EFFECT OF CHAIR SURYANAMASKAR WITH STRENGTH TRAINING ON CARDIOVASCULAR ENDURANCE IN FRAIL OLDER ADULTS: A RANDOMIZED CONTROLLED TRIAL

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KEYWORDS

Chair Suryanamaskar, Cardiovascular endurance, Frailty, Strength training

ABSTRACT

Background: Frailty in older adults impairs cardiovascular endurance, lowering their quality of life. Traditional exercises may be difficult because of mobility limitations. Chair Suryanamaskar, a seated yoga practice combined with strength training, may be an effective way to improve endurance and overall health. While yoga and strength training have been examined separately, their combined effects are uncertain. This randomized controlled trial (RCT) investigates their effectiveness on cardiovascular endurance in frail older individuals.

Objectives: To examine the impact of a 12-week chair Suryanamaskar with strength training on cardiovascular endurance compared to a Health education program in frail older adults using the 6-minute walk test.

Methods: This single-blinded RCT included 108 frail older adults randomly assigned to either the experimental group (Chair Suryanamaskar with Strength Training) or the control group (Health Education Program). Participants gave written informed consent. The randomization was computer-generated, and the allocation was concealed. Assessments were performed at the beginning and end of the 12-week intervention. The key outcome measurement was the 6-Minute Walk Test (6-MWT).

Results: Within-group analysis showed significant improvements in the experimental group for 6-MWT (263.16 m to 281.68 m, $p<0.001$), while the control group showed no significant changes ($p > 0.05$). Between-group comparisons showed substantial improvements in the experimental group with 6-MWT mean change of 18.52±1.95 m vs. 0.71±4.51 m in controls ($p<0.001$). The experimental group showed a significant reduction in heart rate (mean change of 3.6 ± 0.46 bpm, $p< 0.001$), systolic blood pressure (mean change of 4.6±2.67mmHg, $p<0.001$), and rate-pressure product ($p<0.001$). In contrast, diastolic blood pressure remained unchanged ($p=0.107$), while the control group showed no significant changes ($p>0.05$).

Conclusion: This study demonstrates that combining chair Suryanamaskar with strength training, significantly enhances aerobic endurance in frail older adults compared to Health education alone.

INTRODUCTION

Physical frailty is a clinical syndrome characterized by declines in multiple physiological domains, including muscle mass and strength, flexibility, balance, and cardiovascular function (1). Cardiovascular endurance is defined as the ability of the cardiovascular system to sustain extended physical activity, which is a key determinant of functional independence and quality of life in frail older adults (2). The American College of Sports Medicine recommends 20–30 minutes of moderate to vigorous aerobic training at least three days a week and resistance training one or two days a week for older adults (3). Regular physical activity, including both aerobic and strength training exercises, is an effective non-pharmacological intervention for improving physical function and cardiovascular health in the elderly population (4,5). However, frail individuals often face challenges engaging in traditional aerobic exercise due to decreased mobility, balance, and overall physical capacity. (6).

Consequently, there is a need for alternative approaches that effectively improve cardiovascular endurance while accommodating the unique needs and limitations of this population.

Chair Suryanamaskar is a modified version of the traditional yogic practice, consisting of dynamic seated postures synchronized with controlled breathing (7). This seated adaptation makes it accessible to individuals with limited mobility, balance impairments, or frailty-related concerns, enabling them to engage in structured movement without compromising safety (8). Previous studies have demonstrated that Chair yoga enhances physical function and well-being in community-dwelling older adults (9). Strength training is a widely recommended intervention for older adults that is crucial for improving muscle mass, strength, and functional performance. (10, 11). While Chair yoga and strength training independently contribute to improved physical function, the combined effect of these interventions on cardiovascular endurance in frail older adults remains underexplored. This study aims to investigate the effects of a combined Chair Suryanamaskar and strength training program on cardiovascular endurance in frail older adults.

