Original Article

Effectiveness of Hydrotherapy to Lower Blood Pressure in Hypertensive Patients: A Systematic Review

Rini Angraini, RN, MN
Student of Postgraduate Nursing Program, Department of Medical Surgical Nursing, Faculty of Nursing. Hasanuddin University, Makassar, Indonesia

Andi Masyitha Irwan, RN, MAN, PhD
Lecturer, Department of Gerontological Nursing, Faculty of Nursing, Hasanuddin University, Makassar, Indonesia

Rosyidah Arafat, MN
Lecturer Dr., Faculty of Nursing, Hasanuddin University, Makassar, Indonesia

Correspondence: Andi Masyitha Irwan, RN, MAN, PhD Lecturer, Department of Gerontological Nursing, Faculty of Nursing, Hasanuddin University, Makassar, Indonesia Email: citha_ners@med.unhas.ac.id

Abstract

Background: Hypertension is a chronic cardiovascular disease and the leading cause of morbidity and mortality worldwide. Around 53% of patients with hypertension cannot control their blood pressure and are at risk for complications. Currently, the treatment of hypertension consists of lifestyle modification and pharmacological treatment. However, most people need two or more antihypertensive drugs to lower blood pressure. Lifestyle modification can also increase the effect of antihypertensive treatment, one of which is a complementary therapy, such as hydrotherapy. Hydrotherapy is very easy for everyone, inexpensive, has no harmful side effects, and a method of treatment, healing by using a water medium to obtain a therapeutic effect, especially for older people and someone with physical limitations that are mainly related to orthopedic dysfunction due to water floatation that can reduce the force of gravity.
Purpose: This systematic review aimed to explore the effectiveness of hydrotherapy in lowering blood pressure on hypertensive patients, with a variety of relevant studies.
Methods: The study was a systematic review using PubMed, Science Direct, Proquest, EBSCO Host, Wiley, Garuda, and gray literature databases. We included hydrotherapy studies focused on reducing blood pressure in hypertension patients, published in the last ten years (2010 - 2020), had full text available, used randomized controlled trial study design, and published in English and Indonesian.
Results: Eight studies were identified and reviewed. Seven studies revealed the type of water-based exercise hydrotherapy. Only one study revealed the immersion of feet with warm water. All studies showed that hydrotherapy significantly reduced blood pressure in hypertensive patients with varying degrees of decline.
Conclusion: Hydrotherapy effectively lowers blood pressure in patients with hypertension. It can be used as an addition to other therapies. However, further research is needed with follow-up to further ensure the effectiveness of hydrotherapy interventions for the long term in lowering blood pressure.

Keywords: Hypertension, Hydrotherapy, Blood pressure, Systematic review.

Introduction

It is estimated that one billion of the world's population suffer from hypertension, and this prevalence increases every year (WHO, 2013). It is predicted to increase to 1.56 billion by 2025 (Forouzanfar et al., 2017). Southeast Asia is in the third highest position, with a prevalence of 25% of the total world population (Kemenkes RI, 2019), while in Indonesia, it increased from 25.8% to 34.11% in 2018 (Kementerian Kesehatan RI, 2018). Seeing that the incidence of hypertension is increasing, it is necessary to handle it more appropriately in reducing the incidence of hypertension.

Hypertension is one of the cardiovascular diseases that cause significant morbidity and mortality worldwide. It is considered a primary risk factor for stroke, heart disease, and kidney failure (Olsen et al, 2016). This disease can continue to get worse unnoticed until it can threaten the life of patients (Casey, 2012). Due to the high-risk factors that can be caused, it is necessary to use more appropriate strategies to reduce the incidence of hypertension and improve the quality of life of hypertension patients.

Because hypertension is a chronic disease, patients need to manage themselves to reduce symptoms and reduce the risk of complications (Muliaty et al., 2013 ; Sitoresmi et al., 2020 ;Irwan, 2016). Most guidelines emphasize lifestyle modification as the first step in treating hypertension (Whelton et al., 2012).

Lifestyle modification can also increase the effect of antihypertensive treatment, one of which is complementary, alternative, or traditional medicines (Unger et al., 2020). One of the complementary therapies to decrease BP is hydrotherapy, which is a therapeutic application of water in all its forms, for example, liquid, vapor, and solid to maintain or restore health (Williams, L. & Wilkins, 2008), treatment, and healing methods using water media to obtain a therapeutic effect (Chaiton, 2002). According to recommendations by the American College of Sports Medicine/America Hearth Association, water-based exercise is a safe alternative for older people and someone with physical limitations that are mainly related to orthopedic dysfunction due to water floatation that can reduce the force of gravity (Nelson et al., 2007).

The increasing needs of the community and the development of research on complementary therapies are opportunities for nurses to contribute following the community's needs (Smith et al., 2004). Nurses also handle healing professionally, including physical, mental, emotional, social, and spiritual dimensions, and actively engage with other healthcare professionals to provide optimal care and healing (Lindquist et al., 2014 ;Irwan et al., 2016 ; Sitoresmi et al., 2020). With this review, nurses can use several complementary/alternative medicine therapies involving manipulative and body-based therapies, such as hydrotherapy, diathermy, light and color, heat, and alternate nostril breathing (Lindquist & Synder, 2002). In providing nursing care, nurses are authorized to conduct complementary and alternative nursing management in individual health efforts (Presiden RI, 2014). The role of nurses in complementary therapy, following the limits of ability and competence obtained through nursing education and training (Regulation of the Minister of Health of the Republic of Indonesia, 2019).

