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Role of yogic practices in individuals with hypertension and low-Peak Expiratory Flow Rate (PEFR) of Ahmedabad city

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Hypertension is one of the most important risk factors for various heart related diseases in India, especially in South-Asian region. Nowadays because of very fast life style, breathing pattern and its duration is changed considerably. Breathing duration becomes very short. The main aim of the present study was to assess the therapeutic role of yoga on various cardiovascular parameters, peak expiratory flow rate (PEFR) through pulmonary function test and peripheral capillary oxygen saturation (SpO_2), amount of oxygen in the blood in Ahmedabad population. Total 50 individuals with hypertension, low-PEFR and low-SpO_2 were selected for the present study. All participants were subjected to yoga therapy (pranayama, yoga postures and meditation) for various time intervals of 0, 3, 6, 9, and 12 months. Heart rate (HR), systolic pressure (SP), diastolic pressure (DP), pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP), double product (DoP), PEFR and SpO_2 were measured from all individuals at different intervals. At 0 month, all individuals had very high heart rate (HR), systolic pressure (SP), diastolic pressure (DP), pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP), double product (DoP), but PEFR and SpO_2 levels were very low. At the end of 12 month of yoga intervention, significant decrease in all cardiovascular parameters whereas significant elevation of PEFR and SpO_2 levels were observed. In conclusion, a comprehensive yoga therapy programme has immense potential to augment the beneficial effects of standard medical management of hypertension, lungs function and total oxygen concentration. Hence it can be used as an effective complementary therapy for heart related diseases.

Keywords: Ahmedabad, Hypertension, Low-Peak Expiratory Flow Rate (PEFR), Therapeutic role, Yoga

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In today's competitive world, hectic and physically inactive routine leads to various non-communicable diseases (NCDs), such as lung diseases, heart related diseases, stroke and diabetes. They are the real cause of morbidity and mortality in major countries. According to WHO, nearly 16 million people are dying prematurely due to NCDs globally[1]. Cardiovascular diseases (CVDs) had caused 16.6 million of the global deaths in which 7.2 million, 5.5 million and 3.9 million deaths because of ischemic heart disease, stroke and hypertension respectively. In India, among the different cardiovascular diseases, hypertension or high blood pressure (BP) and coronary heart diseases are in top of the list[2]. Higher prevalence rate of CVDs has been notified specifically in urban areas[3,4]. Physical fitness of any person depends upon his blood pressure (BP) and heart rate (HR). A person is considered physically fit if his HR ranges between 65 to 70 beats per minute (bpm) and blood pressure (BP) is 120/80 mmHg (systolic blood pressure-SBP: 120 mmHg and diastolic blood pressure-DBP: 80 mmHg). Such individuals may not be affected much by any kind of stress and tension i.e., at physical as well as mental level. However, in an individual with higher HR (>85/min) and BP (>140/90 mm Hg), the impact of stress may create many other problems, sometimes leading to heart failure also[5]. Rate pressure product (RPP) is also one of the essential determinant of physical fitness among adults as well as a valuable marker of the oxygen requirement in the heart. It indicates the internal myocardial work executed by the beating heart. RPP is defined as the product of resting heart rate (RHR) & systolic blood pressure (SBP). Heart is a muscular organ, its steady functioning needs constant supply of oxygen, but if this

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supply is poor, then there are chances of heart related problems to occur. Hence, the assessment of physical fitness is prerequisite to avoid the stress-induced heart related problems[6]. Lungs are most vital organ of the body. It is involved in exchange of gases. Oxygen enters in lungs as we breathe in and then is goes to the blood vessels deep in lungs and later on to all parts of our body. As our body uses oxygen, it makes carbon dioxide. We get rid of carbon dioxide when we breathe out. Oxygen is the fuel of life that keeps us all alive. Peak expiratory flow rate (PEFR), is a person's maximum speed of expiration that indicates a person's ability to breathe out air. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. Oxygen saturation is used as primary diagnosis of low blood oxygen content. It is very important for patient, athlete and sedentary individuals. The efficiency of respiratory system and ventilation declines as age advances due to various factors[7].

