

Effectiveness of a 12-Week Yoga Program on Physiopsychological Parameters in Patients with Hypertension

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Available Online: 1st October 2014

ABSTRACT

Background: Hypertension is a major chronic lifestyle disease affecting one in three adults over 25 years or about one billion, thereby resulting in cardiovascular, cerebrovascular, and renal complications. In addition, it is an important contributor for increased cardiovascular morbidity and mortality in industrialized countries. Reports suggest that hypertension is rapidly increasing in the developing countries like India. Although medical management is effective in treating hypertension, owing to the side effects, alternative therapy such as Yoga practice is recommended. However, evidences on the efficacy of yoga practice in patients with hypertension are insufficient and further research is required.

Objective: The study aimed to investigate the effectiveness of a 12-week Yoga program on physio-psychological parameters in patients with hypertension.

Methods: Of 238 patients, 118 were randomly assigned to participate in yoga program (YP) group and 120 to the control group (CG) with no treatment. Parameters such as blood pressure (BP), heart rate (HR), body mass index (BMI), anxiety, and perceived stress were measured before and after intervention.

Results: The groups were initially homogeneous; however, after intervention, the groups significantly differed. The YP group exhibited reduced BP, HR, BMI, anxiety, and perceived stress ($P < 0.001$).

Conclusion: Our study suggests a 12-week yoga program may offer an effective intervention in reducing BP, HR, BMI, anxiety and perceived stress in patients with hypertension. Practicing Yogaasanas at home are helpful to avoid increased BP-related complications.

Keywords: Hypertension, Yoga, Blood pressure, Heart rate, Body mass index, Anxiety, Stress

INTRODUCTION

Hypertension is a chronic lifestyle disease and a major public health problem. More than half of coronary heart diseases and two-third of stroke and heart failure events are directly attributed to either high blood pressure (BP) or hypertension¹. In 2000, the total number of adults with hypertension was estimated to be 972 million, of which 333 million were in economically developed countries and 639 million in economically developing countries. By 2025, this number is predicted to increase by about 60% to a total of 1.56 billion².

High BP is estimated to affect one of three adults aged 25 years or about 1 billion people worldwide. The theme of the "World Health Day" 2013 is "Measure your BP, reduce your risk", which is a call for intensified efforts to prevent and control hypertension³. Hypertension is a chronic condition with systolic blood pressure (SBP) of 140 mmHg and/or diastolic blood pressure (DBP) of 90 mmHg (JNC7 2003). An increased workload of the heart can result in the damage to the heart muscles and valves, thereby resulting in heart failure⁴.

Hypertension is a major contributor to the cardiovascular morbidity and mortality in the industrialized countries. Reports suggest that hypertension is rapidly increasing in the developing countries like India. It has now become a

global pandemic. The World Health Organization reports that hypertension affects more than 100 million individuals in India. Due to decreased awareness, the treatment and control rates are abysmally low in India².

Yoga may be an appropriate intervention to reduce BP. There is no single definition of universally accepted yoga practice, although it is generally described as an ancient tradition⁵⁻⁷. Yoga includes the techniques of posture (asana), breath control (pranayama), and meditation, as well as moral and ethical observances^{8,9}. A complete description of the historical origins of yoga and its philosophy can be found elsewhere¹⁰. Reviews of current literature suggests that yoga can reduce BP and related dysfunction in adults^{11,12}, although most of these reviews suggest caution is warranted, as several studies have substantial methodological limitations. Few studies have examined the effect of yoga on stress in patients with hypertension.

In particular, controlled studies on hypertension have demonstrated improvement with yoga practice on BP^{13,14}, obesity¹⁵, lipid¹⁶, depression¹⁷, stress¹⁸, self-concept¹⁹, and anxiety^{20, 21}. The mechanism of yoga in reducing psychosocial stress remains unclear. Theory suggests that yoga alters the extent to which events are experienced as being stressful or impacts reactions to perceived stress²².

Table 1: Frequency distribution of the level of stress before and after intervention.

Level of stress	Before intervention		After intervention	
	YP group	Control group	YP group	Control group
Slightly lower	7 (6%)	3 (2%)	38 (32%)	3 (2%)
Average	51 (43%)	53 (44%)	68 (58%)	52 (44%)
Slightly higher	54 (46%)	57 (48%)	12 (10%)	59 (49%)
Much higher	6 (5%)	7 (6%)	-	6 (5%)

Data described as frequency (percentage); 001YP: yoga program.

