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EFFECTS OF COMBINATION OF UNILATERAL AND PLYOMETRIC EXERCISE IN COMPARISON TO BILATERAL EXERCISE ON PERFORMANCE RELATED COMPONENTS OF MALE KHO-KHO PLAYERS

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Abstract:
Background –A plyometric workout is one that rapidly increases the amount of force a muscle can produce. In order to increase physical capability, such as musculotendinous stiffness and power, plyometric training entails a sequence of explosive body weight resistance exercises that target the muscle fiber's stretch-shortening cycle (SSC) (Dick 2014). If you want to do an exercise activity that requires both limbs to work together, you're doing a unilateral exercise movement. When you exercise one arm or leg at a time, instead than both at once, you are doing unilateral training (Avetisya 2022)".
Aim - The present research aims to examine the impact of unilateral and plyometric workouts on performance-related variables (speed, agility, and power) in male Kho-Kho players, as opposed to a conventional bilateral-based training regimen.
Methodology -Thirty male Kho-Kho players, ages 19 to 24, who were enrolled in Bareilly City colleges, UP ,India were among the participants. They were grouped in three group off and assigned at random to either a bilateral , unilateral , control group eight-week training program. Before and after the eight-week training, there were pre- and post-tests.
Result - The athlete's pre- and post-training test scores on the T-Agility, 50-meter sprint, and double-leg side leap all showed significant improvement after eight weeks of training. Power measured double leg side jump, 50 meter sprint speed, and Agility T-Test for agility were all enhanced in Kho-Kho players who participated in an eight-week offseason strength and conditioning program that included both unilateral and bilateral plyometric exercises.
Key Words – Unilateral, Bi Lateral, Plyometric Exercise

INTRODUCTION

Physical activity is characterized as any bodily movement generated by skeletal muscles that leads to energy consumption. Physical activity in daily life can be classified into occupational, sports, conditioning, domestic, or other types of activities. Exercise is a form of physical activity that is deliberate, organized, and repetitive, with the ultimate or intermediate goal of enhancing or preserving physical fitness (Farley & Stein 2020)
A particular set of attributes inherent to an individual that enables her/him to engage in physical activity with vigor and without excessive fatigue. Certain elements of physical endurance are associated with performance. These six elements—namely, (1) agility, (2) coordination, (3) balance, (4) strength, (5) reaction time, and (6) speed—are employed to assess specific skill sets (Westerterp 2018).
Ferreira (2014) The indigenous people's symbolic patrimonial heritage includes indigenous games. The Latin term "indigena," which meaning "native," is exactly where the word "indigenous" originates. The term "indigenous" actually refers to a particular physical region, which may or may not be very large. This also applies to live things that are born or develop in environments where they truly belong. When it comes to humans, it has a feeling of connection to the first known occupants of a certain location, particularly one that was colonized. The Merriam-Webster dictionary defines indigenous as not simply something that is native, but also something that has never been imported. Therefore, games created in a particular location or culture might be referred to as indigenous games.

Originating from the state of Maharashtra (Marathi Kho-Kho), Kho-Kho is a team sport in which players must avoid physical contact with opponents. The game, originally known as Rathera due to its association with Indian chariots (raths), has developed into a variant of tag, a modified form of "run-and-chase," in which the objective is to pursue, follow, and make contact with the opponent (Saha 2022). Due to the intense and combative character of the game, individual Kho-Kho players need to possess the following qualities: stamina, endurance, strength, and agility, as well as the ability to dodge, feint, and burst into speed. The sport requires endurance and strength, which can be maintained through running, skipping, and weightlifting. Because the game is complex and tactical, players with mesomorphic somatotypes, good muscle development, and superior anaerobic and aerobic fitness outperform other games players (Roy, Ashim 2017). The reason the game has gained popularity is that it only requires wooden posts, string, a measuring tape, and a stop watch, and it still develops strength, stamina, and agility—all of which are put to the test during the game's 45-minute duration.

In India, Kho-Kho is a popular sport, especially in rural regions and educational institutions. It is an economical, easy-to-implement game that requires minimal space and apparatus. Furthermore, it is a game that promotes social skills, cultural values, mental clarity, and physical fitness (Ravindra, Gouda & Virupaksha, 2016). With a sizable and devoted fan base, Kho-Kho hosts numerous competitions and events at all levels, from district to national. The government and the sports authorities have also acknowledged and supported Kho-Kho, and numerous steps have been made to advance and grow the game. For instance, the Kho-Kho Federation of India (KKFI) was established in 1955 with the goals of policing the game, holding both domestic and international tournaments. In order to find and develop young talent, the KKFI has also started a number of initiatives and leagues, including the Kho-Kho Excellence Center, Kho-Kho Premier League, Kho-Kho Talent Hunt, and Kho-Kho Scholarship Scheme.

