

## Developing a Tool for Self-Blood Pressure Monitoring and Control at Home

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### Abstract

Despite the availability of safe and effective treatments, hypertension diseases remain the leading cause of cardiovascular disease originating from combined genetic, environmental, and social determinants. Blood pressure monitoring and control to prevent and manage hypertension require systematic and sustained approach and engagement across communities over time. This study aimed to develop a how-to guidebook for self-blood pressure monitoring and control at home. A rapid review to map and synthesize current literature about preventive and control measures and activities for high blood pressure was conducted with 2 reviewers. Electronic databases such as PubMed, ProQuest and Google Scholar were used to retrieve eligible studies. Only systematic review and interventional studies published in English between 2015-2023 were considered. Out of 1356 retrieved studies, 21 studies met the inclusion criteria. A how-to guidebook was developed based on the results from a rapid review and Classification of Hypertension Based on Office Blood Pressure (BP) Measurement recommended by the International Society of Hypertension Global Hypertension Lines 2020. The findings of this review highlighted that Eating a healthy diet, getting regular exercise, limiting alcohol, not smoking, managing stress, and getting enough sleep are major categories of measures and activities that could play a role in the prevention and control of high blood pressure at home. Based on the findings of the review, a how-to guidebook was developed. further interventional study to test the effectiveness of a how-to guidebook in the prevention and control of blood pressure at home is needed.

**Keywords:** Home, Self-blood Pressure, Control, Prevention, Tool.

### Introduction

Despite the availability of safe and effective treatments, hypertensive diseases remain the leading cause of cardiovascular disease originating from the combination of genetic, environmental, and social determinants. The incidence and prevalence of hypertension continues to rise all over the world [1]. In the last few decades, a remarkable increase in hypertension has been noted in sub-Saharan Africa and this increase has been linked to the

lack of awareness about the diseases [2]. Strict blood pressure (BP) control is one of the most effective approaches to preventing cardiovascular disorders [3]. High blood pressure prevention and Control interventions are urgent and paramount [3]. Home blood pressure monitoring (HBPM) is a promising, easy-to-use, and well-accepted modality that facilitates the diagnosis and control of hypertension [4].

HBPM refers to measurements of BP at home usually by oneself, or on occasion, by

caregivers or research assistants [5]. Compared to office blood pressure (OBP), HBP is more likely to be free of environmental and/or emotional stress (such as the white-coat effect), yet it is a feasible approach to documenting long-term BP variations and can potentially be used for OBP diagnostic confirmation, identification of hypertension phenotypes, guiding treatment, and improved hypertension control when measured appropriately [5].

Additionally, the accurate measurement of blood pressure (BP) is an important diagnostic and monitoring tool in a wide range of clinical conditions. In clinical practice, the measurement of blood pressure (BP) relies on two primary methods: the manual method and the oscillometer method. Its best if cited. The manual method entails the healthcare professional listening to arterial sounds using a stethoscope, while the oscillometer method employs an automatic oscillometer device to detect fluctuations in pressure oscillations caused by arterial wall movement best if cited. The implementation of the oscillometer method

is crucial in accurately measuring BP as it enables the identification of abnormalities, aiding in the prompt administration of appropriate treatment and care to patients [6].

Moreover, the oscillometer technique is an automated and semiautomated HBPM device of choice to monitor blood pressure at home because of its simplicity of use and is widely advertised and sold in pharmacies or supermarkets and even does not require instruction from a knowledgeable health professional [7]. The Omron 705IT Oscillometric was validated to be an accurate device for home blood pressure measurement in normotensive children and adolescents. [8]. Accordingly, the 2020 International Society of Hypertension Global Hypertension lines have recommended that hypertension can be diagnosed when a person's systolic blood pressure (SBP) is  $\geq 140$ mmHg and/ or their diastolic blood pressure (DBP) is  $\geq 90$  mmHg considering repeated examination [9]. Table 1 summarizes different classifications of hypertension measurements.

**Table 1:** Classification of Hypertension Based on Office Blood Pressure (BP) Measurement

Category	Systolic (mmHg)		Diastolic (mmHg)
Normal Bp	<130	And	<85
High normal Bp	130-139	And/or	85-89
Grade 1hypertension	140-159	And/or	90-99
Grade2 hypertension	160-179	And/or	100-109

## Methods

To develop a how-to guidebook, the rapid review methodology was used to identify the literature from systematic and control trial studies relevant to the activities used to prevent and control high blood pressure among adult population. This methodology consisted of 5 important stages [10]: (1) identifying a research question, (2) searching for relevant evidence, (3) selecting relevant studies, (4) appraising

studies, and (5) data synthesis and presentation. In addition, the population, concept, and context (PCC) framework was used to establish the following review question: What is known from existing literature about activities to prevent and control high blood pressure among the adult population?