Table 2: Scores of anxiety as measured using STAI in both the groups before and after intervention.

Anxiety State	Before intervention	After intervention	t value	t (inter)
YP group	50.42 ± 7.65	40.33 ± 7.14	29.12, P = 0.001	0.85, P = 0.39
Control group	49.54 ± 8.17	48.98 ± 8.18	1.80, P = 0.07	8.69, P = 0.001
Trait				
YP group	46.31 ± 9.05	37.27 ± 8.18	52.54, P = 0.001	0.29, P = 0.77
Control group	45.98 ± 8.42	45.55 ± 7.75	1.13, P = 0.26	8.01, P = 0.001
Over all				
YP group	96.72 ± 15.07	77.60 ± 13.13	44.81, P = 0.001	0.61, P = 0.53
Control group	95.52 ± 15.09	94.53 ± 14.51	1.32, P = 0.24	9.36, P = 0.001

Data are described as the mean ± standard deviation; n = 53; P < 0.001 differs before and after the intervention in the corresponding group— student's dependent t-test. P < 0.001 differs between the groups— student's independent t-test.

YP: yoga program.

In addition, yoga on stress management is directly associated the regulation of autonomic arousal. Therefore, parameters such as BP, HR, BMI, and anxiety may provide additional sources of information to understand both the efficacy and mechanisms of yoga.

During yoga practice, participants develop the ability of focused attention to the present moment, instead of being arrested by thoughts and ruminations²³. This mental stability seems to be related to the sympathetic reduction and conversely improvement in the parasympathetic activity contributing to stress and anxiety reduction^{24,25}.

Few studies investigated the stress levels of the hypertension patients before and after yoga therapy. A pilot study was conducted among 24 participants with hypertension. The protocol developed included meditation, yoga body positions, and respiration techniques. The study assessed physiological variables, namely, BP, HR, BMI, and psychological variables such as anxiety and stress level. Application of specific questionnaires allowed the researchers to detect improvement in the participant's state and trait anxiety²² and the perceived stress level²⁶. Therefore, the present study aimed to investigate whether yoga practice alters BP, HR, BMI, stress, and anxiety levels in patients with hypertension.

METHODS

Study participants: The present study was approved by the Research Ethics Committee of SRM University, Protocol no.57/IEC/2010. The study volunteers were recruited by means of announcements on radios and newspapers. Inclusion criteria were as follows: patients with Stage 1 and Stage 2 hypertension (SBP, 140–169 mm hg; DBP, 90–109 mm hg), aged 30–60 years, and those receiving antihypertensive medications. Exclusion criteria included patients with diabetes mellitus, asthma, and hypercholesteremia, alcoholics, smokers, antenatal and

postnatal mothers, and those with regular yoga practice or practicing similar techniques.

Of 272 patients, 238 were randomly allocated into two groups: 118 patients (55 males and 63 females) participated in the yoga program group (YP group), and 120 (55 males and 65 females) in the control group (CG). For ethical reasons, after the study completion, the CG also participated in the suggested intervention. The participants visited the community health centers of SRM University and were subjected to clinical examination for assessing overall health, identification questionnaires were filled, and informed consent was obtained. Furthermore, psychological scales and inventories, such as BP, HR, and BMI were assessed. These assessments were repeated after 12 weeks in both the groups.

Outcome measures

The following instruments were used to assess the physiological aspects:

- An ISO certified weighing machine to measure weight;
- An inch tape and a scale (Stadiometer) to determine height;
- A sphygmomanometer to determine BP; and
- A Stethoscope to determine HR.

BP was recorded in the sitting position in the right arm to the nearest 2 mm Hg using mercury sphygmomanometer (Diamond Deluxe BP apparatus, Pune, India). Two readings were taken 5 min apart, and the mean was recorded as BP. BMI was calculated as weight divided by height squared (Kg/m²)

Psychological variables have been assessed by 2 standardized tools.

State Trait Anxiety Inventory (STAI): A four point Standardised State Trait Anxiety Inventory devised by Spielberger was adapted, which consists of 40 statements in 2 sections to assess the anxiety level (Spielberger 1983)²⁷.

