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Effectiveness o f Blood Flow Restriction Training versus Conventional Exercise on Sleep Quality and Functional Strength in Older Adults A Quasi–Experimental Study

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Abstract

Background: Age-related decline in sleep quality and functional strength significantly affects independence and quality of life in older adults. Blood flow restriction (BFR) training has emerged as a low-load exercise approach that may improve muscular and functional outcomes and may also benefit sleep, compared with conventional exercise programs.

Objective: To evaluate and compare the effectiveness of blood flow restriction training and conventional exercise on sleep quality and functional strength in older adults.

Methods: A quasi-experimental study was conducted among older adults who were allocated into two groups: Group A received blood flow restriction training, and Group B underwent conventional exercise training. Both interventions were administered over a structured training period. We assessed sleep quality using the Pittsburgh Sleep Quality Index (PSQI) and functional strength using the Short Physical Performance Battery (SPPB). We recorded and analysed pre- and post-intervention measurements.

Results: Both groups improved in sleep quality and functional strength, but the BFR group showed greater improvement in PSQI and SPPB scores than the conventional exercise group.

Conclusion: BFR training was more effective than conventional exercise in improving sleep quality and functional strength in older adults.

Keywords: Blood flow restriction training, conventional exercise, sleep quality, functional strength, older adults, quasi-experimental study

INTRODUCTION

As the global population ages, poor sleep and reduced functional strength are increasingly common among older adults, potentially impairing mobility, independence, quality of life, and fall risk [7-9]; while sleep disturbances stem from medical conditions, medications, and lifestyle factors that impact cognition, immunity, physical performance, and overall health [8], sarcopenia—the age-related loss of muscle mass, strength, and physical performance—further exacerbates mobility loss and fall risk, highlighting a bidirectional relationship between sleep and physical function [7,10-12]. Blood Flow Restriction Training (BFR) utilizes a cuff or elastic band to partially restrict venous flow while maintaining arterial inflow during low-intensity exercise [2,4,21], potentially driving muscular adaptations and functional strength gains under low loads [1,14-17,19,20], while also offering prospective sleep benefits through heightened metabolic stress, growth hormone stimulation [2], and increased overall physical activity and independence

[7,8]. Despite BFR's demonstrated potential to enhance strength and physical capacity in older adults [1,17,19], limited research directly evaluates its combined impact on sleep quality and functional performance, raising the research question of whether BFR improves sleep quality and functional strength more effectively than conventional exercise (resistance, balance, flexibility, and functional mobility without vascular restriction) [3,11,18] in individuals aged 50 years and older who can engage in supervised exercise. Within this context, effectiveness is defined as pre- to post-intervention improvements in sleep quality—encompassing duration, latency, efficiency, and disturbances measured via lower scores on the Pittsburgh Sleep Quality Index (PSQI) [22-26]—and functional strength, balance, and mobility, measured via higher scores on the Short Physical Performance Battery (SPPB) [27-32].

METHODOLOGY

The study was approved by the institute ethics committee, IEC- RIPT/DT/21/4533. All eligible older adults who report to the study site will be screened. After determining their suitability according to the inclusion and exclusion criteria, they will be invited to participate in the study. Informed consent will be obtained from all participants before enrolment. A total of 30 subjects will be assigned to two groups: Group A and Group B. Group A will undergo Blood Flow Restriction training, and Group B will undergo conventional exercise. Pre-test and post-test assessments will be conducted for both groups. The following outcome measures will be evaluated: Sleep quality using the Pittsburgh Sleep Quality Index (PSQI) and functional strength using the Short Physical Performance Battery (SPPB)—a quasi-experimental study design. The Study Duration was 6 months. A randomized study of the older age group (50- 70 years; females). Each group will consist of 15 participants, total 30 subjects. The inclusion criteria were older adults with poor sleep quality (PSQI score > 5) and functional ability to perform exercise interventions. The exclusion criteria were severe cardiovascular or respiratory conditions contraindicating exercise. The Independent variables are Blood Flow Restriction (BFR) Training and Conventional Exercise. The Dependent variables are Sleep Quality, Functional Strength, At Tamizha Karunai Illam, Kumar Nagar, Tirupur.

