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Review article

Effects of *Bhramari Pranayama* on health – A systematic reviewMaheshkumar Kuppusamy^{a,*}, Dilara Kamaldeen^a, Ravishankar Pitani^b, Julius Amaldas^c, Poonguzhali Shanmugam^d^a Department of Physiology, Sri Ramachandra Medical College and Research Institute, Chennai, India^b Department of Community Medicine, Ramachandra Medical College and Research Institute, Chennai, India^c Department of Biochemistry, Sri Balaji Dental College and Hospital, Bharath University, Chennai, India^d National Institute for Research in Tuberculosis (formerly Tuberculosis Research Centre), ICMR, Chennai, India

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ABSTRACT

Background: Pranayama, a branch of yoga practice is extremely beneficial to mankind in maintaining sound physical and mental health and this article aims to attain an insight on the studies conducted on the effectiveness of *Bhramari Pranayama* (Bhr.P) on health. The studies done until May 2016 were found using Medline, Embase, Google scholar and manual search. Studies conducted on the health effectiveness of Bhr.P specifically were included on the basis of prisma guidelines. The data were defined by their objectives, methodology, study setting, findings, interventions done and implications suggested in the study. Methodological Quality Rating Scale (MQRS) and Newcastle-Ottawa Scale (NOS) were used in reviewing and reporting results of the included studies. 6 studies satisfied the inclusion criteria; 2 studies were done on the cold pressor test, one on heart rate and BP, one on EEG changes, one each on the inhibitory response and tinnitus condition. In the included studies, the Bhr.P practices have shown parasympathetic dominance. There are some encouraging effects of Bhr.P on various physiological systems. Methodological quality of the included studies was evaluated to be very low and none of them were RCTs. Yet the available studies are heterogeneous, dealing in different grounds and this heterogeneity serves as a resource for the limited scope of studies on Bhr.P. Therefore, further large-scale, properly designed, randomized trials of Bhr.P on various systems have to be done to justify these effects efficiently. © 2018 Center for Food and Biomolecules, National Taiwan University. Production and hosting by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Yoga is an ancient Indian science that designs way of life with its various practices. It is being practiced in the form of *Asana* (Posture), *Pranayama* (breathing manipulation), *Meditation* (concentration technique) etc by the practitioners in range of methods and style.¹ *Pranayama* is one practice that has been found to be effective to physiology of mankind in many ways. The Sanskrit word *Pranayama* contains two segments namely *Prana* (means vital force) and *Yama* (means control).² It literally means a yogic act performed for controlling the flow of vital energy that governs all the physiological process in the body. *Maharishi Patanjali*, in his

Ashtanga yoga, has given more importance to pranayama than asana for good health.³ *Pranayama* consists of three phases: *Purak* (inhalation), *Kumbhak* (retention) and *Rechak* (exhalation).² These can be practiced either alone or with combination which depends upon the type of pranayama. In human beings, the breath is an active connection between the body and mind while the *Pranayama* is considered as manipulation of one's own breathing.⁴ Different types of pranayama produce specific physiological responses and it greatly depend on type and duration of the practice.^{5–7} *Nadisuddhi*, *Savitri*, *Kapalbhati*, *Bhasrika*, *Bhramari Pranayama*, and so on are well known among them.

Pranayama, by continuous practice reduces the dead space ventilation and decreases the work of breathing. Entire lung is ventilated in contrast to the shallow breathing which only refreshes the base of the lung.⁸ Practicing pranayama regularly has a positive impact on cardiovascular,^{9,10} and respiratory functions.^{11,12} Improves the autonomic system towards parasympathetic (vagal tone) dominance.^{13,14} This in turn reduces the effects of stress and

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strain on various systems. Hence the overall physical and mental health improves.¹⁵ Each style of pranayama has its own beneficial effect based on the breathing cycle, tidal volume and other factors like the use of mouth, nostrils, constriction of laryngeal muscles and position of the glottis.¹⁶ The *Bhramari* is one type of pranayama. Its simplicity of slow breathing and that it could be easily practiced by everyone irrespective of their age or gender makes it notifiable. In Bhr.P, the practitioner will sit in any comfortable posture and inhale and exhale through nostrils slowly and deeply. While exhaling, will have to produce sound (humming sound) like bumble bee strictly through nasal airways, keeping oral cavity closed by the lips, ears closed by fingers.¹⁷

When we look into the benefits of this pranayama, the self induced humming sound in this practice resembles mantra repetition technique. Bhr.P changes the normal breathing rhythm, with prolonged exhalation and short inhalation, which produces significant impact in physiological system.¹⁸ Practice of Bhr.P for 5–10 min continuously induce subjective feelings of mind refreshment and blissfulness and sometimes the subjects are believed to go to even meditative state.¹⁹ So Bhr.P technique is not only a breathing practice but also a form of meditation. As compared with other pranayama, it does not have any kind of breath holding or alternate nostril involvement with counting. Added to above, the humming sound which is produced during the breathing gives more attraction and interest to the subjects for practicing the pranayama. In this, it's very convenient to control and check the correctness by the sound of humming which is produced by the pranayama practitioners.

