

**EFFECTS OF DIFFERENT TYPES OF DEAD HANG TRAINING
FOR IMPROVING ISOMETRIC SHOULDER STRENGTH AND
FUNCTIONAL PERFORMANCE IN MALE RECREATIONAL
COURT SPORTS PLAYERS - A RANDOMIZED CONTROLLED
TRIAL**

By

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Of the requirements for the degree of
MASTER OF PHYSIOTHERAPY (MPT)
In
SPORTS**

Under the Guidance of

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**ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH
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I hereby declare that this dissertation/thesis entitled “**EFFECTS OF DIFFERENT TYPES OF DEAD HANG TRAINING FOR IMPROVING ISOMETRIC SHOULDER STRENGTH AND FUNCTIONAL PERFORMANCE IN MALE RECREATIONAL COURT SPORTS PLAYERS - A RANDOMIZED CONTROLLED TRIAL.**” is a bonafide and genuine research work carried out by me under the guidance of Dr. Deepak Kumar Pradhan (PT),), Assistant Professor and Co-Guide Dr. Gayatri Upasana Acharya (PT), Associate Professor, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha, and there are no conflict of interest associated with this dissertation work.

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Thank you.

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LIST OF ABBREVIATIONS USED

1. SMBT – Seated Medicine ball throw test
2. ABSMARI – Abhinav Bindra Sports Medicine and Research Institute
3. ANOVA – Analysis of variance
4. SPSS – Statistical package of social sciences
5. FAH – Flexed Arm Hang
6. DH – Dead hangs

ABSTRACT

Title: EFFECTS OF DIFFERENT TYPES OF DEAD HANG TRAINING FOR IMPROVING ISOMETRIC SHOULDER STRENGTH AND FUNCTIONAL PERFORMANCE IN MALE RECREATIONAL COURT SPORTS PLAYERS - A RANDOMIZED CONTROLLED TRIAL

Background: Shoulder strength and stability are essential for performance in court sports, yet recreational athletes often neglect targeted training for the shoulder complex. Simple hanging exercises, such as the Dead hang and Flexed arm hang, may provide an accessible means to improve shoulder strength and functional performance, but their effects have not been systematically studied in this population.

Objective: To evaluate the effects of Dead hang and Flexed arm hang training on isometric shoulder strength and functional performance in recreational court sport athletes, compared with a control group.

Methods: A total of 38 male recreational court sport athletes (aged 18–28 years) were randomized into three groups: Dead hang (n = 15), Flexed arm hang (n = 10), and Control (n = 13). Training interventions were performed for a defined period, while the Control group received no specific intervention. Outcome measures included right shoulder isometric strength (abduction, flexion, external rotation) assessed using a hanging scale, and upper-body performance assessed by the Seated Medicine Ball Throw (SMBT). Data were analysed using one-way ANOVA or Kruskal–Wallis tests with appropriate post hoc analyses, and paired t-tests for within-group changes.

Results: Both Dead hang and Flexed arm hang groups demonstrated statistically significant improvements in shoulder strength and performance compared with the Control group ($p < 0.05$). No significant differences were observed between Dead hang and Flexed arm hang groups across the outcome measures. Within-group analysis confirmed that both intervention groups improved in multiple strength outcomes, while the Control group showed no significant changes except for a small improvement in SMBT.

Conclusion

Dead hang and Flexed arm hang training are effective, low-cost, and accessible exercises to enhance shoulder isometric strength and functional performance in recreational court sport athletes. Either variation can be incorporated into training programs to improve shoulder health and performance.

Keywords: Dead hang, Flexed arm hang, Isometric training, Recreational athletes, Seated Medicine Ball Throw, Shoulder strength.

TABLE OF CONTENTS

Sr.no	Content	Page No
1	INTRODUCTION	1-4
2	NEED OF THE STUDY	5
3	AIM & OBJECTIVE OF THE STUDY	6
4	HYPOTHESIS	7
5	REVIEW OF LITERATURE	8-16
6	METHODOLOGY & PROCEDURE	17-23
7	STATISTICAL ANALYSIS	24
8	RESULTS	25-29
9	DISCUSSION	30-33
10	CONCLUSION	34
11	LIMITATIONS & RECOMMENDATIONS FOR FUTURE STUDY	35
12	SUMMARY	36
13	STATEMENT OF FUNDING	37
14	BIBLIOGRAPHY	38-42
15	ANNEXURES	42-47

LIST OF TABLES

Sr. No	Table	Page No.
1	TABLE 1: REVIEW OF LITERATURE	14 - 16
2	TABLE 2: Demographic and Pre-intervention data	25
3	TABLE 3: Within group comparison strength measurement	26
4	TABLE 4: Between Group Analysis of Mean Differences	27
5	TABLE 5: Pairwise comparison of Shoulder Abduction	29
6	TABLE 6: Pairwise comparison of Shoulder Flexion	29
7	TABLE 7: Pairwise comparison of Shoulder External rotation	29
8	TABLE 8: Pairwise comparison of SMBT	29

LIST OF FIGURES AND GRAPHS

Sr. No.	Graphs \ Figures	Page No.
Figure 1	Picture of participant performing Dead Hang	21
Figure 2	Picture of participant Performing Flexed Arm Hang	21
Figure 3	Picture of Shoulder strength testing of abduction	22
Figure 4	Picture of Shoulder strength testing of flexion	23
Figure 5	Picture of Shoulder strength testing of external rotation	23
Figure 6	Picture of SMBT	23
Figure 7	Age Distribution	25
Figure 8	Clustered Bar chart for Right Shoulder Abduction, Right Shoulder Flexion, Right External Rotation, SMBT	26
Figure 9	Shoulder Abduction between group analysis	28
Figure 10	Shoulder Flexion between group analysis	28
Figure 11	Shoulder External rotation between group analysis	28
Figure 12	SMBT between group analysis	28

INTRODUCTION

Skeletal muscle strength, which is the most force a muscle can make during a single voluntary contraction, is an important measure of neuromuscular function and total physical ability (1). Muscle strength is not only important for sports and athletic performance, but it is also recognized as a key aspect that affects health, functional independence, and quality of life. Evidence suggests that increased muscle strength is significantly correlated with enhanced physical function, whereas muscle weakness is linked to functional deterioration, elevated disability risk, and diminished quality of life (2). Consequently, the assessment of muscle strength is of significant clinical and research importance, serving as both a health status indicator and a predictor of functional outcomes.

Evaluating the strength of the glenohumeral and scapulothoracic musculature is a crucial component of a thorough shoulder assessment. The supraspinatus, infraspinatus, teres minor, and subscapularis muscles in the rotator cuff are important for dynamically stabilizing the glenohumeral joint by keeping the humeral head centered in the glenoid fossa while the upper limb moves (3). These stabilizing abilities are important for both everyday jobs and high-level sports.

From a sports performance point of view, increased muscle strength has been found to improve force-time characteristics, which lets athletes produce more force in less time. These kinds of alterations make you better at running, jumping, changing directions quickly, and other motions that are specialized to your sport. Stronger athletes not only perform better, but they also have a lower risk of injury because higher strength leads to quicker force potentiation and better load absorption during dynamic exercises (4).

In overhead and throwing sports, the shoulder muscles must work together in a very complicated way. This means that the rotator cuff, deltoid, pectoralis major, latissimus dorsi, triceps brachii, biceps brachii, and scapular stabilizers all have to work together. These muscles are heavily used in fast, repeated actions such the baseball pitch, American football throw, softball windmill pitch, volleyball serve and spike, tennis serve and volley, baseball batting, and golf swing (5). To get the most power out of these kinetic chains and lower the danger of overuse injuries, they need to be activated in a balanced and constant way.

Basketball, tennis, volleyball, handball, badminton, and squash are all examples of court sports. These are physical activities that take place on specific playing surfaces (6). Recreational athletes that play these sports do so mostly for fun, exercise, and health benefits, not to compete or make a living (7). In these situations, upper-body power and pushing actions are very crucial in contact sports like basketball and handball, especially while defending or getting into a fight (8). However, throwing sportsmen often hurt their dominant shoulder or elbow because these joints are put under a lot of stress when they make the same overhead motion over and over again (9,10).