Yoga is a real lifestyle intervention that includes practices such as asana (postures), pranayama (breathing), meditation and relaxation that have been shown to help in reducing cardiovascular risk and high blood pressure. Pranayama are increasingly being used for therapeutic purposes, and it may be especially helpful in managing hypertension[8]. Yoga has been found to be an effective adjunct therapy for various problems like depression, stress, anxiety, hypertension, asthma, dyslipidemia, etc[9,10,11]. Regular and systemic practice of pranayama improves cardio-vascular and respiratory functions. Veerabhadrappa et al.[12], reported an increase in parasympathetic activity i.e., reduced basal heart rate and decline in sympathetic activity after yoga. Six weeks of yogic exercise programme improved ventilatory functions as revealed by significant increase in forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and peak expiratory flow rate (PEFR)[7]. The present study was undertaken to assess the impact of yoga practice in individuals of with hypertension, low-PEFR and low-SpO_2 at different time intervals of 3, 6, 9 and 12 months, of Ahmedabad city.

Materials and methods

Inclusion and exclusion criteria

Inclusion criteria included individuals who were non-smoker, non-athlete, non-medicated and non-pregnant with the willingness to perform different yoga exercises throughout entire year.

Exclusion criteria included individuals who performed various exercises and received medication for heart related problems, mental disorders, hypertension etc.

Informed consent and ethical clearance: Participants were informed about the nature and scope of the study. Written consents were obtained from all of them. Ethical clearance was obtained from Institutional Ethical Committee to perform studies on the effect of yoga therapy on participants.

Study design and data collection: In the present study 50 participants were included who had hypertension, low-PEFR and low-SpO_2 levels.

Yoga training: All individuals were taught pranayama, yoga postures and meditation for 3, 6, 9 and 12 months by expert yoga teacher. Brief yoga intervention module is described in Table 1.

Cardiovascular parameters: Basal data recordings were taken in sitting posture after 5 min of rest in a chair. Systolic pressure (SP) and diastolic pressure (DP) and heart rate (HR) were measured with non-invasive semiautomatic BP monitor (Omron Inc., Japan). Pulse pressure is the difference between the systolic and diastolic blood pressure (PP=SP-DP). It is measured in millimetres of mercury (mmHg). Mean arterial pressure (MAP)=systolic blood pressure PLUS (diastolic blood pressure which is multiplied by 2) and then DIVIDED by 3 (MAP={SBP+2[DBP]}/3). Rate pressure product (RPP=SP x HR x 10^{-3}) and double product (DoP=HR x MAP x 10^{-3}) were calculated for each recording.

Peak Expiratory Flow Rate (PEFR): PEFR was measured by using Mini-Wright standard peak flow meter (Clement Clarke, England). Participants were instructed to blow through the mouth piece into the peak flow meter. When participants blow through the mouth piece, the piston of the instrument is pushed frontward and it drives an independent sliding pointer along a slot marked with a scale graduated 60-800 L/min. The pointer records the maximum

Table 1 — Brief yoga intervention module.

Sequence	Intervention of Yoga	Time duration (60 min)	Schedule
1	Yogic prayer	05 min	6 days/week (Monday, Tuesday, Wednesday, Thursday, Friday and Saturday)
2	Pranayama	20 min	
3	Flexibilities	10 min	
4	Asanas (Yoga postures)	15 min	
5	Sun salutation (Suryanamaskar)	05 min	
6	Meditation	05 min	

movement of the piston and remains in that position until returned to zero by the participant. The mouthpiece is detachable. The instrument is cleaned and wiped regularly after every use.

Peripheral capillary oxygen saturation (SpO_2-amount of oxygen in the blood or Pulse oximetry): Peripheral capillary oxygen saturation was measured using the pulse oximeter device. All participants were instructed to plug their index finger into silicone hole of pulse oximeter (Operon iO2).

Wellness questionnaire: A post-intervention, wellness questionnaire[13] was used to evaluate the overall wellness of participants after 12 months of yoga therapy programme. Five different responses were recorded in the questionnaire. Wellness questionnaire was provided to all study participants after 12 months to provide their responses of wellness.

