

# Effect of 6 weeks Kapalabhati pranayama training on pulmonary and cardiovascular parameters of young, prehypertensive obese medical students

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## Abstract

**Background:** Prehypertension is a state of high normal blood pressure. Obesity is a state of excessive accumulation of fat in body. Yogic exercises may be beneficial in prehypertensive obese people. Kapalabhati is kriya of hath yoga, which involves very fast respiration at 120 respiratory strokes/minute.

**Objective:** To find out the effect of 6 weeks Kapalabhati pranayama training on pulmonary and cardiovascular parameters of young, prehypertensive obese medical students.

**Materials and Methods:** Subjects were divided into two groups of 30 each. Group A (control group) comprised nonobese normotensive subjects, and group B comprised prehypertensive obese subjects. Pulmonary and cardiovascular parameters were recorded using computerized spirometer and impedance cardiograph, respectively. After training of Kapalabhati pranayama, subjects of group B practiced it for 1 min daily for 6 weeks. All parameters were recorded in group B before and after 6 weeks Kapalabhati practice and in group A as control group. Statistical analysis was done by One-way ANOVA and Tukey post hoc tests.

**Result:** Results showed significantly lower forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), peak expiratory flow rate (PEFR), expiratory reserve volume (ERV), and maximum voluntary ventilation (MVV) ( $p < 0.05$ ) and significantly higher inspiratory reserve volume (IRV) ( $p < 0.05$ ) in group B before Kapalabhati in comparison to group A. After 6 weeks training of Kapalabhati, group B presented significantly higher PEFR and MVV ( $p < 0.05$ ) in comparison to group A. FVC, FEV1, FEV1/FVC, ERV, and IRV were insignificantly lower in group B after 6 weeks Kapalabhati training in comparison to group A. In comparison to group A, all cardiovascular parameters were significantly higher ( $p < 0.05$ ) in group B before training but did not show significant difference ( $p > 0.05$ ) after 6 weeks training.

**Conclusion:** Results indicate significant improvement in cardiovascular and pulmonary parameters in prehypertensive obese subjects after 6 weeks practice of Kapalabhati.

**KEY WORDS:** Kapalabhati, obesity, prehypertension computerized spirometer, impedance cardiograph

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## Introduction

Today, human life is full of stress, and people face stress in day-to-day life. Anxiety, stress, and depression are very common mood disorders.<sup>[1]</sup> Many researchers have proven a positive correlation between stress and obesity. Less physical activity and overeating of fast food lead to development of obesity in these children and young adults, especially in high

socioeconomic groups and further development of stress, anxiety, and depression with associated sympathetic overactivity.

Prehypertension is a state of high normal blood pressure that is below the level to be classified as hypertension. Systolic blood pressure (SBP) ranges between 120 and 139 mm Hg and diastolic blood pressure (DBP) between 80 and 89 mm Hg in prehypertension. It is very common in young adults with family history of hypertension.

Obesity is a state of excess adipose tissue mass. Body mass index (BMI) of 30 kg/m<sup>2</sup> is most commonly used as a threshold for obesity in both men and women. Chronic excess of nutrient intake relative to the level of energy expenditure leads to obesity. Obesity is a risk factor for many cardiovascular diseases including hypertension, coronary heart disease, etc. Obesity also adversely affects pulmonary functions and may lead to dyspnea, reduced work capacity, and exercise intolerance. Obesity-induced hypertension is associated with increased peripheral resistance and cardiac output and increased sympathetic nervous system tone. Hypertension is very likely to develop in prehypertensive obese young adults if prevention strategies are not applied on time.<sup>[2,3]</sup>

