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Hypertension in Adults With Diabetes in Southeast Asia: A Systematic Review

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ABSTRACT

Diabetes is one of the most pressing health issues in the Southeast Asian region, and hypertension has been commonly reported as a comorbidity in adults with diabetes. This systematic review aimed to synthesize evidence on the prevalence and management of hypertension in adults with diabetes in Southeast Asian countries. A literature search was conducted in Ovid MEDLINE and Embase Classic + Embase from database inception until March 15, 2024. Studies were included if (1) they were conducted in Southeast Asian countries, (2) the study populations were adults with diabetes, and (3) there was information related to hypertension or blood pressure (BP) in the study results. Of the 7486 abstracts found, 90 studies qualified for this review. Most studies reported a hypertension prevalence of 70% or higher (ranging from 29.4% to 93.4%). Despite this high prevalence, a substantial proportion of these populations did not receive adequate BP control, with most studies indicating a control rate of less than 40%. There was limited evidence on the prescription of antihypertensive therapies and medication adherence. There was a lack of studies from 4 of the 11 countries in the region. This review highlights that BP control in adults with diabetes remains a significant challenge in Southeast Asia. Given the ongoing epidemiological transition, and the increasing older population in this region who are likely to accumulate multiple chronic conditions complicating medication strategies, this review highlights the urgent need to improve BP management in those with diabetes.

1 | Background

The region of Southeast Asia is a rapidly growing and developing part of the world. Geographically, it consists of 11 countries situated south of Mainland China, east of the Indian subcontinent and north of Australia. The 11 countries are (in alphabetical order) Brunei, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor Leste, and Vietnam. The region has a wide diversity in socio-cultural backgrounds and contributes to approximately 9% of the world's global population [1]. Five member countries in the region are ranked among the top 30 most populous countries globally—Indonesia at number 4 (with 274 million people), the Philippines at 13 (with 118 million people), Vietnam at 16 (with 99 million

[Correction added on January 29, 2025, after first online publication: The affiliations of the second author, Tan Van Nguyen, have been corrected in this version.]

people), Thailand at 20 (with 72 million people), and Myanmar at 27 (with 55 million people). Alongside population growth, these countries are undergoing significant demographic changes and are not immune to the global epidemiological transition. Increasing economic development in some low- and middle-income countries has been proposed as a contributing factor to the rising prevalence of diseases like diabetes and cardiovascular disease. The longer life expectancy and increasing older population have strained healthcare resources in these countries. They share common challenges linked to the ongoing epidemiological transition and a shift in the disease burden from communicable to non-communicable diseases [1]. The Southeast Asia region is expected to see an increase in morbidity and mortality associated with cardio-metabolic diseases in the coming decades [2]. As a response, a multidisciplinary expert panel has called for Southeast Asia specific clinical pathways for regional approaches to the growing epidemic of non-communicable diseases [3].

One of the most pressing health issues in this region is the rising incidence of type 2 diabetes, which has become a significant public health concern [4]. The prevalence of type 2 diabetes in this region is estimated to be around 9%, with outcomes generally poorer compared to Caucasian populations [5–7]. It is expected that by 2025, the major prevalence of diabetes will not be in North America or Europe but in the Asia Pacific region [8], of which Southeast Asia is a part. This will further add pressure on already burdened health systems in the region.

Hypertension has been commonly reported as a comorbidity in adults with type 2 diabetes [9]. This is concerning as it can increase the risks of complications associated with diabetes, leading to reduced kidney function and contributing to cardiovascular disease. Therefore, blood pressure (BP) control remains a crucial aspect of managing patients with diabetes, not only in preventing vascular complications related to diabetes but also in managing overall cardiovascular risk. Predictive modeling has shown that aggressive management of both diabetes and hypertension can reduce cardiovascular events [10]. As such, it is critical to manage both conditions effectively in these populations [11].

In this review, we aimed to synthesize the evidence from research related to the prevalence of hypertension and its management in adults with diabetes in Southeast Asian populations.

2 | Methods

2.1 | Search Strategy and Information Sources

A literature search was done in the following databases from database inception until March 15, 2024: Ovid MEDLINE (from 1946), Embase Classic + Embase (from 1947). Articles written in languages apart from English were excluded. Search results were managed using Covidence (Table S1).

Keywords and Medical Subject Headings terms were: diabetes, diabetes mellitus, BP, hypertension, with the combination of countries, and populations: Malaysia, Malaysian, Indonesia, Indonesian, Singapore, Singaporean, Vietnam, Vietnamese, Thailand, Thai, Brunei, Laos, Timor Leste, Cambodia, Cambodian, Myanmar, Burma, Philippines, Filippino, Southeast Asia.

2.2 | Eligibility (Inclusion) Criteria

Studies were included if (1) they were conducted in Southeast Asian countries, (2) the study populations were adults with diabetes, and (3) there was information related to hypertension or BP in the study results.

2.3 | Exclusion Criteria

Case reports, abstracts, reviews, non-English text, study protocols for randomized control trials, studies that looked at diaspora (e.g., Filipino Americans, Vietnamese living in European countries), and studies that included multiple countries outside Southeast Asia and did not provide specific results for Southeast Asian countries, were excluded.

2.4 | Study Selection and Data Extraction

Full texts were retrieved and assessed. All references selected for retrieval from the databases were managed by Covidence. Duplicated references were excluded. Study titles and abstracts were screened independently by two members of the research team (W.J.W. and F.A.), based on the inclusion and exclusion criteria. The full texts of qualified publications were read and selected for the final decision to include after discussion between W.J.W., F.A., and T.N.N. Any disagreement was solved by discussion between these three reviewers. The included studies were then managed into an Excel file listing the year of publication, first author name, title, and journal (Table S2).

2.5 | Quality Assessment

Quality assessment of the included studies was evaluated using the National Heart, Lung, Blood Institute (NHLBI) Quality Assessment Tool for Observational Cohort, Cross-Sectional Studies, and Controlled Intervention Studies. The quality assessment tool consists of 14 items for evaluation in each study design. Items were scored accordingly—Y-Yes, N-No, or O-Others (CD-Cannot determine, NA-Not applicable, NR-Not reported). Studies were then classified as "good," "fair," or "poor."

