

**SOUTH BAYLO UNIVERSITY**

**The Effectiveness of Acupuncture in Essential Hypertension:  
A Systematic Review and Meta-Analysis**

**by**

**Myong Ok Om**

**A RESEARCH PROJECT SUBMITTED  
IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE**

**Doctor of Acupuncture and Oriental Medicine**

**ANAHEIM, CALIFORNIA**

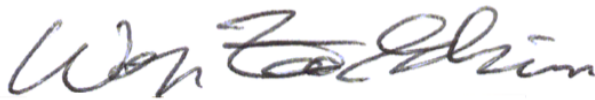
**September 2025**

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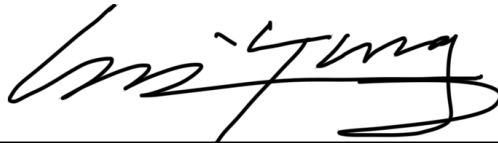
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**September 25, 2025**

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# The Effectives of Acupuncture in Essential Hypertension: A Systematic Review and Meta-Analysis

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## ABSTRACT

**Background:** This study aims to systematically review clinical evidence assessing the effectiveness of acupuncture in the treatment of essential hypertension.

**Methods:** Eligible randomized controlled trials with full text from past 25 years was gathered from PubMed, Cochrane Library, Academia database, Springer, National Library Medicine, Cardiology journal and additional clinical trials were collected from google and Microsoft search using the various combination of keywords: Acupuncture, Hypertension, Blood pressure, Cardio Vascular Disease, TCM, and Randomized Controlled Trial for review. Study selection, data extraction, quality assessment, and data analyses were conducted according to the Cochran standards and PRISMA guideline.

**Results:** 9 RCTs involving a total of 709 patients were included. Most studies demonstrated low risk of bias in outcome assessment and reporting of needling techniques (including *deqi* (得氣) achievement) but high risk of bias in participant and personnel blinding, as well as incomplete outcome data. A meta-analysis of eight trials showed that acupuncture was more effective than sham or no treatment in reducing systolic blood pressure (SBP) and diastolic blood pressure (DBP). Specifically:

- SBP reduction: SMD = 0.49; 95% CI: 0.25–0.72;  $I^2 = 43.6%$ ;  $\tau^2 = 0.0441$

- DBP reduction: SMD = 0.36; 95% CI: 0.20–0.51;  $I^2 = 18.7\%$ ;  $\tau^2 = 0.0001$

Comparisons between acupuncture and sham or no treatment also showed statistically significant improvements in DBP:

- Acupuncture vs. sham: SMD = 0.28; 95% CI: 0.04–0.52;  $I^2 = 23.4\%$ ;  $\tau^2 = 0.0001$
- Acupuncture vs. no treatment: SMD = 0.48; 95% CI: 0.17–0.79;  $I^2 = 25.7\%$ ;  $\tau^2 = 0.0265$

These results suggest that sham acupuncture can influence treatment outcomes, highlighting the importance of control selection in acupuncture trials.

**Conclusion:** Current evidence suggests that acupuncture may be effective in treating essential hypertension. However, further high-quality RCTs with larger sample sizes and longer follow-up periods are necessary to fully establish its effectiveness and safety.

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## I. INTRODUCTION

In 2022 high blood pressure was a primary or contributing cause of 685,875 deaths in the United States. Nearly half of adults have high blood pressure (HBP) (48.1%, 119.9 million) costs the United States about \$131 billion each year, averaged over 12 years from 2003 to 2014 according to CDC report on May 15, 2024. Pharmacological treatment remains the chief treatment option for hypertension. However, hypertension continues to be either untreated or uncontrolled in most adults. BP control in the population is far from optimal, and Systolic Blood Pressure (SBP)/Diastolic Blood Pressure (DBP) values <140/90 mmHg are achieved in no more than 25% of patients with treated hypertension worldwide <sup>(3)</sup>. Also, an American Journal of Hypertension report from June 2016 estimates that 20–97% of patients who take antihypertensive medications experience unintended drug side effects.

Acupuncture, for the western countries, is an innovative and low-cost therapy for treatment and prevention of essential hypertension. Despite numerous researches and clinical trials indicating the effectiveness of acupuncture, most of its effects and mechanisms are poorly understood. Wikipedia which is a well-known site in Western countries defines it as ‘Acupuncture is a form of alternative medicine and a component of traditional Chinese medicine (TCM) in which thin needles are inserted into the body. Acupuncture is a pseudoscience; the theories and practices of TCM are not based on scientific knowledge, and it has been characterized as quackery.’ This is might be due to its treatment principle: ‘individualized’ diagnosis and treatment that Western countries are not familiar with, and this might result in some trials showing that acupuncture can lower blood pressure while another reported contradictory results.

Therefore, this study aims to evaluate the effectiveness of acupuncture for essential hypertension through a systematic literature review and meta-analysis of studies conducted domestically and internationally from year 2000 up to the year 2025 using acupuncture intervention for patients with hypertension using points that are known for regulating blood pressure.

## **OBJECTIVES**

This study reviews evidence from relevant studies and presents a comprehensive evaluation of relative data to validate the therapeutic value of acupuncture, including the effectiveness of acupuncture in treating essential hypertension.

The detail objectives for this study are:

1. To examine effectiveness of acupuncture at selected acupoints to reduce systolic blood pressure and diastolic blood pressure in hypertensive patients.
2. To find out the impact of sham compare to no treatment as a control group while assessing acupuncture effectiveness.

## LITERATURE REVIEW

### Essential Hypertension

There are two factors that affect blood pressure directly, vasodilation capacity and the volume of intravascular fluid. Vasodilation capacity is affected by vascular elasticity, caliber, and reactivity, which reflects the buffering capacity of vessels against pressure shocks. The poorer the vasodilation capacity, the higher the BP. Volume of intravascular fluid is regulated by the body's intake and elimination of fluid. Once the fluid balance is disturbed, the increase in the amount of intravascular fluid can directly result in an increase in BP. Therefore, factors that cause increases in blood volume or decreases in vasodilation capacity can lead to hypertension. These factors usually coexist and are intertwined with each other in the occurrence and progress of hypertension <sup>(2)</sup>.

Essential hypertension, or primary hypertension, is the most common type of hypertension that usually occurs over time without a medical condition. It is complex due to a combination of genetic, lifestyle, and environmental factors, including sympathetic nervous system hyperactivity and dysregulation of the renin-angiotensin-aldosterone system.

#### *Multifactorial Nature <sup>(4)</sup>:*

- Genetic Predisposition: An estimated 30% to 60% of the variation in BP between individuals, after adjustment for age and sex, is attributed to the effect of genetic factors.
- Lifestyle Factors: High sodium intake - reducing dietary salt or administration of diuretic agents, such as thiazides, are effective treatments for elevated BP, obesity, lack of physical activity, excessive alcohol consumption, and smoking.
- Environmental Factors: Exposure to stress, certain medications, and unhealthy environments can also contribute to elevated BP

***Key Pathophysiologic Mechanisms (1, 4–6):***

Hypertension is a significant health risk that can lead to various serious complications if not managed properly

- **Sympathetic Nervous System (SNS) Activation:** Overactivity of the SNS, particularly in the early stages, leads to increased heart rate, blood pressure, and peripheral resistance.
- **Renin-Angiotensin-Aldosterone System (RAAS) Dysfunction:** The RAAS plays a crucial role in regulating blood pressure, and dysregulation can lead to sodium and water retention, contributing to hypertension.
- **Vascular Dysfunction:** Changes in the structure and function of blood vessels, including reduced nitric oxide production and increased production of constricting substances, can lead to increased peripheral resistance.
- **Kidney Function:** The kidneys play a vital role in maintaining blood volume and pressure by filtering fluids and excreting excess sodium and water. In essential hypertension, the kidney's ability to effectively regulate blood pressure can be impaired.
- **Insulin Resistance:** Insulin resistance, a common feature of metabolic syndrome, can contribute to hypertension through increased blood pressure and altered vascular function.
- **Arterial Stiffness:** Increased stiffness of the arterial walls, a common feature of aging and hypertension, can lead to decreased elasticity and difficulty in accommodating blood flow.
- **Inflammation and Oxidative Stress:** Chronic inflammation and oxidative stress can contribute to vascular dysfunction and hypertension.

- Microbiome: Emerging evidence suggests a role for the gut microbiome in regulating blood pressure and hypertension.

***Important Considerations:***

Individual Variation: The specific combination of factors and mechanisms involved in hypertension can vary significantly among individuals. Illustration of Dr. Page<sup>(5)</sup> Concept that hypertension is caused by multiple factors Figure 1 and Figure 2.

