ORIGINAL ARTICLE

Nr 2022;12 (4):562-569

Effect of Eight-Week Proprioceptive Neuromuscular Facilitation (PNF) Pattern-Based Exercises on Performance Scores and Postural Stability in Elite Men Basketball Players

A. Shamlou Kazemi[1], F. Babakhani[2], R. Sheikhhoseini[2], H. Naderifar[3]

[1] *Faculty of Physical Education and Sport Science, University of Guilan, Rasht, Iran*
[2] *Faculty of Sport Sciences, Allameh Tabataba'i University, Tehran, Iran*
[3] *Hearing Disorders Research Center, Hamadan University of Medical Sciences, Hamadan, Iran*

CORRESPONDING AUTHOR:
Farideh Babakhani
Faculty of Sport Sciences
Allameh Tabataba'i University
Varzesh Sq., Dehkadeh Olympic
Tehran, Iran
E-mail: Farideh_Babakhani@yahoo.com

DOI:
10.32098/mltj.04.2022.13

LEVEL OF EVIDENCE: 3

SUMMARY

Background and objective. Balance is essential to an athlete's ability and may be affected by some interventions like exercise. The Proprioceptive Neuromuscular Facilitation (PNF) exercises to facilitate and control neuro-muscular systems. This study investigated the Effect of eight-week Proprioceptive Neuromuscular Facilitation (PNF) pattern-based exercises on function and balance in elite basketball players.

Materials and methods. This study was a randomized field trial. For this purpose, a total of 34 elite athletes were divided into two experimental (N = 17) and control groups (N = 17) by a simple blocked randomization method. The PNF pattern-based exercises were given to the experimental group for eight weeks and three weekly sessions. The athletes' function, balance, and stability range before and after eight weeks were collected using a 15-attempt basketball and Biodex device test. ANCOVA was performed to analyze data at a significant level of $\alpha \geq 0.05$.

Results. After 8 weeks of (PNF) pattern-based exercises, there was a significant difference between two groups on the function ($p = 0.001$) and postural stability indicators (total stability of ($p = 0.001$)), external-internal stability ($p = 0.001$), posterior-anterior ($p = 0.001$) in post-test of two groups ($p < 0.05$).

Conclusions. PNF pattern-based exercises improve the function and balance of elite basketball players. It is recommended that these exercises be used in basketball players' programs.

KEY WORDS

Basketball; exercise therapy; postural balance; athletic performance; proprioception.

INTRODUCTION

Basketball is one of the most popular sports and demands a combination of various technic tactical, psychological, and physiological characteristics (1). Technical skills are essential in distinguishing players and could determine their level (2). Nevertheless, basketball requires the players with or without the ball to execute movements such as passing and receiving the ball while balancing on one leg, looking in the same or the opposite direction, to have constant visual contact with their teammates and opponents during physical contact are required to shoot (3). Basketball players change rules, jump, and run, exerting a great deal of overload on the lower limbs (4, 5). Therefore, balance and neuromuscular control are essential factors affecting the performance of these players (6). Balance is usually a practical component of athletic activity and considerably impacts performance in sports activities (7). Therefore, besides the possible decrease in injuries, it can increase athletic performance with the support of neuromuscular training programs and support the improvement of motor control (8).

Good balance in basketball provides a controlled body for players, minimizes their errors, protects against the drop when changing their directions, quick moves, and practical technical skills (9, 10). Static and dynamic balances require sensory-visual, somatic nervous system data, and atrial receptors to produce effective efferent responses for controlling the body's center of gravity at the reliance level (11). Balance also contributes to preventing injuries and the rehabilitation process (12). Postural stability is essential to reduce sports injuries and improve the performance of basketball players (13).

One of the most common injuries in modern societies is that the treatment of sports injuries is often difficult, expensive, and time-consuming, and preventive strategies are justified for medical and economic reasons (14, 15). Preventive strategies for sports injuries, including functional exercises, training, special sports skills, and balance, should be considered in the pre-season and during the sports seasons (16).

