is the fourth leading cause of mortality among the top ten causes of death.

Objectives: This study aimed to identify the association between health-related factors and prediabetes among middle-aged adults in Mandalay, Myanmar.

Methods: A cross-sectional analytical study was conducted among middle-aged (40-59 years) who were recruited through multistage random sampling. Data were collected using a structured, interviewer-administered questionnaire. Multiple logistic regression was used for data analysis.

Results: The prevalence of prediabetes among middle-aged adults in the Mandalay Region was 41.73% (95% Confidence Interval [CI]: 37.50-46.08). Participants with limited health literacy were 1.61 times more likely to have prediabetes compared to those with adequate health literacy (adjusted odds ratio [AOR]=1.61, 95% CI: 1.01–2.55). Other factors significantly associated with an increased risk of prediabetes included Lisu ethnicity (AOR=3.63, 95% CI: 1.99–6.61), former or current use of tobacco products (AOR=1.52, 95% CI: 1.01–2.26), presence of chronic diseases (AOR=2.41, 95% CI: 1.37–4.22), a family history of non-communicable diseases (AOR=2.12, 95% CI: 1.22–3.69), hypertension (AOR=2.05, 95% CI: 1.28–3.28), moderate to severe stress (AOR=3.14, 95% CI: 1.77–5.57), frequent consumption of plant-based protein (AOR=1.91, 95% CI: 1.05–3.47), and low diabetes knowledge (AOR=2.05, 95% CI: 1.23–3.43).

Conclusion: The prevalence of prediabetes is notably high among middle-aged adults in the Mandalay Region, Myanmar and is significantly associated with health literacy, socio-demographics, health behaviours, physical and mental health status. Public health interventions focusing on improving diabetes awareness, promoting healthy lifestyles and enhancing health literacy are critical to reducing the burden of prediabetes in this population.

Keywords: Health related factors, Mandalay region, Prediabetes

1. Introduction

The global prevalence of impaired fasting glucose in 2021 was 6.2% and is estimated to heighten to 6.9% of the adult population in 2045 [1]. According to public health situation analysis in Myanmar in 2022, it was estimated that 71% of all death rate of Myanmar was related with non-communicable diseases (NCDs) and cancer, and 6% of death rate was related with diabetes [2]. Overall prevalence of prediabetes was 19.7% in Myanmar. Moreover, the silent epidemic of diabetes is widespread across the country [3].

The concept of prediabetes is important because 25% of individuals with prediabetes will progress to type 2 diabetes approximately within 3–5 years. It can also increase the risk of cardiovascular diseases (CVD) and chronic kidney disease. [4, 5]. To prevent progression of prediabetes to overt type 2 diabetes, healthy weight and behaviours are critical [6]. Physical activity [7], and healthy diets [8, 9] can prevent or delay the progression of prediabetes to diabetes. Health literacy is one determinant of self-care behaviour in type 2 diabetes [10].

In Myanmar, diabetes-related health expenditure costs $ 394.5 million in 2021 and that number is expected to increase to $ 457.3 million by 2030 and $ 554.3 million by 2045 [11]. Despite global evidence identifying risk factors such as unhealthy behaviours, physical inactivity, family history of diabetes and other NCDs [12], there is a lack of context-specific data from Myanmar particularly in densely populated urban areas like Mandalay. Mandalay, as the second-largest city, faces unique challenges due to rapid urbanization, changing lifestyles and limited preventive health services, yet few studies have examined the early determinants of prediabetes in this region. Therefore, this study aimed to identify the prevalence and factors associated with prediabetes among middle-aged adults in Mandalay, Myanmar.

2. Methods

2.1 Study Area

This study was conducted in Mandalay Region, Myanmar, located in the central part of Myanmar. This region is administratively divided into seven districts and 30 townships or sub-townships. The total population was 6,165,723 (12% of total population of Myanmar). Of this, 2,928,367 (47.49%) were male and 3,237,356 (52.51%) were female. Among the total population of Mandalay region, 1,360,373 were people 40-59 years. The population density of Mandalay Region

was 200 persons per square kilometre. This is much higher than the Union level population density of 76 persons per square kilometre and it means Mandalay is the second highest in population density among 15 State /Region of Myanmar.