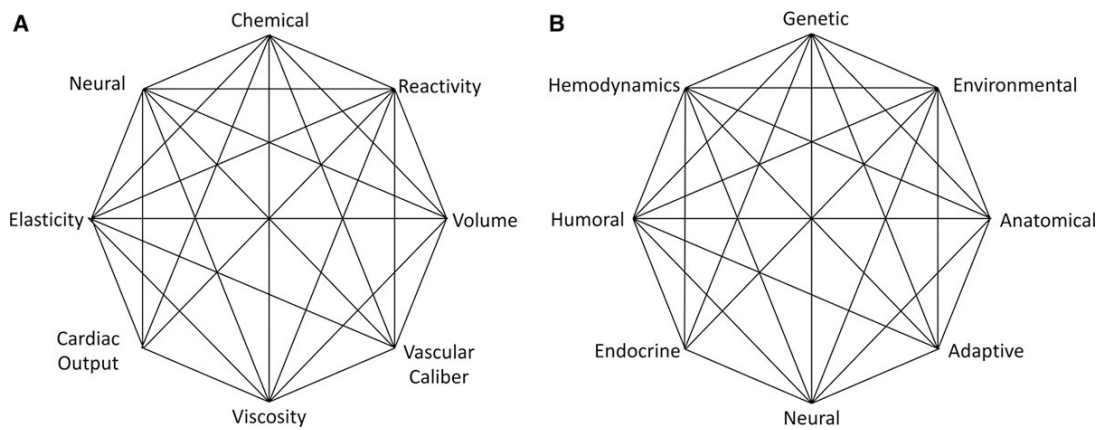


Figure 1. The original (A) and revised (B) Mosaic Theories proposed by Page

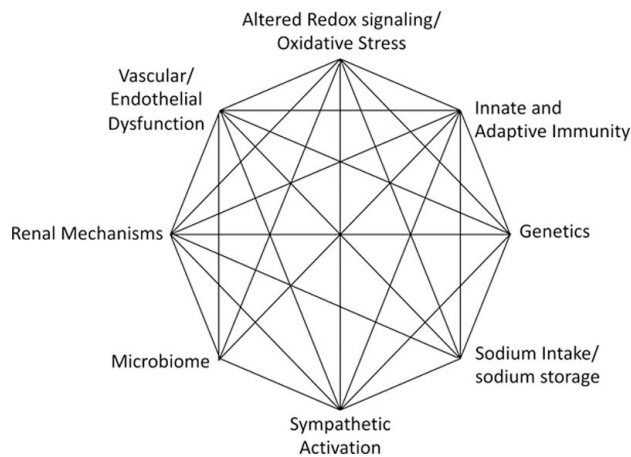


Figure 2. A revised Mosaic Theory incorporating new understanding of cellular, environmental, and genetic mechanisms.

### *First line of medications for hypertension*

There are multiple classes of antihypertensive medications used for the treatment of HTN; the most recommended classes used as a first-line treatment are: first-line for treatment is:

- Thiazide-type diuretics
- Calcium channel blockers
- Angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs)

#### Thiazide Diuretics (water pill)

The thiazide diuretic hydrochlorothiazide (HCTZ) is the second most commonly prescribed antihypertensive in the USA, with approximately 47.5 million prescriptions dispensed in 2008 <sup>(11)</sup>. Because most hypertensives require multidrug regimens for blood pressure control, many more patients are exposed to HCTZ through the use of combination antihypertensive products. Current hypertension treatment guidelines in the USA recommend thiazide diuretics as a first-line treatment for most patients with essential hypertension.

Thiazide diuretics act directly on your kidneys and promote diuresis (urine flow) by inhibiting the sodium/chloride cotransporter located in the distal convoluted tubule of a nephron (the functional unit of a kidney). Thiazides decrease sodium reabsorption which increases fluid loss in urine, which in turn decreases extracellular fluid and plasma volume. This reduces cardiac output (how hard the heart has to work to pump blood around the body) and lowers blood pressure. Thiazides also cause potassium loss while retaining calcium <sup>(11)</sup>.

#### Calcium Channel Blockers CCBs

In order to pump blood, the heart needs oxygen. The harder the heart works, the more oxygen it requires. Angina (heart pain) occurs when the supply of oxygen to the heart is inadequate

for the amount of work that the heart must do

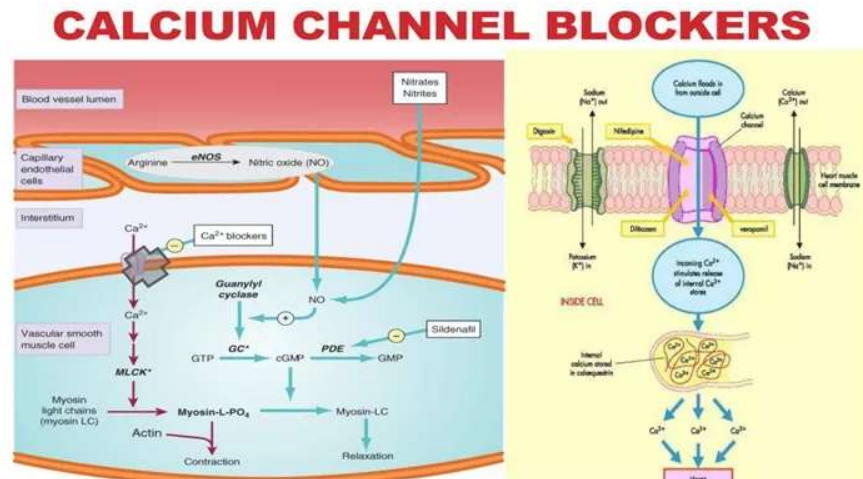


Figure 3. Mechanism of action of Calcium Blockers <sup>(12)</sup>

These drugs work by inhibiting the entry of calcium ions into the cells of the heart and blood vessel walls. Calcium plays a crucial role in muscle contraction, including the contraction of the heart muscle and the smooth muscles lining arteries. By blocking calcium influx, CCBs cause relaxation of blood vessels and reduce the heart's workload, leading to lower blood pressure and improved blood flow. They are particularly useful in elderly patients with stiff arteries and isolated systolic hypertension. However, it comes with some serious side effects such as excessive lowering of heart rate or blood pressure, which can cause dizziness or fainting and worsening of heart failure symptoms, especially patients with systolic dysfunction. Overdose, particularly with verapamil, can be life-threatening due to profound cardiac effects <sup>(12)</sup>.

### ACE Inhibitors and ARBs

ACE inhibitors and ARBs both work by lowering the effects of angiotensin-2 in the body.

Angiotensin-2 is also known as AT2. AT2 is a hormone made by your body that helps balance

our blood pressure. When blood pressure starts to go too low, the body makes AT2 to help bring it up<sup>(13)</sup>.

The main way AT2 works is by narrowing blood vessels, especially in the kidneys. When there is too much AT2, the blood vessels in the kidneys are not able to relax. This can cause high blood pressure and/or kidney damage. It can also make heart failure and other types of CVD worse.

Both medicine categories lower the effects of AT2, but in different ways:

- ACE inhibitors slow down how much AT2 your body makes.
- ACE inhibitors and ARBs: Managing potassium and renal function

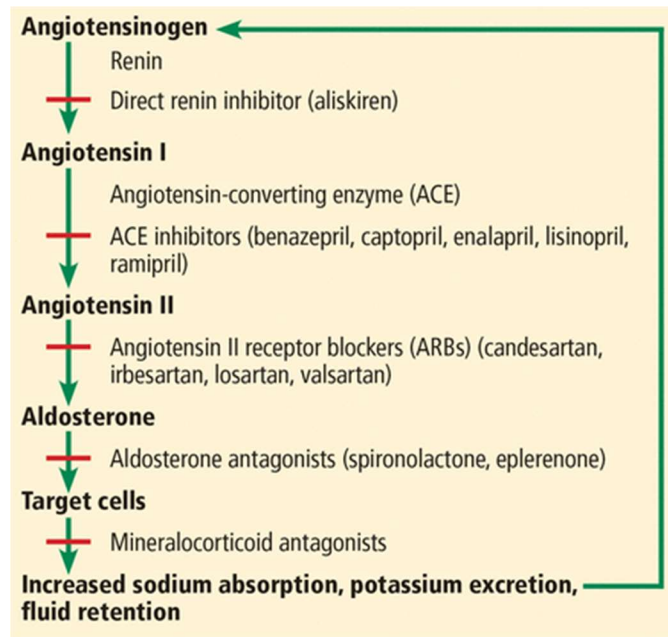


Figure 4. The renin-angiotensin-aldosterone system and drugs that inhibit it<sup>(14)</sup>

Both ACE inhibitors and ARBs are contraindicated during pregnancy, especially in the second and third trimesters, as they can cause fetal harm, including kidney damage and even death<sup>(13)</sup>.

## **Acupuncture for Essential Hypertension**

The awareness of sustained elevations in BP, now known as hypertension, dates to the Chinese Yellow Emperor's Classic of Internal Medicine (2600 BC). Even in those early times, the awareness of salt as a contributor to elevated pressure was explained: "...If too much salt is used in blood, the pulse hardens." Early treatments for what was then called hard pulse disease included acupuncture, venesection, and bleeding by leeches <sup>(15, 16)</sup>. Historically the treatment for what was called the "hard pulse disease" consisted in reducing the quantity of blood by bloodletting or the application of leeches. This was advocated by the Yellow Emperor of China, Cornelius Celsus, and Hippocrates according to Wikipedia, treatment and medications in hypertension history.

Different from Western medicine (WM), Oriental Medicine (OM) has formed a unique way to diagnose and treat diseases. Great efforts have been made by OM ancestors through meticulous observation of nature, the cosmos, and the human body. A series of traditional medical practices were originated in the East including acupuncture, herbal medicine, Chu Na, moxibustion, cupping, qigong, diet, and exercise therapy.

### **Acupuncture**

Acupuncture is well defined in Johns Hopkins Medicine. 'Acupuncture is part of the ancient practice of Traditional Chinese medicine (TCM). TCM is a system of healthcare that has evolved over thousands of years to prevent, diagnose, and treat disease. TCM believes that the body's vital energy, called qi (pronounced chi), flows along specific channels or meridians. If the qi is balanced then the person has spiritual, emotional, and physical health. But when the qi isn't in balance, disease may occur. Qi can be blocked, causing unbalance between the yin and yang. This refers to two opposite but connected principles in Chinese philosophy. TCM uses many

approaches to create harmony between yin and yang and restore correct flow of energy through the meridians. One of these approaches is acupuncture. Acupuncturists believe the human body has more than 2,000 acupuncture points. They are linked through the various meridians.