PNF is a method of exercise therapy that aims to facilitate the neuromuscular system by stimulating proprioceptive, which in the end, will be achieved coordinated ability or movement (17). Proprioceptive Neuromuscular Facilitation (PNF) exercises consist of two parts of movement patterns and techniques (18). There are basics in practices and procedures that can help the individual progress (19). The PNF uses typical or diagonal (spiral) patterns to stimulate proprioception, improve nerve root responses, and increase functional motions, increasing muscle strength, flexibility, and balance (20).

Balance exercises have been developed for various sports (21). For example, one study showed a significant effect of balance exercise training on postural stability and decreasing stature oscillations in skiers (22). Another study also investigated the impact of neuro-muscular exercises on reducing lower limb injury in elite women basketball players (23). The results of this study showed that neuro-muscular practices lead to a reduction of severe injuries in the lower extremity of elite women basketball players (24). Also, a study found a positive effect of neck PNF training on female basketball players' static, dynamic balance, and performance (5).

The relationship between balance ability and sports injury risk has been established in many cases, but the relationship between balance ability and athletic performance is unclear (25). Basketball is a striking discipline that needs balance exercises and greatly anticipates injury planning (26). The primary purpose of this study was to determine whether training based on PNF patterns affects the balance and performance of elite basketball players.

METHODS

This study was a randomized field trial with the IR.USHA.REC.1397.433 Code of Ethics, approved by Hamadan University of Medical Sciences Ethical Committee on September 22, 2018, in which 34 elite men basketball players were randomly assigned into two groups, including PNF pattern-based exercises (N = 17) and control one (N = 17) based on a simple blocked randomization method. The athletes in the PNF pattern-based exercises group participated in 24 sessions of under-supervision PNF exercises over eight weeks. The control group maintained their activity level during the study period before participating. The amount of function and balance indicators were measured before and after eight weeks of intervention in two groups of exercise and control by the researcher. While in this study, the assessor was not blinded. The number of samples was calculated by G.power and based on the results of a previous study (27), considering $\alpha = 0.05$, $\beta = 0.20$, SD = 0.83, and was obtained using the center of gravity displacement data for the external-internal axis in the warm-up and PNF groups.

The criteria for entering the study were a mean age of 18 to 24 years old, a record of at least three years of regular basketball exercises (weekly three sessions), and a minimum form of participation in the first division league of Iran. Individuals with a history of hearing loss, a history of lower extremity surgery, and balance disorders such as systemic diseases, diabetes, lower limb disorders, and the spine were excluded from the study (28). Before the measurements, the participants' informed consent form was studied and signed by all subjects. First, the height and weight of each subject were measured with a meter and a Kinlee digital scale with a height accuracy of 1 mm and a weight measurement accuracy of 50 g. In the pre-test, 15 attempt test throw penalty of basketball was used to determine the accuracy of the throw and function of the athlete, also to measure the stability range, dynamic and static balances, the Biodex balance system was used (5). The intervention group then participated in the training protocol. The exercises were based on PNF patterns regularly and three sessions a week under direct supervision by the researcher. After eight weeks of activities, the tests that were taken in the pre-test were carried out by the researcher in the same laboratory.

Functional test

Fifteen attempts test throw penalty of basketball, which includes 15 free throws basketball, starts from the penalty spot in the form of 3 blocks with five throws. After each exercise block, the subjects have one-minute active rest, and then the next block is done. The method of scoring of test is such that if the ball is thrown from the top to the basket and does not reach the goal, 1 point, and if the goal is 2 points, and if the ball hits the sides of the basket or not collision or failure to plan, do not consider a score (29). The test is performed three times, and the best score is given to the subject (30, 31).

Balance evaluation method

Biodex's stability system is designed to evaluate neuro-muscular control by calculating indicators that illustrate the ability to stabilize or balance. Intraclass correlation coefficient (ICC), standard error measurement (SEM), and 95% confidence interval (95% CI) were calculated (32).

Before each test, subjects rested in a sitting position for 5 minutes. During the trial, subjects were dressed comfortably, light and loose, and on the screen with naked feet. Before each measurement, the proper condition of the legs and stature was controlled by the researcher. Each test was repeated for 30 seconds and three times; the interval among each repetition was considered 10 s. The subjects were asked to use the device's handles on the balance plate so that the distance among the legs is 10% of stature and the person is entirely comfortable (33).

