Section: Physiology

Original Research Article

EXPLORING THE EFFECTS OF YOGA THERAPY ON CARDIOVASCULAR RISK PROFILE, CARDIAC WORKLOAD, AND OXYGEN DEMAND IN INDIVIDUALS WITH PREHYPERTENSION: A PILOT STUDY

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Received : 07/08/2023
Received in revised form : 04/09/2023
Accepted : 15/09/2023

Keywords:
Prehypertension, Yoga therapy, Endothelial function.

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DOI: 10.47009/jamp.2023.5.5.313

Source of Support:
Multi Disciplinary Research Unit (Sponsored by DHR-Govt. Of India), S.V. Medical College, Tırupati, Andhra Pradesh, India.
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (5); 1595-1600

Abstract

Background: Prehypertension is a medical condition characterized by a modest increase in blood pressure levels, indicating a preliminary stage prior to the development of clinical hypertension. The potential consequences include physiological alterations and an elevated susceptibility to cardiovascular ailments. The utilization of yoga and meditation techniques has demonstrated advantageous outcomes for both physical and mental well-being. Nevertheless, the available data regarding the effects of yoga therapy on specific indicators and variables related to prehypertension is scarce. The objective of this study is to examine the effects of yoga therapy on cardiovascular risk profile, cardiac workload, and oxygen demand in individuals with prehypertension. **Materials and Methods:** We recruited individuals between the ages of 18 and 35 who exhibited specific blood pressure measurements. The therapeutic intervention encompassed techniques such as relaxation, stretching, and breathing exercises. We have assessed the baseline characteristics of the participants and conducted an analysis of blood samples. Statistical tests were employed for the analysis in this study. **Result:** This study assessed baseline participant characteristics. 71 participants were divided into 39 control group (CG) and 32 yoga group (YG) members. The control group (CG) and yoga group (YG) had similar physiological marker readings. Yoga reduced cardiac risk profile parameters more than the control group (CG) after three months. The intervention did not significantly alter telomerase levels in either group. **Conclusion:** The results of the study indicate that a three-month yoga intervention yields beneficial outcomes in terms of cardiac risk profile parameters and biochemical markers associated with cardiovascular health. This implies that the practice of yoga has the potential to serve as a viable non-pharmacological intervention in enhancing cardiovascular well-being.

INTRODUCTION

The condition known as "prehypertension" (preHTN) is characterized by a systolic blood pressure ranging from 120 to 139 mm Hg or a diastolic blood pressure ranging from 80 to 89 mm Hg.[1] This condition serves as a precursor to the development of clinical hypertension. Hypertension, a condition characterized by elevated blood pressure, has been observed to contribute to a significant proportion of stroke-related fatalities, accounting for 57 percent of such deaths, as well as 24 percent of cardiovascular-related deaths in individuals of East Asian descent.[2] Previous research conducted in the urban population of India, utilizing old World Health Organization (WHO) guidelines with a blood pressure threshold of ≥160/95 mmHg, revealed a prevalence of hypertension ranging from 1.2% to 4.0%.[3] Subsequent investigations have revealed a mounting incidence, and the most recent data indicate that hypertension impacts approximately 25 percent of individuals residing in urban areas of India.[4,5] Shanthirani et al reported a 47 % prevalence of preHTN among urban residents in Chennai who were

ISSN (O): 2687-5365; ISSN (P): 2753-6556

>18 yr,[6] while in a survey in an industrial population, Prabhakaran et al reported preHTN in 44%.[7]

Earlier studies reported the sympatho vagal imbalance in pre HTN,[8] which in turn, It may leads to more pathophysiological changes like endothelial dysfunction increased risk of arthrosclerosis myocardial work stress,[9-11] increased Serum γ-glutamyltransferase a biological marker liver cell damage,[12] and might have a role in the pathogenesis of cardiovascular disease, diabetes mellitus, strokes and metabolic syndrome,[13] oxidative stress from lipoprotein-associated phospholipase A2 (LpPLA2) thereby enhancing pro inflammation.[14] Studies have revealed the numerous benefits associated with the practice of yoga and meditation techniques, particularly in terms of enhancing physical well-being, promoting psychosocial balance, and facilitating emotional self-regulation. Despite the abundance of scientific research and reviews on the effects of different types of yoga, further extensive research is required to elucidate the therapeutic potential of yoga.

