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Effectiveness of diaphragmatic breathing exercise and Jacobson's progressive muscle relaxation on cardio pulmonary parameters in pre-hypertensive patients

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Abstract
Background: Hypertension, also known as high or raised blood pressure, is a condition in which the blood vessels have persistently raised pressure. One of the potential risk factors of prehypertension is anxiety and it has already well known that cortisol is a marker of anxiety. There are some non-pharmacologic methods to relive anxiety; exercise and relaxation. The study was to assess the effect of diaphragmatic breathing exercise and diaphragmatic breathing exercise combined with Jacobson relaxation technique on cardiopulmonary parameters in pre-hypertensive patients.
Methodology: A total of 40 subjects aged 18 to 40 years, diagnosed with prehypertension were included in the study. Eligible subjects were allocated to two groups i.e., Diaphragmatic breathing exercise group and Jacobson relaxation with diaphragmatic breathing exercise group. Intervention was given for 8 weeks and after that cardiopulmonary parameters such as blood pressure, heart rate, and respiratory rate were assessed.
Results: In pre-hypertensive patients diaphragmatic breathing exercise group found significant difference after giving the intervention within the group (P<0.001) and also diaphragmatic breathing exercise with Jacobson's relaxation group shows highly significant (P<0.001) within the group in comparing 1st day to 8th week of interventions. but there is no significant difference found while comparing difference in between diaphragmatic breathing group and diaphragmatic breathing with Jacobson's relaxation group (P>0.05).
Conclusion: This study concludes that both diaphragmatic breathing exercise and diaphragmatic breathing exercise with Jacobson's relaxation techniques is effective in reducing cardiopulmonary parameters in prehypertensive patients and improving cardio respiratory functions.

Keywords: diaphragmatic breathing exercise, jacobson's relaxation, pre-hypertensive

Introduction
Hypertension, also known as high or raised blood pressure, is a condition in which the blood vessels have persistently raised pressure [1].
Nowadays, the prevalence of hypertension and its concomitant risk of cardiovascular disease development is increasing as the disability evidence in the society also rises.[1] One of the potential risk factors of prehypertension is anxiety and it has already well known that cortisol is a marker of anxiety. There are some non-pharmacologic methods to relive anxiety; exercise and relaxation [2].
Some reports demonstrated that pre-hypertensive have a greater risk of cardiovascular events than normotensives [2-4]. Early intervention significantly prevents or delays progression to hypertension or to other cardiovascular events. Lifestyle changes have been recommended for most pre-hypertensive by the Joint National Committee (JNC7) but there is limited evidence for its effectiveness [5]. This may be related to the diversity of factors affecting blood pressure among which stress exerts the most important influence [6-8]. Therefore, relaxation trainings, such as autogenic training, progressive muscle relaxation, visualization and breathing exercises and yoga, can be used for high blood pressure intervention and have achieved some positive results [9].

Jacobson's progressive relaxation, the most popular approach in the United States (Hertling and Jones, 1990) is based on muscular quiescence and involves alternate tensing and relaxing of skeletal, facial and respiratory muscles, which is used to induce physical and mental relaxation. The technique demands a systematic sequence of isometric contraction, followed by relaxation, which progresses slowly throughout the body [3].

Sternbach (1986) described a mechanism following the onset of stress related disorders and resultant failure in the homeostatic mechanism, thereby preventing the body from returning to baseline level of function [4]. breathing exercise also reduces symptomatic stress it increase the heart rate and respiratory rate and also increase the body demand for oxygen. It can improve body performance during physical activity as well [4].

Many studies are available for the treatment of prehypertension including therapeutic exercises. But there is a lack of evidence for the efficacy of relaxation therapies and breathing exercises in the management of prehypertension. Studies suggest that Jacobson's relaxation techniques or diaphragmatic breathing exercise alone appear to have no effect in stress. Hence there is a need to find the effect of Jacobson's relaxation techniques combine with diaphragmatic breathing exercise in pre-hypertensive patients.

Materials and Methods

An interventional study was conducted in a tertiary hospital, Mangalore, India. The study was approved by the Ethical Committee of AJ Institute of Medical Sciences, Mangalore. After seeking permission, subjects of either gender in the age group of 18 to 80 years diagnosed with prehypertension (systolic 120-139mm Hg, diastolic 80-89mm Hg) JNC 7 guidelines with no previous history of cardiovascular or respiratory problems were recruited on basis of the inclusion and exclusion criteria. Subjects with BP > 140/90mm hg, with unstable angina, MI, heart failure and non-cooperative were excluded from the study. A sample size of forty was estimated.

