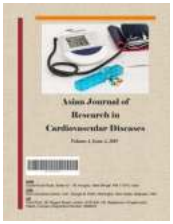

Asian Journal of Research in Cardiovascular Diseases

4(4): 39-47, 2022; Article no.AJRCD.92271

Effect of Integrated Approach of Yoga Therapy on Noninvasive Cardiovascular Responses: Study on Young and Older Healthy Males

Snehasis Bhunia [a#*] and Sohan Raj Tater [a¥]

[a] Singhania University, Pacheri Bari, Jhunjhunu district, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/92271

Original Research Article

Received 15 July 2022
Accepted 24 September 2022
Published 04 October 2022

ABSTRACT

Background and Aims: Arterial stiffness index (ASI) is significantly reduced after physical exercise or after Yoga activities. However, the effect of integrated yoga therapy (IAYT) for longer duration, using PC based cardiovascular analyzer & PPG analysis system on non-invasive cardiovascular responses such as arterial stiffness index or ankle brachial index (ABI) are not yet reported. The aim of the study was to investigate the effect of IAYT for a longer duration on noninvasive cardiovascular responses including arterial stiffness index in both young and older healthy males living in rural areas.

Methodology: A total of 20 healthy subjects were included in the study. All healthy participants were divided into two groups (A&B) based on their age. There were 10 participants in group A considered as young healthy aged below 40 years, 10 old healthy adults aged above 50 years were included in group B. All participants in group A & B were accepted and recorded all non- invasive cardiovascular parameters as experimental control (group C). A 6-weeks integrated approach of yoga therapy (IAYT) was given as an intervention to the participants come under group A & B. The PC based cardiovascular analyzer and PC based PPG analysis system were used to record almost all cardiovascular parameters signifying the status of arterial stiffness index and ankle brachial index at the beginning and end of the yoga program. The arterial stiffness index (ASI) and reflection index (RI) were computed from the pulse data. The data were analyzed using the paired-samples t test.

[#] Research Student;
[¥] Former Vice Chancellor;
**Corresponding author: E-mail: drsnehasis65@yahoo.com;*

Results: There was a significant reduction in Pulse Wave Velocity (PWV), ASI ($P < 0.05$) and no significant alterations ($P>0.05$) on ABI after IAYT for 6-weeks of IAYT in young and old participants. There was non-significant reduction in BMI after IAYT in healthy young and older adults, but the ASI was more significantly low ($P<0.01$) in young adults. There were no significant changes in Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Pulse Pressure (PP) after IAYT for 6 weeks.

Conclusion: Our findings suggest that IAYT offered was more effective than Yoga or brisk-walk separately in reducing ASI. This could be due to reduce sympathetic activity and improved endothelial function with enhancement in bioavailability of NO, which would be less effective in aged individuals. The age-related endothelial dysfunction associated with decreased bioavailability of nitric oxide (NO), a potent vasodilator, contributes to vascular stiffness would not be ruled out. The life-style modalities in IAYT must be considered as a prime candidate to reduce cardiovascular diseases (CVD).

Keywords: Arterial Stiffness Index (ASI); Pulse Wave Velocity (PWV); Reflection Index (RI); Ankle Brachial Index (ABI); Yoga; Integrated Approach of Yoga Therapy (IAYT).

1. INTRODUCTION

"The integrated approach of yoga therapy (IAYT) is an important and essential approach to get positive health which includes a healthy life with nourishing diet, a healthy and natural environment, a holistic lifestyle, adequate bodywork through yoga asanas, invigorating breath work using pranayama, kriyas and the production of a healthy thought process through the higher practices of Jnana and Raja Yoga (Table 1). IAYT slows down the loops of uncontrolled speed of thoughts (stress). In this we provide successive stimulations followed by progressive relaxations and the rest to correct the imbalances and promote mastery over the mind and can harmonize the disturbances at each level. IAYT was developed by S-VYASA is a holistic approach to treat all most all cardiovascular diseases (CVD) and the diseases like diabetes, hypertension, obesity" [1-4]. "The studies based on IAYT have shown significant result on health by reducing arterial stiffness, which emphasizes the importance of holistic treatment rather than focused treatment (Yoga). Yoga therapy is supported by medical physiologist, psychologist and neuroscientist. IAYT provides a sound, evidence-based items in a variety of mental and physical health conditions and gives yoga therapists the knowledge needed to safely tailor a yoga program to the needs of their client and can be designed according to the client's need" [5-7].