2.2 Study Design

A cross-sectional analytical study was conducted to describe the prevalence of prediabetes among middle-aged adults in Myanmar from May 2024 to April 2025.

2.3 Sample Size and Sampling

The sample size of 508 was calculated based on data from a previous study conducted in adults among Dessie Town, Northeast Ethiopia [13] using multiple logistic regression [14]. A total 21 villages from three sub-districts were selected through the multistage random sampling. If there were more than one potential participant willing to participate in the same house, the researcher selected only one participant by lottery method among them to avoid bias. If there was non-response person in the selected house, we left that house and continued data colleting according to procedure. Then, this study added the required sample starting from the end house number of previous procedure. Eligible participants included adults aged 40-59 years who had resided in the study area for at least one year and were able to communicate in Myanmar language. Pregnant women, critically ill patients, and individuals with diabetes and psychological disorder were excluded.

2.4 Data Collection

Data were collected through face-to-face interviews using a structured questionnaire in a Myanmar language, consisting of six parts: socio-demographic characteristic, health literacy, health determinant, knowledge of diabetes mellitus, perception (attitude) towards diabetes, and physical measurements. The validation of the questionnaire was checked with three expertise and revised as required. pilot test was conducted in a neighbouring township with 30 participants prior to the main survey. Based on the pilot test results, further modifications were made to improve the validity and reliability of the questionnaire. The Cronbach's alpha coefficients were 0.80 for health literacy, 0.83 for diabetes knowledge, 0.72 for attitudes, and 0.79 for the Perceived Stress Scale. Prediabetes was defined as a fasting plasma glucose (FPG) level between 100 and 125 mg/dL [15].

2.5 Data Analysis

The data was recorded into MS Excel and imported into the STATA version 18.0 (College Station, Texas 77845 USA), then the data was checked for validation before analysing. Baseline characteristics were described using frequency, percentage, mean, standard deviation (SD), median, and ranges (minimum and maximum). In the bivariate analysis, simple logistic regression was used to calculate the Crude Odds Ratio (COR), 95% Confidence Interval (CI), and P-value for each variable. Variables with a P-value less than 0.25 were selected for inclusion in the initial model by the multivariable logistic regression. The relationship between independent variables was tested with a multicollinearity test before assessing the baseline model, and the Variance Inflation Factor (VIF) was 1.55, which was acceptable. Backward elimination strategies were used to perform multiple logistic regression. As a result, the model correctly predicted the outcome and could be inferenced to the population. When the P-value was less than 0.05, health literacy and other characteristics were considered significantly linked prediabetes mellitus. The association was demonstrated using Adjusted Odds Ratio (AOR) and 95% Confidence Interval (95% CI).

3. Results

3.1 Baseline characteristics of the participants

A total of 508 middle aged men and women from 21 villages were recruited for this study. The mean age was 48.01with the Standard Deviation (SD) of ±5.95 and 35.83% of the participants were in the age group of 40 to 44 years. The male participants were 43.70% and the female was 56.30% respectively. Only 8.27% of them had completed a bachelor's degree or above, accounting for a tiny percentage of the total. 52.56% of the participants were Burma ethnic and 87.80% of the participants were Buddhist. During the data collection period, 49.41% of the participants were adequate financial status but unable to save.

42.13% of participants were currently using of tobacco products and 29.53% were current drinker at the data collection time. 67.52% of the respondents reached HEPA active (Health-enhancing physical activity). Ground nut oil was consumed by 57.68% of the participants. 82.48% of the participant consumed oily food, 78.74% of the participant consumed sugar-sweetened

beverages and 88.19% of the participant consumed salty foods less than five days in a weekly. 71.26% of them ingested animal-based protein less than five days per week (71.26%) and 86.02% of them ingested plant-based protein less than five days per week. 52.17 % of the participants slept for less than 8 hours per night.

