Original Article

Effect Of Agility and Eccentric Training On Athletic Performance In Basketball Players – A Randomized Controlled Trial.

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Abstract

Introduction: Unlike other major sports, basketball requires highly distinct movements that aid in differentiating the risk factors and mechanisms of injury. Agility has got more crucial in the modern sports team as a result of the game has evolved and has turned faster than before. Being correlated with body stability, speed, and rapidity, agility in the sports world has become a multifactorial parameter. The stress on the muscle can be higher than the stress the muscle itself can produce during eccentric contraction which will result in a controlled stretching. Eccentric and concentric components can be developed through strength training programs.

Aim: To compare the effect of combined agility training and eccentric exercise with conventional exercise on basketball athletic performance testing such as vertical jump, 30- meter sprint testing, and agility T-test

Materials and Methods: The study design is a single-blinded randomized controlled trial involving a total of 36 participants of Basketball players. Participants are randomized into 18 subjects in interventional group A (Agility and Eccentric training program) and 18 subjects in control group B (Conventional basketball training) for a 4-week training period. Outcomes are measured using the Agility T-test, 30-meter sprint test, vertical jump test.

Results: Group A Showed greater improvement in the vertical jump, agility T-test, and 30-meter sprint score. That is combined agility and eccentric hamstring training has a greater statistical difference with a p-value <0.001

Conclusion: The study concluded the combined effect of agility training and eccentric hamstring training in college-level basketball players will improve athletic performance.

Keywords: Agility training, Eccentric hamstring training, Nordic hamstring exercise, athletic performance, agility T-test, vertical jump.

INTRODUCTION

Unlike other major sports, basketball requires highly distinct movements that aid in differentiating the risk factors and mechanisms of injury. However, over the past few decades, due to various updates and rule changes, these demands have evolved to adapt to the psychology of the participant. One full-time game of basketball contains at least 35 to 46 vertical jumping and landing motions which are two to four times more than soccer and volleyball. Uncertain acceleration and deceleration are required for this sport as multi-directional motions are required by the players to cope up with the game by changing the direction of the body movement every two or three seconds[1].

The ability and skill that is required to change the human movements in velocity and mode is agility and this is essential for the majority of sports as the direction of the body movements changes quickly in a very brief time span[2]. Agility can be represented in two methods: the ability needed to change the movement of velocity due to swift motion and skill needed to perform locomotion except for the linear sprinting[3].

Agility has got more crucial in the modern sports team as a result of the game has evolved and has turned faster than before. This reflects the increased condition training and the presence of strength given by the team with the highest care to the athletes. Being correlated with body stability, speed, and rapidity, agility in the sports world has become a multifactorial parameter[1].

Coordination and movement control are the key factors that aid agility. However, mobility of joints, dynamic balance, power and flexibility, level of energy resources, strength, speed, and optimal biomechanical structure of movement also contribute vastly to the level of agility[4]. Through his study, Goran Spori et. al has proved that to enhance the power performance of an athlete, agility training is vital[2]. To develop motor control through the development of the neuromuscular system various exercises involving agility, speed, and quickness are included in the training sessions[3]. Through these training, one would be able to reprogram the neuromuscular system to function more efficiently by improving the performance of the athlete in better multi-directional explosive power movements[3,5].

The muscle length can vary by shortening or stretching or remain stable or even resist the stretch when the muscle is activated to produce force. The stress on the muscle can be higher than the stress the muscle itself can produce during eccentric contraction which will result in a controlled stretching[6]. During a quick break while playing the basketball, for the purpose of acceleration, the knee extensor contract concentrically, while for deceleration the flexors come in place using eccentric acceleration. The protective "breaking mechanism" to decelerate the lower limb and by increasing the stability of knee joint occurs during high and rapid force contraction as antagonist co-contraction. Eccentric and concentric components can be developed through strength training programs[6,7].

Physical ability tests are adopted throughout the globe to assess athletic talent and performance. It includes various tests like anaerobic power speed and agility[8]. A four-dimensional agility and body control test called a T-Test is used to access the ability to change directions quickly without losing the speed of the movement all through maintaining the balance[9,8]. To assess the ability to the acceleration of an athlete, a ten-meter sprint test is adopted as it is simple and highly popular as short distance acceleration is very common in a variety of sports[9,10]. Basketball has a lot of vertical jumps required hence the ability to perform vertical jumps is important and to assess this, vertical jump tests are conducted to analyze the lower body power. This ability of vertical jumps sets the basketball player distinct from other sports. The ability of a group of muscles to produce maximum force within a short period is called manifestation force[9,10].

