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Determinants of hypertension along the Myanmar-China border: Lifestyle, knowledge and demographic influences

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ABSTRACT

Background: Hypertension is a leading global risk factor for premature mortality and cardiovascular diseases with Myanmar's prevalence exceeding the global average at 38%. Non-communicable diseases (NCDs) account for 68% of deaths in Myanmar posing significant healthcare challenges.

Objectives: This study aimed to investigate the prevalence of hypertension and its associated factors in Kachin State, Myanmar, an area with ethnic diversity and limited healthcare access.

Methods: A cross-sectional analytical study was conducted in Kachin State, Myanmar involving 527 participants aged ≥40. Participants were selected using a multistage random sampling technique. Data were collected through structured interviews using a validated and reliable questionnaire. Multivariable logistic regressions were employed to analyse the data. Factors with a P-value of <0.05 were considered statistically significant.

Results: The baseline characteristics of participants revealed significant gender differences in age, marital status, financial status, occupation, smoking, alcohol consumption, fruit and vegetable intake, physical activity and knowledge of hypertension. The prevalence of hypertension was 22.39% (95% CI: 19.03-26.16) with 22.88% (95% CI: 18.24-2.28) in male and 21.88% (95%CI: 17.21-27.38) in female. Multiple logistic regression analysis identified several factors significantly associated with hypertension. Participants aged 60 years and older (Adjusted Odd ratio (AOR)=2.30, 95% CI: 1.36-3.89), those who consumed fruits and vegetables at least three times per week (AOR=2.11, 95%CI: 1.26-3.52), individuals with low or minimal physical activity (AOR=1.69, 95%CI: 1.02-2.82) and those with poor or moderate knowledge of hypertension (AOR=1.84, 95%CI: 1.11-3.05) were significantly more likely to develop hypertension.

Conclusion: The prevalence of hypertension is notably high among middle-aged and elderly adults along the Myanmar-China border with significant associations identified with age, physical activity, fruit and vegetable consumption and knowledge of hypertension. Public health interventions aimed at improving hypertension awareness, promoting physical activity and addressing dietary habits could help reduce the risk of hypertension in this population.

Keywords: Hypertension, Middle-aged adults and elderly, Kachin state

1. Introduction

Hypertension is the leading risk factor for premature mortality causing 10.8 million preventable deaths and 235 million disability-adjusted life years annually [1]. It is also a major contributor to cardiovascular diseases, including stroke, myocardial infarction, heart failure and renal damage [2]. Between 1990 and 2019, the number of individuals affected by hypertension doubled from 650 million to 1.3 billion with 33% of adults aged 30-79 years affected globally [3]. Prevalence varies regionally, from 28% in the Western Pacific to 38% in the Eastern Mediterranean, with Myanmar also at 38%, exceeding the global average [3]. In 2019, over half of cardiovascular-related deaths were linked to high systolic blood pressure with low- and lower-middle-income countries experiencing the greatest burden [4]. In Myanmar, NCDs account for 68% of total deaths posing challenges to the public health system [5].

Several factors contribute to hypertension risk, older adults are more likely to develop hypertension than younger individuals [6, 7]. Behavioural risk factors include unhealthy dietary habits, tobacco use, alcohol consumption, physical inactivity and obesity [8]. Alcohol consumption increases hypertension risk 7.4-fold among males [9]. A meta-analysis in China revealed that high salt intake quadrupled hypertension risk while inadequate fruit and vegetable intake increased risk sevenfold [10, 11]. In Indonesia, individuals with low physical activity had nearly three times higher odds of developing hypertension [12]. Knowledge about hypertension plays a role in its prevention and management [13].

Myanmar's ethnic and cultural diversity results in varying health determinants. Kachin State differs from other regions in health facilities, human resources and lifestyle. Many hard-to-reach villages in Momauk, Mansi and Waingmaw were not included in the census accounting for 46,600 people [14]. However, limited study has assessed hypertension prevalence and its determinants in Myanmar-China border areas. Therefore, this study aimed to explore hypertension prevalence and associated factors in Kachin State, Myanmar.

2. Methods

2.1 Study Area

This study was conducted in Kachin State, Myanmar along the Myanmar-China border specifically in Waingmaw, Moemauk and

Mansi townships from April 2024 to March 2025.

