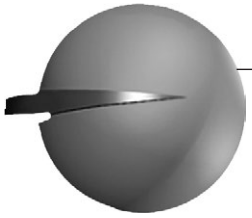

Evidence Review

Effectiveness of the Mindfulness-Based Stress Reduction Program on Blood Pressure: A Systematic Review of Literature

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Keywords
systematic review, mindfulness, mindfulness-based stress reduction, blood pressure, hypertension

ABSTRACT

Background: In spite of the advances in hypertension prevention and treatment, there is a high percentage of people with elevated or uncontrolled blood pressure. New patient-centered strategies are needed to support people managing their condition. A complementary behavioral treatment, the mindfulness-based stress reduction (MBSR) program, needs to be evaluated for its potential to reduce blood pressure.

Aims: To examine the literature on MBSR program effectiveness for blood pressure in adults with hypertension or elevated blood pressure.

Methods: A systematic literature review of randomized control trials reporting the effectiveness of the MBSR program on systolic and diastolic blood pressure in people with hypertension or elevated blood pressure, published between 2012 and 2017 was conducted. Five databases were searched (PubMed, EMBASE, Web of Science, PsycINFO, and Cochrane Library). Data extraction and risk-of-bias assessment were performed.

Results: A total of five articles were included in the review. Most studies found a reduction in systolic and diastolic blood pressure between the intervention and control groups; however, this reduction was only observed in clinical blood pressure (in office settings) and not in ambulatory blood pressure (in out-of-office settings) measurements. Analysis within intervention groups suggests that MBSR program reduces clinical blood pressure measurements. Even though these reductions in blood pressure may be of clinical relevance, the findings should be interpreted with caution in view of the lack of studies and study limitations.

Linking Evidence to Action: The MBSR program is a promising behavioral complementary therapy to help people with hypertension lower their blood pressure through modifications in their lifestyle. More research is needed not only to identify the effectiveness of the MBSR program on blood pressure, but also to explore the mechanisms by which the program influences blood pressure.

INTRODUCTION

Cardiovascular diseases are the leading cause of deaths due to noncommunicable diseases around the world (World Health Organization [WHO], 2014). High blood pressure is a main modifiable risk factor for the development of cardiovascular diseases. Reductions in blood pressure can decrease the risk of developing cardiovascular diseases and mortality. A recent meta-analysis showed that 10 mm Hg reduction in systolic blood pressure decreases the risk of major cardiovascular diseases events, such as myocardial infarction, sudden cardiac death, stroke, and heart failure by 20%, reducing at the same time all-cause mortality by 13% (Ettehad et al., 2016). Therefore, blood pressure control is important to prevent complications in people with blood pressure within the hypertension range (stage 1: 130–139/80–89 mm Hg and stage 2: ≥140/90 mm Hg hypertension) or to prevent the progression to hypertension in people with elevated blood pressure (120–129/<80 mm Hg; Whelton et al., 2018).

Pharmacological treatments, such as antihypertensive drugs, and lifestyle modifications, including sodium reduction in diet, physical activity, weight management, smoking cessation, among others, have been developed for blood pressure control. However, in spite of the advances in hypertension prevention and treatment, there is a high percentage of people with raised or uncontrolled blood pressure (Chow et al., 2013). Thus, new patient-centered strategies are needed to support people managing hypertension to reduce the impact of this risk factor on cardiovascular disease burden, mortality, and quality of life. Complementary behavioral treatments for blood pressure control, which are not a substitute for traditional treatment, can be evaluated for their potential to reduce blood pressure (Hughes et al., 2013; Williams, Simmons, & Tanabe,

Worldviews on Evidence-Based Nursing, 2018; 15:5, 344–352.

2015; Younge, Gotink, Baena, Roos-Hesselink, & Hunink, 2015). Mindfulness-based interventions may be one of those treatments supporting self-management in people with hypertension.