A systematic search was used to locate and retrieve relevant studies consistent with the research question. This search used PubMed, ProQuest, and Google Scholar electronic

databases to retrieve eligible studies. To ensure a systematic search and replicability of the results, a search strategy was developed using keywords, combined using suitable Boolean operators such as AND and OR. The following search strategy was developed: (Hypertension OR High blood pressure) AND (prevention OR control OR management) AND (interventions OR treatment) AND (adult OR older people OR advanced age). In this review, studies were restricted to only systematic review and interventional studies about the prevention and control of high blood pressure among the adult population, published in English between 2015-2023, from any geographical location. our search was not limited to any culture, gender, or socioeconomic characteristics. This review considered studies that include adults people aged over 18 years old with all gender identities. People with secondary hypertension or others with any organ failure were excluded.

All citations obtained through the databases and Google Scholar were uploaded into the Zotero referencing manager and then imported into Rayyan for deduplication and screening. Two independent reviewers analyzed the titles and abstracts to identify eligible studies. In addition, the same reviewers read and analyzed the full text of the selected citations following the inclusion and exclusion criteria. A flow chart of the screening process was documented using a PRISMA diagram (table 1). The review findings were reported by the Preferred Reporting Items for Systematic Reviews and Meta-analyses Extension for Scoping Review (PRISMA-ScR) guidelines to ensure transparency and reproducibility of the study. The number of eligible studies at this stage was recorded using PRISMA (annex 1). A narrative synthesis and tabulation were used to present the findings.

Lastly, the relevant data from the included studies were extracted and summarized using

an established data extraction form (table 1) and the following categories were recorded: Author, Title, Publication year, study objectives, Outcome measured, and Key findings.

### **Designing A How-To-Guidebook Methods**

A how-to guide is a document that gives step-by-step instructions on how to perform a task. The development and designing of a self-blood pressure home monitoring and control tool (A how-to guidebook) followed the Classification of Hypertension Based on Office Blood Pressure (BP) Measurement annex 1) and the findings of this rapid review on preventive and control measures for high blood pressure in the adult population.

### **Validity of A How-To Guidebook Content**

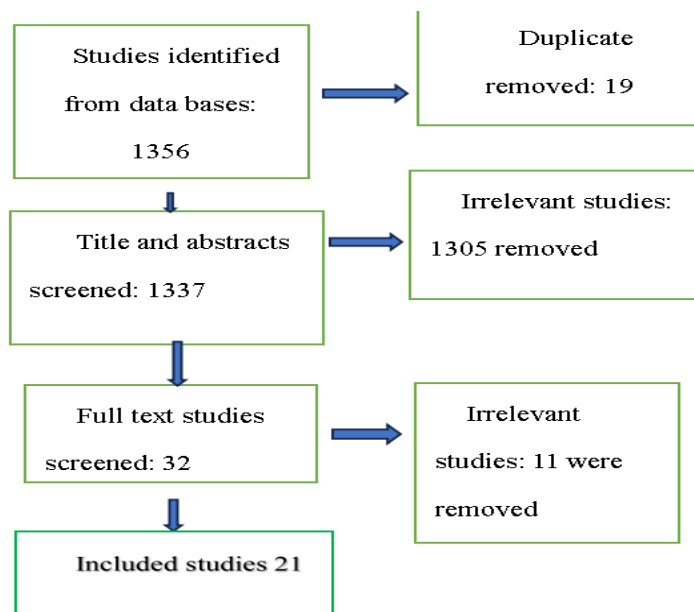
To ensure that the tool contains sufficient activities used to prevent and control blood pressure, the strategy content validity was applied. Different experts including public health managers, clinical nurses, and educators brainstormed the content of the guide, agreed, and validated the content.

## **Study Results**

### **Study Selection Results**

Figure 1 presents the PRISMA flow diagram of studies identified and included in the review. The initial search generated 1356 studies of which nineteen duplicates were identified and removed. The remaining 1337 studies, moved to the next step consisting of titles and abstracts screening where 1305 studies were excluded. Finally, twenty-three studies underwent the full-text screening, where 21 studies were considered for the final review.

The data of the included studies are summarized in Table 2. Studies were published between 2015 and 2024.



