Comparison Between the Effects of Buteyko Breathing Technique and Diaphragmatic Breathing Exercises on Blood Pressure and Rate of Perceived Exertion in Individuals with Hypertension

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Abstract

The aim of this study was to compare the effects of the Buteyko breathing technique and diaphragmatic breathing exercises on blood pressure and rate of perceived exertion in individuals with hypertension. This study included a total of 80 participants of age group 40 to 60 years, both male and female with clinically diagnosed with hypertension for at least 6 months and are taking medications for the same. Participants were randomly divided into 2 groups- Group A and Group B. Group A received Diaphragmatic breathing exercise and Group B received Buteyko Breathing Technique. Both protocols were given for the duration of 4 weeks. Both the groups were assessed for Systolic BP and Diastolic BP and Rate of Perceived Exertion prior commencement of the study and at the end of 4 weeks. BP was measured using Manual Sphygmomanometer and the Rate of Perceived Exertion was measured using a Modified Borg Scale.

The results of the study concluded that, Diaphragmatic breathing exercises and Buteyko breathing technique reduces the systolic and diastolic blood pressure and Rate of perceived exertion in individuals with hypertension. Buteyko Breathing Technique significantly reduces Systolic and Diastolic Blood pressure in individuals with hypertension. Diaphragmatic and Buteyko Breathing Technique equally reduce the rate of perceived exertion in individuals with hypertension.

Index Terms: Buteyko technique, Diaphragmatic Breathing, Blood pressure, Hypertension, Rate of Perceived Exertion

INTRODUCTION:

"Blood pressure refers to the pressure measured within arteries in the systemic circulation." Systolic pressure refers to the maximum pressure within the large arteries when the heart muscle contracts to propel blood through the body. Diastolic pressure describes the lowest pressure within the large arteries during heart muscle relaxation between beatings.[1] The current definition of hypertension (HTN) is systolic blood pressure (SBP) values of 130mmHg or more and/or diastolic blood pressure (DBP) of more than 80 mmHg.[2] Various systems such as cardiac output and peripheral resistance, autonomic nervous system, Renin-angiotensin system, vascular endothelium, etc. work in the body that try to maintain normal blood pressure. Dysfunction of any one or more of these systems leads to hypertension.3

In 1950, K P Buteyko from Russia, developed a unique technique which involves a set of breathing exercises that help to maintain the correct ratio of oxygen and carbon dioxide in the blood. In this method patient is asked to breathe less rather than more.[4] Nasal breathing and breath holding with relaxation are emphasized which promotes the retention of CO_2 in the body, ultimately reducing blood pressure.[5]

Diaphragmatic Breathing involves Diaphragm which is a primary muscle of Inspiration, so this technique reduces work of respiration. This improves baroreflex sensitivity which helps to reduce blood pressure. Slow breathing rate is related to a decrease in heart rate and a decrease in muscle nerve sympathetic activity.
In both techniques, we are reducing the workload on the muscles of inspiration, so assessing the subjective response regarding their perceived exertion, i.e., Rate of Perceived exertion using the Modified Borg Scale becomes necessary. Respiratory and cardiovascular systems are interlinked with respect to mechanism of control, so modification in one system causes alterations / changes in another. So theoretically we can expect voluntary alterations in respiratory system can induce alterations in cardiovascular system.

NEED OF THE STUDY

Hypertension is one of the leading causes of morbidity and mortality in the world. Various studies have shown that hypertension causes problems with vitality, social and mental health, mood, and psychological functioning. The prognosis of hypertension depends on blood pressure control. Only adequate measures help to delay the progression of sequelae of increased blood pressure.[2] There is a lot of information available regarding the effects of the Buteyko Breathing Technique in reducing blood pressure in hypertensive individuals. Also, various research supports the effect of diaphragmatic breathing in the reduction of blood pressure in a hypertensive population. But to the best of our knowledge, no study has been done to compare the effects of these two techniques on blood pressure. Since hypertension is a preventable cardiovascular disorder and proper treatment, and lifestyle modification can reduce the negative health impacts.[9] So, we would like to compare the effects of the Buteyko breathing technique and diaphragmatic breathing exercises on blood pressure and rate of perceived exertion in subjects with hypertension.

