EFFECT OF NEUROMUSCULAR TRAINING ON BASKETBALL PLAYING ABILITY

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Abstract

Context: *Neuromuscular training program (NMTP) enhanced performance in various sports. Evidence is needed to show the effect of NMTP on Basketball (BB) playing ability.*

Aim & Objective: *To determine the effect of 6 weeks of progressive NMTP on BB playing ability.*

Design: *Randomized Controlled Trial.*

Setting: *Basketball Court and Gymnasium.*

Patients or Other Participants: *08 (eight) district-level male BB players (EG – 04 & CG - 04) aged 19-25 years.*

Main Outcome Measure(s): *The Johnson BB ability test items, namely shooting ability, throwing accuracy, and dribbling ability through field goal speed test, BB throw for accuracy, and BB dribble test, respectively, have been tested within two days before and after the training to find out the effectiveness of NMTP plus BB practice in EG and only BB practice in CG. Summing up the scores of all three test items calculates the overall BB ability.*

Results: *The post-test performance of shooting ability ('F' – 29.67), dribbling ability ('F' – 25.63), and overall BB ability ('F' – 12.22) significantly improved due to progressive NMTP plus regular BB practices in EG but not for throwing accuracy ('F' - 0.49). CG did not show any significant improvement.*

Conclusions: *Progressive NMTP significantly improved various aspects of physical, motoric, and musculoskeletal fitness which in turn developed the neuromuscular fitness of BB players. Regular BB practices developed various psychological aspects along with skills. The post-test performance of the EG than the CG established that basketball playing ability not only depends on psychological and technical development but also needs well-developed neuromuscular fitness to execute the skills flawlessly. So the neuromuscular training program should be incorporated along with regular basketball practices to improve basketball playing ability.*

Key Words: Progressive neuromuscular training program, Neuromuscular fitness, Basketball playing ability.

GENERAL INTRODUCTION:

Basketball is a competitive sport [1] involving various motor skills such as dribbling, passing, catching, pivoting, etc., which develops through proper training from childhood [2]. An athlete's basketball career depends on skill development, mental strength to cope with various pressure situations and react quickly, adequate physical and motor fitness, and most importantly, accurate understanding of tactics and proper motivation and self-confidence to perform well [3]. A well-developed neuromuscular system [4] might help to develop all those qualities.

To perform any skillful and powerful physical activity, to get success consistently in the field of competitive sports, as well as to maintain health and fitness throughout the lifespan well developed neuromuscular system is very much needed [5,6]. For neuromuscular development of the athletes, the training program must be incorporated from childhood days onwards [7] so that peak performance in competitive sports can be achieved at the later stage of life [8] with lesser chances of injuries [9, 10].

The neuromuscular system includes all the muscles and nerves of the body [11], which functions in a coordinated manner so that the movements can efficiently perform, maintaining proper postural control and following appropriate gate patterns [12]. During any muscular activity, the impulses generated in the central nervous system and, through nerve terminals, reach the neuromuscular

junction as an action potential. With the help of neurotransmitters, it transfers to the targeted muscles, and the muscles start functioning [13].

Exercises and training programs, including speed, power, strength, hypertrophy etc., have beneficial effects on the nervous system, especially the neuromuscular junction [14]. The neuromuscular Training Program (NTP) proved very effective [15]. NTP focuses on fundamental and sport-specific strength and conditioning activities like resistance, dynamic stability, balance, core strength, plyometric, and agility exercises to develop health-related and skill-related fitness and reduce injury proneness [16].

Basketball is such a sport where the athletes needs to change the intensity and direction of movement suddenly and frequently, sprint most of the time during the game situation, and jump many times. So various motor fitness components like speed, explosive strength, balance, acceleration, agility, core strength etc., of basketball players needs to be developed. In turn, basketball performance will be enhanced [17]. As basketball is a very high-intensity sport, the players are at risk of various sports-related injuries, especially of the lower extremities [18]. In this regard, an integrative neuromuscular training program has been proven beneficial for young athletes [19].