These types of injuries are often connected to muscular weakness and imbalances between agonist and antagonist groups (11,12). Consequently, strength assessment of the rotator cuff and elbow flexor–extensor musculature is essential in rehabilitation, injury prevention, and return-to-play decision making (13).

Shoulder strength, stability, and endurance are the essential factors influencing performance and injury prevention in court sports, including badminton, tennis, and volleyball (14). In these sports, athletes do a lot of fast, high-overhead movements that put a lot of stress on the rotator cuff and scapulothoracic stabilizers (15). Rotator cuff weakness, scapular muscle imbalance, limited range of motion, and an improper training load are all things that may be changed that

can lead to shoulder injury from overuse (16). Functional success in court sports relies not only on peak shoulder strength but also on prolonged isometric capacity, effective kinetic chain power transfer, and recurrent upper-limb force generation during rallies (17).

Field-based tests, including the sitting medicine ball throw (SMBT), have shown to be reliable and valid for measuring upper-body power. They are often utilized in sports studies as realistic functional outcome measures (18).

Dead-hang and flexed-arm hang (FAH) exercises have lately drawn attention as time-efficient isometric stimuli that engage the forearm, hand, and shoulder girdle in a sport-specific manner (19,20). Randomized controlled trials with climbing populations demonstrate that structured hangboard and dead-hang programs can enhance grip strength and endurance after 4–10-week interventions (21–23). Experimental results demonstrate that varying hanging intensities selectively enhance maximal force rather than endurance, underscoring the idea of training specificity (24). Additionally, biomechanical evaluations indicate that executing hangs with partial elbow flexion (lock-offs) elevates shoulder joint loads and engages shoulder stabilizers more effectively than full extension, hence augmenting potential benefits to the shoulder complex (25).

Dead-hang training is said to have benefits like better isometric grip and forearm strength, more muscular endurance, and more activation of shoulder stabilizers that could help with everyday upper-limb duties (26,27). There are many claims that hanging "decompresses" the spine, but there isn't any clinical data to back up the idea that it really unloads the spine (28).

Portable hanging or crane scales have been validated as low-cost, reliable tools for measuring isometric force in clinical and field contexts (29,30). Yet, the majority of controlled evidence for dead-hang or hang board training originates from climbing cohorts, concentrating mostly

on finger and grip outcomes rather than shoulder strength or performance in court sports (19,22). At the same time, consensus statements stress the need to focus on controllable elements like shoulder strength and training load to avoid injuries. They also point out that there aren't any randomized, sport-specific trials assessing new methods like dead-hang training (16,15).

Thus, there is limited direct evidence to determine whether dead-hang or FAH programs can enhance isometric shoulder strength and whether such improvements transfer to functional performance measures, such as SMBT distance, in court sport athletes. Although dead-hang training appears effective for developing grip and finger endurance in climbers, its role in conditioning and injury prevention for recreational court-sport athletes remains untested in randomized controlled designs (19,16).

In this study we evaluate whether a structured dead-hang and flexed-arm hang program can improve isometric shoulder strength (abduction, flexion, and external rotation) and functional upper-body performance especially power (e.g., SMBT) in recreational court sport players, compared with usual training. The study tries to check pre- to post-intervention changes in isometric shoulder strength, and to determine whether strength changes translate to improvements in functional performance, and to compare adaptations between dead-hang, flexed-arm hang, and placebo, and (4) to evaluate the practical use of hanging or crane scales for isometric strength testing in applied sport settings.

NEED OF THE STUDY

Upper-body strength, shoulder health, and endurance are crucial for optimal performance in court sports such as badminton, tennis, and volleyball.

Dead hang and Flexed arm hang, are simple, cost-effective, and require minimal equipment, making them highly accessible for recreational players.

The potential benefits of dead hang training for improving upper-body strength and performance in recreational court sport athletes are largely unknown.

AIM OF THE STUDY

To evaluate the effects of different types of dead hang trainings on isometric shoulder strength and functional performance in recreational court sports players.

OBJECTIVES OF THE STUDY

- **Primary Objective**

To evaluate the impact of dead hangs, flexed arm hangs, and a placebo intervention on isometric shoulder strength and performance in male recreational court sports players.

- **Secondary Objective**

To evaluate which hanging technique offers the most significant improvement in isometric shoulder strength and functional performance.

HYPOTHESIS OF THE STUDY

Null Hypothesis: There will be no significant effect on isometric shoulder strength and functional performance in recreational athletes undergoing dead hangs, flexed arm hangs, and placebo-intervention training.

Alternate Hypothesis: There will be significant effect on isometric shoulder strength and functional performance in recreational athletes undergoing dead hangs, flexed arm hangs, and placebo-intervention training.

REVIEW OF LITERATURE

1. Dignazio et al. (2025)

In “Reliability and Validity of a Crane Scale for Isometric Knee and Shoulder Strength Assessment”, Jon Dignazio et al. (2025) evaluated a commercially available crane scale (CS) against hand-held dynamometers (HHD) and a gold-standard electromechanical dynamometer (Biodex) in measuring isometric shoulder strength. Twenty healthy recreationally active adults were tested in several shoulder motions: internal rotation, external rotation, and abduction. Results showed excellent test-retest reliability for the crane scale in all motions (ICCs ≥ 0.90). Concurrent validity was excellent when compared to HHD (ICCs ≥ 0.90) but moderate to poor relative to the electromechanical dynamometer. The CS tended to underestimate torque values compared to both devices, especially in shoulder abduction.

2. Gilmore et al. (2024)

Gilmore et al. (2024) introduced a novel low-intensity hangboard training protocol called “Abrahangs” and compared it against a traditional maximal-intensity program. The 6-week trial investigated differences in grip endurance and training tolerance. Results indicated that both groups improved finger endurance, but the low-intensity group reported greater comfort and adherence. This study demonstrates that submaximal isometric hanging can still induce meaningful adaptations and may be more suitable for recreational or clinical populations.

3. Bradley et al. (2023)

In 2023, Bradley and colleagues published normative data for isometric shoulder strength testing across a healthy adult population. Their large-scale cross-sectional study provided reference values for various shoulder motions, including abduction, flexion, and external rotation. These normative values serve as important benchmarks for clinicians and researchers when interpreting intervention outcomes. The study underlines the necessity of standardized measures for shoulder isometric testing, which can be directly applied in randomized trials evaluating the effects of dead-hang training.

4. **Exel et al. (2023)**

This study examined the neuromechanical demands of finger hangs combined with arm lock-off positions. The study analysed joint loading and muscle activation across various isometric hanging techniques. Results demonstrated high activation of the shoulder stabilizers, particularly when lock-offs were performed at partial elbow flexion. These findings suggest that hanging exercises not only target the forearm but also impose considerable demands on the scapulothoracic and rotator cuff musculature. The study provides a mechanistic explanation for why dead-hangs could influence shoulder strength outcomes beyond grip capacity.

5. **Mundry et al. (2021)**

A randomized controlled trial by Mundry et al. (2021) compared an 8-week weighted hangboard program to a control group in advanced climbers. The study investigated whether progressive overload in dead-hang exercises could improve isometric grip strength. Findings indicated that the hangboard group achieved significantly greater increases in grip strength compared to controls, confirming the efficacy of structured and progressive isometric hanging. This trial provides direct evidence that dead-hang

training produces measurable strength adaptations and supports the rationale for testing similar interventions in other sports contexts.

6. Ruiz-López et al. (2021)

Ruiz-López and colleagues compared weighted dead-hangs to more dynamic grip exercises in climbers to identify their relative effects on maximal grip strength and muscular endurance. The study found that weighted hangs were superior for developing peak strength, while dynamic methods enhanced muscular endurance. These findings reinforce the principle that different types of hanging exercises produce distinct adaptations. This supports designing intervention arms (e.g., passive vs flexed-arm hangs) that may preferentially target strength or endurance.