2.6 | Data Analysis

We extracted information on the country, published year, study sample size, study design, and the study findings into tables. The results of this review were narratively summarized in accordance with the review objective. This review followed the PRISMA guidelines (Figure 1).

3 | Results

A total of 7486 abstracts (5452 from Embase & 2034 from Medline) were screened and reviewed, and 90 articles were included in this review [12–103] (Figure 1). Of the 90 articles, 88 were observational studies, 1 was a randomized controlled trial, and 1 was a quasi-experimental controlled study. These 90 studies were

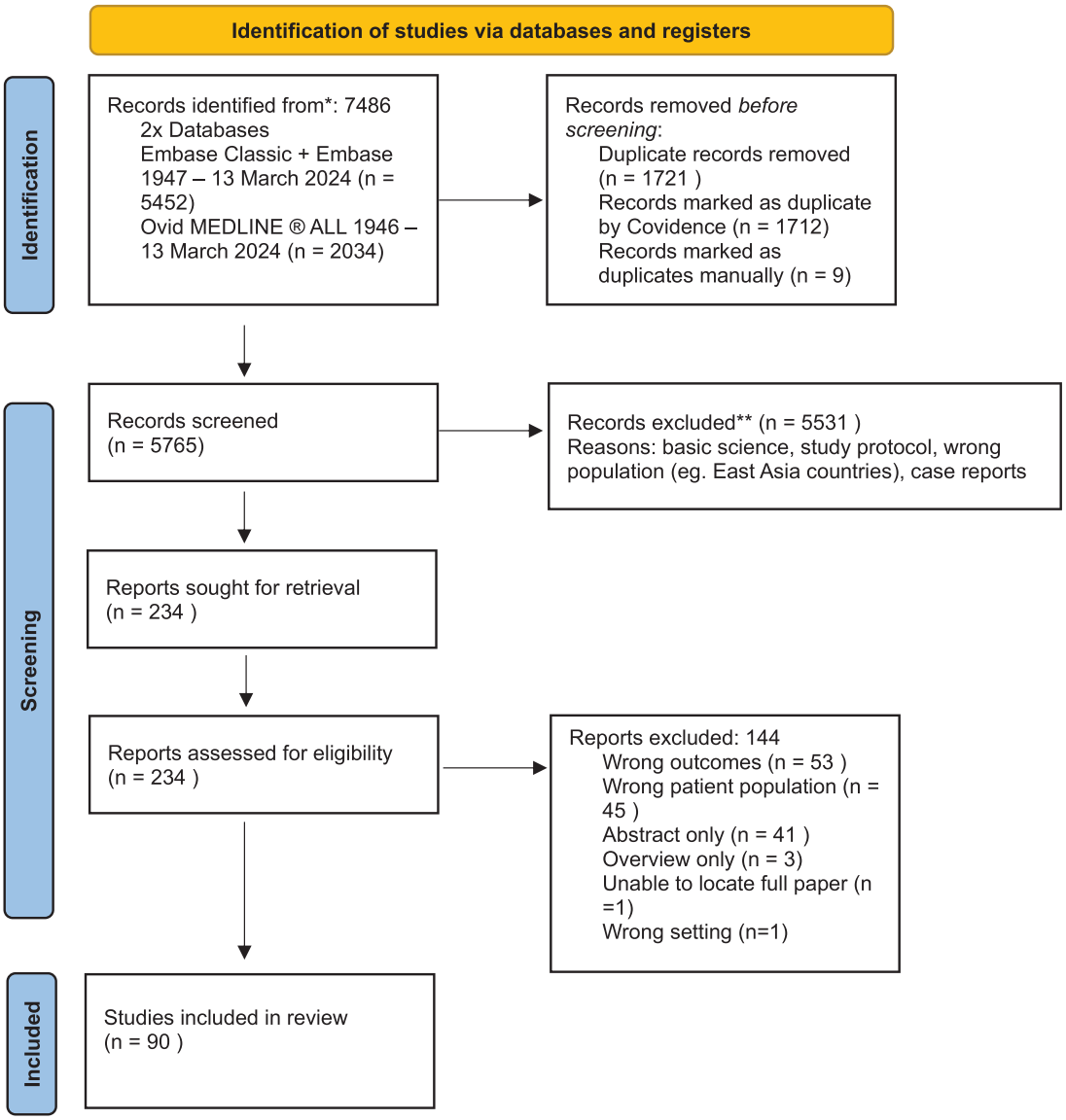

FIGURE 1 | PRISMA flowchart.

from 7 Southeast Asian countries (Figure 2), including: Malaysia (39 articles) [12–51], Thailand (24 articles) [52–75], Singapore (10 articles) [76–86], Indonesia (6 articles) [87–92], Cambodia (5 articles) [93–97], Vietnam (3 articles) [98–100], and Philippines (3 articles) [101–103]. The mean age of the participants in these studies ranged from 50.3 to 72.6 years (Table 1). Most studies were conducted in the general adult population, and only six studies were exclusively devoted to an older demographic, specifically including participants aged 60 or older [40, 41, 58, 65, 82, 99].

3.1 | Quality Assessment/Risk of Bias Analysis

The 88 observational studies were evaluated using the NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. The remaining studies were evaluated using the NHLBI Quality Assessment of Controlled Intervention Studies. Of the 90 included studies, 75 studies were classified as "good," and 15 were classified as "fair" (Table S3).

We summarized the findings into four main themes for adults with diabetes: (1) Prevalence of hypertension (Table 1); (2) BP control rate (Table 2); (3) Percentage of patients with diabetes who received antihypertensive medicines (Table 3); and (4) Adherence to antihypertensive medicines. We also provided information on glucose control in Table S4.

