Original Article

# Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students

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## ABSTRACT

**Context:** Perceived stress is higher for students in various healthcare courses. Previous studies have shown that pranayama practice is beneficial for combating stress and improve cardiovascular functions but both fast and slow pranayama practice produce different physiological responses.

**Aim:** Present study was conducted to compare the effects of commonly practiced slow and fast pranayama on perceived stress and cardiovascular functions in young health-care students.

**Materials and Methods:** Present study was carried out in Departments of Physiology and Advanced Centre for Yoga Therapy Education and Research, JIPMER, Pondicherry. Ninety subjects (age 18-25 years) were randomized to fast pranayama (Group 1), slow pranayama (Group 2) and control group (Group 3). Group 1 subjects practiced Kapalabhati, Bhastrika and Kukkuriya Pranayama while Group 2 subjects practiced Nadishodhana, Savitri and Pranav Paranayama. Supervised pranayama training was given for 30 min, 3 times a week for the duration of 12 weeks to Groups 1 and 2 subjects by certified yoga trainer. Following parameters were recorded at the baseline and after 12 weeks of training; perceived stress scale (PSS), heart rate (HR), respiratory rate, systolic blood pressure and diastolic blood pressure (DBP), mean arterial pressure (MAP), rate pressure product (RPP), and double product (Do P).

**Results:** There was a significant decrease in PSS scores in both Group 1 and Group 2 subjects but percentage decrease was comparable in these groups. Significant decrease in HR, DBP, RPP, and Do *P* was seen in only Group 2 subjects.

**Conclusion:** This study demonstrates that both types of pranayama practice are beneficial in reducing PSS in the healthy subjects but beneficial effect on cardiovascular parameters occurred only after practicing slow pranayama.

**Key words:** Blood pressure; perceived stress scale; pranayama.

## INTRODUCTION

Stress can be considered as a state of mental or emotional strain or tension resulting from adverse or demanding circumstances. Perceived stress has been reported higher for students in health-care courses including dental, medical, nursing, and graduate health-workers.[1-4] Stress management programs for students including meditation, yoga, hypnosis, imagery, muscle relaxation etc., have shown improvement in their positive coping skills.[5] Yoga is an ancient science, which originated in India and many studies have found that yoga and pranayama can be practiced to combat stress. Pranayama involves manipulation of the breath that is a dynamic bridge between the body and mind.[6] Pranayama consists of three phases: "Puraka" (inhalation); "kumbhaka" (retention) and "rechaka" (exhalation) that can be either fast or slow.[7] Pranayama has been assigned very important role in Ashtanga Yoga of Maharishi Patanjali and is said to be much more important than yogasanas for keeping sound health.[8] Previous studies have shown that both fast and slow pranayamas are beneficial,[9-11] but they produce different physiological cardiovascular responses in healthy subjects.[12] Slow pranayama like Nadishuddhi, Savitri and Pranav have been shown to decrease Heart

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rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and increase pulse pressure (PP).[13,14] Very few references are available on the effect of practicing fast pranayamas. Few studies indicate that fast pranayamas like Kapalabhati and Bhastrika when practiced alone increases sympathetic activity[12,15] thereby, increasing HR, SBP, and DBP whereas, other studies showed that they decrease sympathetic activity and therefore, decrease HR, SBP and DBP.[8] Other studies have found no effect of fast pranayama after 12 weeks of practice.[16] Previous studies have shown that perceived stress negatively affects cardiovascular function by raising blood pressure (BP) and diminishing cardiovascular reactivity in the subjects.[17,18] To the best of our knowledge, there is no study comparing the cumulative effect of fast and slow types of pranayama on perceived stress and cardiovascular parameters in health-care students. Therefore, we have planned to compare three commonly practiced fast i.e., Kapalabhati, Bhastrika and Kukkuriya Pranayama and slow pranayama i.e., Nadishodhana, Savitri and Pranav on these parameters.

## MATERIALS AND METHODS

Present study was conducted in the Departments of Physiology and Advanced Centre for Yoga Therapy Education and Research (ACYTER), JIPMER, Pondicherry.

### Study design

This study is a randomized control trial and prior permission for the study was taken from the institutional scientific advisory committee and human ethics committee. After taking written informed consent, 90 healthy subjects pursuing various health-care courses including medical, nursing, and allied medical sciences were recruited for the present study after meeting inclusion and exclusion criteria.