Eligible subjects were allocated to two groups by block randomisation ie,

1. Diaphragmatic breathing exercise group
2. Jacobson relaxation with diaphragmatic breathing exercise group

All participants were given written consent form before entering in to the study.

Outcome measures

Group 1 patients were taught only diaphragmatic breathing exercises 30 minutes in a day, 5 days in a week for 8 weeks.

Group 2 patients were taught diaphragmatic breathing exercises and Jacobson's relaxation techniques 30 minutes in a day, 5 days per week for 8 weeks,

Blood Pressure, Respiratory Rate, Heart Rate were assessed on 1st day, 3rd week and 8th week by the therapist and the patients were doing the exercises daily and were monitored by the therapist carefully every day.

Interventions

Methods to Perform Diaphragmatic Breathing Exercise

The patient assumed a semi-Fowler's position (back and head are fully supported and abdominal wall is relaxed) and performed diaphragmatic breathing. The therapist placed his hands just below the anterior costal margin, on the rectus abdominis, while the patient was instructed to inhale slowly and deeply through the nose, from functional residual capacity to total lung capacity with a three-second inspiratory hold. The patient was then instructed to relax the shoulders, keep the upper chest quiet in order that the abdomen be raised a little. The Patient was then instructed to exhale slowly through the mouth [11, 12].

The Patient was made to experience a slight rise and subsequent fall of the abdomen during inspiration and expiration, by placing his or her own hand below the anterior costal margin. The Patient was instructed to perform 3 sets of 5 deep breaths with the therapist administering them four times a day and the patient being instructed to perform the same once every waking hour for the rest of the day. In between the repetitions of the diaphragmatic breathing exercise, the patient was told to breathe normally [11, 12]. The patient was asked to keep a record of the exercise performed by entering in a log book which was provided beforehand.

Jacobson's Relaxation Method Follows

Following instructions was given to the patients:-

1. Take three deep abdominal breaths, exhaling slowly each time. As you exhale, imagine that tension throughout your body begins to flow away.
2. Clench your fists. Hold for 7-10 seconds and then release for 15-20 seconds. The same time intervals was used for all other muscle groups.
3. Tighten your biceps by drawing your forearms up towards your shoulders with both arms. Hold and relax.
4. Tighten your triceps by extending your arms out straight and lock your elbows. Hold and then relax.
5. Tense the muscles in your forehead by raising your eyebrows as far as you can. Hold and then relax. Imagine your forehead muscles becoming smooth and limp as they relax.
6. Tense the muscles around your eyes by clenching your eyelids tightly shut. Hold and then relax. Imagine sensations of deep relaxation spreading all around you.
7. Tighten your jaws by opening your mouth so widely that you stretch the muscles around the hinges of your jaw. Hold and then relax. Let your lips part and allow your jaw to hang loose.
8. Tighten the muscles in the back of your neck by pulling your head way back; as you are going to touch your head to your back. Hold and then relax.
9. Take a few deep breaths and tune in to the weight of your head sinking into whatever surface it is resting on.
10. Tighten your shoulders by raising them up as if you are going to touch your ears. Hold and then relax.
11. Tighten the muscles around your shoulder blades by pushing your shoulder blades back as if you are going to touch them together. Hold the tension in your shoulder blades and then relax.
12. Tighten the muscles of your chest by taking in a deep breath. Hold for up to 10 seconds and then release slowly. Imagine any excess tension in your chest flowing away with the exhalation.
13. Tighten your stomach muscles by sucking your stomach in. Hold and then release. Imagine a wave of relaxation spreading through your abdomen.
14. Tighten your lower back by arching it up. Hold and then relax.
15. Tighten your buttocks by pulling them together. Hold and then relax. Imagine the muscles in your hips going loose and limp.

16. Squeeze the muscles in your thighs all the way down to your knees. Hold and then relax. Feel your thigh muscles smoothening out and relaxing completely.
17. Tighten your calf muscles by-pulling your toes towards you. Hold and then relax.
18. Now imagine a wave of relaxation slowly spreading throughout your body, starting at your head and slowly penetrating every muscle groups all the way down to your toes [13, 14].