AIM AND OBJECTIVE

AIM: To compare the effects of the Buteyko breathing technique and diaphragmatic breathing exercises on blood pressure and rate of perceived exertion in individuals with hypertension.

OBJECTIVES:
1.To study the effects of the Buteyko breathing technique and Diaphragmatic breathing exercise on blood pressure using manual Sphygmomanometer in individuals with hypertension at the end of 4 weeks.
2.To study the effects of the Buteyko breathing technique and Diaphragmatic breathing exercise on and rate of perceived exertion using Modified Borg Scale in individuals with hypertension at the end of 4 weeks

HYPOTHESIS:

- **EXPERIMENTAL HYPOTHESIS (H1) -** There will be a significant difference between the effects of Diaphragmatic breathing exercise and the Buteyko Breathing Technique on Blood pressure and Rate of Perceived exertion in individuals with hypertension.
- **NULL HYPOTHESIS (H0) -** There won't be a significant difference between the effects of Diaphragmatic breathing exercise and the Buteyko breathing technique on Blood pressure and Rate of Perceived exertion in individuals with hypertension.

METHODOLOGY

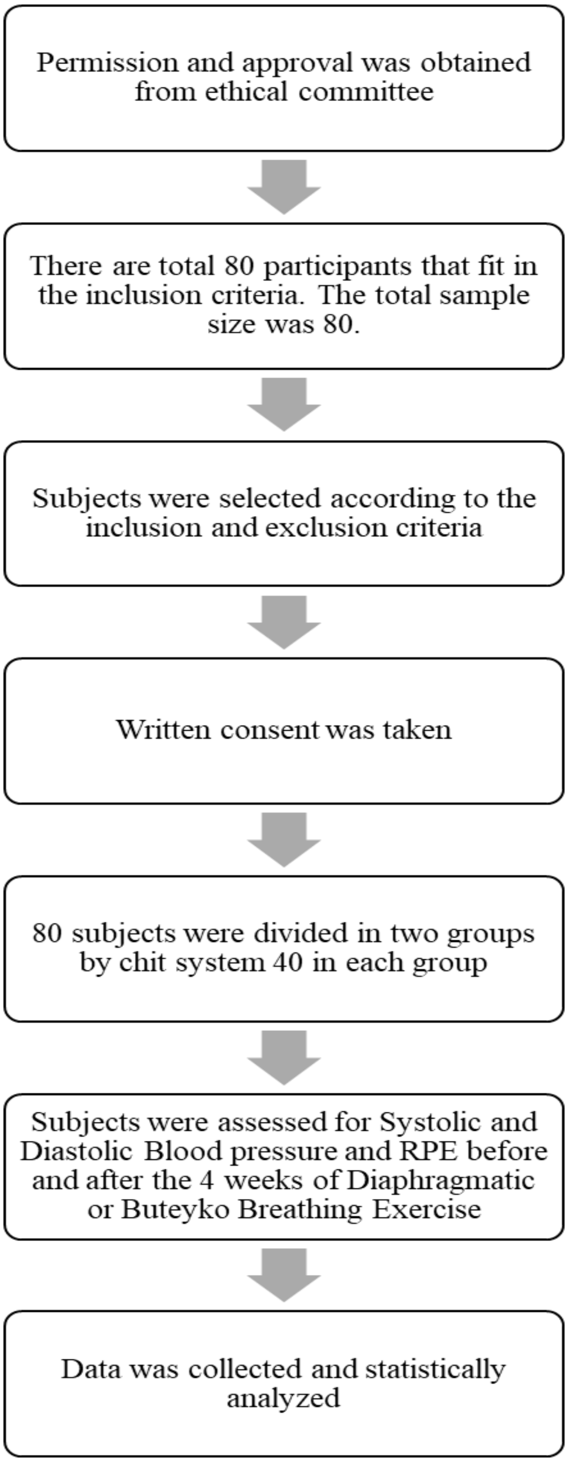
Type of Study – Randomized Controlled Study
Study Duration – 18 months
Study Place – Metropolitan City
Method of Randomization – Simple Randomization
Sampling Population – Hypertensive individuals of age group between 40 to 60 years
Sample Size – 80 (GROUP A – 40, GROUP B – 40)
Material – Sphygmomanometer, Modified Borg scale.

