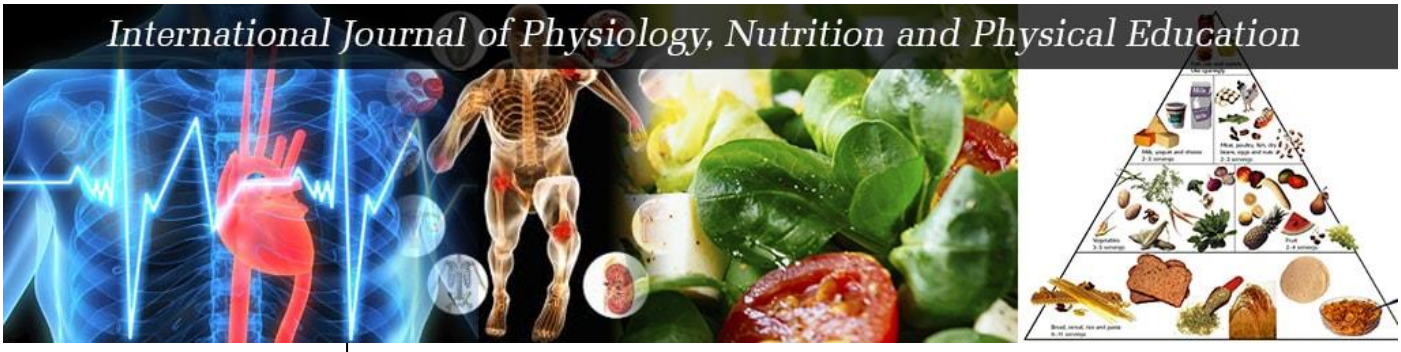

ISSN: 2456-0057
IJPNPE 2019; 4(1): 2120-2124

www.journalofsports.com
Received: 07-11-2018
Accepted: 09-12-2018

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Effect of Kapalbhati and selected Pranayama techniques on physiological parameters of middle aged sedentary women

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Abstract
Environmental pollution, rapid industrialization, overcrowding, sedentary lifestyle due to massive use of software technology, situational stress and anxiety are main responsible factors for deterioration of human physical health. Also prevalence of obesity in developing countries is believed to be on the rise. This requires special and specific techniques to transcend the limits of our physical and mental abilities experienced in everyday life. With increased awareness and interest in health and natural remedies, breathing techniques (Pranayamas) are gaining importance and becoming acceptable throughout the world. A total of thirty eight (38) middle aged sedentary women were selected as subjects in this study from different Yoga Training Institutions and Laughing Clubs of Paschim Medinipur district. They were divided into experimental and control groups, each group containing nineteen (19) subjects. To investigated the benefit of selected Pranayama techniques only the experimental group was asked to perform Kapalbhati, Anuloma Viloma and Bhramari Pranayama techniques for the duration of twelve (12) weeks. The selected physiological characteristics were resting respiratory rate, vital capacity, peak expiratory flow rate, resting heart rate, systolic blood pressure, diastolic blood pressure and body fat percent were measured by their respective standard tests. All physiological characteristics were assessed just before and after twelve (12) weeks in both the groups. Data was analyzed using SPSS, (Version 20.0) software. The level of significance chosen was 0.05. To compare between the mean scores of pre and post-test of the both groups Independent Sample t-test was applied. From the findings of the study it may be concluded that resting respiratory rate, vital capacity, peak expiratory flow rate and systolic blood pressure were significantly improved as compared to that of control group. Insignificant between the group differences were noted in resting heart rate, diastolic blood pressure and body fat percent. From the findings of this study we concluded that Pranayama techniques may be recommended to improve the selected physiological characteristics of middle age sedentary women for their economic and productive life style.

