Determinants of Hypertension among Middle-aged and Elderly Populations: A Study from Myanmar

Htike KM, Thammasarn K, Mahato RK

Faculty of Public Health,

Khon Kaen University,

Khon Kaen, Thailand.

Corresponding Author

Krittiyanee Thammasarn

Faculty of Public Health,

Khon Kaen University,

Khon Kaen, Thailand.

E-mail: krittiyanee@kku.ac.th

Citation

Htike KM, Thammasarn K, Mahato RK. Determinants of Hypertension among Middle-aged and Elderly Populations: A Study from Myanmar. *Kathmandu Univ Med J.* **Onlile First.**

ABSTRACT

Background

Hypertension is a growing global health concern, particularly in low- and middle-income countries (LMICs), driven by demographic shifts, urbanization and lifestyle changes. Myanmar has a 30.1% national wide prevalence, however, data on determinants and management remain limited.

Objective

To assess the prevalence and associated factors of hypertension among middle-aged and elderly populations in Yangon, Myanmar, to inform strategies for prevention and management.

Method

A cross-sectional study of 512 individuals aged 40 years and older in Yangon, Myanmar, was conducted from May to November 2024 using multistage random sampling. Statistical analyses including the Generalized Linear Mixed Model (GLMM) using logistic regression were performed using STATA 18.0 to identify the factors associated with hypertension.

Result

The prevalence of hypertension was 27.54% (95% CI: 23.83-31.58), with a higher prevalence among individuals aged ≥60 years. Risk factors included aged ≥60 years (AOR: 2.17, 95% CI: 1.27-3.70), palm oil usage (AOR: 3.67, 95% CI: 2.05-6.59), current alcohol consumption (AOR: 2.35, 95% CI: 1.19-4.62), elevated waist circumference (AOR: 2.93, 95% CI: 1.80-4.77), chronic illness (AOR: 3.24, 95% CI: 2.08-5.05) and consuming of plant-based protein for 3–7 days per week (AOR: 1.79, 95% CI: 1.13-2.83).

Conclusion

Hypertension is prevalent among middle-aged and elderly adults in Yangon with significant associations identified for age, dietary habits, waist circumference and chronic illness. Interventions focusing on lifestyle modifications, dietary improvements, and targeted health education are essential to mitigate the hypertension burden in this population.

KEY WORDS

Cross-sectional study, Hypertension, Myanmar

INTRODUCTION

Hypertension is a critical global health issue contributing significantly to morbidity and mortality.[1] The prevalence of hypertension has surged globally increasing from 594 million in 1975 to 1.28 billion by 2019, with the most rapid increases seen in low- and middle-income countries (LMICs).[2] This growth is driven by demographic changes, urbanization and lifestyle shifts.[3] In 2015, 88% of deaths attributed to high systolic blood pressure occurred in LMICs underscoring the unequal burden in these regions.[4] Hypertension is a major modifiable risk factor for stroke, chronic kidney disease and hypertensive retinopathy.[5-7] These conditions not only reduce quality of life but also impose heavy economic and productivity losses.[8] In LMICs, the cost of managing hypertension-related complications ranging from $300 to $1,000 monthly drives many households into poverty, disproportionately affecting women due to healthcare inequities.[9-11]

In Southeast Asia (SEA), hypertension affects about one-third of adults and accounts for 1.5 million annual deaths.[1] Among urban populations, the prevalence reaches 33.82% influenced by gender, ethnicity, socioeconomic status and lifestyle behaviours.[12] Despite these alarming figures, awareness, treatment and control rates remain suboptimal across SEA countries.[13,14] Myanmar exemplifies this challenge with a reported hypertension prevalence of 30.1% in 2014.[15] However, data on its determinants and management outcomes are scarce. This study aimed to fill this knowledge gap by identifying the prevalence and associated factors of hypertension in Yangon, Myanmar providing insights to guide targeted interventions for prevention and management.

METHODS

This present study employed an observational cross-sectional design carried out between May and November 2024 focusing on individuals aged 40 years and older. The sample size was determined to be 512 participants using Hsieh's logistic regression formula.[16] A multistage random sampling method was employed to select participants from Yangon. One township was randomly chosen from each of the four districts of Yangon followed by systematic sampling within each selected township to ensure a representative sample. Participants aged 40 or older, of any gender, and residing in Yangon for at least one year were included with informed consent. Exclusions were those with serious chronic or mental health conditions and pregnant women.

Data collection was conducted using the KoboCollect mobile application (v2021.2.4). The study's questionnaire gathered sociodemographic details, physical health information and blood pressure measurements. The questionnaire was translated into both Myanmar and English employing forward and backward translation techniques to ensure consistency and accuracy. A pre-test involving 52 participants (10% of the sample) who were not part of the main study population was carried out to evaluate the reliability of the instrument.