**Figure 1.** The PRISMA Diagram Of Study Selection Results

**Table 2.** Characteristics of Individual Studies

<b>Title</b>	<b>author</b>	<b>Publication year</b>	<b>Study objectives</b>	<b>Concepts</b>	<b>Results</b>
Sodium intake and risk for hypertension: A systematic review and dose-response meta-analysis of observational cohort studies	[11]	2022	The study assessed the relationship between sodium and hypertension risk in cohort studies	The relationship between sodium and hypertension	The review identified an almost linear relationship between sodium intake and hypertension risk in cohort studies and underpinning the validity of recommendations the reduction of sodium intake in the prevention of hypertension in both normotensive and hypertensive adults. Preventive and control activity: Eating healthy diet
Behavioral Counseling to promote a healthy diet and physical activities for cardiovascular disease prevention in adulty with cardiovascular risk factors: Update	[12]	2020	To review the benefits and harms of behavioral counseling interventions to improve diet and physical activity in adults with	Diet and physical activity in adults with cardiovascular risk factors	The review found the statistically significant association between behavioral counseling interventions with reduction in continuous measures of blood pressure, low-density lipoprotein cholesterol levels, fasting glucose

evidence report and systematic review for the US prevention services task force.			cardiovascular risk factors.		levels, and adiposity and heterogeneous measurement of diet and physical activity. Preventive and control activity: Eating healthy diet
Higher dietary total antioxidant capacity (TAC) reduces the risk of cardio-metabolic risk factors among adults: An updated systematic review and meta-analysis	[13]	2021	To evaluate the possible role of dietary total antioxidant capacity against cardio-metabolic risk parameters in the adult population.	Role of dietary total antioxidant capacity against cardio-metabolic risk factors	The review found the association of higher intake of dietary total antioxidant with reduced systolic, diastolic blood pressure and confirm the clinical importance of dietary antioxidants in the reduction of different metabolic disorders. Preventive and control activity: Eating healthy diet
Association of physical activity levels and attitudes towards physical activity with blood pressure among adults with high blood pressure in Bangladesh	[14]	2023	To investigate the associations of physical activity levels, sedentary time, knowledge of and attitude towards physical activity with blood pressure in people with hypertension in rural area in Bangladesh	Physical activity level, sedentary time, knowledge of and attitude with blood pressure	Compared to participant who did not take part in a vigorous- intensity physical activity in the study, the vigorous- intensity physical activity that cause increase in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for at least 10 minutes continuously had lower systolic blood pressure (SBP and sitting time more than four hours a day was associated with higher Diastolic Blood pressure compared to those who had sitting time less than four hours a day. Preventive and control activity: Getting regular exercise:
Dietary calcium intake and	[15]	2018	To investigate the association of	Calcium intake and hypertension	The review identified that the risk of

hypertension risk: a dose-response meta-analysis of prospective cohort studies			calcium intake with the risk of developing hypertension		developing hypertension decreases by 11% for the higher compared with the lowest category of dietary calcium and other blood pressure-related minerals intake. Preventive and control activity: Eating a healthy diet
Dietary factors and hypertension risk in West Africa: a systematic review and meta-analysis of observational studies	[16]	2023	To address dietary factors and the risk of hypertension in West Africa	Dietary factors and hypertension	The high consumption of dietary salt, red meat, dietary fat, junk food, and alcohol are associated with increased odds of hypertension while high fruit and vegetables appear protective. Preventive and control activity: Eating a healthy diet
Dietary interventions analysis and blood pressure in overweight or obese individuals: A Systematic review and meta-analysis.	[17]	2021	To examine if diets with increased fruit and vegetable consumption (FVC) decrease BP in overweight and obese persons.	increased fruit and vegetable consumption and BP	The increase in the fruits and vegetable consumption was significantly associated with a decrease in systolic and diastolic blood pressure in obese and overweight individuals which may lower the risk of cardiovascular events. Preventive and control activity: Eating a healthy diet
Potassium intake and blood pressure: A dose-response Meta-Analysis of randomized controlled trials.	[18]	2020	They suggest the association between potassium intake and blood pressure (BP)	Potassium intake and blood pressure	The findings indicated that adequate intake of potassium is desirable to achieve a lower BP level but suggest excessive potassium supplementation should be avoided. Preventive and control activity: Eating a healthy diet