2.2 Study Design

An analytical cross-sectional study was conducted to examine gender differences in hypertension prevalence and associated factors including sociodemographic characteristics, behaviours, knowledge and attitudes. Participants included adults aged 40 and above who had resided in the study area for at least one year and could communicate in Kachin or Myanmar language. Pregnant women, non-ambulatory individuals and critically ill patients were excluded.

2.3 Sample Size and Sampling

The sample size of 527 participants was calculated based on a previous study on health literacy and hypertension among middle-aged and elderly adults in Myanmar [15] using multiple logistic regression described by *Hsieh et al. (1998)* [16]. The calculation assumed a 95% confidence level, 80% power, and accounted for the expected difference in hypertension prevalence between those with adequate and inadequate health literacy. A multistage sampling method was employed selecting three townships randomly followed by one city and one village from each township. Households were chosen through systematic random sampling ensuring at least one middle-aged or elderly member per household was included.

2.4 Data Collection

Data were collected through face-to-face interviews using the Kobo Collect (v2021.2.4) application. The questionnaire was translated into English and Kachin (with forward and backward translation for accuracy) consisted of four sections: sociodemographic factors, behavioural factors, knowledge of hypertension and attitude towards hypertension. Knowledge was assessed using the Hypertension Knowledge - Level Scale (HK-LS) 22 questionnaire (Cronbach's alpha = 0.82) with 22 questions based on Bloom's theory [17]. Responses were coded as yes/no with scores categorized as poor knowledge (<60%), moderate knowledge (60-79%) and high knowledge (≥80%). Attitude was measured using a 9-item questionnaire covering affective domains based on Bloom's theory scored on a five-point Likert scale [18]. Responses were categorized as poor attitude (<60%), moderate attitude (60-79%) and good attitude (≥80%). The outcome variable in this study was hypertension determined by

direct blood pressure measurements conducted by trained data collectors. Blood pressure was measured twice using a standard digital sphygmomanometer with the participant seated and rested for at least five minutes. The average of the two readings was used for classification. Hypertension was defined as having a systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg in accordance with WHO guidelines [19]. This variable was measured on a nominal categorical scale with participants categorized as either "Hypertensive" or "Normal." For analytical purposes, the responses were recoded as "Yes" = 1 (hypertensive) and "No" = 0 (non-hypertensive).

2.5 Data Analysis

Data were exported to Excel and analysed using STATA version 18.0 (College Station, Texas 77845 USA). Descriptive statistics included frequencies, percentages, means and standard deviations. The prevalence of hypertension was calculated as the proportion of participants who met the diagnostic criteria for hypertension (blood pressure ≥140and/or 90 mmHg) among the total study population, expressed as a percentage. Bivariate analysis used logistic regression to estimate Crude Odds Ratios (COR) with 95% Confidence Intervals (CI). Variables with P <0.25 were included in the multivariable model assessing multicollinearity (Variance Inflation Factor (VIF) = 1.27) [20]. Multiple logistic regression was conducted, reporting Adjusted Odds Ratios (AOR) with 95% CI considering P <0.05 as statistically significant.

3. Results

3.1 Baseline characteristics of the participants

The baseline characteristics of the participants highlighted several factors with significant gender differences. Age demonstrated a notable disparity between males and females (P = 0.014). A higher proportion of females were in the 40–44 (55.05%) and ≥65 (58.75%) age groups whereas a greater proportion of males belonged to the 50–54 (61.45%) and 55–59 (65.67%) age groups. Marital status also varied significantly (P = 0.002) with a markedly higher percentage of females being widowed (75.86%) or separated (75%) compared to males. Financial status exhibited a significant difference (P = 0.002) with a larger proportion of females reporting "adequate but unable to save" (58.92%) relative to males (41.08%) while a greater

percentage of males fell into the "inadequate" category (56.54%). Occupational differences were also apparent (P = 0.018) with more males employed in agriculture (50.92%) and a higher proportion of females classified as dependent or retired (63.77%).

