

**EFFECT OF GERMAN VOLUME TRAINING ALONG  
CONVENTIONAL EXERCISE PROTOCOL ON THROW DISTANCE  
AND PERIPHERAL MUSCLE FATIGUE IN ELITE RUGBY 7s  
PLAYER: A SINGLE GROUP EXPERIMENTAL STUDY**

by

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Dissertation Submitted to the  
Odisha University of Health Science, Bhubaneswar, Odisha.

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of the requirements for the degree of

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in

**SPORTS**

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## LIST OF ABBREVIATIONS USED

1. CEP: Conventional Exercise Protocol
2. GVT: German Volume Training
3. PMF: Peripheral Muscle Fatigue
4. TD: Throw Distance

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# **ABSTRACT**

## ABSTRACT

**Title:** Effect of German Volume Training along Conventional Exercise Protocol on Throw Distance and Peripheral Muscle Fatigue in Elite Rugby Sevens Players: A Single Group Experimental Study

**Background:** Rugby Sevens is a demanding sport requiring repeated sprints, tackles, and quick recovery between efforts. Key skills such as passing, lineout throws, and kicking are performed under pressure, making muscular strength, endurance, and fatigue management critical. German Volume Training (GVT), a high-volume resistance training approach, may support these requirements by improving hypertrophy, endurance, and recovery capacity.

**Objective:** To evaluate the effect of GVT combined with conventional training on throw distance and peripheral muscle fatigue in elite Rugby Sevens players.

**Methods:** A single-group experimental design was used with elite male Rugby Sevens athletes. Outcome measures included throw distance, bench press one-repetition maximum (1RM), heart rate variability (RMSDD using a 25-second mid-thigh hold), and session ratings of perceived exertion (RPE). Pre- and post-test values were compared using paired sample *t*-tests.

**Results:** Throw distance improved significantly by 16% ( $p < 0.05$ ). RMSDD decreased by 22.2% ( $p < 0.05$ ), and RPE reduced by 29.5% ( $p < 0.05$ ), reflecting improved fatigue management and efficiency. Bench press strength increased by 4.1% but did not reach statistical significance ( $p > 0.05$ ).

**Conclusion:** GVT, when integrated with conventional training, enhances explosive throwing performance and reduces fatigue in Rugby Sevens players. Although strength gains were modest, the findings support its role within a structured training framework. Further studies with larger samples and longer interventions are recommended.

**Keywords:** Resistance Training; Athletic Performance; Muscle Fatigue; Sports; Exercise Therapy; Rugby Sevens; German Volume Training; Throw Distance; Heart Rate Variability

# **INTRODUCTION**

## INTRODUCTION

### Background of Rugby

Rugby union football, commonly known as **Rugby Union** or simply **Rugby**, is a full-contact team sport originating in the first half of the 19th century at Rugby School in England. It is played with an oval-shaped ball on a rectangular pitch, featuring H-shaped goalposts at either end. Teams aim to advance the ball through running, passing, and kicking, with the objective of grounding the ball in the opponent's in-goal area or kicking it through the posts to score points. Traditionally, the sport is contested between two teams of 15 players each, with a standard match lasting 80 minutes<sup>1</sup>.

Over time, variations of Rugby Union have emerged, with **Rugby Sevens (7s)** being the most globally recognized and rapidly growing format. Rugby Sevens follows the same fundamental rules as Rugby Union but differs in several critical aspects: it is played with **seven players per side** instead of fifteen, and matches are considerably shorter, typically comprising two halves of seven minutes each<sup>2</sup>. Despite these structural changes, the playing field dimensions remain the same, thereby creating more open space per player and increasing the pace and intensity of the game.

### Rugby Sevens: The Modern Global Format

Rugby Sevens is not merely a shortened form of Rugby Union but a distinct sport in its own right, demanding unique physiological, technical, and tactical adaptations. The game is characterized by its **high intensity, rapid ball movement, and greater emphasis on speed and agility** compared to the traditional 15-a-side version. Given the shorter match duration, there is limited scope for recovery during play, and the reduced number of players requires greater individual contribution to both offensive and defensive actions<sup>3</sup>.

The sport's global popularity surged following its inclusion in the **Olympic Games in Rio 2016**, where it gained international exposure and recognition under the governance of **World Rugby**, the official governing body<sup>4</sup>. Rugby Sevens tournaments, such as the HSBC World Rugby Sevens Series, showcase the sport's dynamic and fast-paced nature, further highlighting the distinctive demands placed on its athletes.

Compared to Rugby Union, Rugby Sevens places a premium on **speed endurance, anaerobic power, repeated sprint ability, and efficient recovery**. With less time to execute set plays

and more frequent transitions between attack and defense, the game requires **explosive strength, tactical awareness, and superior conditioning**. Players often cover greater distances at higher relative intensities in Sevens than in traditional Rugby Union, with match analyses showing that Sevens athletes spend a larger proportion of time sprinting or performing high-speed running<sup>5</sup>

### **Technical Demands in Rugby Sevens**

Despite structural differences between Union and Sevens, several technical elements remain critical, such as **passing, tackling, scrummaging, and lineouts**. However, in Sevens, the execution of these skills occurs under more intense conditions due to the accelerated tempo of the game.

- **Passing:** Passing remains the cornerstone of offensive strategy. With fewer players on the pitch, accuracy and speed of passing are vital to exploiting space. In Rugby Sevens, mis-passes or delays often result in turnovers or conceding tries, as the game transitions rapidly from attack to defense<sup>6</sup>.
- **Lineouts:** Though contested less frequently in Sevens than in Union, lineouts play an equally crucial role in restarting play and gaining possession. Given the reduced number of players, successful execution of lineouts requires highly efficient throws, precise timing of jumps, and coordination between the thrower and jumpers<sup>7</sup>. Research has shown that winning teams lose fewer lineout possessions compared to losing teams, underscoring the significance of this set-piece even in the shorter format<sup>8</sup>.
- **Kicking and Restarts:** Kicking is more strategically significant in Rugby Sevens due to the larger open spaces. Accurate restarts following scores can determine possession and field position. Short, high kicks that allow the kicking team to contest the ball are frequently used, placing emphasis on explosive jumping and aerial skills<sup>9</sup>.
- **Defensive Work:** The defensive demands of Rugby Sevens are particularly high, as fewer players must cover the same field size. This requires outstanding one-on-one tackling ability, lateral agility, and fitness to repeatedly retreat and realign in defensive structures.

## **Physiological Demands of Rugby Sevens**

The unique characteristics of Rugby Sevens translate into specific physiological demands distinct from Rugby Union. Seven players must combine attributes of endurance athletes with those of sprinters, as matches consist of frequent, repeated bouts of maximal or near-maximal intensity activity interspersed with short recovery periods<sup>10</sup>.

Studies of time-motion analysis in Rugby Sevens demonstrate that players typically cover 1.5–1.8 kilometres per match, with a higher proportion of this distance occurring at high speeds compared to Union players<sup>11</sup>. Moreover, the frequency of high-intensity efforts such as sprints, accelerations, and tackles is greater, placing considerable strain on both the aerobic and anaerobic energy systems<sup>12</sup>.

Another defining aspect of Rugby Sevens is limited recovery between matches, particularly in tournament formats where multiple games are played within a single day. This necessitates not only physical conditioning for rapid recovery but also mental resilience to maintain performance across consecutive high-intensity bouts<sup>13</sup>

## **Strength and Conditioning in Rugby Sevens**

The demands of Rugby Sevens require players to perform at high intensity with minimal recovery time, often competing in multiple matches within a single day. This necessitates a training approach that does not merely focus on strength or endurance in isolation, but instead integrates hypertrophy, maximal strength, explosive power, and muscular endurance into a single conditioning framework.

Resistance training forms the cornerstone of physical preparation in Rugby Sevens. It enhances lean muscle mass, which is critical for absorbing and delivering contact during tackles, rucks, and scrums, while also contributing to force generation in sprints, lineout lifts, and explosive directional changes. Unlike Rugby Union, where set-piece play and longer **recovery phases** **may** allow greater specialization, Rugby Sevens demands well-rounded physical conditioning, given the fast-paced and open nature of the game.

One training methodology that has recently gained attention in rugby performance programs is German Volume Training (GVT). Originally popularized by Charles Poliquin in the late 20th century, GVT is a high-volume, hypertrophy-oriented resistance training protocol that

prescribes 10 sets of 10 repetitions for a given exercise at approximately 60% of one-repetition maximum (1RM), often with controlled tempos (e.g., 4-0-2-0) and short rest intervals (60–90 seconds) between sets<sup>14</sup>. Unlike conventional strength programs that emphasize progressive overload through heavier weights and lower repetitions, GVT relies on extreme training volume and density to stimulate muscle adaptation.

The rationale behind GVT lies in its ability to induce the three major mechanisms of hypertrophy—mechanical tension, metabolic stress, and muscular damage. Performing 100 repetitions in a single movement pattern recruits a high proportion of motor units, exhausts both slow- and fast-twitch fibers, and creates an environment of significant metabolic disturbance, which in turn triggers adaptations in muscle growth and endurance<sup>15</sup>.

### **German Volume Training**

German Volume Training (GVT) is a high-volume resistance training method that has gained prominence in recent years as a tool for inducing muscular hypertrophy, strength, and endurance. The protocol, first popularized by Charles Poliquin, is characterized by repeated performance of ten sets of ten repetitions with a load of approximately sixty percent of one-repetition maximum (1RM), usually at a controlled tempo and with short recovery periods of sixty to ninety seconds<sup>14</sup>. Unlike conventional strength training, which relies on progressive overload through increased resistance and lower repetitions, GVT produces adaptations through the extreme training volume that places both mechanical and metabolic stress on the muscle fibers. The primary goal of the method is to completely fatigue targeted muscle groups by repeatedly recruiting both slow- and fast-twitch fibers within the same session, thereby stimulating hypertrophy and muscular endurance simultaneously<sup>15</sup>.

The use of GVT in athletic populations has been justified on the basis of its ability to enhance all three major mechanisms of muscle growth—mechanical tension, metabolic stress, and muscle damage. Athletes performing GVT are exposed to prolonged time under tension, repeated eccentric and concentric actions, and metabolite accumulation, all of which contribute to the adaptive process. While originally implemented in bodybuilding contexts, its potential application in high-intensity team sports such as rugby has attracted increasing attention due to the overlapping demands of hypertrophy, strength, and endurance training<sup>16</sup>.

### **Importance of German Volume Training in Rugby Sevens**

The physical demands of Rugby Sevens require athletes to generate high levels of power during sprints, tackles, and jumps, while also sustaining repeated bouts of maximal effort throughout tournament play. Unlike Rugby Union, in which the game structure allows for longer recovery periods and greater specialization, Rugby Sevens requires players to be physically versatile and resistant to fatigue. German Volume Training offers a unique solution to these challenges because it simultaneously develops muscular size, maximal strength, and endurance capacity.

The hypertrophic effects of GVT are particularly valuable in a contact sport such as rugby, where increased muscle mass enhances the ability to withstand collisions and deliver force in tackles and scrummaging situations<sup>17</sup>. At the same time, the relatively moderate load and high repetition structure of the program contribute to improved muscular endurance, a crucial component for sustaining performance across the multiple matches typically played in a Sevens tournament. The short recovery periods between sets mimic the metabolic conditions of match play, where players are required to repeatedly perform under incomplete recovery. As such, GVT serves as a training modality that not only increases physical size and strength but also conditions athletes to recover rapidly between high-intensity efforts, a quality that is essential in Sevens competition<sup>18</sup>.

### **German Volume Training and Peripheral Fatigue**

Peripheral fatigue is one of the principal factors limiting performance in intermittent high-intensity sports such as Rugby Sevens. It is defined as a decline in muscular performance resulting from changes distal to the neuromuscular junction, including metabolite accumulation, impaired calcium handling, and reduced energy availability<sup>19</sup>. During Rugby Sevens matches, repeated sprinting, tackling, and contact events contribute to the rapid onset of peripheral fatigue, which in turn compromises sprinting ability, passing accuracy, and tackling effectiveness.

German Volume Training induces peripheral fatigue in a controlled training environment through its high volume and short rest structure. The accumulation of lactate, hydrogen ions, and inorganic phosphate during repeated sets simulates the same physiological conditions that players face during competitive play<sup>20</sup>. Over time, this exposure enhances the athlete's buffering capacity, oxidative enzyme activity, and tolerance to metabolic acidosis. These adaptations improve an athlete's ability to sustain force output in the presence of fatigue and

recover between bouts of maximal effort. Therefore, GVT not only builds muscular size and strength but also provides a conditioning effect that is directly transferable to the fatigue management demands of Rugby Sevens<sup>21</sup>.

### **German Volume Training and Throwing Performance in Rugby**

Throwing in rugby lineouts represents a skill that depends on both upper- and lower-limb coordination and power. Research has shown that while upper-limb contributions such as shoulder and elbow velocity remain relatively constant across different throwing distances, the involvement of the lower extremities increases substantially as the throw distance extends beyond ten meters<sup>22</sup>. Accurate and powerful throws require not only technical skill but also sufficient muscular strength, endurance, and stability across the kinetic chain.

German Volume Training can support lineout throwing performance by improving both upper- and lower-limb musculature. Hypertrophy and endurance gains in the scapular stabilizers, rotator cuff, and shoulder musculature enhance the precision and control of ball release, while strengthened lower limbs and core musculature contribute to the generation of force needed for long-distance throws<sup>23</sup>. Additionally, the fatigue resistance developed through GVT allows players to maintain joint angle velocity and throwing accuracy even under conditions of metabolic stress, such as during the later stages of a match. This makes GVT a potentially valuable component of preparation for athletes whose role includes lineout throwing responsibilities<sup>24</sup>

## NEED OF THE STUDY

Elite rugby is one of the most physically demanding sports, requiring athletes to combine strength, endurance, speed, and technical precision under intense competitive pressure. Small improvements in performance can be the difference between winning and losing, which is why training methods must be carefully designed to maximize results. One key component of rugby performance is lineout throwing, a skill that relies on upper- and lower-limb coordination, strength, and endurance. The ability to throw accurately and over greater distances can provide teams with a crucial tactical advantage.

German Volume Training (GVT) has recently gained attention as a high-volume resistance training method designed to stimulate hypertrophy, strength, and muscular endurance. Unlike conventional training protocols, which emphasize progressive overload with lower volume, GVT subjects' muscles to prolonged stress and metabolic challenge, encouraging adaptations that may be particularly valuable in rugby. If shown to be more effective, GVT could not only improve throw distance but also enhance overall power and fatigue resistance, both of which are essential in tournament formats like Rugby Sevens where athletes compete in multiple high-intensity matches in a short period.

Another important aspect is peripheral muscle fatigue, which is a major limiting factor in rugby performance and increases the risk of injuries. By evaluating how GVT influences fatigue compared to conventional training, this study can provide practical insights for designing programs that enhance performance while reducing injury risk.

Therefore, the need of the study lies in exploring whether GVT offers superior benefits for rugby athletes, particularly in improving throw distance and managing fatigue. The outcomes could help optimize training protocols, provide a competitive edge for teams, and contribute to the long-term health and performance of elite rugby players.

## **AIM & OBJECTIVE**

## **AIM & OBJECTIVES**

**Aim of the study:** To find out the significant effect of German volume training along conventional exercise protocol on throw distance and peripheral muscle fatigue in Elite Rugby 7s players

**Objectives of the study:** To evaluate the effect of German volume training to conventional exercise protocol on throw distance. To analyze the effect German volume training to conventional training protocol on peripheral muscle fatigue

# **HYPOTHESIS**

## **HYPOTHESIS**

Independent Variable – German Volume Training

Dependent Variable – Throw Distance, Peripheral Muscle Fatigue

Null Hypothesis:

- $H_0$ - German Volume Training will not produce any effect on throw distance or peripheral muscle fatigue among Rugby 7s players

Alternative hypothesis:

- $H_1$ - German Volume Training will have a significant effect on throw distance and peripheral muscle fatigue among Rugby 7s players negative correlation between trunk stability and reaction time.

# **REVIEW OF LITERATURE**

## REVIEW OF LITERATURE

1. Scott et al. (2023) investigated the impact of complex training methods on physical performance in rugby league players. The study compared variable resistance complex training (VRCT) with traditional complex training (TCT) to determine their effectiveness in improving key performance measures. Both VRCT and TCT interventions demonstrated significant improvements in one-repetition maximum back squat (1RM BS), countermovement jump (CMJ) peak power, and 5 m sprint time ( $p < 0.005$ ). These findings highlight the importance of incorporating structured resistance and power-based training strategies during the competitive season to enhance lower-body strength, explosive power, and short-distance sprint performance. The study further suggests that both VRCT and TCT are practical and effective methods that can be utilized without compromising training schedules. Overall, this research supports the integration of complex training approaches into athlete development programs to optimize performance outcomes in rugby players
2. Weakley et al. (2019) explored the influence of strength and conditioning practices on the development of physical qualities in adolescent rugby players. The study demonstrated that structured and periodized training programs significantly enhanced strength, power, and speed—key attributes required for rugby performance. Importantly, the research highlighted that biological maturation plays a crucial role in determining how effectively players respond to training, suggesting that individualized approaches are necessary to maximize adaptation. Players regularly engaged in well-monitored training displayed superior improvements compared to those following less structured routines, underlining the importance of professional guidance in athletic development. Furthermore, the study emphasized that systematic strength and conditioning not only improve performance but also contributes to reducing the risk of injury, a critical aspect in a physically demanding sport like rugby. These findings provide strong evidence supporting the integration of scientifically designed conditioning practices in youth rugby development programs.
3. Crewther et al. (2016) examined the effects of two equal-volume training protocols on strength, body composition, and hormonal responses in male rugby union players. The study evaluated how different resistance training designs influence both performance adaptations and physiological markers. Findings revealed that both training protocols were effective in increasing strength and improving body composition, with some variations observed in salivary hormone responses across the interventions. This indicates that even when training volume is matched, program design can influence endocrine outcomes, which are critical for recovery and performance. Importantly, the results demonstrate the potential to optimize training approaches for rugby players not only to enhance physical performance but also to regulate physiological stress and

recovery. Such insights are highly valuable for strength and conditioning professionals working with athletes in demanding competitive environments.

4. Argus et al. (2012) investigated the effects of two contrast training programs on jump performance in rugby union players during a competition phase. Contrast training, which alternates between high-load resistance exercises and explosive plyometric movements, was applied in two formats to evaluate its effectiveness on lower-body power. Both training protocols resulted in improvements in jump performance, highlighting the adaptability of rugby athletes to varied resistance–power training models. The study also emphasized that incorporating contrast training during competition is feasible and does not negatively impact performance maintenance. Instead, it may provide an additional stimulus to enhance explosive capacity, which is vital in rugby for actions such as tackling, sprinting, and lineout jumps. These findings reinforce the importance of integrating specialized power-oriented training into competitive phases to maximize athletic performance without excessive fatigue.
  