INTERVENTIONS

GROUP A: Blood Flow Restriction (BFR) Training:

Treatment Duration and Frequency: 2 sets of 15-20 repetitions per exercise (depending on participants' Tolerance); Treatment Sessions: 12 sessions (3 sessions per week for 4 weeks)
Intervention Duration: 4 weeks

GROUP B: Conventional Exercise

Treatment Duration and Frequency: 2 sets of 15- 20 repetitions per exercise (depending on participants' tolerance); Treatment Sessions: 12 sessions (3 sessions per week for 4 Weeks)
Intervention Duration: 4 weeks.

OUTCOME MEASURES;

Functional strength and Sleep quality using the Pittsburgh Sleep Quality Index (PSQI) scale. Outcome assessed: Sleep quality over the previous month. Scoring: 0–21 (higher score = poorer sleep quality Short Physical Performance Battery (SPPB): Outcome assessed: Lower extremity functional strength and physical performance. Scoring: 0–12 (higher score = better performance). Parameters.

STATISTICAL ANALYSES:

Pre – test and post–test values of the study will be collected and assessed for variation in improvements, and their results will be analysed using independent "t" test and paired "t" test.

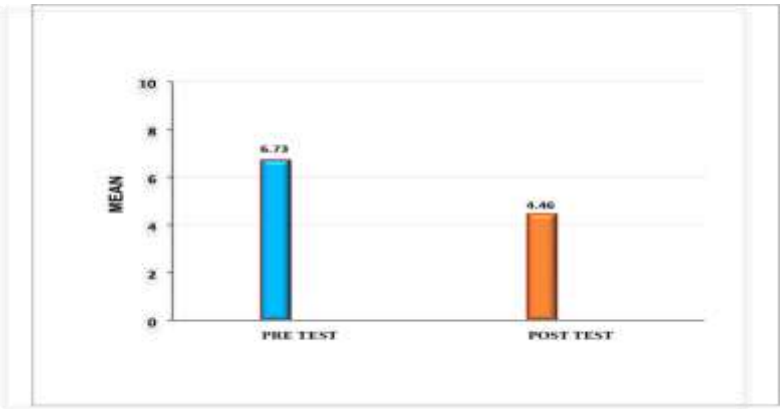
INDEPENDENT "t" TEST (BETWEEN GROUPS;

PAIRED "t" TEST (WITHIN GROUPS); Post - test values of the study will be collected and assessed for variation in each group, and their results will be analysed using paired "t" test, S = combined standard deviation. D1 & d2 = difference between initial and final readings in experimental group A & group B. N1 & n2 = number of patients in experimental group A & group B. – x1 & x2 = means of a experimental group A & group B.

Table 1: Comparison of Pittsburgh Sleep Quality Index Score within Group (Pre-Test and Post-Test Values)

TEST	PRE TEST		POST TEST		t - test	df	Sig
	MEAN	S.D	MEAN	S.D			
PSQI	6.73	4.11	4.46	3.24	3.26	14	.001***

(***- P ≤ 0.001 - Significant. The above table reveals the Mean, Standard Deviation (S.D.), t - test, degrees of freedom (df), and p-value between the pre-test and post-test. There is a statistically significant difference between the pre-test and post-test values within the group at P ≤ 0.001.

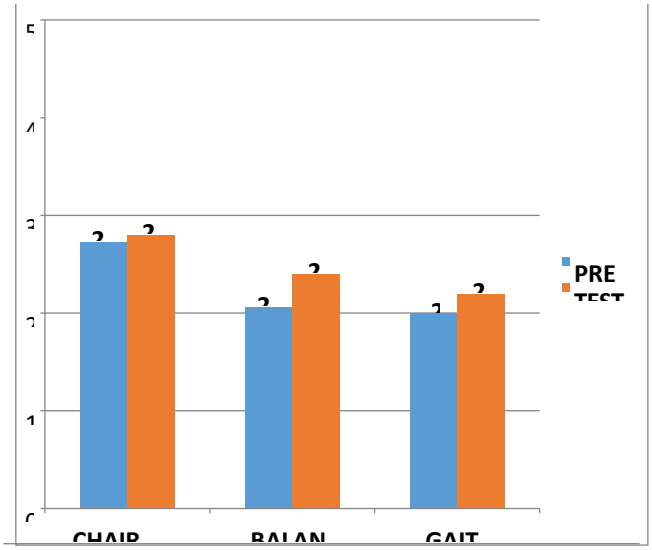


Graph 1: Comparison of Pittsburgh Sleep Quality Index Score within Group (Pre-Test and Post-Test Values)