Isometric hand exercises training attenuates blood pressure in hypertensive subjects at 30% maximum voluntary contraction	[19]	2018	To assess the blood pressure attenuating effect of isometric handgrip exercise in the management of hypertension.	Isometric hand exercise, attenuation of blood pressure in prehypertension	The study indicated that handgrip isometric exercises are effective attenuation of blood pressure in prehypertensive subjects especially when it is combined with the routinely recommended lifestyle modification. Preventive and control activity: Eating healthy diet
Long-Term Habitual Vigorous Physical Activity is associated with lower visits -to visit systolic blood pressure variability: Insights from the SPRINT Trial	[20]	2021	To investigate the association between vigorous physical activities and visit-to-visit systolic blood pressure variability	Vigorous physical activity and systolic blood pressure variability	During a follow up of 1-year, long-term engagement in vigorous activity was associated with lower visits to visit systolic blood pressure. Preventive and control activity: Getting regular exercise:
Primary prevention of CVD: Modification of diet in people with hypertension	[21]	2023	To assess the effects of selected dietary modification for people with hypertension	Primary prevention of CVD	The findings of the study showed that Mediterranean-style diets low salt diets, and calcium supplementation may be more effective at reducing blood pressure in people with hypertension. Preventive and control activity: Eating a healthy diet
The association between sleep deprivation and arterial pressure variation: a systematic literature review	[22]	2022	To systematically review published studies analyzing the possible relationship between sleep deprivation and variations in blood pressure during nighttime and daytime	Deprivation and variations in blood pressure during nighttime and daytime	It was found that sleep deprivation is acutely associated with blood pressure elevation. Preventive and control activity: Get Enough Sleep Sleep

The effects of regular consumption of green or black tea beverage on blood pressure in those with elevated blood pressure or hypertension: A systematic review and meta-analysis	[23]	2020	To assess the efficacy of black or green tea as a as a beverage in subjects with elevated blood pressure (BP), or HTN.	Black or green tea and hypertension	It was found that the longer the duration of tea intake ( $\geq 3$ months), the higher the decrease in both SBP and DBP. Preventive and control activity: Eating healthy diet:
The impact of dietary and lifestyle interventions on blood pressure management in sub-Saharan Africa: A systematic review and metanalysis	[24]	2023	To assess the association of dietary and other lifestyle interventions with BP-lowering effects in populations within Sub-Saharan Africa.	Dietary and other lifestyle interventions with BP-lowering effects	Dietary modifications showed a beneficial overall improvement in SBP and DBP in Africans. Preventive and control activity: Eating a healthy diet:
Assessing the association between smoking and hypertension: Smoking status, type of tobacco products and interaction with alcohol consumption	[25]	2023	to provide epidemiological evidence for the possible relationship between tobacco smoking and future hypertension risk, with the tobacco type and consumption dose into consideration	Relationship between tobacco smoking and Future Hypertension	The interaction effects of heavy smoking-heavy drinking patterns increased the future hypertension risk, with an adjusted HR of 2.58 (95% CI: 1.06–6.33). study did not find a significant association between overall tobacco use status and the risk of hypertension. However, heavy machine-rolled cigarette smokers had a statistically significant increased risk of hypertension compared with non-smokers Preventive and control activity: No Smoking
Cigarette Smoking and Longitudinal Associations with Blood Pressure: The CARDIA Study	[26]	2021	the association between cigarette smoking and longitudinal (30-year) changes in systolic BP, diastolic BP, and	Association between c igarette smoking and changes in Systolic BP, Diastolic	Neither systolic BP nor diastolic BP differed between Black consistent smokers compared with Black never smokers, although Black consistent smokers had higher PP than Black never



			pulse pressure (PP) in 4786 Black and White individuals from the CARDIA (Coronary Artery Risk Development in Young Adults) study using repeated-measures regression models	blood pressure, and Pulse pressure	smokers ( $\beta=1.01$ mm Hg, $P=0.028$ ). Although the associations of cigarette smoking with alterations in BP are small, the greater PP observed in consistent smokers may contribute in part to the higher cardiovascular disease risk observed in this group because PP is a strong predictor of cardiovascular disease risk after middle-age. Preventive and control activity: No Smoking
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Effect of mindfulness-based interventions on people with prehypertension or hypertension: a systematic review and meta-analysis of randomized controlled trials	[27]	2024	Assessed the effect of mindfulness-based interventions on blood pressure and mental health	Mindfulness and Blood Pressure	The results provide evidence for the positive role of mindfulness-based interventions in hypertension management
Job stress, a source of hypertension among workers in Sub-Saharan Africa: a systematic review	[28]	2023	The objective of this review was to explore current knowledge about hypertension and job stress in Sub-Saharan Africa	Job stress and Hypertension	Job stress was significantly associated with hypertension (OR = 2.4 [1.5–4.4]) and stress management was inversely associated with hypertension ( $r = -0.14$ , $p < 0.05$ ).
Association between anxiety and hypertension in adults: A systematic review and meta-analysis	[29]	2021	Assessed the association between anxiety and hypertension in adults via a systematic review/meta-analysis	Anxiety and Hypertension	A significant anxiety-hypertension association was found in cross-sectional (OR = 1.37, 95 % CI = 1.21–1.54) and prospective studies (OR = 1.40, 95 % CI = 1.23–1.59). Preventive and control activity: Manage stress