Mindfulness means paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally (Kabat-Zinn, 1994). Mindfulness has its origin in Buddhist contemplative traditions including meditation (Purser & Milillo, 2015) and has been described as a way of being or a conscious state, in which this dynamic process is practiced during the whole life, rather than a static technique (Cullen, 2011). Mindfulness, as a secular therapeutic intervention, was created by Dr. Jon Kabat-Zinn in 1979 at the University of Massachusetts Medical Center (Kabat-Zinn, 2013). The intervention called "mindfulness-based stress reduction program (MBSR)" was a pioneer in mindfulness-based interventions. The MBSR program has an educational focus, is person-centered, systematic, and well defined; this program uses a relatively intense training in mindfulness-based meditation to teach people how to self-manage to live a healthier and adaptive life (Santorelli, 2014).

The MBSR standards of practice indicate that there are several ways to structure and offer the program; however, it requires at least the use of the present moment as a base (Santorelli, 2014). Usually, the program consists of a weekly session for 8 weeks and includes formal practices (body scan meditation, sitting meditation, hatha yoga, and walking meditation) and informal practices (awareness of pleasant and unpleasant events, routine events, interpersonal communications, repetitive cognitions and emotions and their relationship to bodily sensations, and habitual actions and behaviors in everyday life; Santorelli, 2014).

Mindfulness-based stress reduction program has been growing in the last 30 years (Cullen, 2011) as complementary treatment to the traditional therapeutic strategies for people with different medical and psychiatric conditions (e.g., chronic diseases, depression, and anxiety; Bohlmeijer, Prenger, Taal, & Cuijpers, 2010; Crowe et al., 2016; Demarzo et al., 2015; Li, Yuan, & Zhang, 2016; Noordali, Cumming, & Thompson, 2015; Parswani, Sharma, & Iyengar, 2013; Zainal, Booth, & Huppert, 2013) and as a health promotion and disease prevention intervention in healthy individuals (Khoury, Sharma, Rush, & Fournier, 2015), demonstrating benefits in physical and psychological health.

The MBSR program may be an effective complementary therapy for people with chronic diseases, especially for blood pressure management. However, no systematic reviews or meta-analysis identifying the effectiveness of the MBSR program in reducing blood pressure in people diagnosed with hypertension were found in the literature yet. Thus, the aim of this systematic review was to evaluate the effectiveness of the MBSR program on blood pressure in adults diagnosed with hypertension.

METHODS

This systematic review evaluates the effectiveness of the MBSR program on blood pressure in randomized controlled trials. This review followed Cochrane guidelines (Higgins & Green, 2011). The PICO question guiding the information search was as follows: How effective is participation in a MBSR program on reducing systolic and diastolic blood pressure in people with hypertension?

Search Strategy

Peer-reviewed articles were searched from five databases: PubMed, EMBASE, Web of Science, PsycINFO, and Cochrane Library. The search of the literature included keywords (mindfulness-based stress reduction) and MeSH terms (Hypertension, Prehypertension, Mindfulness). The main strategy to search for articles within the five databases was to create clusters of search terms, one for the type of intervention (mindfulness-based stress reduction OR mindfulness) and another for the population (hypertension OR prehypertension) and the clusters were combined with AND; terms within each cluster were combined with OR. The search was adapted for each database.

Eligibility

Articles were screened for eligibility criteria based first on the title and abstract and then full text. Peer-reviewed articles were eligible if they met the following criteria:

Inclusion Criteria

- Study design: Randomized controlled trials.
- Population: Adults (≥18 years old) with blood pressure within the ranges of elevated blood pressure (120–129/<80), stage 1 hypertension (130–139/80–89 mm Hg) or stage 2 hypertension (≥140/90 mm Hg).
- Intervention: Interventions described as MBSR Interventions based on the program developed by John Kabat-Zinn.
- Comparison: The aim of this study was not to compare the MBSR with a specific type of intervention or standard care; thus, possible comparison groups may include other types of mindfulness-based interventions (i.e., mindfulness-based cognitive therapy) or standard care, wait-list, and other non-mindfulness-based interventions.
- Outcome: Systolic and diastolic blood pressure measured and reported at pretest and post-test.
- Language: Studies published in English and Spanish.
- Time: 2012–2017.