The spatial position of leg placement was recorded by determining the part of the heel of the legs on the graded plate and the positioning angle of the leg axis (along the second finger). The position of the legs was determined using the tip of the screen on the device plate. These values were recorded and used for other test modes. Athletes were placed in a standing position on two legs at a stability level of 4, and the postural stability test and test range were evaluated. Then, all subjects participated in the pre-test to assess the study variables, including postural stability indicators, stability limits, and dynamic and static balances (28).

PNF pattern-based exercises

An exercise session was divided into three parts: warm-up, PNF pattern-based exercises, and cool-down. The first 10 minutes of exercising were devoted to warming up, and then about 20 minutes were considered to do PNF pattern-based activities. At that time, each athlete, in proportion to their 1RM, decided to select a weight proportional to the predetermined percentage 1RM was issued for the same week (**figure 1**); at the end, 10 minutes was considered for cooling down. PNF pattern-based exercises included three patterns as follows:

First pattern: the first motion pattern was based on D1 FLX and D1 EXT patterns performed by a cross-over device with a predetermined 1RM amount in the specified number for each set.

Second pattern: the typical two-way design is that both extremities move in different directions. For example, one D2 FLX limb, another D1 EXT limb, *etc.* These exercises were done in two directions.

Third pattern: asymmetrical two-way patterns, both upper or lower extremities move to one side of the body, and they are common in FLX or EXT, but the first and second types are different. For example, D1 FLX right with D2 FLX left, *etc.* These exercises were done in two directions.

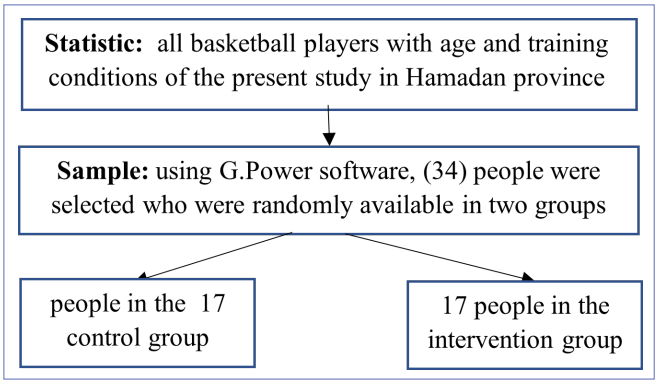

Figure 1. CONSORT.

The reason for choosing these patterns is the close connection among patterns and the similarity of these patterns with the actual sport and motions in basketball. The exercise continued for eight weeks, the first and second weeks of familiarizing with movement practices. In the third to eighth weeks, the patterns were made from first to fourth in 3 sets and 8 to 12 repetitions, respectively.

The rest time among each set was 10 s, the rest time among two emotional patterns was 30 s, and the total exercise session time was 40 minutes. Initiation of exercises with a specific 1RM based on the Brzezinski formula for each emotional pattern and activity were applied from the third week with a

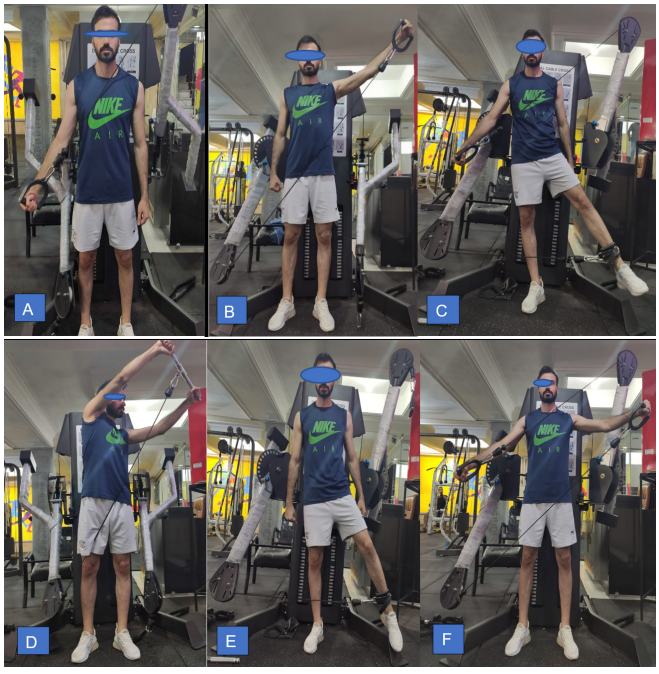

Figure 2. Examples of PNF pattern-based exercises in an experimental group.