5. Aka et al. (2020) investigated the relationship between isokinetic strength and throwing speed and distance in athletes specializing in throwing events. The study explored how muscular strength, particularly in the shoulder and upper extremities, directly correlates with performance outcomes such as throw distance and release velocity. Results highlighted a significant association between isokinetic strength parameters and both throwing speed and distance, demonstrating that greater muscular strength can enhance mechanical efficiency during the throw. The findings suggest that monitoring and developing isokinetic strength may serve as a valuable predictor of throwing performance, allowing coaches to design more targeted strength and conditioning interventions. This research emphasizes the critical role of muscular strength in maximizing technical and performance-related outcomes in throwing-based sports, offering insights applicable not only to athletics but also to sports requiring overhead throwing mechanics.
  
6. Satya Paul et al. (2018) examined the effect of weight training exercises on speed and shoulder strength among javelin throwers from Acharya Nagarjuna University, Guntur. The study focused on how structured resistance training programs could influence both explosive power and specific muscular strength relevant to javelin performance. Findings demonstrated notable improvements in speed and shoulder strength following systematic weight training, which translated into better throwing capability. The research underlined the importance of incorporating tailored weight training exercises to enhance shoulder stability, strength, and overall throwing efficiency. Furthermore, the study provided practical evidence that well-designed resistance training not only improves physical qualities but also supports performance in technical skills such as javelin throwing. These outcomes highlight the need for integrating sport-specific

strength training protocols in the development programs of athletes aiming to maximize throwing distance and competitive performance.

7. Zaras et al. (2013) conducted a study to compare the effects of strength training and ballistic-power training on throwing performance. The research aimed to determine whether maximal strength development or power-oriented exercises had a more pronounced impact on improving throwing distance and velocity. Results indicated that both training methods significantly enhanced throwing performance; however, ballistic-power training demonstrated a stronger influence on explosive movements and throw efficiency. Strength training, on the other hand, contributed to increased force production, thereby supporting overall throwing capability. The study highlighted that the transfer of training adaptations depends largely on the type of exercises implemented, with ballistic-power exercises offering a more sport-specific benefit for throws requiring speed and explosiveness. These findings suggest that integrating a balance of both strength and ballistic-power training may provide athletes with a more comprehensive improvement in performance, particularly in sports involving repeated overhead throws.
  
8. THEBAN AMIRTHALINGAM et. al. (2016) Conducted A Study with The Purpose to Examine the Effects of a Modified German Volume Training Program on Muscular Hypertrophy and Strength. Nine- Teen Healthy Men Were Randomly Assign To 6 Weeks Of 10 Or 5 Sets Of 10 Repetitions for Specific Compound Resistance Exercises Included in A Split Routine Performed 3 Times Per Week. Outcome Measure Use Was Percent 1RM And Total Volume Load. And Concluded That the Modified GVT Program Is No More Effective Than Performing 5 Sets Per Exercise for Increasing Muscle Hypertrophy and Strength. To Maximize Hypertrophic Training Effects, It Is Recommended That 4–6 Sets Per Exercise Be Performed, As It Seems Gains Will Plateau Beyond This Set Range and May Even Regress Due To Overtraining.
  
9. BRUNO BAVARESCO et. al. (2014) conducted a study with a purpose of Acute Effect of German Volume Training Method on Autonomic Cardiac Control of Apparently Healthy Young. This study investigated the Data collection was carried out by physical education undergraduate students from Bahia School of Medicine and Public Health, Brazil. They had been previously trained by the researchers and professors from the Physical Education Department of the institution. This is an experimental study with pre- and post-treatment tests designed for 2 groups. The sample consisted of 16 healthy and active young men with at least 12 months of recreational experience in RT. Outcome measure used were 1rm test and autonomic cardiac control evaluation (comparison of variability) And concluded that GVTM promotes great stress upon ACC of apparently healthy young subjects. However, it is necessary to carry out randomized research with comparing different methods, as well as a longer time to monitor HRV to provide greater scientific contribution to coaches and strength professionals in developing safe exercise prescriptions.

10. Hasan Aka ET AL. September 2020 conducted a study the investigation of the relationship between throwers isokinetic strength and throwing speed and distance in the athletics, The aim of the study is to investigate the relationship between the isokinetic shoulder strength, the throwing speed and the throwing distance of the medicine ball of the throwers in the athletics, It can be suggested that throwers should develop other variables (strengthening all upper and lower limbs and trunk muscles, throwing technique, etc.) in addition to shoulder strength to improve throwing speed and throwing distances.
  
11. Marcelle Schaffarczyk et al .2022, conducted a study Validity of the Polar H10 Sensor for Heart Rate Variability Analysis during Resting State and Incremental Exercise in Recreational Men and Women, aim of this study to compare the HRV data obtained by the Polar H10 sensor chest strap device and an electrocardiogram (ECG) with the focus on RR intervals and short-term scaling exponent alpha 1 of Detrended Fluctuation Analysis (DFA a1) as non-linear metric of HRV analysis. Linear HRV measurements derived from the Polar H10 chest strap device show strong agreement and small bias compared with ECG recordings and can be recommended for practitioners. However, with respect to DFA a1, values in the uncorrelated range and during higher exercise intensities tend to elicit higher bias and wider LoA.
  
12. Schaffarczyk et al. (2022) examined the validity of the Polar H10 sensor for heart rate variability (HRV) analysis during both resting states and incremental exercise in recreationally active men and women. The study compared HRV values obtained from the Polar H10 with those from standard electrocardiogram (ECG) recordings, which are considered the gold standard. Findings indicated a high level of agreement between the Polar H10 and ECG across multiple HRV parameters, confirming its accuracy and reliability in both rest and exercise conditions. This suggests that the Polar H10 can serve as a practical and non-invasive tool for monitoring autonomic function and cardiovascular responses in sports and exercise settings. The results are particularly relevant for applied sports science and physiotherapy, where cost-effective and portable devices are often needed for performance monitoring, recovery assessment, and individualized training programs
  
13. Ni et al. (2022) investigated the use of heart rate variability (HRV) as a tool for subjective physical fatigue assessment. Their study highlighted the strong association between changes in HRV indices and the onset of both acute and accumulated fatigue in athletes. Unlike conventional performance measures, HRV provides an objective and non-invasive method of monitoring autonomic nervous system function, enabling early detection of fatigue before it manifests in performance decline. The research emphasized that HRV-based monitoring could enhance training load management, optimize recovery strategies, and reduce the risk of overtraining or injury. This is

particularly valuable in high-intensity intermittent sports, where effective fatigue monitoring directly influences performance outcomes and player availability.

14. Takanashi et al. (2020) examined the evaluation of explosive upper-body strength in athletic throwers, focusing on its relationship with throwing performance. The study emphasized that upper-body explosive strength, particularly the capacity to generate force rapidly, is a key determinant of throwing distance and accuracy. Using specific testing protocols, they demonstrated that improvements in explosive strength directly translated into enhanced throwing capabilities. Their findings support the integration of targeted resistance and power training for athletes in sports requiring overhead or projectile throws. This study is relevant for disciplines such as rugby, where lineout throws and passing accuracy depend heavily on upper-body explosiveness, reinforcing the need for strength and conditioning interventions aimed at optimizing throwing performance.
  
15. Hackett et al. (2018) carried out a pilot study to investigate the effects of German Volume Training (GVT) by comparing the traditional 10×10 protocol with a reduced 5×10 protocol on strength and hypertrophy outcomes. The study was designed to address concerns raised in earlier literature that the excessive training volume of GVT may be unnecessary or even counterproductive. Participants completed resistance training programs for six weeks, and outcomes such as strength, muscle thickness, and body composition were assessed. The results demonstrated no significant advantage of the 10×10 protocol over the 5×10 protocol in terms of hypertrophy or strength gains. In fact, both groups showed similar improvements, suggesting that excessively high volumes may not always yield superior results. Importantly, the study found that the 10×10 group experienced greater fatigue and difficulty in recovery, highlighting the potential limitations of GVT when applied without consideration for individual tolerance and recovery capacity. This research contributes valuable evidence by questioning the long-standing belief that extreme training volumes are essential for hypertrophy. It also emphasizes the importance of balancing workload and recovery to optimize adaptations. For athletic contexts, especially in sports requiring repeated explosive efforts such as throwing or sprinting, these findings are highly relevant. The study indicates that modified GVT protocols could be more practical and effective in enhancing performance without compromising recovery. Overall, Hackett et al. (2018) provide a foundation for exploring how volume manipulation within GVT impacts both performance and fatigue.
  
16. Amirthalingam et al. (2017) provided one of the few empirical evaluations of the German Volume Training (GVT) method, systematically comparing it with a conventional resistance training approach. The study aimed to determine whether the high-volume 10×10 structure of GVT produced superior muscular adaptations relative to traditional strength training protocols. Participants were assigned to either a GVT

program or a standard training regimen over a six-week period, with assessments made for lean body mass, muscle hypertrophy, and maximal strength. Contrary to the widespread belief that higher training volumes enhance muscular development, the results demonstrated that traditional resistance training elicited greater improvements in lean body mass and muscle thickness than the GVT protocol. While GVT created considerable training stress, this did not translate into superior outcomes. Instead, participants in the GVT group reported greater fatigue and reduced recovery, which likely limited the effectiveness of the adaptive response. The findings highlight an important consideration in program design: excessive training volume can impair recovery and may blunt muscular growth rather than enhance it. The authors proposed that moderate volumes, typical of traditional resistance programs, may offer a more optimal balance between stimulus and recovery, allowing athletes to sustain progress over time. This study is particularly relevant in evaluating the practical application of GVT in athletic populations. It suggests that while the method may induce metabolic stress and fatigue tolerance, it may not provide a superior advantage for hypertrophy or performance when compared to well-structured conventional training.

17. Schlumberger et al. (2001) conducted one of the earlier systematic investigations into the physiological impact of high-volume resistance training protocols, including variations comparable to German Volume Training (GVT). The study examined the effects of different strength training regimens on muscle performance, hypertrophy, and recovery capacity in trained individuals. The authors specifically compared outcomes between traditional progressive overload programs and those emphasizing very high training volumes. The findings indicated that excessive training volume did not necessarily lead to proportional improvements in muscle strength or hypertrophy. Instead, participants subjected to high-volume protocols often demonstrated signs of overreaching, such as elevated fatigue levels, impaired recovery, and reduced training efficiency. While metabolic stress was heightened, this did not translate into superior long-term adaptations. Traditional training protocols, which balanced volume and intensity, proved more effective in promoting sustainable improvements in muscular performance. An important contribution of this study lies in its emphasis on the principle of recovery as a limiting factor in strength development. The results suggest that training strategies like GVT, while capable of generating significant acute muscular fatigue, may compromise the adaptive process if recovery is insufficient. This has implications for athletes in high-performance contexts, where balancing workload and recovery is essential for both performance gains and injury prevention. By critically examining the limits of high-volume strength programs, Schlumberger et al. (2001) provided foundational evidence questioning the superiority of GVT-style protocols. Their findings underscore the need for carefully calibrated training loads that optimize adaptation without inducing excessive fatigue
18. Baker (2009) investigated the use of hypertrophy-oriented resistance training methods, including German Volume Training (GVT), within athletic populations. The article emphasized that while strength and power development are critical in sports

performance, hypertrophy-focused protocols can provide additional benefits by enhancing muscle mass and improving an athlete's capacity to tolerate repeated high-intensity efforts. The review described GVT as a structured program prescribing ten sets of ten repetitions at moderate loads, designed to maximize mechanical tension, metabolic stress, and muscle damage. Baker highlighted that the extreme training volume promotes significant hypertrophic responses, which may support athletes in contact sports where increased body mass and force absorption are advantageous. Importantly, the article noted that hypertrophy alone is not sufficient; integration with strength, power, and speed training is necessary for sport-specific transfer. Baker further emphasized the role of training variation, suggesting that hypertrophy-oriented blocks, such as GVT, should be strategically implemented within broader periodization frameworks. Overuse of high-volume programs risks excessive fatigue, delayed recovery, and diminishing returns if not carefully monitored. Overall, Baker (2009) reinforced the potential of GVT as a supplementary tool in athletic conditioning, provided it is applied in moderation and balanced with recovery and performance-focused training

19. Leite et al. (2015) examined the relationship between medicine ball throw performance and upper-body power in rugby seven players, aiming to establish the predictive value of this test for assessing arm power. The study demonstrated that the medicine ball throw is a valid and practical field-based tool for evaluating explosive strength of the upper body, which is essential in rugby due to the demands of passing, tackling, and lineout throws. The results indicated significant correlations between medicine ball throw distance and other established measures of upper-body power, suggesting its reliability as a non-invasive and cost-effective assessment method. The authors emphasized the test's applicability in both training and performance monitoring, particularly in resource-limited environments where access to advanced laboratory equipment may be restricted. By linking throwing distance with muscular power, this study highlighted the importance of incorporating simple, sport-specific assessments into player development and conditioning programs.

# **METHODOLOGY & SELECTION CRITERIA**

## **METHODOLOGY**

- **Study design** – Single Group Experimental Study
- **Study population** - Rugby 7s Players
- **Sampling technique:** Purposive Sampling
- **Sample Size:** 30
- **Study setting:** Delhi hurricanes Rugby club, Delhi
- **Study duration:** 1 year

## **SELECTION CRITERIA**

### **INCLUSION CRITERIA**

- Elite Rugby players, minimum 2 years of experience and participation in competitive matches.
- Subjects willing to participate in the study.
- Age 18-25 years old
- Only Male Athlete
- Minimum 4 days strength training a week
- Ensure participants are non-smokers or have minimal tobacco use.

### **EXCLUSION CRITERIA**

- Recent fracture or any musculoskeletal condition strain, sprain, dislocation in less than 6months.
- Athlete unable to attend all scheduled training sessions & assessments.
- Athletes using performance enhancing drugs or anabolic steroids.
- Athletes currently involved in another strength training program or competing in competitive
- Players with less than one year of consistent strength training experience

**OUTCOME MEASURES & MATERIAL  
USED**

## OUTCOME MEASURES

### PRIMARY OUTCOME MEASURES

- 1 RM TEST
- OVER HEAD MEDICINE BALL TEST
- HRV MONITOR (RMSSD Reading with 25 sec Mid- Thigh hold)

### INSTRUMENT & TOOLS

- Gym setup
- Medicine ball upto 4kgs)
- Inch tape
- Note book & Pen
- First aid kit
- Heart Rate variability monitor
- Timer

Outcome Measure	Description	Instrument/Tool Used
1RM Bench Press	Maximal strength test	Olympic bench + weight plates
Medicine Ball Throw	Upper body explosive power	Medicine ball (4 kg) + measuring tape
HRV (RMSSD)	Autonomic modulation & fatigue with Mid-Thigh Hold for 25 sec	Polar H10 HR strap, HRV app/software, weight plate,
Session RPE	Perceived exertion after effort	Borg CR-10 Scale

**Table1: Outcome Measures, Description & Instrument Used**

## 1 RM TEST

The one-repetition maximum (1RM) test is widely recognized as the gold standard for assessing maximal muscular strength in both applied and non-laboratory environments<sup>25</sup>. It provides a direct and objective measure of the heaviest load an individual can successfully lift once, making it a cornerstone for evaluating strength capacities in athletes, clinical populations, and general fitness settings. While its primary purpose is to quantify maximal strength, the test has also been adapted to capture additional parameters such as force–time, power–time, and velocity–time characteristics when integrated with specialized equipment like force plates<sup>26</sup>. These adaptations broaden the scope of the test, enhancing its application within performance research and practice.

The standardized procedure of the 1RM test typically begins with a warm-up using light resistance and gradual load increments. Participants generally perform 5–10 repetitions at ~40–60% of their perceived maximum, followed by 3–5 repetitions at 60–80% of their estimated capacity. After adequate rest (2–3 minutes), incremental weight increases are applied until only one successful repetition can be completed with proper technique. Most protocols aim to determine the 1RM within 3–5 maximal attempts to avoid excessive fatigue, ensuring both validity and participant safety. Supervision by qualified personnel is essential to guarantee correct execution and minimize risk of injury<sup>27</sup>.

Research consistently supports the validity and reliability of the 1RM test, with intraclass correlation coefficients (ICC) reported as high as 0.98 across diverse populations<sup>27</sup>. Furthermore, reliability is maintained across a variety of exercises, muscle groups, and even between genders, with ICC values exceeding 0.91<sup>28</sup>. This reinforces the test's credibility as a robust and reproducible strength assessment method.

Overall, the 1RM test not only provides critical data for individualized training prescription but also serves as a valuable benchmark for tracking adaptations and guiding long-term performance development.



1 RM test (Bench Press)

## **Medicine Ball Throw**

The Medicine Ball Throw (MBT) test is a recognized field-based measure for evaluating upper-body explosive power and strength, particularly relevant in sports requiring dynamic throwing or pushing movements<sup>29</sup>. Unlike maximal strength assessments such as the one-repetition maximum (1RM), which primarily test load-lifting capacity, the MBT emphasizes rapid force production, making it a functional and sport-specific assessment of neuromuscular performance.

For the seated medicine ball chest throw test, the participant sits on a sturdy bench or chair with their back supported by a vertical backrest. Thighs remain horizontal and feet are flat on the floor. Elastic straps are placed around the mid-chest just below the armpits to limit trunk movement. The participant holds the medicine ball at chest level and, upon command, explosively pushes the ball forward with both hands, ensuring the back stays against the support during the throw. The best of three throws is recorded for assessment.

During the test, a medicine ball weighing 3 kg or 4 kg (Dynamax Inc®, Dallas, TX) is held at sternum height with both hands. From this position, participants perform a maximal forward throw while maintaining contact with the support and avoiding trunk displacement. Any attempt that deviates from the standardized position is invalidated. The distance is recorded from the release point (A) to the ball's first contact with the ground (B).

The MBT has been reported as a valid and practical method for assessing upper-body power in athletes, particularly in rugby, where overhead passing and throwing mechanics are integral to performance<sup>30</sup>. Its simplicity, minimal equipment requirements, and high sport relevance make it a valuable addition to athlete monitoring and strength evaluation protocols.



**Medicine Ball Throw**

## Heart Rate Variability (Main Outcome)

Heart rate variability (HRV) is a widely used non-invasive tool to evaluate autonomic nervous system (ANS) activity by quantifying the small-time variations between successive heartbeats. It reflects the dynamic interplay between sympathetic and parasympathetic influences on cardiac rhythm, thereby serving as a sensitive indicator of fatigue, recovery, and readiness to perform in athletes<sup>18</sup>. Among the various HRV indices, the **Root Mean Square of Successive Differences (RMSSD)** is considered particularly reliable, as it primarily reflects parasympathetic modulation and is less influenced by respiratory frequency compared to other measures<sup>19</sup>.