Neuromuscular training develops various physical and biomechanical aspects of sports persons [20]. This training is also helpful in preventing sports-related injuries [21]. Very little literature is available on the effect of the neuromuscular training program on playing abilities and performance enhancement in different sports [22, 23]. The present researchers desired to determine whether the effect of NMTP with some modification remains the same or not on the BB playing ability for different level players. With this understanding, we have formulated a six-week neuromuscular training program based on the available literature and in consultation with the experts to investigate its effect on basketball playing ability.

Therefore, the present study aimed to determine the effect of 6 weeks of a progressive neuromuscular training program on basketball playing ability based on selected basketball skills, namely shooting ability, dribbling ability, and throwing accuracy.

MATERIALS & METHODS

Participants: A total of twelve (12) male basketball players aged 19-25 participated at least in the inter-district Basketball competition selected for the study. They have divided into Experimental Group (EG) and Control Group (CG), consisting of six (06) subjects in each group through purposive random sampling technique. During training, two (02) participants of EG got injured and could not continue the training after two weeks, so they did not consider for post-test. In CG also, two participants did not give the post-test for personal reasons. Finally, we considered a total of eight (08) participants for the analysis of the final result of the study (See Table 1 & Fig. 1).

Table 1: Inclusion and Exclusion Criteria of the Participants

Inclusion Criteria
• Male basketball players. • Age 19 to 25 years. • Participated in Inter District Basketball Competition during 2018 – 2021. • Completed the entire six weeks of NMTP. • Participated in both the pre and post-training test.
Exclusion Criteria
• Female basketball players. • Basketball players are aging ≤19 years or ≥25 years. • Basketball players participated in Inter District Basketball Competition before 2018. • Could not complete entire six weeks of training. • Could not participate in post training test.

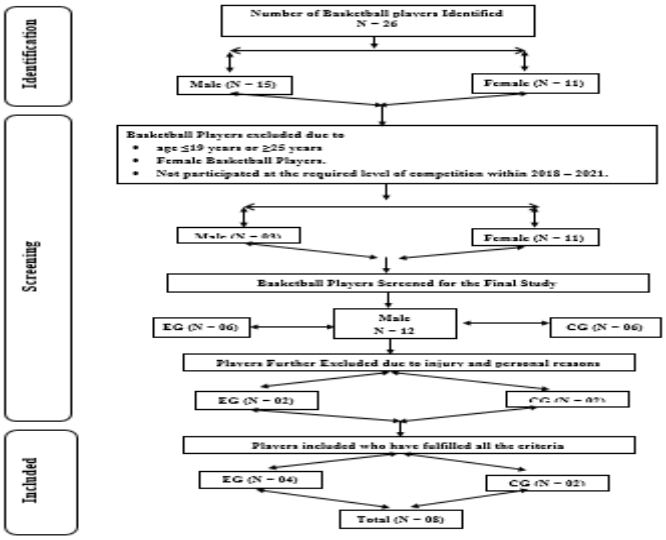

Figure 1: Flow chart of Inclusion and Exclusion Criteria of the participants.

Procedure of the Study: Following the inclusion and exclusion criteria (See Table 1) finally total of 08 (eight) district-level male basketball players (EG – 04 & CG - 04) aged 19-25 years participated in the study. The EG has participated in the progressive Neuromuscular Training Program (NMTP) plus regular basketball practice, and the CG have only participated in regular basketball practice as recommended by their Coach for 06 (six) weeks. Following the experiment conducted by Ahmed [23] and with the help of an expert, we prepared the modified progressive NMTP. The University basketball coach framed the basketball training program (BBTP). NMTP consists of four phases of core stability exercises (See table 2A) and two phases of strength exercises (See table 2B). BBTP consists of various skill and game practices with increased load volume. For a detailed NMTP and Basketball training program, see table 3. EG has participated in NMTP in the morning session (60 min. /session) followed by basketball practice during the evening session (60 min. /session) for 04 (four) days a week with increased intensity and volume of load every week.CG has only participated in regular basketball practice (60 min. /session) along with EG during the evening for four days (Monday to Thursday) in a week. Both morning and evening sessions started with 10 minutes of warm-up consisting of Jogging, general and specific kinds of exercises for the entire body parts. They ended with 10 min cooling down consisting of stretching and relaxation exercises. Before the start of the training program, both the groups got oriented about the Johnson basketball playing ability test items (See Table 4) and the NMTP. We conducted the pre-test at the baseline, i.e., two days before the training program starts, and the post-test within two days after the six weeks training program. We conducted the Johnson basketball ability tests by following the procedure described by Clarke [24].