Exclusion Criteria

- Main intervention: short versions of the MBSR program or other mindfulness-based interventions not described as MBSR.
- Type of article: Published abstracts without full article.

Data Extraction

Data from the articles selected after the assessment of eligibility criteria were extracted following the recommendations of the Cochrane Collaboration and included specific details about the study methods, characteristic of population, the intervention and control group, outcomes, and findings of interest (see Table S1).

Risk of Bias and Study Quality

The risk of bias was determined using the Cochrane Collaboration's tool for assessing the risk of bias, which includes random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias), and other issues (Higgins & Green, 2011). The risk of bias was classified as low, unclear, or high (see Figure S1).

RESULTS

Search Outcome

A total of 87 articles were retrieved in the initial search. After duplicates were removed, 53 articles were screened based on title and abstract; 16 full texts were retrieved for a closer assessment. After applying eligibility criteria, a total of five articles met the criteria for inclusion in the final review. The search outcome and reasons for exclusion are outlined in Figure 1.

Study characteristics. The characteristics and findings of the five studies included in this review (Blom et al., 2014; Hughes et al., 2013; Momeni, Omidi, Raygan, & Akbari, 2016; Nejati, Afrookhteh, Rahmani, & Hoveida, 2015; Palta

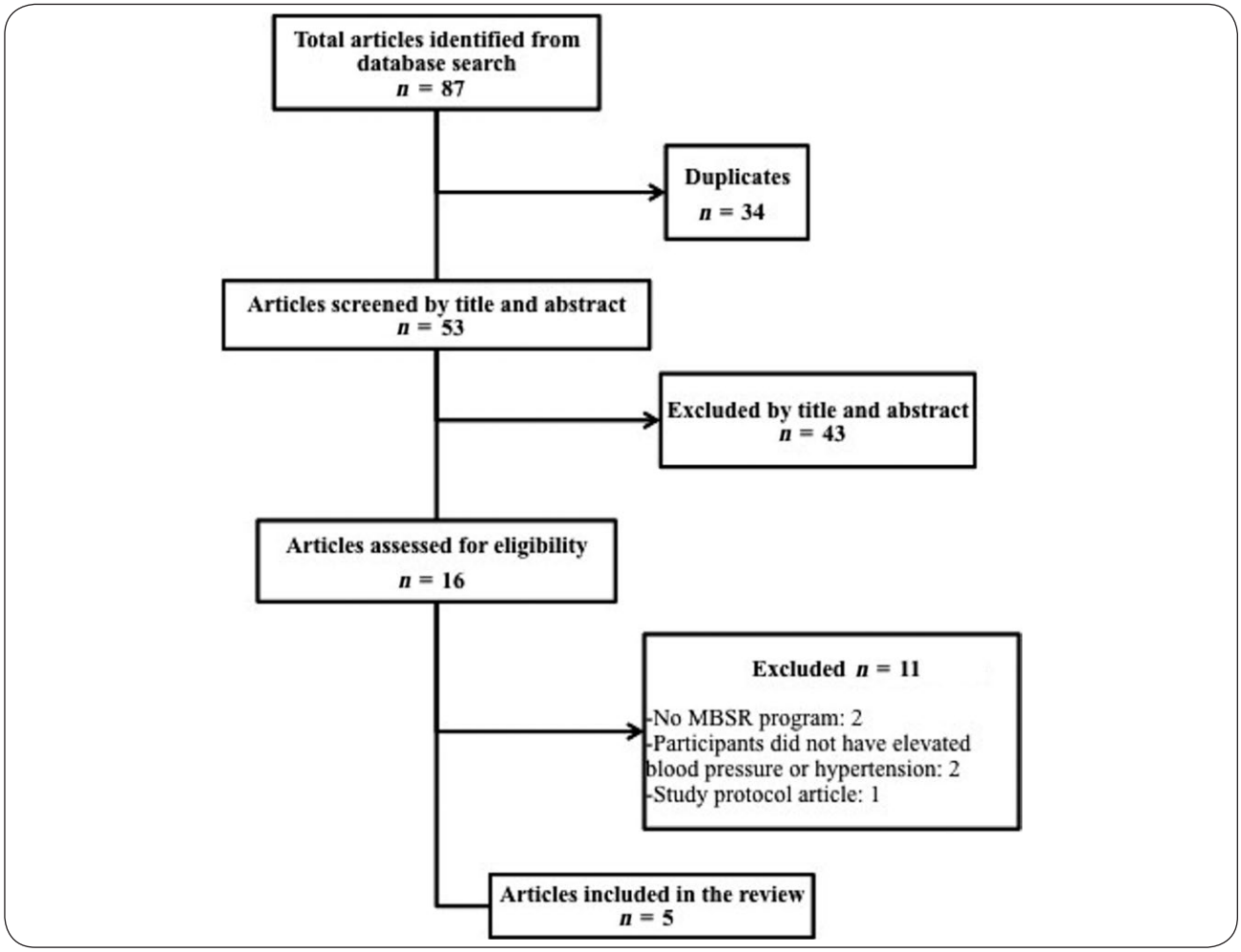

Figure 1. Flow diagram of article selection.

Worldviews on Evidence-Based Nursing, 2018; 15:5, 344–352.

et al., 2012) are summarized in Table S1. All studies were randomized control trials; of them, two were pilot studies (Hughes et al., 2013; Palta et al., 2012). All studies measured blood pressure in pre- and post-test, with a variety of control groups. Articles were published between 2012 and 2016; and two studies were conducted in the United States, two in Iran, and one in Canada.

