EFFECTS OF A SLOW-DEEP BREATHING PROTOCOL ON LOWERING BLOOD PRESSURE: A RAPID REVIEW

Amanda Gravholt
EFFECTS OF A SLOW-DEEP BREATHING PROTOCOL ON LOWERING BLOOD PRESSURE: A RAPID REVIEW

by

Amanda Gravholt

A Thesis Submitted in Partial Fulfillment
Of the Requirements for the
University Honors Program

Department of Nursing
The University of South Dakota
May 2021
The members of the Honors Thesis Committee appointed
to examine the thesis of Amanda Gravholt

find it satisfactory and recommend that it be accepted.

__________________________
Sabina Kupershmidt, Ph.D.
Interim Director, Ph.D. in HSC IHEC Chair
Assistant Professor, Nursing
Director of the Committee

__________________________
Robyn Rentschler, MSN, RN
USD Nursing Faculty

__________________________
Heidi Waters, MSN, RN
USD Nursing Faculty

Abstract

Background

Hypertension is a major contributor to high rates of mortality in the United States and around the world. At the same time, the cost of pharmaceuticals continues to increase, and pharmacological noncompliance grows. There is a growing interest in the efficacy of alternative or integrative methods in lowering blood pressure. Regulated, slow deep breathing has been shown to have beneficial effects on blood pressures.

Objectives

The overarching goal of this study was to identify a non-pharmacological, easy to learn method that could be followed by patients in the home setting to control blood pressures. The target population was adults with hypertension. The intervention was a slow deep-breathing protocol or similar variants. The comparison intervention was either pharmacologic treatment or placebo (e.g., simple breathing exercise). The desired outcome was lowered blood pressure. The time frame was left open to see what studies have been completed, both short term and long term. This review set out to find what studies have been done to answer this question: In adults with
hypertension, how does a slow deep-breathing protocol or a similar variant compared with pharmacologic treatment or placebo affect hypertension?

Data Sources

PubMed Central (December 2015 to December 2020) and CINAHLComplete (via EBSCOhost) (December 2015 to December 2020).

Study Eligibility Criteria, Participants, and Interventions

Published articles relating to blood pressure in which a slow-deep breathing intervention was utilized were included in this review. Terms used in place of slow-deep breathing could be “breathing exercises” or “paced breathing”. To be included, the articles were required to be peer-reviewed and in the English language.

Study Appraisal & Synthesis Methods

The evidence was synthesized by being placed in seven categories: 1. Support implementation of a slow deep-breathing protocol to reduce blood pressures; 2. Support the implementation but contingent upon further research; 3. Do not support the implementation based on current data but are hopeful for implementation after further studies performed; 4. Do not support the implementation of a protocol or any similar variants; 5. Are hesitant on the implementation; 6. Support an acute protocol, but not long-term; 7. Results are inconclusive.

Results & Limitations

The review found 846 papers, which was reduced to 29 after screening and relevance checks (Diagram 1 for detailed analysis).
Conclusions and Implications of Key Findings

A slow-deep breathing protocol appears to reduce blood pressure in adults with hypertension in the short term. More research is necessary to determine the effects of slow-deep breathing’s effect on blood pressure long term.

No review registration number

Introduction

Rationale

Preliminary reports in the literature have indicated that slow deep breathing can be used to regulate blood pressures. However, protocols vary widely and many of the studies were subject to confounding variables that include lifestyle alterations. With this study, an attempt was made to isolate the effects of slow deep breathing from other influences and to define a minimal, standardized breathing protocol.

Objectives

We examined the published literature to answer this PICOT question: In adults with hypertension, how does a slow deep-breathing protocol or a similar variant compared with pharmacologic treatment affect hypertension?

Definition of Terms
Prehypertension (Stage 1 Hypertension): a systolic blood pressure of 130-139 mmHg or a diastolic of 80-89 mmHg

Hypertension (Stage 2): systolic of greater than or equal to 140 mmHg and a diastolic of greater than or equal to 90 mmHg

Loaded Breathing: the imposition of “a workload on the inspiratory muscles, maintains a constant load during inspiration” (Myrrha, Vieira, et al., 2013)

Baseline BP: the BP reading taken during the introductory/consent session

Pre/post BP: the BP reading taken before each breathing protocol and immediately after.