Occupational Noise and Hypertension Risk: A Systematic Review and Meta-Analysis	[30]	2020	updated systematic review with a meta-analysis of Occupational Noise and Hypertension Risk	Occupational Noise and Hypertension	The meta-analysis found a pooled effect size (ES) for hypertension (systolic/diastolic blood pressure $\geq 140/90$ mmHg) due to noise exposures $\geq 80$ dB(A) of 1.81 (95% CI 1.51–2.18). so, the study found high-quality evidence that occupational noise exposure increases the risk of hypertension. Preventive and control activity: manage stress
Relationship of High Stress with Hypertension in Adults: Meta-Analysis	[31]	2022	to estimate the relationship between high stress and hypertension in adults, with a meta-analysis of the primary study conducted by the previous authors	Stress with hypertension	The data collected showed that high stress had a relationship with the occurrence of hypertension in adults as much as 1.66 times compared to adults with low stress (aOR=1.66; 95%CI= 1.28 to 2.17; p= 0.002). Preventive and control activity: manage stress

Following the results of the rapid review and Classification of Hypertension Based on Office Blood Pressure (BP) Measurement as recommended by 2020 International Society of Hypertension Global Hypertension Lines 2020, a how-to guidebook for self-blood pressure monitoring and control at home was designed and validated by a group of experts. A guide is composed of 4 steps to follow that are 1) Self blood pressure measurement at home using an automatized oscillometric device, 2) interpreting the blood pressure value and finding blood pressure category, and 3) reading activity to perform for blood pressure control for each blood pressure category:(copy the link below and paste in the browser then download a guide book ): <https://self-blood-pressure-control.netlify.app/publications>

### Rapid Review Results Discussion

This review aimed to map and synthesize scholarly evidences about strategies to prevent hypertension among the adult population. These findings enabled the development of a how-to guidebook for home blood pressure measurement to prevent and control high blood pressure. This review identified several activities: Firstly, studies revealed that eating a healthy diet has potentially prevented hypertension [11-13, 15-19, 21, 23, 24]. These findings are supported by the Current international guidelines stressing the importance of implementing a dietary approach in preventing hypertension (DASH) [32]. Similarly, these findings are supported by the National Heart, Lung, and Blood Institute (NHLBI) results. The NHLBI suggests that blood pressures were reduced by a dietary

regime low in salt, saturated fat, cholesterol, and total fat. This guideline further emphasizes fruits, vegetables, and fat-free or low-fat milk and milk products regime [33] well presented.

In addition, the World Hypertension League Science of Salt in a regularly updated systematic review of salt and health outcomes studies (Sept 2019 to Dec 2020) identified an association between increased/higher sodium intake and poorer health outcomes. This review further suggested that dietary salt reduction is potentially associated with health benefits and strengthens evidence relating to health outcomes other than blood pressure and cardiovascular disease [34]. A further study examined the relationship between high salt intake and an increase in blood pressure and suggested that under similar blood pressure levels, high salt intake may be associated with increased blood pressure value [35]. Besides salt, the saturated fats have been linked with hypertension disease. The study determined the association between dietary intake of saturated fatty acids and hypertension revealed a significant association of saturated fat diet and hypertension [36].