METHODS OF SELECTION OF STUDY SUBJECTS
INCLUSION CRITERIA:
Age group – 40 to 60 years
Gender – both male and female
Subjects with clinically diagnosed hypertension (at least since last 6 months)
Subjects who have taken or are taking medications for hypertension.

EXCLUSION CRITERIA:
Subjects with active respiratory infection or kidney problems.
Cognitively unstable hypertensive subjects.
Subjects unwilling to cooperate in the study.
Subjects undergoing any cardiac or respiratory rehabilitation program.

OUTCOME MEASURE
1. Systolic blood pressure
2. Diastolic blood pressure
3. Rate of perceived exertion – Modified Borg Scale

STUDY PROCEDURE
1. Study was carried out after the ethical committee approval.
2. Subjects were screened as per the inclusion and exclusion criteria.
3. Subjects were informed about the aim of the study and consent was taken before the study.
4. Demographic data (age, sex, BMI, dominance, medical and surgical history) was taken before the study.
5. Baseline data for systolic and diastolic blood pressure and rate of perceived exertion was taken before the 1st day and at the end of the study i.e. at the end of 4th week
6. Subjects were randomly divided into GROUP A (Diaphragmatic Breathing Exercise) and GROUP B (Buteyko Breathing Technique)
7. Group A received the Diaphragmatic Breathing Exercises
8. Group B received Buteyko breathing technique. For the home program, both groups received video recordings of the techniques according to their groups



Appropriate methods of measurements: Blood pressure measurements will be done according to the Standardized method for assessment of blood pressure with a sphygmomanometer and the Rate of perceived exertion will be assessed using the Modified Borg Scale.

Measurement of Blood pressure: BP measurement is most commonly made in either the seated or the supine position. Seated measurements are preferred given the large amount of data correlating BP obtained in this position with outcomes. So we took the measurement of BP in a seated position only. To maintain the uniformity, we measured BP from by attaching cuff to the Right Arm. Regardless of whether BP is measured in the seated or supine position, the BP cuff should be at the level of the patient’s right atrium. The lower end of the cuff should be 2 to 3 cm above the antecubital fossa. To assess the appropriate tightness, 1 finger should fit easily at the top and bottom of the cuff; 2 fingers should fit but will be very snug. When taking an auscultatory measurement, the cuff should initially be inflated to at least 30 mm Hg above the point at which the radial pulse disappears. Cuff deflation should occur at a rate of 2 mm Hg per second or per heartbeat when the heart rate is very slow to obtain an accurate estimate of BP. As per guidelines by AHA, we took three consecutive reading separated by one minute, and the average of it was taken as the final reading in our study.[10]

DIAPHRAGMATIC BREATHING EXERCISE - (Group A)

- The subjects of group A was instructed to relax and position in a comfortable position so that the back and head are fully supported and the abdominal wall relaxed.
- Then the subjects were asked to breathe in slowly and deeply through the nose, relax the shoulder and upper chest quietly following the abdomen to rise.
- Then the patient were instructed to slowly let all the air out through the mouth.
- The intervention was applied 3 to 4 times and then rest (for one minute), five sets were applied in a treatment session
- The above-mentioned interventions was given for 15-20 minutes duration. Individuals was asked to perform these techniques twice a day and we was supervising every alternate day sessions, thrice a week through online or offline mode as per the convenience of the individuals. The total protocol duration was 4 weeks. [11,,12]

BUTEYKO BREATHING TECHNIQUE – (Group B)
Step 1: Control pause (CP) phase:

- The patient was asked to sit in an upright chair, close the mouth and breathe in normally through the nose for 30 seconds.
- The subjects were further instructed to:
- Breathe in a small breath and breathe out. Then close both the nostrils with empty lungs, taking care lungs are not too void of air
- Keep a count for how much time one is comfortable before feeling an urgency to breathe in again and hold on until then
- Breathe in by releasing the nostrils
- Subjects were asked to keep a watch on their first breath after CP, to avoid taking a breath deeper than the one taken before CP. Subjects were instructed to not hold their breath for a longer duration as this may lead to deep breathing after measuring the CP.