The data were analyzed using STATA version 18.0 (College Station, Texas 77845 USA). Descriptive statistics, including frequencies and percentages for categorical variables and means, standard deviations (S.D.), medians and ranges for continuous variables were calculated. The Chi-square test was used to assess the association between categorical variables and the prevalence of hypertension. The GLMM was used to explore the relationships between various factors and the prevalence of hypertension. Factors with a p-value of less than 0.25 in the bivariate analysis were assessed for multicollinearity using the Variance Inflation Factor (VIF) with a VIF value of 1.22 before being included in the multivariable analysis. The results were reported as Adjusted Odds Ratios (AOR), 95% Confidence Intervals (95% CI) and P-values less than 0.05. This study was approved by the Center for Ethics in Human Research, Khon Kaen University, Thailand with the reference number HE672184.

RESULTS

Among 512 participants, the overall prevalence of hypertension among middle-aged adult and elderly in Yangon, Myanmar was 27.54% (95%CI: 23.83-31.58) and a higher prevalence of hypertension was observed with increasing age particularly among those aged ≥60 years (37.58%, 95% CI: 30.34-45.42). Females had a slightly lower prevalence (26.24%, 95% CI: 21.85-31.16) than that of males (30.18%, 95% CI: 23.72-37.53). Hypertension was more common among participants who were divorced, widowed or separated (40.70%, 95% CI: 30.84-51.37) in reference to those who were single or married. Regarding education, individuals with no formal education or primary schooling reported the highest prevalence (38.39%, 95% CI: 29.85-47.72) while those with a bachelor's degree or higher had the lowest prevalence (16.88%, 95% CI: 11.82-23.51).

Occupation also influenced hypertension prevalence with dependents showing the highest rate (38.42%, 95% CI: 31.76-45.54). The type of oil used in cooking was significant with palm oil users reporting the highest prevalence (38.84%, 95% CI: 30.57-47.81). Among dietary habits, frequent consumption of oily food (43.06%, 95% CI: 32.14-54.69) was associated with increased hypertension rates. Similarly, participants with a waist circumference above the cutoff point had significantly higher rates of hypertension (35.39%, 95% CI: 30.24-40.91).

Individuals with chronic illnesses (44.94%, 95% CI: 37.78-52.33) or a family history of hypertension (32.10%, 95% CI: 25.35-39.68) demonstrated higher hypertension prevalence. Participants with depression (37.93%, 95% CI: 28.36-48.54) also had a significantly higher prevalence compared to those without depression. Hypertension was

most prevalent among participants with diabetes (45.21%, 95% CI: 34.20-56.70) and pre-diabetes (34.42%, 95% CI: 27.33-42.27) (Table 1).

Table 1. Baseline Characteristics of the participants (n=512)