45% of 1RM intensity (34). After three weeks, 1RM was reassessed, and in the case of positive feedback, exercises were more intense than the original 1RM. It should be noted that a cross-over device carried out all activities and appied loads in the gym.

Statistical analyses

Descriptive statistics were used to calculate the height, weight, Age mean, and standard deviation. The Shapiro-Wilk test investigated the normal distribution of data. The ANCOVA was used to compare the experimental and control groups by eliminating the Effect of pre-test scores. Also, an independent t-test was used to compare the anthropometric characteristics of the two groups. SPSS ver.22 software was used for statistical analysis with a significant level of $\alpha = 0.05$. Also, the effect size was calculated and reported using partial eta squared and test power for each variable. Multivariate Analysis of Variance (MANOVA) at a significance level of $p < 0.05$ was used for intergroup comparisons.

Research findings (following images)

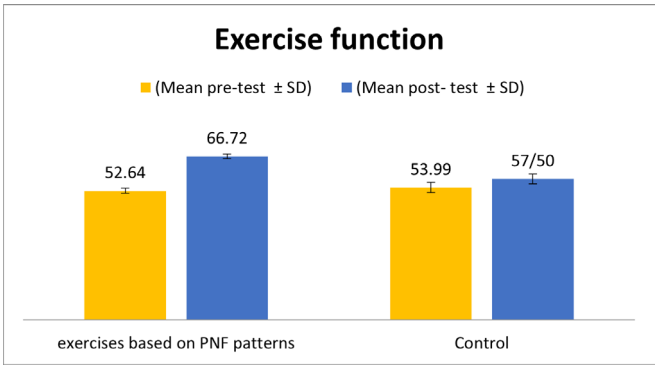

Figure 3. Comparison of the function of the intervention group and the control group.

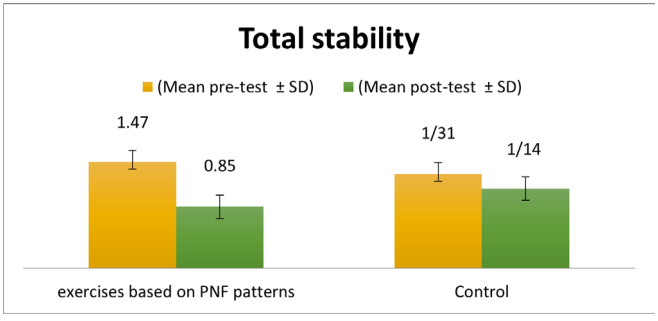

Figure 4. Comparison of total stability of intervention group and control group.

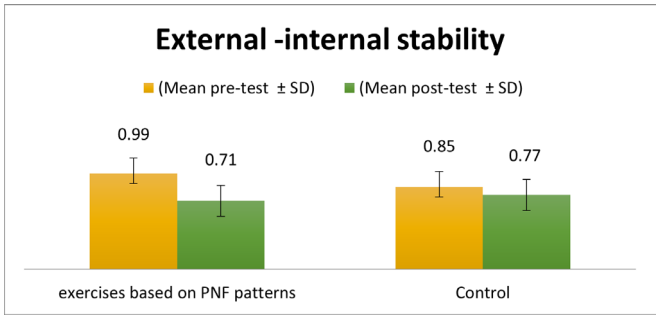

Figure 5. Comparison of internal-external stability of intervention group and control group.