A unilateral exercise movement involves each limb functioning autonomously to produce the intended motion. Unilateral training refers to any type of movement that involves exercising one limb at a time, rather than both arms or legs simultaneously (Avetisya 2022). Unilateral training involves executing a movement or exercise using only one limb or one leg. Many of our preferred exercises, such as the bench press, involve both extremities executing the same movement simultaneously. Although this can serve as an effective muscle strengthening exercise, it does not accurately simulate movements encountered in real-life situations. Unilateral training entails performing physical exercises with a single limb rather than two. Such exercises ought to be regarded as separate from bilateral, two-limbed exercises. For instance, unilateral squats involve the use of a single limb, whereas bilateral squats engage both legs. A unilateral bench press involves the use of one arm, whereas a bilateral bench press employs both limbs. Depending on the exercise, this may also involve utilizing various apparatus, such as a dumbbell instead of a barbell. Unilateral exercises are frequently incorporated into comprehensive training programs, particularly among professional athletes and sports professionals.

It is typically employed as a supplement to bilateral training rather than as a replacement. Unilateral training can provide numerous advantages, such as enhancing muscle symmetry between the left and right sides of the body, increasing overall equilibrium, and assisting in injury prevention or rehabilitation.

Bilateral signifies "pertaining to both sides." Bilateral coordination involves the simultaneous use of both sides of the body in an activity. A bilateral exercise movement involves the simultaneous contraction of muscles in both extremities to generate force, thereby facilitating the movement of a specified burden (Avetisyan, 2022).

Plyometrics are defined as exercises that allow a muscle to generate maximal force within a brief period. Plyometric training comprises a sequence of explosive bodyweight resistance exercises that utilize the stretch-shortening cycle (SSC) of muscle fibers to improve physical capacity, including increased musculotendinous rigidity and power (Dick, 2014). It is a rapid and forceful movement that involves pre-stretching the muscle-tendon unit, followed by a subsequent more vigorous concentric contraction. This process of muscle elongation followed by swift shortening during the SSC is fundamental to plyometric exercise (Zatsiorsky, Kraemer, Fry, 2020). The SSC process markedly improves the capacity of the muscle-tendon unit to generate maximum force in the minimum possible duration. These advantages have led to the adoption of plyometric training as an intermediary between pure strength development and sport-specific power and speed. Plyometric exercise is a widely utilized training modality aimed at enhancing athletic performance (Chmielewski, Myer, Kauffman, Tillman 2006).

Power is the rate at which labor is performed by the body and can be expressed as the product of force and velocity (Hedrick, 1993).

Strength is the capacity to generate force under specific conditions characterized by body position, the manner of body movement involved in applying force, the type of movement (concentric, eccentric, isometric, plyometric), and the velocity of movement (Harman, 1993).

Speed is the scalar quantity representing the magnitude of velocity, independent of its direction.

Agility is the capacity to rapidly alter the direction of movement while preserving appropriate balance.

Measures and Instruments

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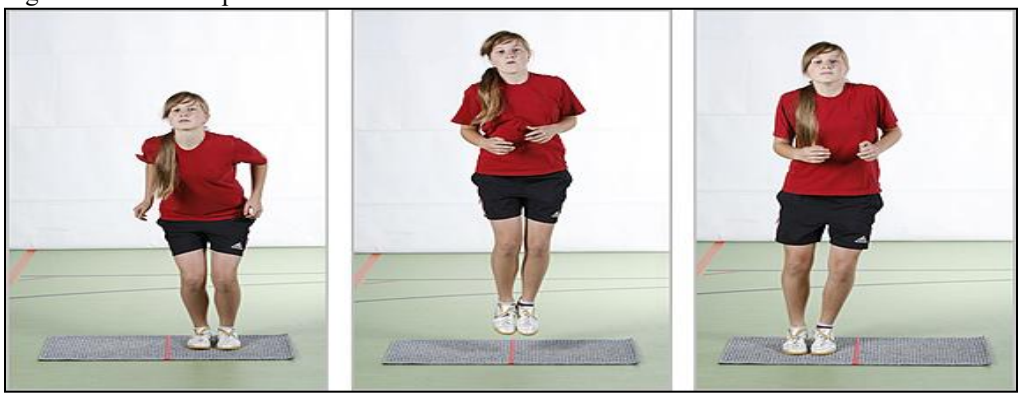
The single leg side jump, which measures power output, the 50-meter sprint, which measures acceleration and maximal sprinting speed, and the T-Test, which measures agility, were the particular variables and tests that were used. A more detailed description of the measurement methods is given below.