The use of acupuncture on certain points within the meridians is believed to improve the flow of blocked or stagnant qi. Acupuncture can unblock these meridians. This restores movement of qi and improves health.

Many clinical trials about effects of acupuncture are conducted and, nowadays, it can be explained in terms of endogenous physiological mechanisms.

#### **Mechanism of acupuncture for blood pressure regulation <sup>(8, 25)</sup>**

Acupuncture signals initiated at the acupoints are transferred to the brain through nervous system pathways, thus modulating multiple neurotransmitter systems at different levels. The output signaling cascades correct abnormal blood pressure, mainly through neural regulation. In addition, acupuncture-induced correction of abnormal blood pressure is also observed to be dependent on the endoclitic, humoral, and dielectric regulation. Collectively, acupuncture induces a comprehensive modulation of the cardiovascular activity, consequently, adjusting the blood pressure.

#### **Stimulation of acupoints regulate autonomic signal <sup>(8)</sup>**

Stimulation of acupoints activates underlying sensory neural pathways that project to a number of regions in the central nervous system (CNS) that ultimately regulate autonomic outflow and hence cardiovascular function. Actions of excitatory and inhibitory neurotransmitters in the supraspinal CNS underlie processing of the somatic input and adjustment of autonomic outflow during Electric Acupuncture (EA). Acupuncture also decreases elevated blood pressure through actions in the thoracic spinal cord. Reflexes that lower BP likewise are modulated by EA through

its actions on sympathetic and parasympathetic nuclei in the medulla. Stimulation at acupoints situated along meridians located over deep somatic nerves activates underlying sensory neural pathways. They project to a number of regions in the CNS which ultimately regulate autonomic outflow and cardiovascular function.

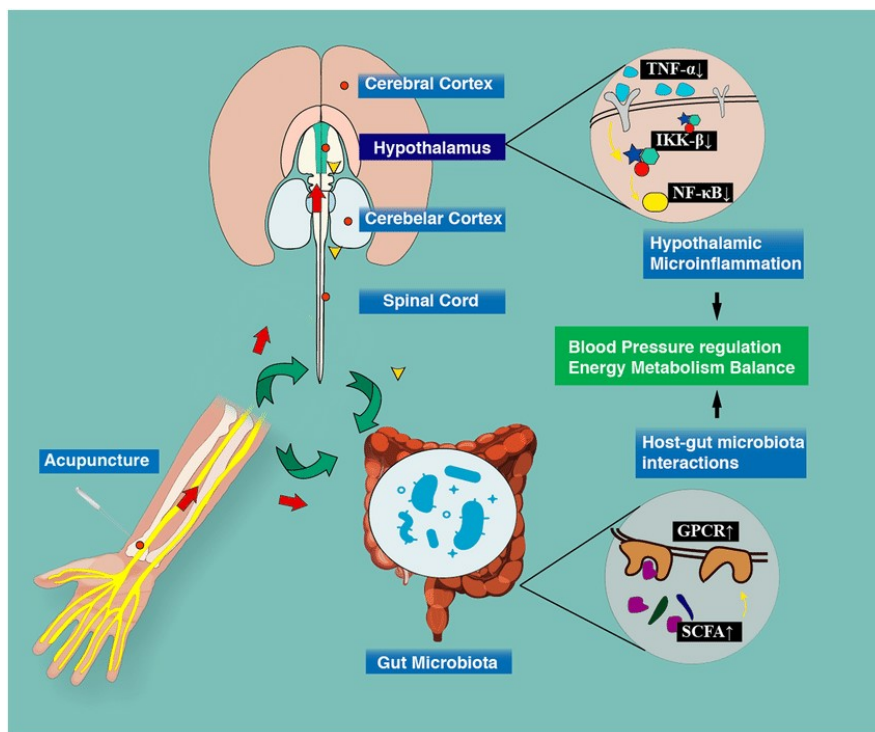


Figure 5. Potential Mechanism of Acupuncture improving BP and Metabolic Function <sup>(19)</sup>

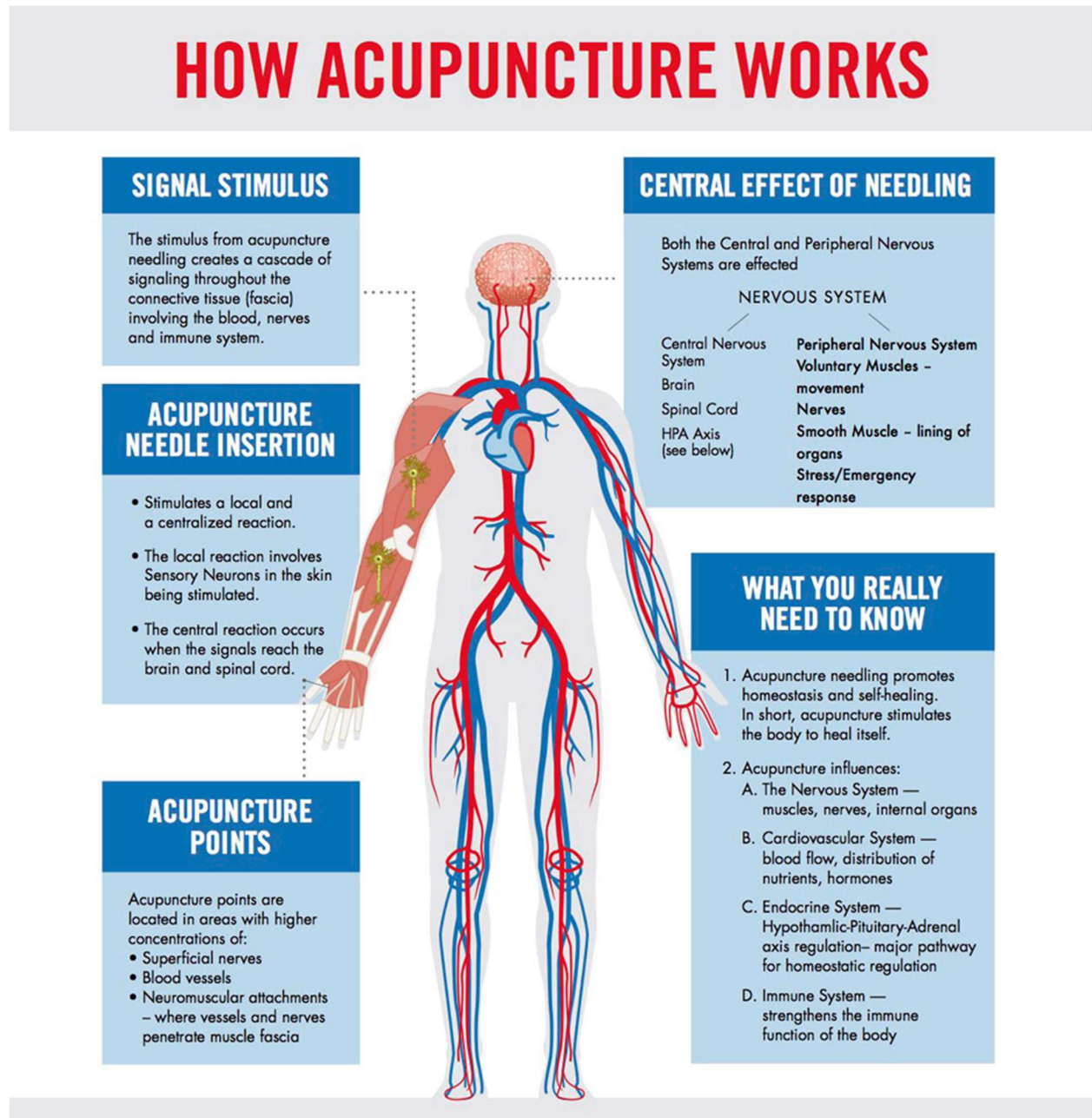
Acupuncture signals can be transferred from peripheral nerves to the central nervous system. The study <sup>(19)</sup> indicates that the alternation of hypothalamic microinflammation and the restoration of host-gut microbiota interactions induced by acupuncture could be a possible mechanism for acupuncture to lower blood pressure and restore metabolic abnormality.

### **Stimulation of different acupoints alter blood flow volume <sup>(7)</sup>**

A comparison of quantitative physiological alterations induced by stimulation on different acupoints in humans. Investigated changes in blood flow volume (BFV) in the SMA as an indicator of physiological effects induced by stimulation on 3 points. All participants underwent

stimulations on 3 points located in the lower legs: ST36, LR3, and a non-acupoint. Following acupuncture on ST36, BFV increased significantly after 20 and 30-min stimulation. Stimulation on LR3 and the non-acupoint revealed no significant differences in BFV. The results suggest that stimulation on the different points causes distinct physiological effects in BFV in the SMA.

Below diagram from CCBC Library explains how acupuncture works in details.



Clinical trials suggest that variability in treatment outcome following acupuncture may also to a significant degree be attributed to the therapist and the patient's interaction with the therapist <sup>(17)</sup>. The effects of acupuncture cannot be explained by a single mechanism, and symptom itself is not entirely a straightforward physiological entity, but a phenomenon that arises from a multitude of varying neuroplastic changes as part of adaptive or sometimes maladaptive reactions. The effects of acupuncture are likely to derive from physiological and/or psychological mechanisms. Acupuncture is part of a healing ritual allowing for a therapeutic alliance between the acupuncturist and the patient. Possibly this may be attributed to the ability to mediate empathy and/or consolation.

## II. MATERIALS AND METHODS

This systemic review was performed in accordance with the Cochrane Handbook for Systematic Reviews of Interventions (Cochrane Collaboration, 2024) and was reported in compliance with the PICO frame work and Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Annals of Internal Medicine, 2020).