Arterial stiffness is an important part in the determination of cardiovascular risk. Non-invasive technique usually in the form of pulse wave velocity (PWV) is a safe, simple method to learn and has good inter and intraoperation reproducibility, to find out cardiovascular diseases. We must know the status of our arterial stiffness like knowing the status of our blood pressure and blood sugar. Due to paucity of instruments as well as trainer, we generally avoid knowing the status of our cardiovascular system. Physicians also confused on importance of knowing the status of arterial stiffness [8-10].

"The standard techniques used for measuring arterial stiffness are carotid-femoral pulse wave velocity (c-f PWV), brachial-ankle pulse wave velocity (ba PWV), through PC based cardiovascular analyzer (PARISCOPE, Genesis Medical System, Hyderabad) and large artery stiffness index (SI) & reflection index (RI) through photoplethysmography (PPG analysis system). Arterial stiffness measured using the carotid-femoral pulse wave velocity technique is considered as the gold standard" [9] and "as per this technique, it is measured as the ratio of the distance between two arteries (carotid and femoral) to the time taken for the pulse to travel from the carotid to the femoral artery. The other technique, i.e., ba PWV, is like c-f PWV except for the pulse location and the clinical utility of arterial stiffness measured at the brachial artery has shown significant results in identifying cardiovascular risks" [10]. "The time interval between systolic and diastolic peaks depends on the stiffness of the arteries and height of the person. The ratio of the height of the person to the time interval between systolic and diastolic peaks is termed stiffness index (SI) which represents the arterial stiffness. The ratio of the diastolic peak amplitude to the systolic peak amplitude is termed reflection index (RI) which tells us the endothelial function" [11-14].

Table 1. Schedule based on IAYT for all subjects come under group A & B for group A and B

Program	Description
Loosening exercises	Toe, ankle, knee, waist, wrist, shoulder, neck rotation and bending (12 round each) & stretching exercises.
Asana (15-20 min)	Adho Mukha Shvanasana, Adho Mukha Vrikshasana, Dhanurasana, Anantasana, Ardha chandrasana, Ardha cakrasana, Pada hastasana, Bhujangasana, Salabhasana, Sarvangasana, Matsyasana, Mayurasana, Viparitakarani, Halasana,Vakrasana, Ardha matsyendrasana, Utrasana, Relaxation technique both instant and quick (3 min each), Deep relaxation technique (3 min)
Pranayama & Kriyas	Kapalbhati (40-120 strokes/min), Sectional breathing (5 rounds), Dhauti (Vamana dhauti), Trataka kriya, Cooling & bhramari pranayama (9 rounds), Anuloma viloma pranayama (21 rounds),
Meditation (10 min)	Spiritual meditation, Mindfulness meditation, Focused meditation, Mantra Meditation
Maitri Milan	Gita chanting & Main lecture of the day in yogic principles & Bhagavat Gita
Breakfast & Lunch	Sattvic food

The effect of integrated approach of yoga therapy with longer duration on almost all noninvasive cardiovascular parameters signifying the status of arterial stiffness in healthy conditions is not yet reported. As IAYT has shown larger clinical interest, we wanted to investigate the effect of a 6-weeks IAYT program on arterial stiffness in young and older healthy male adults. We have reported several reports on the effect of physical fitness but effect of IAYT was not reported by us.

2. MATERIALS AND METHODS

The study protocol and informed consent were duly permitted by the Institutional Ethical Committee (IEC) of the Institute. Normal healthy10 male subjects, aged 30-35 years (32.57±11.74) were included in group A and 10 old healthy male subjects aged 51 years or above (51.80±11.72) were included in group B in this study. All subjects, both healthy young (Group A) and aged (Group B) male subjects were accepted as experimental control (Group C). All noninvasive cardiovascular parameters including arterial stiffness were recorded (Table 2) for one week using both PC based cardiovascular analyzer as per description reported earlier and PPG analysis system (Dicrowin). Study was performed in the surrounding areas of the University.