Smoking status displayed a highly significant difference (P < 0.001) with a vast majority of males being current smokers (96.40%) compared to females (3.60%). Conversely, a substantially greater proportion of females were non-smokers (72.92%) compared to males (27.08%). Alcohol consumption also showed a pronounced gender disparity (P < 0.001) with more males being current drinkers (81.45%) compared to females (18.55%). Regarding dietary habits, a significant difference was observed in the consumption of fruits and vegetables (P < 0.001) with a considerably higher proportion of females (76.71%) consistently consuming these foods compared to males (23.29%). Physical activity also varied significantly (P = 0.001) with a greater proportion of males classified as HEPA active (60.74%) compared to females (39.26%). Finally, knowledge of hypertension differed significantly (P = 0.006) with a higher proportion of males (62.18%) exhibiting high knowledge compared to females (37.82%) (Table 1).

Table 1: Baseline characteristics of the participants (n=527).

Characteristics	Number (n)	Percentage (%)
Age		
40-44	109	20.68
45-49	142	26.95
50-54	83	15.75
55-59	67	12.71
60 -64	46	8.73
≥65	80	15.18
Mean (±SD)	52.64 (±9.99)	
Medium (Min: Max)	50 (40: 90)	
Gender		
Male	271	51.42
Female	256	48.58
Marital status		
Single	11	2.09
Married	476	90.32
Divorced	7	1.33
Widowed	29	5.50
Separated	4	0.76
Education Level		
No formal education and cannot read and write	38	7.21
No formal education but can read and write	23	4.36
Primary	155	29.41
Middle school	168	31.88

Characteristics	Number (n)	Percentage (%)
Hight school	125	23.72
Bachelor's degree	18	3.42
Family monthly income (USD)		
<50	53	10.06
50-100	112	21.25
101-150	95	18.03
151-200	114	21.63
201-300	107	20.30
>300	46	8.73
Mean (± SD)	174.82 (±178.74)	
Median (Min: Max)	150 (5:1500)	
Family monthly expenditure (USD)		
<50	37	7.02
50-100	99	18.79
101-150	93	17.64
151-200	164	31.31
201-300	89	16.89
>300	44	8.35
Mean (±SD)	178.25 (±162.36)	
Median (Min: Max)	150 (5:1500)	
Financial status		
Inadequate and in debt	101	19.16
Inadequate	214	40.61
Adequate but unable to save	185	35.11
Adequate and able to save	27	5.12
Occupation		
Agriculture	326	61.86
Government staff	81	15.37
Employed/ Self employed	11	2.09
Daily wages earner	35	6.64
Dependents/retired	69	13.09
NGO/INGO staff	5	0.95
Smoking status		
Non-User	336	63.76
Former user	80	15.18
Current user	111	21.06
Betel quid chewing		
Yes	79	14.99
No	448	85.01
Alcohol consumption		
Non-drinker	312	59.20
Former drinker	91	17.27
Current drinker	124	23.53
Consumption of Vegetable and fruits		
Never (0 day/week)	42	7.97
Sometimes (1-2 day/week)	119	22.58
Moderate (3-4days/week)	182	34.54
Often (5-6 days/week)	111	21.06
Always (7 days/week)	73	13.85
Consumption of Salty diet		
Never (0 day/week)	88	16.70
Sometimes (1-2 day/week)	294	55.79
Moderate (3-4days/week)	120	22.77
Often (5-6 days/week)	19	3.60

Characteristics	Number (n)	Percentage (%)
Always (7 days/week)	6	1.14
Consumption of Oily food		
Never (0 day/week)	34	6.45
Sometimes (1-2 day/week)	219	41.56
Moderate (3-4days/week)	169	32.07
Often (5-6 days/week)	82	15.56
Always (7 days/week)	23	4.36
Consumption of Fast food		
Never (0 day/week)	114	21.63
Sometimes (1-2 day/week)	257	48.77
Moderate (3-4days/week)	133	25.24
Often (5-6 days/week)	21	3.98
Always (7 days/week)	2	0.38
Consumption of animal-based protein		
Never (0 day/week)	17	3.23
Sometimes (1-2 day/week)	210	39.84
Moderate (3-4days/week)	184	34.92
Often (5-6 days/week)	99	18.78
Always (7 days/week)	17	3.23
Consumption of vegetable-based protein		
Never (0 day/week)	17	3.23
Sometimes (1-2 day/week)	170	32.25
Moderate (3-4days/week)	214	40.61
Often (5-6 days/week)	92	17.46
Always (7 days/week)	34	6.45
Physical activity		
Inactivity (<600 MET score)	201	38.14
Minimal activity (600-<3000MET score)	163	30.93
HEPA activity (≥3000MET score)	163	30.93
Sleeping efficiency		
<85% (Poor sleep efficiency)	142	26.94
≥85% (Good sleep efficiency)	385	73.06
Knowledge on hypertension		
Low (<60%)	98	18.60
Average (60-79%)	273	51.80
High (≥80%)	156	29.60
Mean (±SD)	12.94 (±2.28)	
Median (Min: Max)	16 (9:21)	
Attitude toward hypertension		
poor (<60%)	86	16.32
Moderate (60-79%)	427	81.02
Good (≥80%)	14	2.66
Mean (±SD)	29.46 (± 3.22)	
Median (Min: Max)	30 (21: 42)	

