Review article

Psychophysiological effects of Bhastrika and Kapalabhati: A narrative review

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ABSTRACT

Kapalabhathi and Bhastrika are two techniques that are similar but are known to produce different psycho-physiological changes. This review intends to narrate the present evidence on the psychophysiological changes following these selected yoga practices. A literature review was performed using the keywords "kapalabhati and bhastrika Pranayama" in PubMed, PubMed Central, IndMed, and Google Scholar between 2013 to 2023. A total of 4156 references were retrieved. The review comprised experimental publications, case studies, and case series in English describing the effects of kapalabhati and bhastrika pranayama. The overwhelming body of research indicates that kapalabhati and bhastrika pranayama treatments have positive impacts in both physiological and therapeutic settings. Findings from the studies conclude that Kapalabhati and Bhastrika pranayama improve neurocognitive, respiratory, and cardiovascular functions in healthy adults. They were also proved to be helpful in treating a number of clinical problem like bronchial asthma, diabetes mellitus, obesity, and mental health conditions like stress and anxiety. In general, pranayama can be practiced safely if it is done under the supervision of a qualified teacher. Further large-scale studies with rigorous designs are required to fully understand the mechanisms underlying kapalabhati and bhastrika pranayama in light of the beneficial effects of pranayama.

Keywords: Yoga, Kapalabhati, Bhastrika, Neurocognitive, Respiratory, Cardiovascular System

Yoga is a traditional Indian practice that has been handed down through the ages. As a science of healthy living, it ought to be practiced regularly. It affects a person's life on a physical, physiological, mental, emotional, psychic, and spiritual level. It includes a variety: yama (refraining from doing something), niyama (observing something), asana (postures), pranayama (breath control), pratyahara (withdrawing from senses), dharana (concentration), dhyana (meditation), and samadhi (oneness) are all part of yoga [1]. Pranayama is referred to as the fourth limb of traditional Ashtanga yoga. There are wide-ranging benefits of pranayama for the human body. Pranayama is a Sanskrit word, "Prana" means vital force, and "Yama" means to gain control. According to traditional yogic literature, there are four key characteristics of breathing that are used in pranayama.

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They are Puraka, or inhalation; Rechaka, or exhalation; Anthar kumbhaka, or internal breath retention; and Bahir kumbhaka, or external breath retention [2]. The practice of Pranayama is usually considered to be controlled inhalation and exhalation combined with retention. Retention can be induced through both inhalation and exhalation. The main benefit of retention is that it gives more time for prana assimilation and for the exchange of gases, such as oxygen and carbon dioxide, in the body's cells [3].

According to research, the fast breathing techniques Bhastrika and Kapalbhati belong to have an effect on sympathetic activity and lower stress levels when practiced alone. Both pranayama are fast-breathing exercises, but they differ in that "bhastrika" is concerned with active inhalation and active exhalation, while "kapalbhati" is concerned with passive inhalation and active exhalation. Various yoga breathing practices described in the classical text of hatha yoga are enlisted in **(Table 1)** [3].

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Table 1. Procedure of Bhastrika and kapalabhati pranayama

Name of the practice	Method of practice
Bhastrika (Bellow's breath)	One should sit straight with eyes close and perform inhale and exhale forcefully and quickly. Up to 100 breaths should be practiced, with the ratio of inhalations to exhalations being 50:50. Both inhalation and exhalation must have the same force.
Kapalabhati	One should sit with the back and neck erect, then inhale through both nostrils with the eye close and exhale quickly by flapping the belly with each breath at a rate of 60–120 breaths per minute. Inhalation should be passive, and expiration should be aggressively forceful.

METHODOLOGY

The keywords "Bhastrika" and "Kapalabhati" pranayama were searched for citations in the internet databases PubMed, PubMed Central, IndMed, and Google Scholar. 4156 references were found in total, spanning the databases' creation dates of January 2013 and June 2023. The review comprised experimental publications, case studies, and case series in English describing the effects of Kapalabhati and Bhastrika pranayama. Studies that combined kapalabhati and bhastrika pranayama with other yoga techniques were not included. The review did not include studies that were written in languages other than English. A total of 24 studies were chosen for the final review after the inclusion and exclusion criteria were applied and the duplicates were eliminated. Physiological and clinical investigations were divided into two main groups for the review's studies. The neuropsychological tests, the respiratory and cardiovascular systems, and the pranayama techniques of kapalabhati and bhastrika are used to measure physiological parameters. Studies have also been done to determine how kapalabhati and bhastrika pranayama affect those who have diabetes mellitus, bronchial asthma, and high blood pressure.