Characteristics	Total	Hypertension		p-value
	Number (n)	n (%)	95% CI	
Overall	512	141 (27.54)	23.83-31.58	
Age				< 0.001
40-49	211	38 (18.01)	13.38-23.80	
50-59	144	44 (30.56)	23.57-38.57	
≥ 60	157	59 (37.58)	30.34-45.42	
Sex				0.348
Female	343	90 (26.24)	21.85-31.16	
Male	169	51 (30.18)	23.72-37.53	
Marital status				0.004
Single	76	14 (18.42)	11.21-28.77	
Married	350	92 (26.29)	21.93-31.16	
Divorced/ Widowed/ Separated	86	35 (40.70)	30.84-51.37	
Education				0.003
Bachelor's degree and above	160	27 (16.88)	11.82-23.51	
High school	165	45 (27.27)	21.01-34.58	
Middle school	75	26 (34.67)	24.78-46.08	
No formal education and illiterate/ literate /Primary school	112	43 (38.39)	29.85-47.72	
Occupation				< 0.001
Government staff/ Private employee	182	28 (15.38)	10.83-21.40	
Agriculture and livestock/ Manual labour	62	16 (25.81)	16.43-38.09	
Own business	45	17 (37.78)	24.92-52.62	
Dependent	190	73 (38.42)	31.76-45.54	
Other	33	7 (21.21)	10.44-38.33	
Most used oil in last month				< 0.001
Ground nut oil	180	33 (18.33)	13.33-24.69	
Soybean oil/ Sunflower oil	40	15 (37.50)	24.00-53.27	
Palm oil	121	47 (38.84)	30.57-47.81	
Ground nut and palm oil	78	26 (33.33)	23.78-44.49	
Other (Vegetable oil)	93	20 (21.51)	14.30-31.03	
Consumption of oily food per week (days)				0.027
Never	72	31 (43.06)	32.14-54.69	
1-2 day	106	23 (21.70)	14.85-30.57	
3-4 day	112	29 (25.89)	18.61-34.80	
5-6 day	77	19 (24.68)	16.31-35.51	
7 days	145	39 (26.90)	20.30-34.71	
Consumption of at least 5 servings of fruits and vegetables in a week (days)				0.024
Never	82	26 (31.71)	22.56-42.53	
1-2 day	142	44 (30.99)	23.92-39.07	
3-4 day	165	30 (18.18)	13.00-24.83	
5-7 day	123	41 (33.33)	25.56-42.13	
Consumption of plant-based protein per week				0.196
0-2 day	345	84 (24.35)	20.10-29.17	
3-7 day	167	57 (34.13)	27.33-41.66	
Alcohol drinking				0.218
Non-drinker & Former drinker	454	120 (26.43)	22.57-30.69	
Current drinker	58	21 (36.21)	24.91-49.26	
Body Mass Index (BMI) (kg/m²)				0.048
Normal	202	46 (22.77)	17.50-29.08	
Overweight	123	29 (23.58)	16.89-31.89	
Obesity	187	66 (35.29)	28.77-42.42	
Waist circumference (cm)				< 0.001
Below interim cut off point (< 90 in men & < 80 in women)	204	32 (15.69)	11.30-21.36	
Interim cut off point and above (≥ 90 in men & ≥ 80 in women)	308	109 (35.39)	30.24-40.91	
Having chronic illness				< 0.001
No	334	61 (18.26)	14.47-22.79	
Yes	178	80 (44.94)	37.78-52.33	
Family history of hypertension				0.116
No	350	89 (25.43)	21.13-30.26	
Yes	162	52 (32.10)	25.35-39.68	
Depression disorder (PHQ9)				0.041
No depression	425	108 (25.41)	21.49-29.78	
Depression	87	33 (37.93)	28.36-48.54	
Health Literacy				0.032
Adequate Health Literacy	66	11 (16.67)	9.46-27.68	
Limited Health Literacy	282	130 (29.15)	25.11-33.55	
Fasting Blood Sugar				<0.001
Normal	285	55 (19.30)	15.11-24.31	
Pre-diabetes	154	53 (34.42)	27.33-42.27	
Diabetes	73	33 (45.21)	34.20-56.70	

The multivariable analysis using the GLMM identified several significant factors associated with hypertension. Age emerged as a strong predictor, with individuals aged ≥ 60 years showing a higher AOR of 2.17 (95% CI: 1.27-3.70) compared to the 40-49 age group. Compared to groundnut oil users, the use of soybean or sunflower oil was associated with a higher risk of hypertension, with an adjusted odds ratio (AOR) of 2.72 (95% CI: 1.18-6.27). Similarly, palm oil users had an even greater risk, with an AOR of 3.67 (95% CI: 2.05-6.59). The combination of groundnut and palm oil

also showed a significant association, with an AOR of 2.31 (95% CI: 1.19-4.48).

Individuals consuming plant-based protein for 3-7 days per week had higher odds of hypertension (AOR: 1.79, 95% CI: 1.13-2.83) than those consuming it for 0-2 days. Current alcohol drinkers also showed significantly higher odds of hypertension (AOR: 2.35, 95% CI: 1.19-4.62) in comparison to the non-drinkers or former drinkers. Waist circumference above the interim cutoff point (≥ 90 cm for men and ≥ 80 cm for women) significantly increased the odds of hypertension (AOR: 2.93, 95% CI: 1.80-4.77) compared to those below the cutoff point. Individuals with chronic illness had a significantly elevated risk (AOR: 3.24, 95% CI: 2.08-5.05) compared to those without chronic conditions (Table 2).

Table 2. Factor associated with hypertension by using bivariate and multivariable analysis using GLMM (n=512)