2.1 Measurement of Noninvasive Parameters

“Periscope (Fig. 1) is a PC based low-cost instrument hence used with a computer. It used ECG as a marker. Periscope thus facilitates use in epidemiological studies which has been accepted and has good intraday and inner observer reproducibility for various estimated central and peripheral arterial velocities. In brief, PWV was determined by a non-invasive pulse wave analyzing device (Periscope)” [9,10]. All participants, Group A & B, were asked to have vegetarian diet, asked to refrain from smoking and drinking caffeine-containing beverages 12 hours before the test. Procedure was performed always by the same operator in the morning hours between 7 and 10 a.m. with subject resting in supine position at least 10 min before the recording. Electrodes for electrocardiogram were placed in ventral surface of both wrists and medial side of ankles and BP cuffs were wrapped on both upper arm brachial artery and tibial artery above ankles. The cuff was connected to a plethysmography sensor which determines volume pulse form and an oscillometer pressure sensor, which measures blood pressure volume waveform from the brachial and tibial arteries (Fig. 1).

All the pressure recordings were done as per earlier methods developed by us [9]. SBP, DBP, PP, Heart rate or Pulse Rate (PR), brachial ankle (ba) PWV of both right (R ba PWV) and left (L ba PWV), carotid femoral pulse wave velocity (c-f) PWV) were recorded both before and after following IAYT (Fig. 2 & 3) in all subjects included in both group A & B. Ankle brachial index (ABI) on both right and left were also recorded both before and after following IAYT (Fig. 2 &3) in all subjects included in both group A & B [9,10].

Fig. 1. Elements to record non-invasive cardiovascular parameters (PC based cardiovascular analyzer or Periscope)

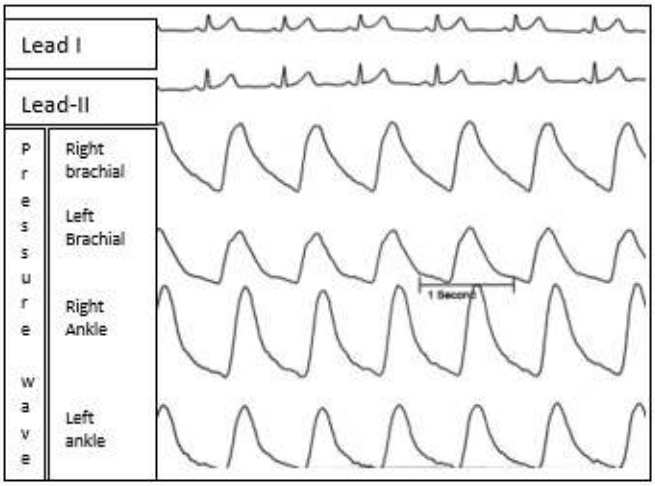

Fig. 2. A record showing ECG tracing (Lead I & II) and pressure wave form obtained from the PC based cardiovascular analyzer or Periscope

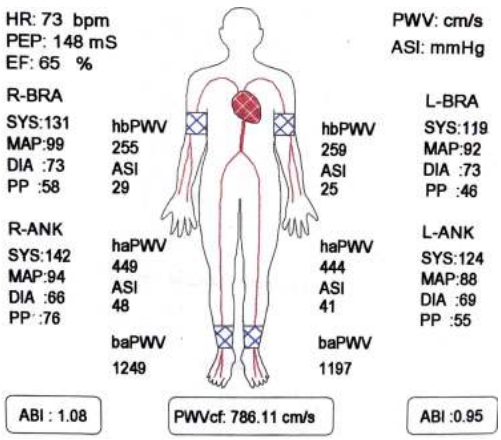

Fig. 3. A record obtained from the PC based cardiovascular analyzer

"PC based PPG analysis system (Dicrowin) was used for collecting pulse data which must record SI and RI. The pulse data was collected for 1 min by placing the sensors on the finger. Initially, the pulse was sensed with fingers to identify the exact pulse locations and then the sensors were placed by closely aligning it with the sensed locations. The pulse was taken from the left finger for males. The pulse data consist of time and amplitudes of the pulse. The pulse data were collected from the participants (Group A & B) at the beginning of the IAYT and later at the end of the IAYT. The systolic, diastolic, mean and pulse pressure were recorded in both the groups of healthy subjects. Vascular parameters such as RI or reflection index (vascular tone) and SI (large artery stiffness index) were recorded" [10-11].