RESULT

Changes in the Neurocognitive: The practice of kapalbhati, used to evaluate cognitive capacities with a letter cancellation test, showed an increase in errors following 1 and 5 minutes of practice [4]. Another study assessed the immediate effect of kapalabhati pranayama for 5 minutes on HRV and EEG activity. This study demonstrated that HF is lower, whereas LF and the LF/HF ratio increased significantly. The findings imply that Kapalbhati alters the autonomic condition by elevating sympathetic activity while decreasing vagal activity. On the other hand, Delta, Theta, and Alpha waves decreased and Gamma and Beta waves increased after kapalbhati pranayama, but there was no significant change in the EEG wave spectrum before, during, and after the kapalbhati [5].

The impact of Bhastrika pranayama as bellow's breath on reaction time was studied by Telles et al. They found that 18 minutes of Bhastrika Pranayama practice had the immediate effect of lowering the proportion of anticipatory responses in the reaction-time test [6]. The same author conducted a second study on reaction time by practicing bhastrika pranayama with 25 healthy female volunteers between the ages of 19 and 32 years for 18 minutes. There were no changes in RT following bhastrika pranayama [7].

Another study suggested that 4 weeks of practice of Bhastrika Pranayama showed a positive impact, as the amygdala, anterior cingulate, anterior insula, and prefrontal cortex were among the brain areas with the most significant changes in activity during Bhastrika Pranayama, according to the fMRI results. Additionally, the Bhastrika group significantly decreased the scores of state anxiety and negative affect and increased positive affect compared to the control group [8].

Table 2: Neurocognitive changes

Author	Year	Sample size	Variable studied	Findings
Pradhan	2013	36	DLST & SLCT	The SLCT and DLST scores were no significant by Kapalabhati practice for 1 or 5 minutes, however errors increased after the practice.
Malhotra et al.	2022	20	>HRV >EEG	HF is lower & LF and LF/HF ratio increased significantly. Delta, Theta, and Alpha waves decreased and Gamma and Beta waves increased after kapalbhati pranayama.
Telles et al.	2013	70	Reaction time	There was a statistically significant decrease in the number of anticipatory reactions after 18 minutes of Bhastrika Pranayama compared to before the practice.
Telles et al.	2018	25	Reaction time	Following bhastrika pranayama there was no change in RT. After a session of breath awareness and quiet sitting significantly decreased in RT.
Novaes et al.	2020	30	fMRI, STAI & PANAS	Following 4 weeks of bhastrika pranayama shows changes in fMRI, decrease in anxiety & negative affect score and increase in positive affect.

Respiratory system: Young, healthy participants who received 6 weeks of training in Kapalabhati pranayama saw a statistically significant rise in PEFR in the measures used to quantify pulmonary function. This increased respiratory muscle activity and coordination of breathing led to a strengthening of the respiratory muscles, which in turn improved pulmonary function [9]. In a study on healthy female subjects who underwent a 4-week training programme of kapalbhati pranayama, significant variations were detected in tidal volume (VT), expiratory reserve volume (ERV), vital capacity (VC), and inspiratory capacity (IC), but no changes were found in inspiratory reserve volume (IRV) [10]. Another study also showed significant increase in all variables i.e., FVC, FEV1, PEFR, and Maximal Voluntary Ventilation (MVV) after 6 days per weeks for 15 min in 1-month practice of bhastrika pranayama as compared to a physical exercise. This indicates that the lungs is allow to expand and contract to their maximum capacity, which strengthens and improves the respiratory muscles' endurance [15].

6 weeks practice of Bhastrika pranayama for 5min shown increase in FVC, FEV1 & PEFR. This indicates that increase respiratory muscle strength, which enhances lung function. Additionally, the quality of life is improved with higher lung function as people age [14]. Another study suggested that 7 weeks of training programmed for Kapalbhati pranayama has significantly improved the vital capacity of physical education students [11]. Impact of Bhastrika prnayam on respiratory parameters. There was significant improvement in breath holding time following Bhastrika Pranayama in healthy young adults [12,13]. Another study evaluated the short-term effects of a 6-week bhastrika pranayama intervention on healthy girls and showed a positive impact on health-related aspects of physical fitness such as muscle strength, flexibility, and Vo2 max. So the daily practice of bhastrika pranayama is beneficial for maintaining healthy lungs and improving respiratory parameters because it helps to build the lungs' immunity. Bhastrika pranayama works out the diaphragm, the main breathing muscle that restores air in the lungs [16].