71.26% of the participants reported being normal health status at the time of data collection and only 17.32% of them reported having a chronic condition. When we queried the study population about their family history, 14.17% had a family history of diabetes and 16.54% had a family history of NCDs. 45.67% were obese and 53.94% fell below WHO's interim cut-off point of less than 90cm in males and less than 80cm in females. 24.80% of the participants were high blood pressure. Of all participants only 20.87% had low stress, whereas moderate stress and high stress were 78.54% and 0.59% respectively. The average Perceived Stress Scale (PSS) score was 15.58 (±4.24). Among the participants, for overall health literacy, only 6.50% had the excellent health literacy, the remaining were adequate (21.65%), problematic (26.77%) and inadequate (45.08%). About 37.40% of them had low level of knowledge and 49.21 of them had good attitudes towards diabetes (Table 1).

Table 1: Baseline characteristics of the participants (n=508).

Characteristic	Number	Percentage (%)
Age (years)		
40-44	182	35.83
45-49	120	23.62
50-54	113	22.24
55-59	93	18.31
Mean (SD)	48.01(±5.95)	
Median (Min: Max)	47.5 (40: 59)	
Sex		
Male	222	43.70
Female	286	56.30
Educational status		
No education	57	11.22
Primary school	154	30.31
Middle school	178	35.04
High school	77	15.16
Bachelor's degree and above	42	8.27
Ethnicity		
Burma	267	52.56
Lisu	124	24.41
Chinese	35	6.89
Kachin	5	0.98
Other	77	15.16
Religion		

Characteristic	Number	Percentage (%)
Buddhist	446	87.80
Christian	62	12.20
Occupation		
Government/NGO employee	31	6.10
Self-employee	42	8.27
Farmer	146	28.74
Merchant	27	5.31
Housewife	159	31.30
Others	103	20.28
Monthly Family income per month (USD)		
<60	134	26.37
60-119	271	53.35
≥120	103	20.28
Mean (SD)	92.55(±64.79)	
Median (Min: Max)	80(20: 400)	
Family monthly expenditure per month (USD)		
<60	133	26.18
60-119	281	55.31
≥120	94	18.51
Mean (SD)	87.45 (±56.66)	
Median (Min: Max)	80 (4: 400)	
Financial status		
Adequate and able to save	51	10.04
Adequate but unable to save	251	49.41
Inadequate	177	34.84
Inadequate and in debt	29	5.71
Tobacco consumption		
Never	264	51.96
Former user	30	5.91
Current user	214	42.13
Alcohol consumption		
Never	296	58.27
Former user	62	12.20
Current user	150	29.53
Physical activity		
Inactive	24	4.72
minimally active	141	27.76
HEPA active	343	67.52
Most commonly used oil in the last month		
Ground nut oil	293	57.68
Soybean oil	2	0.39
Sunflower oil	18	3.54
Sesame oil	1	0.21
Palm oil	72	14.17
Groundnut oil and palm oil	113	22.24
Animal fat	9	1.77
Consumption of oily food such as cooking curry in Myanmar style per weeks (days)		
<5	419	82.48
≥5	89	17.52
Consumption of sugar-sweetened beverages per weeks (days)		
<5	400	78.74
≥5	108	21.26

Characteristic	Number	Percentage (%)
Consumption of salty foods per weeks (days)		
<5	448	88.19
≥5	60	11.81
Consumption of animal-based protein per weeks (days)		
<5	362	71.26
≥5	146	28.74
Consumption of plant-based protein per weeks (days)		
<5	437	86.02
≥5	71	13.98
Sleep duration (Hours)		
<8	265	52.17
≥8	243	47.83
Health status (self-reported)		
Unhealthy	54	10.63
Normal	362	71.26
Healthy	79	15.55
Very healthy	13	2.56
Chronic disease (NCDs)		
No	420	82.68
Yes	88	17.32
Family history of diabetes mellitus		
No	436	85.83
Yes	72	14.17
Family history of other NCDs		
No	424	83.46
Yes	84	16.54
Body mass index (BMI)		
Underweight (<18.5)	22	4.33
Normal weight (18.5 - 22.9)	170	33.46
Overweight (23 - 24.9)	84	16.54
Obesity (≥25)	232	45.67
Mean (SD)	24.97 (±4.65)	
Waist circumference (cm)		
Below interim cut off point (<90 in men & <80 in women)	274	53.94
Interim cut off point and above (≥90 in men & ≥80 in women)	234	46.06
Mean (SD)	84.08 (±11.10)	
Median (Min: Max)	83 (61: 148)	
Hypertension		
No (SBP <140 & DBP < 90 mmHg)	382	75.20
Yes (SBP ≥ 140 &/or DBP ≥ 90 mmHg)	126	24.80
Perceived Stress (PSS)		
Mild (0-13)	106	20.87
Moderate (14-26)	399	78.54
Severe (≥27)	3	0.59
Mean (SD)	15.58(±4.24)	
Median (Min: Max)	16 (0:33)	
Health literacy (overall)		
Inadequate (<26)	229	45.08
Problematic (26-33)	136	26.77
Adequate (34-42)	110	21.65