Hydrotherapy has a relaxing effect on the body, stimulating the production of the hormone endorphin, suppressing adrenaline, and reducing BP (Madyastuti, 2012). Hydrotherapy is very easy for everyone, not expensive, and has no harmful side effects (Sudoyo, 2014), where warm foot soaking therapy can be performed at home (Batjun, 2015). Several reviews have been conducted about the effects of hydrotherapy, including hydrotherapy in stroke patients but only to improve post-stroke life activities (Mehrholz et al., 2011), hydrotherapy for people with type 2 Diabetes Mellitus and Heart Failure but limited to reducing blood sugar (Åsa et al., 2012), hydrotherapy for older people with chronic heart failure (Caminiti et al., 2011), and hydrotherapy for rheumatoid arthritis (Verhagen et al., 2015). However, a systematic review has not been conducted on the effectiveness of hydrotherapy in reducing BP in people with hypertension. Therefore, it is necessary to conduct a systematic review by synthesizing and summarizing existing studies and collecting all relevant evidence, following the study eligibility criteria to provide the best evidence so that nurses can be more familiar with complementary therapies, especially hydrotherapy, in order to be used in various health facilities and communities for hypertensive patients. Therefore, this review was conducted to explore other effects of hydrotherapy, to reduce blood pressure in hypertensive patients with various relevant studies. This systematic review will be reviewed based on patient characteristics, type of hydrotherapy, duration of hydrotherapy, frequency of hydrotherapy, time of doing hydrotherapy, the therapist doing hydrotherapy, and the effect of hydrotherapy on decreasing BP.

Methods

Eligibility Criteria: It uses a systematic review design with Preferred Reporting Items for Systematic Review and Meta-Analysis checklist-guideline 2009 (Moher et al., 2014). Inclusion criteria: hydrotherapy study that focuses on reducing BP in hypertensive patients, hypertensive disease with or without accompanying disease, full-text article, with randomized controlled trial (RCT) research design, published in the last ten years (2010 - 2020), conducted in humans, both English and Indonesia articles. While other interventions accompanied the exclusion criteria, studies with hydrotherapy interventions, the article was only in titles and abstracts, adult population with hypertension but pregnant.

The clinical question was based on PICO (patients, interventions, comparisons, and results) (Brandt Eriksen & Faber Frandsen, 2018)(Polit, Denise F., Beck, 2018) as follows P P: Hypertension I: Hydrotherapy with standard care, C: Standard care O: lowering blood pressure.

Data Sources and Search Methods: Using five databases: PubMed, Sciencedirect, Proquest, EBSCO Host, Wiley, with keywords based on free terms, BOOLEAN OPERATORS AND or OR, The keywords use PICO, P: Hypertension, *I:* Hydrotherapy with Standard care, *C:* Standard care, *O:* Lowering blood pressure, and Garuda Portal (Digital Referral Garba) with keywords using Indonesian, namely P: Hypertension, I: Soak the feet, Hydrotherapy, C: Ordinary care and O: Reducing Blood Pressure.

Study Selection: The selection of studies was carried out following PRISMA guidelines (Moher et al., 2009). Two reviewers of RA and AMI screened titles and abstracts to obtain relevant studies following inclusion and exclusion criteria. If not approved, it will be discussed with the RA until an agreement is reached. In total, 1,088 titles and abstracts. Furthermore, RA thoroughly assessed the full text to assess the feasibility of the article. Then after the screening, 104 articles remained and filtered again into 21 articles; 13 articles were not following the study's results, so eight studies that met the predetermined criteria were evaluated by RA and AMI

Evaluation Quality assessment: Assessment of the feasibility of studies was conducted with the Critical Appraisal Skill Program (CASP) RCT (Critical Appraisal Skills Programme (CASP), 2020) and the Center for Evidence-Based Medicine (CEBM) (Centre for Evidence-Based Medicine (CEBM), 2011) (Table 1). Assessment of the risk of bias was conducted based on the Cochrane Risk of Bias Tool: + (Low risk of bias), - (High risk of bias), ± (Risk of bias is unclear) (J. P. T. Higgins et al., 2011). The bias quality of each study is determined independently by RA, then evaluated to AMI and RA so that consensus occurs (Table 2).

Table 1. Critical Appraisal

No	Critical Appraisal Intervensi (Critical Appraisal Skills Programme (CASP), 2020)	(Arca et al., 2014)	(Bocalini et al., 2017)	(de Barros Cruz et al., 2017)	(Guimãraes et al., 2018)	(Ngomane et al., 2019)	(Ruangthai et al., 2020)	(Malibel et al., 2020)	(Cunha et al., 2012)
1	Is the research focused on the problem?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Is patient selection for intervention randomized?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Are all patients involved in the study taken into account to this end?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	Is the patient, officer, or researcher blind?	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell
5	Are the patient's characteristics the same from the beginning of the study?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	In addition to the interventions provided, are both	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	groups treated equally?								
7	Are the effects of the intervention reported comprehensively?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	Is the unanimity of the estimated effects of the intervention reported?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Are the benefits of the study comparable to the disadvantages and costs used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	Can all clinical outcomes be applied to your local population?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	Are benefits worth the cost?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. CASP = Critical Appraisal Skills Programme

Table 2. Risk of Bias

No	Cochrane risk-of-bias domain (J P T Higgins et al., 2011)	(Arca et al., 2014)	(Bocalini et al., 2017)	(de Barros Cruz et al., 2017)	(Guimãraes et al., 2018)	(Ngomane et al., 2019)	(Ruangthai et al., 2020)	(Malibel et al., 2020)	(Cunha et al., 2012)
1	Random process	+	+	+	+	+	+	+	+
2	Concealing allocation	-	+	-	-	-	+	+	+
3	Blind participants and researchers	+	+	+	+	+	+		
4	blind research results	+	+	+	+	+	+	+	+
5	Incomplete result data	+	+	+	+	+	+	+	+
6	Reporting bias	+	+	+	+	+	+	+	+
7	Other biases	+	+		+	+	+		+