Keywords: Kapalbhati, Anuloma Viloma, Bhramari, vital capacity, peak expiratory flow rate

Introduction
Yoga appears to provide a comparable improvement in stress, anxiety and health status (Caroline *et al*., 2007) [3]. Yogic practices can be used as psycho-physiologic stimuli to increase endogenous secretion of melatonin, which in turn, might be responsible for improved sense of well-being (Harinath *et al*., 2004) [6]. Today yoga being an academic as well as professional subject of varied interests, has gained worldwide popularity. Recent research treads have shown that it can serve as an applied science in a number of fields such as education, physical education and sports, health and family welfare, medical field and also one of the valuable means for the development of human resources for better performance and productivity of life. It has generally been believed that yoga is a spiritual science having emancipation as its goals and hence cannot be treated only as a therapy (Sachan *et al*., 2015) [13]. Pranayama involves systemic and disciplined inspiration and expiration with retention or holding of breathe in specific proportion or specific manner. Pranayama is the first step towards reorienting and improving the functioning of mind and body by learning to utilize the air we breathe. Pranayama (breathing exercise), one of the yogic techniques can produce different physiological responses in healthy individuals (Upadhyay *et al*., 2008) [17].

Due to gradual enhancement of population, pollution and demands of personal need of the individuals, peoples are facing so many psycho-physiological problems in their daily life, mainly mental stress, anxiety, hypertension, obesity and problems of cardio-respiratory system too. Mainly air pollution gradually deteriorates the ventilatory efficiency of our lungs which reducing our functional capacity. This deteriorating ventilatory function of lungs may lead to chronic respiratory diseases like bronchial asthma, chronic bronchitis and bronchiectasis. Breathing exercises improve the functions of respiratory apparatus and improve lung functions. Pranayama, the controlled and conscious breathing exercise not only improves the psycho-physiological functions, but also improves the general well being of the individuals. It helps maintain a better homeostasis and prevents body from degeneration and dysfunctions.

Practice of pranayama in its true essence helps the individual to imbibe the higher universal energies and grow him spiritually. Pranayama is ventilatory function improving technique. Due to proper working of these organs, vital energy flows to maintain the normal homeostasis of the body and thus it helps for prevention, control and rehabilitation of many mental and respiratory diseases. Pranayama is a type of yogic practice which produces many systemic psycho-physical effects in the body, besides its specific effects on the respiratory functions. So, it has become a standard fare at health clubs and community recreation programmes (Mishra 1997) [10]. Many researchers and Yogis have reported the benefits of practicing pranayama on Diabetes Mellitus (Robert *et al*., 2001) [12], Heart Rate and Nervous System (Jerath *et al*., 2006) [7]. There are various techniques of pranayama but we have applied the techniques of Kapalbhati, Anuloma Viloma and Bhramari on the subjects with the discussion of yoga experts. Hence, in the present study, we made an attempt to investigate the beneficial effects if any, of selected Pranayama techniques in those subjects with reference to physiological characteristics.

Material and methods

Subjects: Total thirty eight (38) middle age sedentary female subjects of which nineteen (19) from different recognized Yoga Training Institutions and Laughing Clubs and rest of nineteen (19) middle age sedentary female subjects were selected from Paschim Midnapur district between the age group of 39 to 48 years volunteered to participate in this study. Subjects who were trained in yoga before, subjects with history of previous surgery, recent cardio-respiratory diseases, diabetes, asthma and any chronic illness were excluded from the study. The health status of the subject was assessed by history taking and thorough general and systemic examination. The subjects were explained about the procedure and importance of the study. The selected physiological characteristics were recorded in the subjects just before and after completion of twelve (12) weeks of selected Pranayama techniques and the findings were compared.

The subjects were purposively assigned into the two following groups: Experimental Group: Subjects belonged from Yoga Training Institutions and Laughing Clubs, and Control Group: Subjects those who were not participated in the selected Pranayama techniques. The selected Pranayama techniques were Anuloma Viloma, Kapalbhati and Bhramari. All selected Pranayama techniques were adopted in experimental group. But control group could not take part any kinds of Pranayama technique, yogic exercise or physical activity.

Measurement of physiological parameters: All physiological characteristics were measured by the following means:

Resting respiratory rate (RRR) was measured in number/minute by inspection/palpation of chest movements; vital capacity (VC) in liter by Dry Spirometer and peak expiratory flow rate (PEFR) in liter/min by Wrights Peak Flow Meter (Lifeline Surgicals, New Delhi, India).

Resting heart rate (RHR) was measured in beat/minute by counting the radial pulse; systolic and diastolic blood pressure (SBP & DBP) in mm. of Hg by Doctor Mercury Sphygmomanometer and Stethoscope. Body fat percent (BFP) was measured in percentage by Karada Scan; Body Composition Monitor; OMRAN, Japan.