Statistical analysis: The collected data was analysed using statistical software SPSS version 16.0. Data are represented as Mean±standard error. Statistical analysis was done using a student's t-test for paired samples. P values less than 0.05 (<0.05) were accepted as a statistical significant differences.

Results

Table 2 shows all the cardiovascular parameters as mean±SM. After 3, 6, 9, and 12 months of yoga treatment all parameters showed gradual reduction. After 12 months, HR reduced from 90.12±0.09 to 72.04±0.08 (beats/min) which is a significant reduction ($p<0.05$). SP and DP also reduced from 161.94±0.42 and 107.26±0.19 at 0 month to 124.60±0.16 and 80.26±0.13 ($p<0.05$) after 12 months respectively. PP and MAP reduced from 54.68±0.50 and 125.48±0.17 at 0 month to 44.34±0.21 and 95.04±0.10 after 12 months respectively. After 12 months, RPP and DoP reduced to 8.98±0.01 and 6.84±0.01 ($p<0.05$) from 14.60±0.04 and 11.31±0.02 at 0 month respectively.

Fig. 1 depicts total numbers of participants into two groups. Group 1) <400 L/min which was considered as a low-PEFR, where as another Group 2) 400-640 L/min which was considered as a normal-PEFR. After successful completion of 3, 6, 9 and 12 months of yoga treatment, number of participants reduced gradually in Group 1) i.e., <400 L/min, whereas on the other hand Group 2) i.e., 400-640 L/min showed gradual increase in total number of participants. At 0 month all 50 participants had low-PEFR, but after 12 months of yoga therapy mostly they all showed normal-PEFR.

Fig. 2 illustrates total number of participants into two groups. Group 1) 80-90% SpO_2 level which was adopted as a low-SpO_2 level, whereas another Group 2) 90-100% SpO_2 level which was adopted as a normal-SpO_2 level. At 0 month, out of 50 participants, more than 40 had low-SpO_2 level, whereas remaining had normal-SpO_2 level. After 3, 6, 9 and 12 months of yoga intervention, number of participants gradually declined in Group 1) i.e., 80-90% SpO_2, where as another Group 2) i.e., 90-100% SpO_2 displayed gradual increment in number of participants. Hence, after 12 months of yoga therapy all participants had normal-SpO_2 level.

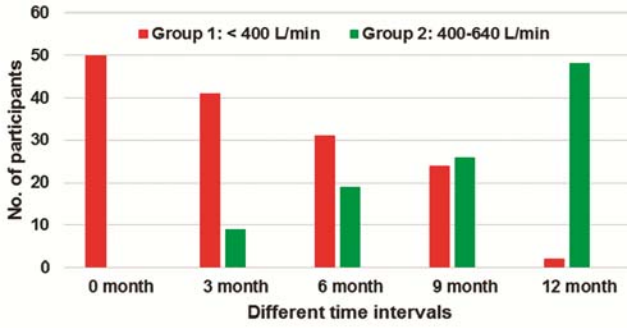

Fig. 1 — Total number of participants with PEFR at different time intervals after yoga treatment

Table 2 — Effect of yoga intervention on heart rate (HR), systolic pressure (SP), diastolic pressure (DP), pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP) and double product (DoP) in hypertensive individuals at different time intervals.

Cardiovascular parameters	0 month	3 month	6 month	9 month	12 month
HR (beats/min)	90.12±0.09	85.34±0.09[a]	81.44±0.07[a]	74.62±0.08[a]	72.04±0.08[a]
SP (mmHg)	161.94±0.42	148.24±0.31[a]	138.96±0.25[a]	128.00±0.16[a]	124.60±0.16[a]
DP (mmHg)	107.26±0.19	103.14±0.19[a]	94.00±0.16[a]	87.52±0.14[a]	80.26±0.13[a]
PP (mmHg)	54.68±0.50	45.10±0.39[a]	44.96±0.32[a]	40.48±0.23[a]	44.34±0.21[a]
MAP (mmHg)	125.48±0.17	118.17±0.15[a]	108.98±0.12[a]	101.01±0.10[a]	95.04±0.10[a]
RPP (units)	14.60±0.04	12.65±0.03	11.31±0.02[a]	9.55±0.01[a]	8.98±0.01[a]
DoP (units)	11.31±0.02	10.08±0.01	8.87±0.01[a]	7.53±0.01[a]	6.84±0.01[a]