Characteristics	Number of samples	% of Hypertension	Crude Odd Ratio	95% CI	AOR	95% CI	p-value
Age							0.016**
40-49	211	18.01	1	1	1	1	
50-59	144	30.56	2.00	1.22-3.30	1.67	0.96-2.92	
≥ 60	157	37.58	2.74	1.70-4.42	2.17	1.27-3.70	
Sex							0.349*
Female	343	26.24	1	1			
Male	169	30.18	1.21	0.81-1.83			
Marital status							0.005*
Single	76	18.42	1	1			
Married	350	26.29	1.58	0.84-2.96			
Divorced/ Widowed/ Separated	86	40.70	3.04	1.48-6.26			
Education							<0.001*
Bachelor's degree and above	160	16.88	1	1			
High school	165	27.27	1.85	1.08-3.16			
Middle school	75	34.67	2.61	1.39-4.91			
No formal education and illiterate/ literate /Primary school	112	38.39	3.07	1.75-5.39			
Occupation							<0.001*
Government staff/ Private employee	182	15.38	1	1			
Agriculture and livestock/ Manual labour	62	25.81	1.91	0.95-3.84			
Own business	45	37.78	3.34	1.62-6.89			
Dependent	190	38.42	3.43	2.09-5.64			
Other	33	21.21	1.48	0.59-3.74			
Most used oil in last month							<0.001**
Ground nut oil	180	18.33	1	1	1	1	
Soybean oil/ Sunflower oil	40	37.50	2.67	1.27-5.62	2.72	1.18-6.27	
Palm oil	121	38.84	2.83	1.67-4.79	3.67	2.05-6.59	
Ground nut and palm oil	78	33.33	2.23	1.22-4.07	2.31	1.19-4.48	
Other (Vegetable oil)	93	21.51	1.22	0.66-2.27	1.58	0.80-3.14	
Consumption of oily food per week (days)							0.031*
7 days	145	26.90	1	1			
5-6 day	77	24.68	0.89	0.47-1.68			
3-4 day	112	25.89	0.95	0.54-1.66			
1-2 day	106	21.70	0.75	0.42-1.36			
Never	72	43.06	2.06	1.14-3.72			
Consumption of at least 5 servings of fruits and vegetables in a week (days)							0.011*
Never	82	31.71	1	1			
1-2 day	142	30.99	0.85	0.44-1.66			
3-4 day	165	18.18	0.40	0.19-0.85			
5-7 day	123	33.33	0.89	0.41-1.90			

Consumption of plant-based protein per week							0.013**
0-2 day	345	24.35	1	1	1	1	
3-7 day	167	34.13	1.61	1.08-2.41	1.79	1.13-2.83	
Alcohol drinking							0.008**
Non-drinker & Former drinker	454	26.43	1	1	1	1	
Current drinker	58	36.21	1.58	0.89-2.81	2.35	1.19-4.62	
Body Mass Index (BMI) (kg/m²)							0.012*
Normal	202	22.77	1	1			
Overweight	123	23.58	1.05	0.62-1.78			
Obesity	187	35.29	1.85	1.18-2.89			
Waist circumference (cm)							<0.001**
Below interim cut off point (<90 in men & <80 in women)	204	15.69	1	1	1	1	
Interim cut off point and above (≥ 90 in men & ≥ 80 in women)	308	35.39	2.94	1.89-4.59	2.93	1.80-4.77	
Having chronic illness							<0.001**
No	334	18.26	1	1	1	1	
Yes	178	44.94	3.79	2.50-5.75	3.24	2.08-5.05	
Family history of hypertension							0.049*
No	350	25.43	1	1			
Yes	162	32.10	1.39	0.92-2.09			
Depression disorder (PHQ9)							0.018*
No depression	425	25.41	1	1			
Depression	87	37.93	1.84	1.11-3.04			
Health Literacy							0.038*
Adequate Health Literacy	66	16.67	1	1			
Limited Health Literacy	282	29.15	2.08	1.04-4.16			
Fasting Blood Sugar							<0.001*
Normal	285	19.30	1	1			
Pre-diabetes	154	34.42	2.19	1.41-3.42			
Diabetes	73	45.21	3.45	2.00-5.96			

* Crude Odd Ratio P-value
**Adjusted Odd Ratio P-value

DISCUSSIONS

In our setting, the prevalence of hypertension among middle-aged adults and the elderly in Yangon, Myanmar was found to be 27.54% in this study. The study was conducted in Yangon, with a significant portion of participants residing in urban slum areas. Urban environments, particularly in low-income settings are often associated with increased risk factors for hypertension such as higher levels of stress, dietary salt intake, physical inactivity and limited access to preventive healthcare services. These factors may contribute to the relatively high prevalence observed in this study. For instance, the prevalence is similar to Nigeria at 27.6% and studies focusing on Myanmar migrant workers in Thailand at 27.8%.[17,18] It was slightly lower than Malaysia (30.1% and 24.5%), India (30.7%) and Singapore (31.1%).[19-22] Meanwhile, the prevalence in Indonesia (32.1%) and the Philippines (32.4%) was higher compared to the findings in Yangon.[23,24] Interestingly, earlier data from Myanmar in 2014 reported a prevalence of 34.5%, which aligned with the upward trend noted in another study that observed a rate of 38.6%.[25,26] In contrast, the prevalence in Nepal is reported at a lower rate of 21.2%.[27] Significantly higher rates were found in Ghana (53.72%) and Thailand (58.4%) reflecting regional disparities and possibly differing definitions or risk factors contributing to hypertension.[28,29]