#### *Inclusion criteria*

- Subjects aged between 18 years and 25 years of either gender.

#### *Exclusion criteria*

- Subjects who practiced yogic techniques in past 1 year
- Subjects with history of previous or current organic diseases.
- Subjects were unable to practice pranayama due to physical abnormalities

Subjects were asked to report to the Department of Physiology, JIPMER between 9 AM and 10 AM at least 2 h after taking light breakfast. Then following measurements were recorded:

#### *Anthropometric parameters*

- Height (in cm) was recorded on Stadiometer (Easy Care, Hongkong)
- Weight (in kg) (weighing machine supplied by Crown, New Delhi).

#### *Resting cardiovascular parameters*

After giving 10 min of supine rest to the subjects, brachial systolic (SBP) and DBP and HR were recorded on semi-automatic non-invasive BP monitor (CITIZENCH432B, Japan). PP = SBP − DBP, mean arterial pressure (MAP = DBP + PP/3), rate pressure product (RPP = [HR × SBP]/100) and double product (Do $P$ = HR × MAP) were calculated for each recording. Three BP and HR recordings at 1-min intervals were taken and the lowest of these values was included for the present study.

#### *Perceived stress scale*

All the subjects were then administered PSS.[19] PSS is the most widely used psychological instrument for measuring the perception of stress. The questions in the PSS are of general nature, relatively free of content specific to any sub-population group and enquire about feelings and thoughts to measure the "degree to which situations in one's life is appraised as stressful" especially, over last 1 month. The items are easy to understand and response alternatives are simple to grasp. Items are designed to tap how unpredictable, uncontrollable, and overloaded respondents find their lives. It comprises of 10 items, four of which are reverse-scored, measured on a 5-point scale from 0 to 4. PSS scores are obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 and 4 = 0) to the four positively stated items (items 4, 5, 7, and 8) and then summing across all scale items. Total score ranges from 0 to 40.

Thereafter, all the subjects were randomized into three groups as follows:

Group 1 ($n$ = 30): Subjects practiced following group of fast breathing pranayama
- Kapalabhati
- Bhastrika
- Kukkriya

Group 2 ($n$ = 30): Subjects practiced following group of slow breathing pranayama:
- Nadishodhana
- Pranava
- Savitri

Group 3 ($n$ = 30): Control group. Subjects did not participate in any form of pranayama training.

### *Pranayama training*

Subjects practiced pranayama in a quiet room maintained at comfortable temperature at 25 ± 2°C. Supervised pranayama training to Group 1 and Group 2 subjects was given for 30 min a day, 3 times per week for the duration of 12 weeks in ACYTER by trained and certified yoga trainer. Before starting pranayama training, the yoga instructor gave 1 week of practice sessions to both Group 1 and 2 subjects to familiarize them with the techniques of pranayama.

The technique used for fast and slow types of pranayamas was as described in the literature.[20] Typical session for Group 1 and Group 2 subjects consisted as follows:

1. Fast Pranayama: Each cycle (6 min) consisted of practicing 1 min of Kapalabhati, Bhastrika and Kukkriya pranayama interspersed with 1 min of rest between each pranayama. Subjects were asked to complete 3 or more cycles in each session.
   - Kapalabhati Pranayama: The subjects were instructed to sit in Vajrasana and to forcefully expel all of the air from the lungs while pushing the abdominal diaphragm upwards. The expulsion is active but the inhalation is passive. Subjects rapidly breathed out actively and inhaled passively through both nostrils. One hundred and twenty rounds at a sitting was the maximum. It is considered an excellent rejuvenator of the respiratory system as all muscles of expiration are exercised.
   - Bhastrika Pranayama: In this, emphasis is given to thoracic (not abdominal) breathing activity. Subjects were instructed to take deep inspiration followed by rapid expulsion of breath following one another in rapid succession. This is called as "bellow" type of breathing. Each round consisted of 10 such "bellows." After 10 expulsions, the final expulsion is followed by the deepest possible inhalation. Breath is suspended as long as it can be done with comfort. Deepest possible exhalation is done very slowly. This completes one round of Bhastrika.
   - Kukkriya Pranayam: To perform this dog pant like breathing technique, the subject sat in Vajrasana with both palms on the ground in front with wrists touching knees and fingers pointing forward. The mouth was opened wide and the tongue pushed out as far as possible. They then breathed in and out at a rapid rate with their tongue hanging out of their mouth. After 10 or 15 rounds they relaxed back into Vajrasana. The whole practice was repeated for 3 rounds.

