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CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 15, Issue, 08, pp.4894-4901, August, 2024

International Journal of Recent Scientific Research

ISSN: 0976-3031

RESEARCH ARTICLE

THE EFFECT OF EIGHT WEEKS PROPRIOCEPTIVE TRAINING ON DYNAMIC BALANCE AND EXPLOSIVE POWER OF MALE KHO-KHO PLAYERS

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DOI: http://dx.doi.org/10.24327/ijrsr.20241508.0922

ARTICLE INFO

Article History:

Received 16th July, 2024
Received in revised form 2nd July, 2024
Accepted 19th August, 2024
Published online 28th August, 2024

Key words:

Proprioceptive training, dynamic balance, explosive power, Kho-Kho.

ABSTRACT

Background: Poor balance ability and lack of explosive power is a predictor of injuries of the lower extremity. Recent scientific researches support the benefits of Proprioceptive training on various dynamic balance and explosive power of leg which increases the performance of the players and reducing the risk of lower extremity injuries in players. ***Objective***: To find out the effect of eight weeks (5 days/week) Proprioceptive training (PT) on dynamic balance and explosive power of leg in male Kho-Kho players. ***Methods***: Fifty male National kho-kho players were selected for the study. Subjects were randomly divided into experimental group (EG) (N = 25) and control group (CG) (N = 25). Dynamic balance (DB), the explosive power of leg (EPL), were measured before and after the intervention. ***Results***: The significant effect of proprioceptive training program was observed ($p < 0.05$) in Dynamic balance (DB) (respectively; 12.54 %, $P < 0.000$; $F < 264.85$; $\eta 2 = .84$ and Endurance and explosive power of leg (EPL), (respectively; 12.55 %, $P < 0.000$; $F < 34.57$; $\eta 2 = .42$ ***Conclusion:*** In conclusion, the 8 - week proprioceptive training (PT) program used in this study was very effective for producing significant benefits to fitness level performance and Dynamic balance, as well as lowering the weight of male Kho-Kho players.

INTRODUCTION

Kho-Kho is a traditional indigenous game, popular in South-Asian countries, and now is also played in South Africa. In rural India, there are clubs and bodies which organize training programs for Kho-Kho and the player's participation in several competitions. The players are at higher risk of injuries as the game requires jumping and cutting (quick direction change) movements, than the players of other games. It has been observed that there is an increasing number of dropouts from the training sessions, due to fear of injuries and it causes loss of participation and fitness. Kho-Kho is a tough game that requires frequent sprints, quick run from a sitting position, lunges, quick changes of direction and dive, anticipation, peripheral alertness, and awareness of the relative position of the body. The mechanism of injury in the Kho-Kho player may be due to sudden, quick, and fast movement which may reduce knee proprioceptive ability, and peripheral motor coordination.

Kho-Kho players require a high level of dynamic balance (DB) during quick movements around the playfield, may it be offensive or defensive play. Balance can be explained as the capacity of individuals to perform an activity in stable conditions while keeping a smaller base of support. Balance can be categorized into static and dynamic (Winter, Patla & Frank, 1990). Dynamic balance is the mechanics that is concerned with the effects of forces on the motion of a body, it is the ability to balance while in motion or switching between positions. The DB enables individuals to maintain a stable base of support during vigorous movement (Ganesh,2012).

Explosive power is the ability of the body to act against resistance with speed. Explosive power is measured by standing broad jump (SBJ) which compels the body to cover maximum range through the projection of the body. SBJ is a body projection skill which largely depends on the principle

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of transfer of momentum (thrust developed by the body parts in the direction of projection) followed by the impact of propulsive forces generated by the body (Holm et al. 2004). Jumping is a projection skill, the body movements are governed by the majority of muscles. Shoulder girdle & trunk facilitated by shoulder flexors & shoulder elevator muscles are the major muscles involved in arm swing. Hip extensors (Gluteus maximus), knee extensors (Quadriceps), ankle extensors, knee flexors (hamstring) & toe flexors (Gastrocnemius) are the muscles involved in body projection (Nelson, Chambers, Mcgown, & Penrose,1986).