Characteristic	Number	Percentage (%)
Excellent (≥43)	33	6.50
Mean (SD)	27.42(±9.02)	
Median (Min: Max)	26.59(0:50)	
Knowledge level		
Low (<60%)	190	37.40
Moderate (60-79%)	163	32.09
High (≥80%)	155	30.51
Mean (SD)	66.05 (±19.93)	
Median (Min: Max)	63.63 (0:100)	
Attitude level		
Poor (<60%)	9	1.77
Moderate (60-79%)	249	49.02
Good (≥80%)	250	49.21
Mean (SD)	79.52 (±10.49)	
Median (Min: Max)	78.18(54.55:100)	

3.2 Prevalence of prediabetes among middle-aged adults in Mandalay Region, Myanmar

In this study, the overall prevalence of prediabetes among middle-aged adults in Mandalay Region was 41.73 % by using American Diabetes Association (ADA) standard.

3.3 Factors associated with prediabetes among middle-aged adults in Mandalay Region, Myanmar: Multivariate analysis

After controlling other covariates, limited health literacy was associated with prediabetes mellitus. The middle-aged adults who had problematic and inadequate level of health literacy were 61% more likely to be prediabetes than those with excellent and adequate health literacy (AOR=1.61, 95% CI: 1.01- 2.55). Lishu ethnicity had 3.63 times higher odds of having prediabetes compared to other ethnic groups (AOR=3.63, 95% CI: 1.99 - 6.61). Moreover, other factors that were associated with increased risk of prediabetes were; those who were former and Current user of tobacco products (AOR=1.52, 95% CI: 1.01 - 2.26), those who had chronic diseases (AOR=2.41, 95% CI: 1.37 - 4.22), those who had family history of other NCDs (AOR=2.12, 95% CI: 1.22 - 3.69), those who had hypertension (AOR=2.05, 95% CI: 1.28 - 3.28) and those who had moderate and severe stress (AOR=3.14, 95% CI: 1.77 - 5.57). The current study revealed that those who consumed plant-based protein on the majority of the days were 1.91 times more likely to have prediabetes compared to those who consumed them on fewer than 5 days per week per weeks (AOR=1.91, 95% CI: 1.05 - 3.47). The participants who with low knowledge level were 2.05 times more likely

to be diabetes compared to those with high level (AOR=2.05, 95% CI: 1.23 - 3.43) (Table 2).

Table 2: Bivariate and Multivariable analysis of factors associated with prediabetes among middle-aged adults in Mandalay Region, Myanmar using simple and multiple logistic regression (n=508).