2. Slow pranayama: Each round (7 min) of session consisted of practicing 2 min of Nadishodhana, Pranava and Savitri pranayama interspersed with 1 min of rest between each pranayama done in comfortable posture (sukhasana). Subjects were asked to perform nine or more rounds according to their capacity.
   - Nadishodhana Pranayama: This is slow, rhythmic, alternate nostril breathing. One round consisted of inhaling through one nostril, exhaling through other nostril and repeating the same procedure through other nostril.
   - Savitri Pranayama is a slow, deep and rhythmic breathing, each cycle having a ratio of 2:1:2:1 between inspiration (purak), held-in breath (kumbhak), expiration (rechak), and held out breath (shunyak) phases of the respiratory cycle. Each lobular segment of the lungs was filled and a six count was used for inspiration and expiration, with a three count for the retained breaths ($6 \times 3 \times 6 \times 3$).
   - Pranava Pranayama is slow, deep and rhythmic breathing where emphasis is placed on making the sound AAA, UUU and MMM while breathing out for duration of 2 to 3 times the duration of the inhaled breath. It is a four part technique consisting of Adham Pranayama (lower chest breathing with the sound of AAA), Madhyam Pranayama (mid-chest breathing with the sound of UUU), Adhyam Pranayama (upper chest breathing with the sound of MMM) and then the union of the earlier three parts in a complete yogic breath known as Mahat Yoga Pranayama with the sound of AAA, UUU and MMM.

At the end of session, all Group 1 and 2 subjects were instructed to lie down in shavasana and relax for 10 min.

Control Group: They did not practice any pranayama during the study period.

All the parameters were again recorded after 12 weeks of intervention and data was statistically analyzed.

## Statistical analysis

For each group, mean and standard deviation of the scores were calculated. Analysis of the data was done using SPSS version 13 and normality testing of data was done by Kolmogorov–Smirrnov test. Power and Sample size software version 3.0 was used to calculate adequate sample size (at assumed power of 0.9) required for the study and to analyze post-test power of the study. Intergroup mean differences in age, anthropometric, physiological parameters and PSS were measured by using one way ANOVA and *post-hoc* analysis was done by Tukeys–Krammer test. For intra-group comparisons of parameters, paired *t*-test was used for parametric and Wilcoxon signed rank test for non-parametric parameter. Chi-square test was used to compare intergroup gender distribution. *P* value less than 0.05 was considered as statistically significant.

## RESULTS

Table 1 demonstrates that there was no significant difference in one way ANOVA test for intergroup comparison of age, height and weight distribution amongst three groups. Similarly, there was no significant difference in gender distribution amongst three groups when analyzed by Chi-square test.

Table 2 shows that there was no significant difference in one way ANOVA test for the comparison of baseline values of all the tested cardiovascular parameters and PSS scores amongst the three groups and *post-hoc* analysis between these groups done by Tukey–Krammer test was also insignificant.

Table 3 shows that there was significant reduction in PSS score in Group 1 and Group 2 subjects ($P = 0.000$) after 12 weeks of intervention (post-test) when compared to pre-test score (baseline value). However, no longitudinal change occurred in PSS score in Group 3 subjects.

Table 4 shows that there was no significant longitudinal change in post-test values in all the tested cardiovascular parameters in Group 1 subjects.

Table 5 shows there was significant decrease in HR ($P = 0.000$), DBP ($P = 0.01$), MAP ($P = 0.01$) RPP ($P = 0.01$) and Do $P$ ($P = 0.000$) in Group 2 subjects after 12 weeks (post-test values) of intervention when compared to baseline values.

Table 6 shows there was no significant change in all the tested parameters at post-test level when compared to baseline (pre-test) values in Group 3 subjects.

Figure 1 depicts the flow chart of protocol carried out during the study.

On post-test analysis, the power of study with the mean PSS difference of 4.67 and SD of 4.5 is 0.99 which shows sample size was adequate and strength of the study is good.