2.2 Study Protocol

A 6-weeks IAYT program was given as an intervention for the study (Table 1). The program starts in the morning at 6 a.m. and ends at 7 p.m. The IAYT program includes loosening exercises, asanas, pranayama, meditation, advanced yoga techniques, bhajans, and lectures on yoga philosophy. All were asked to take sattvic food at the time of taking breakfast & lunch. The yoga practices were rigorous for participants in group A& B when compared to the participants in groups C who had not followed IAYT. The details of yoga practices (IAYT) for both groups are explained in Table 1. The yoga practices as per Table 1, were done every day. There were two sessions of loosening exercises and asanas at 6 a.m. and 5 p.m. for a 1-h duration. Pranayama was done for 1 h at 9 a.m. Meditation and advanced yoga techniques were done for 1 h at 3 p.m. and there were lectures on yoga philosophy for 1 h at 12 p.m. and bhajans for 1 h at 6 p.m. The participants had joined the center to undergo a 6-weeks of IAYT. As the aim of the study was to investigate the effect of integrated yoga therapy on arterial stiffness across young and old healthy adults, participants were divided into two groups based on their age. The participants with a BMI <25 was considered as normal and healthy. We included both young and old participants in the group A & B respectively. Group C (Experimental control) were the same participants of group A & B. A resident physician at the facility reviewed the participants' medical histories. Table 2 contains the participant's demographic information. With the use of a PC-based analyzer, height, weight, blood pressure, and pulse rate were monitored before and after the yoga session. A typical mercury sphygmomanometer was used to monitor blood pressure, and the wrist was used to manually measure pulse rate. The BMI was computed as the ratio of weight to the square of height.

2.3 Inclusion and Exclusion Criteria

All the presenting subjects were screened clinically as well as were investigated to rule out any comorbidities and persons with history of smoking, history of diabetes mellitus, hypertension, angina, arrhythmia, myocardial ischemia, peripheral ischemic disease with documented claudication, respiratory system disease, neurological diseases, persons with hemoglobin less than 10 were excluded from the study. Therefore, the study only included people who did not have any severe cardiovascular disorders and who were not already using any medications for cardiovascular diseases. Participants with cardiovascular conditions and those who refused to participate in the trial were eliminated.

2.4 Statistical Analysis

The obtained data was expressed in mean and standard deviation. The differences between the post-intervention and the baseline measures were calculated to determine the changes in the outcome measures. The data were analyzed using SPSS Statistics Version 10. The pulse data was assessed for normality using the Kolmogorov Smirnov test. The mean values of stiffness parameters (All cardiovascular parameters including SI and RI) from pre- and post-IAYT were analyzed using the paired samples t test in all three groups. A two-tailed *P* value <0.05 is considered statistically significant for all comparisons and the data were reported.

3. RESULTS AND DISCUSSION

1) All non-invasive cardiovascular parameters in group A & B (Experimental control) were not significantly different (*P*>0.05) except age (Table 2).
2) The body weight, height and age of both the groups were almost same (*P*>0.05) after following IAYT for 6 weeks(*P*>0.05) (Table 2).
3) HR, SBP, DBP &PP were not altered significantly(*P*>0.05) after following IAYT in both the groups A & B(Table 3).
4) Pulse wave velocity (right ba PWV, left ba PWV, & c-f PWV) were significantly

reduced (P<0.05) in both the groups (A & B) after following IAYT (Table 3).

5) Arterial stiffness index at four regions (right & left bra, right and left ank) were significantly reduced in both the groups (A & B) after following IAYT for six weeks (Table 3).
6) ABI at right and left were not altered significantly (P>0.05) after following IAYT (Table 3) in both the groups.
7) The mean values of SI and RI for pre- and post-IAYT are shown in Table 3. The young and old groups had shown significant reduction in SI (P < 0.05) after IAYT, whereas there were no significant changes (P>0.05) on RI in the young but non-significant with & older group. The RI was reduced in all the groups but the change in the young group was significant (P>0.05).
8) In all the groups (A & B), the BMI was reduced after IAYT and the reduction in the young and old group was not significant (Table 3).
9) Biochemical parameters such as blood sugar, lipid profile, creatinine was not significantly different in both the groups (A & B) when tested before and after IAYT (Table 3).
10) Mean arterial blood pressure was also insignificant (P>0.05) in both the groups (A & B) when tested before and after IAYT (Table 3) in both the groups.