3.2 | Prevalence of Hypertension in People With Diabetes

Among the 90 studies included in this review, data on the prevalence of hypertension in adults with diabetes was obtained from 55 studies [12, 13, 15, 18, 19, 21, 22, 24, 25, 28, 29, 31, 33, 36, 39–45, 47–51, 55–61, 63, 64, 66, 67, 69, 70, 74, 75, 78, 79, 81, 84, 88, 89, 91, 92, 94, 95, 97, 98, 100–103]. Among the included 90 studies, 85 studies reported using office BP measurements and 5 studies used out-of-office BP measurements (Table S4). Most studies reported a hypertension prevalence of 70% or higher (ranging from 29.4% to 93.4%). Malaysia contributed the most

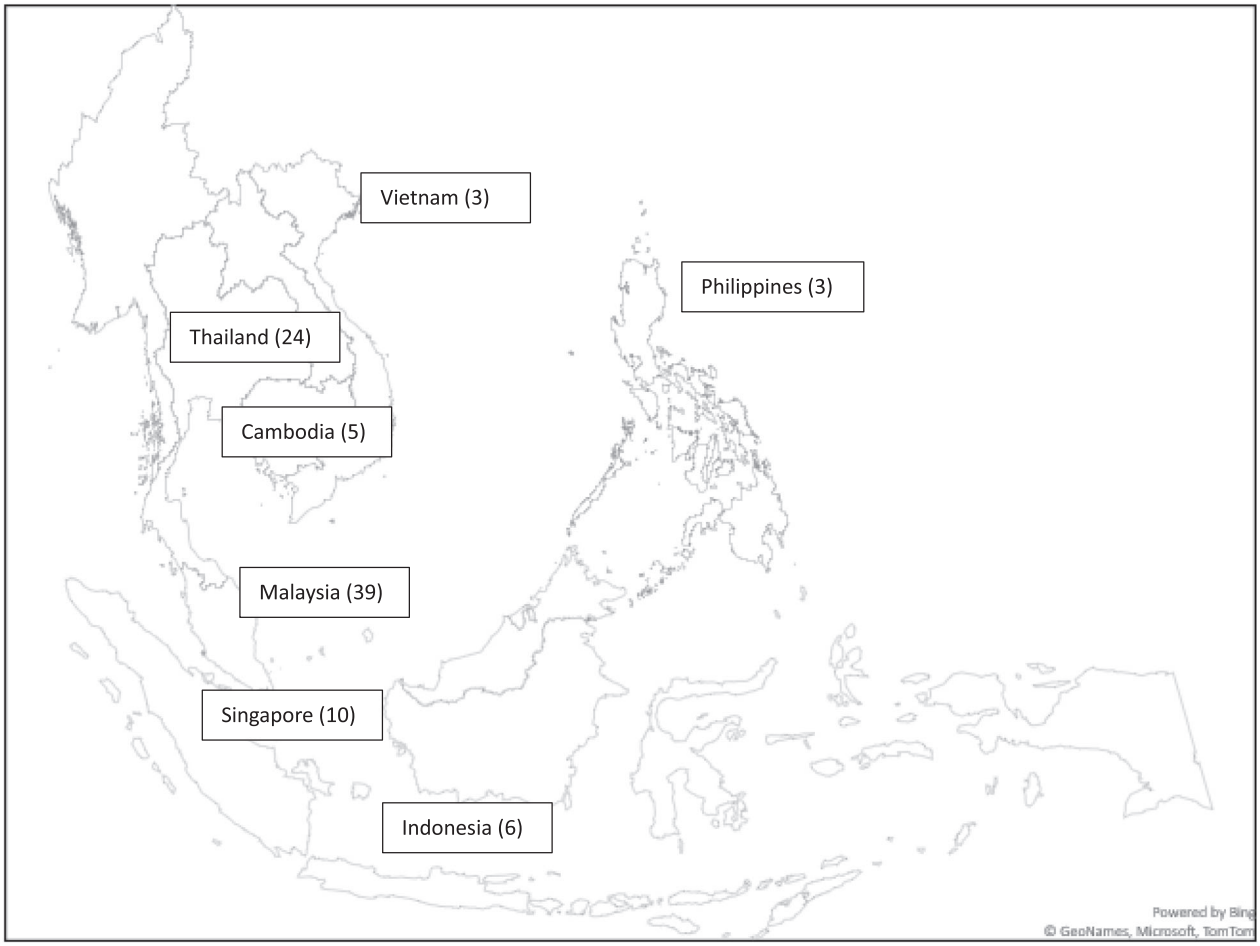

FIGURE 2 | Number of studies per country in Southeast Asia.

studies (25 studies), followed by Thailand (15 studies). Among the 25 studies in Malaysia, the reported prevalence of hypertension was > 70% in most of the studies (90.4%–93.4% in 4 studies, 80.3%–87.9% in 8 studies, 72.9%–79.1% in 8 studies, 57.4%–67.7% in 3 studies, and 32.4%–36.9% in 2 studies) [12, 13, 15, 18, 19, 21, 22, 24, 25, 28, 29, 31, 33, 36, 39–45, 47–51]. Similarly, there was also a very high prevalence of hypertension among adults with diabetes in Thailand: 80.5%–89.3% (4 studies), 70.2%–78.2% (6 studies), 63.4%–69.95% (3 studies), and 55.35%–57.3% (2 studies) [55–61, 63, 64, 66, 67, 69, 70, 74, 75].

In other Southeast Asian countries, the prevalence of hypertension ranged from 29.4% to 58.8% in Cambodia (3 studies) [94, 95, 97], 43.9%–68.1% in Indonesia (4 studies) [88, 89, 91, 92], 42%–73.5% in Philippines (3 studies)[101–103], 59.4%–92.4% in Singapore (3 studies)[78, 81, 84], and 35.6%–78.4% in Vietnam (2 studies) [98, 100].

3.3 | BP Control Rate in People With Diabetes

Among the 90 studies included in this review, information on BP control rate was obtained from 46 studies [14, 16, 17, 20, 23–27, 29–32, 34–37, 40, 41, 45–47, 51, 52, 54, 56, 58, 62, 63, 65, 66, 68, 69, 71–73, 76, 77, 80–82, 85, 90, 93, 96, 99].