Proprioception metaphorically is considered as the sixth sense, extending the classical five senses in the body. This body sense is more than just a feeling of movement. It is intimately tied to our feeling of muscle tone, perception of effort, and, most importantly, our perception of balance. Proprioception is the awareness of posture, movements & changes in equilibrium as well as the knowledge of position, weight & resistance to objects in relation to the body. It is the conscious awareness of limb position & movement, it is also a variety of sensory modality which lead to joint movement & position sense of joint (Lephart, Giraldo, & Borso, 1996), the ability of the body to transmit position sense, analyze it & react accordingly with the proper movement, it is also referred as a collection of sensations concerned with joint movement (kinesthesia) and joint position, sability to predict the respective limb's position without the assistance of vision (Ogard Hamlyn, Behm, & Young, 2007). Acquiring a comprehensive understanding of proprioceptive function is important because of its great contribution in rehabilitation of the sports injuries, and its beneficial effect on athletic conditioning and performance (Nuzzo, McCaulley, Cormie, Cavill, & McBride, 2008). The preventive aspect of the training needs more attention.

Proprioceptive training (PT) includes an exercise on stable and unstable surfaces. Exercise on unstable surfaces, like Swiss ball, wobbler board and BOSU ball are given preference to increase the neuromuscular stress in the core muscles along with stable surface in last few years (Cosio-Lima, Reynolds, Winter, Paolone, & Jones, 2003; Norwood, Anderson, Gaetz, & Twist, 2007) which puts greater proprioceptive demands and stress the muscles to a greater extent (Lehman, Gordon, Langley, Pemrose, & Tregaskis, 2005; Sundstrup, Jakobsen, Andersen, Jay, & Andersen,2012), along with stable surface (Marshall & Murphy, 2006; Behm & Colado Sanchez, 2013). Studies have reported enhanced core muscle activation on an unstable surface compared to a stable surface (Behm & Colado Sanchez, 2013). Instability conditions can impair force, power, and movement velocity while maintaining similar or providing greater core and limb muscle activation. To exert explosive power, a stable base and strong core are necessary Thus, IRT is highly recommended for youth, elderly, and recreationally active individuals and can be judiciously implemented into the training programs of highly trained athletes; e.g. warm-ups and lower load phases of the periodized program (Neilson & Jenson, 1972). Hence, due to the prevalence of injuries among Kho-Kho players and the significance of dynamic balance and explosive strength in preventing injuries, this study aimed to investigate the effect of eight-week PT on the dynamic balance explosive strength of Kho- Kho players.

The proper intervention program is needed to improve fitness levels to achieve the optimal performance of the kho- kho players. The main objective of this research was to investigate the effect of eight-week proprioceptive training (PT) on dynamic balance and explosive power of leg (EPL) in male kho-kho male players of the team. The study assumes that PT can be effective tools for kho-kho players to increase the fitness level and reduce sports injuries, through different proprioceptive exercises.

METHODS

Subjects

Fifty male players who represented the State/ National level competition in Kho-Kho games were randomly selected. The subjects were randomly divided into two groups: experimental group (EG = 25), age (y) = 15.9 ±1.50, height (cm) = 155.49 ±1.11 and body weight 46.13 ±1.73 before training and 44.12 ±1.69 kg after training and control group (CG=25) age = 15.6±1.63 years: height (cm) = 156.8±1.00 cm, weight = 45.8±1.88 kg before experiment and 45.4±1.88 kg after experiment (Figure 1). The PT was scheduled daily from 6.30 to 7.30 am at the Kho-Kho academies, Bhilai, Chhattisgarh, India. The ethical committee of the university approved the study. Before the commencement of the PT program, the players were informed about the aim and methods of the research and agreed with their participation in the research and the use of observed data for research purposes.