Outcome Measures: The primary outcome measure for this study was basketball playing ability. We measured basketball playing ability by the Johnson Basketball ability test [24], consisting of three items (See table 4). Summing up the scores of all three test items calculates the overall BB ability. The pre-and post-test measurements were taken for all the items to determine the effect of progressive NMTP on BB playing ability.

Analytical Procedure: The pre-and post-test performance scores were analyzed using Descriptive statistics such as mean and standard deviation to get the basic idea about all the selected items. The effectiveness of NMTP on basketball playing ability was analyzed through covariance (ANCOVA). The level of significance was 0.05 level of confidence. Graphical representation of pre-test and post-test performance shows the improvement of the score.

Table 2: Neuromuscular Training Program (NMTP)

2B Strength Training (ST)	
Phase 1 (P1)	**Phase 2 (P2)**
Barbell Snatch	Barbell Hang Cleans
Barbell Squat	Sumo Squat Dumbbell Pickup
Barbell Bench Press	Dumbbell Incline Press
Assisted Russian Hamstring Curl	Assisted Russian Hamstring Curl
Dumbbell Shoulder Press	Dumbbell Back Fly
Hamstring Curls	Band Ankle Inversion/Eversion
Latissimus Pull Down	Lateral Lunges With Shoulder Press
Lateral Lunges With Dumbbell	Dumbbell Lateral Raise
Seated Row	Dumbbell Ys & Ts

2A Core Stability Exercises (CSE)			
Phase 1 (P1)	**Phase 2 (P2)**	**Phase 3 (P3)**	**Phase 4 (P4)**
Lateral Jump And Hold	Lateral Jump	Lateral Hop And Hold	Lateral Hops
Step Up & Hold	Jump Single Leg Hold	Single Leg Hop Hold	Crossover Hop-Hop-Hold
Single Tuck Jump	Double Tuck Jump	Repeated Tuck Jump	Side-To-Side Tuck Jump
Front Lounges	Walking Lunges	Walking Lunges With Dumbbells	Walking Lunges With Shoulder Press
Lunge Jumps	Scissor Jumps	Scissor Jumps with Rope	Scissor Jumps with Medicine Ball
Swiss Ball Back Hyper Extension	Swiss Ball Back Hyper Extension With Wall Support	Swiss Ball Back Hyper Extension With Back Fly	Swiss Ball Back Hyper Extension With Ball Reach Lateral

Table 3: Weekly Training Schedule for NMTP & BBTP

BBTP (Evening)		Cool Down
Skills	Duration	
Shooting Drills ➢ One hand shooting drills ➢ Spin Cut Dribbling Drills ➢ Crossover drills ➢ Running with dribbling Throwing Accuracy drills ➢ Two hands passing with partner ➢ Overhead pass with partner	20 Min.	10 Min. at the end of every session
Game Practice	20 Min.	

	Same for entire 06 weeks					
NMTP (Morning)	Set	3/Exercise		3/Exercise	3/Exercise	3/Exercise
	Reps.	6-8/ Exercise		8-10/ Exercise	10-12/ Exercise	12-15/ Exercise
	Duration	40 Min.		40 Min.	40 Min.	40 Min.
	Intensity	65-70% of 1 RM		70-75% of 1 RM	75-80% of 1 RM	80-85% of 1 RM
	Day	4	CSE (P1) + ST (P2)	CSE (P2) + ST (P2)	CSE (P3) + ST (P2)	CSE (P4) + ST (P2)
		3	CSE (P1) + ST (P1)	CSE (P2) + ST (P1)	CSE (P3) + ST (P1)	CSE (P4) + ST (P1)
		2	CSE (P1) + ST (P2)	CSE (P2) + ST (P2)	CSE (P3) + ST (P2)	CSE (P4) + ST (P2)
		1	CSE (P1) + ST (P1)	CSE (P2) + ST (P1)	CSE (P3) + ST (P1)	CSE (P4) + ST (P1)
Warm Up		10 Min. before start of every session				
Week		**1st**		**2nd**	**3rd & 4th**	**5th & 6th**