## DISCUSSION

We observed no significant difference in the baseline parameters of three groups and therefore, they can be considered comparable for the study.

After 12 weeks of study period, we observed a significant decrease in DBP, HR, MAP, RPP, and Do $P$ in only slow pranayama group (Group 2) with no change in control group (Group 3). However, trend towards insignificant decrease in SBP (2%), DBP (1.63%), MAP (1.74%) and RPP (1.93%) was seen in fast pranayama group (Group 1). Similar results were observed in previous studies which found significant decrease in BP and HR with the practice of Savitri Pranayama.[12] Resting HR is mainly determined by parasympathetic nervous system (PNS) and DBP is a function of peripheral vascular resistance (PVR) which is mainly determined by sympathetic nervous system (SNS).[21] MAP is determined by both SNS and PNS and refers to the mean pressure throughout the cardiac cycle. Decrease in HR, DBP, and MAP represents increase in parasympathetic and decrease in sympathetic activity in slow pranayama group.[22] Non-significant increase in PP (15.23%) was observed in slow pranayama group

**Table 1: Comparison of baseline subject's characteristics amongst three groups (mean±SD)**

| Parameters | Group 1 | Group 2 | Group 3 | *F*/df | *P* value |
|---|---|---|---|---|---|
| Age (years) (mean±SD) | 18.43±1.13 | 19.20±1.78 | 18.93±1.52 | 1.996 (2, 87) | 0.142 |
| Height (cm) (mean±SD) | 159.10±7.61 | 157.45±9.09 | 157.16±8.58 | 0.457 (2, 87) | 0.634 |
| Weight (kg) (mean±SD) | 49.63±6.12 | 50.13±8.94 | 53.10±12.32 | 1.174 (2, 87) | 0.314 |
| Gender | | | | | |
| Male | 7 | 4 | 5 | - | 0.587 |
| Female | 23 | 26 | 25 | | |

One way ANOVA test for intergroup comparison of age, height and weight and Chi-square test for the comparison of intergroup gender distribution

**Table 2: Comparison of baseline cardiovascular parameters amongst three groups (mean±SD)**

| Parameters | Group 1 (*n*=30) | Group 2 (*n*=30) | Group 3 (*n*=30) | *F*/df | *P* value |
|---|---|---|---|---|---|
| HR (bpm) | 76.83±5.41 | 76.60±5.15 | 77.70±5.73 | 0.341 (2, 87) | 0.712 |
| RR (bpm) | 17.40±2.13 | 17.06±1.77 | 17.06±1.14 | 0.370 (2, 87) | 0.691 |
| SBP | 114.36±10.86 | 116.26±9.15 | 115.06±8.75 | 0.298 (2, 87) | 0.743 |
| DBP (mm Hg) | 75.80±7.16 | 74.30±7.40 | 73.33±5.35 | 1.031 (2, 87) | 0.361 |
| PP (mm Hg) | 39.43±11.26 | 41.96±9.55 | 41.73±10.43 | 0.540 (2, 87) | 0.585 |
| MAP (mm Hg) | 88.94±7.96 | 89.03±8.09 | 87.24±4.52 | 0.612 (2, 87) | 0.544 |
| RPP (bpm-mm Hg) | 88.01±11.55 | 89.26±11.16 | 89.23±7.52 | 0.145 (2, 87) | 0.865 |
| Do P (bpm-mm Hg) | 6587.40±977.43 | 6839.71±945.51 | 6774.3±556.90 | 0.080 (2, 87) | 0.923 |
| PSS | 19.10±4.53 | 19.50±4.59 | 20.60±3.06 | 1.062 (2, 87) | 0.350 |

One way ANOVA test for the intergroup comparison of baseline cardiovascular parameters; Post-hoc analysis by Tukey-Krammer test for baseline parameters: Group 1 versus Group 2: Nil; Group 2 versus Group 3: Nil; Group 1 versus Group 3: Nil; HR = Heart rate; RR = Respiratory rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; PP = Pulse pressure; MAP = Mean arterial pressure; RPP = Rate pressure product; Do P = Double product; PSS = Perceived stress scale