It has been reported that Bhr.P practice is effective for correcting the hormonal imbalance conditions and other disorders like hypertension, anxiety, and depression. The calming effect of the Bhr.P helps in overcoming drug dependency.²⁰ However very few scientific studies on the effects of this technique have been done so far.

1.1. Need for the review

There are many benefits for pranayama and there have been many studies conducted experimenting these benefits, still there is very few documentation on specific pranayama individually. The Bhr.P is one such technique that has many health benefits but very little scientific evidence showing its effects. Most of the literatures available are the shared effects of pranayama practices as a whole and there is no backup for Bhr.P individually. In this review, we wanted to explore the existing scientific studies on the Bhr.P. Hence we have systematically reviewed the available studies on the benefits of Bhr.P to assess how the studies have been done and what are the benefits of Bhr.P addressed in them. This review could lead in further identifying the gaps in the existing studies as well as exploring the new floor for scientific advances in this field.

2. Methodology

This systematic review has been conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma) guidelines.

2.1. Search criteria

The search was done online in Medline, Embase, google scholar and manual search also carried out till May 2016 to make the search exhaustive and identified all the studies done on the effects of Bhr.P. The key words used were pranayama, *Bhramari* pranayama, tranquilizing pranayama, humming pranayama, benefits, effects, practice of *Bhramari*. The words with similar meaning of the key words were also used for the search. Zotero, open source reference

management software, was used to cite and manage the data by online library program.²¹

2.2. Selection of studies

The selection of studies was done on the basis of inclusion and exclusion criteria.

Inclusion criteria: The studies done specifically on Bhr.P and its benefits. General effects, specific health benefits, systemic effects of Bhr.P were included.

Exclusion criteria: The studies that have been done on Bhr.P in combination with any other practice were excluded.

2.3. Data extraction

After the exhaustive search and selecting the studies on the basis of inclusion criteria, the data extraction was done by two reviewers independently and disagreements were resolved by discussion. Then the final set of manuscripts was assessed as a team by the authors and information was thematically extracted. The data extracted include the objective of the study, the methodology employed, the study setting, salient findings, any interventions performed and implications or recommendations resulting from the study findings.

Then the studies were assessed for their quality and rated by Methodological Quality Rating Scale (MQRS)²² and Newcastle-Ottawa Scale (NOS).²³ Four dimensions of methodological quality were assessed by MQRS scale and based on that all the included studies were scored which has the range from minimum of 1 (extremely poor quality) to maximum of 16 (extremely good quality). Three aspects were considered in the NOS criteria: (1) subject selection: 0–4; (2) subject comparability: 0–2; and (3) clinical outcome: 0–3. NOS scores range from 0 to 9; a score ≥ 7 indicated that the study was of good quality.

2.4. Data synthesis

Following the data extraction, the data synthesis was done by categorizing the study findings under pulmonary effects, cardiovascular effects and autonomic system. The number of studies was limited and was summarized using a narrative approach and hence meta-analysis could not be done.

3. Results

A Prisma flow diagram (Fig. 1) completely depicts the search process and study selection. Following the search through various search engines, 25 papers were derived. Eliminating the duplicates, 19 studies arrived. By reading through the title and abstracts of these 19 papers, the papers dealt with effects of pranayama in general, conference papers, other pranayama papers, and effects of Bhr.P in combination with other practices were eliminated and finally 6 studies satisfied the inclusion criteria and were included for the review. The final included papers describe about the effectiveness of Bhr.P in various physiologic functions. They have been widely distributed all over Indian sub-continent. The included papers are described in detail. (Table 1) Out of the included studies, 2 studies done on the cold pressor,^{24,25} one on heart rate and BP,²⁶ one study on EEG changes,²⁷ each on the inhibitory response²⁸ and tinnitus condition.²⁹ Hence they were broadly categorized under pulmonary, cardiovascular, autonomic and others on the basis of their physiologic effects.