Table 3: Scores of BP of hypertension patients before and after intervention

Blood Pressure	Before Intervention	After intervention	t value	F (inter)	F (within)
SBP					
YP group	152.75 ± 11.57	138.51 ± 9.39	10.88	16.39	384.1
CG	152.85 ± 10.68	152.38 ± 10.25	P = 0.001	P = 0.001	P = 0.001
DBP					
YP group	94.51 ± 6.92	86.17 ± 6.3	9.78	22.7	254.3
CG	94.77 ± 6.4	94.23 ± 6.43	P = 0.001	P = 0.001	P = 0.001

Data are described as mean ± standard deviation; $P < 0.001$ differs before and after the intervention as well as between and within the groups. YP: Yoga program; CG: Control group; SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

Perceived Stress Scale (PSS): A five point Perceived Stress scale consists of 10 statements rated on a five-point likert scale ranged from 0 to 4 as very low, low, average, high, and very high level of stress (Cohen 1983)²⁸.

Intervention: The yoga program comprised a 5-day intensive continuous training for 2 h/day, after which the participants were asked to practice yoga daily for 30–45 mins at home, at least for 5 days per week. They were followed-up for 12 weeks. Instruction was provided to these participants through DVD, and they were requested to attend the yoga group session once in two weeks till 12 weeks. The program included the following traditional Hatha Yoga exercises:

Yoga body poses (*asanas* for 18 min): *Sukhasana*—practitioner sits with the legs crossed and the back straight. *Vajrasana*—practitioner sits on the heels, keeping the legs and thighs together, and the back straight. *Ardha-Matsyendrasana*—practitioner sits intertwining the legs, the back straight, and twists the back to look behind; this movement is performed in both directions. *Shavasana*—practitioner lies on the floor, on the back, with the arms along the body, and the knees extended. *Bhujangasana*—practitioner lies on the floor, on the abdomen, with the palms of the hands on the floor, at the pectoral level. Upon the instructor's command, the practitioner raises the trunk gently from the floor while stretching the back. *Standing Chakrasana*—practitioner stands with the feet together, raises the right arm, and bends the trunk toward the left side; this movement is performed on both sides. The average duration of each movement was approximately 3 min²⁹.

Exercises involving awareness and voluntary regulation of breath (pranayamas for 12 min): *Bhastrika*—forceful expirations through the nose followed by passive inspirations. *Ujjayi*—slow and complete inspiration, retention of the air in the lungs, and slow expiration through partially closed glottis. *Nadi Shodhana*—inspiration through the left nostril, retention of air in the lungs, expiration through the right nostril, inspiration through the right nostril, retention of air in the lungs, and expiration through the left nostril. *Kapalbhati*—forceful, short, and fast expiration through the nostrils followed by passive inspiration³⁰. The average duration of each pranayama was approximately 3 min³¹.

Meditational practices (10 min): mindfulness meditation, originating in Buddhist meditation, involves paying sustained attention to sensations, perceptions, and thoughts with suspension of judgment²³.

Statistical analysis: Data were analyzed using SPSS Version 16 (IBM, Chicago, USA). Baseline equivalence of both the groups related to age, gender, ethnicity, annual family income, medication, and nature of work were determined using independent *t*-tests or chi squared tests as appropriate. BP (systolic and diastolic), HR, and BMI values at pre- and post tests were evaluated for normality for parametric assumptions and were evaluated for baseline equivalence between the groups at pretest using independent *t*-tests. To analyze the psychological (STAI and PSS) and physiological (BP, HR and BMI) measurements, a 2-way ANOVA was applied before and after intervention. The differences between the groups and time points were investigated according to their statistical significance and as was the interaction between these factors. With regard to STAI and PSS, the chi-square test (χ^2) was used to compare the groups.

RESULTS

Before intervention, both groups were statistically homogeneous with regard to the following variables: male gender (YP group: $n = 55$, 47%; CG: $n = 55$, 46%) and female gender (YP group: $n = 63$, 53%; CG: $n = 65$, 54%); educational level, no formal education (YP group: $n = 26$, 22%; CG: $n = 25$, 21%), complete elementary education (YP group: $n = 63$, 53%; CG: $n = 54$, 45%), complete secondary education (YP group: $n = 26$, 22%). The participants in the YP group reported 100% commitment to the suggested program. This level of adherence was most likely facilitated by the relative flexibility of the program, as the group sessions could be attended at two different times. Furthermore, the use of DVD for practice at home facilitated the optimal rate of adherence to the protocol.