Nonpharmacological: any non-drug treatment used in the treatment of disease processes

Pharmacological: any drug treatment used in the treatment of disease processes

Methods

Protocol and registration

N/A

Eligibility criteria

- Published in peer reviewed journals
- English Language
- Empirical studies utilizing qualitative, quantitative, or mixed methods approaches
- Review articles
- Accessible to students through the USD Library resources as full text

Information sources
A rapid review of articles using PubMed Central (December 2015 to December 2020) and CINAHL Complete (via EBSCOhost) (December 2015 to December 2020).

**Search**

**PubMed:**

(("hypertense"[All Fields] OR "hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR "hypertension s"[All Fields] OR "hypertensions"[All Fields] OR "hypertensive"[All Fields] OR "hypertensive s"[All Fields] OR "hypertensives"[All Fields]) AND ("deep breathing"[All Fields] OR ("breathing exercises"[MeSH Terms] OR "breathing exercises"[All Fields]) OR "paced breathing"[All Fields] OR ("slow-deep breathing") OR ("Pranayama")))=325 Results

Published Last 5 years= 71 Results

Full Text Available: 66 Results


Screening of Titles and Abstracts for Relevance= 21 Results

**CINAHL Complete:**
[searched December 2015, through December 2020]

Search Strategy: hypertension or high blood pressure or elevated blood pressure or htn or hypertensive; "Deep breathing" OR "Breathing Exercises" OR "Paced Breathing"; Full Text Available; all Adults; Major Heading: Hypertension= 521 Results

Inclusion/Exclusion Criteria: English Language or Translated; Published Within Past 5 Years; Peer-Reviewed; PubMed Exclusion Terms Above

Results: 12

Combined CINAHL and PubMed Results (Duplicates Removed (4)) = 29 Results

**Study selection**

The selection of the studies occurred according to the exclusion and inclusion principles listed above. Empirical studies, as well as review articles were included.

Each paper that met the inclusion criteria was read in full; the subthemes were identified and categorized according to the “Study Appraisal & Synthesis Methods” section (see pg. ii).

**Data collection process**

The review author assessed studies for inclusion, extracted the data, and entered the data into Table 1. A librarian assisted with search terms, MeSH terms and navigating the databases.

**Data items**

To classify the levels of hierarchy in the second column of the table, the Johns-Hopkins Nursing EBP of classification was applied. Level I is defined as high quality, RCT. Level II is “good quality” and includes quasi-experimental studies or systematic reviews of a combination of RCT and quasi-experimental studies. Level III includes non-experimental studies and systematic
reviews of RCT, quasi-experimental studies, and non-experimental studies. Level IV includes opinions of respected authorities or committees. Level V includes literatures reviews and case reports.

**Summary measures**
Data were summarized based on decisions made by analyzing results that pertained to deep breathing exercises and their effects on blood pressures. The articles were then categorized according to their impressions on approval for implementation of the deep-breathing practices for lowering blood pressure (see objectives).

**Synthesis of results**
Each study was reviewed to determine if it fully supported the implementation of, supported the implementation after further studies, or did not support the implementation of slow-deep breathing as a non-pharmacological treatment for hypertension or the prevention of hypertension.

**Risk of bias across studies**
1. Publication bias – only studies with significant findings are often published
2. RCTs- highest quality level is often underrepresented
3. Quality of studies: See Table 1 for level of evidence
4. Population bias – studies focus on adults over age 50
Results