+ = Low risk of bias, - = High risk of bias,? = Unambiguous risk of bias

Results

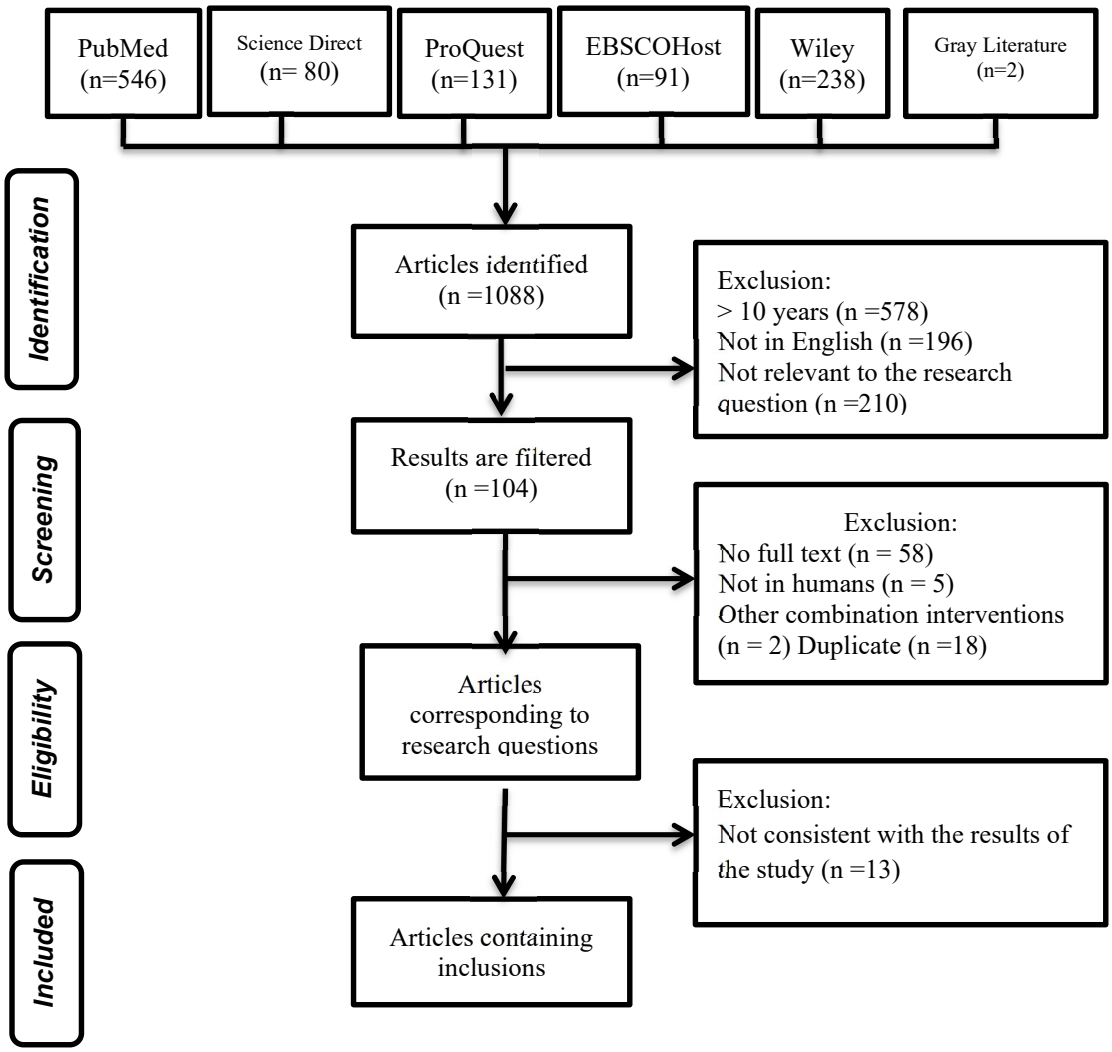
Study Selection

From the screening results of five databases and one gray literature used, 1,088 articles were identified. We excluded 578 articles from publications over the last ten years (2010 to 2020). As many as 196 articles did not use English, 210 articles with titles and abstracts were not following research questions, 58 articles were not full text, five articles were not researched in humans, two articles with combined interventions, 18 duplicate articles, and 13 articles were not following research results. So that the eight articles that meet our review criteria, thus the eight articles that meet our inclusion criteria (Figure 1)

Study Characteristics

The eight articles analyzed were RCTs describing the effects of hydrotherapy interventions on Hypertensive patients, with the level of bias risk assessment was found to be moderate bias risk two studies and six studies low bias risk assessment.

Figure 1. Flowcharts for study selection and inclusion



Note. PubMed= Public/publisher Medline; EBSCO=Elton B. Stephens Company.