Factors	Number	% of prediabetes	COR	95% CI	AOR	95% CI	P-value
Age (years)							0.044*
40-49	302	38.08	1				
50-59	206	47.09	1.45	1.01-2.07			
Educational status							<0.001*
Middle school and above	279	35.02	1				
Primary school	154	46.75	1.62	1.09-2.42			
No education	57	63.16	3.18	1.76-5.73			
Ethnicity							
Other	117	29.06	1		1		<0.001**
Burma	267	37.08	1.44	0.90-2.30	1.17	0.69-1.98	
Lishu	124	63.71	4.29	2.49-7.36	3.63	1.99-6.61	
Religion							<0.001*
Buddhist	446	38.57	1				
Christian	62	64.52	2.90	1.66-5.04			
Monthly Family income per month (USD)							0.071*
≥120	103	36.89	1				
60-119	271	39.48	1.12	0.70-1.78			
<60	134	50.00	1.71	1.01-2.89			
Family monthly expenditure per month (USD)							0.222*
≥120	94	36.17	1				
60-119	281	40.93	1.22	0.75-1.98			
<60	133	47.37	1.59	0.92-2.73			
Financial status							
Adequate but unable to save and able to save	302	37.09	1				0.011*
Inadequate	177	46.33	1.46	1.00-2.13			
Inadequate and in debt	29	62.07	2.78	1.27-6.08			
Tobacco consumption							0.043**
Never	264	36.36	1		1		
Former and Current user	244	47.54	1.59	1.11-2.26	1.52	1.01-2.26	
Alcohol consumption							0.120*
Never	296	38.85	1				
Former and Current user	212	45.75	1.33	0.93-1.89			
Physical activity							0.041*
HEPA active	343	40.23	1				
minimally active	141	41.13	1.04	0.70-1.55			
Inactive	24	66.67	2.97	1.24-7.13			
Most commonly used oil in the last month							0.016*

Factors	Number	% of prediabetes	COR	95% CI	AOR	95% CI	P-value
Ground nut oil, Soybean oil, Sunflower oil and Sesame oil	314	37.58	1				
Palm oil, Groundnut and palm oil and Animal fat	194	48.45	1.56	1.09-2.24			
Consumption of oily food such as cooking curry in Myanmar style per weeks (days)							0.17*
<5	419	40.33	1				
≥5	89	48.31	1.38	0.87-2.19			
Consumption of salty foods per weeks (days)							0.169*
<5	448	40.63	1				
≥5	60	50.00	1.46	0.85-2.50			
Consumption of animal-based protein per weeks (days)							0.046*
<5	362	38.95	1				
≥5	146	48.63	1.48	1.00-2.19			
Consumption of plant-based protein per weeks (days)							0.033**
<5	437	38.90	1		1		
≥5	71	59.15	2.27	1.36-3.79	1.91	1.05-3.47	
Sleep duration (Hours)							0.025*
≥8	243	36.63	1				
<8	265	46.42	1.49	1.05-2.14			
Health status (self-reported)							<0.001*
Very healthy and healthy	92	33.70	1				
Normal	362	39.23	1.27	0.79-2.05			
Unhealthy	54	72.22	5.12	2.45-10.67			
Chronic disease (NCDs)							0.002**
No	420	36.19	1		1		
Yes	88	68.18	3.79	2.31-6.17	2.41	1.37-4.22	
Family history of diabetes mellitus							0.041*
No	436	39.91	1				
Yes	72	52.78	1.68	1.02-2.78			
Family history of other NCDs							0.007**
No	424	38.44	1		1		
Yes	84	58.33	2.24	1.39-3.60	2.12	1.22-3.69	
Body mass index (BMI)							0.069*
Under and Normal weight	192	35.94	1				
Overweight	84	40.48	1.21	0.72-2.05			
Obesity	232	46.98	1.58	1.07-2.34			
Waist circumference (cm)							0.009*
Below interim cut off point	274	36.50	1				
Interim cut off point and above	234	47.86	1.59	1.12-2.27			
Hypertension							0.002**
No	382	35.60	1		1		
Yes	126	60.32	2.75	1.82-4.16	2.05	1.28-3.28	
Perceived Stress (PSS)							<0.001**
Mild (0-13)	106	19.81	1		1		
Moderate and severe	402	47.51	3.66	2.19-6.14	3.14	1.77-5.57	

Factors	Number	% of prediabetes	COR	95% CI	AOR	95% CI	P-value
Health literacy							0.044**
Excellent & Adequate	143	32.87	1		1		
Problematic & Inadequate	365	45.21	1.69	1.12-2.53	1.61	1.01-2.55	
Knowledge level							0.011**
High (≥80%)	155	34.84	1		1		
Moderate (60-79%)	163	39.88	1.24	0.79-1.96	1.15	0.69-1.93	
Low (<60%)	190	48.95	1.79	1.16-2.77	2.05	1.23-3.43	
Attitude level							0.026*
Good	250	36.80	1				
Moderate and Poor	258	46.51	1.49	1.05-2.13			