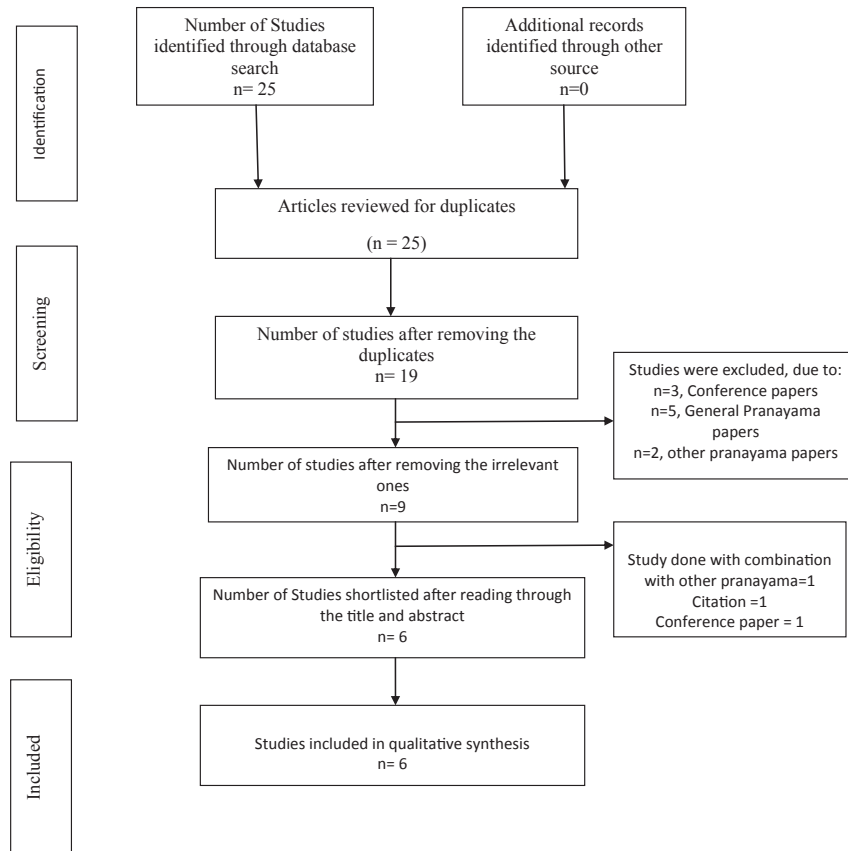


Fig. 1. Prisma flow diagram showing the process of data synthesis.

3.1. Effect on cardiovascular system

The Bhr.P practice reduces the cardio dynamic response to cold pressor test among the practitioners. Of the 6 included studies, three have been done on one or more effects of Bhr.P on the cardio vascular system.^{24–26} Two studies were done by using the cold pressor test of which one was done on the normal adults²⁴ while another on pregnant women.²⁵ The third study was conducted to find its effect on baseline blood pressure and heart rate.²⁶ Pregnant women who were hyper reactive were found to show reduction of blood pressure as a response to the cold pressor test. 79% of 28 hyper reactive respondents noted this reduction by two months practice. Similarly, 81% of 21 medical student volunteers who were hyper reactive at the baseline noted reduction of blood pressure response after 3 months using the same cold pressor test. Another study evaluated the immediate effect of Bhr.P on the heart rate and blood pressure among 50 healthy adults after practicing for 5 min and noted slight decrease of (2–3 beats) heart rate and significant decrease of mean blood pressure 5–6 mm Hg.

3.2. Effect on EEG waves

The effect of Bhr.P on the autonomic nervous system is indispensable. One study noted that Bhr.P increases paroxysmal EEG waves immediately after practice in the healthy volunteers.²⁷ During the Bhr.P practice all the subjects exhibited high frequency hyperphasic patterns, biphasic waves. They have found strong amplitude gamma waves after 30 days of Bhr.P practice (two sessions per day). It was further concluded that continuous practice

would cause the waves to remain for several minutes even after the practice is finished.

3.3. Effect on cognitive functions

Enhanced inhibitory response and cognitive control was noted among the healthy individuals followed by 10 min of Bhr.P practice.²⁸ They have done the stop signal task as one of the important tool to assess the response inhibition in cognitive psychology, cognitive neuroscience, and psychopathology. They found improvement in SST compared with self control groups.