7. Ferreira et al. (2021)

A cross-sectional study by Lara Gabriella Rodrigues Ferreira et al. (2021) evaluated the reliability and validity of the Seated Medicine Ball Throw Test (SMBT) and One Arm Hop Test in young adults ($n = 59$). The goal was to assess whether SMBT is a reliable and valid field measure of upper-body power relative to another functional test (CKCUEST). Results showed good inter-examiner reliability for SMBT ($ICC = 0.84$) and moderate intra-examiner reliability ($ICC = 0.77$). There were low to moderate correlations of SMBT with CKCUEST ($r < 0.70$), indicating SMBT is reasonably valid but captures somewhat different dimensions of upper-body performance.

8. López-Rivera et al. (2019)

A controlled trial was conducted by López-Rivera and colleagues (2019) to investigate the effects of three different dead-hang protocols (maximal, intermittent, and

combined) over an 8-week period in experienced climbers. The intervention aimed to improve finger flexor force and endurance, which are critical for climbing performance. Results demonstrated that each training style produced distinct adaptations, with maximal hangs improving peak force while intermittent hangs enhanced muscular endurance. This study highlighted the principle of training specificity in isometric hanging exercises. Although the focus was on climbers, it shows that structured dead-hang variations can lead to measurable neuromuscular adaptations.

9. **Manoj & Arun C. Nair (2020)**

A cross-sectional study by Manoj & Arun C. Nair (2020) evaluated the relationship between SMBT performance and grip strength among 141 undergraduate students (98 female, 41 male) to test whether SMBT can serve as an alternate test for upper-body strength. Participants threw a medicine ball (2 or 3 kg depending on gender) seated, and grip strength was measured using a digital dynamometer. Results showed significant correlations between SMBT distance and both left, right, and combined grip strength ($r \approx .713$ to $.738$), with SMBT explaining about 64.4% of the variance in total grip strength via regression. The authors concluded SMBT can be a strong proxy for assessing upper-body strength in healthy young adults.

10. **Oliveira et al. (2020)**

A validation study by Matheus Lima Oliveira et al. (2020) tested an inexpensive hanging scale to measure isometric shoulder strength (in abduction, flexion, extension, internal & external rotation) in 32 healthy adults. The aim was to compare the peak force readings of the hanging scale against a laboratory-grade load cell. Results indicated no significant differences between the two devices; intraclass correlation

coefficients (ICC) ranged from 0.96 to 0.99 across shoulder movements, indicating excellent agreement. The scale's standard error of measurement (SEM) was very low (0.02-0.04 kgf). This supports using a hanging scale as a valid, low-cost tool for measuring shoulder isometric strength.

11. Ueda, A. et al. (2022)

A study published in 2022 aimed to verify the intra-rater reliability of measuring the strength of shoulder external rotators using a suspension (hanging) scale. Participants performed isometric external rotation movements while attached to the suspension scale; the same rater measured strength multiple times. Results indicated high intra-rater reliability (i.e., consistent within the same rater) for strength measurements using the suspension scale. This suggests that a suspension or hanging scale can reliably measure shoulder external rotator strength under standardized conditions.

12. López-Rivera et al. (2012)

The aim of the study was to determine the effects of two different strength training methods on grip endurance in elite climbers. The study concluded that the most effective way to improve grip strength and endurance in elite climbers is to first train with weighted dead hangs on a larger edge, followed by unweighted dead hangs on a smaller edge.

13. Niederbracht, Y. et al. (2008)

The aim of the study was to assess the effects of a shoulder injury prevention strength training program on improving eccentric external rotator muscle strength and reducing glenohumeral joint imbalance in female athletes engaged in overhead activities. The

study concluded that the program significantly increased eccentric external rotator muscle strength, potentially reducing shoulder muscle imbalances and the risk of injury in female overhead activity athletes.

14. Clemons et al. (2004)

Clemons et al. (2004) investigated the flexed-arm hang (FAH) as a measure of upper-body muscular endurance and compared it with other established strength tests. Using a cross-sectional design, the authors found that FAH performance correlated moderately with measures of push-up and pull-up capacity, but not perfectly, indicating that FAH captures a blend of muscular endurance and isometric holding strength. This study is relevant to dead-hang interventions as it demonstrates how isometric hold tasks can reflect endurance-based adaptations of the upper limb.

TITLE	AUTHOR & YEAR	AIM	CONCLUSION
Effects of a Shoulder Injury Prevention Strength Training Program on Eccentric External Rotator Muscle Strength and Glenohumeral Joint Imbalance in Female Overhead Activity Athletes	Niederbracht, Y. et al. (2008)	The aim of the study was to assess the effects of a shoulder injury prevention strength training program on improving eccentric external rotator muscle strength and reducing glenohumeral joint imbalance in female athletes engaged in overhead activities	The study concluded that the shoulder injury prevention strength training program significantly increased eccentric external rotator muscle strength, potentially reducing shoulder muscle imbalances and the risk of injury in female overhead activity athletes.
The effects of two maximum grip strength training methods using the same effort duration and different edge depth on grip endurance in elite climbers.	López-Rivera et al. (2012)	The aim of the study was to determine the effects of two different strength training methods on grip endurance in elite climbers.	The study concluded that the most effective way to improve grip strength and endurance in elite climbers is to first train with weighted dead hangs on a larger edge, followed by unweighted dead hangs on a smaller edge.
Comparison of the Effects of Three Hangboard Strength and Endurance Training Programs on Grip Endurance in Sport Climbers	López-Rivera et al. (2019)	The aim of the study was to investigate the effects of three different dead-hang protocols (maximal, intermittent, and combined) over an 8-week period in experienced climbers.	The study concluded that maximal hangs improved peak force while intermittent hangs enhanced muscular endurance, highlighting training specificity in isometric hanging exercises.
Hangboard training in advanced climbers: A randomized controlled trial	Mundry et al. (2021)	The aim of the study was to compare an 8-week weighted hangboard program to a control group in advanced climbers to test whether progressive overload in dead-hang exercises could improve isometric grip strength.	The study concluded that the hangboard group achieved significantly greater increases in grip strength compared to controls, supporting the efficacy of structured and progressive isometric hanging.

Neuromechanics of finger hangs with arm lock-offs: analyzing joint moments and muscle activations to improve practice guidelines for climbing	Exel et al. (2023)	The aim of the study was to analyse joint loading and muscle activation across various isometric hanging techniques.	The study concluded that hanging exercises highly activated shoulder stabilizers, especially during partial elbow flexion lock-offs, suggesting potential benefits for shoulder strength outcomes beyond grip capacity.
Relationships between the flexed-arm hang and select measures of muscular fitness	Clemons et al. (2004)	The aim of the study was to investigate the flexed-arm hang (FAH) as a measure of upper-body muscular endurance and compare it with other established strength tests.	The study concluded that FAH performance moderately correlated with push-up and pull-up capacity, indicating FAH reflects endurance-based adaptations of the upper limb.
Normative Values of isometric shoulder strength among healthy adults	Bradley et al. (2023)	The aim of the study was to provide reference values for isometric shoulder strength across abduction, flexion, and external rotation in healthy adults.	The study concluded with normative values that can serve as benchmarks for clinicians and researchers when interpreting intervention outcomes.
Effects of Different Loading Programs on Finger Strength in Rock Climbers	Gilmore et al. (2024)	The aim of the study was to compare a novel low-intensity hangboard training protocol called 'Abrahangs' with a traditional maximal-intensity program in climbers.	The study concluded that both groups improved finger endurance, but the low-intensity group reported greater comfort and adherence, suggesting suitability for recreational or clinical populations.
Comparative Analysis of Two Grip Strength Training Protocols in Experienced Climbers	Ruiz-López et al. (2021)	The aim of the study was to compare weighted dead-hangs with dynamic grip exercises to determine their effects on maximal grip strength and muscular endurance.	The study concluded that weighted hangs were superior for developing peak strength, while dynamic methods enhanced muscular endurance, supporting targeted training approaches.