"We reported decrease in arterial stiffness after taking physical exercise for a period of 30 minutes where pulsatile stretching of collagen fibers during aerobic exercise would break these collagen crosslinks, resulting in a decrease in arterial stiffness" [8-10]. In this study, ASI and large artery stiffness index (SI) were reduced after following 6-weeks of IAYT, RI was also reduced in both the groups indicates improvement on endothelial dysfunctions (Table 3). This observation is also supported by Patil et al. [15]. In our study, PWV was reduced significantly in both the groups signifying parasympathetic predominance, and inhibition of sympathetic which would reduce vascular tone. Load on heart might also be reduced in both the groups which are to be investigated in future. Activation of nitric oxide-dependent pathways, antioxidants, RAAS inhibitors, TGF-β inhibition, 3-hydroxy-3-methylglutaryl–coenzyme might also be involved in subjects following six weeks of IAYT in both the groups. The vascular benefits of exercise may be indirectly related to a decrease in the release of neurohumoral vasoconstrictors and a reduction in efferent sympathetic tone, as well as to endothelial mechanical-signaling linked to increased pulsatile flow and stretch and subsequently enhanced nitric oxide stimulation during IAYT in both groups. "In older adults and young healthy participants, there was not a significant reduction in BMI, but we did not see a significant reduction in RI and this could be because the average age of the group was just above 50 years. The studies had shown that arterial stiffness increases with age" [13] "for older adults with obesity as well as BMI, which was not supporting our observation. As per others observation 1week of IAYT program reduced the BMI of obese participants" [16-20]. "In this study, both young and older adults had a similar reduction in SI, but significant was observed only in young adults and not in older adults which might be due to age related changes" [16-20]. We suggest that a 6-weeks duration may not have been sufficient for older adults to see significant changes in RI. There was significant change in RI after 6-weeks of IAYT in young males, which needs further investigations using more healthy subjects both young and old.

There is a need to explore the changes in arterial stiffness by extending IAYT, which was only done for six weeks. Future research should concentrate on examining the effect by providing the same yoga practises, diet, and treatments across the groups given that the study found a substantial impact of IAYT on arterial stiffness in both younger and older persons. Our study showed, reduction with SBP, DBP and PP and HR, signifying beneficial modulation in cardiac autonomic nervous system, enhance bioavailability of NO and hence there was a reduction with blood pressure (SBP &DBP). ABI indicates peripheral artery disease and generally do not change with exercise. In this observation also there was significant increase in young adults might be due to increase peripheral blood supply and no alteration with ABI in older males would be due to age factor, resulting no such improvement on peripheral blood supply.

Table 2. Details (non- invasive & other cardiovascular responses) of the male subjects (Experimental control group) or Group C)

Parameter	Group A (n = 10)	Group B (n = 10)	*P* value
Age, (Yrs)	32.57±11.74	51.80±11.72	0.00*
Height(cm)	164.891±8.45	165.20±3.34	0.81
Weight (kg)	76.071±20.72	74.236±10.05	0.73
BMI (Kg/m^2)	26.15±7.85	22.31±3.14	0.77
SBP (mm Hg)	113.60±5.37	121.20±11.45	0.82
DBP (mm Hg)	76.67±13.48	77.60±5.36	0.21
PR (beats/min)	81.33±12.04	84.40±8.25	0.51
PP (mmHg)	41.12±06.04	43.22±10.04	0.63
Right ba PWV (cm/s)_	1249.7±21.74	1209.4±27.71	0.92
Left ba PWV (cm/s)	1197.1±31.70	1207.9±27.04	0.52
C-F PWV (cm/s)	677.2±21.74	607.2±21.24	0.75
R Bra ASI (mmHg)	29.8±06.01	39.8±06.04	0.48
L Bra ASI (mmHg)	25.3±06.14	35.3±05.04	0.21
R Ank ASI (mmHg)	48.5±04.04	58.5±05.01	0.50
L Ank ASI (mmHg)	41.4±06.08	52.4±06.06	0.60
ABI (Right)	1.08±01.01	0.95±02.04	0.82
ABI(Left)	1.01±01.14	0.87±01.09	0.51
RI (%)	14.71±03.14	21.11±02.11	0.43
SI (meter/sec)	5.05±01.12	5.21±01.11	0.61