The percentage of study participants achieving BP control varied across the countries, with most studies indicating a control rate of less than 40%. Among the 23 studies in Malaysia, most of the studies reported a BP control rate of 22% to 39% (15 studies), while several studies reported a much lower rate (3.1%–8% in 2 studies, and 15%–19.9% in 3 studies), or higher (43.4% –47.2% in 3 studies) [14, 16, 17, 20, 23–27, 29–32, 34–37, 40, 41, 45–47, 51]. Among the six studies in Singapore, BP control rate was 12.7%–13.4% in 2 studies, 22.5%–26.2% in 2 studies, and 42.7%–69.9% in 2 studies [76, 77, 80–82, 85]. Among the 13 studies in Thailand, BP control rate was 6.2% in 1 study, 14.9%–18% in 2 studies, 28.4%–39.7% in 5 studies, 47.1%–53.1% in 3 studies, 65.5%–75.4% in 2 studies [52, 54, 56, 58, 62, 63, 65, 66, 68, 69, 71–73]. In other countries, the control rate was 12.3%–58.4% in Cambodia (2 studies) [93, 96], 9.2% in Indonesia (1 study) [90], and 37.2% in Vietnam (1 study) [99].

Regarding the cut-off to define controlled BP, the majority of studies (35 out of 46) employed a cut-off of 130/80 mmHg [14, 16, 17, 20, 23–27, 29, 30, 32, 34–37, 40, 41, 45, 47, 52, 54, 56, 62, 63, 66, 71–73, 77, 80–82, 85, 90]. The remaining 11 studies used a cut-off of 140/80–90 mmHg or a varying cut-off based on patient age [31, 46, 51, 58, 65, 68, 69, 76, 93, 96, 99]. For example, one study in Malaysia defined controlled hypertension as BP < 140/80 mmHg for patients with both diabetes and hypertension, and BP < 150/90 mmHg for those aged 80 years and above [46]. Another study in Thailand set a BP target of < 140/90 mmHg for

TABLE 1 | A summary of the studies providing the prevalence of hypertension in people with diabetes.

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	Prevalence of hypertension
1	Hernandez et al. 2021 [95]	Cambodia	9139	Observational, retrospective	55.7	58.2%
2	Wagner et al. 2017 [97]	Cambodia	13 997	Observational, cross-sectional	—	58.7%
3	King et al. 2005 [94]	Cambodia	2246	Cross-sectional	50.3 (Siemreap) 55.3 (Kampong Chan)	29.4% (Siemreap) 58.8% (Kampong Chan)
4	Soeatmadji et al. 2023 [92]	Indonesia	221	Observational, prospective	55.6	43.9%
5	Sitorus et al. 2022 [91]	Indonesia	144	Cross-sectional	30.6% > 60 years old	68.1%
6	Mutika et al. 2021 [89]	Indonesia	170	Cross-sectional	86% > 45 years old	57%
7	Fajriansyah et al. 2020 [88]	Indonesia	220	Randomized controlled trial	57.7	62.7%
8	Husin et al. 2023 [28]	Malaysia	6719	Quasi-experimental controlled study	59.9	78.2%
9	Shaharuddin et al. 2023 [42]	Malaysia	495	Cross-sectional	52.2	78.3%
10	Sim et al. 2023 [43]	Malaysia	1985	Observational, retrospective	56.9	72.9%
11	Wan et al. 2023 [51]	Malaysia	288 913	Observational retrospective	58.7	81.6%
12	Lee et al. 2022 [31]	Malaysia	425	Cross-sectional	66.8% aged ≥ 60	90.4%
13	Ab Rahman et al. 2022 [12]	Malaysia	2696	Observational retrospective	60.4	85.8%
14	Wan et al. 2022 [47]	Malaysia	18 312	Observational, retrospective	49.4% aged ≥ 60	83.5%
15	Chee et al. 2021 [19]	Malaysia	301	Cross-sectional	61	77.1%
16	Chew et al. 2021 [21]	Malaysia	552	Observational, retrospective	59.9	78.3%
17	Keng et al. 2021 [29]	Malaysia	260	Cross-sectional	58.7	87.9%
18	Wan et al. 2021 [50]	Malaysia	18 341	Observational, retrospective	59.3	83.5%
19	Wan et al. 2021 [48]	Malaysia	17 592	Observational, retrospective	59.1	83%
20	Rahim et al. 2020 [39]	Malaysia	33	Cross-sectional	57.9	63.6%
21	Wan et al. 2020 [49]	Malaysia	7646	Observational, retrospective	58.1	80.4%
22	Lim et al. 2019 [33]	Malaysia	2960	Cross-sectional	60	79.1%
23	Syed Soffian et al. 2019 [44]	Malaysia	23 557	Cross-sectional	26.5% aged ≥ 60	75.8%
24	Sazlina et al. 2015 [41]	Malaysia	21 336	Cross-sectional	67.8	36.9%
25	Sazlina et al. 2014 [40]	Malaysia	10 363	Cross-sectional	71.3	32.4%
26	Abougalambou et al. 2013 [13]	Malaysia	1077	Observational, prospective	22.5% aged ≥ 65	92.7%
27	Chew et al. 2012 [24]	Malaysia	70 889	Cross-sectional	52.3	57.4%
28	Chew et al. 2011 [25]	Malaysia	212	Cross-sectional	62.7	77.3%

(Continues)

TABLE 1 | (Continued)