Side Jump

For this study, we conducted a side jump test. The players hopped from side to side on both limbs . Hands were placed behind their back. The objective of this test is to alternately leap sideways across the central line of a carpeted platform using both legs simultaneously, as rapidly as possible within a 15-second timeframe. The center line must not be touched or crossed. Five preliminary attempts will be permitted before the commencement of the test. The test subject has two attempts at the examination. There is a one-minute interval between the test attempts. The total number of leaps executed across two valid trials, each lasting 15 seconds, is documented. The mean of both attempts is assessed. Space requirements for side jump: 2 m², including a stopwatch, a non-slip carpet mat (2 cm x 50 cm x 50 cm) with a center line, and double-sided tape or armor tape for securing the carpet mat.

Figure 1- Side Jump



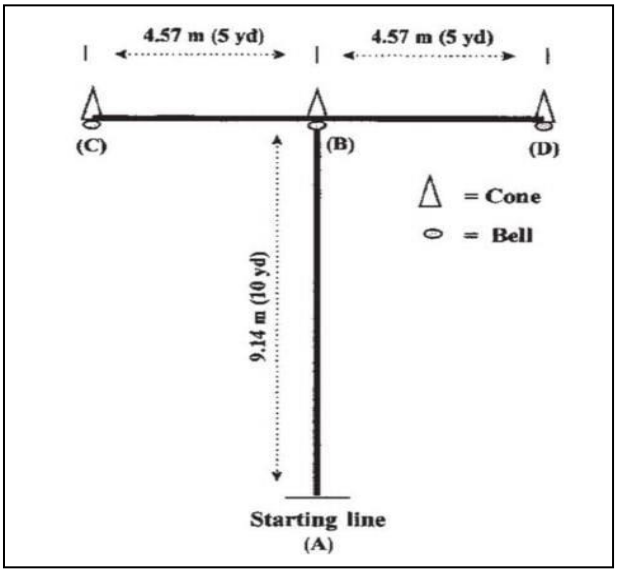
50 Meter Sprint

We employed a stopwatch to measure the speed and agility components of this investigation. In this specific study, the researchers measured a distance of 50 meters across the field and marked it with cones to facilitate the 50-meter sprint measurement. After three sprints, the fastest time was recorded for each student-athlete.

T-Test Agility Test

The T-Test agility assessment was employed to evaluate agility in this study (Figure 2). A widely used assessment recognized for evaluating four-dimensional agility and body control—that is, the ability to rapidly alter directions while preserving balance and speed—is the T-Test. The test is set up in the form of a "T," with three cones spaced five yards apart, and a starting point ten yards away. Beginning at the starting line, the competitors advance 10 yards to touch the cone, shuffle left 5 yards to touch the cone, shuffle right 10 yards to touch the cone, shuffle back 5 yards to the middle cone, and then proceed in reverse.