Table 2: Comparison of Short Physical Performance Battery Score within Group (Pre-Test and Post-Test Values)

TEST	PRE TEST		POST TEST		t – test	df	Sig
	MEAN	S.D	MEAN	S.D			
CHAIR STAND TEST	2.73	1.03	2.80	.941	-2.63	14	.001***
BALANCE TEST	2.06	.798	2.40	.828	-2.64	14	.001***
GAIT SPEED TEST	2.00	.755	2.20	.861	-1.87	14	.001***

(*** p ≤ 0.001 – Significant). The above table reveals the Mean, Standard Deviation (S.D.), t–test, degree of freedom (df), and p-value between the pre-test and post-test. There is a statistically significant difference between the pre-test and post-test values within the group at P ≤ 0.001



Graph 2: Comparison of Short Physical Performance Battery Score within Group (Pre-Test and Post-Test Values)

RESULTS:

On comparing Mean values of Pittsburgh Sleep Quality Index Score between Pre test 6.73 ± 4.11 and post-test 4.46 ± 3.24 within the experimental group, it shows there is a highly significant difference between the pre-test and post-test mean values with a t value of 3.26 at $P \leq 0.001$. The post-test values have shown improvement when compared with the pre-test. Hence, the null hypothesis is rejected. On comparing mean values of Short Physical Performance Battery Score (Stand test, Balance Test & Gait Speed Test) between pre-test 2.73, 2.06 & 2.00 and post-test 2.80, 2.40 & 2.20 within the experimental group, it shows there is a highly significant difference between pre-test and post-test mean values at $P \leq 0.001$. The post-test values have shown improvement when compared with the pre-test. Hence, the null hypothesis is rejected.

DISCUSSION:

This quasi-experimental study demonstrated that both blood flow restriction (BFR) training and conventional exercise improved sleep quality and functional strength in older adults. However, BFR training produced greater improvements in Pittsburgh Sleep Quality Index (PSQI) and Short Physical Performance Battery (SPPB) scores.

These benefits may be attributable to increased metabolic stress, enhanced recruitment of fast-twitch muscle fibres, improved circulation, and reduced joint loading. Improvements in muscular strength may also contribute to better sleep by reducing fatigue and promoting greater functional independence.

Overall, BFR training appears to be a feasible and effective exercise modality for older adults who may be unable to tolerate high-load resistance exercise.

CONCLUSION:

The null hypothesis was rejected. Both blood flow restriction (BFR) training and conventional exercise significantly improved sleep quality and functional strength in older adults; however, BFR training resulted in greater improvements. These findings suggest that BFR may represent an effective alternative for individuals unable to tolerate high-intensity resistance training and may have potential applications in geriatric rehabilitation programs.

LIMITATIONS AND RECOMMENDATIONS:

Limitations:

The quasi-experimental design and small sample size may limit the generalizability of the findings and increase the potential for selection bias. The brief intervention period precluded evaluation of long-term effects. Reliance on subjective sleep measures may have introduced reporting bias associated with individual perceptions. Additionally, medication use, lifestyle factors, and comorbidities were not controlled for and may have influenced the observed outcomes.

Recommendations:

BFR training may improve sleep quality and functional strength in older adults. Future implementation should incorporate individualized pressure settings, appropriate outcome measures, and continuous monitoring. Standardized protocols should be established, and BFR should be integrated with functional, balance, and mobility exercises. Larger, longer-term studies incorporating objective measures of sleep and physical performance are warranted.

Informed consent

Written informed consent was obtained from all participants before enrolment in the study. Participants were informed about the study objectives, procedures, potential benefits, and their right to withdraw from the study at any time without any consequences.

Conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this study.

Author contributions

M. Soundharya: Conceptualization, methodology, participant recruitment, data collection, statistical analysis, manuscript preparation, and manuscript revision.

Dr. B.J.A.C. Darrius: Study conception and design, supervision, methodology validation, interpretation of results, critical revision of the manuscript, and final approval of the manuscript.

Dr. P Bright Alwin Victor: Administrative support, overall academic guidance, and final approval of the manuscript.

Data availability statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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