Table 1 Physical characteristic of subjects

Variables Experimental Group (n = 30) Control Group (n = 25)

	Before	After	Before	After
Stature (cm)	155.49 ±1.11	--	156.8±1.00	--
Body Weight (kg)	46.13 ±1.73	44.12 ±1.69	45.8±1.88	45.4±1.88
Age(years)	15.9 ±1.50	--	15.6±1.63	--

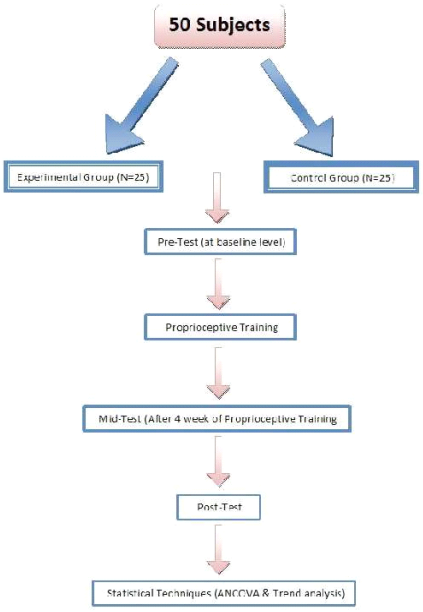

Figure 1 Flow chart for Eight week proprioceptive training

Dynamic balance (DB)

DB was measured by Johnson's modified bass stick test. Eleven pieces of colored marking tape of ¾ x 1-inch size were cut & pasted on the floor at the starting point. The starting line of 15 inches & total 10 blocks of ¾ x 1 inch was placed on the ground. One block was placed in the center of the starting line, two other blocks were placed at the distance of 90 inches & 180 inches from the block placed at the center of the starting line. Four blocks were placed at both the sides of central point of the central line at the distance of 30 inches, then after 60 inches gap again four blocks were placed at both sides of the central point of the centerline at a distance of 30-30 inches. (Figure 2). After marking the required area tester gave the instructions & demonstration with the help of a trained helper with good dynamic balance. The subject was asked to stand on his dominant foot on the starting tape marked & asked to start leaping on the first tape marked with the alternate foot. The subject was required to maintain a steady balance on the ball of the leaping foot as long as possible up to a maximum of 5 seconds, again the subject was asked to leap with other foot on the second tape marked. The subject repeated the process up to the last (10th) tape mark. The subject was instructed that the foot must cover the tape mark completely in such a way that it should not be visible to the tester. Maximum score 100 (5 points for correct landing at each tape mark and 1 point for every second of maintaining balance on the ball of the concerned foot up to a maximum of 5 seconds) were given.

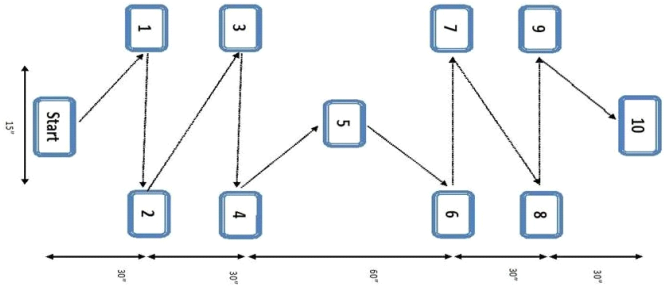

Figure 2 Course for modified modified bass stick test

Explosive power of leg (EPL)

EPL was measured by standing broad jump test SBJT. The subject stands behind a line marked on the ground with feet slightly apart. A two feet take-off and landing area are used, subjects were instructed to perform with the swinging of the arms and bending of the knees to provide forward drive. The subject attempts to jump as far as possible, landing on both feet without falling backward. The longest distance jumped, out of three attempts was recorded. The measurement is taken from the take-off line to the nearest point of contact on the landing (back of the heels). The best distance jumped was recorded out of three trials in centimeter. The ICC of the test was 0.97 (Dugdale,2018).