### **Search Strategies**

Searched PubMed, Cochrane Library, Academia database, Springer, National Library Medicine, Cardiology journal, if available, using custom filter: publication date from 2000 to 2025, free full text, Randomized Controlled Trials (RCT), with various combination of following keywords: “Acupuncture,” “Blood pressure,” “Hypertension,” “Randomized Controlled Trial,” “TCM,” “Cardio Vascular Disease.” Additionally, searched google and Microsoft to gather further RCT publication.

### **Inclusion criteria**

Two reviewers (Om, Kupp) independently evaluated the publication according to the inclusion criteria listed below. If there was any dispute, Om made the final decision.

- 1) Randomly Controlled Trial, share same objectives – effectiveness of acupuncture for (essential) hypertension. The language is limited to Korean and English.
- 2) Definition of Essential Hypertension or non-secondary hypertension, regardless gender, age, and country.
- 3) Interventions in the treatment group included standard acupuncture, electroacupuncture, and Saam acupuncture or one of the above mentioned three methods combined with the treatment recommended by the guidelines (including lifestyle regulation and conventional

antihypertensive drugs (CAD)) while the control group received same guideline-recommended to treatment group, a placebo/sham acupuncture, or no treatment.

- 4) The main outcome indicators were the effective rate of blood pressure reduction, the change of blood pressure before and after treatment, and adverse reactions.

### **The exclusion criteria**

The exclusion criteria are as follows:

- 1) Duplicate publications, animal studies, narrative reviews, and meta-analysis
- 2) Studies with incomplete data or unidentifiable data
- 3) The object of the study is combined with other therapy.
- 4) Studies involving other forms of acupuncture, such as transcutaneous electrical nerve stimulation or laser acupuncture
- 5) RCT that are out of PICOS frame work and inadequately designed for reliable results.

### **Data Extraction**

Following data were extracted; first author, publication date, number of patients, average age, country, study design, treatment frequency and duration, acupuncture treatment methods and points, control type, average blood pressure before treatment, average blood pressure after treatment, average blood pressure change, effective rate of treatment and adverse effect, and outcome using a predefined data extraction form. We defined the change values of blood pressure as pre-treatment BP minus post-treatment BP and extracted the change means and pooled standard deviation (SD) for continuous outcome.

### **Types of Interventions**

Acupuncture was the primary intervention in the observation group. Acupuncture intervention included standard acupuncture, electro acupuncture, or Saam acupuncture in which metallic

needles penetrate skin at the acupuncture points. Sham acupuncture and no treatment were chosen for control group. As long as western medicine was used for both treatment and control group, those studies were included as well.

### **Risk of Bias Assessment**

Two reviewers assessed the risk of bias of the included RCTs using the Cochrane Collaboration's tool for assessing risk of bias <sup>(28)</sup>. Each trial was scored as high, low, or unclear risk for the following 7 domains: 1. Random sequence generation (selection bias); 2. Allocation concealment (selection bias); 3. Blinding of participants and personnel (performance bias); 4. Blinding of outcome assessment (detection bias); 5. Incomplete outcome data (attrition bias); 6. Selective reporting (reporting bias); and 7. any other bias. Considering the characteristic of acupuncture RCTs, other bias was defined as whether the trial reported the method of acupuncture as well as Deqi sensation. Disagreement was resolved by discussion.

### **Statistical Analysis**

Meta analysis was performed using R (R 5.4.1) and Rstudio. Number of patents, mean difference between baseline and after trial, and pooled standard deviation was extracted from 9 included studies for analysis. Heterogeneity was examined using the  $I^2$  and  $\tau^2$ . It was interpreted by following the rough guide set by the Cochrane manual <sup>(29)</sup>.

- 0% to 40%: might not be important;
- 30% to 60%: may represent moderate heterogeneity
- 50% to 90%: may represent substantial heterogeneity
- 75% to 100%: considerable heterogeneity

Continuous outcome was presented as Standardized Mean Difference (SMD), 95% CI, common and random Weight. Random effects model was employed since studies were pooled from trials

that were conducted all over the world – different population and effects were assessed from non-fixed interventions.

Based on different outcome measures, if significant heterogeneity between studies was detected, we would investigate possible causes from clinical perspectives by conducting subgroup analysis. In case some studies compared the effect of more than two intervention groups, the overall effects of acupuncture (i.e., (group1 + group2) VS control) or two groups that were most suitable for this study's objectives were selected.

### **III. RESULTS**

#### **Description of Included Trials**

Utilizing the search strategy, 2,379 potentially qualified studies were initially identified. Upon eliminating duplicates and unrelated titles 128 trials were selected for further screening. Full text of 44 trials were retrieved to assess their eligibility for inclusion in this study and the rest were excluded with reasons listed as the following: patients were complicated with other diseases, no full text, tested on animals, no definitive indication of essential hypertension, intervention of control group was other than sham or no treatment, treatment method was other than traditional acupuncture (acupressure, TERN, Laser), participants did not meet the inclusive criteria, and no or incomplete data for extraction. In the end, 9 RCTs were included. A flow chart depicted the search process and the study selection is shown in Figure 6.

#### **Study Characteristics**

The characteristics and main outcomes of each trial were summarized in Table 1. The 9 RCTs included a total of 761 patients with prehypertension, stage 1, 2 from Europe, USA, and Asia. Varied acupuncture techniques were used in terms of selection of acupuncture points, manipulation or stimulation methods. The intervention measures in the treatment group were one of the three methods; standard acupuncture, electro acupuncture, and Saam, while the control group received either sham acupuncture or no treatment. This study included trials of both acupuncture only and acupuncture with western medication as long as trial was compared on the same bases between treatment group and control group for outcome of acupuncture.

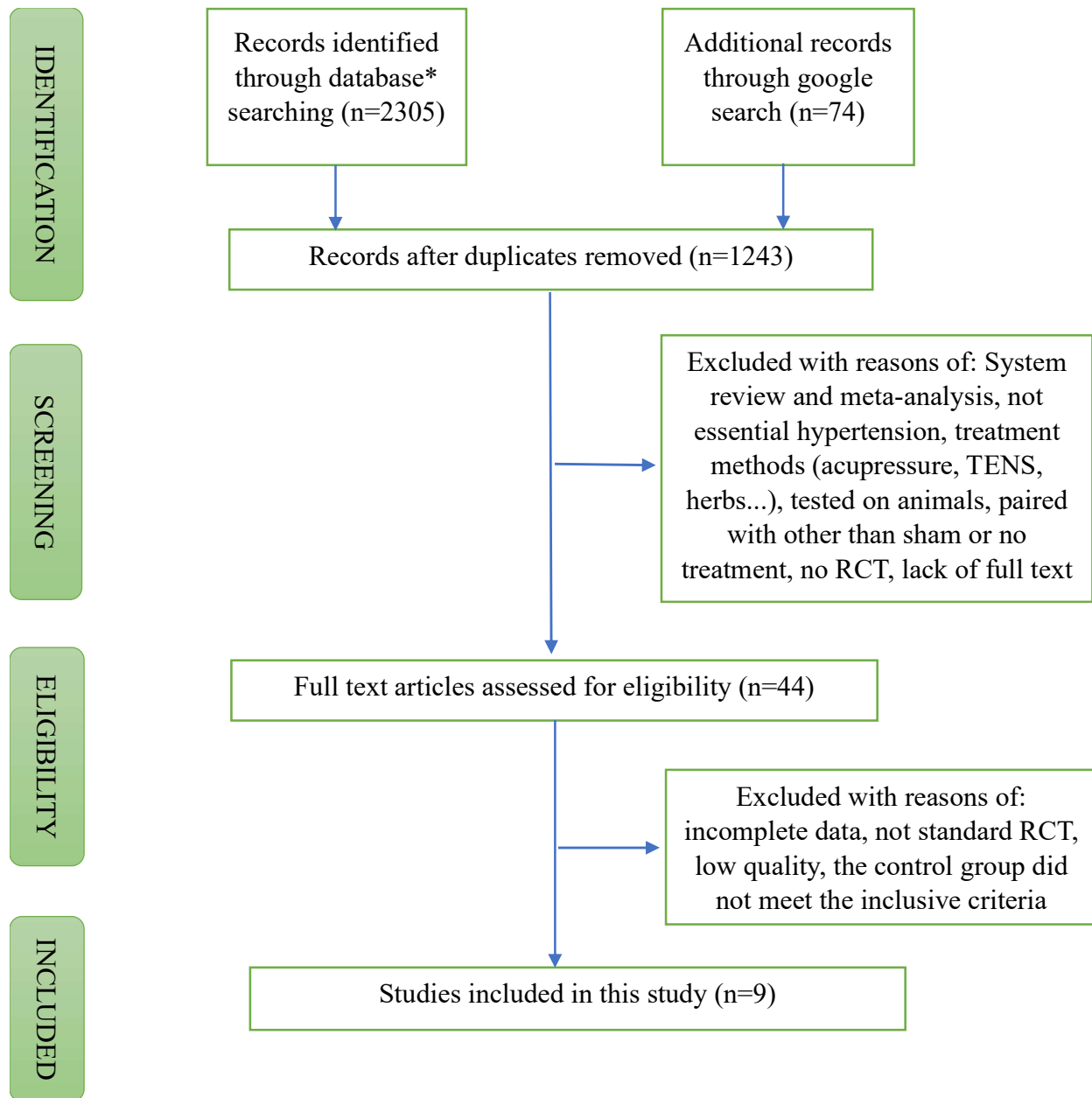


Figure 6. Flow chart of Randomized Controlled Trials [based on the PRISMA]