Statistical analysis

Data were analysed using SPSS 21.0. Descriptive features of the both groups were expressed in means with standard deviation ($\bar{X} \pm SD$). Paired t test was done to analyse the significant difference between the pre and post-test outcomes. Student t test was used to compare difference in the mean RR, HR between the groups. Confidence interval was set at 95%.

Results

Table 1: Shows the descriptive statistics of diaphragmatic breathing exercise group (DB)

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
AGE	20	35.00	65.00	48.8500	8.96352
GENDER	20	1.00	2.00	1.4000	.50262
DB BP Systolic 1st day	20	120.00	138.00	128.7000	4.95347
DB BP Diastolic 1st day	20	82.00	88.00	84.5000	2.03909
DB RR 1st day	20	22.00	32.00	26.3000	2.97534
DB HR 1st day	20	65.00	102.00	84.1000	10.73558
DB BP Systolic 3rd Week	20	120.00	136.00	127.9000	4.87637
DB BP Diastolic 3rd Week	20	80.00	88.00	83.2000	2.28496
DB RR 3rd Week	20	20.00	30.00	24.5000	2.80038
DB HR 3rd Week	20	64.00	100.00	82.1500	10.70305
DB BP Systolic 8th week	20	120.00	136.00	127.1000	4.42362
DB BP Diastolic 8th week	20	80.00	88.00	82.6000	2.34857
DB RR 8th week	20	18.00	29.00	23.1000	2.69307
DB HR 8th week	20	62.00	100.00	80.2500	10.68632
Valid N (listwise)	20				

Table 2: Shows the descriptive statistics of diaphragmatic breathing exercise and Jacobson's relaxation group (DB & R)

	N	**minimum**	**maximum**	**mean**	**Std. deviation**
AGE	20	28.00	62.00	46.2500	9.07788
GENDER	20	1.00	2.00	1.5000	.51299
DB&R BP Systolic 1st day	20	120.00	138.00	127.7000	4.86772
DB &R BP Diastolic 1st day	20	80.00	88.00	85.3000	2.61775
DB &R RR 1st day	20	21.00	37.00	27.6000	4.18519
DB &R HR 1st day	20	72.00	102.00	85.0500	9.52821
DB &R BP Systolic 3rd week	20	120.00	136.00	126.2000	4.39617
DB &R BP Diastolic 3rd week	20	80.00	88.00	84.2000	2.82097
DB &R RR 3rd week	20	20.00	34.00	24.3000	3.61430
DB &R HR 3rd week	20	70.00	100.00	81.8500	9.51052
DB &R BP Systolic 8th week	20	120.00	134.00	124.9000	4.22897
DB &R BP Diastolic 8th week	20	80.00	86.00	83.3000	2.61775
DB &R RR 8th week	20	17.00	33.00	21.4500	3.69174
DB &R HR 8th week	20	68.00	95.00	76.7500	7.55941
Valid N (listwise)	20				

Table 3: Paired t test of diaphragmatic breathing exercise group

	1st Day& 3rd Week	**3rd Week& 8th Week**	**1st Day &8th Week**
DB BPS	t = 3.559 *p*<0.01	t = 3.559 *p*<0.01	t = 5.141 *p*<0.001
DB BPD	t = 5.940 *p*<0.001	t = 2.349 *p*<0.05	t = 7.025 *p*<0.001
DB HR	t = 6.833 *p*<0.001	t = 7.059 *p*<0.001	t = 9.080 *p*<0.001
DB RR	t = 6.990 *p*<0.001	t = 5.871 *p*<0.001	t = 10.771 *p*<0.001

Table 3: Comparison of 1st day and 3rd week, 3rd week and 8th week and 1st day and 8th week in diaphragmatic breathing exercise group.