Risk of bias. The risk of bias is displayed in Figure S1. Based on the Cochrane Collaboration's tool for assessing the risk of bias, most studies had unclear or low risk of bias. In three studies, there is insufficient information to allow judgment. Overall, two studies demonstrated high-quality research due to the detailed explanation of the study protocol (Blom et al., 2014; Hughes et al., 2013).

Sample characteristics. Total sample sizes varied among the studies: 20 and 56 participants in the pilot studies and 30, 60, and 101 participants in the full studies, which used statistical methods to determine sample sizes such as power analysis and Cohen's formula. In total, 267 individuals participated in the studies, and of them, 131 people were in the intervention groups. The number of men and women was balanced across the studies. Some articles identified the number of subjects assessed for eligibility to be able recruit the expected sample size: 483 (Blom et al., 2014), 248 (Hughes et al., 2013), and 103 (Momeni et al., 2016).

Three studies reported attrition; Momeni et al. (2016) had 5% attrition within the whole sample, the three participants that dropped out were no longer interested or had health problem; Blom et al. (2014) reported a 14% attrition within the whole sample and 8% in the MBSR intervention because they were lost to follow-up or dropped out in the post-test, and a 28% in the 12-week follow-up due to complications, change in treatment, or lost to follow-up. At last, Hughes et al. (2013) had 32% attrition within the whole sample, specifically 25% of the participants in the intervention group did not finish the post-test assessment because participants did not start the intervention or dropped out.