*Data were represented as mean ± standard deviation. Group A, young healthy participants; Group B, old healthy male participants; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; PR, pulse rate; n, number of participants. * P<0.05*

Table 3. Effect of IAYT for 6-weeks on noninvasive cardiovascular responses in both young and old healthy males

Parameter	Pre IAYT		Post IAYT			
	Group A n=10	Group B n=10	Group A n=10	*P* value	Group B n=10	*P* value
Age (Yrs)	32.57±11.74	51.80±09.72	32.57±11.74	0.7	51.80±10.72	0.4
Height(cm)	164.891±18.45	165.20±23.34	164.89±8.45	0.8	165.20±3.34	0.6
Weight (kg)	76.07±10.72	76.08±10.72	75.23±10.05	0.6	76.09±6.08	0.8
SI(m/s)	5.08±01.12	5.71±01.18	4.48±01.12	0.05*	4.21±01.18	0.05*
RI (%)	14.41±03.11	22.11±02.18	10.31±03.11	0.05*	20.11±02.11	0.2
BMI	23.01±3.14	28.31±3.14	20.99±2.903	0.7	21.99±2.90	0.8
SBP(mmHg)	113.20±11.45	123.20±11.45	1012±11.22	0.01*	112±11.22	0.05*
DBP(mmHg)	77.60±5.36	84.60±5.36	75.60±6.06	0.4	81.05±09.22	0.8
PP (mmHg)	42.12±06.04	47.33±07.14	40.33±07.14	0.7	41.33±07.14	0.8
PR beats/min	74.40±8.29	84.40±8.29	71.20±7.43	0.8	81.40±6.22	0.6
Right ba PWV (cm/s)	1140.7±38.29	1240.7±31.29	1012.7±28.29	0.03*	1010.7±28.29	0.01*
Left ba PWV (cm/s)	1197.1±28.29	1217.1±28.29	1017.1±28.29	0.03*	1091.1±28.29	0.02*
C-F PWV (cm/s)	608.2±11.45	698.2±11.45	602.2±11.45	0.02*	604.2±11.45	0.01*
R Bra ASI (mmHg)	65.3±3.14	58.3±3.14	25.3±3.14	0.01*	25.3±3.14	0.01*
L Bra ASI (mmHg)	48.5±2.90	58.5±2.90	34.5±2.90	0.01*	49.5±2.90	0.02*
R Ank ASI mmHg	44.4±2.90	41.4±2.90	30.4±2.90	0.02*	31.4±2.90	0.02*
L Ank ASI mmHg	53.4±6.0	63.4±6.0	33.4±6.0	0.03*	51.4±6.0	0.02*
ABI (Right)	0.96±0.02	1.06±0.02	1.01±0.09	0.7	0.97±0.029	0.3
ABI (Left)	0.71±0.06	0.91±0.02	1.07±0.02	0.01*	1.17±0.02	0.4

*Summary of paired samples 't' test. N= number of participants. Data were represented as mean ± standard deviation. Group A, Young healthy adults; group B, old healthy adult SI, stiffness index; RI, reflection index; IAYT, integrated approach to yoga therapy; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; PR, pulse rate. * p value comparing pre and post IAYT data, significance at 0.05(* P<0.05)*

4. CONCLUSION

A 6-weeks IAYT intervention has significantly reduced arterial stiffness in young adults and older adults. Arterial stiffness is considered as one of the potential cardiovascular risk factors and with a significant reduction in arterial stiffness would improve cardiac morbidity and mortality stiffness in young adults and older adults. 6-weeks IAYT program could be suggested as a most effective program to control the cardiovascular risk or CVD. In older adults, arterial stiffness changes are less as compared to young adults and hence it might take longer in old males to see a similar effect.

CONSENT AND ETHICS APPROVAL

The study was approved by the Institutional Ethics Committee. After having explained the aim of the study to the participants, we obtained informed consent from all of them included in group A & B.

ACKNOWLEDGEMENTS

We express our sincere thanks to Dean, Singhania University for supporting this study and all the volunteers of department who helped us at various stages of the project. We sincerely thank Dr Prabhat for reviewing the manuscript. This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

COMPETING INTERESTS

Authors heve declared that no competing interests exist.