3.2 Prevalence of hypertension among middle-aged adult and elderly along the Myanmar-China border Kachin state

The distribution of blood pressure levels by sex reveals key differences. Among males, 25.83% have normal blood pressure with a 95% CI of 20.95% to 31.40%. In contrast, 41.80% of females have normal blood pressure with a 95% CI of 35.88% to 47.96%. For pre-hypertension, 51.29% of males fall

into this category (95% CI: 45.32% to 57.22%) while 36.33% of females are affected (95% CI: 30.64% to 42.43%). In terms of hypertension stage I, 15.87% of males have this condition (95% CI: 11.97% to 20.74%) and 15.62% of females (95% CI: 11.66% to 20.63%) also have stage I hypertension. Finally, 7.01% of males have hypertension stage II (95% CI: 4.51% to 10.75%) while 6.25% of females are affected (95% CI: 3.85% to 9.98%).

The distribution of blood pressure levels among participants was as follows: 33.59% had normal blood pressure, with a 95% CI of 29.67% to 37.74%. The majority (44.02%) were classified as having pre-hypertension, with a 95% CI of 39.83% to 48.30%. A smaller proportion (15.94%) had Hypertension Stage I with a 95% CI of 12.88% to 19.12%. Lastly, 6.45% of participants were categorised as having Hypertension Stage II with a 95% CI of 4.80% to 9.11% (Table 2).

Table 2: Prevalence of hypertension among middle-aged adult and elderly along the Myanmar-China border Kachin State, Myanmar (n=527).

Level of blood pressure	Male			Female		
	Number (n)	Percentage (%)	95% CI	Number (n)	Percentage (%)	95% CI
Normal Blood pressure	70	25.83	20.95-31.40	107	41.80	35.88-47.96
Pre-hypertension	139	51.29	45.32-57.22	93	36.33	30.64-42.43
Hypertension stage I	43	15.87	11.97-20.74	40	15.62	11.66-20.63
Hypertension stage II	19	7.01	4.51-10.75	16	6.25	3.85-9.98

3.3 Factors associated with hypertension among middle-aged adult and elderly along the Myanmar-China border Kachin state

Multivariable analysis using multiple logistic regression was conducted to examine the association between various characteristics and hypertension. Following bivariable analysis, variables with P-values less than 0.25 were included in the initial multiple logistic regression model. These variables included age, monthly expenditure, financial status, smoking status, tobacco and betel chewing, consumption of vegetables and fruits, consumption of fast foods, consumption of animal-based protein, consumption of vegetable-based protein, physical activity, knowledge on hypertension and attitude towards hypertension. Multicollinearity among independent variables was assessed prior to model fitting with a VIF of 1.26 indicating no significant multicollinearity. The model was refined using backward elimination. Associations

were considered statistically significant when the P-value was less than 0.05 and the results were expressed using AOR and 95% CI.

Among middle-aged and elderly participants, those aged ≥60 years were twice as likely to have hypertension compared to those younger than 50 years (AOR = 2.30, 95% CI: 1.36–3.89). Individuals who consumed fruits and vegetables at least three days per week had twice the likelihood of developing hypertension compared to those who consumed them rarely or never (AOR = 2.11, 95% CI: 1.26–3.52). Participants with low or minimal physical activity had a 69% higher risk of hypertension compared to those with high physical activity levels (AOR = 1.69, 95% CI: 1.02–2.82). Furthermore, participants with poor or moderate knowledge of hypertension were 84% more likely to develop the condition compared to those with good knowledge (AOR = 1.84, 95% CI: 1.11–3.05) (Table 3).