Sample characteristics varied across studies. Participants' age ranged between 20 and 75 years old; one study included exclusively older adults (≥62 years old; Palta et al., 2012). Screening protocols used to determine eligibility in terms of blood pressure level varied across studies. In general, the studies used two major types of blood pressure measurements: clinical blood pressure measurement, which takes place in office settings, and ambulatory blood pressure measurement, which takes place in out-of-office settings. Blom et al. (2014) screened potential participants based on clinical and ambulatory blood pressure measurements, and established blood pressure ranges to be included in the study (mean awake ambulatory systolic or diastolic BP ≥135/85 mm Hg or mean 24-hr ambulatory BP ≥130/80 mm Hg, but no more than 160/100 on both clinical and ambulatory blood pressure measurements). Hughes et al. (2013) selected eligible participants with a three-stage clinical blood pressure screening: an initial screening, followed by a second screening a week later, and then a third screening 2 weeks after the baseline screening. Blood pressure ranges for inclusion in the study were established (SBP 120–139 mm Hg or DBP 80–89 mm Hg). Momeni et al. (2016) determined the diagnosis of hypertension via medical history and physical examination by a cardiologist. Nejati et al. (2015) indicated potential participants required a diagnosis of hypertension or a blood pressure >130/80, but did not provide more detail about the screening protocol. Palta et al. (2012) did not include a blood pressure screening for eligibility to participate in the study; however, 90% of the sample were on antihypertensive medications.

Three studies excluded people with hypertension-related complications (e.g., renal disease, myocardial infarction, or comorbidities such as diabetes; Hughes et al., 2013; Momeni et al., 2016; Nejati et al., 2015). Furthermore, in two studies participants were excluded if the individual was undergoing pharmacological treatment with antihypertensive drugs (Blom et al., 2014; Hughes et al., 2013), whereas three studies included participants undergoing pharmacological treatment (Momeni et al., 2016; Nejati et al., 2015; Palta et al., 2012).

Intervention and control groups. The intervention provided in the studies was homogeneous; all studies applied for the MBSR program following the basic guidelines of the program created by John Kabat-Zinn. The duration of the program was a weekly session for 8 weeks, and the duration of each session was between 1 hr 30 min and 2 hr 30 min. All studies applied basic elements of the original program, including formal mindfulness techniques such as body scanning, yoga, meditation, and informal mindfulness techniques, such as awareness of breath, thoughts, or emotions. Some studies included homework for the participants to continue doing mindful practices at home (Blom et al., 2014; Hughes et al., 2013; Momeni et al., 2016; Palta et al., 2012), and one study included a silence retreat (Blom et al., 2014). Moreover, most studies hired therapists trained specifically in the MBSR program to facilitate the sessions (Blom et al., 2014; Hughes et al., 2013; Momeni et al., 2016; Palta et al., 2012).

The types of control groups used in the studies were heterogeneous; some studies selected passive control groups such as wait-list (Blom et al., 2014; Momeni et al., 2016) or no treatment (Nejati et al., 2015), whereas other studies selected active control groups such as social support (Palta et al., 2012) and progressive muscle relaxation (Hughes et al., 2013). None of the active controls groups had components of mindfulness, although the active control groups were designed to have a similar duration as the intervention groups.

Blood pressure measurement. Blood pressure measurements at pre- and post-test varied among the studies. Two studies measured blood pressure in the clinical setting only. Palta et al. (2012) acquired blood pressure readings using an automated electronic device, whereas Momeni et al. (2016) used both the auscultatory method and an automated oscillometric device to measure blood pressure. On the contrary, Blom et al. (2014) measured only ambulatory blood pressure and Hughes et al. (2013) measured both clinical (using an electronic device) and ambulatory blood pressure. Most studies used an established protocol for blood pressure measurement. Nejati et al. (2015) was the only study that did not specify the type of either blood pressure measurement or the protocol they used.

For clinical blood pressure, the mean of two or three measurements was used to determine the final blood pressure at pre- and post-test. For ambulatory blood pressure (awake and nighttime blood pressure), researchers took measurements every 15 min or 1 hr during awake hours (between 6 a.m. or 7 a.m. to 11 p.m.) and every hour or 30 min at nighttime (11 p.m. to 6 a.m. or 7 a.m.), using an electronic device. The mean of all readings was used as final outcome.