Proprioceptive training (PT)

PT for the present study was the independent variable. The PT program was constructed for 5 days/week, once/day, and was given to all the selected subjects for 8 weeks. All the selected parameters were assessed before the intervention of the training program i.e. at a baseline level, after 4 weeks & finally after 8 weeks of the training program. The total duration of each session was 45 minutes. Repetition exercise started with 10 repetitions /day which was increased to 2-5 repetitions /day & for timed exercise, started from 30 seconds hold which was increased by 10 seconds/day, until 30 repetitions and 60 seconds hold for each exercise were obtained till the last day of the week. 10-15 minutes of warming up session were prepared before the commencement of the training program so that the body is prepared for the training. The progression of training load (exercise) was followed according to the principles of training i.e. it was increased gradually concerning the principle of load adaptation. The control group was performing a conventional warm-up with the other strength and conditioning coach during the whole intervention program

Figure 3 Proprioceptive training exercises Statistical Analysis

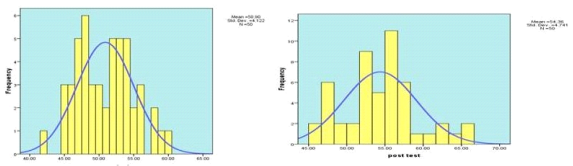

Figure 4. Shows normal distribution of data for Pre-test & Post-test observations of Dynamic balance performance

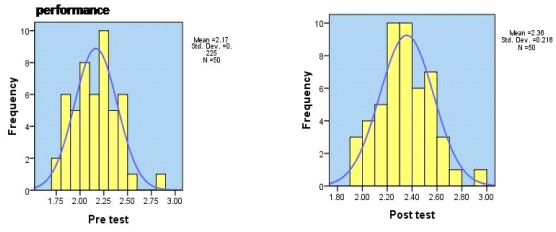

Figure 5. Shows normal distribution of data for Pre-test & Post-test observations of explosive power of leg

Table 2 Weekly Proprioceptive training Program

Week	Surface	Eyes	Exercises	Repetition	Set/time of Hold
Week 1	*Floor*	*Open* *Open* *Open* *Open*	*Single leg stance* *Single leg stance while swinging the raised leg (flexed knee)* *Forward & Backward leg swing with knee extended on single leg stance* *Single Leg Squat*	*03 Rep (20-30 Sec. rest/rep)* *10-20 Rep (20-30 Sec. rest/rep)* *10-20 Rep (20-30 Sec. rest/rep)* *03 Rep (20-30 Sec. rest/rep)*	*30-120 Seconds Hold* *2 Sets/ Leg* *2 Sets/ Leg* *30-120 Seconds Hold*
Week 2	*Floor*	*Open*	*Toe Walking*	*02 Rep (20-30*	
		Open	*Heel Walking*	*Sec. rest/rep)*	
		Open	*Cross leg swings*	*02 Rep (20-30*	*2 Sets/ Leg*
		Closed	*Single Leg Squat*	*Sec. rest/rep)*	*2 Sets/ Leg*
				10-20 Rep (20-	
				30 Sec. rest/rep)	
				10-20 Rep (20-	
				30 Sec. rest/rep)	
Week 3	*Floor*	*Open* *Open* *Open* *Open*	*Advance Leg Balances Maximum forward- backward leg swing with knee extended* *Toe Walking Heel Walking*	*10-20 Rep (20-30 Sec. rest/rep)* *10-20 Rep (20-30 Sec. rest/rep)* *02 Rep (20-30 Sec. rest/rep)* *02 Rep (20-30 Sec.rest/rep)*	*2 Sets/ Leg* *2 Sets/ Leg*
Week 4	*Floor*	*Open* *Open* *Open*	*Single foot side to side ankle hop* *Side to Side ankle hop Tuck Jump with knees up*	*15-30 Rep (20-30 Sec. rest/rep)* *15-30 Rep (20-30 Sec. rest/rep)* *15-30 Rep (20-30 Sec. rest/rep)*	*2 Sets* *2 Sets* *2 Sets*
Week 5	Floor	Closed Open Open Open	Advance one leg balance Runners Pose Bicycle leg swings with resistance Partial Squats	10-20 Rep (20-30 Sec. rest/rep) 10-15 Rep (20-30 Sec. rest/rep) 10-20 Rep (20-30 Sec. rest/rep) 5-10 Rep /Leg	2 Sets/ Leg 2 Sets 2 Sets 3 Sets
Week 6	Floor	Open Open Open Open	High Bench Step ups Straight Pike Jump Split pike Jump Split Squat Jump	10-20 Rep (20-30 Sec. rest/rep) 5-10 Rep(20-30 Sec. rest/rep) 5-10 Rep(20-30 Sec. rest/rep) 5-10 Rep(20-30 Sec. rest/rep)	2 Sets/Leg 2 Sets 2 Sets 2 Sets
Week 7	Wobble board	Open Open Open	Double Leg Stance Single leg Stance Wobble board lunges	3 Rep 3 Rep/ Leg 5-10 Rep /Leg	(30-120 Sec.hold) (30-120 Sec.hold) 3 Sets (20-30 sec hold)
Week 8	Wobble board	Closed Closed Closed	Double Leg Stance Single leg Stance Wobble board lunges	3 Rep 3 Rep/ Leg 5-10 Rep /Leg	(30-120 Sec. hold) (30-120 Sec. hold) 3Sets (20-30