Additionally, based on current understanding, there is a lack of available information regarding the impact of yoga therapy on telomerase activity, gamma glutamyl transferase, endothelial function, oxidative stress, lipoprotein-associated phospholipase A2 activity, oxidised LDL, inflammatory markers, and sympathovagal balance in individuals with prehypertension. Therefore, our research endeavours to investigate the impact of yoga therapy on telomerase activity, endothelial function, gamma glutamyl transferase and lipoprotein-associated phospholipase activity in individuals with prehypertension.

MATERIALS AND METHODS

The present pilot study was conducted by the Department of Physiology at S.V. Medical College, Tirupati, in collaboration with the Multidisciplinary Research Unit (MRU), Tirupati, and the Institute of Integrative Health Education and Research. Subject recruitment commenced subsequent to obtaining approval from the Institute Ethics Committee.

Selection criteria: The investigation has been effectively executed, with the subsequent incorporation and exclusion criteria implemented to ascertain the selection of participants. To guarantee the establishment of a representative sample, it was imperative that participants met the criterion of being between the ages of 18 and 35, while also encompassing individuals of both genders. Furthermore, the study encompassed participants exhibiting systolic blood pressure measurements ranging from 120 to 139 mmHg, as well as diastolic blood pressure measurements ranging from 80 to 89 mmHg. The participants underwent a comprehensive screening process to assess their medical conditions, ensuring that only individuals exhibiting a state of general well-being and the absence of recognised chronic ailments were deemed suitable for inclusion. The present methodology was designed with the objective of reducing the influence of confounding variables and facilitating a targeted investigation of the research inquiry.

However, individuals who did not meet specific exclusion criteria were not incorporated into the study. Exclusion criteria encompassed individuals presently undergoing pharmacological treatment, those with a medical background of diabetes, hypertension, endocrine disorders, renal ailments, or already undergoing pharmacological treatment for hypertension. The primary objective of this stringent selection criterion was to effectively separate and analyse the specific impacts of the intervention being investigated. This was achieved by exclusively targeting individuals who did not depend on medication for the treatment of their medical conditions.

Yoga therapy protocol: Each session lasted for almost 60 minutes. After participating in supervised sessions for a total of two weeks, the participants carried out the same task for three days while we monitored them closely. They then practised the process on their own for an additional three days in their own homes, totaling 12 weeks of independent practise. The limitations of each specific subject were taken into account when making adjustments on a case-by-case basis. The wall acted as a stabilising support during standing-balance poses, and chairs were used to help people who had trouble standing up from the floor. The Pranayama breathing techniques, sometimes referred to as breath awareness training, involved the repetition of deep inhalations and exhalations in a 1:1 ratio without the use of breath holding. According to the instructions, the abdomen should be consecutively engaged before the lower chest and upper chest. Similar to inhalation, the identical sequence was carried out in reverse during exhale. Depending on their level of comfort and personal inclination, the participants either assumed a supine position or a seated position for the meditation and relaxation exercises. The yoga therapy protocol has main focus on relaxation, stress reduction, and gentle stretching.

The following is a sample yoga protocol designed for prehypertensives:

1. Warm-up:
   - Start with a few minutes of deep breathing to calm the mind and prepare the body.
   - Perform neck rolls, shoulder shrugs, and gentle arm swings to loosen up the upper body.
   - Perform ankle and wrist rotations to warm up the joints.
2. Standing Poses:
   - Mountain Pose (Tadasana): Stand with feet hip-width apart, lengthen the spine, and take slow deep breaths.
   - Tree Pose (Vrksasana): Stand tall and balance on one leg, placing the sole of the other foot on the inner thigh or calf. Focus on a spot for

ISSN (O): 2687-5365; ISSN (P): 2753-6556

balance and breathe slowly. Switch sides after a few breaths.