Effect of the MBSR Program on Blood Pressure

Between-group analysis. Studies exploring the effectiveness of the MBSR program on blood pressure showed mixed results. Between-groups analysis showed that studies reporting clinical blood pressure had significant reductions on blood pressure from pre- to post-test between intervention and control groups (Hughes et al., 2013; Momeni et al., 2016; Nejati et al., 2015; Palta et al., 2012). On the contrary, studies reporting ambulatory blood pressure did not show significant differences either in systolic or diastolic blood pressure between the intervention and control groups from pre- to post-test (Blom et al., 2014; Hughes et al., 2013).

Within-group analysis. Within-intervention group analysis showed clinically significant reductions in blood pressure in most studies (see Table S2). Using descriptive mean difference of blood pressure from pre- to post-test, researchers found reductions from 11 to 16.56 mm Hg in clinical systolic blood pressure and from 1.66 to 4.44 mm Hg in clinical diastolic blood pressure. Moreover, using different inferential statistical tests, researchers found reductions from pre- to post-test from 4.9 to 21.9 mm Hg in clinical systolic blood pressure and from 0.7 to 16.7 mm Hg in diastolic blood pressure.

DISCUSSION

The aim of this study was to determine the effectiveness of the MBSR program on blood pressure in adults with elevated blood pressure and hypertension. Findings from this review show lack of research regarding MBSR interventions in people with these cardiovascular risk factors.

From the few articles reviewed, most studies found the intervention group had more reductions in systolic and diastolic blood pressure than control groups; however, this reduction was only observed in clinical and not in ambulatory blood pressure. Moreover, within-group analysis suggests that the MBSR program reduces clinical blood pressure in the intervention group from pre- to post-test, and those reductions may be of clinical relevance.

Even though the mechanisms by which participation in a MBSR program reduces blood pressure are not well established yet, there are some hypotheses that may offer explanations for this association. Shapiro, Carlson, Astin, and Freedman (2006) proposed a theory of the underlying mechanisms of action of mindfulness-based interventions that affects positive change, which is based on the work of Kabat-Zinn. The theory proposes three axioms that are important for a mindful experience: intention, attention, and attitude. Intentionally attending with openness and nonjudgmentalness leads to a shift in perspective (reperceiving) of the present moment experience, which may lead to positive outcomes, among others self-regulation, self-management, and emotional, cognitive, and behavioral flexibility. These outcomes are key components of chronic disease self-management that may have an effect on blood pressure control. There are some empirical studies supporting this hypothesis; mindfulness has been linked with emotional regulation (Carmody, Baer, LB Lykins, & Olendzki, 2009; Chiesa, Serretti, & Jakobsen, 2013; Goldin & Gross, 2010; Hülsheger, Alberts, Feinholdt, & Lang, 2013; Lutz et al., 2014; Robins, Keng, Ekblad, & Brantley, 2012; Teper, Segal, & Inzlicht, 2013), self-monitoring of activities of daily living, and the decision-making process (Black, Sussman, Johnson, & Milam, 2012; Croskerry, 2013; Hughes et al., 2013; Nejati et al., 2015; Reynolds, Lin, Zhou, & Consedine, 2015; Shapiro, Jazaieri, & Goldin, 2012). These skills may have the potential to positively influence people's efforts to modify their lifestyle and to improve treatment adherence. Moreover, mindfulness helps with the management of stress and anxiety (Baer, Carmody, & Hunsinger, 2012; Garland, Tamagawa, Todd, Speca, & Carlson, 2013; Vøllestad, Sivertsen, & Nielsen, 2011), through a reduction in the activation of the sympathetic nervous system in stressful situations and then reducing blood pressure (Hughes et al., 2013; Nejati et al., 2015).

To our knowledge, this is the first systematic review about MBSR and blood pressure in people with hypertension. However, a systematic review and meta-analysis of stress reduction programs in people with elevated blood pressure found that only an intervention with meditation practices (transcendental meditation) showed clinically and statistically significant changes in blood pressure

Worldviews on Evidence-Based Nursing, 2018; 15:5, 344–352.