Makouf et al through their research have proved that a noticeable improvement in the performance of soccer players through combined agility and plyometric[6]. Tansel et al has also undergone through his studies that the athletes who have taken the eccentric hamstring strength training program have better athletic performance with improved muscular strength when compared to the athletes who just went through the basic basketball skills8. While training a basketball athlete for the game, both agility and eccentric contraction training should be addressed to put forth the full potential of the athlete.

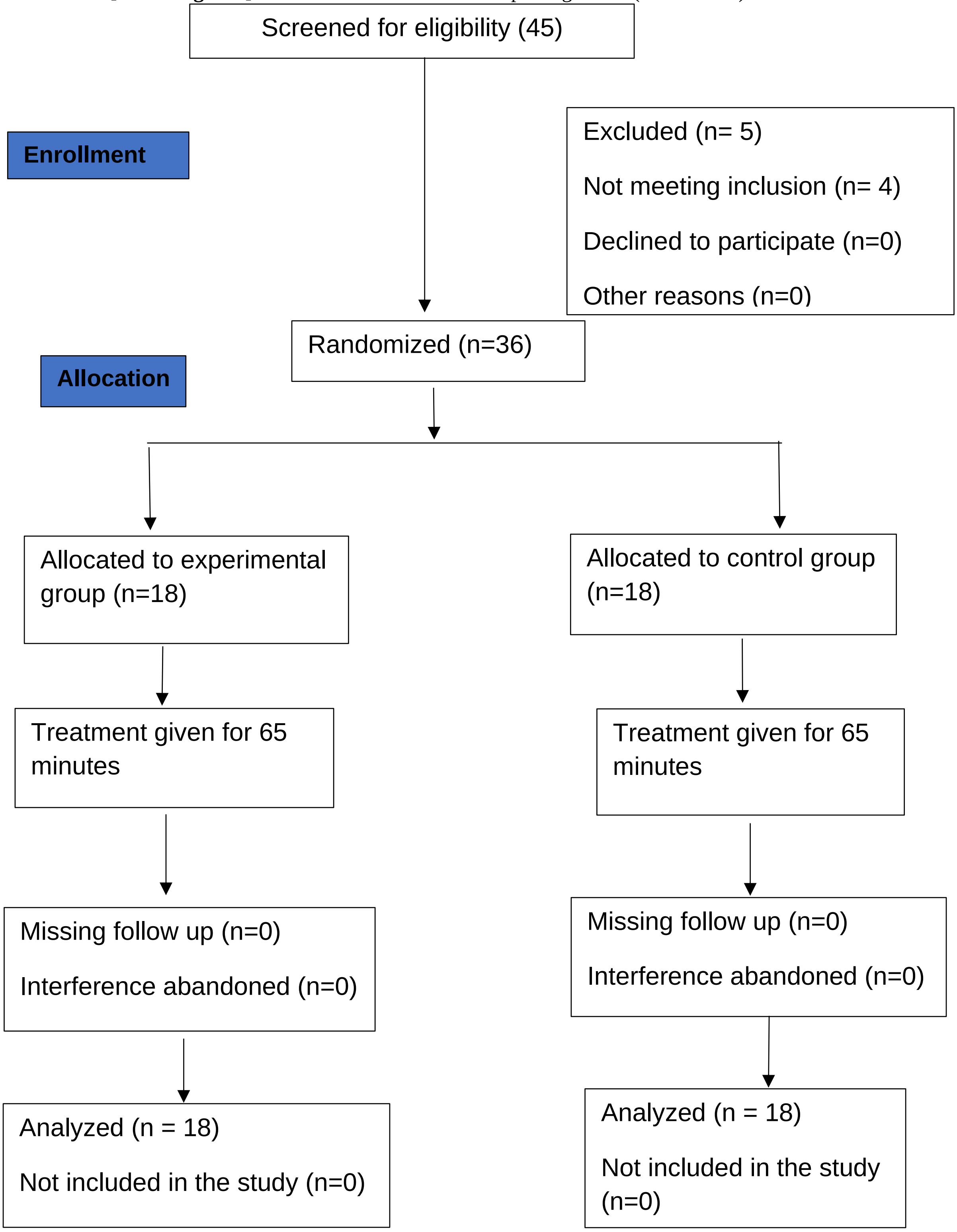
So far, there has been no research or study conducted to analyze the basketball athletic performance with the combined agility and eccentric training. Hence, this study is conducted to evaluate the effect of agility when combining with eccentric training on basketball players.