Table 3 Trend analysis of effect of proprioceptive training on dynamic balance and standing broad jump performance

Variables	Source	Type III Sum of Squares	DF	Mean Square value	F- ratio	P value
Dynamic balance	Intercept	216975.41	1	216975.41	3454.90	.000
	Error	1507.253	24	62.802		
Standing broad jump	Intercept	387.194	1	387.194	2397.36	.000
	Error	3.876	24	.162		

Table 5 Comparison of Descriptive Statistics (linear & quadratic trends) of Dynamic balance & Explosive power performances between Experimental & Control groups.

Experimental group						Control group		
Variable	**Observation**	**N**	**Mean**	**SD**	**Mean Dif.**	**Mean**	**SD**	**Mean Dif.**
Dynamic Balance	Pre-test	25	50.68	0.95		51.12	0.69	
	Post-test	25	57.04	0.9	6.36	51.68	0.65	0.56
Explosive Power	Pre-test	25	2.15	0.05		2.18	0.04	
	Post-test	25	2.42	0.05	0.27	2.29	0.04	0.11

Table 4 Linear and quadratic trends analysis of effect of Proprioceptive training on dynamic balance and standingbroad jump performance

Variables	Source	factor1	Type III Df Mean Sig. Sum of squares Square F of Squares				
Factor1		Linear	505.62	1	505.62	554.61	.000
Dynamic balance	Quadratic		.807	1	.807	2.145	.156
Error(factor1)		Linear	21.880	24	.912		
		Quadratic	9.027	24	.376		
Standing broad jump	Factor1	Linear	.944	1	117.61	.944	.000
		Quadratic	.030	1	.030	8.945	.006
Error(factor1)		Linear	.193	24	.008		
Quadratic			.080	24	.003		

Table 6 Analysis of covariance (ANCOVA) outcomes of Pre-test & Post-test observations between Experimental & Control groups.

Variable	EG (M± SD)		CG (M±SD)		Δ (%)	f-value	p-value	ES
	Pre-test	Post-test	Pre-test	Post-test				
DB (s) 4 week	50.68 ± 4.74	53.64 ± 4.60	51.12 ± 3.46	51.84 ± 3.27	5.84 %	59.55	.000	.55(Moderate)
								.84 (Large)
8 week	50.68 ± 4.74	57.04 ± 4.50	51.12 ± 3.46	51.68 ± 3.26	12.54%	264.85	.000	
EPL (cm) 4 week	2.15 ± .30	2.23 ± .19	2.14 ± .24	2.24 ± .23	3.72 %	.048	.828	.001 (trivial)
8 week	2.15 ± .30	2.42 ± .19	2.18 ± .20	2.29 ± .18	12.55%	34.57	.000	42 (Small)

Data analysis was performed using the Statistical Package for social sciences 22 (SPSS-22). Descriptive statistics (Mean ± SD) were calculated for all the variables. Shapiro- Wilk test was used to test the normality of the values of all dependent variables. Analysis of covariance (ANCOVA) was applied to analyze the between-group (CG and EG) and within- group (pre- and post-) effects. Effect size is also reported through partial eta squared (η2). The ES was used to estimate the

(standardized) magnitude of the difference, and the values were classified according to Cohen15 in: ≤ 0.20 (trivial), 0.21–0.50 (small), 0.51–0.80 (moderate) and > 0.80 (large). For all analyses, a significance level of $P < 0.05$ was adopted. Percent change in test variables was calculated as follows: pre-test value was subtracted from the post value, then divided by the pre-test value, and multiplied by 100.