**Table 3: Comparison of perceived stress scale score between baseline and post 12 weeks in 3 groups (mean±SD)**

| Groups | PSS score | | *W* value | *P* value |
|---|---|---|---|---|
| | Pre | Post | | |
| Group 1 | 19.10±4.53 | 14.43±4.24 | 403 | ***0.000 |
| Group 2 | 19.50±4.59 | 14.00±2.90 | 388 | ***0.000 |
| Group 3 | 20.60±3.06 | 19.86±3.31 | 103 | 0.171 |

Analysis was done by Wilcoxon signed rank test; *W* value represents sum of all signed ranks; PSS = Perceived stress scale

**Table 4: Comparison of parameters between baseline and post 12 weeks in group 1 (Fast pranayama group) (mean±SD)**

| Parameters | Pre | Post | *t* value | *P* value |
|---|---|---|---|---|
| HR (bpm) | 76.83±5.41 | 75.73±4.89 | 0.863 | 0.395 |
| RR (bpm) | 17.40±2.13 | 16.73±1.04 | 1.747 | 0.091 |
| SBP | 114.36±10.86 | 112.30±8.82 | 1.114 | 0.274 |
| DBP (mm Hg) | 75.80±7.16 | 74.16±6.80 | 1.109 | 0.277 |
| PP (mm Hg) | 39.43±11.26 | 38.13±10.3 | 0.691 | 0.495 |
| MAP (mm Hg) | 88.94±7.96 | 86.87±5.76 | 1.376 | 0.179 |
| RPP (bpm-mm Hg) | 88.01±11.55 | 85.01±8.37 | 1.224 | 0.231 |
| Do P (bpm-mm Hg) | 6587.40±977.43 | 6570.70±502.65 | 1.481 | 0.149 |

Pre versus post values were analyzed by paired *t*-test; HR = Heart rate; RR = Respiratory rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; PP = Pulse pressure; MAP = Mean arterial pressure; RPP = Rate pressure product; Do P=Double product

**Table 5: Comparison of parameters between baseline and post 12 weeks in group 2 (Slow pranayama group) (mean±SD)**

| Parameters | Pre | Post | *t* value | *P* value |
|---|---|---|---|---|
| HR (bpm) | 76.60±5.15 | 73.66±3.90 | 4.915 | ***0.000 |
| RR (bpm) | 17.06±1.77 | 16.33±1.29 | 1.943 | 0.062 |
| SBP | 116.26±9.15 | 114.36±7.14 | 0.979 | 0.336 |
| DBP (mm Hg) | 74.30±7.40 | 70.16±4.48 | 2.746 | *0.010 |
| PP (mm Hg) | 41.96±9.55 | 44.20±7.89 | -1.092 | 0.284 |
| MAP (mm Hg) | 89.03±8.09 | 84.90±4.22 | 2.746 | *0.010 |
| RPP (bpm-mm Hg) | 89.26±11.16 | 84.22±6.78 | 2.707 | *0.011 |
| Do P (bpm-mm Hg) | 6839.71±945.51 | 6251.90±426.51 | 4.121 | ***0.000 |

*$P<0.05$; **$P<0.01$; ***$P<0.001$, Pre versus post values were analyzed by paired *t*-test; HR = Heart rate; RR = Respiratory rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; PP = Pulse pressure; MAP = Mean arterial pressure; RPP = Rate pressure product; Do P = Double product

**Table 6: Comparison of parameters between baseline and post 12 weeks in group 3 (Control group) (mean±SD)**

| Parameters | Pre | Post | *t* value | *P* value |
|---|---|---|---|---|
| HR (bpm) | 77.70±5.73 | 76.83±4.59 | 1.089 | 0.285 |
| RR (bpm) | 17.06±1.14 | 17.10±1.37 | -0.235 | 0.816 |
| SBP | 115.06±8.75 | 113.50±8.26 | 1.517 | 0.140 |
| DBP (mm Hg) | 73.33±5.35 | 74.1000±4.18 | -1.104 | 0.279 |
| PP (mm Hg) | 41.73±10.43 | 39.40±0.90 | 1.962 | 0.060 |
| MAP (mm Hg) | 87.24±4.52 | 87.233±4.10 | 0.018 | 0.985 |
| RPP (bpm-mm Hg) | 89.23±7.52 | 87.09±6.91 | 1.581 | 0.125 |
| Do P (bpm-mm Hg) | 6774.3±556.90 | 6698.40±452.01 | 0.813 | 0.423 |