OBJECTIVES

1) To investigate the effect of a 12-week chair Suryanamaskar with strength training on cardiovascular endurance in frail older adults using the 6-minute walk test. 2) To determine the effect of intervention on Heart rate (HR), Blood pressure and Rate pressure product (RPP) in frail older adults.

METHODS

This study was designed as a parallel-group, single-blinded randomized controlled trial (RCT). Participants were randomized into two groups by computer generated random tables, one receiving Chair Suryanamaskar with Strength Training (Experimental group) and the other receiving a health education program (Control group). The study was conducted at MAEER's Physiotherapy College & Bhausaheb Sardesai Talegaon Rural Hospital, Talegaon Dabhade, Pune, India. The Institutional Ethics Committee of Pravara Institute of Medical Sciences (Deemed University) approved this study. The trial is prospectively registered with the Indian Council of Medical Research Trial Registry (CTRI/2021/03/032277). Each participant signed the written informed consent before participating in the study. This study followed the consolidated standards of reporting trials (CONSORT) guidelines. (Figure 1).

SAMPLE SIZE

The sample size was calculated using an effect size from an RCT comparing combined aerobic and strength training with a control group (12). Based on a mean difference of 42 in the 6-Minute Walk Test, 88 participants (44 per group) were estimated for 80% power at a 5% significance level using WinPepi software. Accounting for a 20% dropout rate from a systematic review on chair-based exercises (13), the final sample size was set at 108 (54 in each group).

RANDOMIZATION AND BLINDING:

An impartial statistician used a computer-based randomization tool to create the allocation sequence in a 1:1 ratio to either the Experimental or Control group. Assignments were placed in sequentially numbered, opaque, sealed, and stapled envelopes to guarantee allocation concealment, which was safely kept in a locked drawer. Assessments were conducted at baseline (0 weeks) and post-intervention, after 12 weeks of intervention by a qualified physiotherapist who was blinded to the intervention.

SELECTION CRITERIA:

The study included individuals aged between 65 and 84 who were willing to participate. Participants were required to score between 3 and 7 on the Short Physical Performance Battery (SPPB) test, which indicates frailty (14). Additionally, only those deemed fit to perform exercises, as determined by the Physical Activity Readiness Questionnaire (PAR-Q), were included (15). Cognitive ability was assessed, and individuals who scored ≥ 24 on the Mini-Mental State Examination (MMSE) scale were considered eligible (16). Exclusion criteria included individuals who regularly engaged in exercise programs such as yoga, aerobics, strength training, or recreational sports. Individuals with medical conditions such as liver or kidney dysfunction, significant lung diseases, congestive heart failure, or

unstable coronary heart disease were not eligible. Other exclusions included those diagnosed with benign paroxysmal positional vertigo, prolapsed intervertebral discs, or disc herniation.

OUTCOME MEASUREMENTS:

The 6-Minute Walk Test (6-MWT) is a widely used measure of functional exercise capacity, particularly in older adults and individuals with chronic conditions. It assesses the distance a participant can walk on a flat, hard surface in six minutes at their own pace. This test reflects the individual's endurance and aerobic capacity, providing insights into their overall physical fitness and mobility (17).