* COR P-value, ** AOR P-value

4. Discussion

In this study, the overall prevalence of prediabetes was 41.73%, with 42.31% in females and 40.99% in males, based on the ADA criteria. This prevalence is notably higher than that reported in a previous study conducted in Myanmar, which found a prediabetes rate of 19.7% (16.5% in males and 23% in females) using the World Health Organization criteria [3] and 30.08% among middle-aged adult and elderly in Yangon [16]. Additionally, the prevalence observed in the current study exceeds that reported in Thailand, where a study using the ADA criteria found a prevalence of 38.8% [17]. Similarly, a study in China using the ADA cut-off reported a prediabetes prevalence of 35.7%, which is also lower than the rate identified in this study [18]. This demonstrated that middle-aged adults in Myanmar people were at greater risk of developing prediabetes and accompanying consequences. With regard to the different prevalence of prediabetes in the current study compared with the other studies may be due to definition of prediabetes, geographical variations, age differences, behavioural differences and other variations.

The present study found that individuals belonging to the Lisu ethnic group had 3.63 times higher odds of having prediabetes compared to other ethnic groups. This finding suggested that ethnicity may play a significant role in the risk of developing prediabetes possibly due to underlying cultural, dietary or lifestyle differences. This result aligned with a previous study conducted in Carolina which highlighted ethnicity as a key factor associated with elevated diabetes risk [19]. Furthermore, a study among U.S. adults reported that Asian, Black and Hispanic populations had significantly higher risks of prediabetes compared to White adults [20]. Similarly,

research among Myanmar migrant workers in Chiang Rai Province, Thailand, showed that Burmese individuals had 4.76 times higher odds of developing hyperglycaemia compared to the Akha ethnic group [21]. These disparities may be explained by variations in cultural practices, cooking habits, genetic predispositions and levels of physical activity across different ethnic communities.

In this study, participants who were current or former tobacco users had a 1.52 times higher risk of developing prediabetes compared to those who had never used tobacco products. This finding is consistent with a large cross-sectional study from Liechtenstein, which reported that current smokers had an OR of 1.82 for prediabetes compared to never-smokers [22]. A substantial body of clinical and experimental evidence has demonstrated a significant association between tobacco use and the development of prediabetes, type 2 diabetes, impaired glycaemic control, and diabetic complications. Nicotine is believed to be the primary factor, as it can influence glucose metabolism both directly by affecting insulin sensitivity and indirectly through inflammatory and oxidative pathways [23].

Interestingly, this study also found that participants who consumed plant-based protein on most days of the week were 1.9 times more likely to have prediabetes than those who consumed it less frequently (fewer than five days per week). This finding appeared to align with the Rotterdam Study from the Netherlands, which showed that higher total protein intake was associated with increased insulin resistance, as measured by HOMA-IR, and a higher risk of developing prediabetes and type 2 diabetes (HR = 1.34 [1.24–1.44] for prediabetes; HR = 1.37 [1.26–1.49] for type 2 diabetes) [24]. While plant-based diets are generally considered protective, excessive or imbalanced intake of plant proteins especially those with high carbohydrate content such as legumes or processed plant-based foods may contribute to increased glycaemic load. Additionally, cooking methods, oil use and portion sizes may influence the metabolic effects of these foods.

This study found that participants with existing NCDs were 2.40 times more likely to have prediabetes compared to those without NCDs. Additionally, individuals with a family history of other NCDs had 2.12 times higher odds of being prediabetic. These

associations suggested that both personal and familial health histories of chronic conditions may contribute significantly to metabolic dysregulation. One explanation could be the clustering of unhealthy behaviours within families such as poor dietary habits, physical inactivity and tobacco or alcohol use as well as shared genetic predispositions [25, 26].