Pre versus post values were analyzed by paired *t*-test; HR = Heart rate; RR = Respiratory rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; PP = Pulse pressure; MAP = Mean arterial pressure; RPP = Rate pressure product; Do P = Double product

and no change was observed in other groups. Rise in PP represents better tissue perfusion. RPP and Do *P* represent sympathetic activity and are indirect measures of $O_2$ consumption of heart or work load on heart.[23-26] Rise in PP with decreased RPP indicates that the tissue perfusion is increased with decreased work load on heart in slow pranayama group. Therefore, our study demonstrates that decrease in sympathetic activity and increase in parasympathetic activity and thereby, improvement of autonomic tone towards parasympatho-dominance was seen in both fast and slow pranayama groups but statistically significant change in measured physiological parameters was seen in only slow pranayama group.

We observed significant reduction in PSS scores in both fast and slow pranayama groups. Therefore, both types of pranayama practice were equally effective in reducing perceived stress in both Group 1 and Group 2 subjects. Reduction in stress may have occurred due to better autonomic tone (higher parasympathetic and lesser sympathetic tone) observed in Group 1 and 2 subjects and reduced stress may have resulted in improved cardiovascular functions in the slow and fast pranayama groups.

Both fast and slow pranayamas can be considered as deep breathing exercises performed at different frequencies of respiration. One study has hypothesized how pranayamic breathing interacts with the nervous system affecting metabolism and autonomic functions.[27] During above tidal inspiration (as seen in Hering Breuer's reflex), stretch of lung tissue produces inhibitory signals by action of slowly adapting stretch receptors and stretch of connective tissue (fibroblasts) localized around the lungs generates hyperpolarization currents, which are propagated through neural and non-neural tissues and both of them cause synchronization of neural elements in heart, lungs, limbic system and cortex. Inhibitory current synchronizes rhythmic cellular activity between cardiopulmonary center and central nervous system and also regulates excitability of nervous tissues indicative of state of relaxation. Hyperpolarization of tissues manifests itself in parasympathetic like change. Synchronization within the hypothalamus and the brain stem is mainly responsible for the parasympathetic response. Modulation of the nervous system and decreased metabolic activity is indicative of the parasympathetic state.[27]

Another study has explained changes in cardiovascular autonomic activity by breathing exercises on the basis of known anatomical asymmetries in the respiratory, cardiovascular, and nervous system and that the coupling mechanisms between each of these systems: Lung-heart,