Table 1 shows the frequency of distribution of the level of stress in both the groups. Before intervention, the groups were statistically similar: 2 ($P > 0.001$). In the YP group, 7 (6%) participants had lower stress, 51 (43%) average stress, 54 (46%) with higher stress, and 6 (5%) with extreme level of stress. In the control group, 3 (2%) participants had lower stress, 53 (44%) had average stress, 57 (48%) with higher stress, and 7 (6%) with extreme level of stress.

However, after intervention, the groups exhibited statistically significant differences: 2 ($P < 0.001$). In the YP group, 36% of the participants with higher stress before intervention exhibited lower level of stress after stress. In addition, Table 1 illustrated statistically significant differences in the YP group. Conversely, CG did not

Table 4. Comparison of level of BP Reduction before and after intervention N=238

Level of BP	Group Study (n=118)	Control (n=120)	
		SBP-n(%)	DBP-n(%)
Before	Normal/Pre HT	0(0%)	7(5.9%)
	Stage 1	80(67.8%)	69(58.5%)
	Stage 2	38(32.2%)	36(30.5%)
	Stage 3	0	6(5.1%)
After	Normal/Pre HT	35(29.7%)	68(57.6%)
	Stage 1	75(63.6%)	42(35.6%)
	Stage 2	8(6.8%)	8(6.8%)
	Stage 3	0	0

Pre HT: Pre Hypertension; SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

Table 5: Scores of HR and BMI before and after intervention

Parameters	Before Intervention	After intervention	t value	F (inter)
HR				
YP group	76.23 ± 6.52	73.5 ± 6.1	9.88	0.56 P = 0.04
CG	75.41 ± 5.92	75.39 ± 6.12	P = 0.001	0.59 P = 0.13
BMI				
YP group	27.61 ± 4.96	26.07 ± 4.57	23.09	0.46 P = 0.64
CG	27.29 ± 5.28	27.43 ± 5.3	P = 0.001	2.13 P = 0.03

Data are described as mean ± standard deviation); $p < 0.001$ differs before and after the intervention in both the groups (student's dependent t-test) as well as within the groups (student's independent t-test). HR: Heart Rate; BMI: Body Mass Index; YP: yoga program; CG: Control group.

exhibit any statistically significant change before and after intervention.

Table 2 demonstrates that the average anxiety (STAI) scores exhibited statistically significant interactions with the time point and group factors. These interactions suggest that the groups' profiles differed over time. Both variables exhibited a significant reduction in the YP group. Furthermore, the YP group exhibited a 12.6%, 11.3% and 11.9% reduction in the state, trait and overall anxiety scores, respectively, after the intervention, whereas the CG exhibited only a reduction of 0.7% 0.5% and 0.6% increase, respectively, at the same time point.

Table 3 demonstrates that the average BP scores showed statistically significant interactions with the time point and group factors. Both SBP and DBP exhibited a significant reduction in the YP group in addition to the difference between the groups after intervention. The YP group exhibited a reduction of 14.24% SBP and 8.3% DBP after the intervention, whereas the CG exhibited reduction of 0.5% SBP and 0.5% DBP decrease at the same time point. Table 4 demonstrates that in YG before the intervention, Regarding SBP 5.1% in Stage 3 and 30.5% of clients in Stage 2 SBP, whereas after the yoga intervention it is reduced and shows to none in Stage 3 and only 6.8% in Stage 2 SBP. Similarly in DBP, before the study, 35.5% were in Stage 2 DBP whereas at the end of the study, 2.5% were in Stage 2 DBP and 28.3% were in Stage 2 DBP.

Table 5 demonstrates that the scores of HR and BMI scores exhibited statistically significant interactions with the time point and group factors. These interactions suggest that the groups' profiles differed over time. Both variables exhibited a significant reduction in the YP group in addition to a difference between the groups after

intervention. The YP group exhibited a 3.6% and 5.5% reduction in the HR and BMI score, respectively, after the intervention, whereas CG exhibited a reduction of 0.02% HR and 0.51% increase in BMI at the same time point.

DISCUSSION

The present study aimed to analyze whether an intervention using yoga exercises could change BP, HR, BMI, stress and anxiety levels in patients with hypertension. The stress levels of the participants in the YP group changed from the level of much higher ($N = 6$), slightly higher ($N = 54$), average ($N = 51$), and lower ($N = 7$) to absence in much higher, slightly higher ($N = 12$), average ($N = 68$), and lower ($N = 38$), thereby demonstrating the effectiveness of intervention. These changes indicated that the yoga program could reverse stress-related symptoms (Table 1). The intervention group exhibited a statistically significant reduction in the stress and anxiety scores, thereby indicating that this type of intervention may be useful to reduce stress in patients with hypertension.