3.4. Effect of Bhr.P on tinnitus

One study found that Bhr.P significantly reduced the irritability, depression and the anxiety associated with tinnitus.²⁹ They assessed the loudness, Tinnitus Handicap Inventory (THI) score, Anxiety and depression among the tinnitus patients group who received Bhr.P as a therapy and three other groups of similar patients who were given Ginkgo biloba, Masking therapy and a combination of all the above-mentioned modalities respectively, as treatment for tinnitus. They found that all modality of therapies reduced the post-therapeutic scores in all the parameters.

3.5. Quality assessment of the included studies

The included studies were assessed for their quality using the scale derived from some of the measures of NOS scale and MQRS scale. The scoring was done and the details are given in the [Tables 2 and 3](#). The scores for each study is different, however they all

Table 1
Details of the included studies on Bhr.P.

S.no	Author	Objective	Methodology	Tools used	Participants	Findings	Implication
1	Rajesh et al., 2014	Measure stop signal reaction time (SSRT)	Randomised self as control	Stop signal task (SST)	31 Male participants	Significant decrease ($P = 0.024$) in SSRT after Bhpr session while no significant change in DB group. The go RT increased significantly after Bhpr ($P = 0.007$)	Bhr.P enhanced response inhibition and cognitive control in nonclinical participants
2	Rampalliwar et al., 2013	To see whether the Bhr.P practice reduced the reaction of hyper reactive pregnant women to cold pressor	Experimental study (2 months practice)	Cold Pressor test	28 participants	Hyper reactivity reduced to hypo reactivity and basal blood pressure, rise in blood pressure and pulse rate reduced significantly	Bhr.P is effective for pregnant women for preventing pre eclampsia
3	Jain et al., 2011	To see whether the Bhr.P practice reduced the hyper reactivity to cold pressor	Experimental study (3 months practice)	Cold Pressor test	54 participants	81% reduction was seen in the hyper reactivity to cold pressor and diastolic BP reduced significantly ($p \leq 0.01$)	Regular practice of Bhr.P reduced the hyper reactivity by inducing the parasympathetic predominance.
4	Pramanik et al., 2010	Find the immediate effect of Bhr.P	Experimental study (5 min practice)	Sphygmomano-meter	50 participants	The mean systolic and diastolic BP decrease was about 5 mm Hg. Heart rate and mean BP decreased, Diastolic BP decrease was significant	Balance the autonomic nervous system through enhanced activation of the para sympathetic system and can be practiced for mental relaxation and reduction of stress of daily life
5	Pandey et al., 2010	To observe the effect of Bhr.P on physical and emotional aspect of tinnitus	Experimental study	Loudness, THI score and Anxiety and Depression scale.	84 Participants	BP significantly reduced the irritability, depression and the anxiety associated with tinnitus.	Bhr.P induces parasympathetic pre dominance and serves as a relaxation technique.
6	Vialatte et al., 2008	Observe the EEG, ECG and EMG after the Bhr.P practice	Experimental and control (3 armed study)	EEG	8 participants	All subjects exhibited paroxysmal gamma waves (PGW) during the practice and EEG activity is most probably non-epileptic	Highly speculative influence on the brain, and thereby induce a subjective feeling such as "bliss"

Table 2
Methodological Quality Rating Scale (MQRS) of included studies.

Scale	Scoring	Rajesh et al., 2014	Rampalliwar et al., 2013	Jain et al., 2011	Pandey et al., 2010	Pramanik et al., 2010	Vialatte et al., 2008
Group Allocation High = 4 High = 3 Medium = 2 Low = 1 Low = 0	4 = Randomization 3 = Within 5 counterbalanced 2 = Case control/matching 1 = Quasi-experimental design, arbitrary assignment, sequential cohorts 0 = Violated randomization or non equivalent groups	1 (Low)	0 (Low)	0 (Low)	1 (Low)	0 (Low)	0 (Low)
Quality control High = 1 Low = 0	1 = Treatment standardized by manual, specific training, content coding 0 = No standardization of treatment specified	0 (Low)	1 (High)	1 (High)	1 (High)	1 (High)	0 (Low)
Follow up rate High = 2 Medium = 1 Low = 0	2 = 85–100% follow-ups complete 1 = 70–84.9% follow-ups complete 0 = < 70 % follow up complete	1 (Medium)	1 (Medium)	2 (High)	2 (High)	0 (Low)	0 (Low)
Follow-up length High = 2 Medium = 1 Low = 0	2 = 12 months or longer 1 = 6–11 months 0 = Less than 6 months or unspecified	0 (Low)	0 (Low)	0 (Low)	0 (Low)	0 (Low)	0 (Low)
Independent High = 1 Low = 0	1 = Follow-up conducted by independent interviewers blind to group 0 = Follow-up by non blind, unspecified, or questionnaire data only	0 (Low)	0 (Low)	0 (Low)	0 (Low)	0 (Low)	0 (Low)

Table 3
Newcastle-Ottawa Scale for the included studies.