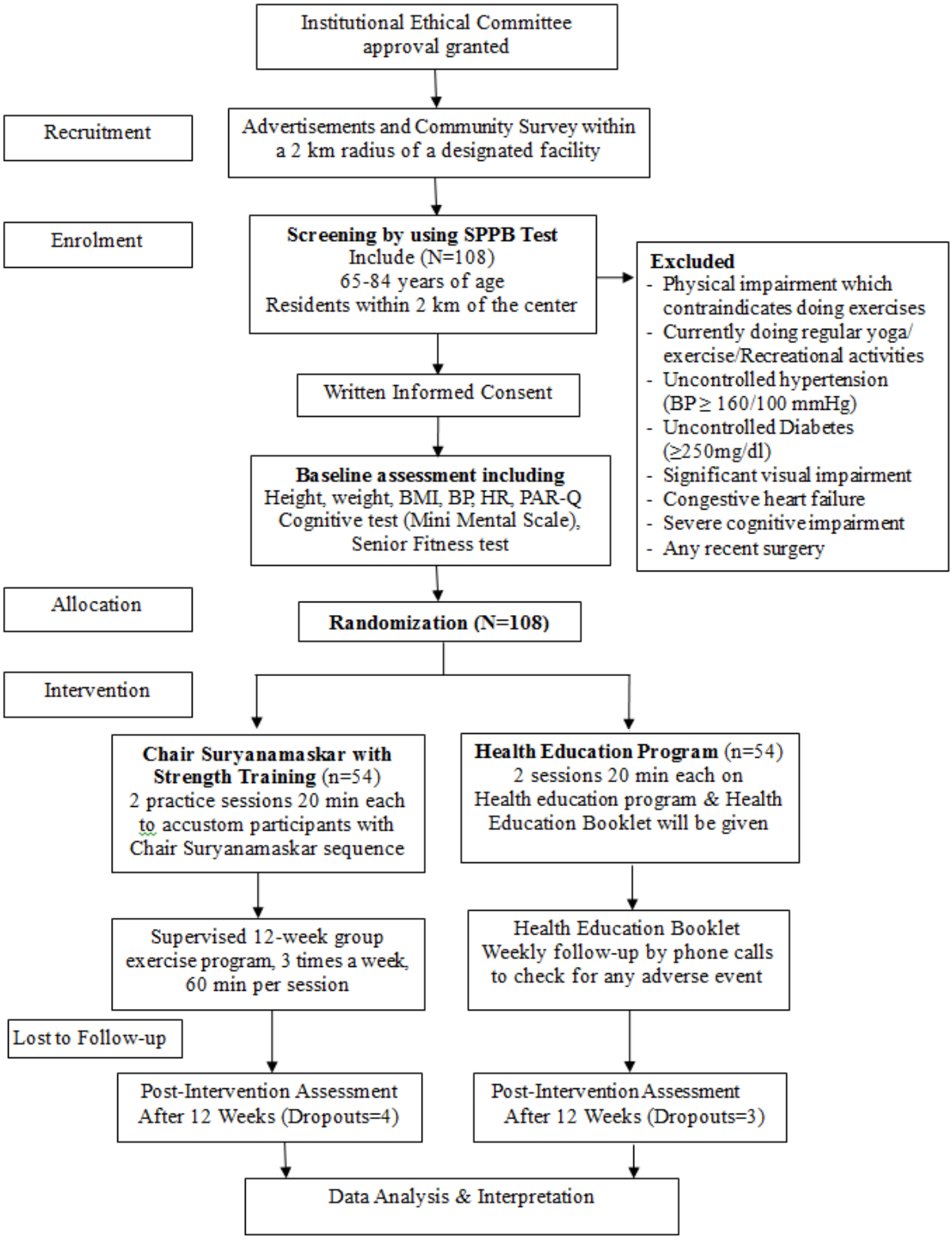


Figure 1. Design and participants flow chart according to SPIRIT 2013 guidelines (Standard Protocol Items: Recommendations for Interventional Trials).

Adherence to the Exercise Protocol

Program adherence was measured by attendance at sessions and adherence to the recommended exercise intensity. Those who reported a perceived exertion level of 13–15 on the Borg RPE scale during each session, and attended at least 85% of the sessions, were considered adherent. Out of 54 individuals, 50 participants met the adherence criterion and had an average attendance rate of 92.22%. According to dropout analysis, one participant stopped participating because of minor injuries, two people withdrew because of schedule issues, and one participant withdrew because of low back pain.