MATERIALS AND METHODS

The current study is an outcome assessor-blinded randomized controlled trial carried out in college students in Institute of Physiotherapy in Mangalore, Karnataka. Written permission to conduct this study was obtained from the Head of the institution where it was conducted. The study was approved by the Institutional Ethical Committee (Ref: NIPT/IEC/Min//08/2019-20) and was prospectively registered in the clinical trials Registry-India with the registration number CTRI/2021/04/033233. Eligible subjects were received information about the intervention and procedure, after which subjects were given an informed consent form to be signed. Those who were willing to participate in the study were asked to give written, informed consent. The study was conducted for a period of 12 months, from April 2020 to April 2021.

Sample size calculation was based on the standard deviation of vertical jump of experimental group 5.0071 and control group 7.606, mean difference 6, effect size 0.9513 and 5 % level of significance, 80 % power, required sample per group is 18 in each group, total of 36 This is calculated using "n" master software. Total of 45 subjects who fit the eligibility criteria were screened, out of which 36 subjects who met the inclusion criteria were recruited into the study. Following the completion of screening and baseline data collection, participants were randomized into two groups. 18 subjects in Group A (intervention group: Agility and eccentric training) and subjects in Group B (control group) by simple random allocation using a computer-generated Sequentially Numbered Opaque Sealed Envelope. The reporting of the RCT followed the recommendations of Consolidated Standards of Reporting Trials (CONSORT) guidelines shown in table/fig1. Eligibility criteria consisted of the participant's age between 19 and 30 years, BMI: 18.5 – 24.9, Basketball players. Both the genders, male and female are included in the study. Exclusion criteria were cognitive impairment (MMSE <21), Lower limb injuries in the past 6 months, Lower limb surgeries in the past 6 months, Athletes who underwent lower limb training to improve performance, Osteoporosis, Lower limb pathologies, and any other systemic illness. Outcome measures vertical jump score, Agility T-test score, and 30-meter sprint were obtained at baseline and on the 5th week after the intervention.

[Table/Figure1] Consolidated Standards of Reporting Trials (CONSORT) Flow Chart



PROCEDURE

Agility Training

Participants of this group were given agility training which involves several change of direction drills. In the beginning, the athlete was given 5 minutes of warm-up period which includes jogging and then 5 minutes of static stretching to hamstring, Calf, Quadriceps, hip Adductors, Hip abductors. Then participants were given 30 minutes of agility training which includes 10 minutes' ladder drills. Especially forward sprint with high knee flexion, Lateral shuffle, Hip in and out, Quick feet ladder sprint, One foot in and out per 2 feet in. And in other 15 minutes of cone drills, oblique shuttle1 runs, Agility T drill, Forward T drill, and Backward T drill. Training followed by 10 minutes of cool-down period. The total treatment duration is for 45 minutes shown in table/fig2,3

[Table/Figure2] Ladder Drills

[Table/Figure3] Cone Drills

Eccentric training

Then the participants were given Nordic hamstring exercise for 3 sets × 8-12 repetitions, rest for 45-60 seconds between the set or 4 weeks.

During exercise sessions, the individual kneeled on a padded surface with the researcher stabilizing his lower legs. Participants were instructed to descend their torsos to the floor in a constant-cadence motion (4-second pre repetitions). Maintaining a stiff torso position with only the knee joint moving. At the level of the shoulder joints, the volunteer's arms were flexed at the elbow joint so that the palms of their hands faced front. The participants were allowed to use their arms to cushion the fall in the last stages of the action. The subject used their upper limbs to avoid concentric hamstring activity throughout the return to the NHE starting posture shown in table/fig 4.

[Table/Figure4] Nordic Hamstring Exercise

RESULTS

The frequency and percentage according to gender and study groups is shown in table/fig 5.

(n = 36)		Frequency	%
Gender	Male	26	72.2
	Female	10	27.8
Groups	Experimental	18	50
	Control	18	50

[Table/Figure5]: Frequency and Percentage according to genders and groups
n= number

Mean and standard deviation according to age is shown table/fig 6.