The first phase of the recording of the parameters was done at the beginning of their course. The second/last phase of the recording was done after 12-weeks of the regular pranayama practices.

Statistical analysis: For the purpose of analysis of data descriptive statistics the Mean, Standard Deviation and Mean Difference were obtained through the software of SPSS, Version 20 software. To check the difference of mean scores between pre-test and post-test of experimental and control groups the Independent Sample t-test were applied. The level of significance was set at 0.05.

Results

The research that was conducted aimed to determine the effect of selected pranayama techniques on physiological characteristics of middle age sedentary women. Table 1 shows the Mean value (±SD), Mean Difference and Independent Sample t-test of physiological characteristics of experimental and control groups (N=19 each) before (Pre) and after (Post) 12-weeks selected pranayama techniques (Experimental group only).

Table 1: Mean, SD, mean difference and Independent sample t-test of pre and post-test scores of experimental and control groups on selected physiological characteristics

Physiological Characteristics	Group	Pre-Test (N=19)	Post-Test (N=19)	t-value	p-value
Resting Respiratory Rate (No./min.)	Experimental	18.73±1.24	17.12±1.24	4.051	0.00*
	Control	18.52±1.86	18.42±1.70	0.181	0.85
Vital Capacity (Liter)	Experimental	2.66±0.20	2.87±0.19	-3.276	0.00*
	Control	2.63±0.28	2.61±0.28	0.228	0.82
Peak Expiratory Flow Rate (Lit.)	Experimental	353.15±22.62	341.57±17.08	-2.833	0.00*
	Control	348.31±21.58	346.81±21.51	0.302	0.81
Resting Heart Rate (bpm)	Experimental	78.21±2.97	76.73±1.82	1.842	0.07
	Control	78.63±3.93	78.31±3.01	0.278	0.78
Systolic Blood Pressure (mm. Hg.)	Experimental	124.42±4.92	120.21±3.99	2.894	0.00*
	Control	125.18±4.95	124.86±4.94	0.212	0.79

Diastolic Blood Pressure (mm. Hg.)	Experimental	81.15±4.23	80.63±4.05	0.391	0.69
	Control	80.73±3.73	80.10±3.94	0.507	0.61
Body Fat Percent (%)	Experimental	28.30±3.80	26.36±2.69	1.822	0.07
	Control	29.89±2.82	30.05±2.83	-0.172	0.86

*Significant at 0.05 level.

Table 1 depicts the effect of selected Pranayama techniques on physiological characteristics on experimental group and control of middle age sedentary women. Results of the findings revealed that twelve weeks selected pranayama techniques significantly improved the resting respiratory rate ($p<0.05$), vital capacity ($p<0.05$), peak expiratory flow rate ($p<0.05$) and systolic blood pressure ($p<0.05$) as compared to pre-test and post-test scores of experimental group but insignificant differences were noted between the test scores (pre-test and post-test) of experimental group in resting heart rate, diastolic blood pressure and body fat percent of middle age sedentary women. In control group no significant differences were exist in all the physiological characteristics between pre-test and post-test scores of middle age sedentary women.

Discussion of findings

Yogic exercise and Pranayama are psychophysical practices to culture body and mind. Yogic exercise and pranayama are known to significantly improve health status and reduce stress and anxiety in our daily life. From the findings it was evident that the twelve weeks of selected pranayama techniques statistically improved the resting respiratory rate, vital capacity, peak expiratory flow rate and systolic blood pressure as compared to pre and post test scores of experimental groups and insignificant differences found in resting heart rate, diastolic blood pressure and body fat percent between the group differences of middle age sedentary women. No significant differences were found in all the selected physiological parameters between pre-test and post-test scores of control group.