Table 3. Study Characteristics

Author, year, Country	Design	Age (years)	Number of Samples	Blood pressure (mmHg) initial	Hypertension Categories	Length of suffering from hypertension	Healthcare professionals who perform
(Arca et al., 2014); Brazil	RCT	>64	52	Between 140/90 and 179/109	Stage 2 Hypertension	Not specified	Physiotherapist
(Bocalini et al., 2017); Brazil	RCT	> 60	45	Systole 155±4 and diastole 92 ± 3	Stage 2 Hypertension	Not specified	Not specified
(de Barros Cruz et al., 2017); Brazil	RCT	>50	44	Systole >140 Diastole >90	Stage 2 Hypertension	Five years	Not specified
(Guimãraes et al., 2018); Brazil	RCT	40-65	32	Systole >140 Diastole >90	Stage 2 Hypertension	Five years	Not specified
(Ngomane et al., 2019); Brazil	RCT	>60	45	Systole 131 ± 9 Diastole 81 ± 9	Stage 1 Hypertension	Five years	Not specified
(Ruangthai et al., 2020); Thailand	RCT	>60	53	Systole ≥ 130 Diastole ≥ 80	Stage 1 Hypertension	6,5 years	Not specified
(Malibel et al. 2020); Indonesia	RCT	50-59	60	Systole 144 Diastole 91	Stage 2 Hypertension	Not specified	Nurses
(Cunha et al., 2012); Brazil	RCT	60-70	32	Systole ≥ 160 Diastole ≥100	Stage 2 Hypertension	Not specified	Physiotherapist

Note. RCT = Randomized controlled trials; mmHg = Milimeter merkuri hydrargyrum.

Table 4. Summary of the results of hydrotherapy intervention on BP reduction in hypertensive patients

Author, Year, Country	Methods	Objectives	Participants	Intervention	Outcome	Results
(Arca et al., 2014); Brazil	RCT	Compare the effect of water gymnastics with training on land in women with hypertension.	52 female hypertensive patients Water Group (WG, N = 19), Land Group (LG, N = 19) Control group (CG, N = 14).	WG: walking with water levels to the xiphoid process. Includes the stretch of lower limb muscles (10 minutes), the isotonic movement of lower limbs, and relaxation for 10 minutes LG: Hold walking (10 minutes) CG: do static bicycles. For 12 weeks.	WG: pretest systole pretest 136±6 mmHg, pretest diastole 86 mmHg, posttest systole: 124 ± 15 mmHg, posttest diastole: 77mmHg. LG: pretest systole 138 ± 15mmHg, pretest diastole 87 mmHg, posttest systole 126 ± 9 mmHg, posttest diastole after 78 mmHg. CG: pretest systole 140 mmHg, posttest systole 139 mmHg, pretest diastole 89 mmHg, posttest diastole 84 mmHg. (p=0.001)	Water gymnastics significantly reduces systole and diastole BP
(Bocalini et al., 2017); Brazil	RCT	To evaluate the effects of water and soil-ergometric training sessions in Post Exercise Hypotension (PEH) of the subject of healthy normotensive with hypertensive	45 older women Normotensive (N) (n = 10) Hypertension treated (TH) (n = 15) Untreated hypertension (UH) (n = 20).	Ergometer cycling training (on land or water-based) for 45 minutes in two different sessions (48 hours between sessions) Water-based sports are carried out in ponds with adjustable temperatures up to 30 ± 1 ° C, and the water depth is set at the xiphoid process level.	Systole water training 150±2 mmHg and water training systole 88±1 mmHg Systole land exercises 153±2 mmHg, diastole land exercise 91±1 mmHg, (p <0.001), in untreated hypertension	Water-based cycling exercises significantly lower the BP in hypertension that is not treated.

		patients treated or untreated				
(de Barros Cruz et al., 2017)	RCT	To see the heat-based effects of heated exercise (HEX) in hypertensive patients resistant to the decrease in BP	44 resistant hypertensive patients. HEX (N = 28) Control group (n = 16)	The control group maintains their habitual activities by practicing calisthenic exercises and running in heated pools for 1 hour, three times a week for 12 weeks.	Intervention group pretest systole 162.2 ± 23.2, pretest diastole 83.8 ± 2.5, and posttest systole 135.5 ± 11, posttest diastole 76.7 ± 2.1. The control group pretest systole 157.6 ± 17.6, pretest diastole 86.4 ± 2.5, and posttest systole 157.8 ± 16.6, posttest diastole 87.1 ± 2.0. (p <0.05).	Water-based running exercises significantly reduce systolic and diastolic BP
(Guimãraes et al., 2018); Brazil	RCT	To find out whether water-based heating exercises (HEX) can reduce BP in patients with resistant hypertension	32 patients Hypertension resistant HEx group (n = 16) Control group (n = 16)	Given 36 sessions (60 minutes) of warm-up exercises in a hot tub (32° C) The control group was evaluated over the same period and instructed to maintain their habitual activity for 12 weeks (training), followed by 12 weeks of cessation of training.	Intervention group: systolic BP -19.5 ± 4.6 mmHg and diastolic -11.1 ± 2.4 Systolic BP control group 3.0± 0.7 mmHg and diastolic 2.06 ± 0.9 mmHg, (p = 0.001)	Water-based warm-up exercises have a significant effect on lowering systolic and diastolic BP
(Ngomane et al., 2019); Brazil	RCT	To test the hypothesis that HEx is superior to LEx for acutely reducing BP in older age.	45 older age systemic hypertension patients Heated water-based (HEx) group (n=15) Land-based exercise (LEx) group (n=15) Control intervention	At controlled room temperature (LEx and CON) (21–23 °C) or controlled swimming pool temperature (Hex) (29–32 °C), at the same time Both HEx and LEx consist of a 5-minute warm-up, a 30-minute walk in the pool (HEx), a motorized treadmill (LEx), and a 5-minute cool-down. The control group (CON) was given 40 minutes of rest quietly in a sitting position.	Hex group pretest systole 132 ± 15 and pretest diastole 81 ± 10, posttest systole 132 ± 15 and posttest diastole 81 ± 9. Lex group: pretest systole 129 ± 16 and pretest diastole 83 ± 13, posttest systole 129 ± 16 and posttest diastole 81 ± 13. Control group pretest systole 130 ± 11 and pretest diastole 81 ± 10, posttest systole 130 ± 11 and posttest diastole 86 ± 13	Exercise walking in the pool has a significant effect on lowering systolic and diastolic BP.