Step 2: Shallow Breathing:
The patient were asked to:

- Sit up straight.
- Monitor the amount of air flowing through the nostrils by placing the finger under the nose in a horizontal position.
- The patient's finger should lie close enough to the nostrils so that the airflow can be felt, but not so close that the airflow is blocked.
- Subjects were asked to repeat Steps 1 and 2 for 5 mins (or approximately 6 cycles)

Step 3: Putting it together:

- Take Control Pause. Reduced breathing for 4 min. Wait for 2 mins and take control pause.
- Repeat it for 3 times again. [13,14]

A baseline assessment was conducted before the initiation of treatment. Also, the assessment of blood pressure and the Rate of perceived exertion was conducted at the end of the 4th week.

STATISTICAL ANALYSIS

- Data Analysis: The data were entered using Microsoft Office Excel 2013 and were analysed using Graph Pad Prism 9.5.1
- Descriptive data analysis was done for Age and Gender

- The Shapiro-Wilk test was used to check the normality in both groups.
- Wilcoxon rank test was used to analyse non-parametric data within both groups (Diastolic Blood Pressure and Rate of Perceived Exertion).
- Paired t-test was used to analyse parametric data within both groups (Systolic Blood Pressure).
- Mann-Whitney U test was used to analyse two independent groups' non-parametric data (Diastolic Blood Pressure and Rate of Perceived Exertion).
- Unpaired t-test was used to analyse parametric data in two independent groups (Systolic Blood Pressure).
- P value less than 0.05 was considered statistically significant.

RESULTS

- The total sample size was 80, of age 40-60 years was divided into two groups – 'Group A' and 'Group B' each having 40 subjects.
- The mean age of Group A was 53.77 years with a Standard Deviation of 6.45 years. The mean age of Group A was 54.17 years with a Standard Deviation of 5.66 years.
- The mean BMI of Group A was 25.42 kg/m2 with a Standard Deviation of 3.14 kg/m2. The mean BMI of Group A was 24.77 kg/m2 with a Standard Deviation of 3.21 kg/m2.
- The total number of females in the study was 43 which constituted 53.75% and the total number of males was 37 which constituted 46.25%.

Table 1 – Demographic Data

	GROUP A	GROUP B
Sample size	n=40	n=40
Age	53.77±6.45	54.17±5.66
Gender Male	18	19
Female	22	21
BMI	25.42±3.14	24.77±3.21

Table 2.1 – Within Group analysis of Systolic Blood Pressure of Group A

Group	Systolic Blood Pressure	Mean ± SD	P Value
Group A	Pre	137.05 ± 6.91	<0.0001 ****
	Post	133.6 ± 7.03	

Inference – As the above data passed normality, paired t-test was used to analyze the data. There was a statistically significant difference in the pre and post-values of systolic BP within Group A. (p <0.0001)

Table 2.2 – Within Group analysis of Diastolic Blood Pressure of Group A

Group	Diastolic Blood Pressure	Median	P Value
Group A	Pre	81	<0.0001 ****
	Post	80	

Inference – As the above data didn't pass normality, the Wilcoxon matched-pairs signed rank test was used to analyse the data. There was a statistically significant difference in the pre and post-values of diastolic BP within Group A. (p <0.0001)

Table 2.3 – Within Group analysis of Rate of Perceived Exertion of Group A

Group	Rate of Perceived Exertion	Median	P Value
Group A	Pre	1	<0.0001 ****
	Post	1	

Inference - As the above data didn't pass normality, the Wilcoxon matched-pairs signed rank test was used to analyse the data. There was a statistically significant difference in the pre and post-values of Rate of Perceived Exertion within Group A. (p <0.0001)