Table 3: Bivariate and Multivariable analysis of factors associated with hypertension among middle-aged adult and elderly along the Myanmar-China border Kachin State, Myanmar (n=527).

Characteristic	Total Samples	% of hypertension	COR	95% CI	AOR	95% CI	P-value
Age							0.002**
<50	251	15.14	1		1		
50-59	150	28.00	2.18	1.33-3.58	2.19	1.32-3.65	
≥60	126	30.16	2.42	1.45-4.05	2.30	1.36-3.89	
Marital status							0.611*
Single/ other	51	19.61	1		-		
Married	476	22.69	1.20	0.58-2.48	-		
Education Level							0.396*
High school	143	20.28	1		-		
Secondary	168	21.43	1.07	0.62-1.86	-		
Primary	155	21.94	1.10	0.63-1.93	-		
No formal education	61	31.15	1.78	0.90-3.50	-		
Family Income (USD)							0.423*
<100	165	20.61	1	1	-		
100-200	209	21.05	1.03	0.62-1.70	-		
>200	153	26.14	1.36	0.81-2.30	-		
Family monthly expenditure							0.127*
<100	136	27.94	1		-		
100-200	258	18.99	0.60	0.37-0.98	-		
>200	133	23.31	0.78	0.45-1.36	-		
Family financial status							0.166*
Inadequate	315	20.32	1		-		
Adequate	212	25.47	1.34	0.89-2.03	-		
Occupation							0.881*
Agriculture & daily wages	361	21.88	1		-		

Characteristic	Total Samples	% of hypertension	COR	95% CI	AOR	95% CI	P-value
Government staff & NGO staff	86	24.42	1.15	0.66-2.00	-		
Retire and depend on and self-owner	80	22.50	1.04	0.58-1.85	-		
Smoking status							0.002*
Non-user	336	20.83	1		-		
Former smoker	80	37.50	2.28	1.35- 3.85	-		
Current smoker	111	16.22	0.74	0.42-1.30	-		
Tobacco and betel quid chewing							0.073*
No	448	20.98	1		-		
Yes	79	30.38	1.64	0.97-2.79	-		
Alcohol consumption							0.452*
Non-drinker	312	24.04	1		-		
Former Drinker	91	21.98	0.89	0.51-1.56	-		
Current drinker	124	18.55	0.72	0.43-1.21	-		
Consumption of vegetables and fruit							0.004**
0-2days /week	161	14.29	1		1		
3-7 days/ week	366	25.96	2.10	1.28-3.46	2.11	1.26-3.52	
Consumption of salty food							0.274*
0-2 days/week	382	21.99	1		-		
3-4 days/week	120	20.83	0.93	0.56-1.54	-		
5-7 days/week	25	36.00	2.00	0.85-4.68	-		
Consumption of oily food							0.787*
0-2 days/week	253	23.32	1		-		
3-4 days/week	169	22.49	0.95	0.60-1.52	-		
5-7 days/week	105	20.00	0.82	0.47-1.44	-		
Consumption of fast food							0.009*
0-2 days /week	371	19.68	1		-		
3-4 days per week	133	25.56	1.40	0.88-2.23	-		
5-7 days/week	23	47.83	3.74	1.59-8.82	-		
Consumption of animal-based protein food							0.028*
0-2 days/week	227	18.06	1		-		
3-4 days/week	184	22.28	1.30	0.80-2.11	-		
5-7 days/week	116	31.03	2.04	1.22-3.43	-		
Consumption of vegetable-based protein							0.001*
0-2 days/week	187	22.99	1		-		
3-4 days/week	214	15.42	0.61	0.37-1.01	-		
5-7 days/week	126	33.33	1.67	1.01-2.77	-		
Physical Activity							0.043**
HEPA activity	163	14.72	1		1		

Characteristic	Total Samples	% of hypertension	COR	95% CI	AOR	95% CI	P-value
Minimally active and inactive	364	25.82	2.02	1.23-3.30	1.69	1.02-2.82	
Sleep efficiency							0.777*
Good	385	22.08	1		-		
Poor	142	23.24	1.07	0.68-1.69	-		
Knowledge on hypertension							0.018*
High & moderate	429	20.05	1		1		
Poor	98	32.65	1.93	1.19-3.14	1.84	1.11-3.05	
Attitude toward hypertension							0.113*
Good & average	441	21.09	1		-		
Poor	86	29.07	1.53	0.91-2.58	-		