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	Prevalence of hypertension
29	Mafauzy et al. 2011 [36]	Malaysia	1670	Cross-sectional	57.5	80.3%
30	Abougalambou 2010 [15]	Malaysia	1077	Prospective, cross-sectional	58.3	92.7%
31	Tan et al. 2008 [45]	Malaysia	196	Cross-sectional	60	93.4%
32	Chan et al. 2005 [18]	Malaysia	517	Cross-sectional	57.9	67.7%
33	Giron et al. 2022 [101]	Philippines	405	Cross-sectional	—	73.5%
34	Jimeno et al. 2012 [102]	Philippines	770	Cross-sectional	61.6	68.4%
35	Sy et al. 2009 [103]	Philippines	172	Cross-sectional	50.8	42%
36	Sun et al. 2021 [84]	Singapore	189 520	Observational, retrospective	64.2	92.4%
37	Luo et al. 2018 [81]	Singapore	943	Cross-sectional	56.5	59.4%
38	Lee and Tang 2015 [78]	Singapore	786	Cross-sectional	63.95	83.1%
39	Lertsakulbunlue et al. 2023 [60]	Thailand	84 602	Cross-sectional	58.4 (2014), 58.8 (2015), 59.3 (2018)	73.4% (2014) 75.7% (2015) 75.3% (2018)
40	Puangpet et al. 2022 [63]	Thailand	488	Cross-sectional	63.9	80.5%
41	Euswas et al. 2021 [55]	Thailand	104 472	Cross-sectional	61.1 (2014), 61.5 (2015), 62.3 (2018)	76.2% (2014) 78.2% (2015) 78.1% (2018)
42	Sakboonyarat et al. 2021 [66]	Thailand	186 010	Cross-sectional	61.1	74.4%
43	Zaman et al. 2021 [75]	Thailand	4050	Cross-sectional	56.7% aged ≥ 60	57.3%
44	Kaewput et al. 2020 [57]	Thailand	8464	Observational, retrospective	69.3	89.3%
45	Nata et al. 2020 [61]	Thailand	30 377	Cross-sectional	61.2	76.8%
46	Vonok et al. 2019 [74]	Thailand	24 992	Cross-sectional	59.9	70.2%
47	Kaewput et al. 2019 [58]	Thailand	54 295	Cross-sectional	72.6	83.5%
48	Sakboonyarat and Rangsin 2018 [67]	Thailand	25 902	Cross-sectional	60.6	70.9%
49	Sieng et al. 2017 [69]	Thailand	26 860	Cross-sectional	59.6 (specialized diabetes clinic), 68.3% (general medical clinic)	65.5% (specialized diabetes clinic) 74.3% (general medical clinic)
50	Hurst et al. 2015 [56]	Thailand	55 797	Cross-sectional	61.6	55.35%
51	Sieng et al. 2015 [70]	Thailand	26 869	Cross-sectional	60	69.95%

(Continues)

TABLE 1 | (Continued)

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	Prevalence of hypertension
52	Leelawattana et al. 2006 [59]	Thailand	9284	Cross-sectional	65.6 (long-DM), 58.2 (short-DM)	85% (long-DM) 80% (short-DM)
53	Rawdaree et al. 2006 [64]	Thailand	9419	Cross-sectional	59.4	63.4%
54	Sahl et al. 2023 [98]	Vietnam	806	Cross-sectional	74.8% ≥ aged 60	35.6%
55	Nguyen KT et al. 2020 [100]	Vietnam	1631	Cross-sectional	62.7	78.4%

adults younger than 60 years, while a goal of $< 150/90$ mmHg was used for those 60 years and older [68].

3.4 | Percentage of Patients With Diabetes Who Received Antihypertensive Medicines

Among the 90 studies included in this review, information on the percentage of patients with diabetes who received antihypertensive medicines was obtained from 15 studies [14, 24, 34–36, 52, 53, 58, 60, 62, 72, 83, 86, 90, 102]. A study from Indonesia reported that 52% of the participants received antihypertensive medicines [90]. In Malaysia (5 studies) [14, 24, 34–36], this ranged from 32.4% to 94.2%. A study in the Philippines reported that 64.4% of the participants received antihypertensive medicines [102]. In Singapore (2 studies) [83, 86], the uptake ranged from 78.9% to 97.2% while in Thailand (6 studies) [52, 53, 58, 60, 62, 72], the uptake ranged from 21.8% to 84%.

There was limited information on the types of antihypertensive medications used in these studies. One study in older adults (aged 65 or above) in Thailand reported that angiotensin converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs) were the most commonly used (63.8%) [58]. One study in Malaysia reported that 68.9% were on 2 antihypertensives or more (31.3% on 2, 17.9% on 3, and 19.7% on more than 3 antihypertensives) [14]. Another study in Singapore reported that 43.1% of the participants were on ≥ 2 types of antihypertensives [86].

3.5 | Adherence to Antihypertensive Medicine in People With Diabetes

Among the 90 studies included in this review, information on adherence to antihypertensive medicine in patients with diabetes was obtained from only one study in Indonesia [87], where, of 571 participants with type 2 diabetes, 45.5% reported being non-adherent to antihypertensives. This study also highlighted that older age was associated with non-adherence to antihypertensives: adjusted odds ratios for non-adherence were 2.37 (95% CI 1.11–5.07) in patients aged 50–59, 5.65 (95% CI 2.68–11.92) in the age group 60–69, and 4.14 (95% CI 1.74–9.82) in patients aged 70 or older (with patients aged 49 or younger as the reference group).

3.6 | Glucose Control

Out of the 90 studies included, 17 studies did not provide information on glucose control (HbA1c or plasma glucose levels), 51 studies reported the percentages of participants achieving target glucose control, while the remaining 22 studies reported mean or median values of HbA1c and/or plasma glucose levels. Of the 51 studies reporting the percentages of participants with target glucose control, 46 studies reported that less than 50% of the study populations achieved target glucose control, and the remaining 5 studies reported 51%–75% of the study participants achieving targeted glucose control (Table S4).

TABLE 2 | A summary of studies reporting BP control in people with diabetes.