In this study, HRV served as the **primary outcome measure**, with RMSSD extracted using the **Polar H10 chest strap monitor (Polar Electro Oy, Kempele, Finland)**. The Polar H10 has demonstrated high validity in comparison with electrocardiography for RR interval assessment during both resting and exercise conditions<sup>29</sup>. Its practical application has been reinforced by recent validation work confirming accuracy in recreationally active men and women, establishing it as a dependable alternative to laboratory-grade devices<sup>30</sup>.

### Procedure for HRV assessment:

1. The Polar H10 strap was secured firmly around the participant's chest to ensure consistent electrode contact.
2. Baseline HRV was recorded in a seated position for 5 minutes before the fatiguing task.
3. Immediately following the **mid-thigh isometric hold**, HRV was again recorded during recovery.
4. RMSSD values were extracted to evaluate autonomic modulation, with particular focus on the decline during exercise and rebound during recovery.

### Sub-outcomes from HRV:

- **Acute fatigue response:** Post-exercise suppression of RMSSD, reflecting sympathetic predominance.
- **Recovery kinetics:** RMSSD rebound following cessation of effort, reflecting parasympathetic reactivation.

## Rating of Perceived Exertion (Sub-Outcome)

The **Rating of Perceived Exertion (RPE)** provides a psychophysiological measure of effort by integrating sensory feedback from working muscles with central motor drive. Borg's CR-10 scale is frequently used for quantifying muscular strain and fatigue, especially in resistance and isometric exercise contexts<sup>20</sup>. Its utility lies in capturing subjective intensity when objective measures may not fully reflect localized muscular exertion<sup>21</sup>.

In this study, RPE was used as a **secondary outcome** to assess **peripheral fatigue** after the mid-thigh hold. Participants were familiarized with the scale and asked to report their exertion immediately after the 25-second task.

**Procedure for RPE collection:**

1. The Borg CR-10 scale was explained prior to testing.
2. At the end of the isometric hold, participants verbally reported their perceived exertion.
3. The scores were documented as a reflection of localized muscular fatigue.

**Sub-outcome from RPE:**

- **Peripheral fatigue index:** Higher RPE values indicated greater quadriceps and hip extensor effort during the hold.

**Mid-Thigh Isometric Hold (Fatigue Protocol)**

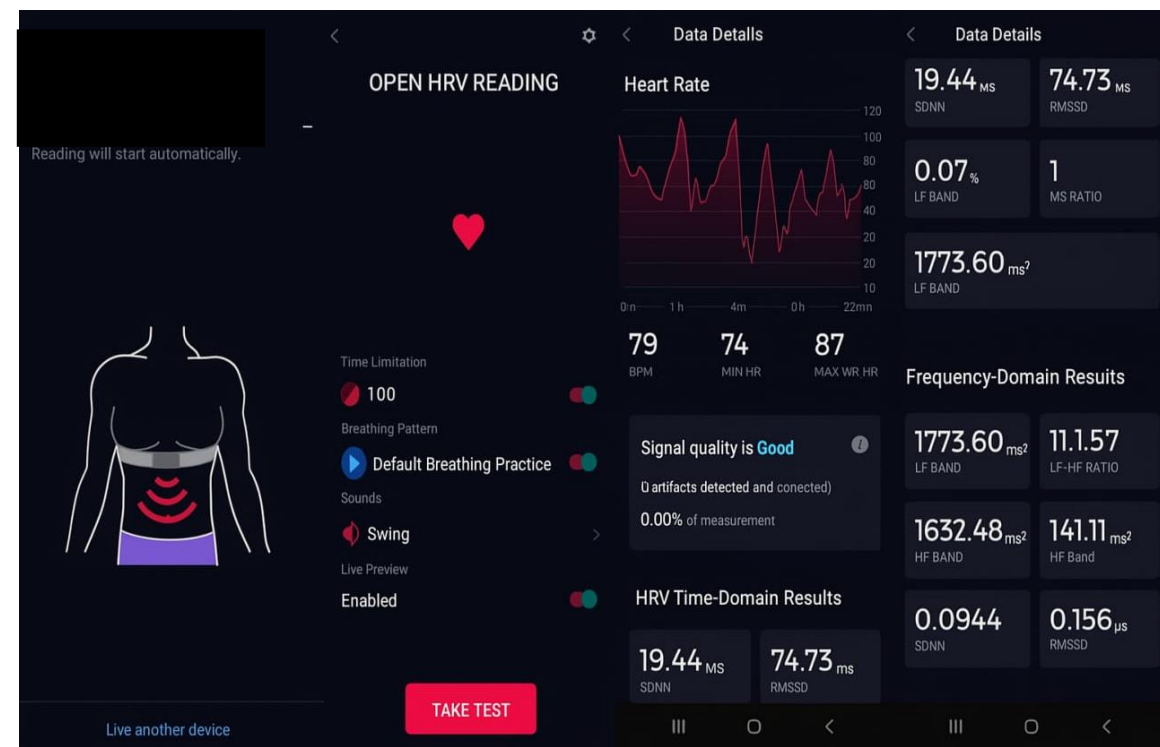
The **mid-thigh isometric hold** for 25 seconds was employed as the fatiguing protocol to elicit peripheral fatigue in the lower body musculature. This task is commonly applied in neuromuscular performance testing as it isolates the quadriceps and hip extensors under a controlled isometric load<sup>22</sup>. By standardizing duration, it enables reliable inter-individual comparisons while ensuring sufficient fatigue is induced<sup>23</sup>.

**Procedure for fatigue protocol:**

1. Participants assumed a mid-thigh pull position against an immovable resistance.
2. The hold was sustained for 25 seconds at maximal voluntary effort.
3. HRV (via Polar H10 RMSSD) and RPE were recorded immediately after task completion and during recovery.



**Mid-Thigh Hold ( 25 sec)**

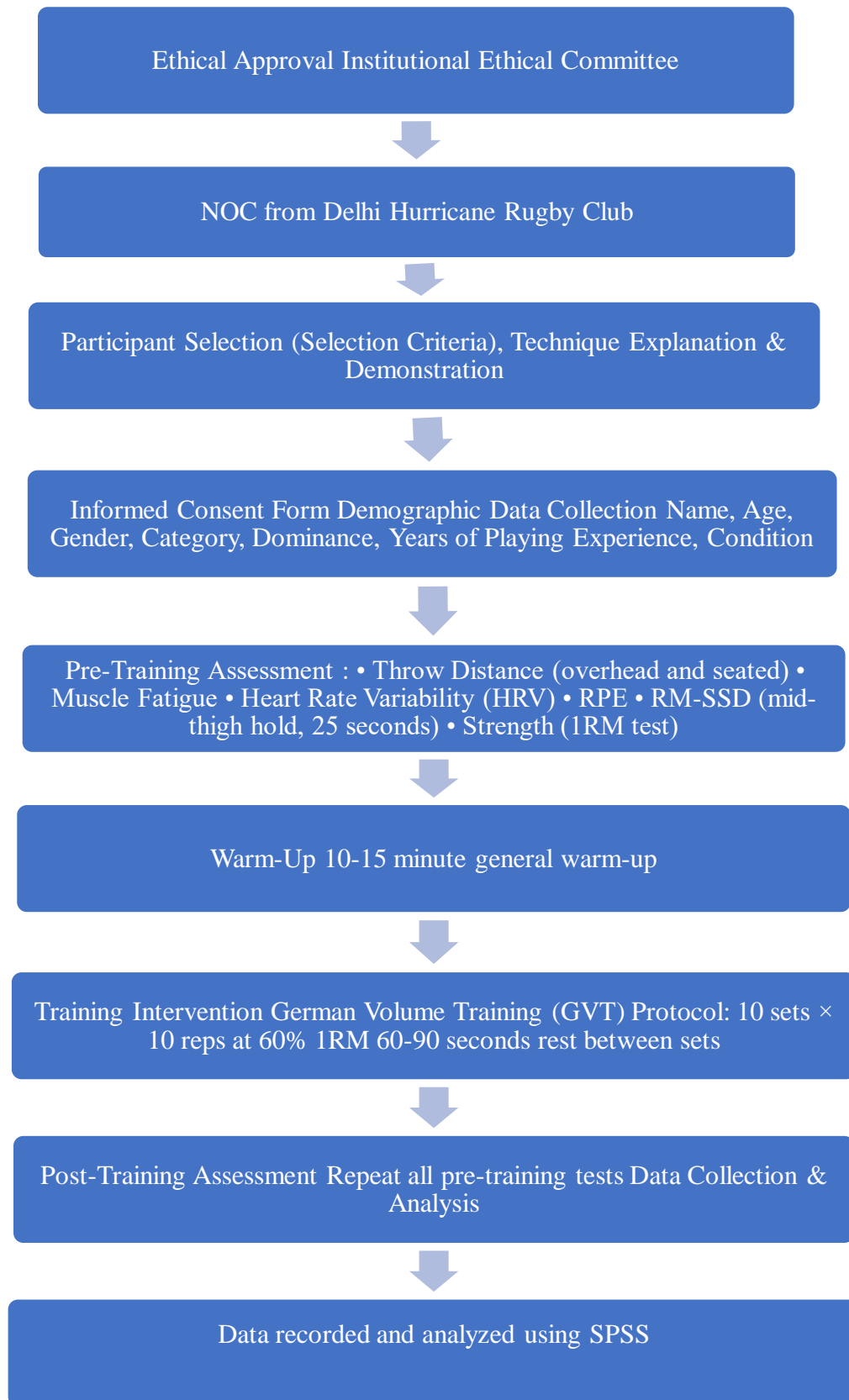


**HRV (RMSSD)**

## PROCEDURE

- Ethical approval was obtained from the institutional ethical committee.
- NOC was taken from Delhi Hurricane Rugby Club
- Participants were selected on the basis of the selection criteria.
- Explanation and demonstration of the technique was done for the participants.
- Informed consent form was obtained from the participants.
- Demographic data was obtained which included name, age, gender, category, dominance, years of playing experience and condition.
- . Pre-Training Assessment
  - Before training, the following will be measured:
    - Throw distance (overhead and seated)
    - Muscle fatigue
    - Heart Rate Variability (HRV)
    - Rate of Perceived Exertion (RPE)
    - RM-SSD (mid-thigh hold, 25 seconds)
    - Strength (1RM test) Bench Press
  - Warm-Up, Participants will perform a 10–15-minute general warm-up
  - Training Intervention
    - German Volume Training (GVT) protocol:
      - 10 sets × 10 reps at 60% 1RM
      - 60–90 seconds rest between sets
    - Post-Training Assessment. All pre-training tests will be repeated to assess changes after the training.
  - Data Collection and Analysis
    - All the data was recorded and was analysed using the latest version of SPSS.

## FLOWCHART



# **STATISTICAL ANALYSIS & RESULTS**

## STATISTICAL ANALYSIS

All data were entered into Microsoft Excel and analyzed using SPSS (latest version). Descriptive statistics, including mean and standard deviation (SD), were calculated for all outcome measures. Normality of the difference scores (Post–Pre) was tested using the Shapiro–Wilk test. For variables following a normal distribution, a paired sample t-test was applied to compare pre- and post-training values. For non-normally distributed data, the Wilcoxon signed-rank test was used. Effect sizes were calculated using Cohen’s d for parametric data and effect size r for non-parametric data to determine the magnitude of changes. Percentage change was also reported for better interpretation of training effects. Graphical representations, including paired line plots, boxplots, and histograms of differences, were prepared to illustrate pre- and post-intervention changes across participants. A significance level of  $p < 0.05$  was set for all statistical analyses.

## RESULTS

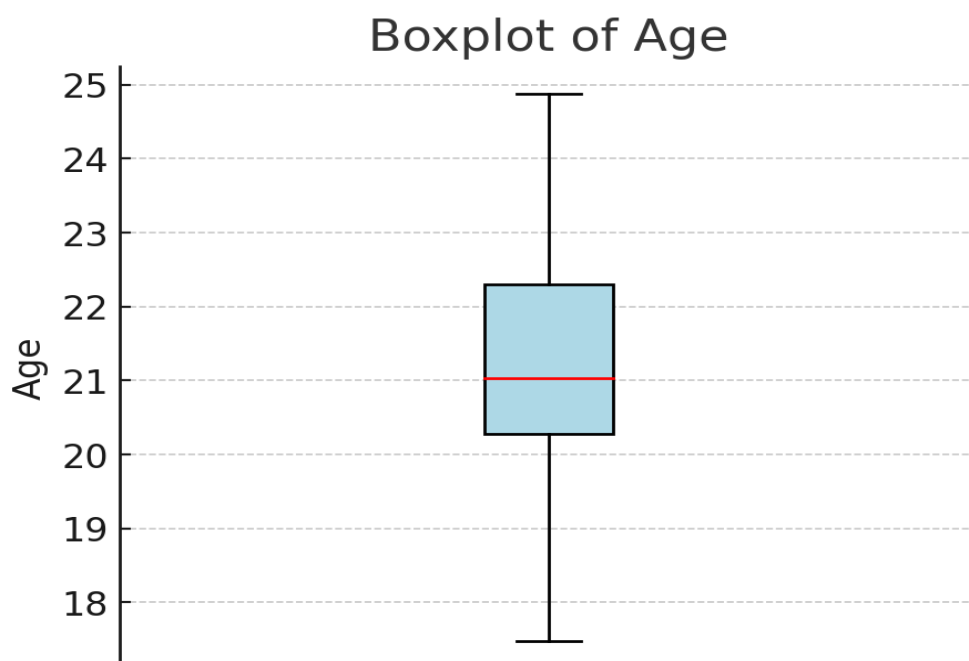
### Demographic Characteristics of Participants

The baseline characteristics of the 30 participants are summarized in Table 1. The mean age of participants was  $21.53 \pm 2.12$  years, with a height of  $184.93 \pm 4.21$  cm and weight of  $89.83 \pm 5.46$  kg. The age range of the participants was 18–25 years.

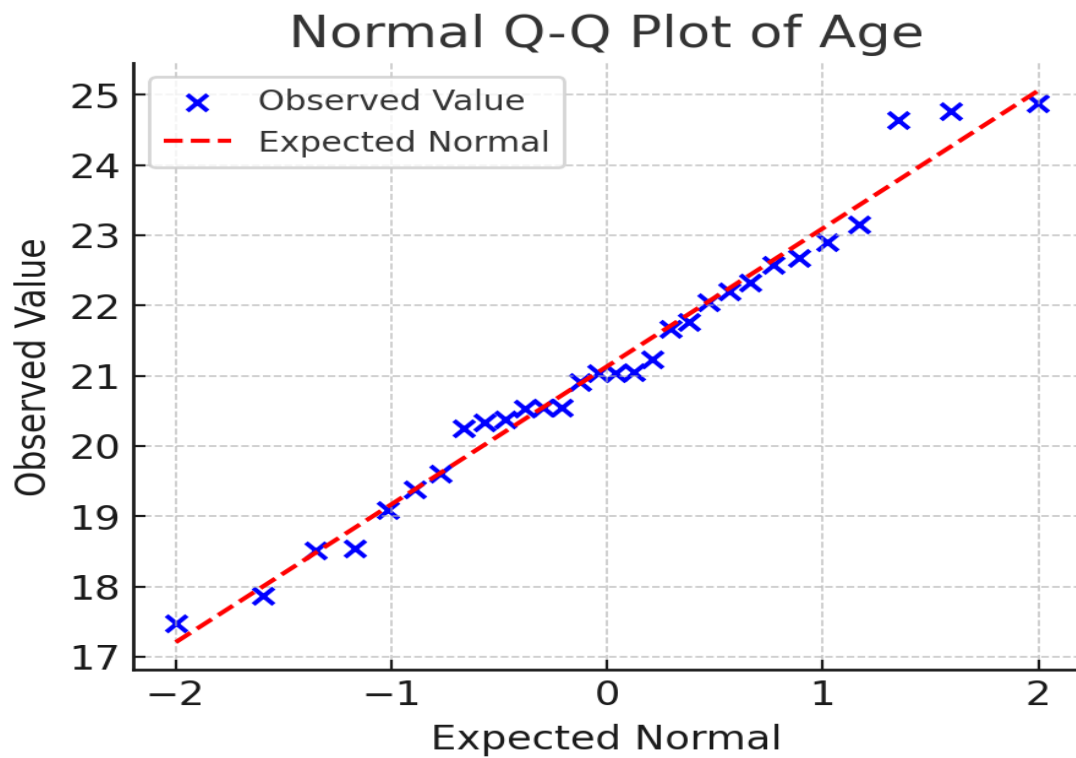
The distribution of demographic variables was further examined through descriptive plots. Boxplots and Q-Q plots confirmed a normal distribution for age, height, and weight (Figures 1–6).