Yoga and meditation have been found useful in the treatment of generalized anxiety disorder, stress, and related disorders such as obesity.<sup>[4,5]</sup> Yoga and meditation may modulate hypothalamus and limbic system activity leading to conditioning of these areas to regulate sympathetic activity and endocrine secretions for restoration of normal homeostatic conditions.<sup>[6,7]</sup> *Kapalabhati* is a kriya or cleansing technique mentioned in *Hatha Yoga Pradipika*. It is supposed to shine the forehead. In contrast to deep breathing relaxation exercises of pranayama, *Kapalabhati* involves very fast respiration at 120 respiratory strokes/minute during the exercises, which are obviously shallow in nature. It is considered as stimulating in nature.<sup>[8,9]</sup>

It leads to "autonomic activation." *Kapalabhati* exercise leads to increased heart rate and systolic blood pressure as an immediate effect.<sup>[10]</sup> Studies have demonstrated increased heart rate and SBP during *Kapalabhati* and immediately after it. Heart rate variability (HRV) spectrum also established the fact that *Kapalabhati* shifts the sympathovagal balance toward sympathetic activation, which increases the heart rate and blood pressure. *Kapalabhati* markedly influences the brain activities during and after exercise. Relaxation on a subjective level is reported as the after effect of KB (*Kapalabhati*) exercise with a relative increase of slower EEG frequencies. During *Kapalabhati*, alpha, beta 1, and theta activities were increased, while after exercise, alpha and beta 1 activities decreased below basal level but not the theta activity.<sup>[11]</sup> Similar types of studies using HRV as an indicator of the cardiac autonomic control have also shown the effect of *Kapalabhati* on autonomic nervous system and found a significant increase in low-frequency (LF) power and LF/HF ratio with significantly lower high frequency (HF) during *Kapalabhati* and suggested that *Kapalabhati* modifies the autonomic status by increasing sympathetic activity with reduced vagal activity.<sup>[12]</sup>

Most of the systems of *Hatha Yoga* involve *Kapalabhati* practice, which indicate the long-term beneficial effect of

sympathetic arousal. Studies have also shown decrease in blood urea and increase in creatinine and tyrosine after 1 min of *Kapalabhati* indicating that *Kapalabhati* promotes decarboxylation and oxidation mechanisms leading to quieting of respiratory centers.<sup>[13,14]</sup>

Studies have shown evidence for the relationship between chronic stresses, alterations in hypothalamic–pituitary–adrenal axis activity, and obesity.<sup>[15]</sup> Therefore, this study was conducted to find out the effect of 6 weeks *Kapalabhati* pranayama training on pulmonary and cardiovascular parameters of young, prehypertensive obese medical students.

## Materials and Methods

This study was conducted in the Department of Physiology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India. Sixty asymptomatic healthy male subjects, aged 17–22 years, participated voluntarily in this study undertaken, to assess the effect of 6 weeks *Kapalabhati* pranayama training on pulmonary and cardiovascular parameters of young, prehypertensive obese medical students. Experiment procedures were in accordance with the ethical committee on human experimentation. Study was carried out at ambient temperature with minimal external or internal sound disturbances in the room. Subjects reported to laboratory 3 h after light breakfast. They were explained in detail about the experimental procedure. Informed consent was taken from all subjects. On the basis of BMI, subjects were divided into two groups. Group A (control group) comprised nonobese normotensive subjects (BMI < 25 kg/m<sup>2</sup>, SBP < 120 mm Hg, and DBP < 80 mm Hg) and group B comprised prehypertensive obese subjects (BMI > 30 kg/m<sup>2</sup>, SBP > 120 mm Hg; <139 mm Hg, and DBP > 80 mm Hg; < 89 mm Hg). Basal parameters and baseline characteristics of all subjects of both group A and group B were recorded (Table-1). Pulmonary function tests were done using computerized spirometer (RMS-Helios). Cardiovascular parameters were recorded using impedance cardiograph (Nivomon) and mercury sphygmomanometer.