Figure 2 - T-Test Agility Test



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METHODOLOGY

Study Design

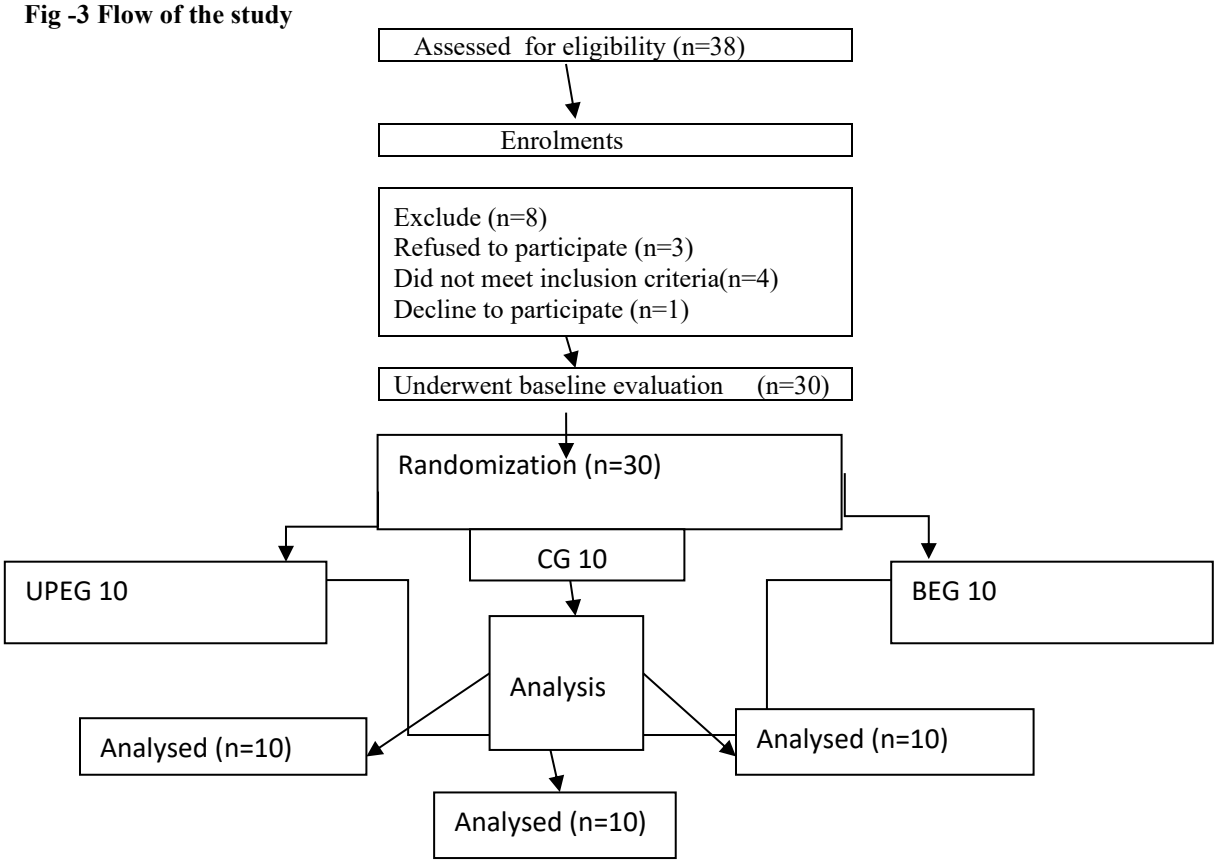
This study employed a quasi-experimental, quantitative design to evaluate two distinct training programs targeting athletes' speed, power, and agility, which have been shown to significantly influence on-field Kho-Kho performance.

Participants

38 male Kho-Kho players, ages 19 to 24, who were enrolled in Bareilly City colleges, volunteered to take part in the study. The predetermined inclusion criteria included having a body mass index (BMI) of more than 25 kg/m2, not smoking, not having any cardiovascular conditions, such as diabetes, not having a history of liver dysfunction, renal impairment, endocrine disorders, or utilizing weight-loss supplements and refraining from consistent, structured physical activity exceeding one session per week. Because they did not fulfill the inclusion criteria, eight participants were excluded from the study.

In our study, participants underwent a comprehensive initial screening procedure, following which they were assigned to one of three groups of n=10 each: unilateral and plyometric exercise group (UPEG), bilateral exercise group (BEG) and control group. The exclusion of eight participants was attributable to their inability to complete the training program due to various personal factors, including time limitations, logistical difficulties in attending the training center, and waning interest in the program. Although this approach departs from the traditional intention-to-treat analysis framework, we consider it essential to maintain the accuracy and reliability of our data. This exclusion has been thoroughly evaluated in relation to the study's internal validity, and we have already implemented measures to prevent participant attrition from adversely affecting the trial's results. Figure 1 further elucidates the progression of the investigation.

Fig -3 Flow of the study



Procedure

Specifically, we assessed force through a double-leg side leap, speed via the 50-meter sprint, and agility using the T-Test Agility Test. All of these variables were evaluated prior to and following the training cycle to measure the outcomes and facilitate comparison between the two groups. We subsequently analyzed the percentage of change between the pre-tests and post-tests across all metrics and identified the training group that exhibited the greatest improvement in relation to their strength and power program. To account for other variables, the player's age, training history, and playing experience were obtained through a questionnaire as supplementary variables.

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The training programs for the unilateral and bilateral groups are outlined below, exhibiting equivalent intensity and duration.

Training Program

The training regimen for this investigation spanned eight weeks and was conducted during the off-season for the Kho-Kho teams. The participants adhered to the designated lifting and plyometric regimens three days per week during the initial four weeks, and subsequently twice per week during the following four weeks, coinciding with the commencement of team Kho-Kho practice. Each training session comprised a comprehensive full-body lift, with the lower body segment performed at the outset of the exercise to ensure participants were more refreshed, given that lower body development has been identified as more essential for Kho-Kho performance. For each training day, the dynamic warm-up routines were identical for both groups and comprised a combination of hip mobility, glute activation, knee stability, and ankle mobility exercises. Upon completion of the dynamic warm-up, the groups transitioned to the primary movements. The movements for the unilateral and plyometric exercise group training programs are detailed in Table 1, while the movements for the bilateral exercise group training program are outlined in Table 2.