Interventions:

The experimental group performed the Chair Suryanamaskar with strength training thrice weekly for 12 weeks at a designated facility. Participants in the intervention group received two practice sessions (20 minutes each) of the exercise program to familiarize themselves with the chair Suryanamaskar sequence. The combined chair Suryanamaskar and strength training program was conducted as a group exercise session with approximately 6-8 participants. The group exercise program was standardized using a metronome throughout the sessions to maintain consistency and avoid the risk of intervention variability. The intervention protocols were implemented as follows:

Chair Suryanamaskar with Strength Training Program (Experimental group):

The study intervention followed a structured 12-week exercise program, progressing through different intensities and repetitions over time. Each session lasted approximately 60 minutes, including warm-up, chair-based Suryanamaskar, strength training, and cool-down exercises.

1. Warm-up (10 Minutes)

The session began with warm-up exercises targeting flexibility and joint mobility. These included ankle circling, calf stretch, chair marching, hamstring stretch, trunk rotation, trunk side bending, arm circling, pectoral stretch, triceps stretch, and neck rotation. (18)

2. Chair Suryanamaskar (20 Minutes)

A modified Chair Suryanamaskar sequence was performed following a metronome for rhythmic pacing. The sequence of 12 physical postures (asanas) considered one round in the following order each time (7):

1. Hands at Chest in Chair (Pranamasana) → 2. Arms Raised Parallel (Hasta Uttanasana) → 3. Forward Fold with Palms on the Floor (Hasta Padasana) → 4. Seated Low Lunge Variation in Chair (Anjaneyasana) → 5. Knee-to-Head Pose in Chair (Ek Padhastasana) → 6. Legs Extended Parallel (Dandasana) → 7. Arms Raised Parallel (Hasta Uttanasana) → 8. Forward Fold with Palms on the Floor (Hasta Padasana) → 9. Seated Low Lunge Variation in Chair (Anjaneyasana) → 10. Knee-to-Head Pose in Chair (Ek Padhastasana) → 11. Arms Raised Parallel (Hasta Uttanasana) → 12. Hands at Chest in Chair (Pranamasana).

1-4 Weeks: 6 rounds × 3 sets with a metronome at 60 beats/min, 1-2 minute rest between sets.
5-8 Weeks: 7 rounds × 3 sets with a metronome at 70 beats/min, 1-2 minute rest between sets.
9-12 Weeks: 8 rounds × 3 sets with a metronome at 80 beats/min, 1-2 minute rest between sets.

3. Break (3 Minutes)

A short break was provided for recovery before progressing to strength training exercises.

4. Strength Training (20 Minutes)

Strength training exercises targeted major muscle groups and were progressively increased in repetitions. Exercises included forward lunges, lateral lunges, chair squats, hip abductions, double-leg calf raises, and wall push-ups.

- Weeks 1-4: 1 set of 8-10 repetitions
- Weeks 5-8: 1 set of 10-12 repetitions
- Weeks 9-12: 1 set of 12-15 repetitions

This structured progression was designed to systematically enhance strength and endurance over the course of 12 weeks (19, 20).

5. Cool-down (7 Minutes)

The session concluded with gentle stretching and deep breathing exercises to promote relaxation and recovery (21). The cool-down stretches included the calf, hamstrings, shoulders, triceps, and pectoral muscles, with each stretch held for 10 seconds, repeated three times.

Health Education Program (Control Group)

The control group received two health educational sessions of 20 minutes each. The first session covered the importance and benefits of exercise, and various exercise training available for frailty management, while the second session included a demonstration of conventional stretching and strengthening exercises by a qualified physiotherapist. In addition, participants received a health education booklet, and weekly follow-up phone calls were conducted to track any adverse events.

RESULTS

The statistical analysis was performed using IBM SPSS Statistics 26.0**.** Normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) were performed to determine whether the data followed a normal distribution ($p < 0.05$). A Student's paired t-test was used for parametric data. For non-parametric data, the Wilcoxon Signed Ranks Test was used for within-group (pre- and post-test) comparisons and the Mann-Whitney U test for between-group comparisons.

A Cohen's d of 0.00–0.19, 0.20–0.49, 0.50–0.79, and ≥ 0.80 was considered as Trivial, Small, Medium, and Large, respectively (22). The experimental group showed a significant reduction in heart rate from 80.96 ± 6.05 to 77.36 ± 5.59 beats per minute ($p < 0.001$), whereas the control group showed no significant change ($p = 0.254$). The effect size in the experimental group was large (1.33) while in the control group it was trivial (0.16).