Variable	Mean $\pm$ SD	Range
Age (years)	$21.53 \pm 2.12$	18–25
Height (cm)	$184.93 \pm 4.21$	178–192
Weight (kg)	$89.83 \pm 5.46$	82–100

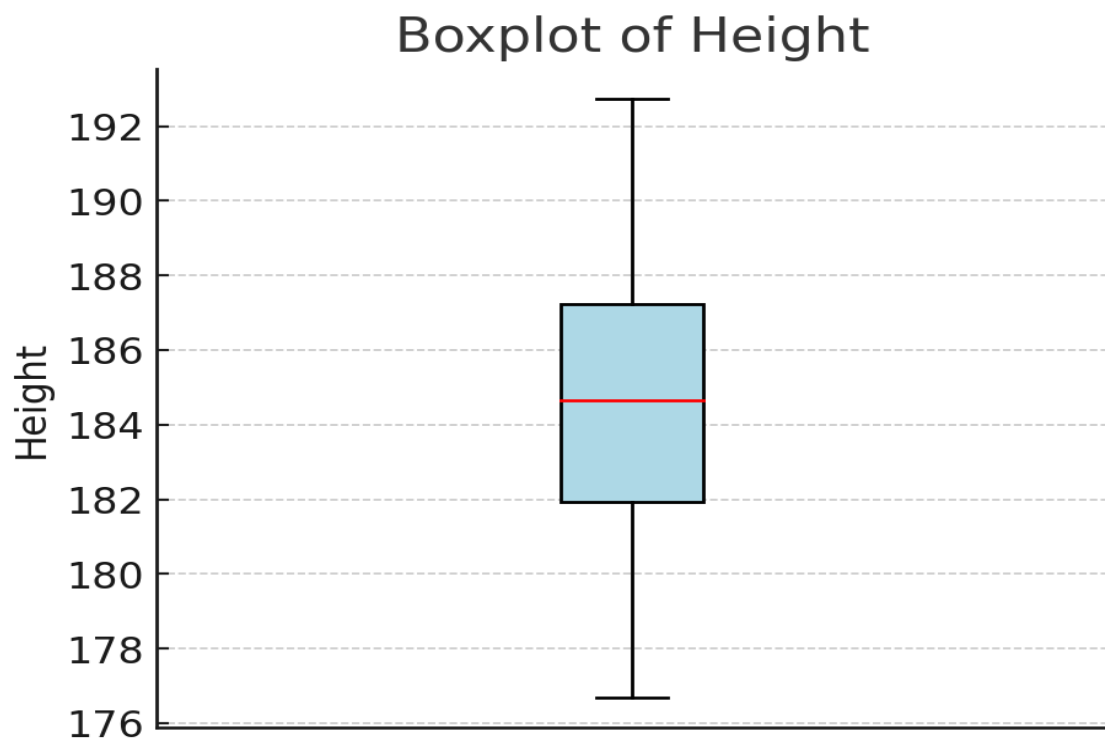
**Table 2.** Baseline Characteristics of Participants



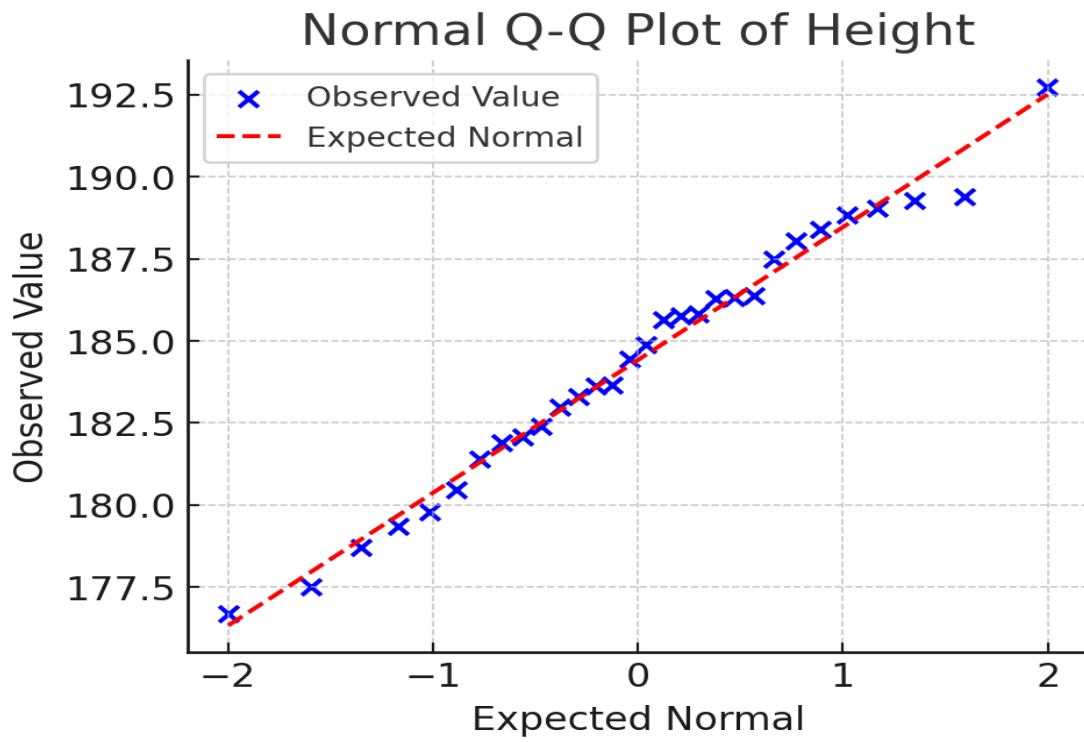
**Figure 1.** Boxplot of Age distribution of participants



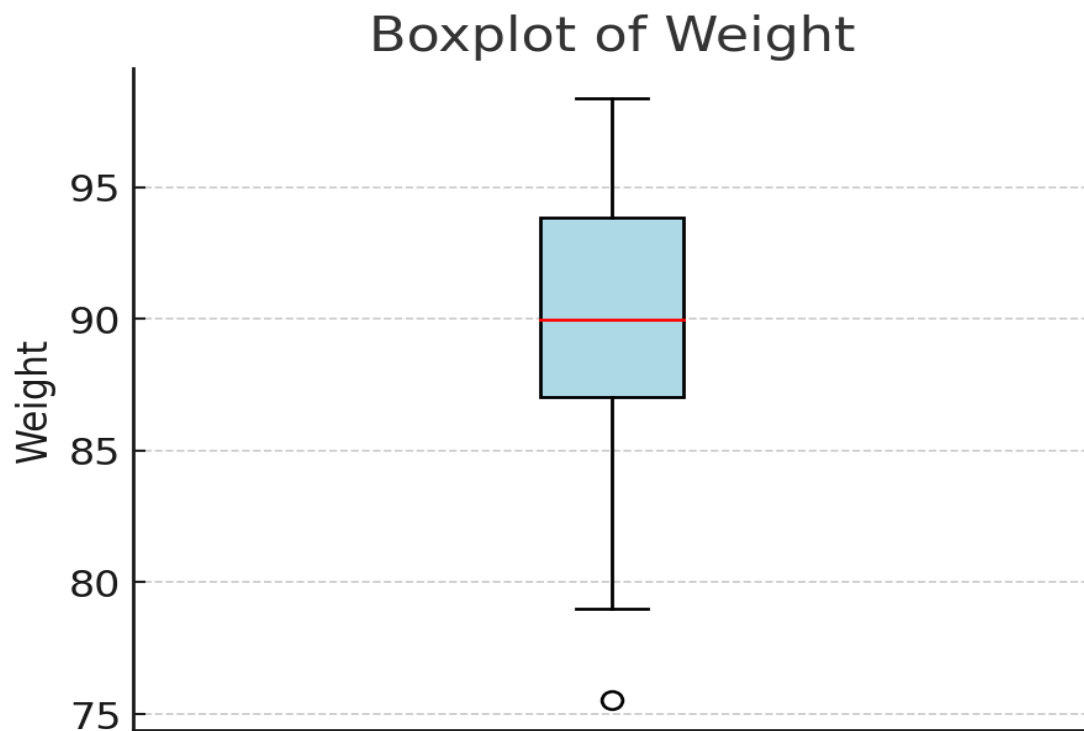
**Figure 2.** Q-Q Plot of Age showing normal distribution



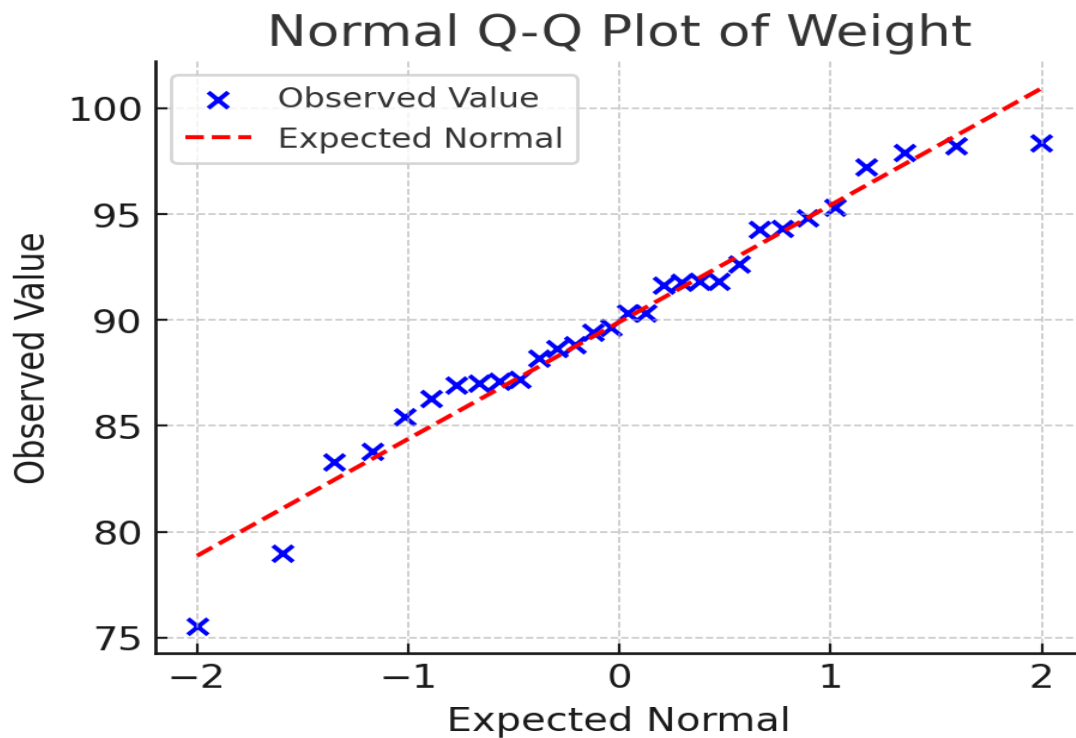
**Figure 3.** Boxplot of Height distribution of participants



**Figure 4.** Q-Q Plot of Height showing normal distribution



**Figure 5.** Boxplot of Weight distribution of participants



**Figure 6.** Q-Q Plot of Weight showing normal distribution

### Descriptive Statistics

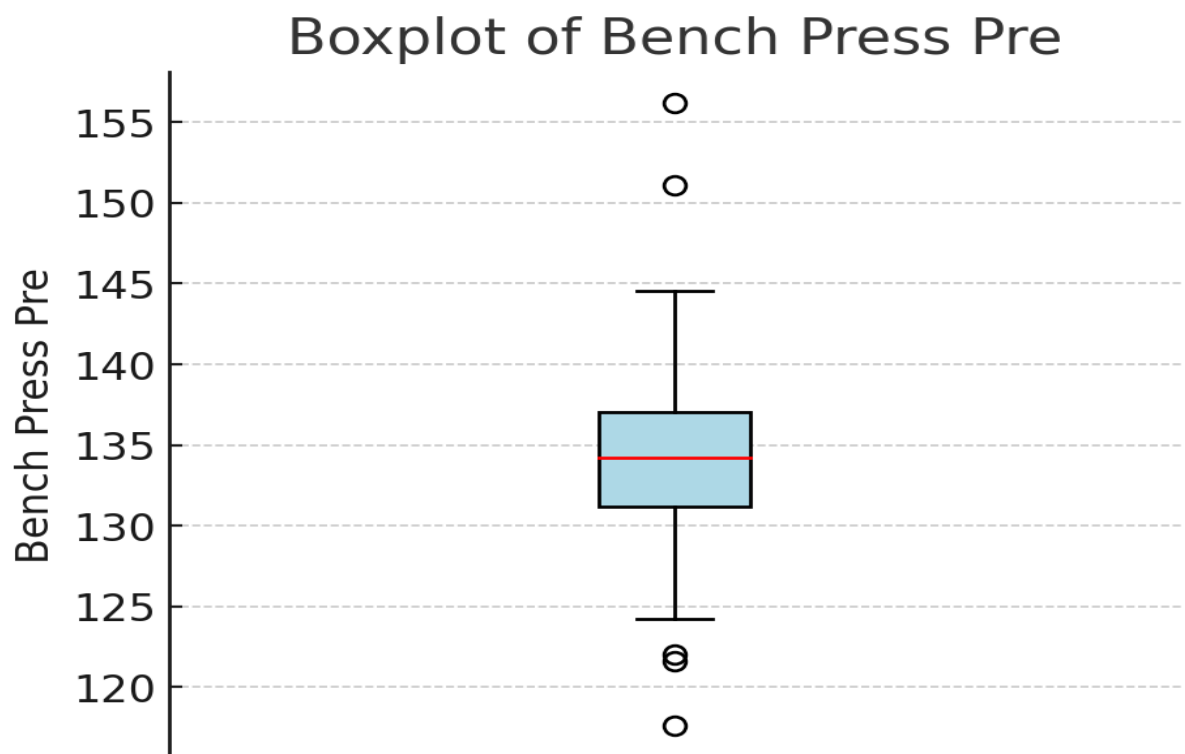
Descriptive statistics of pre- and post-test performance variables are presented in **Table 2**. The mean bench press increased from  $134.50 \pm 8.80$  kg (pre-test) to  $140.03 \pm 14.95$  kg (post-test). Similarly, throw distance improved from  $5.30 \pm 0.00$  m (pre-test) to  $6.15 \pm 0.59$  m (post-test).

In terms of muscle fatigue indices (RMSDD), both pre- and post-session values showed marked reductions across the training period. RMSDD (Pre-Pre) reduced from  $90.50 \pm 8.80$  to  $70.43 \pm 7.41$ , while RMSDD (Post-Pre) dropped from  $67.50 \pm 8.80$  to  $59.63 \pm 9.52$ . Additionally, session RPE declined from  $6.00 \pm 2.38$  to  $4.23 \pm 2.50$ , indicating reduced perceived exertion.

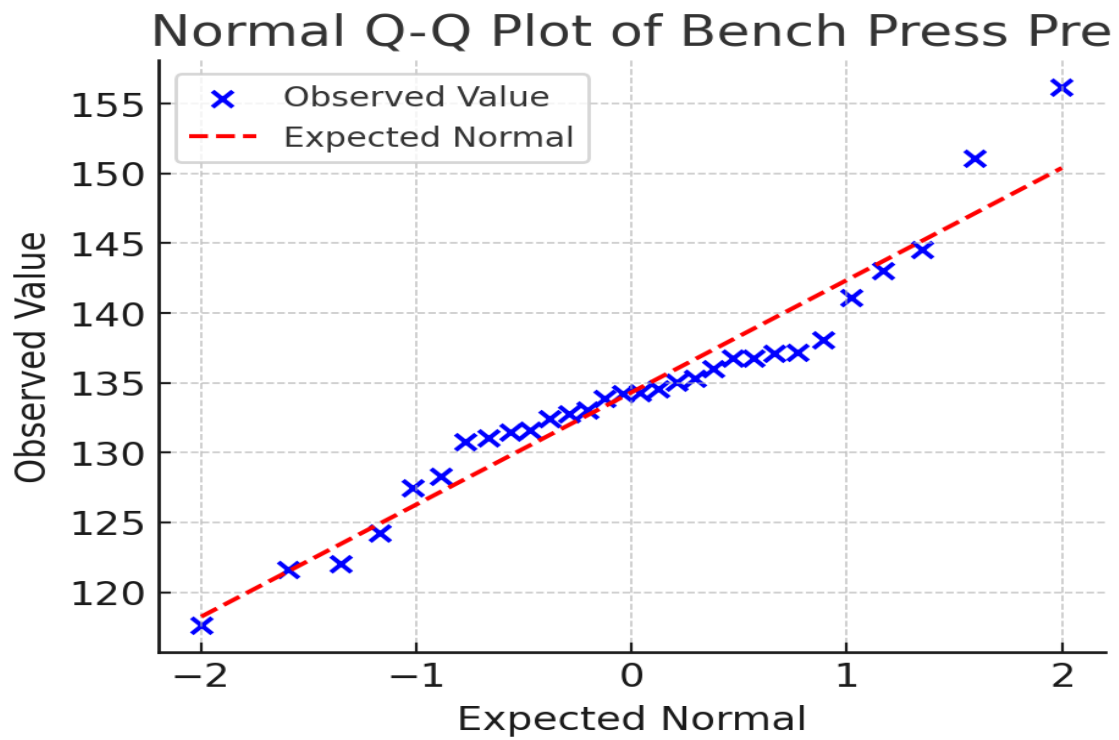
Box Plot and Q-Q plots of performance variables are presented in **Figures 7–24**, demonstrating distribution and spread of the data

**Table 3. Pre- and Post-Test Performance Variables**

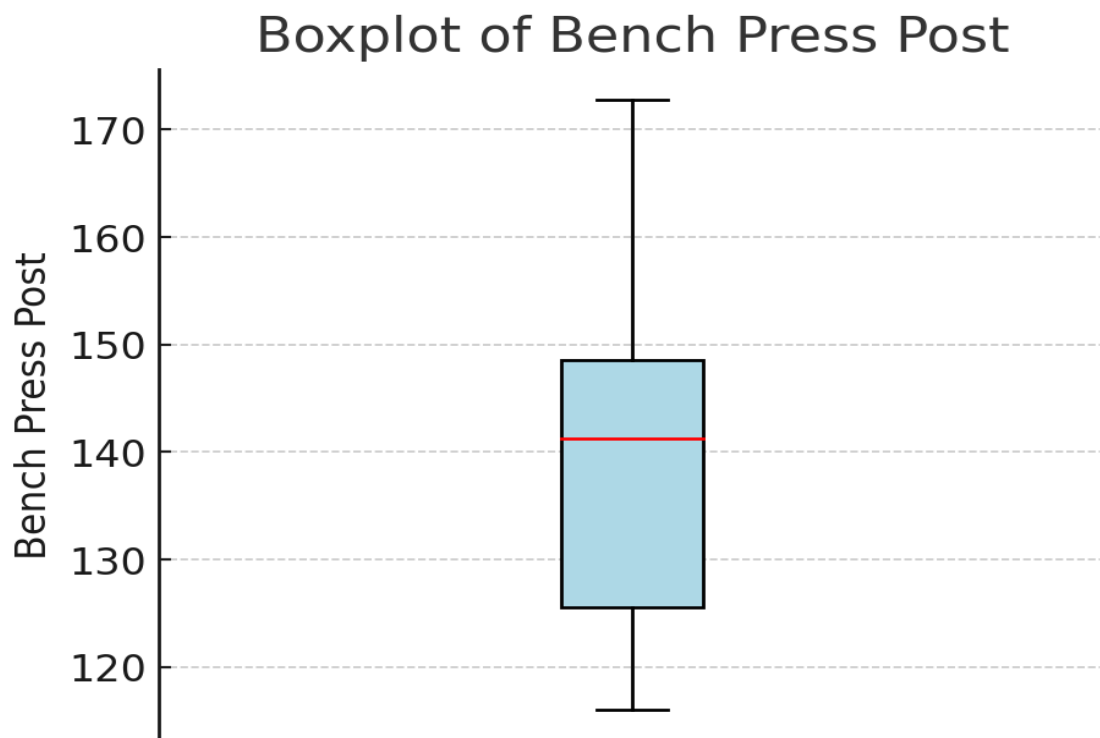
Variable	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)
Bench Press (kg)	134.50 $\pm$ 8.80	140.03 $\pm$ 14.95
Throw Distance (m)	5.30 $\pm$ 0.00	6.15 $\pm$ 0.59
RMSDD (Pre-Pre vs Pre-Post)	90.50 $\pm$ 8.80	70.43 $\pm$ 7.41
RMSDD (Post-Pre vs Post-Post)	67.50 $\pm$ 8.80	59.63 $\pm$ 9.52
Session RPE	6.00 $\pm$ 2.38	4.23 $\pm$ 2.50