Validity of an Inexpensive Hanging Scale During Isometric Shoulder Movements	Oliveira et al. (2020)	The aim of the study was to validate an inexpensive hanging scale for measuring isometric shoulder strength compared to a laboratory-grade load cell.	The study concluded that the hanging scale had excellent validity (ICC 0.96–0.99) and low SEM, supporting its use as a low-cost tool for isometric shoulder strength testing.
Reliability and validity of a crane scale for isometric knee and shoulder strength assessment	Dignazio et al. (2025)	The aim of the study was to evaluate the reliability and validity of a commercially available crane scale (CS) against HHD and Biodex in isometric shoulder strength measurement.	The study concluded that the CS showed excellent reliability and validity against HHD but underestimated torque values compared to Biodex, especially in abduction.
Verification of shoulder external rotators strength measurement using a suspension scale	Ueda, A. et al. (2022)	The aim of the study was to verify intra-rater reliability of measuring shoulder external rotator strength using a suspension (hanging) scale.	The study concluded that suspension scale measurements had high intra-rater reliability under standardized conditions.
Reliability and validity of the One Arm Hop Test and Seated Medicine Ball Throw Test in young adults: A cross-sectional study	Ferreira et al. (2021)	The aim of the study was to evaluate the reliability and validity of the Seated Medicine Ball Throw Test (SMBT) and One Arm Hop Test in young adults.	The study concluded that SMBT showed good inter-examiner reliability and moderate intra-examiner reliability, with moderate validity compared to CKCUEST.
The seated medicine ball throw as a test of upper body strength in undergraduate students	Manoj & Arun C. Nair (2020)	The aim of the study was to evaluate the relationship between SMBT performance and grip strength in undergraduate students.	The study concluded that SMBT significantly correlated with grip strength ($r \approx .713-.738$) and explained ~64.4% variance, supporting SMBT as a proxy for upper-body strength.

TABLE 1: REVIEW OF LITERATURE

METHODOLOGY AND PROCEDURE

- **STUDY POPULATION:** Recreational court sports players
- **STUDY DESIGN:** Randomized controlled trial
- **SAMPLING TECHNIQUE:** Purposive sampling
- **SAMPLE CRITERIA:**

INCLUSION CRITERIA:

1. Able to perform 2-Pullup test
2. Athletes aged 18 to 28 years.
3. Athletes who participate in court sports at least 3 times per week.
4. No history of recent upper-body injury (within the past 6 months).

EXCLUSION CRITERIA:

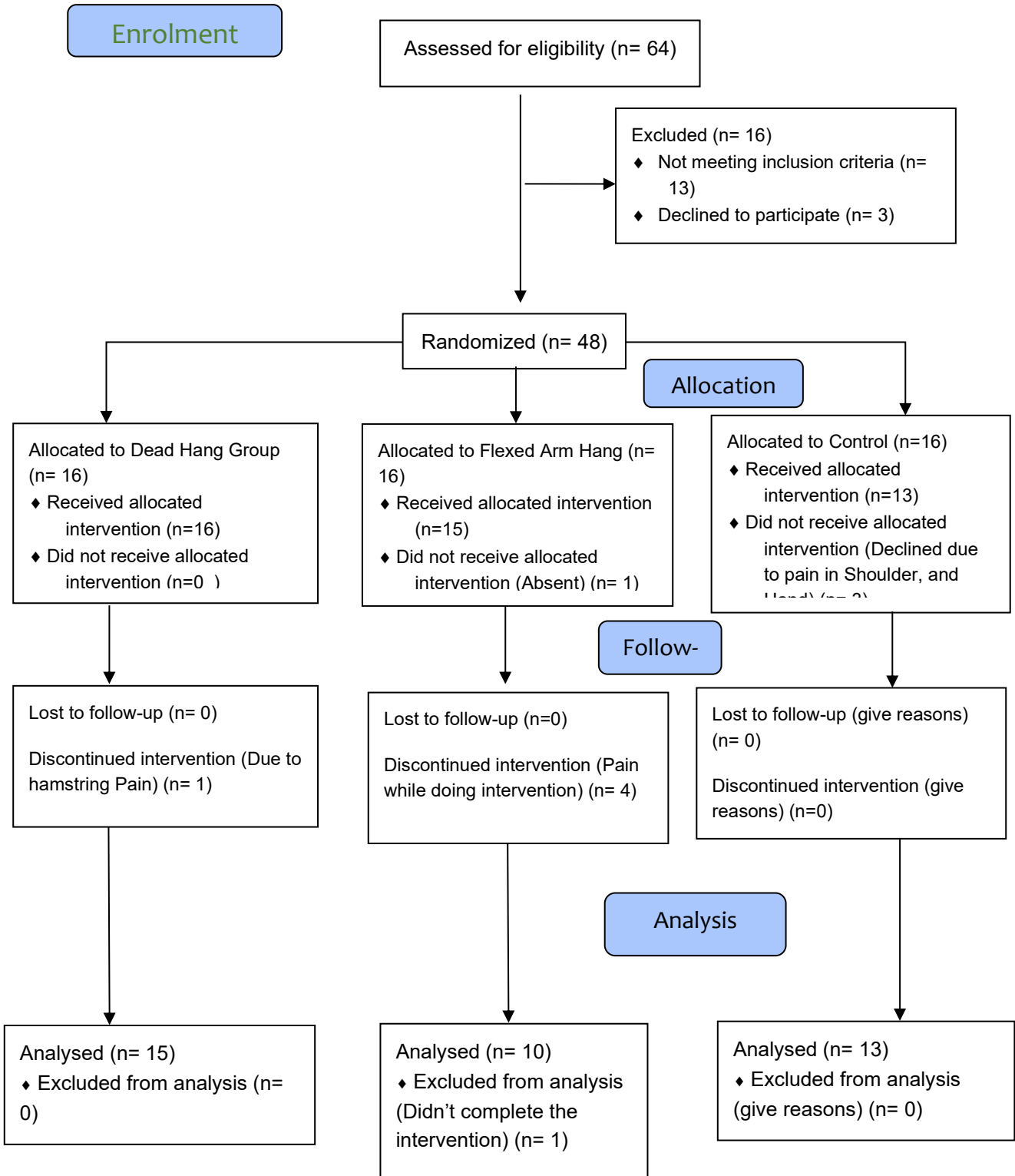
1. Professional athletes or individuals with ongoing rehabilitation for upper-body injuries.
 2. Athletes who have previously included dead hangs as part of their training regimen.
- **STUDY SETTING:** ABSMARI, Bhubaneswar, Odisha
 - **SAMPLE SIZE:** 48, Sample size was calculated a priori using G*Power v3.1.
 - **STUDY DURATION:** 6 months
 - **Ethical clearance:** 1 months
 - **Sample selection, data collection:** 4 months
 - **Statistical analysis, results analysis, discussion:** 1 months

➤ **MATERIALS REQUIRED:**

- Hanging Scale used for isometric shoulder strength in movements of Shoulder Abduction, Shoulder Flexion, Shoulder External rotation.
- Stopwatch (Mobile application) for measuring time for the repetitions.
- Hanging Bar (max weight carried was 200kg)
- Medicine ball (2kg)
- Phone Video Camera to record the Peak Value
- Measuring Tape (5m)
- Marker
- Weighted Plate (5kg)
- Steal Chain for attaching to the hanging scale
- Cuff to hold the Hanging scale

FLOW CHART

CONSORT Flow Diagram



PROCEDURE

An experimental study was undertaken at ABSMARI, Bhubaneswar. 48 participants were randomly assigned based on the inclusion and exclusion criteria mentioned earlier.

A brief demographic data of all the participants was obtained, written consent was taken from all the participants, and the experimental protocol was explained with its benefits and harm. The study duration was 8 weeks which included 16 sessions of experimental protocol.

48 participants who cleared the 2-pullup test and inclusion criteria were randomly divided to Dead Hang Group, Flexed Arm Hang Group and the Control Group.

The study conducts a pretest-post-test control group design with two interventions. Subjects are divided into three groups, two experimental Groups and Control group. All the participants were informed about the Dead hang training program, after a familiarization session, the participants performed the pretest prior to the intervention.

Before the pre-test, a specific 15-min warm-up was performed, consisting of neck, shoulder, arm and finger flexing and extensions, and three progressive sets of the test exercise of shoulder abduction, shoulder flexion shoulder external rotation with moderate intensity.