			(CON) group (n=15)		(p<0.05)	
(Ruangthai et al., 2020); Thailand	RCT	To compare combined water and land-based training programs (aerobic and resistance) on functional cardiometabolic parameters. Fitness and quality of life (QoL) in older people with hypertension.	53 older people with hypertension Land-based exercise (LET) group (n = 17) Water-based exercise (WET) group (n = 16) Control group (CON) (n = 20).	The pond water temperature with a temperature of 26-29 ° C and a depth between the xiphoid process and the shoulder (1.2 meters). The intervention group: the exercise session consisted of 10 minutes of warm-up with stretching, 20 minutes of aerobic exercise, 20 minutes of resistance training, and 10 minutes of stretching and cooling down. Ground exercise group: training sessions including aerobic exercise, resistance training, and stretching exercise: 10 minutes warm-up with stretching exercises, 20 minutes aerobic exercise, 20 minutes resistance training, and 10 minutes stretching and cool-down exercises. The intervention was conducted three sessions a week for 60 minutes for 12 weeks.	LET group systolic BP decreased by 11.6 mmHg (8.2), p < 0.01) and diastolic 10.6 mmHg (7.5%) (p < 0.05) WET group systolic BP 6.5 mmHg (4.6%) (p < 0.01) and diastolic 7.6 mmHg (5.4%) (p < 0.01) Control group (CON), there is no change in BP.	Pool-based exercise has a significant effect on lowering systolic and diastolic BP
(Malibel et al. 2020); Indonesian	RCT	To determine the effect of BP before and after warm water foot soak therapy in	60 Hypertension patients Intervention group (n=30)	Do soaking feet using warm water with a temperature of 38-40^{o}C for 20-30 minutes, and the length of the intervention is not explained.	Intervention pretest average systole: 144.33 mmHg, posttest: 131.00 mmHg Pretest diastole: 91.00 mmhg, posttest: 83.00 mmhg	Soak the foot of warm water has significant

		hypertensive patients	Control group (n = 30)		Pretest systole control group: 144.00 mmHg, posttest: 145.33 mmHg prestest diastole: 89.33 mmHg, posttest: 93.33 mmHg (p = 0.000).	significantly reduced systole and diastole
(Cunha et al., 2012); Brazil	RCT	To evaluate the behavior of subacute BP in the older woman with hypertension after a water gymnastics session.	32 women's older people with hypertension Experimental groups (EP) (N = 16) Control Group (CP) (n = 16)	A swimming pool as deep as 1.4 m with an average temperature of 28.5 C. A 40-minute water training session, mostly aerobics, was done. The EP group starts with 5 minutes period. The main part of the session lasts 30 minutes and a cooling session for 5 minutes. Hout any physical exercise, for the same period (40 minutes) The CP group also occurs aquatic center pool, a condition like EP, but without any physical exercise, for the same period (40 minutes)	EP group pretest systole: 135.46 (- 7.42), posttest: 126.93 (- 11.51) CP group pretest systole: 138.25 (- 12.78), posttest: 137.06 - 16.20 (p=0,014)	Water gymnastics significantly reduces systolic BP

Sample Characteristics

All participant data (n = 363) with six studies from Brazil, one study from Thailand, and one study from Indonesia. The majority of the participants were > 60 years old on average; the majority were women, with aged 32 (Guimãraes et al., 2018; Cunha et al., 2012) to 60 (Malibel et al., 2020), with a BP of >140 mmHg and a diastole of 90 mmHg, but two studies with a BP of 130/80 mmHg are presented in Table 3 (Ngomane et al., 2019; Ruangthai et al., 2020) (Table 3).

Type, Intervention, and Duration of Hydrotherapy Intervention

In this review, seven studies reported the type of hydrotherapy exercises based on water, and only one study revealed the immersion of feet with warm water (Malibel et al., 2020). The majority of studies (four studies) provided a 12-week intervention (Arca et al., 2014; de Barros Cruz et al., 2017; Guimãraes et al., 2018; Ruangthai et al., 2020), one study conducted a 7-day intervention (Ngomane et al., 2019), then the study explained the duration of the intervention for 90 minutes (Bocalini et al., 2017)), two studies with the shortest duration of intervals of 30 minutes (Cunha et al., 2012; Malibel et al., 2020). Moreover, total immersion was performed between 20 and 60 minutes, with the most immersion limit to the xiphoid process. The water temperature used is between 26ºC (Ruangthai et al., 2020) to 40 ºC (Malibel et al., 2020) are presented in Table 4.

Effects of Hydrotherapy intervention on decreasing BP in Hypertension

Hydrotherapy shows a statistically significant decrease in BP in hypertensive patients of the eight reviewed studies. The administration of water gymnastics interventions in women with hypertension significantly decreased blood pressure with systole 124 ± 15 mmHg and diastole 77 mmHg compared to the control group systole 139±2 mmHg and diastole 84 mmHg (p =0.001) (Arca et al., 2014). Water-based ergometer cycling exercise interventions in treated or untreated hypertension significantly decreased BP with systole 150±2 mmHg and diastole 88±1 mmHg compared to the control group systole 153±2 mmHg and diastole 91±1 mmHg (p <0.01) (Bocalini et al., 2017). Exercise intervention in hot water in patients with resistant hypertension was significant in the decrease of systole 135.5 ±11 and diastole 76.7 ± 2.1 compared to the control group systole 157.8 ± 16.6 and diastole 87.1 ± 2.0 (p <0.05) (de Barros Cruz et al., 2017).