A significant decrease in systolic blood pressure (SBP) was observed in the experimental group (128.96 ± 8.19 mmHg to 124.36 ± 5.52 mmHg, $p < 0.001$), with a large effect size (1.43). The control group showed no significant difference ($p = 0.289$). Diastolic blood pressure (DBP) did not change significantly in either group ($p > 0.05$). The experimental group demonstrated a significant reduction in rate-pressure product (RPP) ($p < 0.001$), with a large effect size (1.34), while the control group showed no significant difference ($p = 0.107$).

The experimental group significantly improved their walking distance in 6-MWT from 263.16 ± 23.48 m to 281.68 ± 24.98 m ($p < 0.001$), whereas the control group showed no significant improvement ($p = 0.110$). The between-group comparison confirmed a significant difference ($p < 0.001$), with a mean change of 18.52 ± 1.95 m in the experimental group versus 0.71 ± 4.51 m in the control group. The 6-MWT showed a very large between-group effect size (5.132), while heart rate, SBP, and RPP had large effect sizes in the experimental group but trivial or small effects in the control group.

Table 1: Comparison of sociodemographic characteristics at baseline

	Experimental (N=50) Mean±SD	**Control (N=51) Mean±SD**	**P-value**
***Age* (years)**	75.40 ± 7.24	74.04 ± 6.77	0.363
Anthropometric Measures			
Height (cm)	154.98 ± 7.71	155.98 ± 8.01	0.543
Weight (kg)	58.62 ± 7.17	60.13 ± 9.31	0.474
BMI (Kg/m^2)	24.39 ± 2.29	24.64 ± 2.66	0.501
Cognition			
MMSE Scale	25.00 ± 0.96	25.02 ± 0.96	0.892
Gender			
Male	19 (38.0%)	23 (45.1%)	
Female	31 (62.0%)	28 (54.9%)	
Socioeconomic Status			
Lower Class	2 (4.0%)	4 (7.8%)	
Lower Middle	18 (36.0%)	21 (41.2%)	

Upper Lower	6 (12.0%)	7 (13.7%)	
Upper Middle	23 (46.0%)	19 (37.3%)	
Upper Class	1 (2.0%)	0 (0.0%)	
Co-morbidities			
Diabetes (DM)	6 (12.0%)	9 (17.6%)	
Hypertension (HTN)	3 (6.0%)	1 (2.0%)	
DM+HTN	8 (16.0%)	9 (17.6%)	

There was no significant difference between the experimental and control groups (P>0.05)

Table 2: Pre-post Comparison of Outcome Measures in the Control group and Experimental group

Variables	**Group**	**N**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Mean Differ**	**t-value**	**p-value**	**Effect Size**	**Magnitude**
Heart Rate (Beats/min)	Con	51	78.67±6.36	78.94±6.20	-0.27	-1.15	0.254	0.16	Trivial
	Exp	50	80.96±6.05	77.36±5.59	3.6	19.92	<.001*	1.33	Large
Systolic BP (mmHg)	Con	51	126.55±7.60	126.86±8.47	-0.31	-1.07	0.289	0.15	Trivial
	Exp	50	128.96±8.19	124.36±5.52	4.6	10.12	<.001*	1.43	Large
Diastolic BP (mmHg)	Con	51	81.37±3.21	81.57±3.33	-0.2	-1.53	0.133	0.12	Trivial
	Exp	50	81.96±2.93	81.68±2.33	0.28	1.73	0.090	0.24	Small
RPP (HRxSBP)	Con	51	9991.92 ± 1344.4	10052.71± 1370.94	-60.78	-1.64	0.107	0.23	Small
	Exp	50	10463.92 ± 1258.55	9634.72 ± 981.84	829.2	15.17	<.001*	1.34	Large