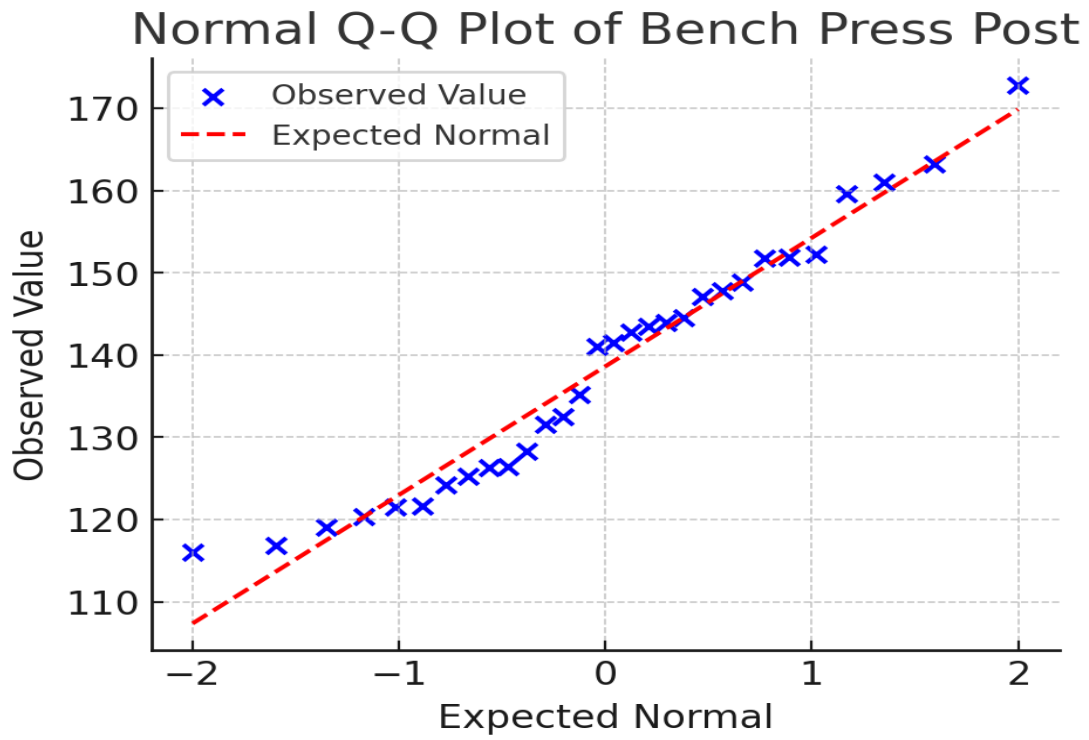
**Figure 7.** Boxplot of Bench Press (Pre-test)



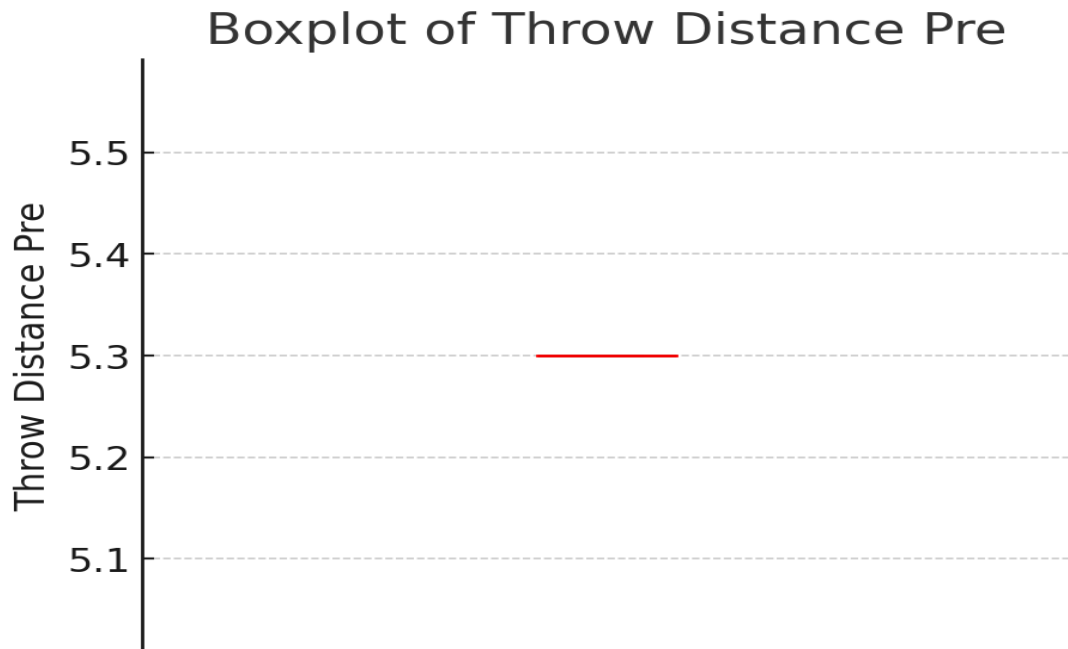
**Figure 8.** Normal Q-Q Plot of Bench Press (Pre-test)



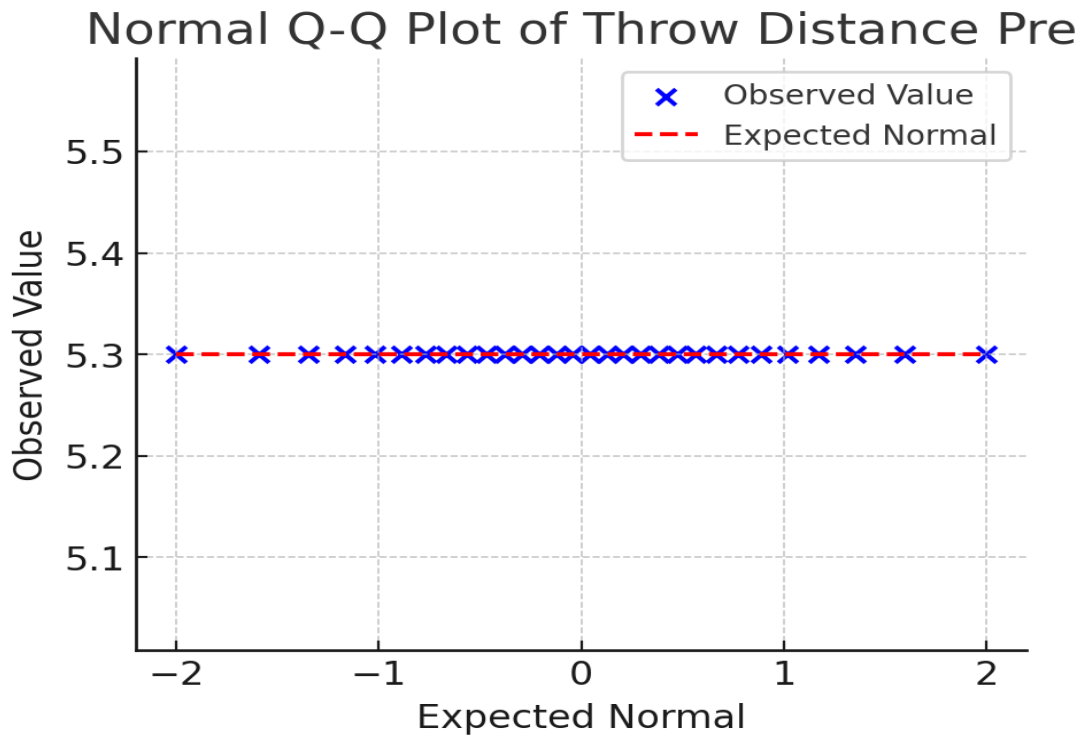
**Figure 9.** Boxplot of Bench Press (Post-test)



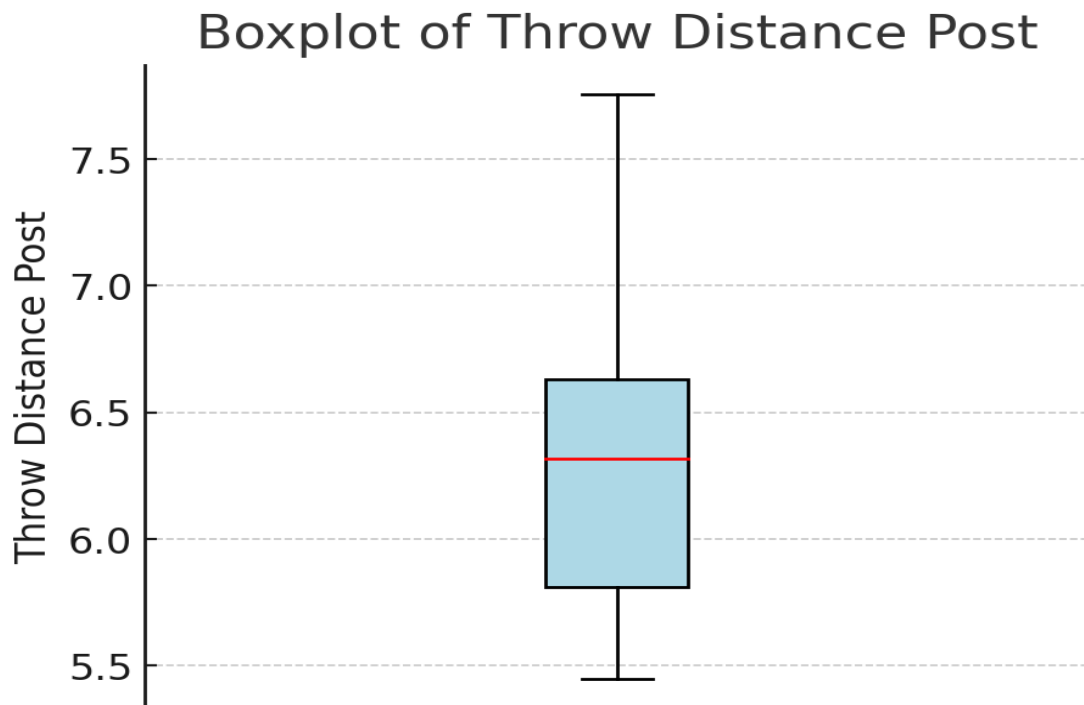
**Figure 10.** Normal Q-Q Plot of Bench Press (Post-test)



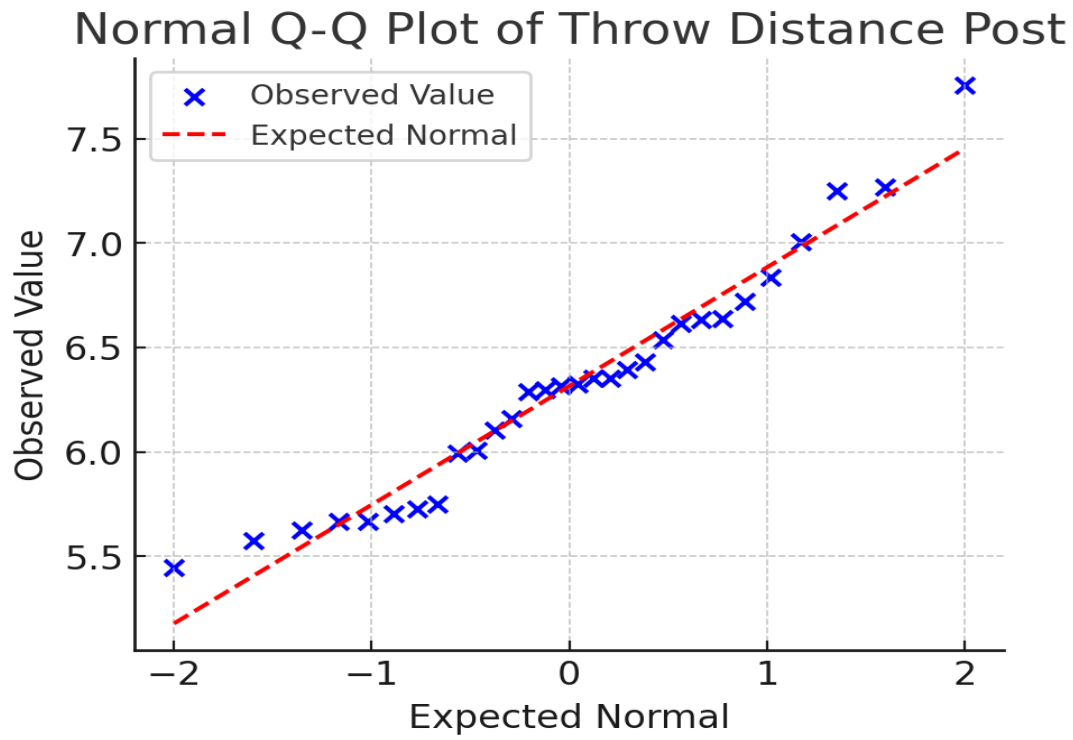
**Figure 11.** Boxplot of Throw Distance (Pre-test)



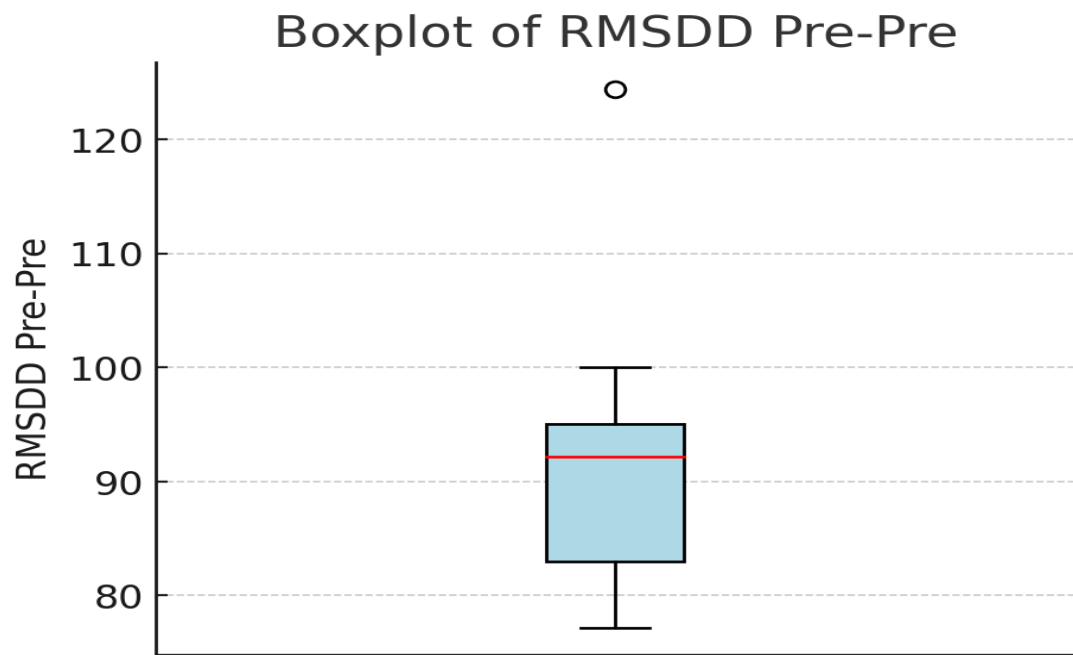
**Figure 12.** Normal Q-Q Plot of Throw Distance (Pre-test)



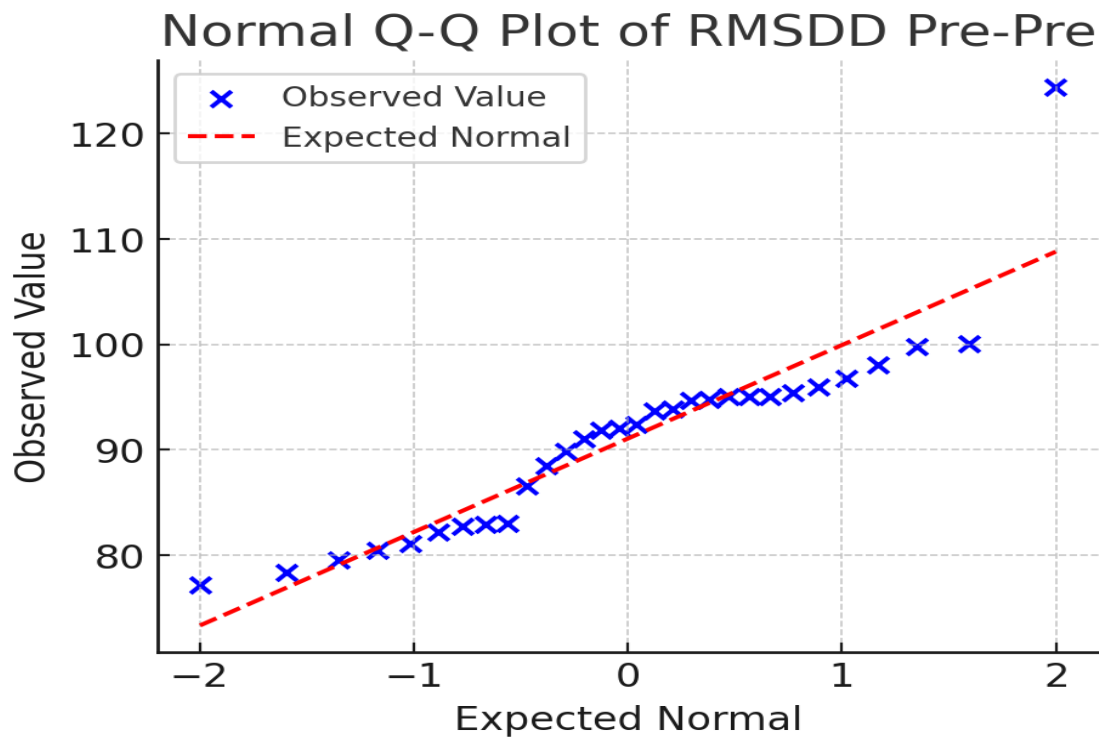
**Figure 13.** Boxplot of Throw Distance (Post-test)