Table- 1 **EIGHT WEEK'S PROGRAMME PLYOMETRIC AND UNILATERAL WORK**

20 Yard DYNAMIC WARMUP	Jog - Walking Butt Kick - Walking HighKnee - Skip for Height- Lateral Hop - Arms Extended Rotation - Sprint 10 meter sprint x 5					
DURATION	**PLYOMETRIC EXERCISE**	**SETS**	**REPETITION**	**RECOVERY BETWEEN THE SETS**	**INTENSITY**	**TRAINING METHOD**
1 & 2 WEEK	1. Lateral Jump 2. Burpee 3. Single Leg tuck jump	**3**	**20 - 25**	**120 SECONDS**	**100%**	**Isotonic Method**: Lateral Jump, Burpee; **Isometric Method**: Single Leg tuck jump
3 & 4 WEEK		**3**	**20 - 25**	**120 SECONDS**	**100%**	
5 & 6 WEEK		**3**	**25-30**	**60 SECONDS**	**100%**	
7 & 8 WEEK		**3**	**25-30**	**60 SECONDS**	**100%**	

DURATION	**UNILATERAL EXERCISE**	**SETS**	**REPETITION**	**RECOVERY BETWEEN THE SETS**	**INTENSITY**	**TRAINING METHOD**
WEEK 1 & 2	**1.Trap Bar Deadlifts 2.Bridge / Hip Thrusts 3.Barbell Front Squats**	**3**	**20 - 25**	**60 SECONDS**	**50% to 60%**	**Isotonic Method**: Trap Bar Dead lifts, Barbell Front Squats; **Isometric Method**: Bridge / Hip Thrusts
WEEK 3 & 4		**3**	**20 - 25**	**60 SECONDS**	**60% to 70%**	
WEEK 5 & 6		**3**	**25-30**	**120 SECONDS**	**60% to 70%**	

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WEEK 7 & 8		**3**	**25-30**	**120 SECONDS**	**70% to 80%**	

Note: 1. Before Training Dynamic warm – up and after training cool – down is compulsory.
2. Slightly Changes in load and volumes according to the fitness level of the subjects.

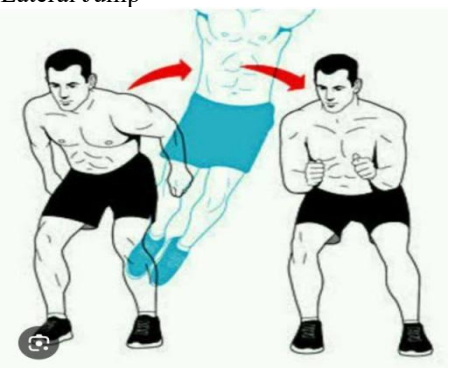
Table 2 **EIGHT WEEK'S PROGRAMME BILATERAL WORK**

20 Yard DYNAMIC WARMUP	Jog - Jumping Jacks- Walking Knee Hugs- Lunges with a Twist - Lateral Hop - Arms Extended Rotation - Sprint 10 meter sprint x 5

DURATION	**UNILATERAL EXERCISE**	**SETS**	**REPETITION**	**RECOVERY BETWEEN THE SETS**	**INTENSITY**	**TRAINING METHOD**	
WEEK 1 & 2	**1.Push-Ups 2.Pull- Ups 3.Over Head Press**	**3**	**20 - 25**	**60 SECONDS**	**100%**		
WEEK 3 & 4		**3**	**20 - 25**	**60 SECONDS**	**100%**		
WEEK 5 & 6		**3**	**25-30**	**120 SECONDS**	**100%**	**Isotonic Method**	**Push-Ups** **Pull- Ups** **Over Head Press**
WEEK 7 & 8		**3**	**25-30**	**120 SECONDS**	**100%**		

Note: 1. Before Training Dynamic warm – up and after training cool – down is compulsory.
2. Slightly Changes in load and volumes according to the fitness level of the subjects.