Values are mean±S.E
S.E.=Standard Error, NS=Non Significant,
[a]$p<0.05$ (when compared with 0 month)

Table 3 shows detailed breakup of responses of all participants in percentage after 12 months of yoga treatment. Fig. 3 explains the post-intervention overall wellness of the participants. Overall wellness indicated 56% participants felt complete relief and total satisfaction, 28% participants felt much better than before, 12% participants felt better than before and 4% participants felt same as before. None of the participants felt worse than before, after 12 months of yoga therapy programme.

Discussion

In the present study, yoga treatment of 3, 6, 9, and 12 months to study participants showed gradual decrease in HR, SP and DP. Eight weeks of yoga treatment significantly reduced HR, SP and DP in support of our data[12]. Innes & Vincent[14] mentioned that yoga reduces pathogenesis of atherosclerosis and cardiovascular diseases by decreasing activation of the sympathetic system and the hypothalamic-pituitary-adrenal axis and also by promoting a feeling of wellness along with direct improvement of parasympathetic activity. Udupa et al.[15], reported that 3 months of pranayama training results in modulation

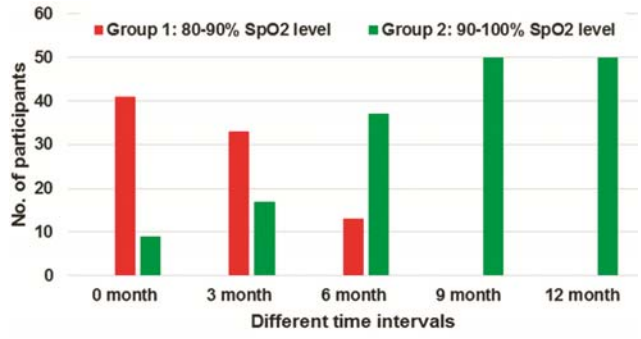

Fig. 2 — Total number of participants with SpO_2 levels at different time intervals after yoga treatment.

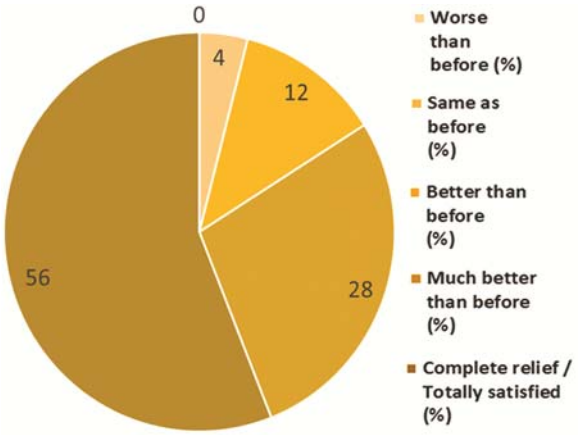

Fig. 3 — Post-intervention overall responses of the participants (in percentage) to the wellness questionnaire

Table 3 — Post-intervention responses of participants (in percentage) to wellness questionnaire.