Study	Selection	Comparability	Outcome	NOS score
Rajesh et al., 2014	**	*	*	4
Rampalliwar et al., 2013	*	—	*	2
Jain et al., 2011	*	*	*	3
Pramanik et al., 2010	*	*	*	3
Vialatte et al.	*	*	*	3
Pandey et al., 2010	**	**	*	5

Star (*) = item present. Selection criteria have four components and outcome has three components. Maximum 1 star (*) for the Selection and Outcome components. Maximum 2 stars (**) for the Comparability component.

resemble to be poor in their methodological quality scoring. None of the studies were RCTs. In addition, they neither fully satisfied the case control category. Most of the studies were experimental studies and resembled case control but did not have clear control group.²⁸ The non response rate was not measurable in most of the studies. As the control group is not clear, the case and control comparison could not be analyzed and understood with clarity. The positive aspect is that all the studies described the cases however and they were represented well. In the MQRS scale, the follow up duration was very low in all the studies however the studies have followed certain standardized interventions. Still the overall scores obtained by the included studies are low.

4. Discussion

The effect of Bhr.P is pronounced in the evidences obtained from the above results. All the studies directly or indirectly have found the effect of Bhr.P to have parasympathetic predominance²⁶ and this was the basis for their results derived, namely; reduction in heart rate and BP, reduction in response to cold pressor test, improvement in cognition, reduction in irritability in tinnitus, favorable EEG changes and reduction in stress levels.

Though there have been some studies conducted on the Bhr.P eliciting the benefits, the number is too small to completely assess

the effect of Bhr.P because each study had dealt different grounds; CVS, EEG wave patterns, cognition etc. that they could not be derived to common conclusion. In spite of grouping about three studies under the CVS effect, each study had different population; methodology design and focus for the study were unique. Due to this heterogeneity, the studies are discussed descriptively as they could not be pooled to a meta-analysis.

Of the included studies, none of them were RCTs and the methodological designs of the studies were unclear. It shows high risk of bias that poses a major setback in the reliability and validity of the results. The subjects selected for each study does not have any background reason for choosing them. For instance one study has been conducted on hyper reactive pregnant women to identify the reaction to cold pressor in the form of BP. Most of the studies were experimental study designs but they either did not have control group or if they had, they were not properly blinded and maintained to measure the effect among the experimental group.²⁸

Two studies have assessed the immediate effect of Bhr.P intervention^{26,28} but generally, yoga practice is known to have pronounced and long lasting effect when it is practiced for longer period of time. For instance, the effect produced will be more replicable when it is practiced for months together rather than finding its effect after practicing it once for about 5 min. In such cases, one thing is that the results tend to change if the same practice applied for a longer period of time and the other is that it may not be purely the effect of practice.

In summary, this review has attempted to describe the effect of Bhr.P from the studies so far found. The available studies are heterogeneous, dealing in different grounds and this heterogeneity serves as a resource for the limited scope of studies on Bhr.P. Even though the studies are very few, it creates a floor for further research in this field. There is a vast area unexplored on Bhr.P. On this aspect, when we look into it, the Bhr.P is a slow pace, breathing technique that is accompanied with a humming bee sound. Unlike other pranayama practices, in Bhr.P acoustic vibration is produced by humming sound during the exhalation phase along with the

yogic posture. This acoustic vibration could have significant impact in producing the desired effect of Bhr.P. Since, for brain we don't have any stretching exercises like other parts of the body, vibration of head is a good alternative for that and vibration by one's own voice might not be harmful for the brain tissues.^{30,31} Hence it is evident that it influences multiple systems in the body and there is definitely a scope to have desirable effects on respiratory system, autonomic nervous system, stress, anxiety level, over all emotional status of the practitioner etc. At a deeper level, the studies could even focus on the effect of Bhr.P on stress markers (Cortisol, alpha amylase, MDA etc) too. However there is a need to focus on strengthening the methodology and study designs for more valid and reliable result. RCTs are universally accepted top rated study design due to its high degree of reproducibility. Hence more RCTs are essential in this field to evidence the effect of Bhr.P empirically.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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