(n = 36)	Mean	S.D
Age	22.56	2.063

[Table/Figure 6]: Mean and Standard Deviations according to age
n= number, S.D= Standard Deviation

The Chi square test was used to compare gender according to groups. The obtained p value is > 0.05 and hence the distribution of gender was homogeneous between the groups shown in table/fig 7.

(n = 36)		Experimental		Control		Chi square	p value
		Frequency	%	Frequency	%		
Gender	Male	14	77.78	12	66.67	0.554	0.457
	Female	4	22.22	6	33.33		

[Table/Figure 7]: Comparison of gender according to groups
n = number, p value>0.05 denotes no significant difference

The Independent sample "t" test was used to compare the baseline characteristics between the groups. The obtained p values are > 0.05 for all the comparisons and hence there was no difference in the baseline measurements of "age", "Vertical Jump score", "Agility T Test score", "30-meter Sprint score" between the Experimental and control groups is shown in table/fig 8.

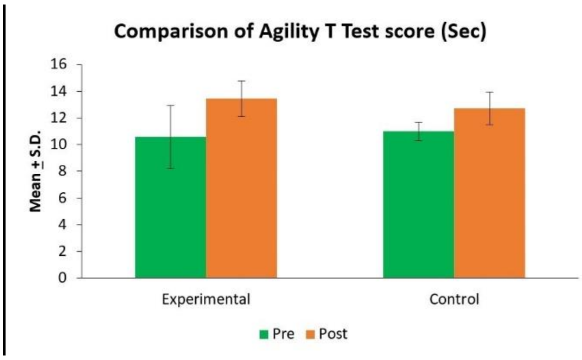
(n = 36)		Mean	S.D	"t"	p value
Age (Years)	Experimental	22.06	1.92	-1.479	0.148
	Control	23.06	2.13		
Vertical Jump score (Inch)	Experimental	18.00	2.52	1.348	0.186
	Control	16.89	2.42		
Agility T Test score (Sec)	Experimental	10.57	2.34	-0.742	0.463
	Control	10.99	0.70		
30 meter Sprint score (Sec)	Experimental	6.09	0.91	-0.771	0.446
	Control	6.34	1.02		

[Table/Figure 8]: Comparison of baseline characteristics between the groups
n= number, p value>0.05 denotes no significant difference

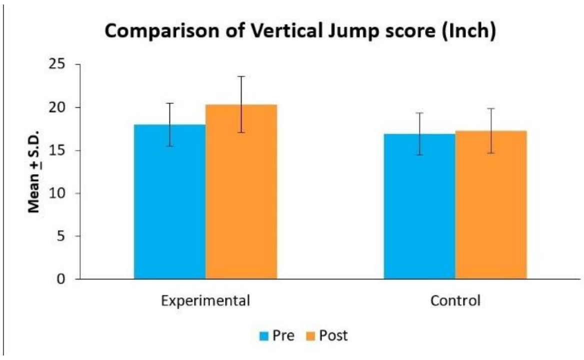
The Paired "t" test was used to compare "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" irrespective of the group before and after the interventions. The obtained p values are < 0.05 for all the comparisons and hence there was a difference in the pre and post-measurements of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" irrespective of the groups were shown in table/fig 9,10,11,12.

(n = 36)		Mean	S.D	"t"	p value
Vertical Jump score (Inch)	Pre	17.44	2.50	-4.824	< 0.001*
	Post	18.81	3.27		
Agility T Test score (Sec)	Pre	10.78	1.72	4.307	< 0.001*
	Post	9.64	1.38		
30 meter Sprint score (Sec)	Pre	6.22	0.97	4.307	< 0.001*
	Post	5.14	0.52		

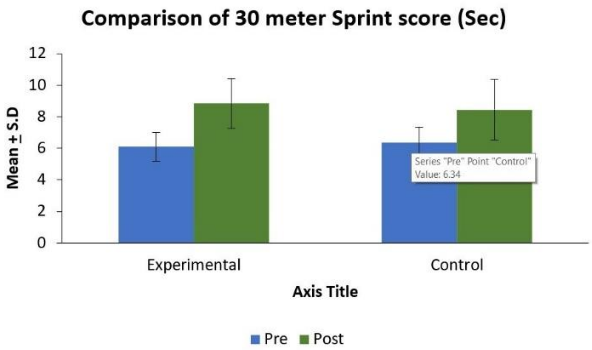
[Table/Figure 9]: Comparison of "Vertical Jump score", "Agility T Test score" & "30-meter Sprint score" irrespective of the groups
n= number, S.D= Standard Deviation, p value<0.05 denotes significant difference.