Table 3.1 – Within Group analysis of Systolic Blood Pressure of Group B

Group	Systolic Blood Pressure	Mean ± SD	P Value
Group B	Pre	137.15 ± 7.65	<0.0001 ****
	Post	132.65 ± 8.13	

Inference - As the above data passed normality, paired t-test was used to analyse the data. There was a statistically significant difference in the pre and post-values of systolic BP within Group B. (p <0.0001)

Table 3.2 – Within Group analysis of Diastolic Blood Pressure of Group B

Group	Diastolic Blood Pressure	Median	P Value
Group B	Pre	86	<0.0001 ****
	Post	80	

Inference - As the above data didn't pass normality, the Wilcoxon matched-pairs signed rank test was used to analyse the data. There was a statistically significant difference in the pre and post-values of diastolic BP within Group B. (p <0.0001)

Table 3.3 – Within Group analysis of Rate of Perceived Exertion of Group B

Group	Rate of Perceived Exertion	Median	P Value
Group B	Pre	1	<0.0001 ****
	Post	1	

Inference - As the above data didn't pass normality, the Wilcoxon matched-pairs signed rank test was used to analyse the data. There was a statistically significant difference in the pre and post-values of Rate of Perceived Exertion within Group B. (p <0.0001)

Table 4.1 – Between Group Analysis of Systolic Blood Pressure

	Group	Mean Difference ± SD	P Value
Systolic Blood Pressure	Group A	3.45 ± 1.81	P < 0.05 *
	Group B	4.5 ± 2.16	

Inference - As the above data passed normality, an unpaired t-test was used to analyse the data. There was a statistically significant difference in means of Systolic BP in Group A and Group B. (p <0.05)

Table 4.2 – Between Group Analysis of Diastolic Blood Pressure

	Group	Median of Differences	P Value
Diastolic Blood Pressure	Group A	0	P < 0.05 *
	Group B	4	

Inference - As the above data did not pass normality, the Mann Whitney test was used to analyse the data. There was a statistically significant difference in the medians of Diastolic BP in Group A and Group B. (p <0.05)

Table 4.3 – Between Group Analysis of Rate of Perceived Exertion

	Group	Median of Differences	P Value
Rate of Perceived Exertion	Group A	0	0.7558
	Group B	0	

Inference - As the above data did not pass normality, the Mann Whitney test was used to analyse the data. There was no statistically significant difference in the medians of Rate of Perceived Exertion in Group A and Group B. (p = 0.7558)

DISCUSSION

This study was done to study and compare the effects of Diaphragmatic breathing exercise and Buteyko breathing technique in people with hypertension, measurements were taken before the commencement and at the end of 4 weeks.

Diaphragmatic Breathing Exercise was given to Group A, pre-treatment mean of systolic blood pressure was 137.05 ± 6.91 mm of Hg, and the post-treatment mean of systolic blood pressure was 133.6 ± 7.03, paired t-test indicates there was a statistically significant reduction in systolic blood pressure post-treatment. In the same group, the pre-treatment median of diastolic blood pressure was 81 mm of Hg and the post-treatment median of diastolic blood pressure was 80 mm of Hg, Wilcoxon matched-pairs signed rank test indicates there was a statistically significant reduction in diastolic blood pressure post-treatment. In this group, the pre-treatment median of the Rate of Perceived Exertion was 1 and post-treatment was 1, Wilcoxon matched-pairs signed rank test indicates there was a statistically significant reduction in the score of Rate of Perceived Exertion post-treatment.

Diaphragmatic Breathing Exercise was given to Group B, pre-treatment mean of systolic blood pressure was 137.15 ± 7.65 mm of Hg, and the post-treatment mean of systolic blood pressure was132.65 ± 8.13, and paired t-test indicates there was a statistically significant reduction in systolic blood pressure post-treatment. In the same group, the pre-treatment median of diastolic blood pressure was 86 mm of Hg and the post-treatment median of diastolic blood pressure was 80 mm of Hg, Wilcoxon matched-pairs signed rank test indicates there was a statistically significant reduction in diastolic blood pressure post-treatment. In this group, the pre-treatment median of the Rate of Perceived Exertion was 1 and post-treatment was 1, Wilcoxon matched-pairs signed rank test indicates there was a statistically significant reduction in the score of Rate of Perceived Exertion post-treatment.