Table 1. Characteristics and main outcomes of included studies

Author (Year)		F. Flachskampf (2006) (22)	Y. Liu (2015) (23)	H. Zheng (2019) (9)
<i>Patient</i>	Size (T/C)	83/77	15/15	209/104
	Age (T/C)	58.8±8.2/58.0±7.9	49.4±8.4/53.4±8.2	58.2±9.9/59.4±10.5
	BP Class*	Stage 1, 2 w	Pre, Stage 1, 2.	Stage 1, 2
	Country	Germany	Korea	China
<i>Study Methods</i>	Design	Two arm, single blind, RCT	Two armed parallel, Assessor blind, RCT	Multicenter, single blind, RCT
	Sessions	22	16	18
	Duration	6wks	8wks	6wks
	Base BP (T)/(C)	(131±13/81±9)/(129±9/80±8)	(137.1±10/86.4)/(138.5±10.9/85.19±8.1)	(147.8±5.8/89.8±7.7)/(147.6±5.6/90.2±7.6)
<i>Acu. points</i>	T	3 points bilaterally/Tx Tai Yang (20 min), CV12, 6, 4, PC6, LI4, 11, SP6, 9, KD3, LR2, 3, ST36, 40, DU20, GB20, BL18, 20.	ST36, PC6, LR3, SP4, LI11	Affected Ch. group ST9, LR3, PC6, KD3, LI11, ST36 Non affected Ch. DU20, SJ5, SP10, SP9
	C	Sham: P1, 2. 3.	No treatment	Sham: 4 pts w same procedures
<i>Inter-vention</i>	Retention	30 mins	20 mins	30 mins
	T	Standard Acu.	Standard Acu.	Electro Acu.
	C	Sham	No Treatment	Waiting treatment
<i>Outcome</i>	Adv effect	T: local complication	None	T: Hematoma, nausea
	Result (BP changes)	SBP: 6.4 mm Hg (95% CI, 3.2 to 7.6) DBP: 3.7 mm Hg (95% CI, 1.6, 5.8)	SBP: -6.0mmHg (95% CI-113.7, 1.7: P=0.123) DBP: -5.7 mmHg (95% CI: -10.7, -0.08; P=0.025)	SBP: 2.9 mmHg (95% CI -0.2 to 6.0 p=0.078 DBP: 0.4 (95% CI -2.2 to 3.1 p=0.915). Acu. Was superior after trials, 9 <sup>th</sup> wks.

Abbreviation: BP, Blood Pressure; RCT, Randomized Controlled Trial; Acu., Acupuncture; Adv, Adverse; Ch, Channel; T, Treatment; C, Control; mins, Minutes; \* BP class chart

### Classification of blood pressure for adults

Blood pressure classification	Systolic BP	Diastolic BP
Normal	less than 120	and less than 80
Prehypertension/Elevated	120-129	and less than 80
Stage 1 Hypertension	130-139	or 80-89
Stage 2 Hypertension	140 or higher	or 90 or higher
Hypertensive Crisis	Higher than 180	and/or higher than 120

Source: 2017 Guidelines for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

<b>Author (Year)</b>		<b>J. Kim (2017) (24)</b>	<b>Y . Zheng (2016) (21)</b>	<b>C. Yin (2007) (27)</b>
<i>Patient</i>	Size (T/C)	40/20	15/15	15/15
	Age (T/C)	56.9±4.8/53.9±4.7	56.53 ± 7.52/56.73 ± 4.91	52/54
	BP Class	Pre, Stage 1.	Stage 1, 2	Pre, Stage 1, 2, 3
	Country	CA, USA	China	Korea
<i>Study Methods</i>	Design	Multi center, four arm, no blind, RCT	Two arms, RCT	Two arms, double blind, RCT
	Sessions	20	10	17
	Duration	8wks	2wks	8wks
	Base BP (T/C)	(131.1±9.7/86.7±6.3)/ (130.7±8.6/84.5±6.0)	(134.93 ± 9.05/86.29 ± 7.35)/ 136.86 ± 18.26/87.86 ± 11.22)	(136.8/83.7)/133.1/81.8)
<i>Acu. points</i>	T	PC5-6 + ST36-37	LR3	4 prescribed set points 1) ST36, LI11, BL25; 2) SP3, LU9, BL13; 3) KD7, 2, CV4; 4) LI1, GV14, GB20 & PC6, 7 optional add
	C	LI6-7 + GB37-39	Sham – upper thigh	Sham; no skin penetration
<i>Inter-vention</i>	Retention	30 mins	30 min	~90°, every 2 sec. till De Qi sensation
	T	Electro Acu.	Standard Acu.	Modified Saam Acu.
	C	Electro Sham	Sham	Sham
<i>Outcome</i>	Adv effect	Discomfort	None	None
	Result (BP changes)	T; 130.0±10.3/83.2±6.7 C;127.9±13.3/84.9±8.6	T: 129.71±8.66/86.71 ± 6.11 C: 132.64±12.97/84.21 ± 7.47	T;-14.8 (-20.3 to -9.2)/-6.9 (-10.6 to -3.1) C; -4.0 (-10.7 to 2.7)/-1.1 (-5.8 to 3.7)

Author (Year)		H. Kim (2012) (10)	W. Choi (2015) (25)	Z. Hou (2023) (26)
<i>Patient</i>	Size (T/C)	12/16	25/25	30/30
	Age (T/C)	52.08±8.69/52.38±10.3	48.04±6.13/46.2±9.26	60.63±7.08/60.73±6.22
	BP Class	Stage 1	HT Due to HwaByung	Mild to moderate
	Country	Korea	Korea	China
<i>Study Methods</i>	Design	Double Blind, RCT	Assessor blind, two arms, RCT	Three arms, RCT
	Sessions	16	4	12
	Duration	8wks	2wks	4wks
	Base BP (T)/(C)	(139.88±10.72/94.11±7.8)/(139.29±14.08/93.61±7.9)	(121.56±6.69/76.32±3.89)/(124.96±8.79/78.72±7.95)	(157.17±9.48/97.47±5.1)/(159.4±6.73/96.83±.13)
<i>Acu. points</i>	T	ST36, PC6	Saam SimpoJeongkyeok PC9, LR1, PC3, KI10	Bilaterally; GV20, LI11, LR3, LI4, SP6
	C	Placebo points	Placebo points	No treatment
<i>Inter-vention</i>	Retention	20 mins	20 min	20
	T	Standard Acu.	Saam Acu.	Standard Acu.
	C	Sham Acu.	Sham Acu.	No treatment
<i>Outcome</i>	Adv effect	None	None	None
	Results (BP changes)	T;142.88±8.13/95.16±6.2 C;138.99±12.66/93.82±8.84	The differences T; 5.84±7.17/3.80±7.62 C;-0.80±4.63/0.96±2.94	T;144.07±7.88/90.57±3.91 C;152.43±7.20/92.88±3.70

### Heterogeneity and Subgroup Analysis

Based on Cochrane manual, <sup>(29)</sup> substantial heterogeneity between included RCT's was found in SBP (Figure 2. SBP after intervention  $I^2 = 61.2\%$ ,  $\tau^2 = 0.1391$ ,  $\chi^2 = 20.61$  ( $p = 0.0082$ )) but not in DBP (Figure 3. DBP after intervention  $I^2 = 21.8\%$ ,  $\tau^2 < 0.0001$ ,  $\chi^2 = 10.24$  ( $p = 0.2488$ )).

Upon studying plots, one study (H. Kim (2012)) stood out, and it was decided to further investigate the possible cause for such a large heterogeneity in SBP. The trial was revisited and the following were found; 1. The study was well designed and professionally carried out but conducted with too small a sample (T/C = 12/16). 2. The trial was designed to compare standard

acupuncture vs. sham. Two acupuncture points were selected for test (ST 36 and PC6), and sham points were only 1cm lateral to testing points. Considering there are several ways to locate the acupuncture points (30) such as Cun measure or through palpation, selecting sham point only 1cm away from testing points could lead to unreliable effect measurements. Therefore, we decided to run meta-analysis again without this trial, and results in Figure 9. SBP heterogeneity went down to moderate heterogeneity ( $I^2 = 43.6\%$ ,  $\tau^2 = 0.0441$ ,  $\chi^2 = 12.40$  ( $p = 0.0881$ )).