Table 3: Respiratory system changes

Author	Years	Sample size	Variable studied	Findings
Dinesh T at el.	2013	60	PEFR	Increase significantly in PEFR following 6 weeks of kapalabhati pranayama.
Bal BS	2016	50	TV, ERV, IRV, VC & IC	TV, Expiratory ERV, VC & IC shown significant changes whereas insignificant were noted in IRV following 4 weeks of kapalbhati pranayama.
Sharma D	2017	20	VC	Significantly improved in VC.
R Petchimuthu & S Sethu	2016	20	BHT	Increase in breath holding time.
C Duraj & S Athisayaraj	2019	20	BHT	Increase in breath holding time.
Shrikrishna N Bamne	2017	40	FVC, FEV1 & PEFR	FVC, FEV1 & PEFR were increases significantly following 6 weeks of bhastrika pranayama.
Budhi et al.	2019	30	FVC, FEV1, PEFR & MVV	Following 1month bhatrika pranayama increases FVC, FEV1, PEFR & MVV significantly.
Bal BS et al.	2021	52	VO2 max, flexibility, muscular strength & muscular endurance.	Positive impact on VO2 max, flexibility, muscular strength & no effect were observed in muscular endurance following 6 weeks bhastrika pranayama.

Changes on Cardiovascular system (CVS): A study demonstrates that kapalabhati and bhastrika pranayama practice significantly improved metabolic fitness (VO2max, BP, and blood sugar) while having minimal impact on blood lipid levels and bone integrity in university-level girls after 4 weeks [17,20]. A study on effect of kapalabhati on blood pressure shows all values are significantly drop towards the baseline when we compare post-value (immediate) with at the end of 3 minutes of kapalbhati. After the final 3 minutes of Kapalbhati, the DBP even falls. This demonstrates that the effects of Kapalbhati are distinct from those of many other types of exercise. This has a distinctive impact. This shows that parasympathetic activity is being activated or sympathetic activity is being reduced, as indicated by a drop in blood pressure that is near or even below baseline [18]. In another study of kapalbhati on heart rate variability (HRV), during kapalabhati practice, there is an increase in the LF/HF ratio, and low frequency (LF) both indicate sympathetic system activation and predominance, respectively, but high frequency (HF) showed a significant decrease, which indicates a decline in parasympathetic tone. These findings thus imply that sympathetic tone dramatically increases during kapalbhati, whereas parasympathetic activity decreases [19].

The study conducted on the immediate effect of slow bhastrika pranayama for 30 minutes shows a reduction in blood sugar levels, heart rate, and blood pressure. This shows that activating the parasympathetic nervous system, which improves the body's healthy cardiovascular function, can lower blood sugar by encouraging the pancreas to secrete more insulin

[21]. A study done on cerebrovascular hemodynamics during bhastrika pranayama shows a significant reduction in end-diastolic velocity (EDV) and mean flow velocity (MFV) and an increase in pulsatility index (PI) between 15 and 60s, which suggests sympathetic activation was reported indirectly through the rise in heart rate, rate pressure product, and double product. Since vasoconstriction-induced lowering of EDV is the primary mechanism by which the arteriolar sphincters limit blood flow [22].

Another study conducted by the same author suggested that following 5 minutes of bhastrika pranayama practice, there was a significant increase in diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), and cardiac output (CO), as well as a significant decrease in PI. This indicates that parasympathetic withdrawal or sympathetic activity may have affected cardiovascular processes. Bhastrika and Kapalbhati practices both cause circulatory alterations in healthy people that are more or less identical [23].

Table 4: Changes in cardiovascular system

Author	Years	Sample size	Variables studied	Findings
Bal BS	2015	40	VO2max, Cholesterol, Triglycerides, SBP, DBP, FBS, PPBS & BI.	Increase VO2max, decreases in SBP, DBP, FBS & PPBS. No changes in cholesterol, Triglycerides & BI.
Jha KS et al.	2017	100	SBP & DBP	Following 3 mins of kapalabhati shows significantly reduced in SBP & DBP after 3 mins of practice.
Gupta R	2020	20	HRV	There is increase in LF & reduction in HF band power lead to a significant increase in the LF/HF ratio during-kapalbhati as compared to the baseline.
Bal BS	2015	30	VO2max, Cholesterol, Triglycerides, SBP, DBP, FBS, PPBS & BI.	Increase VO2max, decreases in SBP, DBP, FBS & PPBS. No changes in cholesterol, Triglycerides & BI.
Payel D & Vivek P	2017	10	Blood glucose level, HR & BP	Reduced in blood glucose level, HR & BP following 30 mins of slow bhastrika pranayama.
Nivethitha L at el.	2017	15	Cerebrovascular hemodynamic (PSV, EDV, MFV and PI)	Reductions in EDV and MFV with a increase in PI significantly during Bhastrika Pranayama
Nivethitha L at el.	2021	20	SBP, DBP, MAP, HR, SV, CO, PI & TPR	Significant increase in DBP, MAP, HR and CO as well as significant decrease in PI during following 5 min of Bhastrika practice.