Type of feeling	Worse than before (%)	Same as before (%)	Better than Before (%)	Much better than before (%)	Complete relief / Totally satisfied (%)
Ability to concentrate	-	4.00	18.00	30.00	48.00
Control of anger / loss of temper	-	8.00	12.00	28.00	52.00
Appetite	-	6.00	10.00	36.00	48.00
Confidence level	-	8.00	14.00	48.00	30.00
Ease of breathing	-	6.00	12.00	46.00	36.00
Energy levels	-	4.00	14.00	48.00	34.00
Enjoyment of life	-	6.00	18.00	26.00	50.00
Feeling calm & fresh	-	8.00	12.00	42.00	38.00
Feeling of hopelessness	-	4.00	14.00	36.00	46.00
Feeling of loneliness	-	2.00	16.00	34.00	48.00
General Flexibility	-	4.00	12.00	38.00	46.00
General mood	-	6.00	10.00	26.00	58.00
General sense of relaxation	-	8.00	16.00	50.00	26.00
General wellbeing	-	6.00	12.00	24.00	58.00
Joint mobility	-	4.00	16.00	52.00	28.00
Nervousness	-	2.00	12.00	46.00	40.00
Pain levels	-	4.00	14.00	30.00	52.00
Performance of day-to-day activity	-	6.00	16.00	46.00	32.00
Sleep quality / duration	-	8.00	8.00	42.00	42.00
Stress levels	-	6.00	10.00	34.00	50.00
Overall wellness	-	4.00	12.00	28.00	56.00

of ventricular performance by enhancing parasympathetic activity and decreasing sympathetic activity, which may be the main reason in our study to reduce HR, SP and DP. 12 weeks of pranayama training showed slight decrease in all basal cardiovascular parameters i.e., HR, SP and DP as observed in our study[16]. Sharma et al.[17], found that 30 days of yogic kriya significantly reduces DP, as reported in our data. RPP is an important indicator of ventricular functional status. Determination of cardiac oxygen consumption becomes very important in monitoring the level of exercise to be done by various individuals like obese persons, cardiac patients and diabetic patients. In the present study, PP, MAP, RPP and DoP showed gradual decrease after 3, 6, 9 and 12 months of yoga intervention programme. The PEFR is commonly considered as an indicator of alterations in elastic recoil of lungs, airway resistance and strength of expiratory muscles. Breathing is the only autonomic function and is the key in bringing the sympathetic and the parasympathetic nervous system into harmony. By practicing pranayama, the various reflex mechanisms may get altered by producing a strong cortical force which in turn alters the autonomic nervous system so that it shifts towards the parasympathetic dominance and has favorable effects on respiratory system. After 12 months of yoga, there was a significant difference in all these parameters when compared to 0 month, which has also been supported by several other authors[6,13]. Present study showed gradual increase in PEFR after 3, 6, 9 and 12 months of yoga programme. After 12 months, there was a significant difference in PEFR when compared to 0 month. Chakraborty et al.[7], documented that yogic exercise significantly increases FVC, FEV1 and PEFR in corroboration of our data. 6 months of yoga training, significantly improved PEFR and vital capacity in study subjects[18]. Sing et al.[19], concluded from their research study that pranayama and stretching postures increase respiratory stamina, relax the chest muscles, expand the lungs, raise energy levels, and calm the body in asthma patients. They also found that pranayama significantly enhanced PEFR as observed in our study. Jiwtode and Rathod[20] documented significant increase in PEFR after integrated yoga module in children. In wheezing patients, practice of pranayama significantly improved PEFR[21] as observed in individuals with low-PEFR in present study. In present study, after 3, 6, 9 and 12 months of yoga intervention, significant enhancement of SpO_2 level was observed. In corroboration of data, Gokhle et al.[22], documented that pranayama intervention significantly increases oxygen saturation in blood (SpO_2). Yogic exercise improves oxygen saturation level, may be because of improvement in the blood circulation. Also there may be better perfusion of tissues, which increases the strength of respiratory muscles. With pranayama practice, there may be more intake of oxygen as much as five times. There may be also great improvement in the health by doing pranayama. Three months of yogic exercise significantly increased SpO_2 levels in chronic smokers[23].

Conclusion

It is evident from the present study that one year of yoga intervention programme produces significant improvement in various cardiovascular parameters, PEFR and SpO2 levels. It is a very cost effective and non-pharmacological technique for the treatment of hypertension. Yoga intervention programme has significant potential to enhance the beneficial effects of standard medical management of hypertension and can be used as an effective complementary treatment. This study also provides a scientific basis for improvement of PEFR and SpO_2. This may be due to systemic, scientific, regular slow and forceful inspiration and expiration during yoga practice, leading to strengthening of respiratory muscles and more blood circulation.

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