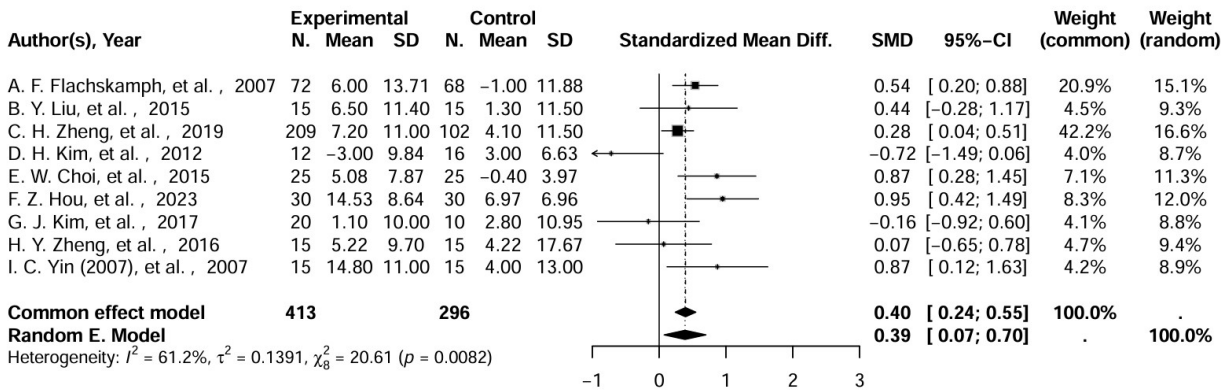


Figure 7. Forest plot of SBP after intervention

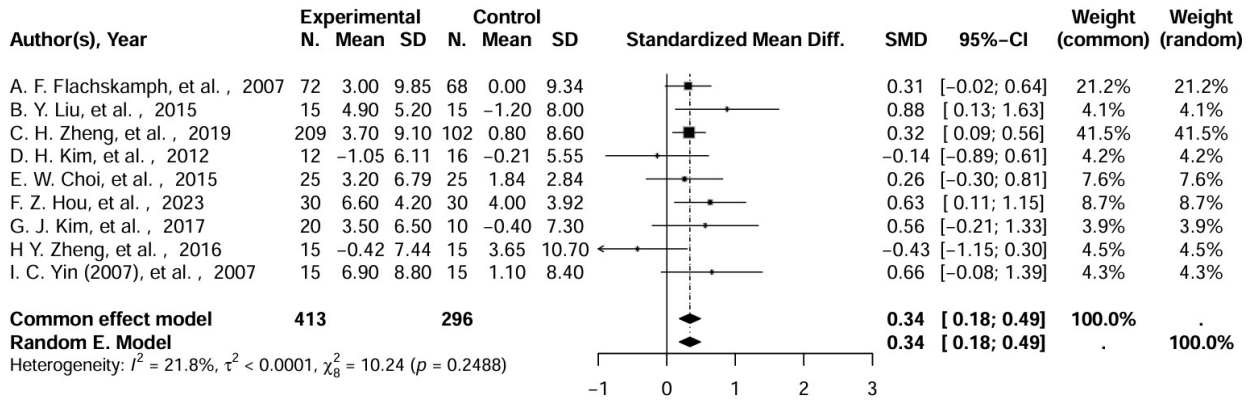


Figure 8. Forest plot of DBP after intervention

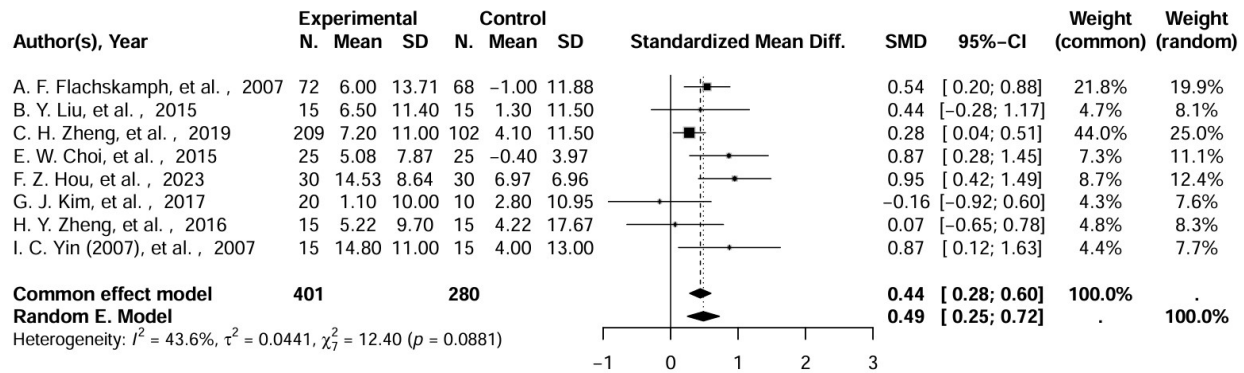


Figure 9. Forest plot of SBP without (10)

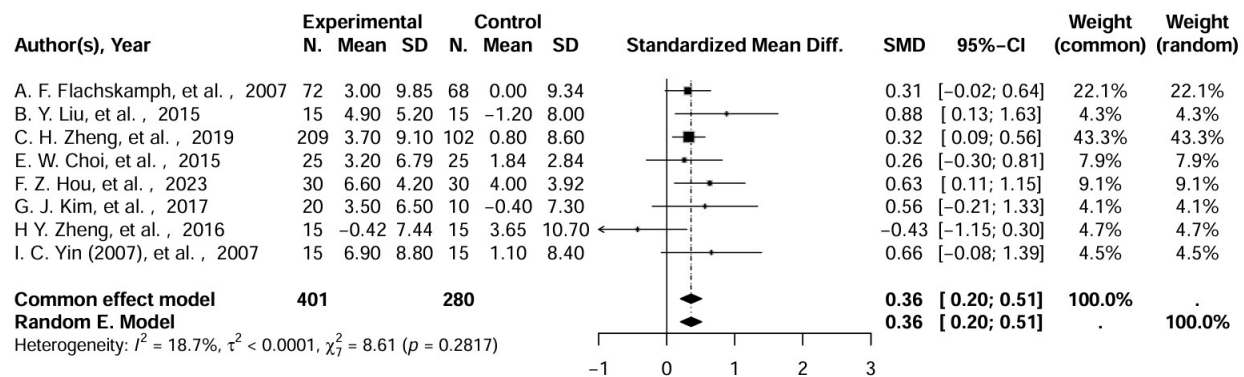


Figure 10. Forest plot of DBP without (10)

## Outcome

Out of 9 initial included studies, one trial (10) was excluded from meta-analysis because its sham acupuncture points were too close to testing acupuncture points, and therefore, its outcome could be questionable. The 8 trials effect estimates of acupuncture were shown in the forest plots (Figure 9, 10).

Each study was represented in a square and a horizontal line graph. The square represents the effect size for that study, and the horizontal line displays the 95% Confidence Interval. The size of the square indicates the weight of each study, which was determined by the study's sample size. Diamond shape at the bottom of graph representing the combined effect size of all studies.

The width of the diamond represents the 95% confidence interval of the pooled effect size. If the diamond does not cross the vertical line (Line of 0), it indicates that the effect is significant.

The results from the random-effects model shows that the average BP reduction in the experimental group, compared to the control group, was a standardized mean difference (SMD) of 0.49 [ 0.25; 0.72] for SBP and 0.36 [ 0.20; 0.51] for DBP. Acupuncture decrease SBP and DBP by 0.49 and 0.36 standard deviation as compare to sham or no treatment.

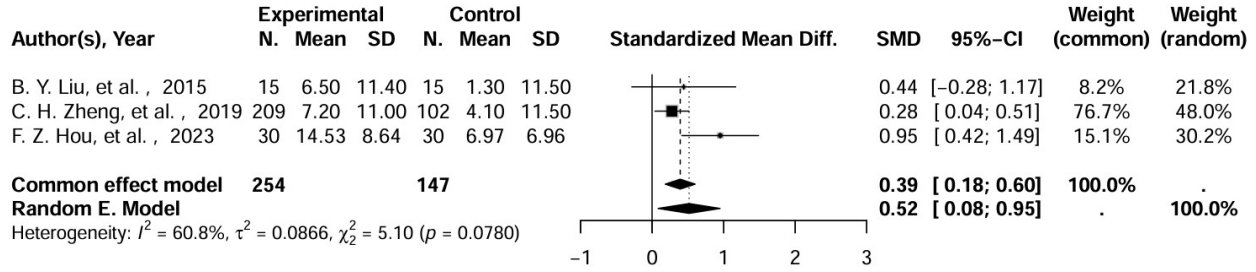
Using rules of thumb effect size, based on Cohen (31), 0.2 represents a small effect; 0.5 a moderate effect: and 0.8 a large effect. This study shows that acupuncture is moderately effective for essential hypertension treatment.

Also, both SBP and DBP 95% CI range does not include effect size 0 which tells us that the mean effect size is not 0. We can reject the null hypothesis and conclude that (on average) the acupuncture indeed reduced blood pressure and was moderately effective for the essential hypertension treatment.

### **Analyzing the effects of Sham vs No treatment**

We performed the comparisons between acupuncture vs. sham and acupuncture vs. no treatment to find out the impact of sham compare to no treatment as a control group while assessing acupuncture effectiveness. There was a noticeable difference between two on DBP (Figure 11, 12). DBP with no treatment 0.52 [ 0.08; 0.95],  $\tau^2 = 0.0866$  and DBP with sham 0.28 [ 0.04; 0.52] ( $\tau^2 < 0.0001$ ) while SBP remains almost same. Therefore, we can conclude that physiological and/or psychological mechanisms may contribute or play some role on effectiveness of acupuncture treatment especially treating DBP.