Table 4: Johnson Basketball Ability Test Items

S.No.	Variables	Tools
1.	Shooting Ability	Field Goal Speed Test
2.	Throwing Accuracy	Basketball Throw for Accuracy
3.	Dribbling Ability	Basketball Dribble test
4.	Overall Basketball Playing Ability	Sum of the scores of all the three items

RESULTS & DISCUSSION

Results: A total of eight (08) basketball players have finally been considered for the analysis and interpretation of the collected data to determine the effectiveness of NMTP on basketball playing ability. In each of the selected test items, the BB players scored according to Clarke's scoring procedure [24]. We calculated the overall basketball ability by summing up the three items' scores. The descriptive analysis of the pre and post-test data would provide a basic idea about the effectiveness of the training program. Further, the ANCOVA would provide a conclusive result about the effectiveness of the training program.

The descriptive analysis of pre-test data of all the selected test items and overall basketball ability shows very little difference between EG and CG at the baseline. The result of ANOVA (See table 5) for the pre-test data also proved the groups' homogeneity. However, the mean (M) and standard deviation (SD) values of post-test data of those items show a noticeable difference from the pre-test data in EG. In contrast, we found a negligible difference between pre and post-test data in CG. So descriptive analysis based on the mean and standard deviation of pre and post-test data of both groups indicates that the NMTP has a noticeable effect on EG. Table 6 and Fig. 2 present the detailed descriptive analysis of both groups.

Table 5: ANOVA of Pre-Test Scores for Basketball Playing Ability Test Items

Parameters	Sources of Variance	d.f	Sum of Squares	Mean Square	F-ratio
Field Goal Speed Test	Between Groups	1	02	02	0.150
	within Groups	6	80	13.333	
Throwing Accuracy test	Between Groups	1	0.50	0.50	0.043
	within Groups	6	69.50	11.583	
Dribbling Test	Between Groups	1	4.50	4.50	0.213
	within Groups	6	127	21.167	
Overall Playing Ability	Between Groups	1	08	08	0.097

	within Groups	6	495.50	82.583

*Significant at 0.05 Level. Tab 'F' (1, 6) = 5.99

Table 6: Descriptive Analysis of Basketball Playing Ability Test Items

Parameters	Experimental Group				Control Group			
	Pre Test		Post Test		Pre Test		Post Test	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Field goal speed test	7.00	3.92	14.50	2.65	6.00	3.37	6.25	2.06
Throwing accuracy test	11.25	3.59	14.75	6.02	11.75	3.20	11.75	6.60
Dribbling ability test	24.50	5.20	31.25	2.99	23.00	3.92	22.25	2.63
Overall Basketball ability	42.75	9.60	60.50	10.28	40.75	8.54	40.25	4.86

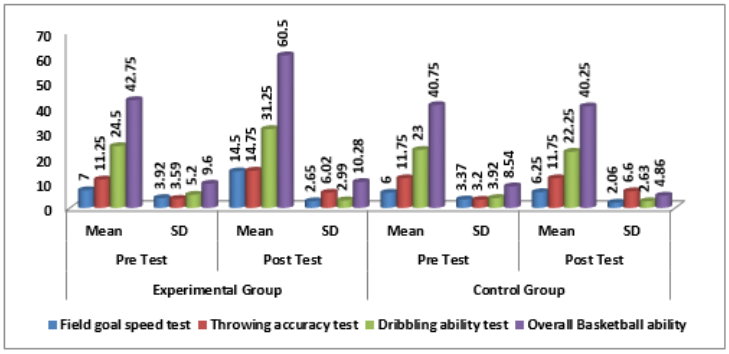

Figure 2: Descriptive Analysis of Basketball Playing Ability Test Items

Figure 2: Descriptive Analysis of Basketball Playing Ability Test Item

There is a clear indication of improvement in all the items of basketball ability as per the mean score of EG due to the 06 (six) weeks of NMTP plus Basketball practices, but not in CG. The NMTP has significantly affected and improved the basketball playing ability in EG as compared to CG. Table 7 is showing the result of Analysis of Covariance (ANCOVA).