Table 4: Paired t test of group of diaphragmatic breathing exercise group and Jacobson's relaxation group

	1st Day & 3rd Week	**3rd Week & 8th Week**	**1st Day & 8th Week**
DBR BPS	t = 4.682 *p*< 0.001	t = 5.940 *p*< 0.001	t = 7.094 *p*< 0.001
DBR BPD	t = 4.067	t = 3.327	t = 6.892

	$p< 0.01$	$p< 0.01$	$p< 0.001$
DBR HR	t = 9.676 $p< 0.001$	t = 8.948 $p< 0.001$	t = 13.195 $p< 0.001$
DBR RR	t = 4.686 $p< 0.001$	t = 5.491 $p< 0.001$	t = 8.549 $p< 0.001$

Table 4: Comparison of 1st day and 3rd week, 3rd week and 8th week and 1st day and 8th week in diaphragmatic breathing exercise group and Jacobson's relaxation group.

Table 5 Comparison between diaphragmatic breathing group, and diaphragmatic breathing and Relaxation group

Independent t test		
	t value	**p value**
BPSF	0.510	0.613
BPDF	1.217	0.231
HRF	-0.296	0.769
RRF	-1.132	0.265
BPSW	1.158	0.254
BPDW	-1.232	0.226
HRW	0.094	0.926
RRW	0.196	0.846
BPSE	1.608	0.116
BPDE	-0.890	0.379
HRE	1.196	0.239
RRE	1.615	0.115

Discussion

The main purpose of this study was to find the effectiveness of diaphragmatic breathing exercise and Jacobson's progressive muscle relaxation on cardiopulmonary parameters in pre-hypertensive patients**.** In the study we included 40 patients who had diagnosed with prehypertension (systolic 120-139mm hg, diastolic 80-89mm hg) JNC 7 guideline from 18 to 80 years of age. The patients were equally and randomly assigned to two groups, diaphragmatic breathing exercise group and diaphragmatic breathing exercise group with Jacobson's relaxation groups, for eight weeks of intervention. Following intervention, diaphragmatic breathing exercise group and diaphragmatic breathing exercise group with Jacobson's relaxation techniques showed significant reduction in Systolic blood pressure, diastolic blood pressure, respiratory rate and heart rate ($p< 00.1$).

Prehypertension is defined as systolic BP 120 to 139 mm Hg or diastolic BP 80 to 89 mm Hg it tends to increase in severity over time. Thus prehypertension progresses to clinical hypertension at a rate of 19% over 4 years.[14] Progression depends on the levels of prehypertension is 43% compared with 20% in those with lower levels of prehypertension(SBP 120 to 129 mm Hg and DBP 80 to 84 mm Hg) and 10% in those with SBP <120 and DBP <80 mm Hg [15].

Our results are in accordance with the findings of Wang SZ *et al.* prehypertension could lower their systolic blood pressure (SBP) 8.4 mm Hg ($p< 0.05$) using slow abdominal breathing combined with EMG biofeedback. The slow abdominal breathing also significantly decreased the SBP 4.3 mm Hg ($p< 0.05$) while it had no effect on the DBP ($p>0.05$) [1]. Sinaga, G. M., *et al*, The result showed that there are significant differences ($p< 0.05$) in SBP and DBP after performing diaphragmatic breathing exercise, while there is an insignificant difference ($p>0.05$) of heart rate before and after diaphragmatic breathing exercise (DBE). The DBE was effective in decreasing systolic and diastolic pressure among pre-hypertensive clients [16].

Rajagopal *et al*. found that there was significant reduction in mean heart rate, systolic blood pressure, and diastolic blood pressure after practicing Jacobson's relaxation techniques and so found to be effective in reducing hypertension among adolescents [14]. According to Nisha Shinde *et al*. she found a significant difference (<0.05) in systolic and diastolic blood pressure and heart rate immediately after thirty minutes of Jacobson's relaxation which agrees that Jacobson's progressive muscular relaxation may be used as an adjuvant therapy for immediate control of hypertension [17]. Victoria L Salt, *et al.* proved that Jacobson's relaxation technique showed significant reduction in SBP, DBP and HR and RR when compared with Mitchell's simple physiological relaxation in prehypertensive individuals [18].

Limitations of the study

The limitation of the study was there was no control group and a smaller sample size; this limits the generalizability of the results. The patients' adherence to interventions was not assessed, as a result of which we are not sure that the patients have strictly followed the instructions. Further research can be done on a larger sample size with a control group.

Conclusion

This study concludes that both diaphragmatic breathing exercise and diaphragmatic breathing exercise with Jacobson's relaxation techniques is effective in reducing cardiopulmonary parameters in prehypertensive patients and improving cardio respiratory functions.

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