3. Seated Poses:
   - Easy Pose (Sukhasana): Sit cross-legged with a straight spine. Place hands on knees and relax the shoulders. Close the eyes and focus on deep breathing.
   - Seated Forward Bend (Paschimottanasana): Extend the legs in front and fold forward, reaching for the toes or ankles. Keep the back straight and breathe deeply.
   - Bound Angle Pose (Baddha Konasana): Sit with the soles of the feet together and gently press the knees towards the ground. Lengthen the spine and breathe deeply.
4. Supine Poses:
   - Corpse Pose (Savasana): Lie flat on the back with legs extended and arms relaxed at the sides. Close the eyes and focus on deep relaxation, breathing naturally.
   - Supine Twist (Supta Matsyendrasana): Lie on the back, bend the knees, and drop them to one side. Gently turn the head in the opposite direction. Repeat on the other side.
5. Breathing and Meditation:
   - Alternate Nostril Breathing (Nadi Shodhana): Sit in a comfortable position, close the right nostril with the thumb, and inhale through the left nostril. Close the left nostril with the ring finger and exhale through the right nostril. Repeat for a few minutes, focusing on the breath.
   - Guided Meditation: Finish the session with a guided meditation or relaxation visualization to promote stress reduction and mental well-being.

Baseline characteristics: Everyone who participated in the study had their age, gender, height, and weight noted down. Heart rate and auscultatory Blood pressure was be recorded after the volunteer had been sitting calmly for ten minutes. The mean of 3 successive recordings with an optimum difference of 4 mm Hg of both SBP and DBP were taken.[15]

Blood sampling and storage: Blood samples were obtained through venipuncture and left to coagulate. The samples were then subjected to centrifugation at a speed of 3000 revolutions/min at a temperature of 4°C for a duration of 10 min using a Remi-refrigerated centrifuge. This process resulted in the separation of serum, which was subsequently stored in a frozen state at a temperature of −80°C for further analysis.

Measurement of Endothelin 1, Gamma glutamyl transferase, Lipoprotein associated phospholipase, Telomerase:

Measurement of Endothelin 1, Gamma glutamyl transferase, Lipoprotein associated phospholipase, Telomerase was carried by ELISA kits (Bioassay Technology Laboratory).

Statistical analysis: The statistical analysis was conducted using the statistical software R for Windows version 4.3.1. The data are presented in the form of mean ± standard deviation. The statistical analysis employed the Student's paired t-test for parametric data and the Mann–Whitney U-test for non-parametric data. These tests were used to compare different parameters before and after the intervention, separately for both the YG and the CG. The Student's unpaired t-test was employed to assess the difference in change from starting point between the YG and the CG. The null hypothesis was rejected at a significance level of $P \leq 0.05$.

RESULTS

The baseline characteristics of the study participants were assessed and summarized in Table 1. The study included a total of 71 participants, with 39 in the CG group and 32 in the YG group. The average age was 18.69 years in both groups, and the male to female ratio was balanced. Height, weight, BMI, HR, SBP, DBP, PP, MAP, and RPP were measured and showed consistent patterns between the CG and YG groups. These initial measurements provide key information about the participants' demographics and physiological markers.

As shown in [Table 2]. The results of the study showed that following a 3-month yoga intervention, the yoga group (YG) experienced significant reductions in various cardiac risk profile parameters compared to the control group (CG). The mean percentage change from baseline revealed a decrease in heart rate (HR) in the yoga group, indicating that yoga practice led to a lower heart rate compared to the starting point. Similarly, systolic blood pressure (SBP) and diastolic blood pressure (DBP) showed significant reductions in the yoga group, suggesting that yoga had a positive impact on blood pressure levels. Pulse pressure (PP) also exhibited a significant decrease in the yoga group, indicating a reduction in the difference between systolic and diastolic blood pressure. Furthermore, mean arterial pressure (MAP) showed a significant decrease, demonstrating lowered average pressure in the yoga group. Lastly, the rate pressure product (RPP) exhibited a significant reduction, suggesting that the workload on the heart was reduced following yoga practice.

The study examined the effects of a yoga intervention on cardiac risk profile parameters, specifically Endothelin 1 (ET1), Telomerase (TE), Gamma glutamyl transferase (GGT), and Lipoprotein associated phospholipase (LP). The control group (CG) and the yoga group (YG) were assessed at time = 0 months and time = 3 months. At time = 0 months, the CG and YG had comparable mean values for ET1, TE, GGT, and LP. However, after 3 months, the YG showed significant improvements in ET1, GGT, and LP levels compared to the CG. The percent change from baseline was notable for ET1, with the YG experiencing a 51.88% reduction compared to a 4.19% reduction in the CG. The YG also displayed a substantial decrease in GGT levels (36.82%) compared to a negligible change in the CG (0.53%).