Table 7: ANCOVA of Adjusted Post-Test Scores for Basketball Playing Ability Test Items

Parameters	Sources of Variance	d.f	Sum of Squares	Mean Square	F-ratio
Field Goal Speed Test	Between Groups	1	119.86	119.86	29.76*
	within Groups	5	20.14	4.03	
Throwing Accuracy test	Between Groups	1	21.37	21.37	0.49
	within Groups	5	217.62	43.52	
Dribbling Test	Between Groups	1	173.96	173.96	25.63*
	within Groups	5	33.94	6.79	
Overall Playing Ability	Between Groups	1	742.87	742.87	12.22*
	within Groups	5	303.97	60.79	

*Significant at 0.05 Level. Tab 'F' (1, 5) = 6.61

The ANCOVA of adjusted post-test scores shows that the six weeks of NMTP plus basketball training have significantly affected the performance of Johnson basketball ability test batteries of EG. Significant improvement in the post-test performance of shooting, dribbling, and overall basketball ability as the calculated 'F' values i.e. 29.67, 25.63, and 12.22, respectively, were found to be higher than the tabulated 'F' (1,5) value i.e. 6.61. The throwing accuracy performance does not significantly improve as the calculated 'F' value 0.49 was lesser than the tabulated 'F' value i.e. 6.61.

Discussion: Statistical Analysis has revealed significant facts about the effect of the neuromuscular training program on basketball ability. Research Scholar believes that the findings in terms of neuromuscular training program justify the very purpose of the study. Research Scholars are more than satisfied that the successful accomplishment of this study has paved a significant contribution in the area of Physical Education, sports science, and basketball coaching-related research.

Comparing the control group's pre and post-test performance of all three test items and overall basketball ability shows negligible improvement. Only in the field goal speed tests, we found slight improvement may be due to the regular basketball training framed by the basketball coach comprised of a warm-up, various skill-related drills, and game practice.The data collected on basketball playing ability before and after the training clearly shows that the post-training data is better than the pre-training data of EG. Apparent differences in the post-training data between EG and CG were there. The statistical analysis of post-training data proved that the NMTP has significantly improved all the selected variables of the Johnson basketball ability test battery and overall basketball ability except the throwing accuracy test in EG.So it is clear that along with regular basketball practices, the progressive neuromuscular training program can bring significant effect and improvement in basketball ability. The research scholar would like to attribute these findings to a few reasons and facts.

Strength is a prerequisite motor component for excellent performance in any sporting event [25]. Along with skill development, speed and strength development is also necessary for executing any technique by an athlete [26] in any sports. A progressive weight training program develops strength among the participants [27], and the proper amount of strength of the arm and shoulder girdle is very much necessary for accurate shooting [28] in basketball. The strength training exercises performed by the basketball players as a part of the neuromuscular training program must have improved the shoulder and arm strength of the basketball players in EG. In turn, it helped to improve post-training shooting ability performance compared to pre-test performance and CG. The result of the present study is in line with a few previous studies where the researchers have found a significant effect of resistance training on shooting abilities in basketball [29, 30].

During shooting in basketball, the power shifts from the lower extremities to the upper extremities through the trunk [31], this involves various complex movements of core muscles along with postural control and balance of the core area [32]. The performance of various specific motor skills depends on the proper amount of core strength through various kinds of core strengthening programs [33]. Core strength training helps the basketball player to develop solid body posture by developing strong core muscles. It ultimately helps power transmission from lower to upper extremities in a coordinated manner during the execution of the skills [34]. The basketball players of EG must have developed the strength of the core muscles, postural control, and balance through core stability exercises, ultimately improving the shooting performance compared to the CG in the post-training test of the field goal speed test. Ning [35] also found a significant effect of core training on shooting ability in basketball, which supports the present study's findings.