Then the test for isometric strength were carried out. A Hanging scale to measure isometric shoulder strength is being attached to a nonmobile bar, a steel chain is being connected from the bar with a belt, and chain is followed by the weight carrying hook of the hanging scale. Hanging scale is attached to a cuff for a cylindrical grip while measuring.

The participants did midrange (shoulder abduction = 90, shoulder flexion = 90, shoulder external rotation = 45 degrees respectively), of every movement to be assessed to measure isometric shoulder strength.

Rater was standing near to the screen of the hanging scale in every movement to record the

peak value.



Figure 1 Picture of Participant Performing Dead Hang



Figure 2 Picture of Participant Performing Flexed Arm Hang

Strength measurement is followed by Seated medicine ball throw test measure upper body performance. For Seated medicine ball throw test participant did to sit on the ground with legs extended back flat against a wall to restrict lower body and trunk contribution. A medicine ball of 2kg was given Pre-test will be performed on the day of the intervention starts.

After the completion of pretest, the control group did go for no intervention. Experimental Groups will receive dead hang training. The dead hang exercise is a simple yet effective exercise that targets multiple muscles in your upper body, primarily back, shoulders, and arms. It involved hanging from a bar or other stable object with your arms fully extended and your feet off the ground.

And the variation called flexed arm hangs which is hanging from a bar by putting both elbows of participants in 90 degrees flexion.

Participants performed dead hanging exercises twice a week for 8 weeks with a regime of 3 sets, each set have 3 repetitions with an effort duration of 10s per set never reaching the

point of muscular failure (leaving 3 s in reserve according to a study did it on rock climbers for finger hangs as intervention talks about the perceived effort and a pause of 3 min between sets (33).

Dead hangs were performed on a pullup bar, after 4 weeks of the training exercise with progressively heavier weight of 5 kg.

Each participant was given 5 kgs of added weight after 4 weeks of training set of each session as follows: the weight should allow participants to hang for 13 s, but the effort duration would be for 10s in any case; if this perceived 3-s margin was to be exceeded, then continue with the same weight of 5kg. In contrast, if the margin were to be closer to 10 s, some weight would be removed.

No adverse events were reported during the training sessions.

OUTCOME MEASURES

- **Hanging Scale**

To measure peak force in Newton for measuring shoulder strength through movements like Shoulder Abduction, Flexion, External rotation.

Reliability: Excellent test–retest reliability ($ICC \geq 0.90$ for all shoulder motions).

Validity: Excellent vs. handheld dynamometer ($ICC \geq 0.90$). Moderate vs. Biodex (32).

- **Seated Medicine Ball Throw Test (SMBT Test)**

To check upper body power and performance.

Test–retest reliability: Excellent ($ICC \approx 0.95$).

Inter-rater reliability: High consistency.



Figure 3 Picture of Shoulder Strength Testing of Abduction



Figure 4 Picture of Shoulder strength Testing of Flexion



Figure 5 Picture of Shoulder Strength Testing of External Rotation



Figure 6 Picture of SMBT

STATISTICAL ANALYSIS

Data were entered into SPSS version 27.0 (IBM Corp., Armonk, NY, USA) for statistical analysis. Descriptive statistics were computed for all outcome measures and presented as mean and standard deviation (SD).

Prior to inferential Statistics, assumptions of normality and homogeneity of variances were assessed. Normality of the distribution of difference scores (post–pre) for each outcome variable (right shoulder abduction strength, right shoulder flexion strength, right shoulder external rotation strength, and seated medicine ball throw [SMBT]) was tested using the Shapiro–Wilk test, histograms, and normal Q–Q plots. Homogeneity of variances was assessed using Levene’s test.

For outcome variables that met the assumptions of parametric testing, a one-way analysis of variance (ANOVA) was performed to compare mean difference scores across the three groups (Dead hang, Flexed arm hang, and Control). Where the ANOVA showed significant differences, post hoc multiple comparisons were conducted using Tukey’s HSD and Bonferroni adjustments. Effect sizes were reported as eta-squared (η^2), epsilon-squared (ϵ^2), and omega-squared (ω^2) with 95% confidence intervals.

For outcome variables in which the assumption of normality was violated, a non-parametric Kruskal–Wallis H test was conducted to compare distributions of difference scores across the three groups. When significant, pairwise comparisons were carried out using Mann–Whitney U tests with Bonferroni-adjusted significance values.

The level of significance for all tests was set at $p < 0.05$.

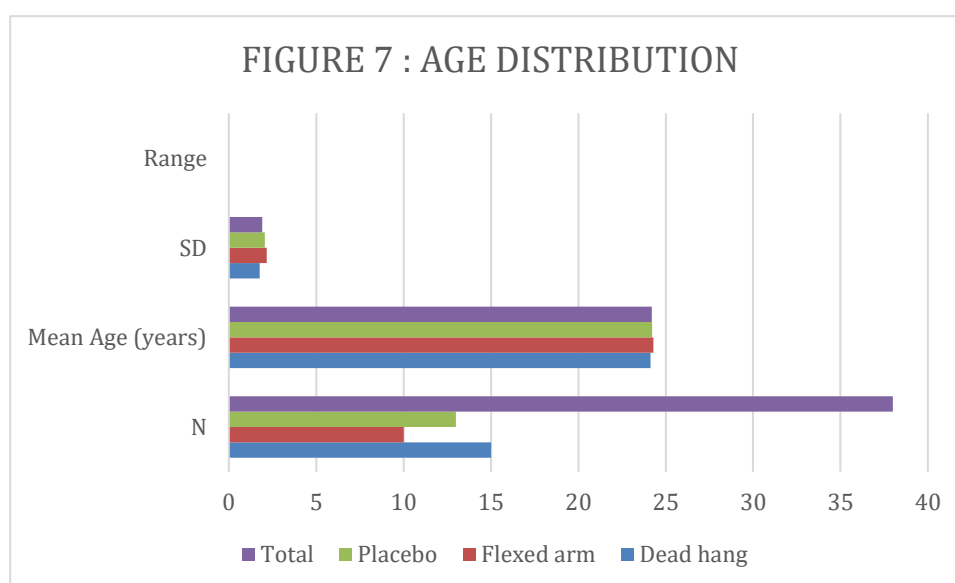
RESULTS AND INTERPRETATION

Current study included 48 participants, and after removing dropouts, 38 participants aged 18 to 28 years were analysed. A comparison pre intervention measurement of shoulder strength using Hanging scale (Shoulder Abduction, Shoulder flexion, Shoulder External rotation), and the Seated Medicine Ball Throw test (SMBT) among three groups revealed no statistically significant difference in the pre- intervention data ($p>0.05$). **FIGURE 5** illustrates the age distribution among groups.

Group	N	Mean Age (years)	SD	Range
Dead hang	15	24.13	1.77	20–26
Flexed arm	10	24.3	2.16	21–29
Placebo	13	24.23	2.05	19–27
Total	38	24.21	1.92	19–29

DEMOGRAPHIC & PRE - INTERVENTION DATA

Table 2 DEMOGRAPHIC & PRE- INTERVENTION DATA



In a within-group comparison of pre-and post-intervention measurements of shoulder strength using Hanging scale (Shoulder Abduction, Shoulder flexion, Shoulder External rotation) showed improvements in strength in the Dead hang and Flexed arm Hang groups

while the Control group demonstrated minimal change. (TABLE 2 and FIGURE 6).