Systolic blood pressure - when both the groups compared for their mean differences, the mean difference of systolic blood pressure of Group A was 3.45 ± 1.81 and that of Group B was 4.5 ± 2.16, unpaired t-test shows that there was a statistically significant reduction in systolic blood pressure in Group B than Group A.

Diastolic blood pressure - when both the groups compared for their differences in the median, the median difference in diastolic blood pressure of Group A was 0 and that of Group B was 4, Mann Whitney test shows that there was a statistically significant reduction in diastolic blood pressure in Group B than Group A.

Rate of Perceived Exertion - when both the groups compared for their differences in the median, the median difference in Rate of Perceived Exertion of Group A was 0 and that of Group B was 0, Mann Whitney test shows that there was no statistically significant reduction in the scores of Rate of Perceived Exertion.

Baroreflex sensitivity is inversely proportional to arterial blood pressure.[12]

The possible mechanism behind the reduction in systolic blood pressure in the diaphragmatic breathing exercise group is an increase in the baroreflex sensitivity, which regulates heart rate, contractility of the heart, the diameter of the blood vessels, reduces sympathetic tone which ultimately results in the reduction of the systolic blood pressure. Improvement in the vagal tone causes a decrease in the heart rate and thus blood pressure. So improvement in vagal activity and reduction in sympathetic activity collectively leads to a reduction in blood pressure. [15] This increase in parasympathetic tone helps to normalize the Fight – fright – flight response and brings the heart rate to normal. Also, it directly affects the autonomic nervous system which controls the heart functions.[16]

Slow and deep diaphragmatic breathing helps to reduce chronic stress, the tension causing the rise in blood pressure means it works in the psychological aspect and relaxes the body and thus reduces the blood pressure. Diaphragmatic breathing causes movements of diaphragm which gives massaging effect to vital organs. During inhalation abdomen expands and blood circulation improves. During controlled breathing abdominal muscles get toned and strengthened which reduces tension in muscle which further leads to dilatation of blood vessels and diastolic blood pressure can return back to normal. [16]

Diastolic blood pressure is directly proportional to peripheral resistance.[18] Diaphragmatic breathing causes physiological changes that helps to tune sympathetic and parasympathetic activity, improve baroreflex sensitivity which leads to dilatation of arterioles which directly leads to reduction in diastolic blood pressure.

Diaphragmatic slow breathing increases the parasympathetic tone which causes fall in systolic blood pressure, diastolic blood pressure, and heart rate. [16]

Furthermore, deep diaphragmatic breathing enhances lung inflation, and lower breathing rate which stimulates slowly adapting pulmonary stretch receptors, the information from this reflex mechanism is used by medulla in association with arterial baroreceptors to control the blood pressure. [8]

Hypertensive people have tendency of spontaneous hyperventilation, which is indicative of the common link between cardiovascular and respiratory abnormalities, i.e. common pattern of excitation which can be modified by adapting to the specific pattern of breathing. [8] There is linear correlation between respiratory frequency and RPE, and Diaphragmatic breathing helps to normalize the breathing pattern which results in reduction in perception of exertion i.e. RPE.[19]

Diaphragmatic breathing improves peripheral oxygen saturation and also regulates heart rate.[12] There is established fact about the linear relationship between Heart rate and Rate of perceived exertion, so reduction in heart rate leads to lower scores of RPE. [20]

Buteyko breathing emphasis on nasal breathing which greatly improves Nitric oxide (NO) levels in paranasal sinuses. NO is involved in Broncho dilatation and vasodilatation, which reduces blood pressure. [13,21,22]

Buteyko technique also increases baroreflex sensitivity which leads to heart rate variability, increase in venous return and decrease in peripheral resistance, which helps to reduce systolic and diastolic blood pressure. This effect is mediated through mechanical and neural mechanisms. [14]

Extended voluntary expiration phase causes increase in intrathoracic pressure causes increase in blood flow from lungs to the heart, which increases the stroke volume, which gives feedback to carotid sinus baroreceptors and increases its discharge leading to an inhibitory action on vasoconstrictor nerves and excites vagal innervation of the heart and all this together reduces the blood pressure.