Secondly, the reviewed literature showed that physical activity can reduce the risk of getting high blood pressure [14, 20]. These findings are consistent with other literature. A systematic review of interventional studies on physical activity and hypotension has shown that aerobic exercises, dynamic resistance exercises, concurrent exercises, and isometric exercises increase cardiorespiratory fitness and reduce the risk of developing hypertension [37]. Similarly, according to the 2020 WHO Guidelines on physical activity and sedentary behaviors, regular physical activity is a key protective factor for the prevention and management of non-communicable diseases (NCDs) [38]. The guideline provides evidence-based public health recommendations for children, older adolescents and older adults on the amount of physical activity (frequency, intensity, and duration) required to offer

significant health benefits and mitigate health risks. In children and adolescents, physical activity confers benefits for the following health outcomes: improved physical fitness (cardiorespiratory and muscular fitness), cardiometabolic health (blood pressure, dyslipidemia, glucose, and insulin resistance), bone health, cognitive outcomes (academic performance, executive function), mental health (reduced symptoms of depression); and reduced adiposity [39]. In older adults, physical activity confers benefits for the following health outcomes: improved all-cause mortality, cardiovascular disease mortality, incident hypertension, incident site-specific cancers, incident type-2 diabetes, mental health (reduced symptoms of anxiety and depression), cognitive health, and sleep; measures of adiposity may also improve. In older adults, physical activity helps prevent falls and fall-related injuries and declines in bone health and functional ability [40]. Moreover, in pregnant and postpartum women, physical activity during pregnancy and postpartum confers benefits on the following maternal and fetal health benefits: decreased risk of pre-eclampsia, gestational hypertension, gestational diabetes, excessive gestational weight gain, delivery complications, and postpartum depression, fewer newborn complications, no adverse effects on birthweight; and no increase in the risk of stillbirth [41] well structured.

Third, the findings of the present review found also that high consumption of alcohol is associated with an increased risk of developing hypertension. However, limiting alcohol is one of the strategies to prevent hypertension disease. These have been emphasized by the review on alcohol intake and arterial hypertension short-term studies, which showed a biphasic BP response after ingestion of high doses of alcohol, sustained alcohol consumption above 30g/day, and dose-dependent significantly increased risk of hypertension [42]. The effect of reducing

alcohol consumption on the improvement of health outcomes among patients with hypertension was evidenced in the population-based observational study in adult primary care patients with hypertension who screened positive for unhealthy alcohol use. The findings revealed a change in heavy drinking/past 3 months, drinking days/week, drinking day and drinks/week from baseline to 12-month follow-up, based on results of alcohol screening conducted in routine care [43].

Fourth, the review also found that smoking is significantly associated with hypertension [25, 26]. These findings are supported by the study on the prevalence of hypertension among current cigarette smokers' patients in an outpatient department of a tertiary care center in the Outpatient Department (OPD) of Kathmandu Medical College, Duwakot, Bhaktapur. Participants with a history of smoking more than 100 cigarettes and who are still smoking were included in the study. One hundred fifty-six (40.51%) males and 53 (13.76%) females were hypertensive [44]. The study highlighted that limiting smoking can be a good behavior to prevent the occurrence of hypertension.

Lastly, the review found also that sleeping deprivation is associated with blood pressure elevation. These findings are supported by studies revealing that sleep disorder prevalence is higher in hypertensive patients than in non-hypertensive patients [45]. Additionally, associations of short sleep and severe sleep restriction with higher blood pressure were identified in a review of the effect of sleep disturbances on blood pressure [45]. Another study evaluated the association between sleep duration and hypertension among adults in southwest China and found a higher risk of hypertension in individuals with short (<6h/day) or long (>8h/day) sleep durations compared to those with a normal (6–8 h/day) sleep duration [46].

## **Conclusion**

The study aimed to develop a how-to guidebook for self-blood pressure monitoring and control at home. A rapid review to map and synthesize current literature about preventive and control measures and activities for high blood pressure was conducted by two reviewers. A how-to guidebook was developed based on the results from a rapid review and Classification of Hypertension Based on Office Blood Pressure (BP) Measurement recommended by the International Society of Hypertension Global Hypertension Lines 2020. The results from the included studies were categorized into seven major categories following different activities identified in the findings of the studies as measures that could play a role in the prevention and control of high blood pressure. These categories include eating a healthy diet, getting regular exercise, limiting alcohol, Not smoking, managing stress, and Get Enough Sleep.

Following the results of the rapid review and Classification of Hypertension Based on Office Blood Pressure (BP) Measurement as recommended by 2020 International Society of Hypertension Global Hypertension Lines 2020, A how-to guidebook for self-blood pressure monitoring and control at home was designed and validated by a group of experts. The researcher recommends that health policymakers establish encouraging strategies for the community to refer to a how-to guidebook and adhere to preventive and control blood pressure activities at home. Lastly, further research is needed to test the effectiveness of a how-to guidebook in the prevention and control of blood pressure at home.

## **Conflict of Interest**

The authors certify that they have no affiliations with any organization with any financial, personal, knowledge, or beliefs interest in the subject matter or materials discussed in this manuscript.

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