## SBP



## DBP

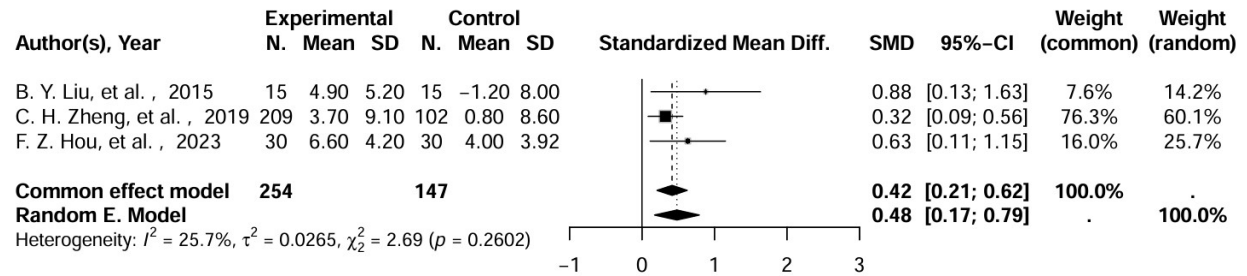
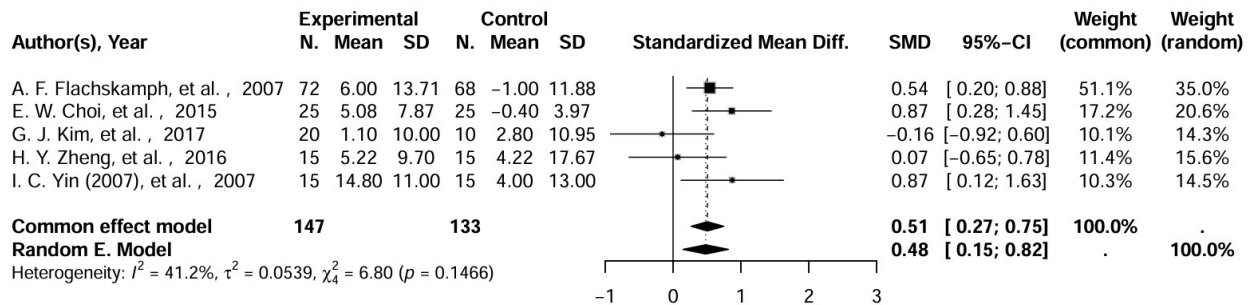


Figure 11. Forest plot for acupuncture vs. no treatment

## SBP



## DBP

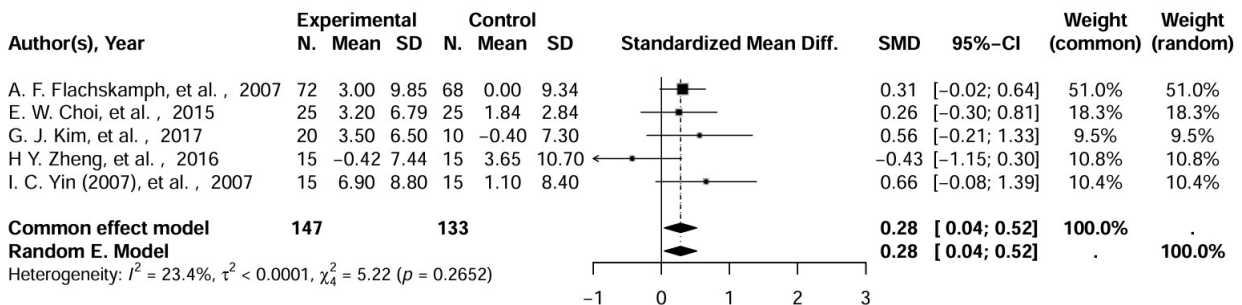


Figure 12. Forest plot for acupuncture vs. sham

## Publication Bias Assessment

In Figure 13, the Funnel Plot shows that most estimates are visually relatively symmetric suggesting no publication bias. Equal distribution of studies effect size above and below the central line of overall effect size estimate. Smaller studies scattered more widely around a central line representing the pooled effect size of estimate. However, this conclusion is only based on visual confirmation.

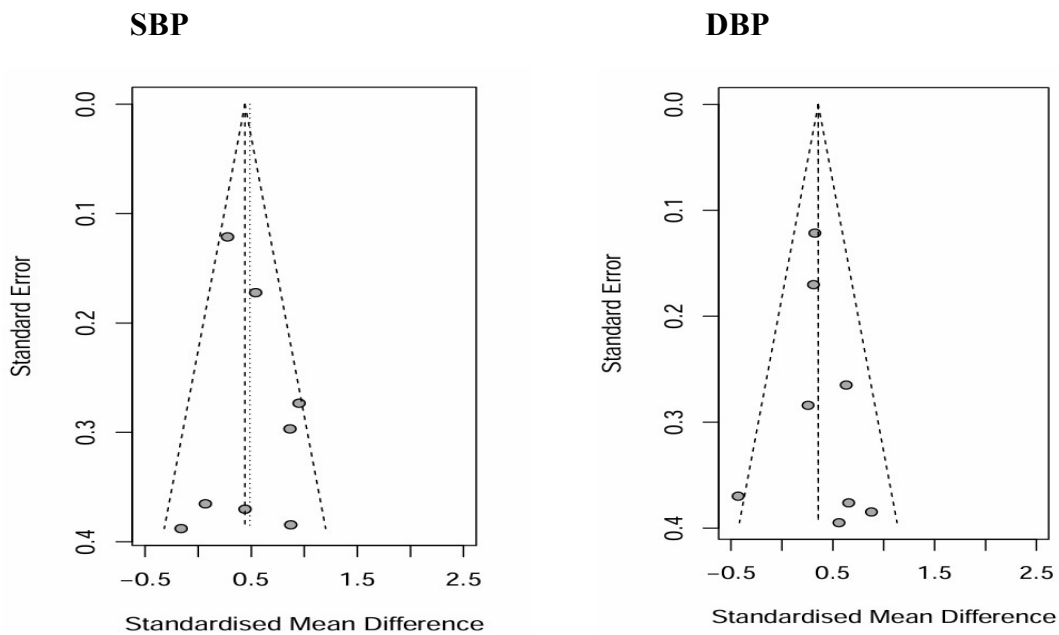


Figure 13. Funnel plot for SBP and DBP

## Risk of Bias Assessment

We used the Cochrane 'Risk of bias' template to assess the methodological quality of the included studies. Detailed report on each study is below and summarized in Table 2, Figure 14, and Figure 15.

**F. Flachskamph (2006)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Unclear	Only described the block randomization used, but no description of method and detail of randomization.
Allocation concealment (selection bias)	Low	Closed envelope, without indicating assignment to participants
Blinding (performance bias and detection bias)	Low	Study described as single blind, Chinese physicians who included participants blinded.
Incomplete outcome data (attrition bias)	Low	Mentioned intention-to-treat analyses and reported number of dropouts and related reasons.
Selective reporting	Low	All outcomes are reported
Other bias	Low	Needle points, angle, depth, and type of manipulation of needling was prescribed.

**Y. Liu (2015)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Low	Software is used to generate the random allocation sequence
Allocation concealment (selection bias)	Low	Sealed envelope until participants are included in study
Blinding (performance bias and detection bias)	High	Blinding unlikely to have been achieved as sham procedure did not involve needle penetration.
Incomplete outcome data (attrition bias)	Low	Reported number of dropouts and related reasons and all patients are included in final analysis
Selective reporting	Low	Used machine. Measured 3 times at both arms. All measured data was reported
Other bias	Low	Deqi

**H. Zheng (2019)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Low	Generated by Brightech-Magnsoft Data Service
Allocation concealment (selection bias)	Low	Generated by Brightech-Magnsoft Data Service
Blinding (performance bias and detection bias)	Low	Specified as blind
Incomplete outcome data (attrition bias)	Low	Study flow chart reports detailed data process
Selective reporting	Medium	Two active group was designed – meridian vs non meridian. No comparison between two group
Other bias	Low	Electro machine frequency, needle depth, and Deqi specified.

**J. Kim (2017)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Unclear	Computer program is used to generate random sequence.
Allocation concealment (selection bias)	Low	Sealed envelope. Distributed at the door as participants enter.
Blinding (performance bias and detection bias)	High	Only outcome assessor is blind
Incomplete outcome data (attrition bias)	Unclear	Reported number of drop outs but no mention of intention to treat analysis
Selective reporting	Low	All the study's prespecified outcomes and expected outcomes of interest to the review were reported
Other bias	Low	Needling was based on acupuncture theory book and achieved Deqi.

**Y. Zheng (2016)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Unclear	Only described the block randomization used, but no description of method and detail of randomization.
Allocation concealment (selection bias)	Unclear	No mention of allocation concealment
Blinding (performance bias and detection bias)	Unclear	No mention of blinding
Incomplete outcome data (attrition bias)	Unclear	reported number of dropouts and related reasons but no mention of intention to treat analysis
Selective reporting	Low	All the study's prespecified outcomes and expected outcomes of interest to the review were reported
Other bias	Low	Detailed needle technique is reported. Deqi

**C. Yin (2007)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Low	Computerized random allocation
Allocation concealment (selection bias)	High	No report found
Blinding (performance bias and detection bias)	Low	Assessor and subject blind
Incomplete outcome data (attrition bias)	Unclear	There were several drop outs in the middle of trial but no mention of intention to treat analysis.
Selective reporting	Low	All the study's prespecified outcomes and expected outcomes of interest to the review were reported
Other bias	Low	Detailed needle manipulation and Deqi achieved

**H. Kim (2012)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Unclear	Stated randomized but no indication of methods nor description of randomization
Allocation concealment (selection bias)	Low	Consecutively numbered opaque envelopes containing a sheet with the allocation were prepared and opened after the patients had been included in the study
Blinding (performance bias and detection bias)	Low	Study described as double blind but no detailed description.
Incomplete outcome data (attrition bias)	High	28/33 participants (5 in A, 0 in B) dropped out early or could not be analyzed. Detailed description, no intention-to-treat analysis.
Selective reporting	Low	Relevant outcomes reported
Other bias	Low	Needle manipulation and Deqi achieved

**W. Choi (2015)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Low	Used SAS program
Allocation concealment (selection bias)	Low	Random code was sealed in a double non penetrable envelop, and it was opened just before the trial
Blinding (performance bias and detection bias)	Unclear	Patient assessor blind. No mention about practitioner
Incomplete outcome data (attrition bias)	Low	No drop out
Selective reporting	Low	Relevant outcomes reported
Other bias	Low	Needle manipulation and Deqi achieved

**Z. Hou (2023)**

<b>Bias</b>	<b>Judgement</b>	<b>Support for Judgement</b>
Random sequence generation (selection bias)	Low	Computer generated
Allocation concealment (selection bias)	Low	Randomly generated card was in opaque envelop and distributed randomly.
Blinding (performance bias and detection bias)	High	Due to the test scheme, double blind was not possible. Assessors were separated (blinded)
Incomplete outcome data (attrition bias)	Unclear	No report.
Selective reporting	Low	Relevant outcomes reported
Other bias	Low	Needle manipulation and Deqi achieved