Table 3- Unilateral and Plyometric exercise group training programme

Unilateral exercise	Plyometric exercise
Trap Bar Deadlifts 	Lateral Jump 
Glute Bridge / Hip Thrusts	Burpee

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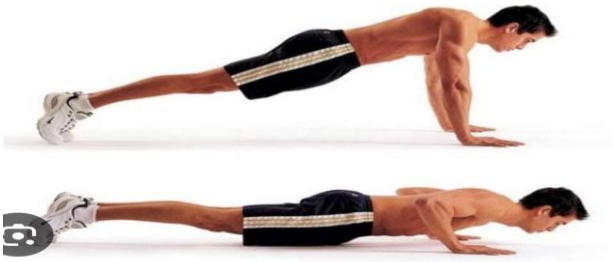
Barbell Front Squats

Single Leg tuck jump

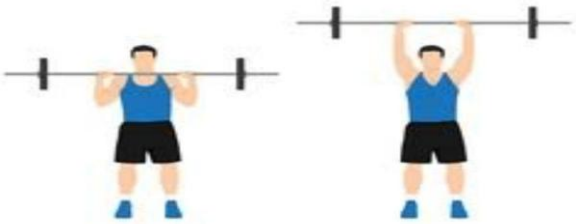
Table 4- Bilateral exercise group training programme

Push-Ups



Pull- Ups

Barbell front Squat



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DATA ANALYSIS

The subsequent data analysis methods were employed. Initially, a descriptive data analysis was performed to summarize the player's background, performance metrics, and the normality and variability of the variables. Secondly, a correlation analysis was performed to assess the degree of association among the dependent variables—agility, power, and speed.

RESULTS

The purpose of this study was to compare the effects of a unilateral plyometric exercise group (UPEG), a bilateral exercise group (BEG), and a control group when incorporated into an offseason training program for collegiate Kho-Kho players. It was hypothesized that a unilateral and plyometric exercise program would enhance power as measured by double-leg side leaps, speed in the 50-meter sprint, and agility in the T-Test relative to a bilateral exercise group employing a bilateral-based program and a control group.

Prior to the experimental treatment, all subjects were assessed in performance-related fitness components, including agility (T-Test agility test) and speed (50 M Run), which constituted the pre-test scores. Following the eighth week, all three groups were assessed on the designated variables, resulting in post-test scores. The control group did not receive any training. The difference between pre-test and post-test scores was regarded as the effect of the chosen experimental treatments. To assess the statistical significance of the difference, the pre- and post-test scores of all three groups were analyzed using ANCOVA. In all instances, a significance level of 0.05 was employed.

Table 5 The ANCOVA results for the study variables

Training Groups	Variables		Pre test			Post test	
		Mean	SD	F ratio	Mean	SD	F ratio
UPEG	Speed	7.73	0.43	1.38*	7.78	0.43	1.89*
BEG		7.76	0.48		7.83	0.37	
CG		7.69	0.53		7.70	0.52	
UPEG	Power	1.45	0.23	2.39 *	1.52	0.22	2.40*
BEG		1.49	0.29		1.51	0.27	
CG		1.43	0.25		1.43	0.25	
UPEG	Agility	10.42	0.58	2.90*	10.67	0.68	2.94*
BEG		10.56	0.54		10.71	0.51	
CG		10.48	0.42		10.48	0.42	