Diagram 1
Study Selection Flow Diagram

Study selection


For more information, visit: http://www.prisma-statement.org
<table>
<thead>
<tr>
<th>Reference</th>
<th>Evident Level/Study Design</th>
<th>Study Aim</th>
<th>Setup and Outcomes Assessed</th>
<th>Results</th>
<th>Authors’ Conclusions</th>
</tr>
</thead>
</table>
| (Benjarat, Chule et al. 2016) CINA HL       | Level I/Double Blind Randomized Controlled Trial | “Investigated whether slow breathing training, with and without an inspiratory load, could reduce the resting blood pressure of older well-managed ISH patients.” | Prospective Randomized Control Trial  
“Thirty ISH patients (66 T 4 yr) were randomized into loaded breathing (six breaths per min, 18 cm H2O), unloaded breathing (six breaths per min, no load), or control (normal breathing) groups. After a 2-wk run-in, loaded and unloaded groups trained at home for 30 min every day for 8 wk. Morning home blood pressure and heart rate were measured daily throughout the” | “Within-group analysis showed the loaded group to differ significantly from pretraining run-in from weeks 6 to 14 (P < 0.035) and for the unloaded group from weeks 4 to 10 with the maximum reduction occurring after the full 8 wk of training, amounting to 18 T 7 (95% confidence interval [CI] = j13 to j22) and 11 T 4 (95%CI = j9 to j13) mm Hg for the loaded and unloaded groups, respectively. Post hoc analysis showed significant” | “We found [breathing training] to significantly reduce systolic and pulse pressure even in patients who were apparently well managed with conventional medication. The reductions were greatest when using loaded breathing, and the benefits after loaded breathing training were sustained for 6 wk after the end of training.” |
<table>
<thead>
<tr>
<th>Study Title</th>
<th>Database</th>
<th>Evidence Level</th>
<th>Objective</th>
<th>Methodology</th>
<th>Findings/Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Brandani, Mizuno, et al., 2017)</td>
<td>CINAHL &amp; PubMed</td>
<td>Level I/ Systematic Review</td>
<td>To evaluate the effect of pranayama (Yoga's breathing exercises) on BP and its applicability in the treatment of hypertension</td>
<td>“Thirteen trials, assessing acute (eight studies) and chronic (five studies) BP response to pranayama were included”</td>
<td>“Significant BP reductions after pranayama were found in both acute (2-10 mmHg mean SBP reduction, N = 5 studies; 1 mmHg mean DBP reduction, N = 1 study) and chronic studies (4-21 mmHg mean SBP reduction, N = 3 studies; 4-7 mmHg mean DBP reduction, N = 2 studies)”</td>
</tr>
<tr>
<td>(Bremer, LeBlang et)</td>
<td>Level V/ Literature Review</td>
<td>To determine if “mindfulness with paced breathing”</td>
<td>“eligible and willing subjects would be assigned at This article did not consist of actual trials, but was rather a hypothesis of “The hypothesis that mindfulness with paced...”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Study: At the end of training, all participants reverted to normal breathing, and blood pressure and heart rate were recorded for a further 8 wk. Differences between loaded and unloaded groups at weeks 7 (P = 0.049), 8 (P = 0.02), and 9–14 (P = 0.014).”

Interventions with slow and alternate pranayamas appear to be effective to reduce blood pressure in normal and hypertensive patients. However, the evidence must be regarded as preliminary...Methodological improvements are required so that we can get reliable results and to earning potential for the inclusion of pranayamas as a complement to pharmacologic treatment.”
<table>
<thead>
<tr>
<th>Study</th>
<th>Level</th>
<th>Design</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>al. 2020) CINA HL</td>
<td></td>
<td>decreases BP.</td>
<td>random to mindfulness with paced breathing or mindfulness without paced breathing. In this trial, the primary outcome would be BP reduction... “An adequate test of the hypothesis that mindfulness with paced breathing reduces BP requires a sample size of about 400 to achieve 90% power.”</td>
</tr>
<tr>
<td>(Catella and Mercè 2019) CINA HL</td>
<td>Level I/ Randomized Controlled Trial</td>
<td>“To verify the effect of learned diaphragmatic breathing on cardiac autonomic function in elderly with Mild to Moderate Isolated Systolic Hypertension (MMS).”</td>
<td>“Vital signs were collected in 22 elderly (76.36 ± 7.93 years old, 13 women); 13 with optimal to Normal High Blood Pressure (ONH group) and 9 with MMS, in the supine position, during 6 min in each of two “in B [normal pace breath], MMS group had significantly higher Diastolic Pressure (DP), but in D [slow paced learned breath] no significant difference was found between groups. Also, compared to B, in D MMS group significantly “Results of this study support the hypothesis that an easily learned diaphragmatic breathing technique, inexpensive and non-intrusive, can help elderly with isolated systolic hypertension, to remediate its effects on vital signs.”</td>
</tr>
<tr>
<td>(Jiménez-Rodríguez, Conea-Garcéán et al. 2019)</td>
<td>CINA HL</td>
<td>Level II/Quasi-Experimental Study</td>
<td>&quot;To evaluate whether the application of a relaxation therapy reduces the blood pressure in hypertensive patients and whether there is improvement in several parameters which can influence blood pressure such as anxiety, quality of life and sleep.&quot;</td>
</tr>
<tr>
<td>(Lokesh and Sudhanna 2017) CINAH HL</td>
<td>Level I Experimental Study</td>
<td>To determine if “progressive resisted exercise lowers the blood pressure.”</td>
<td>“Experimental study design.” “The 20 hypertensive subjects were selected and explained about the study... The parameters such as blood pressure, respiratory rate, pulse rate, spo2 level were measured before and after the test and noted. “Macqueen’s technique of progressive resisted exercise showed statistically significant improvement in resting blood pressure values at the end of 4th week compared to baseline values (Group I). Macqueen’s technique of progressive resisted exercise with breathing control technique showed statistically improvement in resting blood pressure values at the end of 4th week compared to baseline values (Group II).” “We can conclude that hypertension can be reduced by using Macqueen’s progressive resisted exercise and breathing control training.”</td>
</tr>
<tr>
<td>(Misra, Smith) Level I Randomized</td>
<td>“Our objective was to determine “Eligible participants were “Intervention participants were “In this RCT, statistically significant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Intervention</td>
<td>Results</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>CINA HL</td>
<td>Controll ed Trial</td>
<td>whether 15 min yogic breathing exercises practiced 5 times a week can lower blood pressure in uncontrolled hypertensive patients”</td>
<td>randomly assigned to in-class instruction (n = 44), DVD/YouTub e group (n = 57), or control (n = 32).”</td>
</tr>
<tr>
<td>(Shetty, Reddy B et al. 2017)</td>
<td>Level 1/ Randomized Controll ed Trial</td>
<td>“The study aimed to measure the effects of Sheetali and Sheetkari pranayamas on BP, the autonomic nervous system, and respiratory</td>
<td>“The study was a randomized controlled clinical trial with pre- and postinterventio n evaluations following the 30-day study.”</td>
</tr>
</tbody>
</table>