[TABLE/FIG 10] Comparison of Agility Test Score



[TABLE/FIG 11] Comparison Of Vertical Jump Score



[TABLE/FIG 12] Comparison Of 30 Meter Sprint Score

The Paired "t" test was used to compare "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the experimental group before and after the interventions. The obtained p values are < 0.05 for all the comparisons and hence there was a difference in the pre and post-measurements of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the experimental group. It indicates that the intervention was effective in improving the "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the experimental group were shown in table/fig 13,10,11,12.

(n = 18)		Mean	S.D	"t"	p value
Vertical Jump score (Inch)	Pre	18.00	2.52	-6.153	< 0.001*
	Post	20.33	3.25		
Agility T Test score (Sec)	Pre	10.57	2.34	-3.023	< 0.001*
	Post	13.45	1.33		
30 meter Sprint score (Sec)	Pre	6.09	0.91	-3.645	< 0.001*
	Post	8.84	0.59		

[Table/Figure 13]: Comparison of "Vertical Jump score", "Agility T Test score" & "30-meter Sprint score" within the Experimental group

n = number, S.D= Standard Deviation, p value<0.05 denotes significant difference.

The Paired "t" test was used to compare "Vertical Jump score", "Agility T-Test score" & "30- meter Sprint score" within the control group before and after the interventions. The obtained p values are < 0.05 for all the comparisons and hence there was a difference in the pre and post-measurements of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the control group. It indicates that the intervention (control) was effective in improving "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the control group were shown in table/figure14.

(n = 18)		Mean	S.D	"t"	p value
Vertical Jump score (Inch)	Pre	16.89	2.42	-4.441	< 0.001*
	Post	18.28	2.84		
Agility T Test score (Sec)	Pre	10.99	0.70	-3.102	< 0.001*
	Post	12.73	1.23		
30 meter Sprint score (Sec)	Pre	6.34	1.02	-3.634	< 0.001*
	Post	8.44	1.93		

[Table/Figure 14]: Comparison of "Vertical Jump score", "Agility T Test score" & "30-meter Sprint score" within the Control group

n= number, p value<0.05 denotes significant difference.

The Independent sample "t" test was used to compare the change (Pre – Post) in "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" between the groups. The obtained p values are < 0.05 for all the comparisons and hence there was a difference in the change (Pre – Post) of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" between the groups were shown in table/figure 15. The obtained mean difference was higher in the experimental group for "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" when compared with the control group. It indicates that the experimental group is better in improving "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score"

(n = 36)		Mean	S.D	"t"	p value
Vertical Jump score (Inch)	Experimental	2.44	1.423	3.983	< 0.001*
	Control	0.94	0.725		
Agility T Test score (Sec)	Experimental	1.88	0.441	3.382	< 0.001*
	Control	0.72	0.014		
30 meter Sprint score (Sec)	Experimental	0.45	0.041	-4.265	< 0.001*
	Control	0.19	0.067		

[Table/Figure 15]: Comparison of change (Pre – Post) in "Vertical Jump score", "Agility T Test score" & "30-meter Sprint score" between the groups

n= number, S.D= Standard Deviation, p value<0.05 denotes significant difference.

DISCUSSION

Basketball requires highly distinct movements that aid in differentiating the risk factors and mechanisms of injury. One full-time game of basketball contains at least 35 to 46 vertical jumping and landing motions which are two to four times more than soccer and volleyball. Uncertain acceleration and deceleration are required for this sport as multi-directional motions are required by the players to cope up with the game by changing the direction of the body movement every two or three seconds.[1]

Eccentric contractions are characterized by the active extension of muscle fibers, with the force of contraction increasing in proportion to the speed of contraction. In sports that demand a lot of acceleration, deceleration, and maximal sprinting, hamstring injuries are prevalent. The Nordic hamstring exercise proved more effective than the classic hamstring curl exercise in establishing maximal eccentric hamstring strength.[10]

In the present study, recruitment occurred over one year with 45 students screened to achieve a target of 36 students. The reason for the exclusion from the trial was that the students haven't fulfilled the specified inclusion requirements and some are rejected to give consent. In the present study, Group A received agility drills and Eccentric hamstring training, where group B received regular basketball drills. Group A showed a significant difference in vertical jump score, Agility T-test score, and 30-meter sprint score both within the group and between the groups. In between the group analysis, the mean difference of Agility T-test score in the experimental group is 1.88 and in the control group is 0.72. Since the experimental group shows the greater improvement compared to the control group and the p-value is <0.05, hence there is a statistically significant difference among group A. The mean difference of Vertical jump score in the experimental group is 2.44, and in the control group is 0.94 which shows more gain in the experimental group than the control group and the p-value is <0.05, so there is a statistically significant difference among group A. The mean difference of 30m sprint score in experimental group was 0.45 and in the control group 0.19 that shows greater improvement in the experimental group than the control group. The p-value is <0.05, so there is a statistically significant difference among group A.