Group	Outcome	Pre Mean	Post Mean	Mean Difference	p-value (2-tailed)
Dead hang	Abduction	95.1333	96.1333	-1	0.645
	Flexion	90.5333	97.3333	-6.8	0.056
	ER	69.4	77.0667	-7.67	0.006
	SMBT	520.0667	545.2	-25.13	0.001
Flexed arm hang	Abduction	79.1	88.9	-9.8	0
	Flexion	88.7	95.5	-6.8	0.006
	ER	70.8	76.8	-6	0
	SMBT	566.8	572	-5.2	0.836
Control	Abduction	93.8462	94.0769	-0.23	0.84
	Flexion	95.6154	94.9231	0.69	0.826
	ER	77.5385	77.6154	-0.08	0.949
	SMBT	582.2308	549.7692	32.46	0.002

Within group comparison Strength measurement

Table 3 Within Group comparison strength Measurement

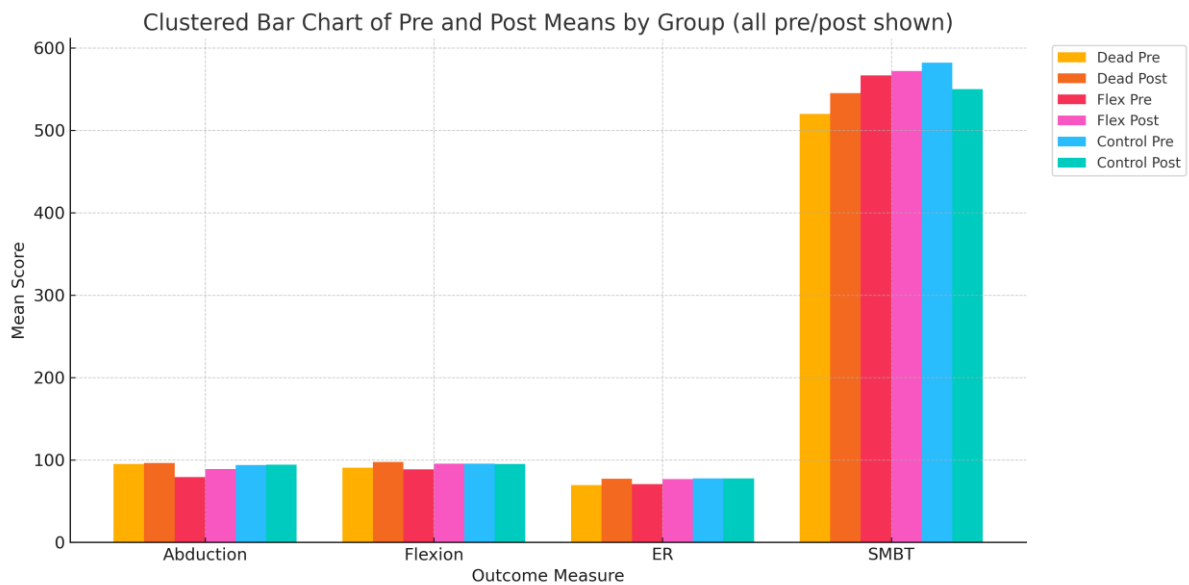


Figure 8 Clustered Bar chart for Right Shoulder Abduction, Right Shoulder Flexion, Right External Rotation, SMBT

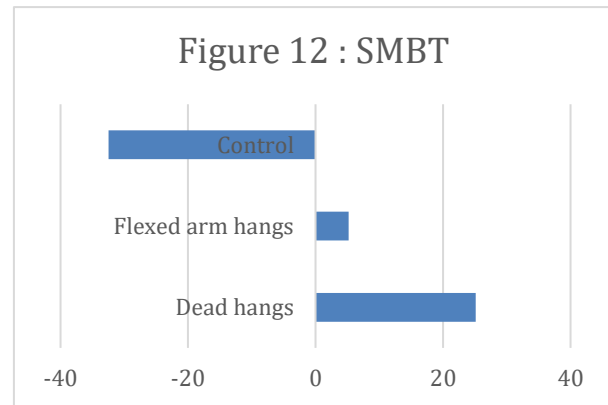
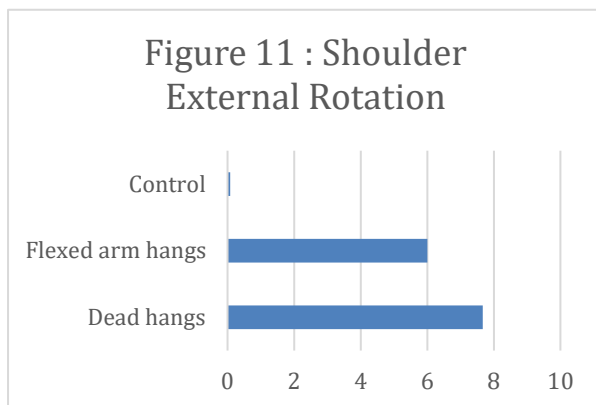
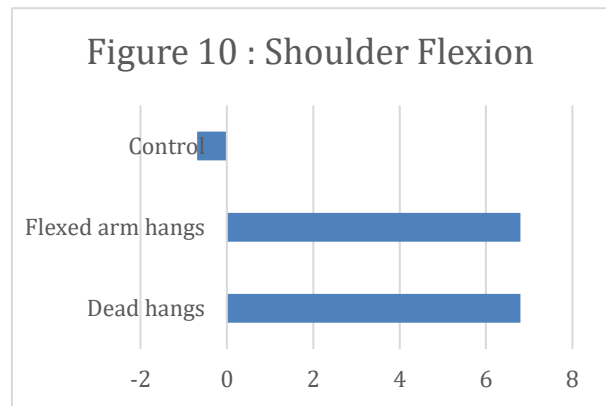
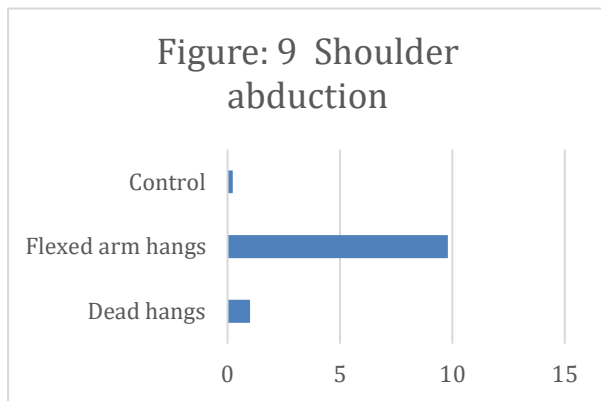
Within group comparison of pre- and post- intervention performance in the SMBT test showed a significant improvement in the Dead hang group, a small non-significant gain in the Flexed arm hang group, and a reduction in the Control group.

A comparison of the post intervention measurements of shoulder strength (Hanging scale: abduction, flexion, external rotation) and the Seated Medicine Ball Throw test (SMBT) indicates that there is a statistically significant ($p < 0.05$) differences among the Dead hang, flexed arm hangs, and Control groups.

Comparison of means of Shoulder Abduction, Shoulder Flexion, Shoulder External rotation, SMBT among all three groups, i.e Dead hangs (DH), Flexed arm hangs (FAH), and Control groups demonstrated in **TABLE 4** and **FIGURE 9**, **FIGURE 10**, **FIGURE 11**, **FIGURE 12** respectively.

Outcome Measure	Groups	Group Mean Difference (Post-Pre)	Between Group ANOVA	Effect size	95% CI
			P- Value		
Shoulder Abduction	Dead hangs	1	0.001	0.325	0.070 - 0.500
	Flexed arm hangs	9.8	0.001	0.325	0.070 - 0.500
	Control	0.23	0.001	0.325	0.070 - 0.500
Shoulder Flexion	Dead hangs	6.8	0.14	0.106	0.000 - 0.282
	Flexed arm hangs	6.8	0.14	0.106	0.000 - 0.282
	Control	-0.69	0.14	0.106	0.000 - 0.282
Shoulder External Rotation	Dead hangs	7.67	0.012	0.224	0.013 - 0.409
	Flexed arm hangs	6	0.012	0.224	0.013 - 0.409
	Control	0.08	0.012	0.224	0.013 - 0.409
SMBT	Dead hangs	25.13	0.007	0.249	0.025 - 0.434
	Flexed arm hangs	5.2	0.007	0.249	0.025 - 0.434
	Control	-32.46	0.007	0.249	0.025 - 0.434

TABLE 4: Between Group Analysis of Mean Differences



The pairwise comparison of Shoulder abduction, Shoulder flexion, Shoulder external rotation, SMT between groups, shown in **TABLE 5**, **TABLE 6**, **TABLE 7**, **TABLE 8** respectively, indicate that Dead hang and Flexed arm hang training groups have Significantly improved shoulder strength and performance compared to the control group. However, no statistically significant difference was observed between the Dead hangs and Flexed arm hangs for any outcome measures.