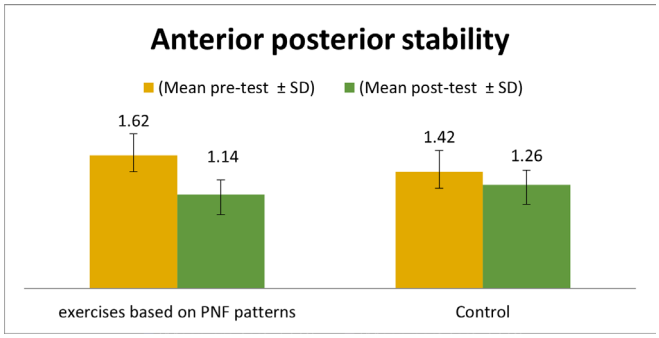

Figure 6. Comparison of anterior-posterior stability of intervention group and control group.

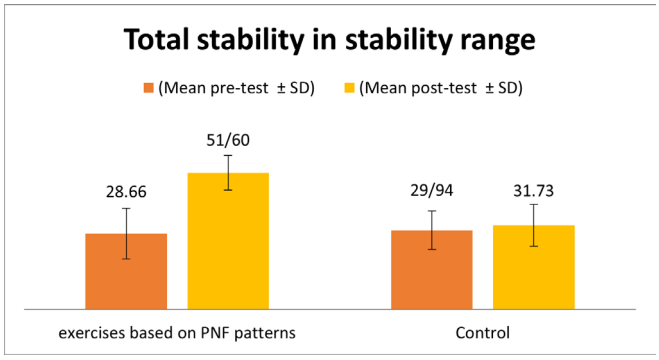

Figure 7. Comparison of total stability of intervention group and control group.

RESULTS

The study groups' information, such as Age, body weight, height, and Body Mass Index (BMI), are summarized in the table below (**table I**). According to the Shapiro-Wilk test data and the normal distribution of the obtained data ($p > 0.05$), ANCOVA was used to compare between-group differences concerning Age (0.214), weight ($p = 0.576$),

height (p = 0.332), and BMI (p = 0.362). There was no significant difference between the study groups regarding the variables mentioned above. The results of the test showed that after controlling the Effect of the pre-test, there was a significant difference among the two groups in function (0.001), mean postural stability indicators (total stability (0.001), external-internal stability (0.001), anterior-posterior stability (0.001) and total stability (0.001) in the stability range in post-test ($p < 0.05$). These findings are summarized in **tables II**, **III**, **IV**.

Table I. Anthropometric characteristics of subjects in control (N = 17) and Experimental (N = 17) groups.

Variable	Group	N	Mean	SD	P-value	Levene's Test for Equality of Variances (Sig)
Age	Experimental	17	21.26	2.05	0.683	0.214
	Control	17	21.46	2.41		
Height	Experimental	17	186.84	8.23	0.349	0.332
	Control	17	183.53	5.52		
Weight	Experimental	17	74.58	6.47	0.838	0.576
	Control	17	75.56	5.82		
BMI	Experimental	17	21.53	2.56	0.912	0.362
	Control	17	22.64	3.43		

Table II. The results of covariance analysis for comparing exercise function among two groups in the post-test.

Variable	Group	N	Mean pre-test	SD	Mean post-test	SD	p	Effect size	Test power
Exercise function	Experimental	17	52.64	0.98	66.72	2.04	0.001*	0.14	0.73
	Control	17	53.99	1.03	57.50	2.12			

Table III. The results of the covariance test for comparing postural stability indicators among two groups in the post-test.

Variable	Group	N	Mean pre-test	SD	Mean post-test	SD	p	Effect size	Test power
Total stability	Experimental	17	1.47	0.27	0.85	0.10	0.001	0.60	0.95
	Control	17	1.31	0.25	1.14	0.08			
External -internal stability	Experimental	17	0.99	0.10	0.71	0.16	0.001	0.39	0.99
	Control	17	0.85	0.23	0.77	0.16			
Anterior-posterior stability	Experimental	17	1.62	0.64	1.14	0.20	0.001	0.20	0.89
	Control	17	1.42	0.29	1.26	0.18			

Table IV. The results of the covariance analysis for comparing the total stability indicator in the stability range among two groups in the post-test.