Figure 4. Side Jump results in meter pre and post-test following the 8 week

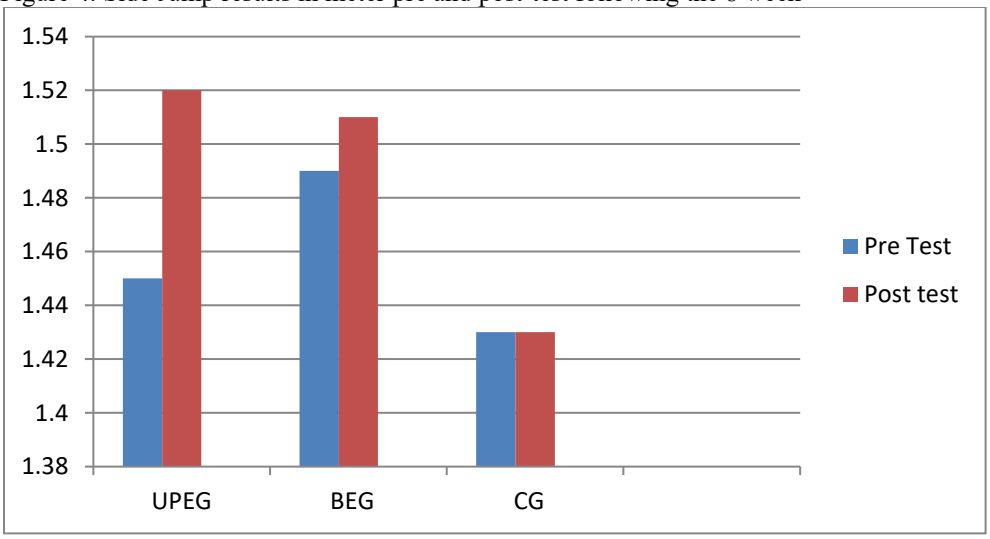


Figure 5. 50 meter sprint (seconds) pre and post-test following the 8 week

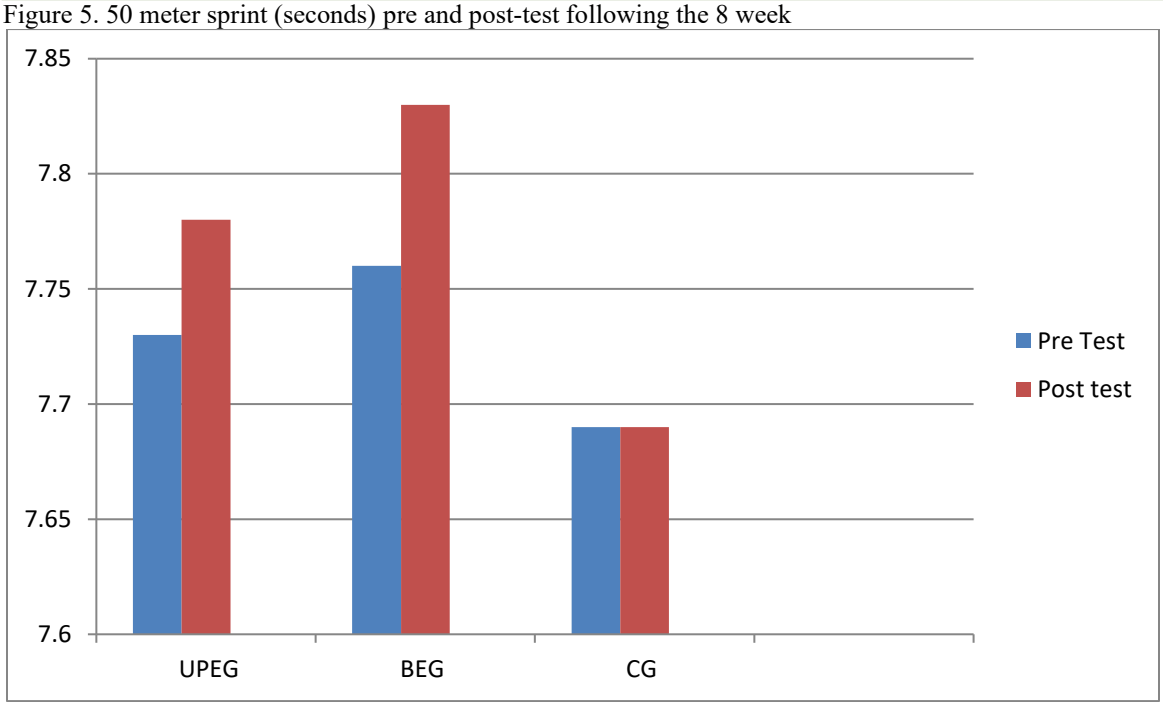
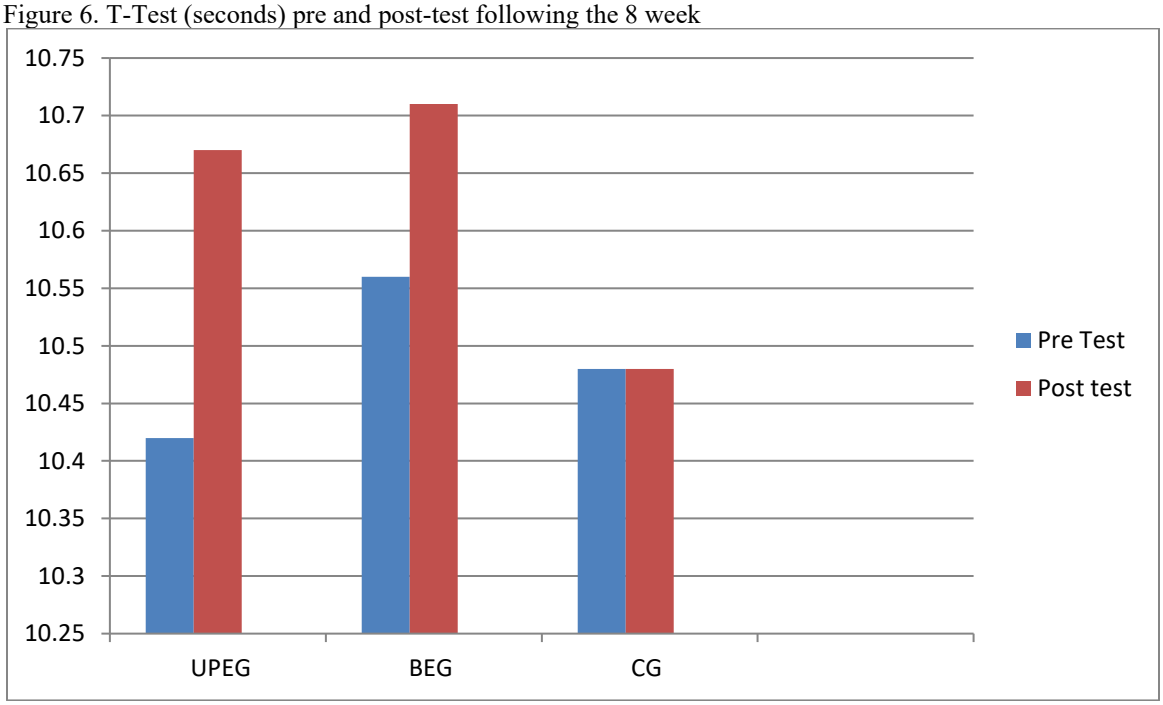