Age consistently emerged as a significant predictor of hypertension in this study. Individuals aged ≥ 60 years had an adjusted odds ratio (AOR) of 2.17 times to those aged 40-49 years, indicating a higher likelihood of hypertension in older age groups. This finding aligned study in Thailand in which increased age was associated with a higher risk of hypertension, with an AOR of 1.10 per year of increased age.18 Similarly, a study in the Philippines reported that individuals aged > 50 years had 5.3 times the odds of hypertension compared to those < 50 years.[24] In Myanmar, individuals aged 55-64 years had 6.86 times higher odds

of hypertension compared to those aged 15-24 years in males and 14.63 times higher odds in females within the same age group.[30] Another study in Myanmar found that individuals aged > 60 years had 19.97 times higher odds of hypertension compared to those aged < 40 years.[22] In Ethiopia, respondents aged > 35 years were nearly 4 times more likely to have hypertension than younger individuals, with an AOR of 3.97.31 These findings consistently highlighted advancing age as a significant and independent risk factor for hypertension across diverse populations, as older adults require targeted interventions including regular blood pressure monitoring, health education and improved access to affordable treatment. Lifestyle modifications such as reducing salt intake and increasing physical activity are critical to promoting healthy aging and preventing hypertension-related complications.

The analysis showed significant associations between cooking oil types and hypertension risk. Compared to groundnut oil, the use of soybean or sunflower oil (AOR: 2.72), palm oil (AOR: 3.67), and a combination of groundnut and palm oil (AOR: 2.31) was linked to a higher prevalence of hypertension, with palm oil showing the strongest association in this study. This finding is consistent with other study. A study in Myanmar reported that the use of sesame oil for cooking was associated with lower odds of hypertension compared to peanut oil, with odds ratios of 0.64 for males and 0.75 for females.[30] Conversely, an Ethiopian study found that individuals using unsaturated oils (AOR: 6.5) and those consuming unspecified different types of oils (AOR: 8.2) were more likely to develop hypertension compared to those using vegetable oils.[31] These findings highlighted the influence of dietary oil choices on hypertension risk, suggesting the need for promoting healthier cooking oils and dietary habits to mitigate hypertension prevalence.

Conversely, individuals consuming plant-based protein 3-7 days per week showed higher odds of hypertension (AOR: 1.79) compared to those consuming it for 0-2 days. This counterintuitive result may reflect dietary patterns where plant-based proteins are consumed in processed forms high in sodium or prepared using unhealthy cooking methods, such as frying or adding excessive oils. Additionally, it could suggest a lack of dietary variety, where a reliance on plant-based proteins may result in imbalances in other essential nutrients, like omega-3 fatty acids or micronutrients typically found in animal-based proteins. Our findings contrasted with those of a prospective cohort study conducted in Korea, which found that consuming fruits more than four times per day was linked to a significantly reduced incidence of hypertension, with a 56% risk reduction in men and a 67% reduction in women.[32] Additionally, a study from India found that fruit and vegetable consumption was significantly associated with an increased odds of hypertension, with an adjusted odds ratio (AOR) of 1.32.[33]

Current alcohol drinkers in this study showed significantly higher odds of hypertension (AOR: 2.35) compared to non-drinkers or former drinkers. Similarly, a study in Thailand found that current alcohol consumption was associated with higher odds of hypertension (AOR: 2.80) compared to non-drinkers.[18] In the Philippines, alcohol consumption was strongly linked to hypertension, with an adjusted odds ratio (aOR) of 1.7.[24] A study in Myanmar also reported an odds ratio of 2.00 for alcohol consumption and hypertension.[25] Additionally, a study in Ethiopia found that individuals who consumed more than five alcoholic drinks per day (> 60 g) were three times more likely to develop hypertension compared to those consuming fewer than five drinks per day (AOR: 2.9).[31] This suggested that heavy alcohol consumption is a significant contributor to hypertension risk, likely due to its effects on blood pressure regulation. Alcohol may elevate blood pressure by increasing sympathetic nervous system activity, promoting vasoconstriction, altering electrolyte balance, and contributing to weight gain, poor diet, and high sodium intake. These findings highlight the importance of moderating alcohol consumption to prevent and manage hypertension.

Waist circumference above the interim cutoff point significantly increased the odds of hypertension (AOR: 2.93) compared to those below the cutoff point. Similarly, a study found that hypertension was associated with waist circumference (AOR: 2.92).[19] In Myanmar, increased waist circumference was found to be highly significantly associated with hypertension, with odds 3.4 times higher in males and 2.71 times higher in females.[30] It highlighted the importance of considering waist circumference as an indicator of central obesity which has been linked to various cardiovascular risk factors including hypertension.