Variable	Group	N	Mean pre-test	SD	Mean post-test	SD	p	Effect size	Test power
Total stability in the stability range	Experimental	17	28.66	9.55	51.60	7.23	0.001	0.21	0.90
	Control	17	29.94	6.55	31.73	7.93			

DISCUSSION

This study aimed to investigate The Effect of Eight-Week Proprioceptive Neuromuscular Facilitation (PNF) pattern-based Exercises on Performance scores and Postural Stability in Elite Men's Basketball Players. The present study also showed that performing 8-week-long exercises based on PNF patterns under observation will significantly improve penalty free throw, balance (static and dynamic), Total stability, and limit of strength.

While in this study, the assessor was not blinded. The results of a survey conducted by Boccolini (in which he investigated the effect of balance training on the performance of male basketball players) showed that by doing balance training, the performance (the ability to jump vertically) of the young basketball players improved (34). Also, the results of a study conducted by Kumar (in which he investigated the effect of 12-week-long plyometric exercises on the performance of male basketball players) showed a significant difference in the shooting ability between the two experimental and control groups (35). In addition to that, the results of a study conducted by Canli (in which he investigated the effect of neuro-muscular exercises on basketball motor and selected skills in basketball players before puberty) showed significant effects of neuro-muscular practices on shooting and motor skills in making basketball players before puberty (36). The results of these studies regarding the fact that PNF patterns have significant effects on the performance of basketball players were consistent with our findings. The reason for this can be the Effect of these exercises on the proprioception and the similarity of these patterns with the original motor patterns in basketball. These items were the reason for the performance improvement of the basketball players in this research.

Basketball season is one of the longest seasons in professional sport (37). Constant physiological stress and high movement demand on the players during the pre-season and competitive season may result in cumulated fatigue, leading to a higher risk of injury (38). Furthermore, accumulated fatigue over a season may also impact players' performance, such as technical skills and reaction time (39). Each training program should conform to a particular level of sensorimotor processes according to a specific sports discipline to perform skills and protect the neuromuscular system from injury (40). Balance is an integral part of an athlete's activity (33). In basketball, the ability to control the posture is essential to reduce non-contact injuries and improve performance; for this reason, researching exercises that increase Sensory-motor system responses have different effects on improving the dynamic balance index depending on the type and intensity of exercise (41). Also, several studies have shown that resistance exercises and proprioception affect people's ability to keep dynamic balance (42). In a study, Ondra *et al*. investigated the Effect of in-season neuromuscular and proprioceptive training on postural stability. The results showed in male youth basketball players, the specific proprioceptive and neuromuscular training had a positive effect on postural stability for both the dominant and non-dominant limbs in basketball players (7). In a study by Kate *et al*. On the dynamic balance and landing mechanism of female basketball players after six weeks of neuromuscular training, the results showed a significant effect of exercise on emotional balance and landing mechanism during nine months (42). In a study, Kim *et al*. investigated the instantaneous Effect of PNF lower body patterns on balance and daily life activities in patients with stroke, and the results showed a significant and positive difference between the experimental group and the control group in the level of balance and daily activities (43). In a study, Naderifar *et al*. examined the effect of neck PNF exercises on static, dynamic balance, and performance of women basketball players and concluded that the static, dynamic balance and performance indices in the intervention group improved compared to the control group (5). Also in a study examining the effect of balance and proprioceptive training on balance and technical skills of young basketball players, Emanwell *et al*. Found that there was a significant difference between static, dynamic balance and fast shooting and passing accuracy between the intervention and control groups (29).

The results of these studies were the same as the results of our research based on the Effect of exercises based on PNF patterns which may be due to the more significant effect of PNF exercises on proprioception recall, which would be a factor in improving and enhancing the level of balance. Also, the similarity of PNF patterns with specific sports subject movements can be considered another factor in improving balance indicators.

Limitations and research suggestions

The Elastafit Thera band can be used because of the limitation of cross-over weights. The effect size in the case of balancing and function is small, and it may increase the effect size by continuing the exercises based on the PNF patterns over a more extended period. It is suggested that dynamic sports athletes use activities based on PNF patterns to improve balance and function and increase total stability within the stability range.

Total resulting

The programming exercise based on PNF patterns improves sports function, postural stability indicators, and the range gauge stability (total stability) after eight weeks of activities based on PNF patterns in men basketball players. Therefore, it is recommended that coaches and basketball players use these patterns in their exercise programs and benefit from them.