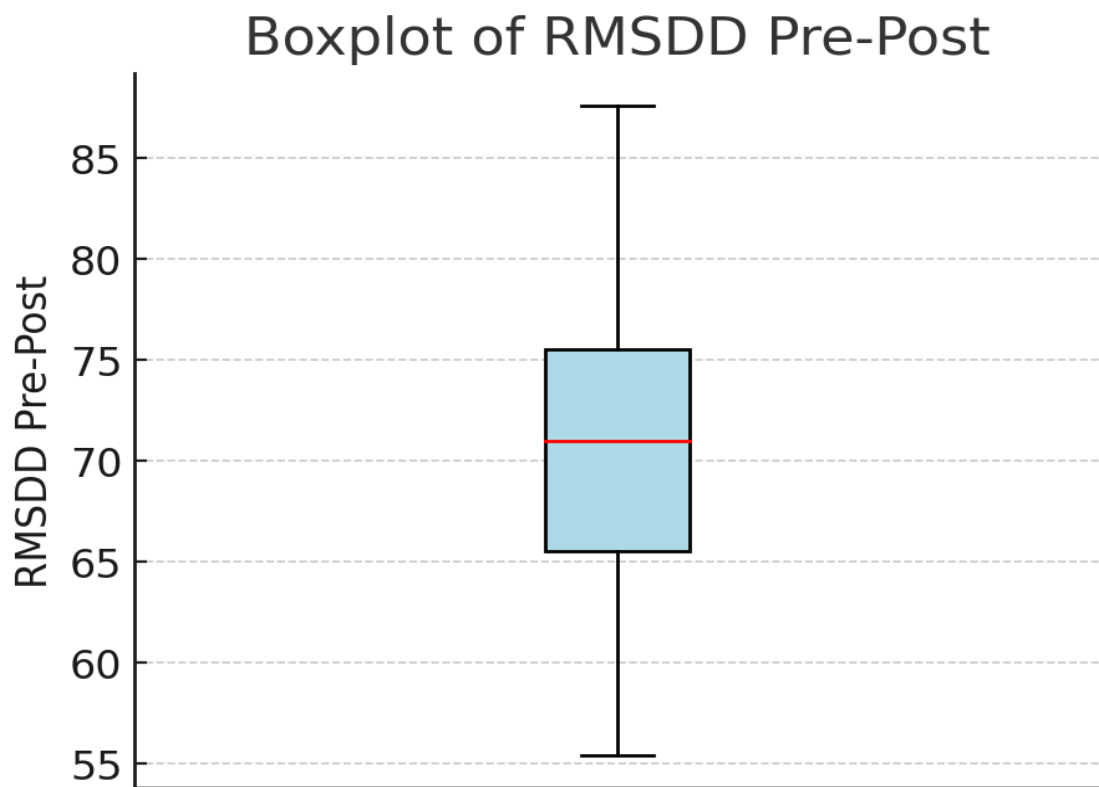
**Figure 14.** Normal Q-Q Plot of Throw Distance (Post-test)



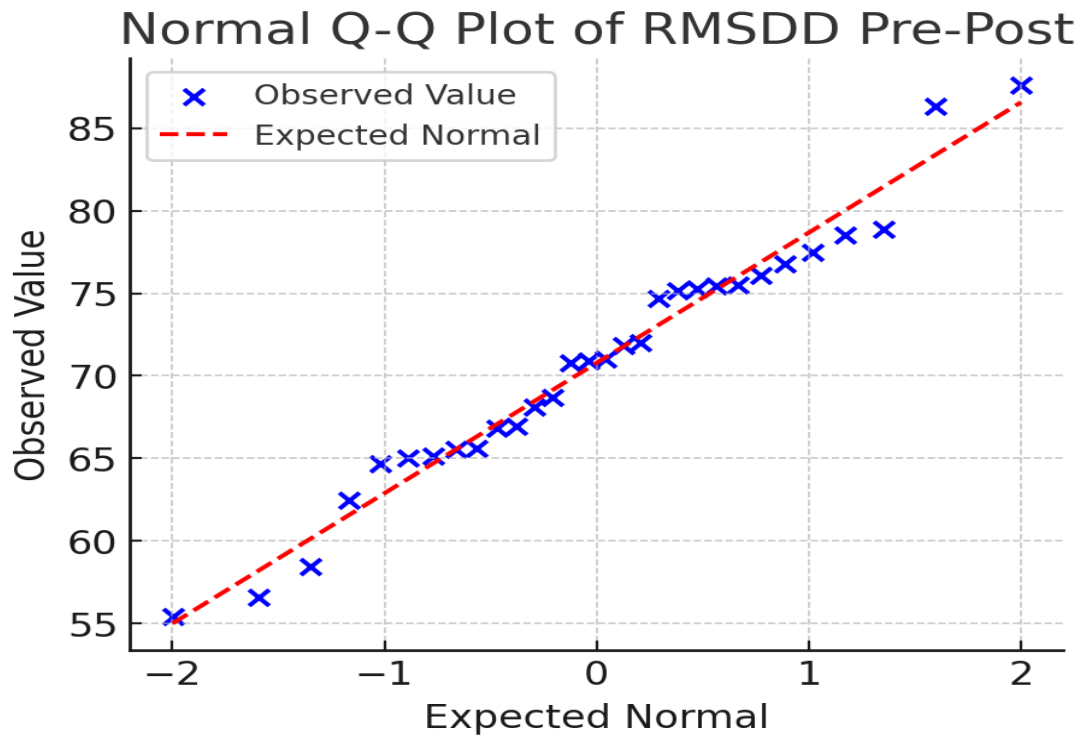
**Figure 15.** Boxplot of RMSDD (Pre-Pre)



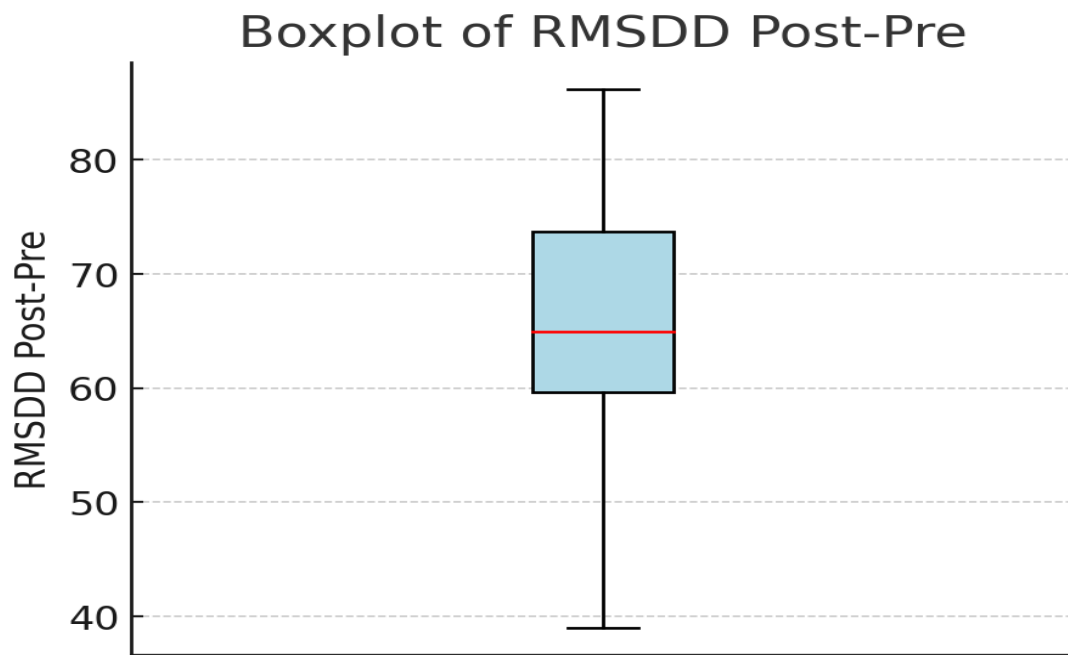
**Figure 16.** Normal Q-Q Plot of RMSDD (Pre-Pre)



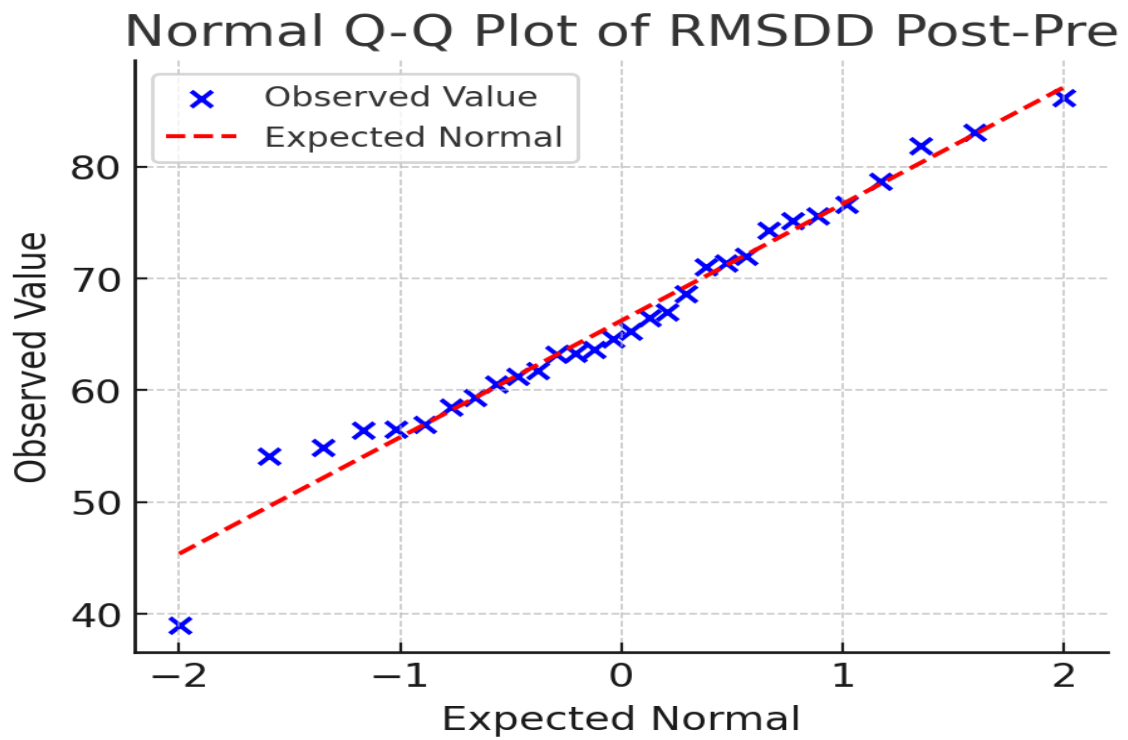
**Figure 17.** Boxplot of RMSDD (Pre-Post)



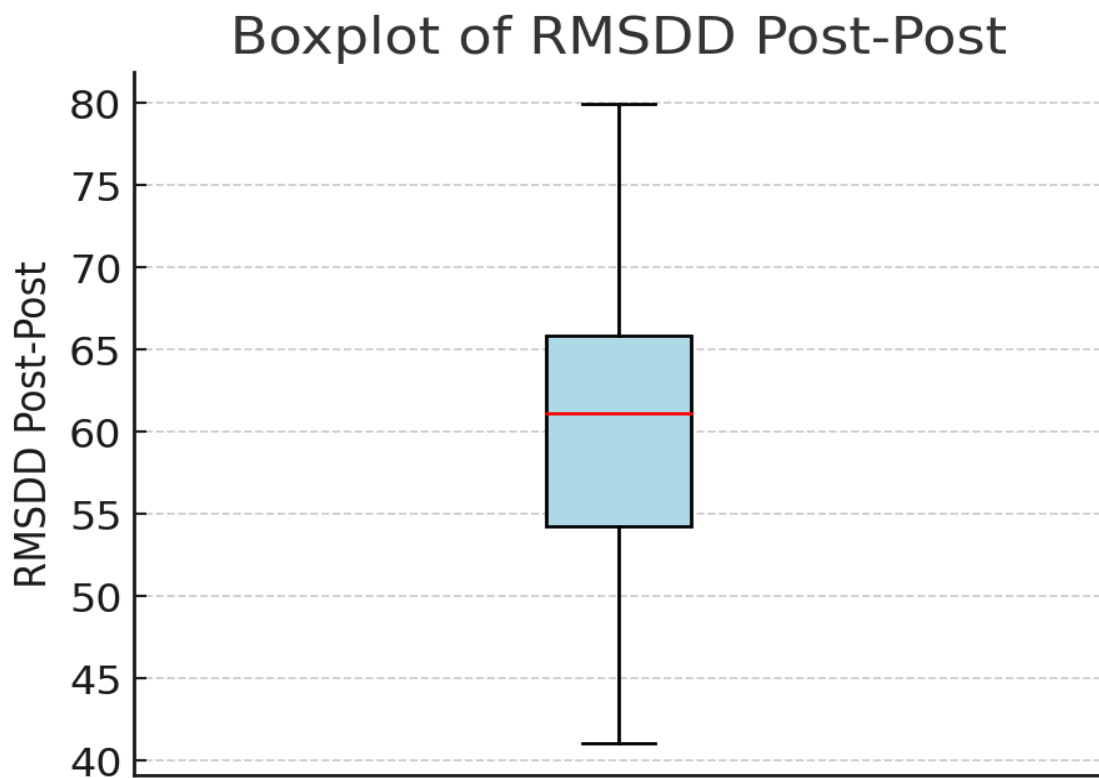
**Figure 18.** Normal Q-Q Plot of RMSDD (Pre-Post)



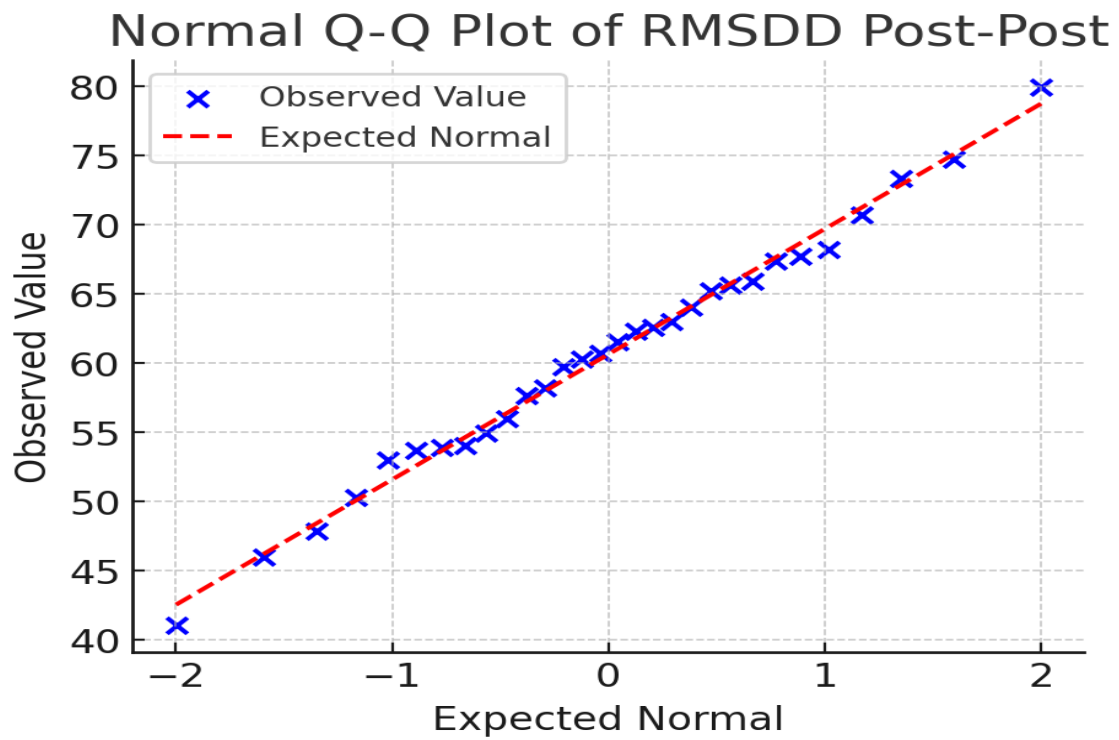
**Figure 19.** Boxplot of RMSDD (Post-Pre)



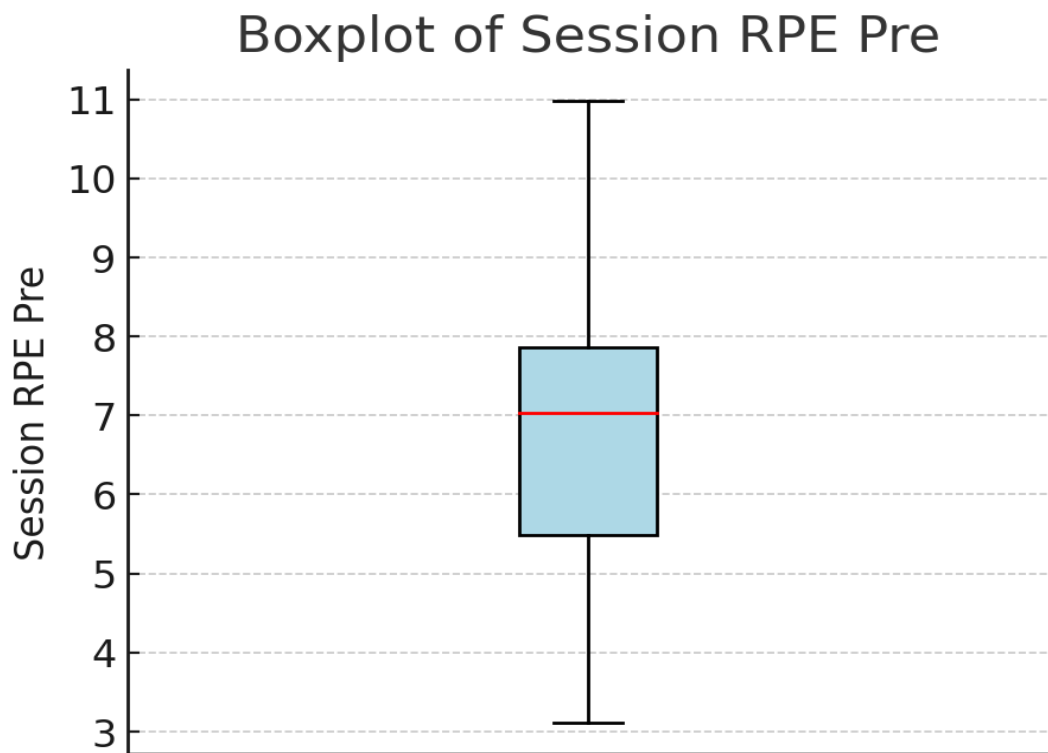
**Figure 20.** Normal Q-Q Plot of RMSDD (Post-Pre)