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	BP control rate	Cut off (SBP/DBP mmHg)
1	Taniguchi et al. 2017 [96]	Cambodia	2230	Observational, retrospective	54.5 (median)	58.4%	140/90
2	Isaakidis et al. 2011 [93]	Cambodia	2858	Observational, prospective	57 (median)	12.3%	140/90 (non-diabetics), 130/80 (diabetics)
3	Soegondo et al. 2009 [90]	Indonesia	770	Cross-sectional	57	9.2%	130/80
4	Lim et al. 2024 [32]	Malaysia	5094	Cross-sectional	59	22.8%	130/80
5	Wan et al. 2023 [51]	Malaysia	288 913	Observational retrospective	58.7	35.8% achieved < 140/80, 24.3% achieved < 130/80	130–140/80
6	Wan et al. 2022 [47]	Malaysia	18 312	Observational retrospective	59.3	22.2%	130/80
7	Lee et al. 2022 [31]	Malaysia	425	Cross-sectional	66.8% > 60	43.5%	140/80
8	Keng et al. 2021 [29]	Malaysia	214	Cross-sectional	58.7	30.9%	130/80
9	Teh et al. 2020 [46]	Malaysia	13 784	Cross-sectional	61	35.2%	140/80 (for diabetic hypertensive patients) 150/90 (for patients aged 80 years and above)
10	Hieng 2017 [27]	Malaysia	233	Cross-sectional	55.9	36.4%	130/80
11	Mahmood et al. 2016 [37]	Malaysia	706	Cross-sectional	58.7	31.7%	130/80
12	Cheong et al. 2015 [20]	Malaysia	1107	Cross-sectional	56.9	24.3%	130/80
13	Sazlina et al. 2015 [41]	Malaysia	21 336	Cross-sectional	67.78	19.9%	130/80
14	Sazlina et al. 2014 [40]	Malaysia	10 363	Cross-sectional	71.28	21.9%	130/80
15	Chew et al. 2013 [23]	Malaysia	70 889	Cross-sectional	68.1 (≥ 60 years), 50.2 (≤ 60 years)	21.8%	130/80
16	Ahmad et al. 2013 [16]	Malaysia	520	Cross-sectional	61.28	43.4%	130/80
17	Lee et al. 2013 [30]	Malaysia	70 092	Cross-sectional	58.3	21.3% (Malay) 25% (Chinese) 30% (Indian)	130/80
18	Chew et al. 2012 [24]	Malaysia	70 889	Cross-sectional	58.3	23.5%	130/80

(Continues)

TABLE 2 | (Continued)

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	BP control rate	Cut off (SBP/DBP mmHg)
19	Abougalambou et al. 2011 [14]	Malaysia	1077	Observational, prospective	22.5% > 65	47.2%	130/80
20	Chew et al. 2011 [25]	Malaysia	212	Cross-sectional	62.7	24.5%	130/80
21	Mafauzy et al. 2011 [36]	Malaysia	1670	Cross-sectional	57.5	39.1%	130/80
22	Tan et al. 2008 [45]	Malaysia	196	Cross-sectional	60	32%	130/80
23	Mafauzy 2006 [35]	Malaysia	1099	Cross-sectional	55.8	15%	130/80
24	Chan 2005 [17]	Malaysia	517	Cross-sectional	56.7	3.1%	130/80
25	Mafauzy 2005 [34]	Malaysia	438	Cross-sectional	54.1	17.5%	130/80
26	Eid et al. 2004 [26]	Malaysia	211	Cross-sectional	53.7	8%	130/80
27	Feng et al. 2021 [76]	Singapore	209 930	Cross-sectional	51.7% ≥ 65 in 2013 and 56.2% in 2019	69.9% in 2013 decreased to 62.5% in 2019 (decrease by 7.4%)	140/90
28	Liu et al. 2020 [80]	Singapore	2189	Cross-sectional	60.6	12.7%	130/80
29	Luo et al. 2018 [81]	Singapore	943	Cross-sectional	56.5	42.7%	130/80
30	Huang et al. 2010 [77]	Singapore	3280	Cross-sectional	62.5	13.4%	130/80
31	Malhotra et al. 2010 [82]	Singapore	4494	Cross-sectional	33.5% 60–64, 42.7% 65–74, 23.8% ≥ 75	22.5%	130/80
32	Toh et al. 2007 [85]	Singapore	575	Cross-sectional	55.9% aged ≥ 65	26.2%	130/80
33	Puangpet et al. 2022 [63]	Thailand	488	Cross-sectional	63.9	39.1%	130/80
34	Sakboonyarat et al. 2022 [65]	Thailand	98	Observational, prospective	69.2	53.1%	140/90
35	Sakboonyarat et al. 2021 [66]	Thailand	186 010	Cross-sectional	61.1	29.8%–39.7%	130/80
36	Sakboonyarat et al. 2019 [68]	Thailand	65 667	Cross-sectional	63.9	75.4%	140/90–< 60 years 150/90–> 60 years
37	Kaewput et al. 2019 [58]	Thailand	54 295	Cross-sectional	72.6	65.5%	140/90
38	Sieng and Hurst 2017 [69]	Thailand	26 860	Cross-sectional	59.6 (specialized clinics), 60.4 (general medical clinics)	53% (specialized clinics), 48.6% (general medical clinics)	140/80
39	Changsirikulchai et al. 2016 [54]	Thailand	1254	Cross-sectional	68.2	47.1%	130/80

(Continues)

TABLE 2 | (Continued)

	Author and year	Country	Sample size	Study design	Age (years), mean (or an alternative when not stated)	BP control rate	Cut off (SBP/DBP mmHg)
40	Hurst et al. 2015 [56]	Thailand	55 797	Cross-sectional	61.6	32.8%	130/80
41	Sudchada et al. 2012 [72]	Thailand	714	Cross-sectional	58.4 (Males), 60 (Females)	28.4%	130/80
42	Tiptaradol 2012 [73]	Thailand	3996	Cross-sectional	55.8	6.2%	130/80
43	Sriwijitkamol et al. 2011 [71]	Thailand	722	Observational, retrospective	64.5	31%	130/80
44	Aekplakorn et al. 2007 [52]	Thailand	37 138	Cross-sectional	—	14.9%	130/80
45	Ngarmukos et al. 2006 [62]	Thailand	4875	Cross-sectional	58.9 (without nephropathy, 61.8 (with nephropathy)	18%	130/80
46	Cam et al. 2021 [99]	Vietnam	390	Cross-sectional	—	37.2%	140/90

Abbreviation: BP, blood pressure.