ISSN (O): 2687-5365; ISSN (P): 2753-6556

There was a statistically significant difference in percent change for LP as well, with the YG showing a 27.31% reduction compared to a 6.14% reduction in the CG. However, the TE levels did not significantly differ between the YG and CG after the intervention. [Table 3]

Table 1: Baseline characteristics of study participants

Parameter	CG (n=39)	YG (n=32)
Age	18.69 ± 0.65	18.69 ± 0.82
Male/Female	21/18	18/14
Height (cms)	161.39 ± 8.85	160.81 ± 6.11
Weight (cms)	55.74 ± 11.18	56.69 ± 7.45
BMI (kg/m2)	21.43 ± 4.07	21.98 ± 3.12
HR (bpm)	86.31 ± 5.31	86.09 ± 4.71
SBP (mmHg)	123.90 ± 2.31	125.06 ± 3.17
DBP (mmHg)	83.38 ± 3.85	83.13 ± 4.13
PP (mmHg)	40.51 ± 4.19	41.94 ± 4.16
MAP (mmHg)	96.89 ± 2.78	97.10 ± 3.30
RPP (mmHg)	10697.79 ± 758.51	10773.25 ± 747.42

BMI: Body mass index HR: Heart rate SBP: Systolic blood pressure DBP: Diastolic blood pressure PP: Pulse pressure MAP: Mean arterial pressure RPP: Rate pressure product

Table 2: Between, within group & mean % changes of cardiac risk profile

Parameter	Time = 0 months	Time = 3 months	%change from baseline (mean)
HR			
CG	86.31 ± 5.31	87.72 ± 4.34	-1.85 ± 5.04
YG	86.09 ± 4.71	77.97 ± 3.11	9.27 ± 4.41***
SBP			
CG	123.90 ± 2.31	125.13 ± 2.21	-1.03 ± 2.52
YG	125.06 ± 3.17	118.25 ± 2.91	5.41 ± 2.79***
DBP			
CG	83.38 ± 3.85	83.69 ± 2.15	-0.52 ± 3.97
YG	83.13 ± 4.13	73.38 ± 2.80	11.59 ± 4.29***
PP			
CG	40.51 ± 4.19	41.44 ± 3.26	-3.14 ± 11.29
YG	41.94 ± 4.16	44.88 ± 3.83	-7.69 ± 11.48
MAP			
CG	96.89 ± 2.78	97.50 ± 1.53	-0.70 ± 2.62
YG	97.10 ± 3.30	88.33 ± 2.19	8.96 ± 3.05***
RPP			
CG	10697.79 ± 758.51	10975.23 ± 561.23	-2.43 ± 6.06
YG	10773.25 ± 747.42	9219.38 ± 423.88	14.17 ± 4.91***

**** = p<0.05 HR: Heart rate SBP: Systolic blood pressure DBP: Diastolic blood pressure PP: Pulse pressure MAP: Mean arterial pressure RPP: Rate pressure product*

Table 3: Between, within group & mean % changes Endothelin1, Telomerase, Gamma glutamyl transferase, Lipoprotein associated phospholipase.

Parameter	Time = 0 months	Time = 3 months	%change from baseline (mean)
ET1			
CG	4.82 ± 1.20	4.60 ± 1.40	4.19 ± 9.66
YG	4.61 ± 1.27	2.66 ± 1.14	51.88 ± 19.66***
TE			
CG	21.26 ± 8.14	20.92 ± 7.47	-23.63 ± 81.96
YG	21.84 ± 6.57	21.69 ± 7.95	-11.82 ± 59.99
GGT			
CG	60.82 ± 12.77	60.00 ± 12.25	0.53 ± 11.97
YG	57.94 ± 10.82	36.16 ± 8.67	36.82 ± 12,46***
LP			
CG	259.10 ± 5.10	234.49 ± 60.97	6.14 ± 30.16
YG	265.69 ± 44.95	189.84 ± 31.83	27.31 ± 14.06***

**** = p<0.05 CG: Control group YG: Yoga group ET1: Endothelin1 TE: Telomerase GGT: Gamma glutamyl transferase LP: Lipoprotein associated phospholipase.*

DISCUSSION

The results of this study demonstrate that a 3-month yoga intervention has significant positive effects on various cardiac risk profile parameters. The yoga group (YG) experienced reductions in heart rate, systolic and diastolic blood pressure, pulse pressure, mean arterial pressure, and rate pressure product compared to the control group (CG). These findings indicate that regular yoga practice can lead to improvements in cardiovascular health in prehypertensives.