Figure 6. T-Test (seconds) pre and post-test following the 8 week



The data indicates that the pre-test means (M) and standard deviations (SD) for the speed of UPEG, BEG, and CG were 7.73 ± 0.43, 7.76 ± 0.48, and 7.69 ± 0.53, respectively. The obtained F ratio was statistically significant, indicating a meaningful difference among the group means at the initial stage. The post-test mean and standard deviation for the speed of UPEG, BEG, and CG were 7.78 ± 0.43, 7.83 ± 0.37, and 7.70 ± 0.52, respectively. The calculated F ratio of 1.89 indicated a significant difference among the group means following the experimental treatment.

The data indicates that the pre-test mean (M) and standard deviation (SD) for the potency of UPEG, BEG, and CG were 1.45 ± 0.23; 1.49 ± 0.29; and 1.43 ± 0.25, respectively. The obtained F ratio was statistically significant, indicating a meaningful difference among the group means at the initial stage. The post-test mean and standard deviation for the speed of UPEG, BEG, and CG were 1.52 ± 0.22; 1.51 ± 0.27; and 1.43 ± 0.25, respectively. The

calculated F ratio of 2.40 indicated a statistically significant difference among the group means following the experimental treatment.

The data indicates that the pre-test mean (M) and standard deviation (SD) for agility in UPEG, BEG, and CG were 10.42 ± 0.58; 10.56 ± 0.54; and 10.48 ± 0.42, respectively. The obtained F ratio was statistically significant, indicating a meaningful difference among the group means at the initial stage. The post-test mean and standard deviation for the speed of UPEG, BEG, and CG were 10.67 ± 0.68; 10.71 ± 0.51; and 10.48 ± 0.42, respectively. The obtained F ratio of 2.94 indicated a statistically significant difference among the group means following the experimental treatment.

SUMMARY

The results of the eight-week intervention, utilizing both unilateral and bilateral lifting and plyometric programs, demonstrated improvements across all performance measures, including side jump, 50-meter run, and T-test. Both UPEG and BEG demonstrated improvements in power, speed, and agility relative to the control group. There were significant differences between the pre-test and post-test, indicating that a training program involving unilateral plyometric exercises and bilateral exercises was effective in enhancing force, speed, and agility.

CONCLUSION

The primary findings of this study indicate that incorporating unilateral plyometric exercises alongside bilateral exercises within a comprehensive eight-week offseason strength and conditioning program can enhance power, as measured by double-leg side jumps, 50-meter sprint speed, and agility assessed through the T-Test for Kho-Kho players.

RECOMMENDATION FOR FUTURE RESEARCH

Future studies involving a unilateral training-based lifting and plyometric program for Kho-Kho players, or any athlete, should take into account the following factors in light of the investigation's findings. First, the training program's duration needs to be extended.

Secondly, the frequency of exposure to unilateral (as opposed to bilateral) training should be increased in future research.

Third, different exercises with comparable movement patterns—the only distinction being whether they involve a single or double leg variation—should be used in future studies.

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