Regarding Resting Respiratory Rate: Resting respiratory rate is one of the important physiological parameter of our investigation. The Mean and Standard Deviation (±SD) of pre-test and post-test scores of resting respiratory rate were 18.73±1.24 and 17.12±1.24 in number per minute respectively in favour of experimental group. The calculated value of (t=4.051) is greater than tabulated value of $t_{.05}$ (19) = 2.093 for the selected degree of freedom and significance level of experimental group had clearly indicated that statistically significant difference exist in resting respiratory rate of middle age sedentary women. However, no significant changes over that 12-weeks period were noted in the control group of middle age sedentary women. A group of physical educationist also reported that after regular practice of yogic exercises and pranayama techniques reduced significantly in resting respiratory rate and it may be due to increased vagal tone and decreased in sympathetic activity (Subbalakshmi *et al*., 2005 and Singh *et al*., 2011) [15, 14].

Regarding Vital Capacity: Table 1 shows that the Mean and Standard Deviation (±SD) scores of vital capacity of pre-test and post-test of experimental groups were 2.66±0.20 and 2.87±0.19 respectively, whereas the Mean and Standard Deviation (±SD) scores of vital capacity of pre-test and post-test of control groups were 2.63±0.28 and 2.61±0.28 respectively. The "t" value in case of experimental group was -3.276 and for control group it was 0.228. Since the calculated value of (t= -3.276) is greater than tabulated value of $t_{.05}(19)$ = 2.093, thus it clearly indicated that statistically significant difference exist in vital capacity between pre-test and post-test scores of experimental group of middle age sedentary women. The t-value of pre-test and post-test scores of control group showed insignificant difference was found in vital capacity. There might be a few possible reasons for the significant improvement in vital capacity. The effects can be explained on the following basis that, increased power of respiratory muscles that is due to work hypertrophy of the muscles during selected pranayama techniques by which the chest and lungs inflate and deflate to the fullest possible extent. The maximum inflation and deflation near to total lung capacity is an important physiological stimulus for the release of lung surfactant and prostaglandins increasing the alveolar spaces thereby increasing lungs capacity. Stimulation of pulmonary stretch receptors by inflation of slow and deep inhalation and prolonged exhalation as in Anuloma Viloma and Bhramari pranayama techniques causes efficient use of intercostals and diaphragmatic muscle. This trains the respiratory apparatus to get emptied and filled more completely. In breathing exercises like Kapalbhati powerful strokes of exhalation in quick succession with contraction of abdominal and diaphragmatic muscles trains the subject to make full use of diaphragm and abdominal muscles in breathing. This result is in line with that of the study earlier conducted by Bal B S (2010) [1].

Peak Expiratory Flow Rate: Peak expiratory flow rate (PEFR) is considered as one of the most important respiratory parameter in this investigation. Results showed that peak expiratory flow rate changes significantly in experimental group. Practice of 12-weeks Kapalbhati, Anuloma Viloma and Bhramari Pranayama techniques brings increase the peak expiratory flow rate due to improving the respiratory muscles activity (Joshi L N and Joshi V D, 1998) [8]. The effects can be explained on the following basis that increased power of respiratory muscles that is due to work hypertrophy of the muscles during pranayama and other exercises due to which the chest and lungs inflate and deflate to the fullest possible extent. The maximum inflation and deflation near to total lung capacity is an important physiological stimulus for the release of lung surfactant and prostaglandins increasing the alveolar spaces thereby increasing lung compliance and decreasing bronchial smooth muscle tone activity respectively Makwana *et al*. (1998). Stimulation of pulmonary stretch receptors by inflation of the lung reflexely relaxes smooth muscles of larynx and tracheobronchial tree; probably this modulates the airways caliber and reduces airway resistance via bronchodilation Dhungel *et al*. (2008) [5]. Slow and deep inhalation and prolonged exhalation as in Anulom Vilom causes efficient use of intercostals and diaphragmatic muscle. This trains the respiratory apparatus to get emptied and filled more completely. This allows in inhaling more, thus pulling more oxygen lower into the lungs, resulting in more perfusion of lungs thus increasing the efficiency of oxygen infusion into the blood stream because the oxygen is exposed to more of the blood. In breathing exercises like Kapalbhati powerful strokes of exhalation in quick succession with contraction of

abdominal and diaphragmatic muscle trains the subject to make full use of diaphragm and abdominal muscles in breathing.