In this study, individuals with chronic illness had a significantly elevated risk (AOR: 3.24) compared to those without chronic conditions. This finding was consistent with studies from Indonesia and Ethiopia which also found a higher risk of hypertension in individuals with a family history. The Indonesian study reported a 3.44-fold higher risk, while the Ethiopian study showed a 4.33-fold increased risk.[34,35] Moreover, Chronic illness was found to significantly increase the risk of hypertension in our study, aligning with research from the American cohort study which found that individuals with DM were 3.14 times more likely to develop hypertension.[36] These results underscored the critical role of chronic illnesses. Chronic conditions like diabetes and genetic predisposition contribute to the development of hypertension through mechanisms such as insulin resistance and vascular dysfunction. Public health strategies should focus on early screening and targeted interventions for individuals with chronic conditions to help prevent the onset of hypertension.

This study has several strengths worth noting. It provides valuable insights into the prevalence and associated factors of hypertension among middle-aged and elderly

individuals in an urban setting, contributing to the limited data available for Yangon, Myanmar. The study utilized standardized tools and rigorous statistical analyses, ensuring reliable and valid results. Moreover, its focus on a vulnerable population living in urban slum areas highlights critical health disparities, which can inform targeted public health interventions and policies. However, there are some limitations. First, the cross-sectional design limits the ability to establish causal relationships between risk factors and hypertension. Second, self-reported data on chronic illnesses and family history of hypertension may be subject to recall bias, potentially affecting the accuracy of the information. Third, the study focused on a specific population, which may limit the generalizability of the findings to other regions or populations with different demographics and health conditions. Lastly, the sample size and selection methods may not fully capture the diversity of the target population, potentially limiting the robustness of the findings.

CONCLUSION

This study found a significant prevalence of hypertension among middle-aged and elderly adults in Yangon, Myanmar with higher rates in individuals aged ≥ 60 years. Factors such as age, dietary habits, palm oil consumption and waist circumference were significant predictors of hypertension. Chronic illness and alcohol consumption were also strongly linked to increased hypertension risk. The findings highlighted the importance of addressing modifiable risk factors like diet and lifestyle through public health interventions to reduce hypertension prevalence particularly in high-risk groups.

ACKNOWLEDGEMENTS

I sincerely thank the Karen Baptist Convention Hospital team for their exceptional support and dedication in facilitating data collection for this study. Their invaluable contributions and expertise played a pivotal role in its successful completion.

REFERENCES

1. WHO. Noncommunicable diseases country profiles 2018 2018 [Available from: https://www.who.int/publications/i/item/ncd-country-profiles-2018.
2. WHO. World health statistics 2022: monitoring health for the SDGs, sustainable development goals 2022 [Available from: https://www.who.int/publications/i/item/9789240051157.
3. Sarki AM, Nduka CU, Stranges S, Kandala NB, Uthman OA. Prevalence of Hypertension in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Medicine (Baltimore)*. 2015 Dec;94(50):e1959. doi: 10.1097/MD.0000000000001959. PMID: 26683910; PMCID: PMC5058882.
4. Zhou B, Perel P, Mensah GA, Ezzati M. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. *Nat Rev Cardiol.* 2021 Nov;18(11):785-802. doi: 10.1038/s41569-021-00559-8. Epub 2021 May 28. PMID: 34050340; PMCID: PMC8162166.
5. Li AL, Zhu S, Hu ZH, Peng Q, Fang X, Zhang YY. The distribution and epidemic characteristics of cerebrovascular disease in followed-up hypertension patients. *Sci Rep*. 2021 Apr 30;11(1):9366.
6. Yu Z, Rebholz CM, Wong E, Chen Y, Matsushita K, Coresh J, et al. Association Between Hypertension and Kidney Function Decline: The Atherosclerosis Risk in Communities (ARIC) Study. *Am J Kidney Dis.* 2019 Sep;74(3):310-319. doi: 10.1053/j.ajkd.2019.02.015. Epub 2019 Apr 25. PMID: 31031087; PMCID: PMC6760841.
7. Fraser-Bell S, Symes R, Vaze A. Hypertensive eye disease: a review. *Clin Exp Ophthalmol*. 2017 Jan;45(1):45-53. doi: 10.1111/ceo.12905. Epub 2017 Jan 21. PMID: 27990740.
8. MacLeod KE, Ye Z, Donald B, Wang G. A Literature Review of Productivity Loss Associated with Hypertension in the United States. *Popul Health Manag*. 2022 Jun;25(3):297-308. doi: 10.1089/pop.2021.0201. Epub 2022 Feb 3. PMID: 35119298; PMCID: PMC9536345.
9. Gheorghe A, Griffiths U, Murphy A, Legido-Quigley H, Lamptey P, Perel P. The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: a systematic review. *BMC Public Health*. 2018 Aug 6;18(1):975. doi: 10.1186/s12889-018-5806-x. PMID: 30081871; PMCID: PMC6090747.
10. Murphy A, Palafox B, Walli-Attaei M, Powell-Jackson T, Rangarajan S, Alhabib KF, et al. The household economic burden of non-communicable diseases in 18 countries. *BMJ Glob Health*. 2020 Feb 11;5(2):e002040. doi: 10.1136/bmjgh-2019-002040. PMID: 32133191; PMCID: PMC7042605.
11. Idris A, Olaniyi O. Analysis of Economic Burden of Hypertension in Nigeria. *Niger J Econ Soc Stud*. 2020;62(2)
12. Mohammed Nawi A, Mohammad Z, Jetly K, Abd Razak MA, Ramli NS, Wan Ibadullah WA, et al. The prevalence and risk factors of hypertension among the urban population in Southeast Asian countries: a systematic review and meta-analysis. Int J Hypertens. 2021;2021(1):6657003.
13. Aekplakorn W, Chariyalertsak S, Kessomboon P, Assanangkornchai S, Taneepanichskul S, Goldstein A, et al. Trends in hypertension prevalence, awareness, treatment, and control in the Thai population, 2004 to 2020. *BMC Public Health.* 2024 Nov 13;24(1):3149. doi: 10.1186/s12889-024-20643-1. PMID: 39538168; PMCID: PMC11562084.
14. Wang H, He L, Ma M, Tang M, Lu J, Sikanha L, et al. The comparison of the prevalence, awareness, treatment and control of hypertension among adults along the three provinces of the Lancang-Mekong River countries-China, Laos and Cambodia. *Arch Public Health*. 2024 Nov 26;82(1):224. doi: 10.1186/s13690-024-01458-3. PMID: 39593170; PMCID: PMC11590357.
15. Bjertness MB, Htet AS, Meyer HE, Htike MM, Zaw KK, Oo WM, et al. Prevalence and determinants of hypertension in Myanmar-a nationwide cross-sectional study. *BMC Public Health*. 2016 Dec;16:1-0.
16. Hsieh FY, Bloch DA, Larsen MD. A simple method of sample size calculation for linear and logistic regression. *Stat Med*. 1998 Jul 30;17(14):1623-34. doi: 10.1002/(sici)1097-0258(19980730)17:14<1623::aid-sim871>3.0.co;2-s. PMID: 9699234.
17. Ezeala-Adikaibe BA, Mbadiwe CN, Okafor UH, Nwobodo UM, Okwara CC, Okoli CP, et al. Prevalence of hypertension in a rural community in southeastern Nigeria; an opportunity for early intervention. *J Hum Hypertens*. 2023 Aug;37(8):694-700. doi: 10.1038/s41371-023-00833-x. Epub 2023 Apr 29. PMID: 37120682.