This study demonstrates statistically significant reduction in the anxiety symptoms among the participants in the YP group. An emergent body of evidence points to the possible therapeutic effects of the practice of aerobic or anaerobic exercises on anxiety (Kang et al 2009). In addition, these exercises may be either mindful or nonmindful physical exercises, which proved to be effective in reducing anxiety symptoms³³.

It is worth noting that among other activities, the volunteers in our study were subjected to the practice of hatha yoga, which includes physical exercise, most were anaerobic. Nevertheless, our results cannot be discussed on

the grounds of the therapeutic effects of practicing only physical exercise, because our purpose was to subject the volunteers to a program that included exercises to the mind and meditation. Therefore, our results must be attributed to the program as such and not merely to one of its parts. In addition, Kozasa et al. investigated the efficiency of a program that included mantra meditation and pranayamas, known as Siddha Samadhi Yoga, in reducing scores of anxiety in participants with anxiety. This program includes meditation exercises associated with exercises of respiration (pranayamas). of 22 volunteers, 14 were allocated to the intervention group and eight to the control group. The intervention group received practice 3 times a day for 15 mins. The intervention group exhibited a significant reduction in the anxiety and depression scores compared to the control group (Kozasa et al 2008), and the results were consistent with the present study.

With regard to BP, 80 (67.8 %) adults with Hypertension in the YP group had Stage 1 systolic hypertension, 38 (32.2%) had Stage 2 SBP, whereas at the end of 12th week, 35 (29.7%) shows Normal or in Pre hypertension stage. In CG, 75 (63.6%) had Stage 1 and only 8 (6.8%) had Stage 2 level of systolic hypertension. Similarly in DBP, 69 (58.5 %) had Stage 1 level of hypertension, 36 (30.5%) had Stage 2 DBP, whereas at the end of 12th week, 68 (57.6%) shows Normal or in Pre hypertension stage, 42 (35.6%) had Stage 1 and only 8(6.8%) had Stage 2 levels of diastolic hypertension. Though it is evident that more than 70% of participants exhibited a improvement in both systolic and diastolic BP in study group, they did not achieve 100% achievement. Hence further research is needed and those who have not received yoga also to be provided with other alternative methods .

A significant reduction in HR (5%) and BMI (7%) scores were also observed in the YP group compared to that in the control group. These findings were similar to the study conducted by Pramanik et al to evaluate the immediate effect of slow pace bhastrika pranayama (respiratory rate; 6/min) on HR and BP and the effect of the same breathing exercise for 5 mins. It was noted that after slow bhastrika pranayamic breathing for 5 mins, both the systolic and diastolic BP significantly decreased with a slight fall in HR. Similarly, Soubia Malik et al observed the effect of BMI on BP among 100 respondents from Karachi. The findings proved that decreased BMI reduces the systolic pressure and diastolic pressure³⁴.

Comparing to previous studies in patients with hypertension³⁴, the present study is randomized and controlled and has a bigger sample. However, both the groups are under regular antihypertensive medications, which could be a study limitation. We suggest that further research is necessary to analyze the effect of Yoga program in those without treatment. The control group could be given some other mode of exercises. In this study, data on the impact of yoga on quality of life was not collected.

As previously mentioned, the mental stability could be related to sympathetic reduction and improvement in the parasympathetic activity contributing to decrease in BP, HR, BMI, stress and anxiety. Several studies about the

effects of yoga practice have been indicating a number of physiological changes, such as increased GABA concentration, adrenalin and noradrenalin reductions³⁶, increased serotonin and melatonin concentrations³⁷, which can be related to improvements in mood, reductions in body temperature^{38, 39}, and increased galvanic skin resistance may be related to stress management, and also increased gray matter density in brain regions related to emotional regulation⁴⁰.

CONCLUSIONS

The study reported that the yoga practice may represent an effective intervention in patients with hypertension to reduce BP, HR, BMI, stress, and anxiety. Therefore, it is considered to have positive effects on the cardiovascular system. In addition, yoga practice can be encouraged to be used as a non- pharmacological method to prevent hypertension-related complications.

ACKNOWLEDGEMENT

The author acknowledges Dr. Hema for yoga training and Dr. Venkatesan, statistician, for his guidance in advanced statistical analysis and friends. Furthermore, the author would like to thank all participants for their voluntary participation.

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