Regarding Resting Heart Rate: The Mean and Standard Deviation (±SD) score of resting heart rate of pre-test of experimental group was 78.21±2.97 beat per minute as compared to 76.73±1.82 beat per minute after practices of 12-weeks Kapalbhati, Anuloma Viloma and Bhramari Pranayama techniques showed statistically insignificant at 0.05 level of confidence. In control group the pre-test and post-test Mean and Standard Deviation (±SD) scores of resting heart rate were 78.63±3.93 and 78.31±3.01respectively indicated that no significant changes found over the 12- weeks period were noted in the control group. This finding is supported with the study of Biswas *et al*. (2014) [2].

Regarding Blood Pressure (Systolic & Diastolic): The Mean and Standard Deviation (±SD) values of systolic blood pressure of pre-test and post-test of experimental group were124.42±4.92and 120.21±3.99 respectively. However, the Mean and Standard Deviation (±SD) values of systolic blood pressure of pre-test and post-test of control group were 125.18±4.95 and 124.86±4.94. The t-value in case of experimental group was 2.894 and for control group it was 0.212. Significant between-group differences were noted in systolic blood pressure in favour of experimental group before (Pre) and after (Post) subjected to practices of 12-weeks Kapalbhati, Anuloma Viloma and Bhramari Pranayama techniques since, the calculated value of (2.894) is greater than tabulated value of $t_{.05}$ (19) = 2.093 for the selected degree of freedom and level of significance. However, no significant changes occurred over the 12-weeks period in the control group.

The Mean and Standard Deviation (±SD) values of diastolic blood pressure of pre-test and post-test of experimental group were 81.15±4.23 and 80.63±4.05 respectively. However, the Mean and Standard Deviation (±SD) values of diastolic blood pressure of pre-test and post-test of control group were 80.73±3.73 and 80.10±3.94 respectively. The t-value in case of experimental group was 0.391and for control group it was 0.507. Significant between-group differences were noted in systolic blood pressure in the experimental group before (Pre) and after (Post) subjected to practices 12-weeks pranayama techniques. The probable causes that the pranayama techniques increases frequency and duration of inhibitory neural impulses by activating pulmonary stretch receptors during above tidal volume inhalation as in Hering Bruer reflex which bring about withdrawal of sympathetic tone in the skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing decrease in peripheral resistance and decreasing the diastolic blood pressure (Pramanik *et al*., 2009) [11]. However, no significant changes occurred over 12-weeks period in the control group. In this study, the finding of systolic and diastolic blood is consonance with the study of Biswas *et al*., (2014) [2].

Regarding Body Fat Percent: The Mean and Standard Deviation (±SD) values of body fat percent of pre-test and post-test of experimental group were 28.30±3.80 and 26.36±2.69 respectively. However, the Mean and Standard Deviation (±SD) values of body fat percent of pre-test and post-test of control group were 29.89±2.82 and 30.05±2.83 respectively. The t-value in case of experimental group was 1.822 and for control group it was -0.172. Insignificant between-group differences were noted in body fat percent in the experimental group before (Pre) and after (Post) subjected to practices of 12-weeks selected pranayama techniques since, the calculated value of (t=1.822) is less than tabulated value of $t_{.05}$ (19) = 2.093 for the selected degree of freedom and level of significance of middle age sedentary women.

Conclusion

Based on the analysis of the results obtained, we concluded that the significant differences were found in resting respiratory rate, vital capacity, peak expiratory flow rate and systolic blood pressure as compared to pre-test and post-test scores of experimental group and insignificant between the group differences were noted in resting heart rate, diastolic blood pressure and body fat percent of middle age sedentary women. It revealed that regular practice of systematic pranayama techniques decreased the risk factors of cardio-respiratory system, maintain to moderate level arousal level and reduce the trait anxiety directly or indirectly by promoting our health and wellbeing. Pranayama breathing techniques can be used effectively for improvement of concentration, mental stability, preventive and therapeutic purposes of cardio-vascular diseases too. It may obviate the need of drug therapy or may decrease the dosage or reduce the number of drugs needed mainly in hypertension and obese of middle aged sedentary women. Making of pranayama practice is a part and parcel of our daily life. In light of these facts, it can be said that regular practice of systematic pranayama programme can be adopted as a potent way of maintaining health as well as economic and productive life.

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