xv
<p>| (Spies shoeferrer, Becker et al. 2019) | functions among hypertensive participants. | “Participants were randomly assigned either to an intervention group (n = 30) or wait-list control groups (n = 30). The intervention included 2 types of pranayama breath practices (ie, Sheetali and Sheetkari) each practiced for 10 min/d...BP and autonomic and respiratory functions were measured at baseline and postintervention.” | “In PAH patients, voluntary hyperventilation led to a 15% decrease in the high-frequency component of HRV (p &lt; 0.05) and a 5% increase in CI (p &lt; 0.05).” |
| CINAH HL | Level I/Randomized Controlled Trial | “To investigate the effects of voluntary hyperventilation and simulated PB [periodic breathing] on hemodynamics and SVB [sympathovagal balance] in healthy subjects, in patients with...” | “Simulated PB [periodic breathing] had positive effects on SVB [sympathovagal balance] in healthy volunteers but neutral effects on SVB and hemodynamics in patients with HF or PAH” |</p>
<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Description</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I/Randomized Controlled Trial</td>
<td>“The primary outcome of the study is to determine the effect of <em>Sheetali</em> pranayama (Cooling) on cardiac autonomic functions using heart rate variability (HRV). The secondary outcome is to find impact of <em>Sheetali</em> pranayama on resting blood pressure variables.”</td>
<td>“The current study was conducted on 100 patients with HTN, randomly allocated to HTN with pranayama (Intervention group, n = 50) and HTN without pranayama (control group, n = 50) group. The intervention group practiced <em>Sheetali</em> pranayama for a period of 3 months. Blood pressure and HRV was assessed before and after the intervention.”</td>
</tr>
<tr>
<td>CINA HL &amp; PubMed</td>
<td>(Thanalkshmi, Maheshkumar et al. 2020)</td>
<td>“Intervention group showed a significant (P &lt; 0.05) reduction in blood pressure variables when compared to the control group.”</td>
</tr>
</tbody>
</table>