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

4. Discussion

The prevalence of hypertension in this study was found to be 22.39% (95% CI: 19.03-26.16%) which indicated a significant burden of hypertension among middle-aged and elderly adults along the Myanmar-China border in Kachin State. This result was consistent with similar studies in Myanmar such as the study by *Shwe et al. (2022)* which reported a prevalence of 21.95% [21]. This alignment suggested that hypertension is a prevalent health issue within the country especially in rural and border regions. When comparing this prevalence with other studies from the region, it is slightly lower than the 27.8% prevalence found in Myanmar migrant workers in Thailand as reported by *Aung et al. (2022)* [22]. The higher prevalence among migrant workers may be attributed to factors such as lifestyle changes, stress related to migration and limited access to healthcare which may exacerbate hypertension in this population. On the other hand, the prevalence in this study was higher than the 16.7% prevalence observed in India according to *Giri et al. (2022)* [6] suggesting that hypertension might be more common in certain regions of Southeast Asia particularly Myanmar where the health system faces challenges in managing non-communicable diseases (NCDs). These differences highlighted the need for context-specific interventions. The higher prevalence in Myanmar compared to India may also reflect differences in healthcare access, dietary patterns, physical activity and public health initiatives between the two countries. Further research is needed to investigate the regional disparities in hypertension prevalence and to understand the unique risk factors contributing to its high burden in Myanmar.

Among middle-aged and elderly participants, those aged 60 years and older were twice as likely to have hypertension compared to those younger than 50 years. These findings confirmed that advancing age is a significant risk factor for hypertension with a notable increase in prevalence among older adults. This aligned with previous research demonstrating similar trends. A study in Myanmar found that increasing age was associated with a higher prevalence of hypertension (AOR = 1.10) [22]. A study in Ethiopia further supported these findings reporting a threefold increase in hypertension odds among individuals aged 30–49 years (AOR = 2.79) and an eightfold increase among those aged 50 and older (AOR = 8.23) [7]. Similarly, research from Eastern India indicated that aging is a significant risk factor for hypertension [6]. Age-related physiological changes including arterial wall thickening, increased vascular resistance and endothelial dysfunction contribute to the progressive rise in blood pressure. These changes reduce the compliance of blood vessels, impair nitric oxide-mediated vasodilation and increase sympathetic nervous system activity all of which promote hypertension [23]. Additionally, lifestyle factors such as reduced physical activity, weight gain and dietary changes with age may further exacerbate hypertension risk. Beyond biological factors, social and environmental determinants may also influence the age-hypertension relationship. Older adults often experience higher levels of stress, reduced access to healthcare and a greater burden of comorbidities all of which contribute to hypertension development. Moreover, cumulative exposure to risk factors such as smoking, unhealthy diet and physical inactivity over the life course increases the likelihood of developing hypertension later in life.

This study identified dietary patterns as significant risk factors for hypertension particularly vegetables and fruit consumption. Individuals who consumed fruits and vegetables at least three days per week had twice the likelihood of developing hypertension compared to those who consumed them rarely or never. This finding aligned with previous studies that highlighted the role of unhealthy dietary habits in increasing hypertension risk. For instance, a study conducted in Myanmar among middle-aged and elderly adults found that individuals who frequently consumed salty foods were over three times more likely to suffer from hypertension (AOR = 3.12) while excessive consumption of sweet fruits also increased

the risk (AOR = 4.00) [21]. Another study in India contrasted with our finding and demonstrated that inadequate vegetable consumption (≤3 days per week) significantly elevated hypertension risk (AOR = 2.44) [7].