Then, *Kapalabhati* pranayama training was given to the prehypertensive obese subjects of group B. Subjects were instructed to inhale deeply and start exhaling forcibly at the rate of 120 breath cycles per minute (2.0 Hz frequency). Forceful exhalations were followed by passive inhalations.<sup>[12,16]</sup> After training, subjects of group B were asked to practice *Kapalabhati* pranayama for 1 min daily for 6 weeks. After 6 weeks practice of *Kapalabhati* pranayama, subjects again

**Table 1:** Baseline characteristics of all subjects of both groups A and B before 6 weeks *Kapalabhati* pranayama training

	Group A	Group B
Age (in years)	21.12 (1.14)	21.54 (1.36)
Height (cm)	172.56 (2.34)	171.84 (2.18)
Weight (kg)	64.45 (4.47)	84.34 (4.14)
BSA (m <sup>2</sup> )	1.75 (0.06)	1.98 (0.19)
BMI (kg/m <sup>2</sup> )	23.62 (1.12)	31.26 (1.16)

**Table 2:** Comparison of pulmonary function parameters in prehypertensive obese subjects of group B before and after 6 weeks Kapalabhati pranayama training with control group A

Respiratory parameters	Group A (control group, n = 30)	Group B (prehypertensive obese, n = 30)	
		Before training	After training
Forced vital capacity (FVC) (L)	4.15 (0.12)	3.73 (0.1)*	3.98 (0.12)
Forced expiratory volume in the first second (FEV1) (L)	3.36 (0.13)	3.16 (0.08)*	3.24 (0.09)
FEV1/FVC	85.06 (0.82)	85.15 (1.12)	84.2 (1.46)
Peak expiratory flow rate (PEFR) (L/s)	8.41 (0.18)	8.02 (0.13)*	8.62 (0.32)#
Inspiratory reserve volume (IRV) (L)	2.12 (0.07)	2.52 (0.92)*	2.11 (0.08)
Expiratory reserve volume (ERV) (L)	0.96 (0.03)	0.73 (0.05)*	0.92 (0.04)
Maximum voluntary ventilation (MVV) (L/min)	134.32 (5.51)	113.92 (6.56)*	145.24 (8.56)#

Data presented as mean (SD). Analysis of data was done by One-Way ANOVA and Tukey post hoc tests.

\*Comparison between groups A and B before training, \* $p < 0.05$  (significant).

#Comparison between groups A and B after training, # $p < 0.05$  (significant).

**Table 3:** Comparison of cardiovascular parameters in prehypertensive obese subjects of group B before and after 6 weeks Kapalabhati pranayama training with control group A

Cardiovascular parameters	Group A (control group, n = 30)	Group B (obese, n = 30)	
		Before training	After training
Systolic blood pressure (SBP) (mm Hg)	114.12 (3.25)	132.74 (4.2)*	115.2 (2.82)^
Diastolic blood pressure (DBP) (mm Hg)	72.22 (2.63)	82.32 (2.85)*	73.02 (2.34)^
Heart rate (HR) (per minute)	70.28 (0.13)	76.4 (2.46)*	71.28 (0.83)^
Cardiac output (CO) (L/minute)	5.12 (0.18)	5.64 (0.37)*	5.22 (0.11)^
Stroke volume (SV) (mL/beat)	72.84 (0.68)	75.21(1.75)*	73.04 (1.86)^
Systemic peripheral resistance (SPR) (dyne.sec/cm <sup>5</sup> )	1,356.18 (15.14)	1,398 (16.44)*	1,346.1 (18.4)^
Cardiac index (CI) (L/minute/m <sup>2</sup> )	3.02 (0.07)	3.2 (0.46)*	3.01 (0.35)^
Stroke volume index (SI) (mL/beat/m <sup>2</sup> )	43.11 (0.02)	45.56 (0.03)*	44.12 (0.13)^
Systemic vascular resistance index (SVRI) (dyne.sec/cm <sup>5</sup> /m <sup>2</sup> )	768.54 (13.52)	788.5 (14.16)*	764.5 (11.43)^

Data presented as mean (SD). Analysis of data was done by One-way ANOVA and Tukey post hoc tests.

\*Comparison between groups A and B before training. \* $p < 0.05$ , significant.