RESULTS

The PT intervention had a possibly large beneficial effect on fitness variables. Description of participants of EG and CG are given in the methodology section. Results of fitness tests can be seen in Table 6. Significant effect of PT was observed in DB ($P = 0.00$,$F= 264.85$, $\eta2 = 0.53$), and EPL at $P < 0.000$,$F= 34.57$, $\eta2 = .42$) after 8weeks of PT. The percentage increased in DB and EPL were 12.54 % and 12.55 % respectively Table 5. Table 6 depicts significant improvements at the the end of 4thweek of PT among EG forDB and EPL (Δ (%) = 5.84 % $P = 0.00$,$F= 59.55$, $\eta2 = 0.55$), and EPL at (Δ (%) = 3.72% $P < 0.828$,$F= 0.048$, $\eta2 = 0.01$) .Moderate effect was observed in DB at 4rth week (.55) ,where as large

effect(.84)was seen after 8th week. Table 3 & 4 reported the significant improvement in the trend of DB & EPL performance after proprioceptive training respectively ($F (1, 24) =3454.90$, $p < 0.05$), at 0.05 level of significance. Table 4 revealed that „F" value of 505.62 & 117.61, (in case of linear trend) was found significant at 0.05 level of significance in DB and EPL.

DISCUSSION

The purpose of this present study was to examine the effect of eight weeks PT on dynamic balance & explosive power in male kho-kho players. The tests were conducted before the intervention program followed by 4 weeks & finally after the completion of the intervention program (8 weeks). Hypothesis framed for dynamic balance & explosive power was rejected since these variables showed significant improvement in the experimental group after eight weeks of proprioceptive training. Results provide evidence that the performance of DB and EPL increased after 8 weeks PT, which indicates an increase in strength, muscle endurance, and power. Increased muscle strength, can be attributed to physiological and neural adaptation of muscles. Neural adaptation enhanced motor unit synchronization, efficient neural recruitment, and increased conduction velocity. Apart from this neural inhibitor reflexes are lowered (McGill,2010).

Significant improvement ($p<0.05$) in dynamic balance performances was seen, 84.9% variance was observed as a result of PT in the experimental group. The result of the present study is in coherence with the study conducted by Ganesh (2012) who reported significant improvement in dynamic balance performance on modified bass stick test after 12 weeks PT program in male hockey players. Dynamic balance in female handball players improved by 15.8% from test-1 to test-2 Pre-test & post-test after 7 weeks neuromuscular training & further 6.3% improvement from test-2 to test-3 (after 7 weeks to 12 months) as a result of 7 weeks neuromuscular training.

Dynamic balance can be attributed to better balance skills and learning effect developed due to neuromuscular training (Holm, Fosdahl, Friis, Risberg, Myklebust, Steen,2004). Enhanced dynamic balance can be attributed to the increased threshold of Golgi tendon organs to excess load in the muscle which permits muscle to stretch more utilizing elastic component of muscle which has been reported in plyometric training (Chimera, Swanik , Swanik, Straub,2004). Golgi tendon organs act as a defense mechanism, it causes the muscle to relax, beyond which muscle cannot stretch , proprioceptor training causes decreased sensitivity of the Golgi tendon organ, hence facilitate the performance of muscle spindle causing increase proprioception (Lephart, Pincivero, Giraido,1997). Proprioceptive training enhances the functioning of proprioceptors present in joints, muscles & tendons which improves the neuromuscular mechanism, resulting in better performance.