*Sheetali* pranayama significantly reduces blood pressure in patients with HTN and improved heart rate variability. *Sheetali* pranayama could thus be practiced in addition to regular medications for the efficacious management of HTN.”
<table>
<thead>
<tr>
<th>Study</th>
<th>Level I/Randomized Controlled Trial</th>
<th>Purpose</th>
<th>Findings</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Ubolsakka-Jones, Tongde et al. 2019)</td>
<td>To determine whether [slow loaded breathing training] also reduces their exaggerated BP responses to exercise.</td>
<td>“The study was a randomized controlled trial with block allocation stratified by sex. Twenty ISH patients (68 ± 5 yrs, 11 males) were randomized with one group undertaking 8-weeks training with slow loaded breathing (SLB: 25% maximum inspiratory pressure, 6 breaths per minute, 60 breaths every day) or deep breathing control (CON), with 8 weeks follow-up. Outcome measures were home BP and heart rate (HR) with laboratory measures of BP and HR responses to static handgrip and dynamic arm cranking exercise.”</td>
<td>“Home systolic BP fell by 22 mmHg (20–23; mean, 95% CI), diastolic BP by 9 mmHg (7–11), and HR by 12 bpm (9–15; all p &lt; .001) as a result of SLB training.”</td>
<td>“The results reported here show that 8 weeks of SLB training not only reduced resting BP and HR but also the responses to both static and dynamic exercise. Moreover, significant reductions in resting sBP and PP remained 8 weeks after the end of training, and the attenuated response to exercise was still evident 4 weeks after training...If SLB were to be widely used in conjunction with conventional drug therapy, it could result in considerable savings in the cost of health care for an aging population.”</td>
</tr>
<tr>
<td>Reference</td>
<td>Study Aim</td>
<td>Setup and Outcomes Assessed</td>
<td>Results</td>
<td>Authors’ Conclusions</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td>-----------------------------</td>
<td>---------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Cerne...</td>
<td>Level III / Systematic Review of a combination of RCTs and quasi-experimental, or quasi-experimental studies only</td>
<td>Review the literature</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Hama...</td>
<td>Level II/ Systematic Review of RCTs and Systematic Reviews</td>
<td>“the effects of DB on human health need to be further investigated.”</td>
<td>“The author conducted a PubMed search regarding the current evidence of the effect of DB on health.”</td>
<td>“Based on this narrative review, the exact usefulness of DB in clinical practice is unclear due to the poor quality of studies. However, it may be a feasible and practical treatment method for various disorders.”</td>
</tr>
<tr>
<td>Ublo...</td>
<td>Level I/ Randomized controlled trial</td>
<td>“Slow loaded breathing training reduces resting blood”</td>
<td>“Thirty-two people (67 ± 5 years, 16 male) with controlled”</td>
<td>“Home based measurement of resting systolic BP decreased by”</td>
</tr>
<tr>
<td>PubMed</td>
<td>With block allocation stratified by sex</td>
<td>Pressure and the question is whether this can also improve lung function.</td>
<td>Isolated systolic hypertension undertook an eight weeks randomised controlled training trial with an inspiratory load of 25% maximum inspiratory pressure (MIP) at 6 breaths per minute (slow loaded breathing; SLB) or deep breathing control (CON). “</td>
<td>20 mm Hg (15 to 25) (Mean and 95%CI) for SLB and by 5 mm Hg (1 to 7) for CON.”</td>
</tr>
<tr>
<td>———-</td>
<td>———-</td>
<td>———-</td>
<td>———-</td>
<td>———-</td>
</tr>
<tr>
<td>(Gholamrezaei, Van Diest, et al., 2021) PubMed</td>
<td>Level I/ Randomized Controlled Trial</td>
<td>To assess the Psychophysiological responses to various slow, deep breathing techniques</td>
<td>“Compared four deep breathing techniques and examined outcomes in blood pressure variability, respiratory sinus arrhythmia, baroreflex function, and emotional state… Healthy adult volunteers performed pursed-lips breathing, left and right unilateral nostril breathing… blood pressure variability was higher during loaded breathing versus other conditions and higher during pursed-lips breathing versus left and right unilateral nostril breathing… loaded breathing was associated with enhanced cardiovascular effects”</td>
<td>“These findings can be informative in applying deep breathing techniques as self-management interventions for health conditions, in which baroreceptors stimulation and autonomic and emotional modulations can be beneficial, such as pain and hypertension.”</td>
</tr>
<tr>
<td>(Chadha, Modaf f, et al., 2019) PubMed</td>
<td>Level I/ Systematic review and meta-analysis</td>
<td>“assesses the impact of device-guided and non-device-guided (pranayama) slow breathing on blood pressure reduction in these patient populations.”</td>
<td>“We searched PubMed, EMBASE, CINAHL, Cochrane CENTRAL, Cochrane Database of Systematic Reviews, Web of Science, BIOSIS (Biological Abstracts) Citation Index and Alt HealthWatch for studies meeting these inclusion criteria: randomized controlled trial or first phase of a randomized cross-over study; subjects with hypertension, prehypertension or on antihypertensive medication; intervention consisting of slow breathing at ≤10 breaths/minute</td>
<td>“Overall, slow breathing decreased SBP by -5.62 mmHg [-7.86, -3.38] and DBP by -2.97 mmHg [-4.28, -1.66].”</td>
</tr>
<tr>
<td>(Adler, Coovadia, et al., 2019)</td>
<td>Level I/Randomized Controlled Trial</td>
<td>“the extent to which blood pressure (BP) responses to SLOWB differ between men and women are not well-established. Therefore, we tested the hypothesis that an acute bout of SLOWB would induce larger decreases in BP in males than in females, given that males typically have higher resting BP”</td>