For Shoulder Abduction	Dead hang vs Flexed arm hang	Flexed arm hang vs Control	Dead hang vs Control
Mean difference	-8.8	8.03	-0.77
Cohen's d	1.2	1.05	0.05
95% CI	-14.5 to -3.1	2.7 to 13.4	-6.1 to 4.5
p-value	0.003	0.002	0.77

TABLE 5 : PAIR-WISE COMPARISON OF SHOULDER ABDUCTION

For Shoulder Flexion	Dead hang vs Flexed arm hang	Flexed arm hang vs Control	Dead hang vs Control
Mean difference	-0.27	2.73	2.46
Cohen's d	0.03	0.2	0.18
95% CI	-6.7 to 6.2	-3.9 to 9.4	-3.7 to 8.6
p-value	0.99	0.39	0.43

TABLE 6: PAIR-WISE COMPARISON OF SHOULDER FLEXION

For Shoulder External Rotation	Dead hang vs Flexed arm hang	Flexed arm hang vs Control	Dead hang vs Control
Mean difference	1.67	5.92	7.58
Cohen's d	0.15	0.45	0.7
95% CI	-3.5 to 6.9	0.2 to 11.7	2.0 to 13.1
p-value	0.73	0.06	0.012

TABLE 7: PAIR-WISE COMPARISON OF SHOULDER EXTERNAL ROTATION

For SMBT	Dead hang vs Flexed arm hang	Flexed arm hang vs Control	Dead hang vs Control
Mean difference	20	25.4	45.4
Cohen's d	0.25	0.4	0.8
95% CI	-15.0 to 55.0	-9.0 to 59.8	12.0 to 78.8
p-value	0.26	0.15	0.005

TABLE 8: PAIR-WISE COMPARISON OF SMBT

Based on the within- and between-group comparisons, both Dead hang and Flexed arm hang training groups demonstrated significant improvements in shoulder strength (abduction, flexion, and external rotation) compared to the Control group. Improvements in SMBT performance were observed in the Dead hang group and the Control group, but not in the Flexed arm hang group. No statistically significant differences were found between the Dead hang and Flexed arm hang groups across any of the outcome measures.

DISCUSSION

The Aim of the study was to compare Dead hang and Flexed arm hang training on improving shoulder strength and performance among recreational court sports players. The shoulder strength was measured using a hanging scale, while upper body performance was measured using Seated Medicine Ball Throw test. The participants were selected were within age group of 18-28 years and can complete a two-pullup test.

The results of the study revealed that the strength measured using the primary outcome measure (Hanging scale) and the secondary outcome measure (SMBT) improved in all groups. However, statistically significant improvements were seen in the Dead Hang and Flexed arm hang groups. The Control group showed statistically significant improvement only in SMBT but not in shoulder strength, and it demonstrated less improvement when compared to the intervention groups.

Thus, the results of the study indicate that shoulder strength and performance can be effectively improved through both Dead hang and Flexed arm hang training in recreational court sports players. This study aimed to evaluate the hypothesis that Dead Hang and Flexed Arm Hang training will enhance isometric shoulder strength and functional performance among recreational court sport players. The null hypothesis stated the absence of significant effects from these therapies relative to a placebo condition, while the alternative hypothesis said that substantial improvements would manifest in the intervention groups. To clarify the interpretation, additional sub-hypotheses were proposed: first, that both the Dead Hang and Flexed Arm Hang groups would exhibit greater mean improvements than the Control group; second, that no significant differences would be present between the two intervention groups; and third, that each intervention group would show substantial within-group improvement on at least one of the outcome measures.

Based on the results, the null hypothesis was rejected for most outcomes. Between-group comparisons demonstrated that the Dead hang and Flexed arm hang groups produced significantly greater improvements than the Control group in shoulder abduction, flexion (as confirmed by non-parametric testing), external rotation, and SMBT performance. Post-hoc pairwise analysis revealed that the intervention groups outperformed the Control group, but no consistent differences were found between the Dead hang and Flexed arm hang groups. Thus, the hypothesis that both hanging variations would be superior to Control was supported, while the hypothesis of a meaningful difference between Dead hang and Flexed arm hang was not supported. Within-group paired analyses further confirmed that participants in the Dead hang group improved significantly in external rotation and SMBT, with a trend toward improvement in flexion, while those in the Flexed arm hang group showed significant improvements in abduction, flexion, and external rotation. In contrast, the Control group showed no significant changes in shoulder strength, although they did demonstrate improvement in the SMBT, likely due to test familiarity rather than true training adaptation.

The physiological and biomechanical foundations of these findings can be understood using the available research. Hanging exercises mainly involve prolonged isometric contraction of the shoulder muscles and scapular stabilizers, which is a stimulus that can cause neuromuscular changes like better motor unit recruitment and synchronization. This can lead to measurable increases in strength even if there are no big changes in muscle size. Reviews of isometric training consistently show that this mode of exercise enhances muscle-tendon stiffness and neural efficiency, translating into functional strength gains across multiple joints (31). In a study conducted on rock climbers they found that different dead hang procedures made rock climbers' grip strength and endurance much better. This shows that hanging-based therapies could be a good way to build isometric strength. (19)

The improvements observed in external rotation and abduction are also consistent with studies on scapulohumeral stability. The rotator cuff and scapular stabilizers are highly engaged during both Dead hang and Flexed arm hang tasks, and biomechanical studies confirm that partial lock-off and hanging positions increase activation of these muscles (25). Enhanced recruitment of these stabilizers likely contributed to the observed gains in shoulder external rotation and abduction strength. The overhead position of the arms in the Dead Hang may also stretch and relieve pressure on the shoulder capsule and nearby tissues, which can improve range of motion and mechanical efficiency. Such changes may partly explain the superior SMBT outcomes observed in the Dead hang group, since the SMBT requires coordinated power transfer across the shoulder girdle. The validity and feasibility of the SMBT as a measure of upper-body power have been confirmed in recent studies, supporting its relevance as a secondary outcome measure in this context (30).

The Flexed arm hang, by contrast, imposes higher mechanical demands on the shoulder and elbow flexors due to the partial lock-off position, which places the muscles at a biomechanical disadvantage. This increased stress likely accounts for the consistent improvements observed in abduction, flexion, and external rotation in the Flexed arm hang group. Researchers have also shown associations between the Flexed Arm Hang and various measures of upper-body muscular fitness in a study (20). This supports its possible usefulness as a strengthening exercise.

Importantly, the absence of substantial differences between Dead Hang and Flexed Arm Hang in this study indicates that both techniques offer similar overall advantages, with the selection between them potentially influenced by athlete interest, comfort, or particular training objectives.

Finally, the Control group did not demonstrate meaningful improvements in shoulder

strength, a finding consistent with the expectation that structured, targeted training is necessary to provoke physiological adaptation. The small but significant improvement in SMBT within the Control group is likely attributable to a learning or familiarization effect rather than a true training effect. This pattern has been documented in other intervention studies where active training groups demonstrate large improvements relative to controls (31).

This study looked at whether two simple hanging exercises — the Dead hang (hanging from a bar with straight arms) and the Flexed arm hang (hanging with elbows bent) — could improve shoulder strength and performance in recreational court sport players.

The results showed that both exercises worked well. Players who trained with Dead hangs or Flexed arm hangs became stronger in shoulder movements like lifting the arm to the side (abduction), raising it forward (flexion), and rotating it outward (external rotation). They also improved in a functional test, the Seated Medicine Ball Throw (SMBT), which measures power and performance.

On the other hand, the Control group, who did not perform any hanging exercises, showed little or no improvement in shoulder strength. They only showed a small improvement in the ball throw, which was not as meaningful as the changes seen in the other groups.

Both training exercises worked just as well when they were compared to each other. This suggests that athletes who exercised either Dead hangs or Flexed arm hangs had almost the same benefits.