4 | Discussion

This review showed that the prevalence of hypertension in people with diabetes in Southeast Asia was often high and a large proportion of people with diabetes fail to receive adequate BP control. There was limited evidence on the prescription of antihypertensive therapies and medication adherence in the region.

Our study found that the high prevalence of hypertension in people with diabetes in Southeast Asia was comparable with other regions and countries worldwide, reporting a prevalence of > 50%. In an analysis using the UK Biobank data (a large prospective study of residents in the United Kingdom), Sun et al. reported that 85.1% of patients with type 2 diabetes (mean age 56.2 years) had hypertension [104]. In a separate analysis, Mohamed et al. found that uncontrolled hypertension in diabetic patients in sub-Saharan Africa ranged from 54% to 85% [105]. A secondary analysis of the Framingham cohort study reported that the prevalence of hypertension in adults with new-onset diabetes ranged between 56% (using 140/90 mmHg as a cut-off) and 58% (using 130/8 mmHg as a cut-off) [106]. Similarly, Tatsumi & Ohkubo reported approximately 50% of diabetic patients in Japan have hypertension [107]. Collectively, these findings, along with our analysis highlight the persistent global challenges in managing patients with diabetes. For the Southeast Asian region, this is even more important with the burden of cardiovascular disease expected to rise by 85.4% from 2025 to 2050 [108].

Although most of the studies included in this review reported a hypertension prevalence of 70% or higher, the range of this prevalence varied widely, from 29.4% to 93.4%. Differences in study settings, locations, and participant age may contribute to this wide range. Studies based on urban clinics/hospitals and electronic medical records tend to report a higher prevalence of hypertension in adults with diabetes. For example, Lee and colleagues [31] reported that 90.4% of participants with type 2 diabetes had hypertension. The participants in this study were patients who presented at two primary care government clinics in urban areas in Malaysia, and majority were 60 years or older (67%) [31]. A separate study in Singapore using the Singapore Health Services Diabetes Registry database found the prevalence of hypertension to be 92.4% [84]. This study was based on data from electronic medical records from SingHealth consisting of four hospitals, five national centers, eight primary care clinics, and three intermediate long-term-care community hospitals [84]. On the other hand, studies in rural and community settings tend to report a much lower prevalence of hypertension. For instance, in a study conducted by King and colleagues in Cambodia [94], the prevalence of hypertension was 29.4% in adults living in Siamreap (classified as rural) compared to 58.8% in adults living in Kampong Chan (classified as semi-urban). In a separate analysis by Sahl et al. looking at rural areas in Vietnam, hypertension prevalence among individuals with type 2 diabetes was found to be 35.6% [98]. These findings may suggest the potential of undetected cases in rural/semi-urban areas. The relationship between rurality and the prevalence of non-communicable diseases like diabetes and hypertension is complex. Rural populations may experience different patterns of hypertension compared to urban populations due to a possible lack of resources or awareness. For patients with diabetes and hypertension living

TABLE 3 | Percentage of people with diabetes who received antihypertensive medicines.

	Author and year	Country	Sample size	Study design	Age (years), mean (unless specified otherwise)	Percentage with antihypertensive treatment
1	Soegondo et al. 2009 [90]	Indonesia	770	Cross-sectional	57	52%
2	Chew et al. 2012 [24]	Malaysia	70 889	Cross-sectional	52.3	58.2%
3	Abougalambou et al. 2011 [14]	Malaysia	1077	Observational, prospective	22.5% > 65	94.2% (25.3% on monotherapy, 31.3% on 2 medications, 17.9% on 3 medications, 19.7% on more than 3 medications)
4	Mafauzy et al. 2011 [36]	Malaysia	1670	Cross-sectional	57.5	75%
5	Mafauzy 2006 [35]	Malaysia	1099	Cross-sectional	55.8	75.9%
6	Mafauzy 2005 [34]	Malaysia	438	Cross-sectional	54.1	32.4%
7	Jimeno et al. 2012 [102]	Philippines	724	Cross-sectional	61.6	64.4%
8	Seng 2023 [83]	Singapore	83 721	Observational, retrospective	65.3	78.9%
9	Wu et al. 2006 [86]	Singapore	388	Cross-sectional	58.3	97.2% (56.9% on monotherapy, 43.1% on ≥ 2 drugs)
10	Lertsakulbunlue 2023 [60]	Thailand	84 602	Cross-sectional	58.4 (2014), 58.8 (2015), 59.3 (2018)	71.5% (2014), 72.9% (2015), 72.6% (2018)
11	Kaewput et al. 2019 [58]	Thailand	54 295	Cross-sectional	72.6	63.8% of elderly with T2DM patients with HTN received ACE-I/ARB
12	Sudchada 2012 [72]	Thailand	714	Cross-sectional	59.3	21.8%
13	Aekplakorn et al. 2007 [52]	Thailand	37 138	Cross-sectional	—	82.2%
14	Ngarmukos et al. 2006 [62]	Thailand	4875	Cross-sectional	58.9 (without nephropathy), 61.8 (with nephropathy)	84%
15	Aekplakorn et al. 2003 [53]	Thailand	5105	Cross-sectional	54 (newly diagnosed diabetes), 58.6 (known diabetes)	67%

Abbreviation: ARB, angiotensin receptor blocker.

in rural areas, the lack of health access and support may also put these patients at a disadvantage to those living in urban areas.