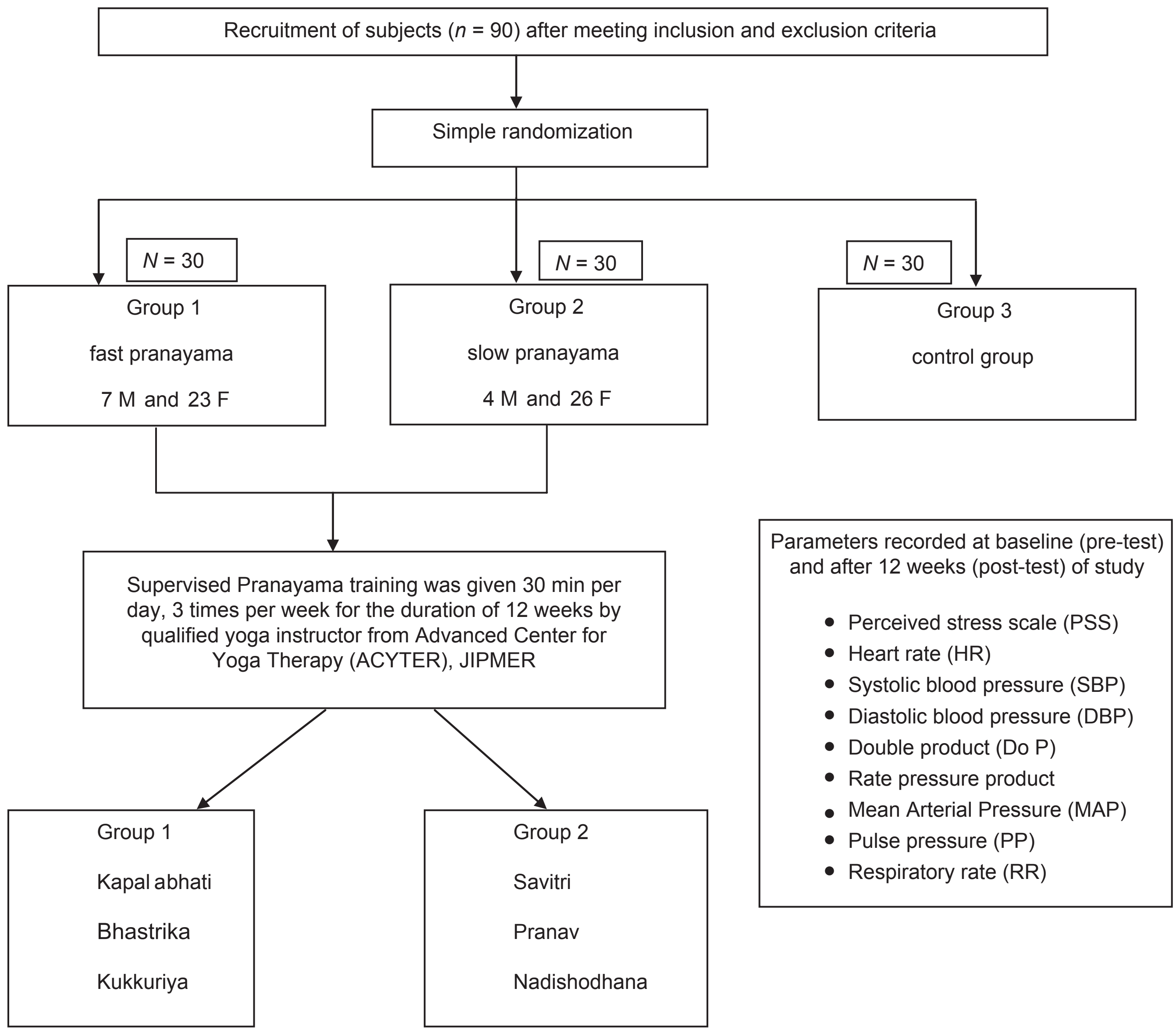


**Figure 1:** Flow chart of protocol carried out during the study

heart-brain and lungs-brain, are also asymmetrical.[28,29] These asymmetrical vector forces resulting from the mechanical activity of the lungs, heart and blood moving throughout the circulatory system, will also produce a lateralization effect in the autonomic balance. There are negative feedback loops between brain autonomic controls and mechanical functions in the body as a fundamental part of the body's homeostatic mechanisms. A long-term improvement in autonomic balance as well as in respiratory, cardiovascular and brain function can be achieved if mechanical forces are applied to the body with the aim of reducing existing imbalances of mechanical force vectors. This technique implies continually controlling the body functions for precise timings like in pranayamic breathing techniques.[29]

Explanation of finding more effect with slow pranayamic breathing can be due to the reason that slow breathing has been found to increase baroreflex sensitivity, reduce sympathetic activity and chemo reflex activation in healthy subjects as well as hypertensives.[30,31] Furthermore, strongest cardioventilatory coupling is seen when there is decreased breathing frequency like slow pranayamic breathing.[31] Increase in parasympathetic activity decreases resting HR and decrease in sympathetic tone in skeletal muscle blood vessels decreases PVR resulting in decrease in DBP, MAP, reduced work load on heart and improved tissue perfusion.[22]

To summarize, our study demonstrates that both types of pranayama practice are equally effective in reducing perceived stress but significant benefit on physiological parameters is seen in only subjects practicing slow pranayama. Since the results on perceived stress are comparable, slow pranayamas can be given to subjects in all age groups (both young and old) whereas fast pranayamas are more suitable for subjects with stable cardiovascular function. On post-test analysis, sample size (power = 0.99) was found adequate for the present study.

In the present study, it was not possible to attempt double blind conditions. Only single composite questionnaire was used to measure perceived stress. Future studies should include biochemical parameters such as vanillylmandelic acid, metanephrines along with other personality scales, which could be related to stress levels. Therefore, the results can be considered to be preliminary and be viewed with caution of potential rater bias. No significant clinical side-effects (confusion, cardiovascular accidents, dyspnea etc.) occurred with pranayama practice during the study period.

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