In the throwing accuracy test, the pre-test and post-test performance do not show any significant improvement in EG or CG. It means the NMTP did not affect the passing ability of basketball. The present NMTP has developed the strength of the upper and lower extremities and the core muscles. So it was expected that the throwing accuracy would also significantly improve, which did not happen. This result does not support the result of Kaberna [36], where he has concluded that the strength of various body parts may improve the release time of the ball while throwing. However, it will not necessarily improve the chest pass's total performance time or the ball's actual speed. The present findings contradict the findings of Vargheese and Selvam [30], who found a significant effect of strength on passing ability.

Dribbling is one of the essential attacking skills in basketball, which involve control over the ball by one hand, bouncing, controlling the ball in static or dynamic condition, and frequently changing the direction at a faster rate [37]. So a good amount of motor fitness, especially strength, agility, stability, speed etc., are prerequisites to being a good dribbler in basketball. According to the situation, a player can start, stop or change the direction [38]. The neuromuscular training program comprising of core stability and strength-enhancing exercises developed various physical, motoric, and biomechanical qualities [20] and musculoskeletal fitness [23] of the BB players. Due to these reasons, the post-test dribbling performance significantly improved compared to the pre-test and CG.

The pre and post-test performance of overall basketball ability show significant improvement after six weeks of training in EG compared to CG. One reason behind such results may be regular basketball practice, which must have developed technical skills, physical and motor fitness like speed, coordination, flexibility etc., as well as psychological aspects like self-esteem, concentration, confidence etc. [39]. The improvement was supposed to occur in both groups, as both groups attended the regular basketball practice sessions together, which has not happened. So the difference between the groups might have occurred due to neuromuscular training performed by the basketball players of EG. In this program, the BB players' body balance, fitness levels, and biomechanical performance were developed, improved, and maintained through neuromuscular training [20, 40]. Further reduced the chances of sports-related injuries and maintained good health [15], thus improving skills performance. The findings of the present study align with those of a few previous studies conducted by Canli [22] and Ahmed [23], where they found a significant effect of the neuromuscular training program on basketball skill performance.

According to the above facts and findings, participation in a progressive neuromuscular training program significantly improved a variety of physical, motoric, and musculoskeletal fitness factors, including strength, coordination, flexibility, balance, and stability. Ultimately, development of neuromuscular fitness is one of the reasons behind the significant improvement in basketball playing ability post-test performance. Besides these, the regular BB practices have done the skill development, and the development of various psychological aspects like self-esteem, concentration, confidence etc. might be another reason for improved BB ability post-test performance for EG. Nevertheless, in the case of the participants of CG, only regular basketball practice could not create significant improvement in basketball playing ability compared to EG. So it is evident that basketball playing ability not only depends on regular basketball practices, which might help the participants to develop psychologically and technically but also needs well-developed neuromuscular fitness to execute the skills flawlessly according to the situations.

CONCLUSIONS

After analyzing the present results and various related facts, the present researchers have drawn the following conclusions:

- Progressive NMTP significantly improved physical, motoric, and musculoskeletal fitness, ultimately neuromuscular fitness.

- Regular BB practices develop various psychological aspects along with skills.
- Basketball playing ability not only depends on regular basketball practices, which might help the participants to develop psychologically and technically but also needs well-developed neuromuscular fitness to execute the skills flawlessly per the situations.
- The neuromuscular training program and regular basketball practices would improve basketball playing ability.

ACKNOWLEDGEMENTS:
We would like to thank Visva-Bharati University Sports Board, Santiniketan, India, for providing detailed information about the participants. Furthermore, we are grateful to the Department of Physical Education and Sport Science, Visva-Bharati University, India, for their constant support and help in conducting the study, especially for permitting using their gymnasium and basketball court. Further, we would like to thank Dr. Sentu Mitra, Asst. Professor & Basketball Coach, Visva-Bharati University, India, for his constant help in formulating the basketball training program for this study. We want to thank Mr. Asit Mahara, Ph.D. Scholar, Department of Physical Education and Sport Science, Visva-Bharati University, India, for his continuous help and support in conducting the study. Last but not least, we thank all the participants for their direct participation in the study.

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