Breathing control phase in Buteyko Breathing facilitates acute slow and regular breathing pattern which positively affects reflex control system of cardiovascular system via stimulating slowly adapting pulmonary stretch receptors which helps in modulation of blood pressure. [23]

Buteyko breathing technique emphasis on expiratory hold which cause retention of carbon dioxide in the lungs up to certain level, which causes vasodilatation of blood vessels, which further decreases peripheral resistance hence ultimately results in reduction in diastolic blood pressure. [21]

One study conducted by Buteyko clinic in the year 2006 found that slow controlled breathing triggered the parasympathetic response of the body which caused decrease in respiratory rate and heart rate which further caused reduction in systolic and diastolic blood pressure. [22]

Improvement in RPE following the Buteyko technique may be due to voluntarily holding the expiration phase till one can sense the lack of air sensation, which might consequence a positive response in individuals' breath-holding capacity and may help to overcome spontaneous breathing difficulties during the activities. Repetition of this breath holding increases body's endogenous production of antioxidant's and increases anaerobic threshold of the body, which increases the body's capacity to do activities at higher levels of exertion, thus RPE for the daily activities shows significant improvement. [23]

Also, low CO_2 levels are known to cause bronchoconstriction and vasoconstriction. So reverse occurs in Buteyko technique, levels of CO_2 are purposely increased to a certain level which causes Broncho dilatation, which facilitates Oxygen and Carbon dioxide exchange, which causes improvement in scores of RPE. [24]

Holding the breath causes accumulation of Carbon dioxide, which improves collateral ventilation in the lungs which reduces the blood pressure and also reduces the Rate of perceived exertion in individuals. [5]

Systolic blood pressure was reduced in both groups but more statistical reduction was seen in Group B, Diastolic blood pressure was reduced in both groups but more statistical reduction was seen in Group B. RPE was reduced in both groups but there was no statistical difference when compared to both groups.

Diaphragmatic breathing works through baroreflex sensitivity, relaxation, and maintenance of parasympathetic tone, and Buteyko Breathing works through baroreceptors and also through maintaining the levels of Nitric oxide, Carbon dioxide in the body. Diaphragmatic breathing works via Neural and mechanical pathways while Buteyko breathing works via neural, mechanical, and biochemical pathways. Hence effects of Buteyko overpower the effects of diaphragmatic breathing.

Since blood pressure and individuals' perception of the exertion are interlinked, but in this study, we didn't segregate the participants on their daily levels of activities, which could be the possible reason why we could not find out which group had a statistically significant reduction in RPE.

CONCLUSION

- The present study concluded that the effects of both, Diaphragmatic breathing exercises and Buteyko breathing technique reduces the systolic and diastolic blood pressure and Rate of perceived exertion in individuals with hypertension.
- Buteyko Breathing Technique significantly reduces Systolic and Diastolic Blood pressure in individuals with hypertension.
- Diaphragmatic and Buteyko Breathing Technique equally reduce the rate of perceived exertion in individuals with hypertension.

SUGGESTIONS

- Future studies can be done for a prolonged period of time to observe long-term effects.
- Participants with wide pulse pressure, and isolated systolic hypertension can be studied separately

LIMITATIONS

- Sample size was limited.
- Daily or weekly measurements of BP have not been measured.

CLINICAL IMPLICATION

This study showed highly significant reduction of blood pressure in hypertensive individuals. Also, it significantly improved rate of perceived exertion during the daily activities, in individuals with hypertension. So, this needs to be incorporated in daily practises as an adjunct along with antihypertensive medications, to control the hypertension and reduction in BP, one may seek for reduction in the dosage of the medication with the guidance of physician.

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