Table 2. Risk of bias assessment summary

Study	Random sequence generation	Allocation concealment	Blinding participants/ Personnel	Blinding outcome assessment	Incomplete outcome data	Selective reporting	Other Bias
F. Flachskampf (2006)	Unclear	Low	Low	Low	Low	Low	Low
Y. Liu (2015)	Low	Low	High	Low	Low	Low	low
H. Zheng (2019)	Low	Low	Low	Low	Low	Medium	Low
J. Kim (2017)	Low	Low	High	Low	Unclear	Low	Low
Y. Zheng (2016)	Unclear	Unclear	Unclear	Unclear	Low	Low	Low
C. Yin (2007)	Low	High	Low	Low	Unclear	Low	Low
H. Kim (2012)	Unclear	Low	Low	Low	High	Low	Low
W. Choi (2015)	Low	Low	Unclear	Low	Low	Low	Low
Z. Hou (2023)	Low	Low	High	Low	Unclear	Low	Low

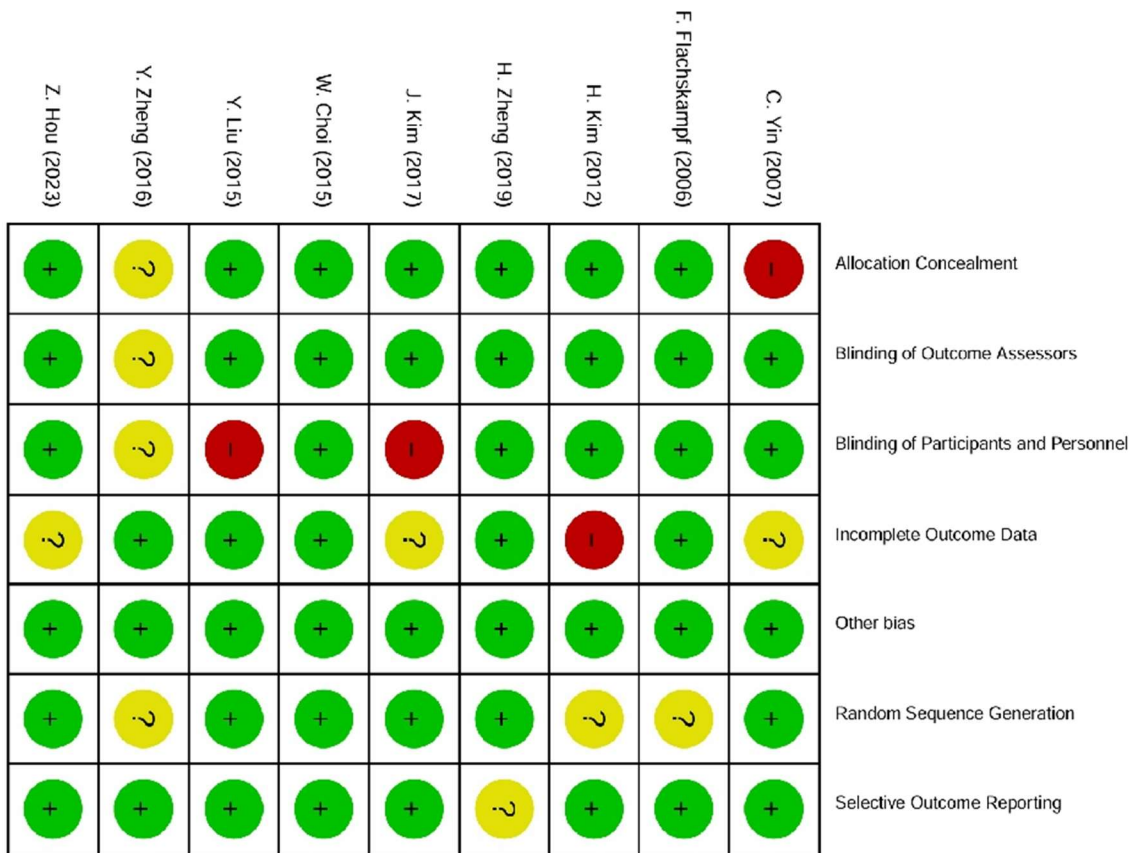


Figure 14. The risk of bias assessment for each included study

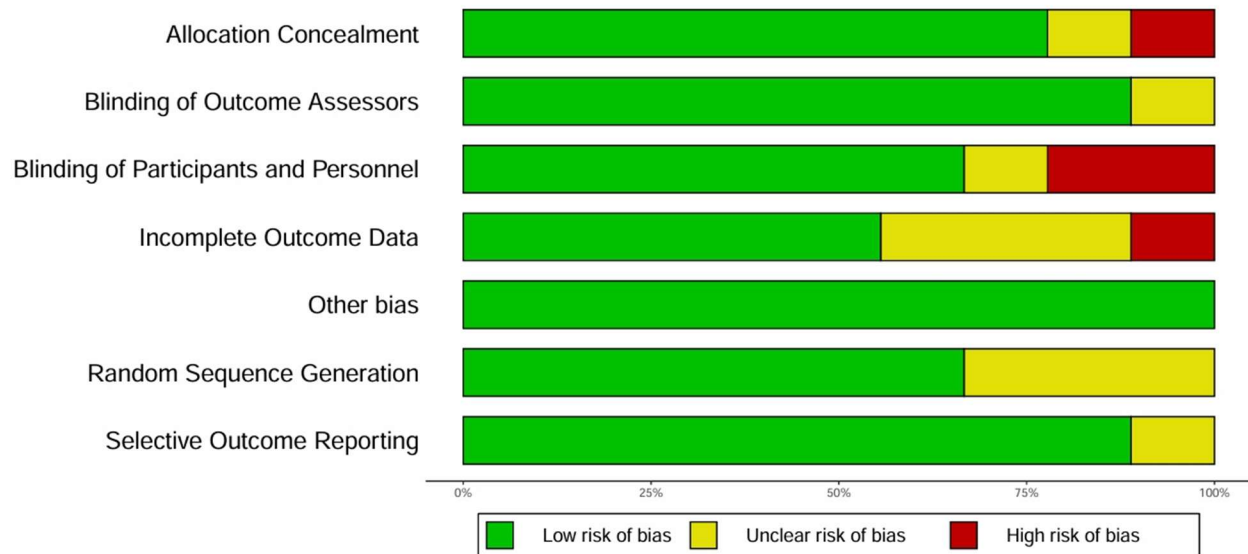


Figure 15. Risk of bias summary of included randomized controlled trials (RCTs)

### Adverse Effect

Three of included studies reported adverse events during the trial (9, 22, 23). No study reported subject dropout due to acupuncture adverse events. Frequently reported adverse effects are; local pain, discomfort, and hematoma.

#### IV. DISCUSSION

Many clinical trials are conducted to demonstrate how acupuncture works and its effect. Other than traditional expression of Qi, Blood, Jing, Yin and Yang, homeostasis and self-healing, it can now be explained in terms of endogenous and physiological mechanism.

First, acupuncture influences the nervous system - muscles, nerves, internal organ. Second, acupuncture regulates the cardiovascular system – blood flow, distribution of nutrients, hormones. Third, acupuncture regulates the endocrine system – hypothalamic pituitary-adrenal axis regulation – major pathway for homeostatic regulation. Fourth, acupuncture strengthen the immune function of the body <sup>(19)</sup>.

This study reviewed 9 original articles on the treatment of essential hypertension using acupuncture and meta-analysis were using 8 RCTs.

Acupuncture treatment found to be more effective than sham or no treatment. In addition, the adverse effects of acupuncture were milder. Therefore, acupuncture is expected to be a complementary alternative therapy for essential hypertension.

In addition to the primary objective, data was analyzed to find out the impact of sham compared to no treatment. The results indicates that there were no differences in SBP but significant changes in DBP. Therefore, depending on the purpose of the trial, one should consider the effect of sham when designing RCT trials.

It was also noticed that selecting sham points too close to the intended acupuncture points while testing the effectiveness of acupoints or overall acupuncture is not recommended; one might not be able to achieve reliable and intended results <sup>(10)</sup>.

While searching and gathering RCTs, it was noticed that most of the sample size were under 60 and duration was under 8 weeks. There was little testing done for long term effects of acupuncture treatment and how long the positive effects were sustained. If patient has to

undergo once a week treatment to maintain optimum blood pressure, it might not be economical in the USA, and some might find it torturous.

## V. CONCLUSION

This systemic review and meta-analysis validate that acupuncture was more effective in treating sessional hypertension in reducing SBP; SMD 0.49, 95% CI (0.25, 0.72),  $I^2 = 43.6\%$ ,  $\tau^2 = 0.0441$  and DBP; SMD 0.36, 95% CI (0.20, 0.51),  $I^2 = 18.7\%$ ,  $\tau^2 = 0.0001$  than sham or no treatment.

Comparison between sham and no treatment as a control group vs. acupuncture shows significant differences in DBP change; Acu vs. sham: SMD 0.28, 95% CI (0.04, 0.52),  $I^2 = 23.4\%$ ,  $\tau^2 = 0.0001$  and Acu vs. no treatment: SMD 0.48, 95% CI (0.17, 0.79),  $I^2 = 25.7\%$ ,  $\tau^2 = 0.0265$  demonstrating that sham can influence the outcome of an acupuncture treatment effectiveness trial.

In summary, our review provides evidence of efficiency of acupuncture for treating essential hypertension. Owing to few limitations, higher quality RCTs with a larger sampling with longer duration are needed to better evaluate the results of acupuncture in the treatment of essential hypertension.

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