REFERENCES

1. Villacres MC, Jagannathan A, Nagarathna R, Ramakrsihna J. Decoding the integrated approach to yoga therapy: qualitative evidence based conceptual framework. Int J Yoga. 2014;7:22–31.
2. Ebnezar J, Nagarathna R, Yogitha B, Nagendra H. Effect of integrated yoga therapy on pain, morning stiffness and anxiety in osteoarthritis of the knee joint: a randomized control study. Int J Yoga. 2012;5:28–36.
3. Ebnezar J, YogithaBali M, John R, Gupta O. Role of integrated approach of yoga therapy in a failed post-total knee replacement of bilateral knees. Int J Yoga. 2014;7:160–164.
4. Jagannathan A, Hamza A, Thirthalli J, Nagendra H, Nagarathna R, Gangadhar B.Development and feasibility of need-based yoga program for family caregivers of in-patients with schizophrenia in India. Int J Yoga. 2012;5: 42–47.
5. Radhakrishna S: Application of integrated yoga therapy to increase imitation skills in children with autism spectrum disorder. Int J Yoga. 2010;3:26–30.
6. Ranjita R, Badhai S, Hankey A, Nagendra H: A randomized controlled study on assessment of health status, depression, and anxiety in coal miners with chronic obstructive pulmonary disease following yoga training. Int J Yoga. 2016;9:137–144.
7. Tekur P, Chametcha S, Hongasandra R, Raghuram N: Effect of yoga on quality of life of CLBP patients: a randomized control study. Int J Yoga. 2010;3:10–17.
8. Giri PV, Despande S, Joshi A, More P, Singh A, Nagendra HR.Effect of integrated Yoga Therapy on Arterial Stiffness: A pilot study on young and older adults with obesity. Integr Med Int 2017;4:85-93.
9. Bhunia S, Bhunia B, Basavaraj AS, Sant SK. Acute changes after 30 minute of dynamic exercise in arterial stiffness and pulse wave velocity of healthy young and middle aged individuals. Journal of Advance Research in Biological Sciences. 2015; 7(1); 17-23.
10. Bhunia S, Tripathy NK. A comparative analysis of non-invasive cardiovascular functions in proficient and non-proficient healthy subjects. International Journal of Physiology. July-Dec 2013;1(2);22-27.
11. Lumbani QA, Bhunia S, Hyder ANG. A study to assess sympathetic response changes in carotid femoral pulse wave velocity using cold pressor test in normal BMI, overweight and obese subjects. Int J of Basic Appl Physiol. 2020; 9(1);75-79.
12. Sugawara J, Tanaka H. Brachial-ankle pulse wave velocity: myths, misconceptions, and realities. Pulse (Base). 2015; 3:106–113.
13. Hertzman AB: The blood supply of various skins areas as estimated by the photoelectric plethysmograph. Am J Physiol. 1938;124:328–340.
14. Millasseau SC, Ritter JM, Takazawa K, Chowienczyk PJ. Contour analysis of the photoplethysmographic pulse measured at

the finger. J Hypertension. 2006;24:1449–1456.
15. Patil SG, Aithala MR, Das KK: Effect of yoga on arterial stiffness in elderly subjects with increased pulse pressure: a randomized controlled study. Complement Ther Med. 2016;23: 562–569.
16. Richard C Jin, Joseph L. Vascular nitric oxide: formation & function. Journal of Blood Medicine.2010;1:147-162.
17. Wildman RP, Farhat GN, Patel AS, Mackey RH, Brockwell S, Thompson T, et al. Weight change is associated with change in arterial stiffness among healthy young adults. Hypertension. 2005;45: 187–192.
18. Wildman RP, Farhat GN, Patel AS, Mackey RH, Brockwell S, Thompson T, et al. Weight change is associated with change in arterial stiffness among healthy young adults. Hypertension .2005;45:187–192.
19. Millasseau SC, Guigui FG, Kelly RP, Prasad K, Cockcroft JR, Ritter JM, et al. Noninvasive assessment of the digital volume pulse. Comparison with the peripheral pressure pulse. Hypertension. 2000;36:952–956.
20. Selvamurthy W, Sridharan K, Ray US, Tiwary RS, Hegde KS, Radhakrishan U, et al. A new physiological approach to control essential hypertension. Indian J Physiol Pharmacol. 1998;42(2):205–13.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/92271