Clinical benefits

Bronchial asthma: A study was conducted on the effect of kapalabhati on 60 patients with bronchial asthma. According to this study, bronchial asthma patients' lung functions significantly improved after 10 minutes of kapalabhati. This practice, which involves the contraction and expansion of abdominal and intercostal muscles isometrically, may also boost the forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) by strengthening the intercostal muscles. So this study hypothesises that an increase in FEV1 will cause a momentary rise in muscular tone and a rise in FVC points after kapalabhati, which will contribute to improving red blood cells' ability to carry oxygen and overall respiratory muscle endurance. Kapalabhati may be a useful treatment to enhance lung function in bronchial asthma patients [24].

Diabetes mellitus: A study conducted with 50 outpatient diabetes patients involved comparing the effects of bhastrika and kapalabhati pranayama on blood glucose levels over the course of five weeks. The results demonstrate that there is considerable improvement in both groups. Therefore, pranayama can be used in the treatment of diabetes [25].

Obesity: A study on the effects of kapalabhati pranayama on 60 overweight people for 8 weeks suggested that there were small improvements in hip and waist circumference in the pranayama group. Consequently, kapalabhati can be used to regulate body weight [26]. A study on the impact of bhastrika pranayama on obese subjects for 60 days, during which time it was practiced twice daily for 10 minutes, showed differences between the study group and the control group in terms of weight, BMI, and skin fold thickness. Bhastrika pranayama can therefore be used as a therapeutic module in the management of weight loss [27].

On Hypertension: A study was conducted on the effect of bhastrika pranayama on hypertension with related complaints such as loss of focus, insomnia, anxiety, DBP and SBP, and constipation. The results suggested that there was significant relief. Was provided for diastolic hypertension, improved the quality of sleep, and relieved constipation with bhastrika, which also improves digestion. Bhastrika Pranayama primarily affects the pituitary gland, thyroid gland, and adrenal gland by controlling their activity, which has an antihypertensive effect on the body and generates calmness, tranquilly, and single-mindedness of the mind by balancing and enforcing the endocrine and neurological systems. It is also thought to help with respiratory problems, obesity, and diabetes [28].

Table 5: Clinical benefits

Author	Years	Sample size	Conditions	Variable studied	Finding
Raghavendra P et al.	2016	60	Bronchial Asthma	FEV1, FVC & FEV1/FEC ratio.	Increase in FEV1, FVC & FEV1/FEC ratio after 10mins of kapalabhathi.
Varun V	2018	50	Type 2 Diabetes Mellitus	FBG, PPBG.	Reduced in both FBG & PPBG following 5 weeks.
Kekan et al	2013	60	Overweight	Waist circumference & hip circumference	Slightly change in Waist circumference & hip circumference following 8 weeks kapalabhati pranayama.
Rani J	2018	60	Obesity	Height, Weight, BMI, Hip & Waist Circumference & Waist-Hip ratio & Abdominal skin fold thickness	Reduction in weight, BMI, and skin fold thickness following 60 days.
Ranawat RS et al.	2015	30	Hypertension	Lack of concentration, Insomnia, Anxiety score, constipation, SBP & DBP.	Improved concentration, quality of sleep, digestion & decreased in SBP & DBP.

Contra-indication of kapalabhati and bhastrika pranayama: Hath Yoga Pradipika and the Asana Pranayama Mudra Bandhas book state this. Patients with high blood pressure, heart illness, brain tumours, epilepsy, stroke, retinal issues, glaucoma or vertigo, stomach or intestinal ulcers, dysentery or diarrhoea, hernias, or gastric ulcers should refrain from practicing bhastrika and kapalabhati pranayama [1,3].

CONCLUSION

It has been found that kapalabhati and bhastrika pranayama have an impact on the body's pulmonary, autonomic, and cognitive functions. The effects of kapalabhati and bhastrika pranayama for treating bronchial asthma symptoms and enhancing pulmonary functions, changing body weight, and reducing blood sugar levels in diabetics have been studied in clinical populations. As a result, bhastrika pranayama and kapalabhati are safe, low-cost practices that can aid in the prevention of a range of non-communicable diseases. The search was restricted to free internet databases, which might restrict access to actual field research activities, which is one of the limitations of the current review. Additionally, no attempt was made to determine the statistical validity of the data offered in the literature; instead, the current review is restricted to a narrative of the most recent scientific research on kapalabhati and bhastrika pranayama that is currently available. In general, we discovered that performing kapalabhati and bhastrika pranayama under the instruction of a qualified teacher was safe. Further large-scale research with stronger methodological methods to understand the mechanisms associated with pranayama is necessary in light of the benefits of kapalabhati and bhastrika pranayama.

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