CONCLUSION

In conclusion, this study demonstrated that both Dead hang and Flexed arm hang training are effective in improving shoulder isometric strength (abduction, flexion, and external rotation) and functional performance, as measured by the Seated Medicine Ball Throw, in recreational court sport athletes. Compared to the Control group, both intervention groups showed significantly greater improvements, while no consistent differences were observed between Dead hang and Flexed arm hang, indicating that either exercise can be used to enhance shoulder function. These findings suggest that simple hanging exercises may serve as practical and accessible training strategies to strengthen the shoulder complex and improve upper-body performance in recreational athletes. Future studies with larger cohorts, longer intervention periods, and more objective measurement methods are needed to confirm these findings and explore their applicability to competitive athletes and clinical populations.

LIMITATION

This study has several limitations. The sample size was modest and limited to young recreational athletes, which restricts generalizability. The duration of intervention was short and may not reflect long-term adaptations. Shoulder strength was assessed with a hanging scale, which, while practical, is less precise than validated tools such as handheld dynamometry or isokinetic testing. The SMBT test, although useful, can be influenced by technique and learning effects.

Potential confounding factors such as participants prior training experience, nutrition, and lifestyle factors were not controlled, which may have affected outcomes. In addition, blinding of participants and assessors was not performed, raising the risk of bias.

Future studies should use larger samples, longer interventions, and more objective measurement tools (e.g., dynamometry, EMG). Better control of confounding factors, familiarization sessions for outcome tests, and assessor blinding would improve internal validity.

RECOMMENDATIONS FOR FUTURE STUDIES

Future studies should include larger and more diverse samples, longer training durations, and follow-up assessments to examine long-term effects. The use of advanced tools such as dynamometry or EMG could provide more accurate insights into neuromuscular adaptations. Exploring variations in hanging protocols and their role in injury prevention or rehabilitation would further expand the application of these exercises.

SUMMARY

This study examined the effects of Dead hang and Flexed arm hang training on shoulder strength and functional performance in recreational court sport athletes. Thirty-eight participants were analysed across three groups (Dead hang, Flexed arm hang, and Control), with outcomes measured using the hanging scale for right shoulder abduction, flexion, and external rotation, and the Seated Medicine Ball Throw (SMBT) test for performance. Both intervention groups showed significant improvements in strength and performance compared to the Control group, while no significant differences were observed between Dead hang and Flexed arm hang training. These findings suggest that simple hanging exercises are effective, accessible strategies for enhancing shoulder strength and functional performance in recreational athletes.

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ANNEXURES

ANNEXURES A :

ETHICS COMMITTEE APPROVAL



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA
CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/160 Date: 09/05/2025

APPROVAL LETTER
APPENDIX- VIII

To,

MADHAVAN S.S
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Effects of Different types Dead hang training for improving Isometric shoulder Strength and functional Performance in Male Recreational court sports players- A Randomized Controlled Trial

Protocol ID.: ABS-IEC-2025-PHY-050

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr. **Madhavan S.S**

With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 24/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	24/04/2025
2	Informed Consent Form	24/04/2025
3	Undertaking form PI	24/04/2025
4	CRF	24/04/2025
5	COI from the Investigators	24/04/2025

The following members were present at meeting held on 24-04-2025

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert


Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person


Mr. Deepak Ku. Pradhan
Scientific Member


IEC-SECRETARIAT


Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani



1

 **Utkal Signature, Plot No.-273,
Ground Floor, Pahal, Bhubaneswar-752101**

 **+91-63707-03654**

 **iec@absmari.com**

ANNEXURE B :

INFORMED CONSENT

Informed Consent form to participate in a clinical trial Study Title: Effects of Different types Dead hang training for improving isometric shoulder Strength and functional Performance in Male Recreational court sports players- A Randomized Controlled Trial.

*Subject 's Name: _____

*Subject 's Initials: _____

*Date of Birth / Age: _____

*Address of the Subject _____

Qualification _____

*Occupation: Student/Self-Employed/ Service/Housewife/Others (Please tick as appropriate) (i) I confirm that I have read and understood the information sheet dated 10/06/2025 for the above study and have had the opportunity to ask questions. (ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. (iii) I understand that the Sponsor of the clinical trial, others working on the study, Sponsor 's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published. (iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s) (v) I agree to take part in the above study. *Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

_____ *Date: ____ / ____ / ____

*Signatory 's Name: _____ Signature of the Investigator:

_____ Date: ____ / ____ / ____ Study

Investigator 's Name: _____ *Signature of the Witness: _____

*Date: ____ / ____ / ____ *Name of the Witness: _____

#Copy of the Patient Information Sheet and duly filled Informed Consent Form shall be handled over to the subject or his/her attendance.

ANNEXURE: C

MASTERCHART

Name s	Partici pant id	Group id	Age	PreRtS hdrA	PostRt ShldrA	PreRtS hdrF	PostRt ShldrF	PreRtS hdrER	PostRtShldrER	PostS MBT	PreSM BT
Palash	15	1	26	76	78	98	102	67	69	590	550
Chaitan ya	17	1	25	60	65	71	76	42	49	480	440
Chavan Prem	24	1	26	88	93	111	117	76	83	538	500
Absala m	36	1	20	106	112	96	106	92	98	515	500
Parimal	25	1	25	82	93	52	65	37	48	420	350
Dibyans hu	35	1	22	144	150	140	142	70	70	630	600
Kritish	33	1	23	125	132	124	123	86	89	625	600
Ashish rout	27	1	24	100	83	107	94	86	78	530	553
Ananda nayak	28	1	23	90	76	99	96	67	93	520	530
Nrupraj	29	1	23	107	98	75	121	51	79	485	476
Chirag	6	1	26	96	100	81	92	74	82	575	538
Rohit Kumar Panda	41	1	25	75	82	65	69	66	70	500	472
Sougat	19	1	26	74	70	59	70	47	60	470	438
Bimal	3	1	23	116	120	110	115	105	109	620	592
Shivans h	11	1	25	88	90	70	72	75	79	680	662
Suraj	8	2	26	48	58	89	98	62	66	555	540
Rakesh	2	2	24	66	79	66	85	38	40	530	520
Neeraj	20	2	24	52	59	84	90	50	56	620	670
Bhaibha ba	34	2	21	113	130	118	116	106	112	640	617
Ronit Roy	45	2	22	119	126	150	159	109	122	630	600
Sushant adeuri	32	2	29	77	88	89	88	80	87	520	500
Sumukh	18	2	25	82	95	87	92	73	79	640	500
Anshu	21	2	24	36	45	48	59	55	59	530	665
Vivek	4	2	24	121	130	88	96	70	77	550	476
Atharva	12	2	24	77	79	68	72	65	70	505	580
Satya Parida	1	3	23	116	110	117	120	66	66	620	664
Prajwal Joshi	5	3	26	132	129	144	135	121	125	650	650
Anirudh	7	3	26	105	106	109	105	54	60	525	582
Sandes h	14	3	25	107	105	101	106	72	78	480	534
Pravee n	16	3	25	98	100	102	98	52	54	600	650
Nilotpal	23	3	24	107	112	108	105	79	77	495	500
Sidarth	26	3	25	83	85	103	102	81	82	500	500
Ifham	30	3	22	97	104	129	106	130	120	635	734
Ashish Behera	31	3	24	90	91	100	102	113	112	670	684
Satyaka m	37	3	27	35	39	28	29	71	70	470	486
Debashi sh	38	3	25	88	89	63	60	44	41	452	500
Ayushm an Ratna	39	3	19	39	33	39	38	41	42	430	435
Palthya Subash	46	3	24	123	120	100	128	84	82	620	650

ANNEXURE: D

PLAGIARISM AND AI REPORT

Madhavan S S

EFFECTS OF DIFFERENT TYPES OF DEAD HANG TRAINING FOR IMPROVING ISOMETRIC SHOULDER STRENGTH AND FU...

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Madhavan S S

EFFECTS OF DIFFERENT TYPES OF DEAD HANG TRAINING FOR IMPROVING ISOMETRIC SHOULDER STRENGTH AND FU...

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ANNEXURE: E

HANGING SCALE USED IN THE STUDY