(−5.0/−2.8 mm Hg; Rainforth et al., 2007). Another systematic review of lifestyle interventions to reduce raised blood pressure found that cognitive and behavioral interventions promoting relaxation and stress management significantly reduced blood pressure only when relaxation interventions were compared with nonintervention control (Dickinson et al., 2006). However, MBSR was not part of these reviews.

Limitations

The findings of this systematic review should be interpreted with caution in view of several limitations such as the small number of studies, low research quality, incomplete reporting, or methodological issues. There were several methodological limitations in the included studies. First, studies measured blood pressure for screening purposes used different protocols and methods. Only two studies explained in detail the screening protocol used to determine eligibility for the study; of them, one study screened both clinical and ambulatory blood pressure (Blom et al., 2014) and the other one screened only clinical blood pressure (Hughes et al., 2013). Second, most studies measured clinical blood pressure at pre- and post-test and only two studies measured ambulatory blood pressure. However, recent studies indicate significant differences between clinical and ambulatory blood pressure, suggesting that ambulatory blood pressure may be a better indicator of the actual blood pressure of the individual (Mancia & Verdecchia, 2015; Redon & Lurbe, 2014; Turner, Viera, & Shimbo, 2015). Third, sample sizes were small and sample characteristics were heterogeneous, for example, the presence or the absence of comorbidities, complications, or pharmacological treatment. For example, the presence of antihypertensive medications and individuals' medication adherence may be directly influencing blood pressure. Fourth, only one study included a 2-month follow-up; thus, the long-term effects of the MBSR program on blood pressure are still unknown. At last, the variety of controls group types limited the analysis of between-group analyses.

In addition, none of the studies addressed the cost-effectiveness of this type of intervention. The economic implications of a behavioral intervention should be considered to effectively implement this program in clinical settings if it is found to be beneficial for the management of chronic disease patients.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Mindfulness-based stress reduction programs may be effective as a behavioral complementary therapy for clinical blood pressure control; however, to establish its effectiveness on blood pressure, it is necessary to conduct more well-rounded, high-quality, experimental research. Thus, for clinical practice, this research offers preliminary evidence of an established standardized mindfulness-based program such as the MBSR program on people with raised blood pressure.

Limitations found in this review may be solved in future research to provide high-quality evidence on this topic. Future research requires exploring the underlying mechanisms by which the MBSR program may be influencing blood pressure, and explorations of potential mediators and moderators of this relationship are needed.

Also, other delivery methods of the MBSR program such as mHealth strategies should be considered in the future in order to provide cheaper and accessible mindfulness-based interventions. Furthermore, future research may also explore whether mindfulness is associated with self-regulation skills and self-management behaviors such as treatment adherence that are known to be linked with the modification of cardiovascular risk factors.

CONCLUSIONS

Despite the limited evidence, preliminary findings of the effectiveness of MBSR program on blood pressure in people with cardiovascular risk factors such as elevated blood pressure or hypertension reveal this intervention as a promising behavioral complementary therapy to assist people in need to lower their blood pressure through modifications in their lifestyle. More research is needed not only to determine the effectiveness of the mindfulness-based stress reduction program on blood pressure but also to explore the mechanisms by which the program influences blood pressure. **WVN**

LINKING EVIDENCE TO ACTION

- There is insufficient evidence to determine the effectiveness of the MBSR program on blood pressure; therefore, more RCTs on this topic are needed.
- Within-intervention group preliminary changes suggest that MBSR program may be a promising complementary practice for people with high blood pressure.
- The standardization of blood pressure measurement protocol in mindfulness-based approaches is required for researchers to determine the effect size of this intervention on blood pressure and enhance generalizability of the findings.
- Explorations of the underlying mechanisms (mediators and moderators) by which the MBSR program may be influencing blood pressure are needed.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web site:

Table S1. Characteristics of included articles.
Table S2. Within intervention group analysis of blood pressure reductions.
Figure S1. Risk of bias summary based on the Cochrane collaboration's tool for assessing the risk of bias.

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