The administration of water-based warm-up exercise interventions in resistant hypertension was significant in decreasing BP of systole-19.5±4.6 and diastole 11.1±2.4 compared to the control group systole 3.0±0.7 mmHg and diastole 2.06 ± 0.9 mmHg (p = 0.001) (Guimãraes et al., 2018). Exercise intervention by walking in the pool of older hypertensive patients was significant in the decrease in blood pressure systole 132 ± 15 and diastole 81 ± 9 compared to the control group systole 130 ± 11 and diastole 86 ± 13l (p <0.05) (Ngomane et al., 2019). Water-based exercise intervention in hypertensive older people significantly decreased systole 6.5 mmHg (4.6%) and diastole 7.6 mmHg (5.4%) compared to the control group with no change (p < 0.01) (Ruangthai et al., 2020). Warm water immersion intervention in patients with hypertension significantly decreased systole 131.00 mmHg and diastole 83.00 mmHg compared to the control group systole 145.33 mmHg and diastole 93.33 mmHg (p = 0.001)(Malibel et al., 2020). Water gymnastics intervention in older women with hypertension significantly decreased systole 126.93 (- 11.51) compared to the control group systole 137.06 (- 16.20) (p =0.014) (Cunha et al., 2012)

Discussion

Research design, feasibility study, and risk of bias

The effects of hydrotherapy interventions to decrease BP in patients with hypertension have been identified and evaluated in this systematic review. All studies used the RCT design in 363 patients with hypertension, and all hydrotherapy interventions decreased BP in patients with hypertension. RCT is the best type of study to determine causality between interventions and effects (Kabisch et al., 2011). All studies are valid, reliable, and applicable for the study feasibility assessment because statistically, the intervention results can reduce BP in people with hypertension. Critical assessment evaluates research articles carefully and systematically to determine

reliability, validity, and application (Abdullah & Firmansyah, 2012). In this review, the majority of studies with low risk of bias. If it can be resolved, the unique strength of randomization and blind will prevent or reduce bias (J. Higgins et al., 2016).

Type, intervention, duration of hydrotherapy intervention

In this review, the majority of types of hydrotherapy exercises are water-based. The intervention is given 12 weeks, with a total immersion carried out between 20 - 60 minutes, the majority immersion to the xiphoid process using antihypertensive therapy, for the water temperature used between 26ºC - 40 ºC. Following previous studies evaluating the effect of water sports regularly on BP, training sessions ranged from 15 to 60 minutes. The frequency of exercises is one to three sessions per week, duration of intervention ranges from 8 to 24 weeks (median 12 weeks), water temperature ranges from 27ºC - 36 ºC (Igarashi & Nogami, 2018). The Aquatic Exercise Association (AEA, 2006) recommends a water temperature of 30-31ºC. It can use warm water at a temperature of 32-35°C is declared to have a physiological impact on the body (Bates A, & Hansen N, 1996).

Although in this review, we found only one study that reported the administration of this hydrotherapy intervention by nurses, it was shown that hydrotherapy intervention is part of complementary/alternative medicine therapies involving manipulative and body-based therapies where nurses can use several other therapies in this group including hydrotherapy, diathermy, light and color, heat, and alternate nostril breathing (Lindquist et al., 2014)

Nurses have a role as counselors in providing information about the implementation of hypertension. In this interaction, there will be communication between nurses and patients, a form of collaboration intervention care (Lindquist et al., 2014). For this reason, the role of nurses as counselors is obliged to provide counseling to hypertensive patients in improving understanding and changing attitudes for better therapy compliance (Priyanto, 2010). Nurses can also be a place of questioning, consultation, and discussion if the client needs information before making a decision (Lindquist et al., 2014).

Effects of Hydrotherapy intervention on decreasing BP in Hypertension

On administering hydrotherapy intervention on decreasing BP, all studies show a significant decrease in systole and diastole compared to the control group. Hydrotherapy interventions are given in water gymnastics, water-based ergometer cycling exercises, hot water exercises, water-based warm-up exercises, walking exercises in the pool, water-based exercises, and warm water foot soak. A previous study reported that when subjects were confined to those with hypertension who performed resistance exercises, the net change in systolic and diastolic BP decreased significantly (Igarashi & Nogami, 2018). Exercising (e.g., aquatic treadmill, walking, or jogging) in water results in an increase in cardiac output, in blood flow to the muscles, and in the diffusion of metabolic waste products from the muscle to the blood, as well as a reduction in the time it takes to transport oxygen, nutrients, and hormones to fatigued muscles. Moreover, heart volume increased by 30-35% with immersion into the neck, then more significant activity than when doing the same exercise at the same speed on land (Torres-Ronda & Schelling I Del Alcázar, 2014).

Acute immersion in water causes many physiological changes related to the hormonal, cardiovascular, and kidney systems. The primary hemodynamic changes are decreased total peripheral resistance, BP, HR, increased end-systolic volume, and cardiac output. Hormonal and renal changes are diuresis, natriuresis, potassiuresis, and increased levels of circulating atrial natriuretic peptide and inhibition of the renin-angiotensin-aldosterone system (Hall et al., 1990). When renin is produced in the kidneys, angiotensin I will be formed, which will turn into angiotensin II, increasing BP and indirectly stimulating the release of aldosterone, which results in sodium and water retention in the kidneys (Smeltzer & Bare, G, 2001). Later a study revealed that systolic BP decreased in the same way in cold (36°C), neutral (31.1°C), and warm (39°C) water. However, warm water immersion significantly reduced systolic BP by 11,596 mmHg and diastolic BP by 25.826 mmHg (Becker et al., 2009).