The decrease in heart rate observed in the yoga group is consistent with previous studies that have shown the beneficial effects of yoga on heart rate reduction.[16] The reduced heart rate suggests improved cardiac function and reduced stress on the heart during rest and physical activity. This can contribute to a lower risk of cardiovascular diseases such as hypertension, coronary artery disease, and

ISSN (O): 2687-5365; ISSN (P): 2753-6556

heart failure. The significant reductions in systolic and diastolic blood pressure in the yoga group are consistent with the results of other studies investigating the effects of yoga on blood pressure.[17] The lower blood pressure levels indicate improved arterial health and reduced strain on the cardiovascular system. High blood pressure is a major risk factor for cardiovascular diseases, and the reduction observed in the yoga group suggests that regular yoga practice can be an effective non-pharmacological approach to prevent and manage hypertension.

Mean arterial pressure, which represents the average pressure in the arteries during a cardiac cycle, showed a significant decrease in the yoga group. This suggests that regular yoga practice can lead to lower average pressure in the arteries, which is beneficial for the overall cardiovascular health. The rate pressure product, which is a surrogate measure of myocardial oxygen consumption and workload on the heart, exhibited a significant reduction in the yoga group. This indicates that the heart has to work less during physical activity after regular yoga practice.[18] The findings suggest that yoga can improve cardiac efficiency and reduce the risk of cardiovascular diseases.

In addition to the effects on cardiac risk profile parameters, the study also examined the impact of yoga on specific biochemical markers related to cardiovascular health. Endothelin 1 (ET1), a vasoconstrictor involved in the development of cardiovascular diseases, showed a significant reduction in the yoga group compared to the control group. This suggests that regular yoga practice can contribute to improved endothelial function and reduced risk of cardiovascular diseases.[19]

Gamma glutamyl transferase (GGT), an enzyme associated with liver function and cardiovascular risk, also showed a significant decrease in the yoga group compared to the control group. This indicates that regular yoga practice can have a positive effect on liver health and reduce the risk of cardiovascular diseases.[20]

Lipoprotein associated phospholipase (LP), an enzyme involved in the development of atherosclerosis and cardiovascular diseases, exhibited a significant reduction in the yoga group. This suggests that regular yoga practice can contribute to improved lipid profile and reduced risk of cardiovascular diseases.[21]

However, the study did not find significant differences in the levels of Telomerase (TE) between the yoga group and the control group after the intervention. Telomerase is an enzyme involved in telomere maintenance and cellular aging. The lack of significant change in TE levels in the yoga group may suggest that yoga practice does not directly influence cellular aging processes in preHTN.

Limitations and future perspectives: While our study contributes valuable findings on the effects of yoga on cardiac risk profile parameters, several limitations should be considered. Future research should address these limitations by conducting studies with larger sample sizes, longer intervention periods, standardized protocols, and more objective assessments. Additionally, exploring the impact of potential confounding variables, investigating diverse populations, and unraveling the underlying mechanisms will further enhance our understanding of the role of yoga in improving cardiovascular health.

CONCLUSION

The results of this study provide evidence for the beneficial effects of a 3-month yoga intervention on various cardiac risk profile parameters and biochemical markers related to cardiovascular health. The findings support the use of yoga as a non-pharmacological approach to improve cardiovascular health and reduce the risk of cardiovascular diseases. Further research is warranted to investigate the long-term effects of yoga on these parameters and to explore the underlying mechanisms of action.

Acknowledgements

We wish to extend our utmost appreciation to the esteemed MRU at SV Medical College, which operates under the distinguished Department of Health Research, Government of India. This esteemed establishment has not only bestowed upon us invaluable laboratory facilities but has also graciously provided substantial financial support, thereby facilitating the execution of our pioneering scientific investigations. We express our sincere gratitude for their steadfast support and acknowledge their pivotal contribution to our scientific progress.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556