Hypertension was also strongly associated with prediabetes in this study. Participants with high blood pressure were 2.05 times more likely to be prediabetic than those with normal blood pressure. This finding is in line with a community-based cross-sectional study, where 54.26% of individuals with prediabetes had hypertension, compared to only 23.3% of those with normal glucose levels [27]. Similarly, a study conducted among the Karen ethnic population in Thailand reported that hypertensive individuals were 2.15 times more likely to develop prediabetes compared to those without hypertension [28]. The physiological basis for this association may be due to shared pathophysiological mechanisms such as insulin resistance, endothelial dysfunction, and chronic inflammation which are common to both hypertension and prediabetes [29].

Furthermore, psychosocial stress emerged as another significant factor. Participants who experienced moderate to severe stress had a 3.14 times higher risk of prediabetes compared to those with mild stress levels. This result is supported by a study among the Indian population which showed that individuals with higher stress levels had elevated fasting blood glucose levels and a greater likelihood of prediabetes [30]. Chronic stress is known to increase cortisol levels and disrupt hormonal balance which can impair insulin sensitivity and glucose regulation. Stress may also indirectly contribute to prediabetes through unhealthy coping behaviours such as overeating, reduced physical activity and increased substance use [31].

In this study, middle-aged adults with problematic or inadequate health literacy were 1.61 times more likely to have prediabetes compared to those with excellent or adequate health literacy. This finding aligned with a study conducted in the United States, which reported that nearly one in five adults with prediabetes had low health literacy [32]. This is critically important as about two third of this population had problematic or inadequate health literacy which is lower than a study conducted among Myanmar migrant workers in Thailand [33]. Poor health literacy may contribute to

increased risk of prediabetes through multiple pathways: individuals with limited health literacy may struggle to comprehend dietary guidelines, interpret medical instructions or navigate healthcare systems which in turn reduces their ability to engage in preventive behaviours and effective disease self-management.

Additionally, the study found that participants with low knowledge level about diabetes were 2.05 times more likely to have prediabetes compared to those with high knowledge level. This result is consistent with a previous study conducted in Iran which emphasized that diabetes-related knowledge is a critical factor in preventing the progression from prediabetes to type 2 diabetes [34]. Knowledge enables individuals to recognize risk factors, adopt healthier lifestyles and make informed decisions related to nutrition, physical activity and screening practices.

This study was conducted among middle-aged adults in the Mandalay Region of Myanmar which may limit the generalizability of the findings to other regions or to the national population. Additionally, the data collection relied on participants' self-reported responses to structured questionnaires which may be subject to recall bias or social desirability bias. Although efforts were made to minimize interviewer-related bias, it could not be completely excluded.

5. Conclusion

This study identified a high prevalence of prediabetes among middle-aged adults in the Mandalay Region indicating a significant public health concern. Lishu ethnicity, lifestyle factors such as current or former tobacco use and frequent consumption of plant-based protein were also linked to elevated risk. In addition, individuals with existing chronic diseases, family history of non-communicable diseases, hypertension, and moderate to severe stress levels were more likely to be prediabetic. Notably, low knowledge about diabetes and inadequate health literacy emerged as significant predictors underscoring the need for community-based education and health promotion interventions. Targeted strategies addressing these modifiable risk factors are essential to prevent the progression of prediabetes to type 2 diabetes in this vulnerable population.

Acknowledgement

I wish to extend my sincere thanks to village administers, community leaders and health

staffs of Mandalay Region, Myanmar to allow me data collection, helpful assistance and participation in this study. I deeply appreciate to all the participants who willingly participated and gave their valuable information for my study. Without their kind co-operation, this study would not have been possible.

Author contributions

MMW and TP contributed to the study conception and design, data collection, data analysis, and manuscript drafting. Both authors critically revised the manuscript and approved the final version for publication.

Declaration

Ethics approval and consent to participate

This study was approved by the Centre for Ethics in Human Research, Khon Kaen University, Thailand with the reference number HE 672274 from Khon Kaen University approval date on 19th Feb 2025.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

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Received 19/04/2025
Received in revised form 13/05/2025
Accepted 13/05/2025