Nursing implications

This finding provides information that hydrotherapy intervention can reduce the BP in hypertension with a temperature of 27-40^{o} C with depth to the xiphoid process. However, the exercise runs in warm water and water-based heating exercises, more effective in reducing BP, carried out three times a week, soaking for 60 minutes, with the most significant temperature, which is 32^{o} C and duration of the 12-week intervention. These findings can be introduced and applied by nurses as additional therapy to reduce BP in patients with hypertension. Even though the facilities and infrastructure in the hospital are still limited, not all hospitals can provide facilities in the form of hydrotherapy pools so that this intervention can be done in the patient's room using a basin that does not efficiently deliver heat and can be performed in the patient's room.

Limitations

Although the majority of the hydrotherapy interventions evaluated had a BP-lowering effect on hypertension, there were some limitations when evaluating the effectiveness of this intervention, such as no follow-up to ensure a more prolonged intervention effect; follow-up is needed to ensure the effectiveness of an intervention (Zuraida et al., 2021). There are still two studies with moderate risk of bias because they did not use blinds and did not evaluate the side effects of the given therapy. In addition, the type of hydrotherapy being reviewed is still heterogeneous, so it is hoped that further research will conduct more specific research on certain types of hydrotherapy however, in this systematic review, all articles used an RCT design. To the best of our knowledge, this is the first systematic review to evaluate the effect of hydrotherapy for lowering BP in Hypertension.

Conclusions

Hydrotherapy effectively reduces BP in hypertension patients and can be used as an additional therapy in hypertension management and taking antihypertensive drugs. It is recommended to use warm water, performed three times a week, 60 minutes of immersion, and the intervention duration of 12 weeks. However, further research is needed with better study quality and follow-up to confirm further the effectiveness of hydrotherapy intervention in lowering BP.

Acknowledgements: The authors appreciate the substantial contributions of everyone who participated in this study.

References

Abdullah, M., & Firmansyah, M. A. (2012). Critical appraisal on journal of clinical trials. *Acta Medica Indonesiana*, *44*(4), 337–343.

Arca, E. A., Martinelli, B., Martin, L. C., Waisberg, C. B., & Franco, R. J. da S. (2014). Aquatic exercise is as effective as dry land training to blood pressure reduction in postmenopausal hypertensive women. *Physiotherapy Research International*, *19*(2), 93–98. https://doi.org/10.1002/pri.1565

Åsa, C., Maria, S., Katharina, S. S., & Bert, A. (2012). Aquatic exercise is effective in improving exercise performance in patients with heart failure and type 2 diabetes mellitus. *Evidence-Based Complementary and Alternative Medicine*, *2012*. https://doi.org/10.1155/2012/349209

Bakar, A., Khusniyah, I. M., & Pratiwi, I. N. (2020). The effect of listening to asmaul husna, isometric handgrip exercise, and foot hydrotherapy intervention to reduce blood pressure in the elderly with hypertension. *International Journal of Psychosocial Rehabilitation*, *24*(9), 837–844.

Becker, B. E., Hildenbrand, K., Whitcomb, R. K., & Sanders, J. P. (2009). *Biophysiologic Effects of Warm Water Immersion*. 24–37.

Bocalini, D. S., Bergamin, M., Evangelista, A. L., Rica, R. L., Pontes, F. L., Figueira, A., Serra, A. J., Rossi, E. M., Tucci, P. J. F., & Dos Santos, L. (2017). Post-exercise hypotension and heart rate variability response after water- and landergometry exercise in hypertensive patients. *PLoS ONE*, *12*(6), 1–15. https://doi.org/10.1371/journal.pone.0180216

Brandt Eriksen, M., & Faber Frandsen, T. (2018). The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. *Journal of the Medical Library Association*, *106*(4), 420–431.

Caminiti, G., Volterrani, M., Marazzi, G., Cerrito, A., Massaro, R., Sposato, B., Arisi, A., & Rosano, G. (2011). Hydrotherapy added to endurance training versus endurance training alone in elderly patients with chronic heart failure: A randomized pilot study. *International Journal of Cardiology*, *148*(2), 199–203.

Centre for Evidence-Based Medicine (CEBM). (2011). *Oxford Centre for Evidence-Based*

Medicine 2011 Levels of Evidence (Vol. 3, Issue 12, pp. 1–3).

Critical Appraisal Skills Programme (CASP). (2020). Randomised Controlled Trial Standard Checklist. *CASP Checklists Oxford*, *September 2020*, 1–4.

de Barros Cruz, L. G., Bocchi, E. A., Grassi, G., & Guimaraes, G. V. (2017). Neurohumoral and endothelial responses to heated water-based exercise in resistant hypertensive patients. *Circulation Journal*, *81*(3), 339–345.

Forouzanfar, M. H., Liu, P., Roth, G. A., Ng, M., Biryukov, S., Marczak, L., Alexander, L., Estep, K., Abate, K. H., Akinyemiju, T. F., Ali, R., Alvis-Guzman, N., Azzopardi, P., Banerjee, A., Bärnighausen, T., Basu, A., Bekele, T., Bennett, D. A., Biadgilign, S., … Murray, C. J. L. (2017). Global burden of hypertension and systolic blood pressure of at least 110 to 115mmHg, 1990-2015. *JAMA - Journal of the American Medical Association*, *317*(2), 165–182.