18. Aung TNN, Shirayama Y, Moolphate S, Lorga T, Jamnongprasatporn W, Yuasa M, et al. Prevalence and Risk Factors for Hypertension among Myanmar Migrant Workers in Thailand. *Int J Environ Res Public Health*. 2022 Mar 16;19(6):3511. doi: 10.3390/ijerph19063511. PMID: 35329196; PMCID: PMC8955730.

19. Liew JK, Cheong XP, Law L, Teo WH, Eng SS, Ngim CF, et al. Prevalence and factors associated with hypertension among adolescents in Malaysia. *IIUM Med J Malays*. 2019 Apr 1;18(1):55-63.

20. Grace Kho WF, Cheah WL, Hazmi H. Elevated blood pressure and its predictors among secondary school students in Sarawak: a cross-sectional study. *Cent Eur J Public Health*. 2018 Mar;26(1):16-21. doi: 10.21101/cejph.a5186. PMID: 29684292.

21. Ramakrishnan S, Zachariah G, Gupta K, Shivkumar Rao J, Mohanan PP, Venugopal K, et al. CSI-Great India BP Campaign Investigators. Prevalence of hypertension among Indian adults: Results from the great India blood pressure survey. *Indian Heart J*. 2019 Jul-Aug;71(4):309-13. doi: 10.1016/j.ihj.2019.09.012. Epub 2019 Sep 18. PMID: 31779858; PMCID: PMC6890959.

22. Liew SJ, Lee JT, Tan CS, Koh CHG, Van Dam R, Müller-Riemenschneider F. Sociodemographic factors in relation to hypertension prevalence, awareness, treatment and control in a multi-ethnic Asian population: a cross-sectional study. *BMJ Open.* 2019 May 19;9(5):e025869. doi: 10.1136/bmjopen-2018-025869. PMID: 31110091; PMCID: PMC6530395.

23. Christiani Y, Byles JE, Tavener M, Dugdale P. Gender Inequalities in Noncommunicable Disease Risk Factors Among Indonesian Urban Population. *Asia Pac J Public Health*. 2016 Mar;28(2):134-45. doi: 10.1177/1010539515626265. Epub 2016 Jan 5. PMID: 26733115.