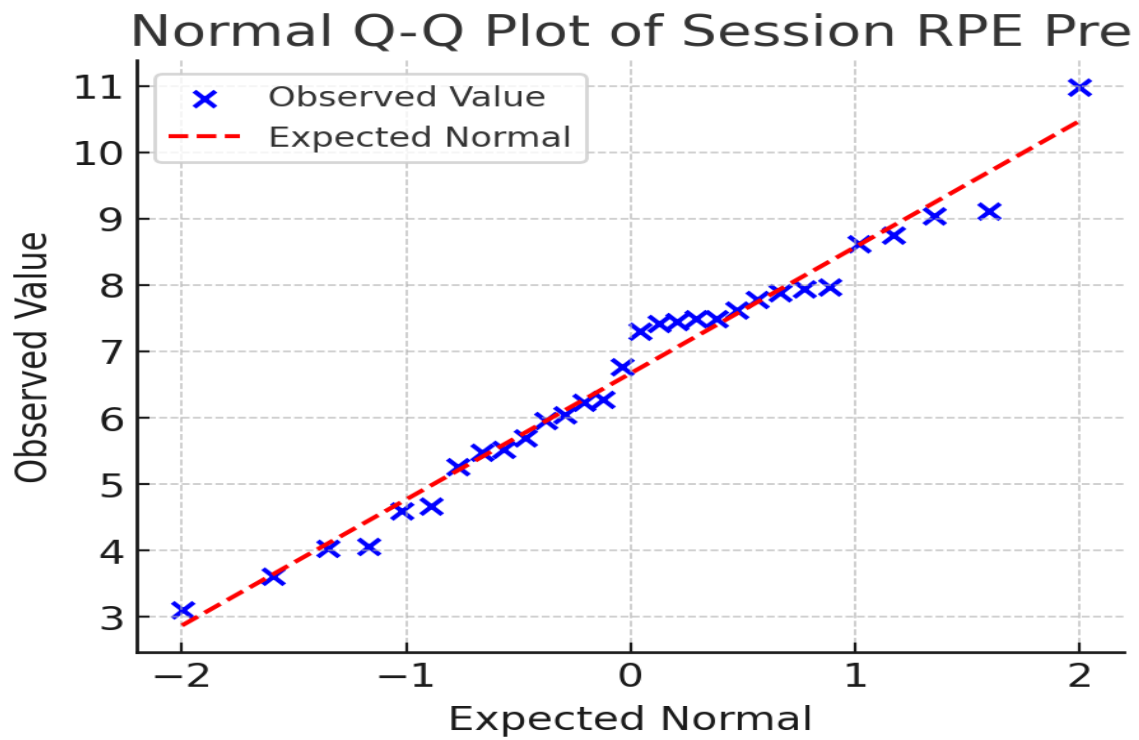
**Figure 21.** Boxplot of RMSDD (Post-Post)



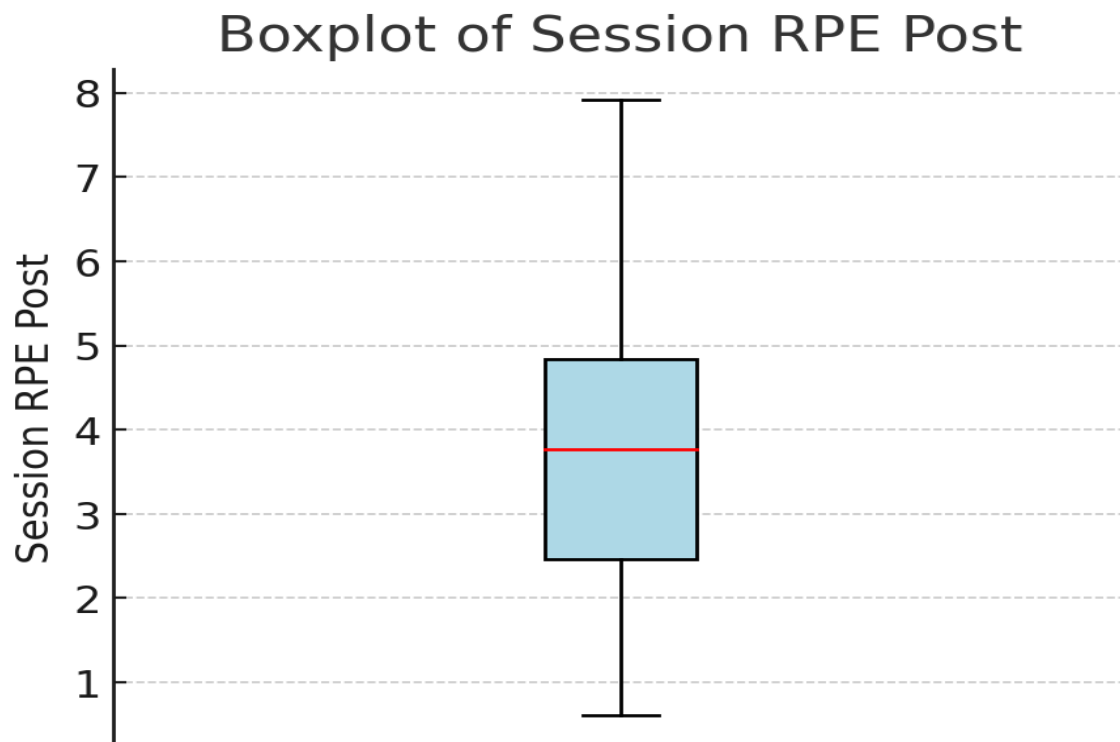
**Figure 22.** Normal Q-Q Plot of RMSDD (Post-Post)



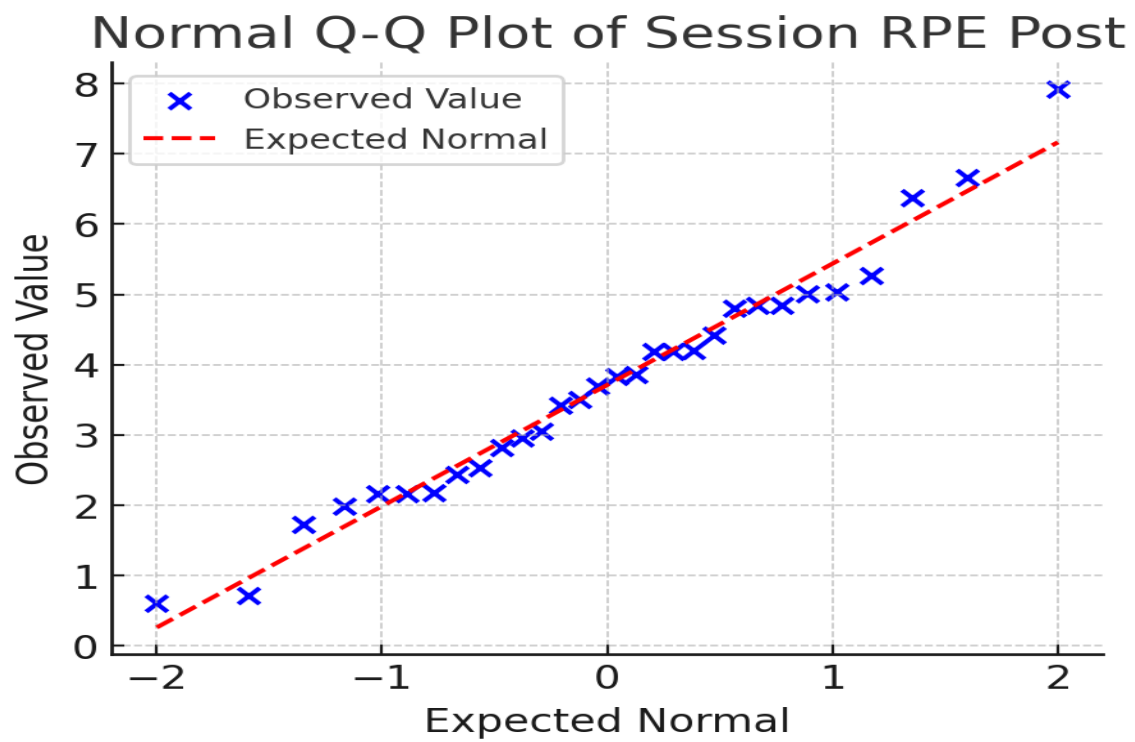
**Figure 23.** Boxplot of Session RPE (Pre-test)



**Figure 24.** Normal Q-Q Plot of Session RPE (Pre-test)



**Figure 25.** Boxplot of Session RPE (Post-test)



**Figure 26.** Normal Q-Q Plot of Session RPE (Post-test)

The results of paired sample t-tests are presented in **Table 4**.

Variable	Mean Difference	t (df=29)	p-value	Interpretation
Bench Press	-5.53	-1.915	0.065	↑ but NS
Throw Distance	-0.85	-7.818	0.000	Significant ↑
RMSDD Pre-Pre vs Pre-Post	20.07	8.687	0.000	Significant ↓
RMSDD Post-Pre vs Post-Post	7.87	3.247	0.003	Significant ↓
Session RPE	1.77	14.253	0.000	Significant ↓

The results statistics are presented in **Table 4**.

- **Bench Press:** Although the mean bench press increased by 5.53 kg from pre- to post-test, the change was not statistically significant ( $t = -1.915$ ,  $p = 0.065$ ).
- **Throw Distance:** Throw distance improved significantly from 5.30 m to 6.15 m ( $t = -7.818$ ,  $p < 0.001$ ), indicating enhanced performance.
- **Peripheral Muscle Fatigue (RMSDD):** Significant reductions were observed in both RMSDD Pre-Pre vs Pre-Post ( $t = 8.687$ ,  $p < 0.001$ ) and RMSDD Post-Pre vs Post-Post ( $t = 3.247$ ,  $p = 0.003$ ), reflecting improved neuromuscular recovery.
- **Session RPE:** The perceived exertion score reduced significantly from 6.00 to 4.23 ( $t = 14.253$ ,  $p < 0.001$ ).

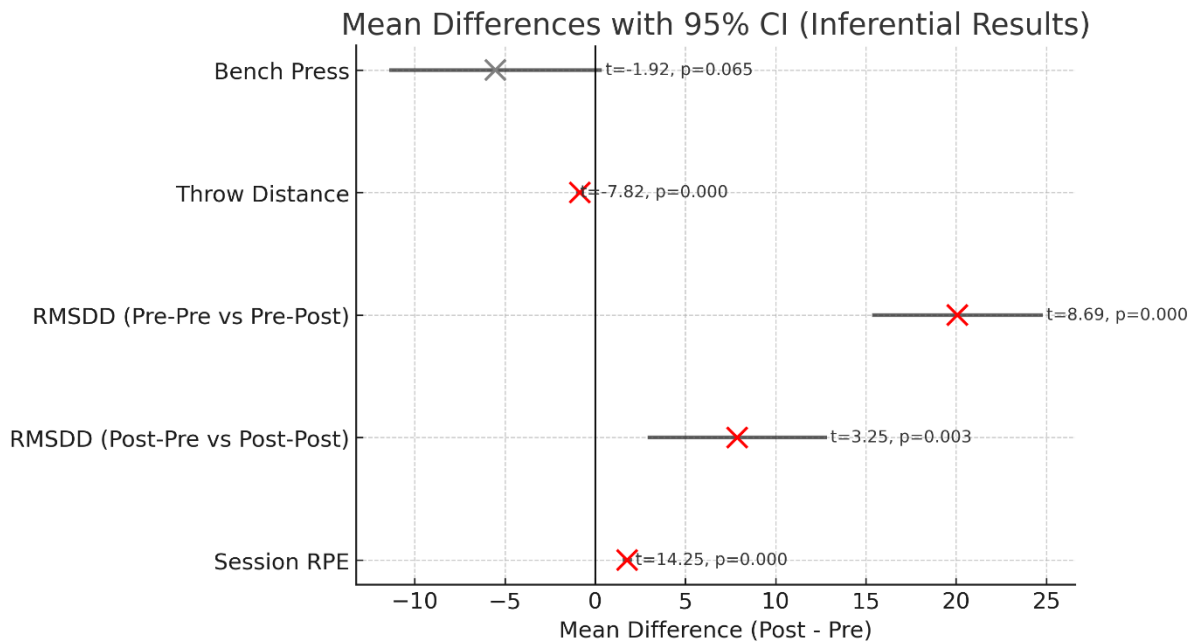
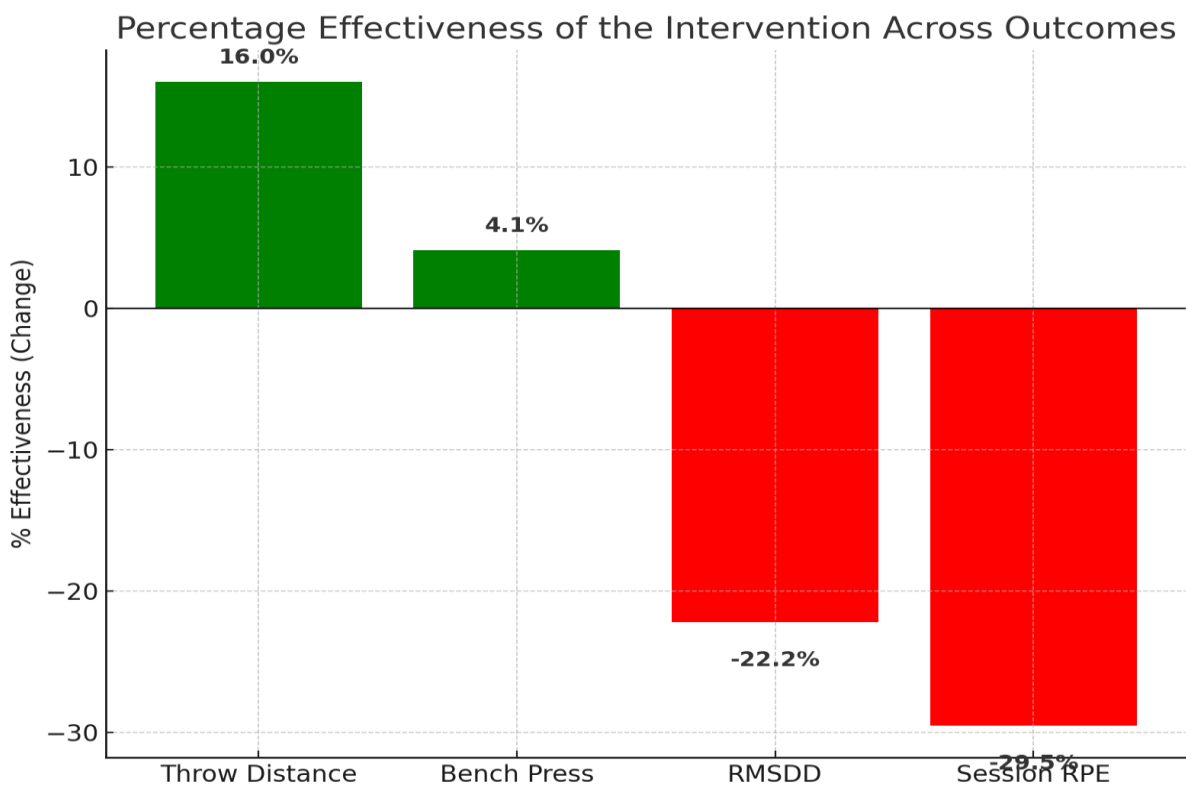


Figure 27. Mean differences (post–Pre) for primary outcomes with 95% confidence intervals. Points show mean differences; horizontal lines indicate 95% CIs. Annotated t and p values are shown to the right of each line. Bench Press showed a non-significant trend ( $t = -1.915$ ,  $p = 0.065$ ). Throw distance, both RMSDD comparisons, and Session RPE showed statistically significant changes ( $p < 0.05$ ).

**Interpretation:** The intervention produced statistically significant improvements in throw distance ( $t = -7.818$ ,  $p < 0.001$ ), reductions in peripheral muscle fatigue as measured by RMSDD ( $t = 8.687$  and  $t = 3.247$ ,  $p \leq 0.003$ ), and lower session RPE ( $t = 14.253$ ,  $p < 0.001$ ). Bench Press increased numerically but did not reach significance ( $t = -1.915$ ,  $p = 0.065$ ). These changes align with the effectiveness table reported earlier (Throw Distance +16.0%; Bench Press +4.1%; RMSDD -22.2%; RPE -29.5%).

Outcome Measure	Mean Pre	Mean Post	Mean Difference	% Effectiveness
Throw Distance (m)	5.30	6.15	+0.85	+16.0%
Bench Press (kg)	134.50	140.03	+5.53	+4.1%
RMSDD	90.50	70.43	-20.07	-22.2%
Session RPE	6.00	4.23	-1.77	-29.5%

**Table 5.** Percentage Effectiveness of the Intervention Across Outcome Measures



**Figure 28.** Percentage effectiveness of the intervention across outcome measures

## **Summary of Results**

“The combined analysis of descriptive and inferential statistics offers a clear picture of the intervention’s impact. While throw distance showed a significant improvement, bench press strength reflected a positive yet non-significant trend. Reductions in RMSDD and session RPE were both statistically meaningful, highlighting improved fatigue regulation and greater tolerance to training stress. Taken together, these findings demonstrate that the integration of German Volume Training with conventional exercise produced beneficial adaptations in elite Rugby Sevens players. This evidence provides a strong foundation for the following discussion, where the practical implications and relevance of these outcomes are examined in greater depth.

# **DISUSSION**

## DISCUSSION

The purpose of this study was to investigate the effects of German Volume Training (GVT) combined with a conventional exercise protocol on throw distance and peripheral muscle fatigue in elite Rugby Sevens players. Rugby Sevens is a high-intensity, collision-based sport that requires athletes to sustain repeated bouts of sprinting, tackling, and skill execution within short recovery windows. Optimal performance depends on a combination of muscular strength, explosive power, endurance, and fatigue resistance. Given these demands, exploring advanced resistance training strategies such as GVT is highly relevant to the conditioning needs of Rugby Sevens athletes. The present findings provide meaningful evidence that GVT can positively influence sport-specific outcomes while enhancing recovery capacity.

### **Throw Distance**

A key finding was the significant increase in throw distance following the intervention. This improvement is likely linked to the hypertrophy- and endurance-oriented structure of GVT, which recruits a high number of motor units and promotes both slow- and fast-twitch fiber development. These adaptations enhance power transfer through the kinetic chain, thereby improving throwing performance. Previous studies in throwing athletes have demonstrated similar results, where targeted resistance training improved velocity and distance (Aka et al., 2020; Zaras et al., 2013). The present study extends these observations to Rugby Sevens, where accurate and powerful lineout throws are critical. This highlights the capacity of high-volume resistance protocols to transfer effectively into rugby-specific technical skills.

### **Bench Press Performance**

Bench press performance demonstrated a numerical increase, though the change did not reach statistical significance ( $p > 0.05$ ). This result may be partly explained by the high baseline strength levels of elite rugby players, who often exhibit a ceiling effect where further improvements are difficult to achieve (Hackett et al., 2018). Moreover, GVT primarily emphasizes hypertrophy and muscular endurance rather than maximal strength gains. Studies comparing traditional strength programs with GVT have reported that maximal strength improvements are greater when moderate volumes are combined with progressive overload (Amirthalingam et al., 2017). In this context, the modest increase in bench press strength observed here may still hold practical value for rugby, where even small improvements in pushing force can influence collisions, rucking, and tackling performance.