Despite the high prevalence of hypertension, a substantial proportion of these populations did not receive adequate BP control, with most studies reporting a control rate of less than 40%, and diabetic patients who were older were more likely to have uncontrolled BP [109]. Additionally, the majority of the studies included in this review reported that fewer than 50% of the study populations achieved targeted glucose control, indicating a dual burden of poor glucose and BP control in these populations. As both hypertension and diabetes prevalence rise alongside increasing lifespans in the region, substantial work remains. In one of the included studies on the Malaysian population, the investigators identified age ≥ 60 as an independent risk factor for diabetes-related complications, even with good control of cardiovascular risk factors [23]. Furthermore, participants in that study were able to achieve glycemic and lipid control but failed to meet the BP targets [23]. Another study in Singapore highlighted the influence of socioeconomic status on patients with diabetes and uncontrolled hypertension [110]. Additionally, high systolic BP was identified as the leading contributor to disability-adjusted life years (DALYs) at 56.9% in Southeast Asia [111].

In this review, the majority of studies focused on adults aged 18 or older. Most studies used the same target BP for all age groups, either 140/90 or 130/80 mmHg. Only six studies exclusively focused on older adults (aged 60 years and above) [40, 41, 58, 65, 82, 99]. The optimal BP target in older adults remains controversial due to the scarcity of studies in this population. Some researchers have suggested that stricter BP control may be worthwhile to improve outcomes in patients aged 75 years or more with diabetes [112]. Other studies have suggested that in people aged 80 or older with diabetes, the BP target should be less than 140–150/90 mmHg and antihypertensive treatment should be tailored to prevent sudden changes in BP [9]. For instance, the Japanese hypertension guidelines recommend a target of < 140/90 mmHg for those aged 65–74 and < 150/90 mmHg for those aged over 75, and if stable and tolerated, a target of < 130/80 mmHg can be cautiously considered [113]. A separate systematic review of nine studies found significant differences in hypertension guidelines across Southeast Asia, Europe, and the United States. Southeast Asian and European guidelines classify hypertension onset at BP 140/90 mmHg, whereas American guidelines classify it at BP 130/90 mm [114], to reduce the burden of hypertension-related diseases on health systems [115]. In Southeast Asian countries, the population is aging rapidly, with the prevalence of diabetes among older adults (aged 65 years and above) projected to more than double from 35.5 million in 2019 to nearly 80 million by 2045 [116]. Given the varying BP targets across different population groups and settings, future studies focusing on older populations should consider these differences. The additional influence of frailty status in older adults further highlights the opportunities and challenges associated with targeted BP management for this population [117, 118].

The use of antihypertensive medicines remains a crucial component of management for adults with diabetes. However, in some Southeast Asian countries, the availability and access to these medicines continue to be an issue [119]. It was reported that where antihypertensives were available and affordable, patients were more likely to use them or have their BP controlled [120]. Besides medicine availability, there are other challenges that can affect BP control. One of the issues identified is the lack of adherence to antihypertensive medicines [87], which may be because of forgetfulness and lack of knowledge [87]. Sakboonyarat and colleagues described the use of an innovative, low-cost model using a network of homecare providers to help promote BP control among older Thai patients [65]. This program highlighted medication non-adherence as a problem but showed that the intervention group experienced improved adherence [65]. In a separate randomized controlled trial in Indonesia, the study investigators further described an innovative, low-cost pharmacist-led intervention to help patients with type 2 diabetes improve adherence to antihypertensive medicines [121]. Given that the majority of Southeast Asian countries are classified as low- to middle-income, prioritizing the costs of future and further interventions to improve BP control is essential. Efforts have also been made to explore the use of technology, such as telemonitoring, which has been studied in a multi-ethnic Asian population [122]. These integrated approaches, combining increasing access to medications, innovative low-cost interventions, and technology, hold promise in improving BP control among people with diabetes in Southeast Asia. Most member states in the region are classified as low- to middle-income countries, making the allocation and utilization of health resources crucial in such resource-constrained settings. The recent COVID-19 pandemic highlighted the inadequacies of some health systems to manage systemic shocks, with repercussions extending beyond healthcare to negatively impact economies and development. The pandemic underscored the importance of preventive care in addressing population-level health challenges. In resource-limited areas, collaboration becomes crucial in managing population-level health challenges. Region-specific management strategies can help mitigate the impact of these health issues.

4.1 | Strength and Limitations

Our study sought to provide evidence on the prevalence and management of hypertension in populations with type 2 diabetes across Southeast Asian countries. The literature search was meticulously conducted, yet it was limited to studies published in English. Therefore, studies only published in other languages or unpublished would have been missed, potentially leading to a bias in the data collated. There may be potential discrepancies among the reviewers in the processes of study selection and data extraction. However, we have followed the review protocol and have regular communications to minimize these discrepancies. There was also a lack of evidence on this topic from 4 out of the 11 countries in the region, including Brunei, Lao People's Democratic Republic, Myanmar, and Timor Leste—highlighting a substantial gap in the existing literature on the research topic from these countries. Nevertheless, a key strength of this review was the systematic and extensive search conducted across multiple large databases such as MEDLINE and Embase, ensuring a broad and representative collection of studies. The inclusion criteria and methodologies employed were designed to minimize bias and maximize the relevance and quality of the evidence gathered.

5 | Conclusion

This review highlights that BP control in adults with diabetes remains a significant challenge in the Southeast Asian region and there is a lack of studies examining medication adherence, particularly in older people with diabetes. More studies focusing on older populations are required, especially in the context of providing age-specific recommendations for BP targets and factors influencing medication adherence in these populations. Our work underscores the need for more inclusive and comprehensive research efforts to address hypertension in populations with type 2 diabetes, particularly in Southeast Asian countries. Longitudinal studies are essential to understand the long-term impact of uncontrolled hypertension on cardiovascular events and survival rates in the region.

Author Contribution

T.N.N. and W.J.W. conceptualized the study, designed the study protocol, conducted the literature search, and performed the data extraction and analysis. W.J.W., F.A., and T.N.N. conducted the abstract screening and study selection. W.J.W. drafted the paper with critical inputs and supervision from T.N.N. All authors (W.J.W., T.V.N., F.A., H.T.T.V., A.S.K., K.M.T., Y.Z., C.H., M.W., T.N.N.) contributed to the interpretation of the results and critically revised the manuscript. All authors accept responsibility to submit for publication and gave approval for the final version to be published.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.