Within the group, in the experimental group the p values of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" are < 0.05 for all the comparisons, and hence there was a statistically significant difference in the pre and post measurements. It indicates that the intervention was effective in improving the "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" within the experimental group. Within the group in control group the p values of "Vertical Jump score", "Agility T-Test score" & "30-meter Sprint score" before and after the interventions are < 0.05 for all the comparisons and hence there was a statistically significant difference in the pre and post measurements within the control group. It indicates that the intervention was effective in improving the "Vertical Jump score", "Agility T-Test score” & “30-meter Sprint score” within the control group. Hence it proves that the combined effect of agility and eccentric training has more effect on athletic performance in basketball players. therefore we are rejecting the null hypothesis and accepting the alternative hypothesis that the effect of agility and eccentric training has improved athletic performance in basketball players.

Ardian et al. in conducted an experimental study to find the effect of ladder drills in improving agility in basketball players. They explained that ladder drills training is an important aspect of many sport exercises that require athletes to move their feet fast and precisely. They have proved that ladder drills will improve agility in basketball players assessed by the Illinois Agility test which correlating with our study. In our study, we have given various agility drills including ladder drills and it showed improvement in agility T-test in both within and between the groups.[11]

Wilderman et al. in their 6-week agility training program found the impact of agility training in thigh muscle activity, knee motion, and impact force during sidestep pivoting in female basketball players. They found Agility training that promotes hamstring activation could help prevent anterior cruciate ligament sprains linked with side-step pivots. Correlating with our study where agility training has improved athletic performance in basketball players and improved their skills and thereby prevent sports injuries. But in our study, we included both genders to evaluate the effect of agility in athletic performance.[12]

Brien et al. found the effect of eccentric training in female basketball players. They explained basketball entails a lot of high-intensity activities like sprinting, rapid stops, quick changes of direction, lateral shuffling, explosive jumping, and hard landings. They have given flywheel inertial training as eccentric training, were in our study intervention was Nordic hamstring exercise. But the outcome measures used are similar. Their conclusion is adding evidence to our study where eccentric training has shown improvement in athletic performance which has been reflected in vertical jump test and sprint test.[13]

Baran et al. conducted a study on basketball players to evaluate eccentric hamstring training on lower extremity strength has correlated with our study where the Nordic hamstring exercise has shown improvement which is evaluated by vertical jump. The intervention and outcome used are similar in both studies which support that eccentric strength training improves performance in basketball players.[14]

Reactive agility is the prominent training technique aimed at developing sports skills requiring perceptual abilities. Athletes' ability to efficiently change direction, called planned agility. Agility is categorized as a motor skill. The reaction component of agility possesses greater perceptual characteristics. so the agility training improves speed, strength, change of direction, and perceptual decision-making abilities and thereby performance. [15]

Hamstring injuries are caused by eccentric hamstring contractions in the descending limb of the muscle's length-tension relationship during vertical jumps. This is thought to be related to non-uniform sarcomere lengthening caused by sarcomere length instability, which causes microscopic injury to the hamstring muscles, leading to a severe soft tissue tear further. The Nordic hamstring workout method was found to be more effective than typical hamstring curls in increasing eccentric hamstring strength.[16]

STRENGTH OF THE STUDY

According to the data bases searched, it is the first study to measure the combined effect of agility training and eccentric training in basketball players. The age of the patients was homogenously distributed between the groups. No dropouts were reported during the study

LIMITATIONS OF THE STUDY

The study had a small sample size. The long-term benefits of the intervention was not determined

CONCLUSION

Basketball players require explosive strength and rate of force development of lower body and speed over short distances. The available literature advises that strength, speed, power, change of direction are essential characteristics of basketball and that improving these will lead to increase game performance. Hence the study concluded that both agility and eccentric exercise training are unavoidable in basketball players. Both factors are important in enhancing athletic performance, thereby preventing sports related injuries.

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