Guimãraes, G. V., Fernandes-Silva, M. M., Drager, L. F., de Barros Cruz, L. G., Castro, R. E., Ciolac, E. G., & Bocchi, E. A. (2018). Hypotensive Effect of Heated Water-Based Exercise Persists After 12-Week Cessation of Training in Patients With Resistant Hypertension. *Canadian Journal of Cardiology*, *34*(12), 1641–1647.

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., Savović, J., Schulz, K. F., Weeks, L., & Sterne, J. A. C. (2011). c. *BMJ (Online)*, *343*(7829), 1–9. https://doi.org/10.1136/bmj.d5928

Higgins, J., Sterne, J., Savović, J., Page, M., Hrobjartsson, A., Bourton, I., Reeves, B., & Eldridge, S. (2016). A revised Cochrane risk of bias tool for randomized trials. *Cochrane Database of Systematic Reviews*, *1*(10), 1–52.

Igarashi, Y., & Nogami, Y. (2018). The effect of regular aquatic exercise on blood pressure: A meta-analysis of randomized controlled trials. *European Journal of Preventive Cardiology*, *25*(2), 190–199.

Irwan, A. M., Kato, M., Kitaoka, K., Ueno, E., Tsujiguchi, H., & Shogenji, M. (2016). Development of the salt-reduction and efficacy-maintenance program in Indonesia. *Nursing and Health Sciences*, *18*(4), 519–532.

Kabisch, M., Ruckes, C., Seibert-Grafe, M., & Blettner, M. (2011). Randomized Controlled Trials. *Deutsches Arzteblatt*, *108*(39), 663–668.

Kemenkes RI. (2019). Hipertensi Si Pembunuh Senyap. *Kementrian Kesehatan RI*, 1–5.

Kementerian Kesehatan RI. (2018). Laporan Hasil Riset Kesehatan Dasar (Riskesdas) Indonesia tahun 2018. In *Riset Kesehatan Dasar 2018* (pp. 182–183).

Lindquist, R., Synder, M., & Tracy, M. F. (2014). *Complementary & alternative therapies in nursing*. Springer.

Malibel, Y. A., Herwanti, E., & Djogo, H. . (2020). Pengaruh pemberian hidroterapi (rendam kaki air hangat) terhadap penurunan tekanan darah pada pasien hipertensi di wilayah kerja Puskesmas Sikumana Kota Kupang. *CHMK Health Journal*, *4*(1), 0–7.

Mehrholz, J., Kugler, J., & Pohl, M. (2011). Water-based exercises for improving activities of daily living after stroke. *Cochrane Database of Systematic Reviews*, *1*. https://doi.org/10.1002/14651858.cd008186.pub2

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., Gøtzsche, P. C., … Tugwell, P. (2014). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Revista Espanola de Nutricion Humana y Dietetica*, *18*(3), 172–181. https://doi.org/10.14306/renhyd.18.3.114

Ngomane, A. Y., Fernandes, B., Ciolac, E. G., & Bauru, C. (2019). *Hypotensive Effect of Heated Water-based Exercise in Older Individuals with Hypertension*.

Polit, Denise F., Beck, C. T. (2018). *Essentials of nursing research : appraising evidence for nursing practice / Denise F. Polit, Cheryl Tatano Beck.*

Presiden RI. (2014). Undang-Undang Republik Indonesia Nomor 38 tahun 2014. In *Presiden RI*.

Ruangthai, R., Phoemsapthawee, J., Makaje, N., & Phimphaphorn, P. (2020). Comparative e ff ects of water- and land-based combined exercise training in hypertensive older adults. *Archives of Gerontology and Geriatrics*, *90*(June), 104164. https://doi.org/10.1016/j.archger.2020.104164

Sitoresmi, H., Masyitha Irwan, A., Sjattar, E. L., & Usman, S. (2020). The effect of foot massage in lowering intradialytic blood pressure at Hemodialysis Unit in Indonesian Hospital. *Clinical Epidemiology and Global Health*, *8*(4), 1272–1276. https://doi.org/10.1016/j.cegh.2020.04.026

Smeltzer, suzanne C., & Bare, G, B. (2001). *Buku ajar keperawatan medikal-bedah brunner & Suddarth* (EGC (ed.); 8th ed.).

Torres-Ronda, L., & Schelling I Del Alcázar, X. (2014). The properties of water and their applications for training. *Journal of Human Kinetics*, *44*(1), 237–248. https://doi.org/10.2478/hukin-2014-0129

Unger, T., Borghi, C., Charchar, F., Khan, N. A.,

Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020). 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension*, *75*(6), 1334–1357.

Verhagen, A. P., Bierma-Zeinstra, S. M., Boers, M., Cardoso, J. R., Lambeck, J., De Bie, R., & De Vet, H. C. W. (2015). Balneotherapy (or spa therapy) for rheumatoid arthritis. An abridged version of Cochrane Systematic Review. *European Journal of Physical and Rehabilitation Medicine*, *51*(6), 833–847.

Zhou, B., Bentham, J., Di Cesare, M., Bixby, H., Danaei, G., Cowan, M. J., Paciorek, C. J., Singh, G., Hajifathalian, K., Bennett, J. E., Taddei, C., Bilano, V., Carrillo-Larco, R. M., Djalalinia, S., Khatibzadeh, S., Lugero, C., Peykari, N., Zhang, W. Z., Lu, Y., … Eggertsen, R. (2017). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. *The Lancet*, *389*(10064), 37–55.

Zuraida, E., Irwan, A. M., & Sjattar, E. L. (2021). Self-management education programs for patients with heart failure: A literature review. *Central European Journal of Nursing and Midwifery*, *12*(1), 279–294.