^Comparison between groups A and B after training. ^ $p > 0.05$ , nonsignificant.

reported to the laboratory. All pulmonary and cardiovascular parameters were recorded again.

### Statistical Analysis

Statistical analysis was done by One-way ANOVA and Tukey post hoc tests using SPSS software, version 17. Data were expressed as mean, and standard deviation and  $p$  value  $< 0.05$  was considered as significant.

### Result

Table 2 shows that prehypertensive obese subjects of group B before Kapalabhati presented significantly lower forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), peak expiratory flow rate (PEFR), expiratory reserve volume (ERV), and maximum voluntary ventilation (MVV) ( $p < 0.05$ ) and significantly higher inspiratory reserve volume (IRV) ( $p < 0.05$ ) in comparison to group A.

After 6 weeks training of Kapalabhati, group B presented significantly higher PEFR and MVV ( $p < 0.05$ ) in comparison to group A. FVC, FEV1, FEV1/FVC, ERV, and IRV were insignificantly lower in subjects of group B after 6 weeks Kapalabhati training and nonobese subjects of group A.

Table 3 shows that all cardiovascular parameters such as SBP, DBP, heart rate, cardiac output, cardiac index, stroke volume, stroke volume index, systemic peripheral resistance, and systemic resistance index were significantly higher ( $p < 0.05$ ) in group B before training in comparison to group A. There was no significant difference in cardiovascular parameters in subjects of group B after training in comparison to group A ( $p > 0.05$ ).

### Discussion

Obesity has been found to be associated with a number of pulmonary abnormalities including reduced chest wall

compliance, increased work of breathing, increased minute ventilation owing to increased metabolic rate, and decreased total lung capacity and functional residual capacity. Our results also have shown significantly decreased FVC, FEV<sub>1</sub>, PEFR, ERV, and MVV and increased IRV in prehypertensive obese subjects before 6 weeks Kapalabhati practice. All these parameters significantly improved after 6 weeks Kapalabhati practice, and pulmonary functions were comparable with the nonobese normotensive subjects leading to no significant difference in FVC, FEV<sub>1</sub>, ERV, and IRV. In addition to these parameters, PEFR and MVV values were significantly higher in prehypertensive obese than the nonexercising, nonobese normotensive subjects, which indicate marked improvement in pulmonary functions of prehypertensive obese subjects. This improvement in respiratory function seems to be owing to increase in strength of abdominal muscles, diaphragm, and accessory muscles of respiration and reduction of local fat from abdomen. It also seems to improve alveolar ventilation and perfusion in lungs.

Simultaneously, there was high normal blood pressure of prehypertensive obese, which also came to normotensive level after 6 weeks practice of Kapalabhati, with significant reduction in heart rate and systemic peripheral resistance. This indicates that Kapalabhati exercise increases the sympathetic tone only during the exercise, but final after effect of exercise is reduced sympathetic tone or increase in vagal tone. This may be comparable with increased vagal tone and resting bradycardia in trained athletes, where isotonic exercise produces increased sympathetic activity during the exercise, but final after effect is increased vagal tone leading to resting bradycardia.

### Strength and Limitations of the Study

Direct measurement of effect of Kapalabhati cardiovascular parameters such as cardiac output and systemic peripheral resistance by impedance cardiograph is the key strength along with accurate measurement of pulmonary functions using computerized spirometer. Study is limited to healthy young adults and not involving subjects with epilepsy, asthma, chronic smoker with chronic obstructive pulmonary disease, etc. Risk of precipitation of acute attack of these diseases by performing Kapalabhati is the limitation of the study.

### Conclusion

Kapalabhati practice improves the pulmonary functions and normalizes the high normal blood pressure of prehypertensive obese; therefore, it may be a useful tool to keep the person healthy throughout the life if it is practiced regularly as the beneficial effects of Kapalabhati pranayama are encouraging, and duration of exercise is very less—only 1 min per day in comparison to other yogic exercises. Therefore, possible superiority of Kapalabhati pranayama over other yogic exercises cannot be ruled out.

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