**Indicates significant difference pre versus post variables in experimental and control group(P<0.001)*

Table 3: Pre-post Comparison of 6-MWT in Experimental & Control Group

Variables	**Group**	**N**	**Pre (Mean±SD)**	**Post (Mean±SD)**	**Z**	**p-value**	**Effect Size**	**Magnitude**
6 Min Walk Test (Meters)	Exp	50	263.16±23.48	281.68±24.98	-6.16	<.001*	0.764	Large
	Con	51	263.08±20.31	262.37±22.12	-1.59	0.110	0.053	Trivial

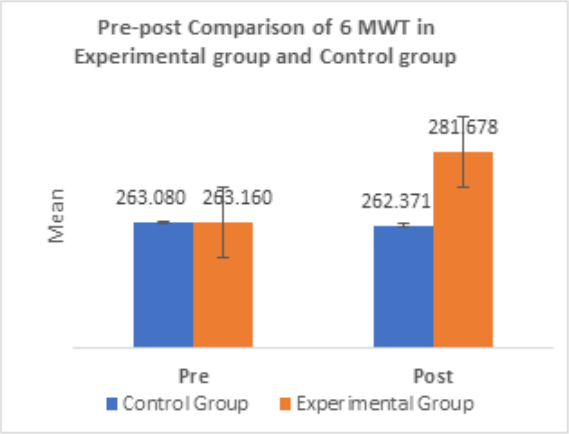
**Indicates significant difference pre versus post 6-MWT in experimental and control group(P<0.001)*

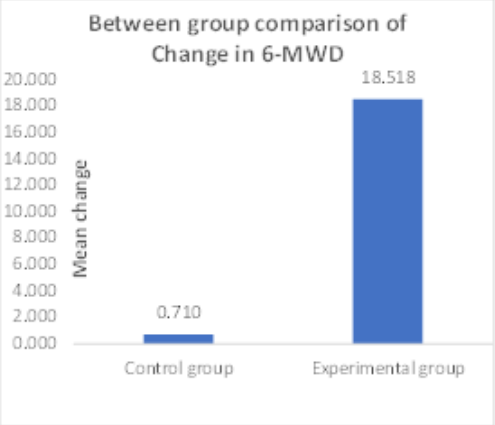
Table 4: Between-group Comparison of 6-MWT Change

Variables	**Group**	**N**	**Change (Mean±SD)**	**SEM**	**Z**	**p-value**	**Effect Size**	**Magnitude**
6 Min Walk Test Change (Meters)	Exp	50	18.52±1.95	0.275	-8.66	<.001*	5.132	Very large
	Con	51	0.71±4.51	0.631				

**Indicates Significant difference between 6-MWT change in experimental and control group (P<0.001)*

Graph 1: Pre-post and Between-group Comparison of 6-MWT in Experimental & Control Group