### **Peripheral Muscle Fatigue**

Another important outcome was the significant reduction in peripheral muscle fatigue, measured via RMSDD. Rugby Sevens requires players to repeatedly accelerate, tackle, and recover within brief intervals, making fatigue resistance a decisive factor in match performance. The reduction in RMSDD indicates improved autonomic regulation and enhanced neuromuscular recovery, possibly linked to adaptations such as improved mitochondrial efficiency, buffering capacity, and energy utilization (Ni et al., 2022). This finding reinforces earlier research suggesting that structured resistance training contributes not only to strength and hypertrophy but also to improved recovery and resilience in team-sport athletes.

### **Ratings of Perceived Exertion (RPE)**

Session RPE scores decreased significantly post-intervention, suggesting that athletes perceived their workloads as less strenuous despite similar or greater intensities. Lower RPE scores reflect improved physiological efficiency and tolerance to high training volumes, which are critical for elite players exposed to demanding schedules. Reduced subjective fatigue may also contribute to psychological benefits, including increased motivation and better adherence to training programs. These outcomes align with earlier reports that resistance training interventions can reduce subjective exertion levels while enhancing overall workload management (Douglas et al., 2017).

### **Comparison with Previous Literature**

The findings of this study are consistent with research highlighting the multifaceted benefits of high-volume resistance training in athletic populations. While most GVT-related studies have focused on bodybuilding or hypertrophy (Amirthalingam et al., 2016; Hackett et al., 2018), the present results confirm its applicability in elite sport contexts. Similar to studies in rugby and other team sports (Weakley et al., 2019; Argus et al., 2012), this intervention demonstrated improvements in both performance metrics and fatigue management. Notably, this study provides new evidence of the transfer of GVT adaptations to rugby-specific throwing skills, thereby broadening its practical relevance for coaching practice.

### **Practical Implications**

From a practical standpoint, the following recommendations emerge for coaches and practitioners:

1. **Integration into Periodization:** GVT can be strategically implemented during preparatory or hypertrophy phases to build muscular endurance and size before progressing to maximal strength and power training.
2. **Fatigue Management:** The significant reductions in RMSDD and RPE suggest that GVT enhances recovery, but workloads should be closely monitored to prevent overtraining.
3. **Transfer to Sport-Specific Skills:** The marked improvement in throw distance underscores the importance of linking gym-based training with field-based technical practice.
4. **Balanced Training Programs:** Since bench press improvements were not statistically significant, GVT should be complemented with maximal strength protocols and power training to ensure well-rounded performance development.

# **CONCLUSION**

## CONCLUSION

This study set out to explore the effect of German Volume Training (GVT) alongside a conventional exercise protocol on key performance indicators in elite Rugby 7s players. The results provide strong evidence that this training approach is effective in improving throw distance, reducing peripheral muscle fatigue, and lowering athletes' perception of exertion during training sessions. These outcomes highlight the practical value of GVT in preparing players for the demanding nature of Rugby 7s, where repeated explosive efforts and rapid recovery are vital to success.

Although the bench press performance improved slightly, the change was not statistically significant. This outcome could be due to the already high baseline strength levels of elite athletes and the relatively short duration of the intervention. However, even modest improvements in strength can be meaningful in rugby, where upper body force contributes to tackling, scrummaging, and rucking.

The findings also emphasize the dual benefit of GVT in enhancing both performance and recovery. A notable reduction in muscle fatigue and perceived exertion suggests that athletes adapted physiologically and psychologically to tolerate higher workloads more efficiently. This is a crucial advantage in a sport characterized by intense competition schedules and limited recovery time.

Overall, the study demonstrates that GVT, when systematically integrated into rugby training programs, can complement conventional methods and provide measurable performance benefits. For practitioners, the inclusion of GVT within a well-structured periodized plan offers a valuable strategy to support athlete development, improve match readiness, and enhance long-term performance outcomes.

# **LIMITATIONS**

## LIMITATIONS

This study contributes meaningful insights into the effects of German Volume Training (GVT) on Rugby Sevens performance; however, certain limitations must be acknowledged. To begin with, the study used a single-group design without a control group, which makes it difficult to directly attribute all observed improvements to the intervention alone. Other factors, such as concurrent training or natural performance variations, may also have influenced the outcomes.

The sample size was small and restricted to elite male Rugby Sevens players, which narrows the scope of applicability. Results may differ in female athletes, younger players, or individuals at amateur levels where baseline fitness and physiological adaptations are different. Another limitation lies in the short duration of the training program, which may not have been sufficient to capture long-term strength or hypertrophy adaptations. This could explain why bench press performance showed only modest gains and did not reach statistical significance.

The outcome measures chosen—throw distance, bench press, RMSDD, and session RPE—provided valuable information but did not represent the complete spectrum of Rugby Sevens performance. Critical elements such as sprint performance, agility, acceleration, or game-related statistics like tackle success or lineout accuracy were not included. A broader range of measures would have allowed a more comprehensive evaluation of training impact.

Additionally, external influences such as diet, hydration, recovery quality, and psychological stress were not controlled, even though they are known to significantly affect performance and recovery. These uncontrolled variables may have introduced inconsistencies in the data. Recognizing these limitations is essential, as it highlights the areas where future research can build upon and produce stronger evidence.

## **FUTURE SCOPE OF STUDY**

## FUTURE SCOPE OF STUDY

To strengthen the evidence base, future research should focus on addressing the limitations of the present study. Larger and more diverse samples are needed, including both male and female players, athletes at different stages of development, and those from varied competitive backgrounds. Such diversity would enhance the generalizability of findings. The adoption of randomized controlled trial designs would further strengthen conclusions by allowing direct comparisons between GVT and other training approaches.

Extending the duration of the intervention is another important step. Longer training programs, supported by follow-up assessments, would help determine whether the observed benefits—such as improvements in throwing performance and reduced fatigue—are sustainable throughout an entire competitive season. Studies could also evaluate how GVT fits into a periodized training plan, identifying whether it is most effective in pre-season, competition, or recovery phases.

Expanding the scope of performance assessments is also necessary. Alongside throw distance and strength, future research should include sprint times, agility tests, vertical jump performance, and rugby-specific match statistics. This would provide a more complete understanding of how GVT translates into real game performance. Comparative studies examining GVT against or alongside plyometric training, contrast methods, or high-intensity interval training could further clarify the most effective strategies for Rugby Sevens athletes.

Finally, incorporating monitoring of external factors such as nutrition, recovery strategies, and sleep quality would give a more accurate picture of adaptation. Exploring the underlying mechanisms of change—including hormonal responses, neuromuscular activation, and autonomic regulation—would also provide deeper scientific insight. Addressing these aspects will help coaches and practitioners design more evidence-based, well-rounded conditioning programs that meet the demanding requirements of Rugby Sevens.

**CONFLICT OF INTEREST  
STATEMENT**

## **CONFLICT OF INTEREST STATEMENT**

No conflicts of interest were reported by the author(s) in the preparation of this thesis. The author maintains full accountability for the entirety of its content and original composition.

# **SUMMARY**

## SUMMARY

### Introduction

Rugby Sevens places exceptional physical demands on athletes, as players must execute repeated sprints, tackles, and high-intensity movements with very short recovery opportunities. Compared with the fifteen-a-side Rugby Union, Sevens involves fewer players sharing the same pitch, shorter matches, and a considerably faster tempo. This places enormous demands on speed, strength, endurance, and recovery capacity. To meet these requirements, strength and conditioning programs must not only focus on enhancing physical attributes but also improve fatigue resistance and recovery efficiency.

Among the various training methodologies, German Volume Training (GVT) has become notable for its emphasis on high training volume to stimulate muscle growth, strength, and endurance. Traditionally, it involves 10 sets of 10 repetitions performed at around 60% of an individual's one-repetition maximum, with relatively brief rest periods. This structure is intended to maximize muscle activation and create strong mechanical and metabolic challenges. However, limited evidence exists regarding the application of GVT in team sport athletes, especially when combined with conventional rugby-specific conditioning.

This study therefore aimed to evaluate the effect of German Volume Training, combined with conventional training protocols, on throw distance and peripheral muscle fatigue in elite Rugby Sevens players. Secondary outcomes included maximal bench press strength (1RM) and session rate of perceived exertion (RPE).

### Methodology

A single-group experimental design was used, involving thirty elite Rugby Sevens players. All participants were experienced in resistance training and medically cleared for high-intensity exercise.

- Training Protocol: Players underwent a six-week intervention combining GVT (10 × 10 repetitions at ~60% 1RM with 60–90 seconds rest) with conventional rugby conditioning (sprints, plyometrics, and mobility drills). Training was carried out three times per week.
- Outcome Measures:
  - Bench Press (1RM): To evaluate maximal upper-body strength.
  - Medicine Ball Throw: To assess upper-body explosive power (throw distance).
  - Heart Rate Variability (RMSSD): Using a Polar H10 sensor, to measure fatigue and autonomic regulation.
  - Session RPE: Using Borg's CR-10 scale to reflect subjective training intensity.

- Analysis: Descriptive statistics (mean  $\pm$  SD) and paired sample *t*-tests were conducted. Percentage effectiveness was also calculated to determine the magnitude of change. A significance level of  $p < 0.05$  was considered.

## Results

The findings highlighted both performance gains and improved fatigue regulation:

- Throw Distance: Increased significantly from 5.30 m to 6.15 m ( $t = -7.818, p < 0.001$ ), reflecting a 16% improvement in upper-body explosive power.
- Bench Press (1RM): Improved from 134.50 kg to 140.03 kg (mean difference 5.53 kg), but the change was not statistically significant ( $p = 0.065$ ).
- RMSSD: Both comparisons (Pre-Pre vs Pre-Post and Post-Pre vs Post-Post) showed significant reductions ( $p < 0.05$ ), amounting to ~22% overall. This indicated enhanced autonomic regulation and improved fatigue management.
- Session RPE: Decreased from 6.00 to 4.23 ( $t = 14.253, p < 0.001$ ), reflecting a 29.5% reduction in perceived exertion.

## Discussion

The results confirm that combining German Volume Training with rugby-specific conditioning can enhance key performance indicators while improving fatigue resistance.

1. Explosive Power: The significant gain in throw distance underscores the role of high-volume resistance training in enhancing explosive upper-body strength. This outcome is directly relevant to Rugby Sevens, where long passes and lineout throws contribute to competitive success.
2. Maximal Strength: While bench press strength showed a positive increase, the absence of statistical significance suggests that the six-week duration may have been insufficient to elicit large improvements in maximal strength. Prior research (Amirthalingam et al., 2016) also noted that excessively high training volumes may plateau strength adaptations.
3. Fatigue Management (RMSSD): The marked reduction in RMSSD suggests improved neuromuscular recovery and autonomic efficiency. This finding aligns with existing literature on heart rate variability as a valuable indicator of training load and fatigue monitoring. For Rugby Sevens athletes, the ability to recover quickly between matches is a crucial advantage.
4. Training Tolerance (RPE): The reduction in perceived exertion indicates better adaptation to training stress. Lower RPE scores imply that athletes could sustain similar or greater workloads with less subjective fatigue, a vital factor in high-intensity sports.

## **Limitations**

While the findings are promising, several limitations should be noted:

- The single-group design limits comparisons with control groups.
- The short six-week intervention may not fully capture long-term strength adaptations.
- Only male players were studied, limiting generalizability to female athletes.
- Additional rugby-specific measures such as sprint times or agility were not included.

## **Conclusion**

This study demonstrates that German Volume Training, when combined with conventional conditioning, effectively enhances explosive power and fatigue management in elite Rugby Sevens players. Significant improvements were observed in throw distance, autonomic regulation, and perceived exertion, while maximal strength showed a moderate but non-significant increase.

Overall, the intervention provided both performance-related and physiological benefits, highlighting its potential as a valuable training strategy for Rugby Sevens. The findings reinforce the importance of balancing training intensity and recovery while applying high-volume protocols like GVT. Future research should consider longer interventions, larger samples, and inclusion of additional rugby-specific performance metrics to build on these insights.

# **STATEMENT OF FUNDING**

## STATEMENT OF FUNDING

This dissertation was undertaken as part of the academic requirements for the degree of *Master of Physiotherapy in Sports* at *Odisha University of Health Sciences*. The research did not receive any financial assistance or institutional support from the University or any external funding agency. All expenses related to data collection, analysis, and preparation of the thesis were independently managed by the researcher.

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**APPENDIX 1**  
**(CONSENT FORM)**

I have been informed by Mr. Tapas Kumar Mohanty pursuing MPT (Sports) conducting a scientific study guided by Dr. Chinmaya Kumar Patra, Principal, Department of Physiotherapy, ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE (ABSMARI), BHUBANESWAR.

I have no objection regarding the study. I also understand that the study does not negatively affect my health. I understand that the information produced by the study will become a part of the institute's record and will be utilized as per the institute's confidentiality regulations. I am also aware that the data might be used for medical literature and teaching purposes, but all my personal details will be kept confidential.

I am well informed to ask as many questions as I can to Mr. Tapas Kumar Mohanty during the study or later. I wish to discuss my participation and concerns regarding this study with a person not directly involved.

I understand that my assent is voluntary and I reserve the right to withdraw or discontinue participation in the study at any point of time during the study.

I have explained to Mr./Miss/Mrs. \_\_\_\_\_ the purpose of the research, and the procedure required in the language he/she could understand to the best of my ability.

(Investigator)

(Date)

I confirm that Mr. Tapas Kumar Mohanty (Investigator) has explained to me in the language I can understand, the purpose of the study and the procedure.

Therefore, I agree to give my assent for participation as a subject in this study and I will be accountable for the decisions.

(Signature)

(Date)



## ETHICAL CLEARANCE



# 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/2025/181

Date: 12/05/2025

### APPROVAL LETTER APPENDIX- VIII

To,

**TAPAS KUMAR MOHANTY**  
ABSMARI  
273, PAHAL, BHUBANEWAR-752101

**Protocol Title: Effect of German Volume Training Along Conventional Exercise Protocol on Throw Distance and Peripheral Muscle Fatigue in Elite Rugby 7s Player: A Single Group Experimental Study**

Protocol ID.: ABS-IEC-2025-PHY-086

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr **TAPAS KUMAR MOHANTY**

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 26/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	26/04/2025
2	Informed Consent Form	26/04/2025
3	Undertaking form PI	26/04/2025
4	CRF	26/04/2025
5	COI from the Investigators	26/04/2025

The following members were present at meeting held on 26-04-2025

#### 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**



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# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,  
BHUBANESWAR, ODISHA

CDSO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao  
Chairperson

Mr. Chinmaya Kumar Patra  
Member Secretary

Ref. No. ABSMARI/IEC/2025/181

Date: 12/05/2025

MEMBERS
<b>Dr. Smaraki Mohanty</b> Clinician
<b>Dr. Satyajit Mohanty</b> Scientific Member
<b>Mr. Shib Shankar Mohanty</b> Legal Expert
<b>Ms. Annie Hans</b> Social Scientist
<b>Ms. Subhashree Samal</b> Lay Person
<b>Mr. Deepak Ku. Pradhan</b> Scientific Member
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<b>Mr. Gouranga Ku. Padhy</b> <b>Mr. Susant Ku. Raychudamani</b>

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
6	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
7	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

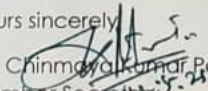
This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

**This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.**

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.


Yours sincerely,

  
Mr. Chinmaya Kumar Patra  
Member Secretary

**ABSMARI Ethics Committee**  
Pahal, Bhubaneswar  
Member Secretary  
**ABSMARI ETHICS COMMITTEE**



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# MASTERCHART

Subject ID	Age	Height (cm)	Weight (lbs)	Bench Press 1RM (lbs)	Throw Distance (m)	RMSD Pre (ms) with 25s mid-high hold	RMSD Post (ms) with 25s mid-high hold	Session RPE	RPE Comment	Recovery Note
1	18	181	90	120	5.3	76	53	4	Moderate effort	Moderate fatigue, rest recommended
2	20	185	86	121	5.3	77	54	9	Very hard	High fatigue, full recovery advised
3	25	183	96	122	5.3	78	55	4	Moderate effort	Recovered well
4	20	191	97	123	5.3	79	56	6	Moderate effort	Moderate fatigue, rest recommended
5	23	185	82	124	5.3	80	57	8	Hard effort	High fatigue, full recovery advised
6	20	186	82	125	5.3	81	58	4	Moderate effort	Moderate fatigue, rest recommended
7	22	182	87	126	5.3	82	59	5	Moderate effort	High fatigue, full recovery advised
8	19	180	91	127	5.3	83	60	8	Hard effort	High fatigue, full recovery advised
9	20	189	82	128	5.3	84	61	5	Moderate effort	Moderate fatigue, rest recommended
10	19	186	92	129	5.3	85	62	9	Very hard	High fatigue, full recovery advised
11	21	181	90	130	5.3	86	63	3	Light session	High fatigue, full recovery advised
12	24	179	100	131	5.3	87	64	6	Moderate effort	Moderate fatigue, rest recommended
13	21	191	92	132	5.3	88	65	3	Light session	Moderate fatigue, rest recommended
14	19	192	92	133	5.3	89	66	8	Hard effort	High fatigue, full recovery advised
15	25	188	84	134	5.3	90	67	5	Moderate effort	Moderate fatigue, rest recommended
16	22	183	98	135	5.3	91	68	8	Hard effort	High fatigue, full recovery advised
17	18	185	97	136	5.3	92	69	8	Hard effort	High fatigue, full recovery advised
18	25	190	95	137	5.3	93	70	3	Light session	Recovered well
19	24	179	91	138	5.3	94	71	10	Very hard	High fatigue, full recovery advised
20	19	187	89	139	5.3	95	72	6	Moderate effort	Moderate fatigue, rest recommended
21	25	189	99	140	5.3	96	73	3	Light session	Recovered well
22	21	186	83	141	5.3	97	74	3	Light session	Moderate fatigue, rest recommended
23	22	180	82	142	5.3	98	75	7	Hard effort	Moderate fatigue, rest recommended
24	21	179	88	143	5.3	99	76	3	Light session	Moderate fatigue, rest recommended
25	22	186	92	144	5.3	100	77	9	Very hard	High fatigue, full recovery advised
26	22	181	90	145	5.3	101	78	3	Light session	Moderate fatigue, rest recommended
27	24	188	90	146	5.3	102	79	8	Hard effort	High fatigue, full recovery advised
28	22	187	83	147	5.3	103	80	10	Very hard	High fatigue, full recovery advised
29	22	178	90	148	5.3	104	81	7	Hard effort	Moderate fatigue, rest recommended
30	21	191	85	149	5.3	105	82	5	Moderate effort	Moderate fatigue, rest recommended

# Tapas Kumar Mohanty

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# Tapas Kumar Mohanty

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