<td>“We tested normotensive females ( n = 10 ), age: ( 22 \pm 2 ) y, body mass index: ( 22 \pm 2 ) kg/m(^2) and males ( n = 12 ), age: ( 23 \pm 3 ) y, body mass index: ( 26 \pm 4 ) kg/m(^2). Subjects were tested at baseline and during the last 5 min of a 15-min RESPeRATE-guided SLOWB session”</td>
<td>“Overall, SLOWB reduced systolic BP by ( 3.2 \pm 0.8 ) mmHg (main effect, ( P &lt; 0.01 )).”</td>
</tr>
<tr>
<td>(Gholamrezaei, Van Diest, et al., 2019)</td>
<td>Level I/Randomized Controlled Trial</td>
<td>“We investigated whether adding inspiratory threshold load can enhance the cardiovascula”</td>
<td>“Healthy volunteers ( N = 29 ) performed controlled breathing at 0.1 Hz (6 breaths/minute) without load”</td>
<td>“The amplitude of the systolic blood pressure variation during respiratory cycles increased with”</td>
</tr>
<tr>
<td>PubMed</td>
<td>r responses to controlled breathing at the frequency of 0.1 Hz, a common form of slow, deep breathing.</td>
<td>and with inspiratory threshold loads of 5 cmH₂O and 10 cmH₂O. Respiratory airflow, heart rate, and blood pressure were continuously recorded.</td>
<td>increasing loads’</td>
<td>loads on baroreflex function and cardiac vagal control needs to be investigated, particularly in pain and hypertension patients</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Rodrigues, Gurgel, et al., 2018</td>
<td>Level I/ Randomized Controlled Trial</td>
<td>“To investigate the influence of breathing patterns and blood pressure behavior postural control in older adults.”</td>
<td>“A total of 20 older adults carried out spontaneous, controlled (15 cycles/min) and deep (6 cycles/min) breathing trials, in random order.”</td>
<td>“there were also significant differences in systolic blood pressure during spontaneous breathing between the baseline measures (sitting position 123 ± 11 mmHg) and the first minute of active standing (117 ± 13 mmHg; d = 0.24; P &lt; 0.05).”</td>
</tr>
<tr>
<td>PubMed</td>
<td>(Ghati, Killa, et al., 2020)</td>
<td>“The present study was designed to evaluate the immediate effect of BHB (a simple yogic practice) exercise on blood pressure parameters and heart rate variability”</td>
<td>“a randomized control trial including 70 patients with essential hypertension, randomly allocated to perform either BHB exercise (n=35) or placebo slow breathing exercise (n = 35) for 5-</td>
<td>“There was no significant decrease in systolic [effect size (95% CI): 2.22 (-13.20, 17.64); p 0.77], diastolic [4.54 (-17.40, 26.48); p 0.68] and mean blood pressures [1.37 (-8.78, 11.52); p 0.78] after BHB exercise</td>
</tr>
<tr>
<td>PubMed</td>
<td>“This is the first randomized controlled trial to show that though a single short session of BHB exercise in hypertensive patients does not significantly reduce BP, it</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Level</td>
<td>PubMed ID</td>
<td>Evidence Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
<td>-----------</td>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>(Fonkoue, Marvar, et al., 2018)</td>
<td>Level I/Randomized Controlled Trial</td>
<td>PubMed</td>
<td>“summarise the evidence base on efficacy [of the Respirate]”</td>
<td>“In 23 prehypertensive veterans with PTSD, we measured continuous BP, ECG, and muscle sympathetic nerve activity (MSNA) at rest and during 15 min of DGB at 5 breaths/min (n = 13) or identical sham device breathing at normal rates of 14 breaths/min (sham; n = 10).” “There was a significant reduction in systolic BP (by -9 ± 2 mmHg, P &lt; 0.001), diastolic BP (by -3 ± 1 mmHg, P = 0.019), mean arterial pressure (by -4 ± 1 mmHg, P = 0.002), and MSNA burst frequency (by -7.8 ± 2.1 bursts/min, P = 0.004) with DGB but no significant change in HR (P &gt; 0.05).” “DGB acutely lowers BP and MSNA and improves sympathetic but not cardiovascular BRS in prehypertensive veterans with PTSD”</td>
</tr>
<tr>
<td>(Mahtani, Beinorta, et al., 2016)</td>
<td>Level V/Summary Evidence Review</td>
<td>PubMed</td>
<td>“although some clinical trials exist that demonstrate a BP-lowering effect, others do not.”</td>
<td>“There is currently insufficient evidence from pooled data to recommend the routine use of device-guided breathing in hypertensive patients.”</td>
</tr>
<tr>
<td>(Lachowska, Bellwon, et al., 2019) PubMed</td>
<td>Level I/Randomized Controlled Trial</td>
<td>&quot;We examined the acute and long-term impact of device-guided breathing on hemodynamic and prognostic parameters in HF patients with reduced ejection fraction (HFrEF).&quot;</td>
<td>&quot;Twenty-one patients with HFrEF (23.9 ± 5.8%, SD ± mean) on optimal medical therapy underwent blood pressure (BP), heart rate (HR), HR variability, 6-min walk test (6MWT), cardiopulmonary exercise testing (CPET), and echocardiography measurements before and 3 months after SLOWB home training (30 min daily). After 3 months, all patients were assigned to continue SLOWB (Group 1) or no-SLOWB (Group 2). All tests were repeated after 6 months.&quot;</td>
<td>&quot;Acute SLOWB (18 ± 5 vs 8 ± 2 breaths/min, P &lt; 0.001) had no influence on BP and HR but improved saturation (97 ± 2 vs 98 ± 2%, P = 0.01). Long-term SLOWB reduced office systolic BP (P &lt; 0.001) but not central or ambulatory systolic BP.&quot;</td>
</tr>
<tr>
<td>(Krüterke, Simöes-Wüst, et al., 2018) PubMed</td>
<td>Level I/Randomized Controlled Trial</td>
<td>&quot;This prospective, exploratory, pre-post study was performed to investigate&quot;</td>
<td>&quot;Patients received three ATS treatments, alternating with three sham&quot;</td>
<td>&quot;The mean systolic BP did not change significantly during this study.&quot;</td>
</tr>
<tr>
<td>CINA HL &amp; PubMed</td>
<td>ATS effects on baroreflex sensitivity (BRS), heart rate (HR), HRV by standard deviation of beat to beat intervals (SDNN), blood pressure (BP), and mood in hypertensive patients.”</td>