This finding was intriguing and warranted further exploration. While it may seem counterintuitive, it was important to consider several factors that could contribute to this finding. First, it's possible that individuals who consume fruits and vegetables more regularly may be more health-conscious overall which could result in them having other lifestyle factors such as higher stress levels, increased sodium intake or other dietary habits that could contribute to hypertension. Additionally, it's possible that individuals with pre-existing health concerns such as those with a higher Body Mass Index (BMI) or underlying conditions may be more inclined to consume fruits and vegetables which in turn could be indicative of a health-seeking behaviour pattern rather than the consumption of fruits and vegetables directly causing hypertension. Another consideration is the possibility of confounding variables in this study. Individuals who consume a higher quantity of fruits and vegetables might also have higher levels of physical activity, higher socioeconomic status or other factors that could contribute to hypertension. It's crucial to control for these confounders in future studies to better understand the true relationship between fruit and vegetable consumption and hypertension risk. Moreover, the preparation methods of fruits and vegetables might play a role in this association. If individuals are consuming fruits and vegetables in processed forms such as canned or salted varieties, this could contribute to the increased sodium intake which is a known risk factor for hypertension. Future research should also consider the type of fruits and vegetables consumed and their preparation methods.

In this study, physical inactivity and minimal physical activity were found to increase the likelihood of hypertension by 69% compared to those who engaged in highly active physical activity. This aligned with previous research such as a Chinese study that reported a 2.9 times higher prevalence of hypertension among adult female migrant workers with physical inactivity [24]. Similarly, a study in Ethiopia showed that 77.1% of participants lacked aerobic physical activity and the prevalence of hypertension was found to be three times higher among those without aerobic physical activity [25]. These findings

supported the established evidence that physical activity plays a critical role in the prevention and management of hypertension. Regular physical activity is one of the most effective non-pharmacological approaches to treating or preventing hypertension [26], underscoring the strong association between physical inactivity and hypertension.

Furthermore, the study revealed that compared to participants with good knowledge of hypertension, those with poor and moderate knowledge were 84% more likely to experience increased hypertension. This highlighted the crucial role of knowledge in the prevention and management of hypertension. Individuals with a good understanding of hypertension are more likely to adopt lifestyle changes and adhere to treatment leading to better blood pressure control. This was consistent with findings from Poland, where higher health literacy was associated with better hypertension management [27]. Additionally, studies in rural Ghana (AOR = 2.28) [28] and among Myanmar migrant workers in Thailand (AOR = 2.33) [29] similarly found that limited knowledge significantly increased the risk of hypertension. Therefore, promoting health literacy about hypertension prevention and management is essential for improving public health outcomes especially in regions with limited access to healthcare education.

This is the first study conducted along the Myanmar-China border in Myanmar providing valuable information for regional health. Additionally, this study could provide information for cross-border health regarding non-communicable diseases. Moreover, this study also highlighted the details of demographic distribution, knowledge, attitude, and behaviour factors which are valuable for policymakers. Likewise, the choice of statistics can control the potential confounding effects that may distort the study findings by giving reliable results. However, despite the best efforts we made, there were some limitations that we needed to address. First, due to the study design, we were not able to identify the causal relationship between independent and dependent variables. Moreover, due to the limitations of time frame, we could not address the medication adherence, and other comorbidities apart from DM which might have impacts on the hypertension. Additionally, although we used systematic procedures to get the samples, the elderly population was distinct in our research due to the political conflict and the migration due to

war. Furthermore, some behavioural variables such as frequent fruit and vegetable consumption showed associations with hypertension that are inconsistent with existing biomedical theory. This unexpected finding may be due to residual confounding or the small number of participants in that subgroup. Future longitudinal studies are recommended to explore this association in more depth and to better clarify potential causal pathways.

5. Conclusion

This study found that over one-fifth of middle-aged and older adults in the Myanmar-China border region of Kachin State had hypertension, a prevalence slightly lower than the national average. Hypertension was significantly associated with age, fruit and vegetable consumption, physical activity and insufficient knowledge about the condition. These findings underscored the importance of adopting comprehensive health promotion strategies. Targeted interventions should prioritise the promotion of healthy dietary habits, active lifestyles and educational initiatives to enhance awareness and prevention of hypertension. Strengthening public health efforts in these areas is essential to mitigating the burden of hypertension in this population.

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Author Contribution

BHN and KMH contributed to the study conception and design, data collection, analysis, and manuscript drafting. RKM contributed to study supervision, critical revision of the manuscript, and final approval of the version to be published. All authors read and approved the final manuscript

Declaration

Ethical 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 of HE672254 from Khon Kaen University approval date on 20th Jan 2025.

Competing interests

The authors declare that they have no competing interests.

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