24. Sison O, Castillo-Carandang N, Ann Ladia M, Sy R, Eduardo Punzalan F, Jasper Llanes E, et al. Prevalence of Metabolic Syndrome and Cardiovascular Risk Factors among Community Health Workers in Selected Villages in the Philippines. *J ASEAN Fed Endocr Soc.* 2019;34(2):171-9. doi: 10.15605/jafes.034.02.08. Epub 2019 Nov 10. PMID: 33442153; PMCID: PMC7784100.

25. Htet AS, Bjertness MB, Oo WM, Kjøllesdal MK, Sherpa LY, Zaw KK, et al. Changes in prevalence, awareness, treatment and control of hypertension from 2004 to 2014 among 25-74-year-old citizens in the Yangon Region, Myanmar. *BMC Public Health*. 2017 Oct 26;17(1):847. doi: 10.1186/s12889-017-4870-y. PMID: 29073891; PMCID: PMC5659019.

26. Soe MS, Hlaing SS, Mon AS, Lynn KT. Prevalence of hypertension and factors associated with the utilization of primary health care services for hypertension among hypertensive population aged 40 years and above in Pyin Oo Lwin Township, Myanmar. *PLoS One*. 2024 Oct 16;19(10):e0312186. doi: 10.1371/journal.pone.0312186. PMID: 39413085; PMCID: PMC11482684.

27. Kibria GMA, Swasey K, Kc A, Mirbolouk M, Sakib MN, Sharmeen A, et al. Estimated Change in Prevalence of Hypertension in Nepal Following Application of the 2017 ACC/AHA Guideline. *JAMA Netw Open.* 2018 Jul 6;1(3):e180606. doi: 10.1001/jamanetworkopen.2018.0606. PMID: 30646022; PMCID: PMC6324293.

28. Dai B, Addai-Dansoh S, Nutakor JA, Osei-Kwakye J, Larnyo E, Oppong S, et al. The prevalence of hypertension and its associated risk factors among older adults in Ghana. *Front Cardiovasc Med*. 2022 Dec 20;9:990616. doi: 10.3389/fcvm.2022.990616. PMID: 36606290; PMCID: PMC9807661.

29. Visanuyothin S, Plianbangchang S, Somrongthong R. Appearance and potential predictors of poorly controlled hypertension at the primary care level in an urban community. *J Multidiscip Healthc.* 2018 Feb 23;11:131-38. doi: 10.2147/JMDH.S156518. PMID: 29503561; PMCID: PMC5826083.

30. Bjertness MB, Htet AS, Meyer HE, Htike MM, Zaw KK, Oo WM, et al. Prevalence and determinants of hypertension in Myanmar - a nationwide cross-sectional study. *BMC Public Health*. 2016 Jul 18;16:590. doi: 10.1186/s12889-016-3275-7. PMID: 27430560; PMCID: PMC4950687.

31. Dereje N, Earsido A, Abebe A, Temam L. Undiagnosed and diagnosed hypertension in a community setting at Hosanna town: Uncovering the burden. *BioRxiv.* 2019 Feb 26:560748.

32. Kim J, Kim J. Association between Fruit and Vegetable Consumption and Risk of Hypertension in Middle-Aged and Older Korean Adults. *J Acad Nutr Diet.* 2018 Aug;118(8):1438-1449.e5. doi: 10.1016/j.jand.2017.08.122. Epub 2017 Nov 4. PMID: 29113723.

33. Rajkumar E, Romate J. Behavioural Risk Factors, Hypertension Knowledge, and Hypertension in Rural India. *Int J Hypertens*. 2020 Mar 9;2020:8108202. doi: 10.1155/2020/8108202. PMID: 32231796; PMCID: PMC7085393.

34. Kurnianto A, Kurniadi Sunjaya D, Ruluwedrata Rinawan F, Hilmanto D. Prevalence of Hypertension and Its Associated Factors among Indonesian Adolescents. *Int J Hypertens*. 2020 Sep 16;2020:4262034. doi: 10.1155/2020/4262034. PMID: 33014450; PMCID: PMC7519181.

35. Tesfa E, Demeke D. Prevalence of and risk factors for hypertension in Ethiopia: A systematic review and meta-analysis. *Health Sci Rep*. 2021 Sep 22;4(3):e372. doi: 10.1002/hsr2.372. PMID: 34589614; PMCID: PMC8459032.

36. Tsimihodimos V, Gonzalez-Villalpando C, Meigs JB, Ferrannini E. Hypertension and Diabetes Mellitus: Coprediction and Time Trajectories. *Hypertension.* 2018 Mar;71(3):422-428. doi: 10.1161/HYPERTENSIONAHA.117.10546. Epub 2018 Jan 15. PMID: 29335249; PMCID: PMC5877818.