<td>interventions (control). During the sessions, BP and electrocardiography were continuously recorded. BRS and SDNN were analyzed from those measurements. Changes in mood score were assessed by a questionnaire. All data were compared before and after intervention (ATS and control).”</td>
<td>which play an important role in BP regulation capability.”</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>(Yau &amp; Loke, 2021) PubMed Level V Literature Review</td>
<td>“examine the effects of diaphragmatic breathing on physiological and psychological measures in prehypertensive or hypertensive adults and to (2) determine the appropriate length, frequency, and duration of an effective diaphragmatic</td>
<td>“Relevant studies were searched using electronic databases, and 13 studies that met the inclusion criteria were included.”</td>
<td>“voluntary diaphragmatic deep breathing resulted in decreased of systolic and diastolic blood pressures, reduced heart rate, a relaxing effect, and reduced anxiety in hypertensive or prehypertensive individuals.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>breaths per minute for 10 min twice a day for 4 weeks was effective in producing positive outcomes. The results of this review provide directions for related interventions</td>
<td>“It is concluded that voluntary diaphragmatic breathing at &lt;10 or 6 breaths per minute for 10 min twice a day for 4 weeks was effective in producing positive outcomes. The results of this review provide directions for related interventions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Sangthong, Ubolsakka-Jones, et al., 2016) PubMed</td>
<td>Level I/Randomized Controlled Trial</td>
<td>“investigated whether slow breathing training, with and without an inspiratory load, could reduce the resting blood pressure of older well-managed ISH patients.”</td>
<td>“Thirty ISH patients (66 ± 4 yr) were randomized into loaded breathing (six breaths per min, 18 cm H2O), unloaded breathing (six breaths per min, no load), or control (normal breathing) groups. After a 2-wk run-in, loaded and unloaded groups trained at home for 30 min every day for 8 wk. Morning home blood pressure and heart rate were measured daily throughout the study. At the end of training, all participants reverted to normal breathing, and systolic blood pressure was reduced by 18 ± 7 and 11 ± 4 mm Hg for loaded and unloaded groups, respectively (P &lt; 0.001), the reduction being significantly larger for the loaded group (P &lt; 0.05) after 8-wk training. There were no changes in the control group. After the end of training, systolic blood pressure remained below pretraining levels for a further 6 wk for the loaded group but for only 2 wk with the unloaded group. There was a small nonsignificant reduction in diastolic blood pressure.”</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>breathing exercise in the management of prehypertension and hypertension.”</td>
<td>“slow breathing training, especially with an inspiratory load, is very effective in reducing resting systolic and pulse pressures and could be a valuable adjunct in the management of ISH.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Chauhan, Semwal et al., 2017)</td>
<td><strong>Level I/Randomized Controlled Trial</strong></td>
<td>“to evaluate the effect of 1-month yoga practice on body mass index (BMI), and blood pressure (BP).”</td>
<td>“determine the effect of yoga practice on 64 participants (age 53.6 ± 13.1 years) (experimental group) whereas the results were compared with 26 healthy volunteers (control group). We examined the effects of yoga on physiological parameters in a 1-month pilot study. Most of the participants were learner and practiced yoga for 1 h daily in the morning for 1 month. BMI and BP (systolic and diastolic) were studied before and after 1 month of yoga practice.”</td>
<td>“Yoga practice causes decreased BMI (26.4 ± 2.5 - 25.22 ± 2.4), systolic BP (136.9 ± 22.18 mmHg to 133 ± 21.38 mmHg), and diastolic BP (84.7 ± 6.5 mmHg to 82.34 ± 7.6 mmHg). On the other hand, no significant changes were observed in BMI and BP of control group.”</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(de Barros, da</td>
<td><strong>Level I/Randomized</strong></td>
<td>“to evaluate the long-term use of DGB”</td>
<td>“Hypertensive patients were randomized to “There was no change in office BP”</td>
<td>“Long-term DGB did not reduce BP,”</td>
</tr>
<tr>
<td>Silva, et al., (2017)</td>
<td>open-label clinical trial</td>
<td>in BP and SNA.”</td>
<td>listen music (Control Group-CG) or DGB (aim to reduce respiratory rate to less than 10 breaths/minute during 15 minutes/day for 8 weeks). Before and after intervention ambulatory blood pressure monitoring (ABPM), catecholamines and muscle sympathetic nerve activity (MSNA) by microneurography were performed.”</td>
<td>before and after intervention in both groups. There was a reduction in systolic and diastolic BP in the awake period by ABPM only in the CG (131 ± 10/92 ± 9 vs 128 ± 10/88 ± 8mmHg, p &lt; 0.05). In relation to SNA, no difference in catecholamines was observed.”</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(Posser, Callegaro, et al., 2016)</td>
<td>Level I/ Double-Blind Randomized Controlled Trial</td>
<td>“test the efficacy of inspiratory muscle training in reducing blood pressure in adults with essential hypertension”</td>
<td>“randomized, double-blind clinical trial... Intervention consists of inspiratory muscle training loaded with 40% of maximum inspiratory pressure, readjusted weekly. Control sham intervention consists of unloaded”</td>
<td>Unresolved</td>
</tr>
</tbody>
</table>
exercises. Systolic and diastolic blood pressures are co-primary endpoint measures assessed with 24 h ambulatory blood pressure monitoring.”