McLeod, Armstrong, Miller, and Saucers, (2009) also reported significant improvement in dynamic balance performance on star excursion balance test (SEBT) for the training group. They reported improvement in lateral, anteromedial, medial & posterior excursion distance performance on high school basketball players after undergoing 6 weeks of neuromuscular training (Gaurav, Pooja, Shishir, & Tanvi, 2013). Gohary, Khaled, Ibrahim, Alshenqiti, and Ibrahim, (2016) reported significant improvement in dynamic balance after 8 weeks of proprioception cross-training for the dominant leg. Cross-training stimulates the contralateral homologous muscle of contralateral limb to accelerate motor neuron output which enhances neuro-sensory stimulation leading to improvement in dynamic balance (Simek Salaj, Milanovic, Jukic, 2007). The results of this study demonstrated that a six-week Improvement in balance can be achieved by either strength gains or improved motor control (or both).

The result of the present study shows an increase in EPL performance by 12.55%. Improved performance in EPL may be due to an increase in power relay to lower extremities through increased strength of muscles after training. Gaurav, Pooja, Shishir, Tanvi (2013) reported significant improvement in vertical jump after multi-station PT. Improved double leg vertical jump performance (explosive power) on kinesiology students undergoing 10 weeks PT was suggested by Simek, Milanovic, Jukic, (2007). In another study on sprinter after 6 weeks specific PT program on unstable & stable surfaces, significant improvement in squat jump performance (explosive power) was recorded (Romero-Franco, Martinez-Amat, Martinez- Lopez, 2013). Nelson, Cambers, Mc Gown, Pearose also suggested that 25% improvement in throwing distance & 16% improvement in vertical jump performance after 8 weeks proprioceptive neuromuscular facilitation training. The force generated as a result of neuromuscular stimulation due to PT possibly justifies the improvement in explosive strength performance (Gruber & Gollhofer,2004). Heitkamp, Horstmann, Mayer, Weller, Dickhuth, (2001) also suggested PT is effective in increasing the strength of hamstring, which plays a vital role in jumping performances. Increased explosive power can be attributed to increases neuromuscular adaptability through enhanced neural recruitment of motor unit or neural firing frequency, enhances reflex potentiation, and/or changes elastic properties of the muscle and connective tissue, which have been reported in Plyometric training (Vissing et al 2008). The neuromuscular system has been greatly influenced by

eight weeks PT in the present study, leading to enhancement in the explosive strength of Kho-Kho players. The force generated as a result of neuromuscular stimulation due to PT (Gruber & Gollhofer possibly justifies the improvement in explosive strength performance (Heitkamp, Horstmann, Mayer, Weller, Dickhuth, (2001). Heitkamp, Horstmann, Mayer, Weller, and Dickhuth suggested proprioceptive training to be effective in increasing the strength of hamstring, which plays a vital role in jumping performances (Johnson & Leach,1968). The result of the study indicate increased dynamic balance and explosive strength as a result of PT . The methods utilized in this study can be implemented to other populations.

CONCLUSION

In conclusion, PT for 8 weeks significantly improved dynamic balance and explosive strength of healthy Kho- Kho (indigenous game) players. Hence, proprioceptor training can be utilized byKho-Kho coaches and players to improve dynamic balance and explosive power, which in turn may reduce injuries. Limitations of this study include small sample size, and the lack of strength measurement of the subject's ankles, knees, and hips. Future studies should employ players of other sports and larger sample sizes. These results may be important in preventing ligament injury, further investigation of the effect of proprioceptor training on other fitness component and reduction of injuries in Kho-Kho at various skill levels, age, sex, is highly recommended.

Acknowledgments

The authors gratefully acknowledge the Kho-Kho academies, Bhilai, Chhattisgarh, India for permitting to conduct the stu

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How to cite this article:

Ashutosh Pandey., Shabir Kumar Anant and Reeta Venugopal. (2024). The Effect of eight weeks Proprioceptive training on Dynamic balance and Explosive power of male Kho-kho players. Int J Recent Sci Res.15(08), pp.4894-4901

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