DISCUSSION

This study highlights the combined benefits of Chair Suryanamaskar and strength training in improving cardiovascular endurance among frail older adults. The experimental group showed significant reductions in heart rate and systolic blood pressure, indicating improved cardiovascular efficiency due to enhanced autonomic regulation and cardiac output. These findings align with a systematic review by Grässler et al. (2021) demonstrating that multimodal exercise interventions combining aerobic and resistance training significantly improved cardiac autonomic control and blood pressure (23). Malhotra et al. (2024) conducted a comparative analysis of heart rate variability (HRV) parameters between Surya Namaskar and stationary cycling exercise and they found that Surya Namaskar significantly improved HRV markers, indicating enhanced autonomic balance and parasympathetic dominance (24). A systematic review by Cornelissen and Smart (2013) confirmed that endurance and resistance training effectively reduce blood pressure, with the most pronounced effects in hypertensive individuals (25). Our study supports these findings, demonstrating that Chair Suryanamaskar combined with strength training significantly lowers systolic blood pressure, thereby improving cardiovascular health. The significant decrease in rate-pressure product (RPP) suggests reduced myocardial oxygen demand. Krishna et al. (2014) found that yoga interventions improve heart rate, blood pressure, and rate-pressure product in heart failure patients (26), findings that parallel our study's outcomes. These results further support the role of yoga-based interventions in cardiovascular health management. The control group, which received only health education, showed no significant cardiovascular improvements, emphasizing the necessity of exercise for such benefits. The significant improvement in aerobic endurance, as indicated by the increased 6-MWT distance (mean increase of 18.52 m) in the experimental group, highlights the efficacy of chair Suryanamaskar combined with strength training in enhancing functional mobility and endurance. The control group, however, showed no meaningful improvement. The observed improvements can be attributed to the synergistic effects of chair Suryanamaskar and strength training. Bandyopadhyay et al. (2022) found that Suryanamaskar performed rhythmically for more than 5 minutes, can serve as an effective aerobic workout (27). Sah & Bhise (2020) demonstrated that 8-week chair-based aerobic program significantly increased 6-MWT distance and reduced fatigue levels, further supporting the efficacy of low-impact exercises for cardiovascular health (28). In contrast, a study by Čekanauskaitė et al. (2020) found no significant improvement in cardiovascular endurance among older adults following a 10-week yoga program, despite 90-minute sessions twice per week (29). The very large between-group effect size (5.132) highlights the strong impact of the intervention on cardiovascular endurance, emphasizing its potential to enhance mobility and independence in older populations.

Integrated into the intervention, strength training likely played a crucial role in enhancing muscular endurance and mobility, thereby supporting sustained physical activity. Hurst et al. (2019) found that resistance training improves blood circulation, vascular function, and metabolic efficiency to enhance cardiovascular performance (30). Bohannon and Crouch (2016) determined that a minimal clinically important difference (MCID) in the 6-MWT ranges from 14.0 to 30.5 meters, making the observed

increase in 6-MWT distance in our study clinically meaningful (31). Thapa and Pattanshetty (2016) demonstrated that chair aerobics significantly reduced systolic blood pressure and heart rate while improving 6-MWT performance in post-coronary artery bypass graft (CABG) patients (32), reinforcing the effectiveness of chair-based aerobic exercises in rehabilitation and cardiovascular function improvement. The clinical implications of these improvements are significant, particularly for frail older adults who are at increased risk of functional decline and cardiovascular disease. The chair Suryanamaskar in seated position makes it an accessible, feasible, and effective intervention for individuals with mobility limitations. Despite its strengths, this study has some limitations. The intervention duration was limited to 12 weeks, and long-term adherence and effects were not assessed. Future research should explore the sustainability of these benefits and compare chair Suryanamaskar with other low-impact exercise modalities. Additionally, incorporating objective physiological markers such as heart rate variability could provide deeper insights into autonomic adaptations. Continued research and implementation of such interventions could significantly improve quality of life among frail older adults.

CONCLUSION

This study provides preliminary evidence that the combination of Chair Suryanamaskar and strength training can significantly improve cardiovascular endurance, as measured by the 6-Minute Walk Test. The results suggest that even low-impact, seated yoga exercises, when combined with strength training, can enhance the cardiovascular system's ability to perform sustained physical activity. This combination may be especially beneficial for frail older individuals with limited mobility, or those with chronic conditions who may find traditional aerobic exercise challenging.

ABBREVIATIONS

SFT: Senior Fitness Test; SPPB: Short Physical Performance Battery; MMSE: Mini-Mental State Examination; BMI: Body Mass Index; PAR-Q: Physical Activity Readiness Questionnaire; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; RPP: Rate-Pressure Product; 6-MWT: 6-Minute Walk Test; HRV: Heart Rate Variability; RCT: Randomized controlled trial; SPSS: Statistical package for social sciences.

DECLARATIONS

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AUTHORS' CONTRIBUTIONS

NN is the Chief Investigator. He was involved in the conception and design of the research, literature search, protocol development, Data collection, Data analysis & interpretation, and writing a significant portion of the manuscript. VP contributed to the study design, methodology development, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

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