Study characteristics
See Table 1

Results of individual studies
See Table 1

Additional analysis
No additional analyses completed

Discussion

Summary of evidence

- Slow-loaded breathing decreases blood pressure more than slow breathing alone.
- 11 studies supported the implementation of slow-deep breathing or a similar variant as an evidence-based practice to reduce blood pressures
- 12 studies supported the implementation contingent on additional research
- Two studies did not support the implementation, but still seemed hopeful with continued research

xxix
• Two studies did not support the implementation of a slow-deep breathing protocol or a similar variant

• One study revealed no change in BP with an acute slow-deep breathing variant, but a decrease in BP long term

• One study was unresolved

**Limitations**

Limitations to this study include time constraints, some low-quality evidence (level V), and the use of only two databases.

**Conclusions**

Additional studies must be conducted to add to the evidence demonstrating that slow-deep breathing alone reduces blood pressures. In addition, the effects of slow-deep breathing on blood pressure should be studied acutely (one week to one month, once a day) and long-term (six weeks, once a day). Ideally, the studies would then assess for the slow-deep breathing’s effects on blood pressure for one month follow-up after the slow-deep breathing practice has concluded. In bedside nursing, this would mean providing education to the patient regarding the effectiveness of deep breathing, the consequences of prolonged hypertension, and the benefits of a deep breathing protocol over antihypertensive medications. In public health, this deep breathing protocol could also prove beneficial where the protocol may be implemented in a community health education class. This would include education on the same topics discussed for bedside nursing and demonstration of the proper breathing technique so citizens can confidently perform the protocol at home. The rise of hypertension in the United States necessitates the widespread use of an effective and simple slow-deep breathing protocol.
Funding

The study was unfunded.
References


blood pressure and heart rate variability in patients with essential hypertension.

EXPLORE. doi:10.1016/j.explore.2020.03.009