CONCLUSIONS

Basketball is a dynamic sport, and keeping balance is essential in improving performance. Various studies have proved that the prevalence and risk of injury in basketball are very high. Balance is one of the main components of most daily activities and an essential factor for athletes' athletic performance; According to researchers, balance is the most critical factor in the ability to perform sports. Therefore, having a healthy and capable balance control system while improving a person's performance during physical activity is also essential to preventing sports injuries. One of the factors considered by researchers is the Effect of applying different training methods on improving balance and postural control. In general, it can be said that PNFs are mainly performance-based, and implementing these exercises and training patterns can be practical and helpful in improving people's athletic performance in their sports. One of the mechanisms of PNF is its Effect on proprioception function. PNF pattern-based Exercises improve balance in elite men's basketball players and following elite men's basketball balance, players also improve their performance.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

ASK: design. FB: data collection. HN, ASK: writing. RS: editing, revision, results analysis, improvement of the discussion section.

ACKNOWLEDGMENTS

This manuscript is drafted from the MSc thesis of the Faculty of Physical Education and Sport Sciences, Allameh Tabataba'i University, Tehran, Iran.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

REFERENCES

1. Masin H. Basketball's Most Unforgettable Game. Library 2003;73(5):27-9.
2. Roman IR, Molinuevo JS, Quintana MS. The relationship between exercise intensity and performance in drills aimed at improving the proficiency, technical and tactical skills of basketball players. Rev Int Cienc Deporte 2009(14):1-10.
3. Winter DA. Human balance and posture control during standing and walking. Gait Posture 1995;3(4):193-214.
4. Strniště M, Hůlka K, Lehnert M, Maixnerová E, Vařeková R, Lazecká Š. Neuromuscular control of the knee joint during basketball season in male youth players. Acta Gymnica 2019;49(3):125-31.
5. Minoonejad H, Barati AH, Ghanbari L, Naderifar H. The effect of Proprioceptive Neuromuscular Facilitation exercises on dynamic visual acuity and Sport performance of young basketball players. Pajouhan Sci J 2022;20(2):71-7.
6. Curtolo M, Tucci HT, Souza TP, Gonçalves GA, Lucato AC, Yi LC. Balance and postural control in basketball players. Fisioter Mov 2017;30:319-28.
7. Ondra L, Nátěsta P, Bizovská L, Kuboňová E, Svoboda Z. Effect of in-season neuromuscular and proprioceptive training on postural stability in male youth basketball players. Acta Gymnica 2017;47(3):144-9.
8. McLeod T, Armstrong T, Miller M, Sauers JL. Balance improvements in female high school basketball players after a 6-week neuromuscular-training program. J Sport Rehabil 2009;18(4):465-81.
9. Mahmoud MH. Balance exercises as the basis for developing the level of physical and skill performance in basketball young players. World J Sport Sci 2011;4(2):172-8.
10. Naderifar H, Ghanbari L. Effect of Selected Corrective Exercises on Glenohumeral Rotation range of Motion in Overhead Athletes with Scapular Dyskinesis. Studia Sport 2022;16(1):54-62.
11. Rogge A-K, Röder B, Zech A, Hötting K. Exercise-induced neuroplasticity: Balance training increases cortical thickness in visual and vestibular cortical regions. Neuroimage 2018;179:471-9.
12. Hahn T, Foldspang A, Vestergaard E, Ingemann-Hansen T. One-leg standing balance and sports activity. Scand J Med Sci Sports 1999;9(1):15-8.
13. Notarnicola A, Maccagnano G, Tafuri S, Pesce V, Digiglio D, Moretti B. Effects of training on postural stability

in young basketball players. Muscles Ligaments Tendons J 2015;5(4):310.
14. Multon KD, Parker JC, Smarr KL, et al. Effects of stress management on pain behavior in rheumatoid arthritis. Arthritis Rheum 2001;45(2):122-8.
15. Mohammadi SF, Aghazade Amiri M, Naderifar H, et al. Vision Examination Protocol for Archery Athletes Along With an Introduction to Sports Vision. Asian J Sports Med 2016;7(1):e26591.
16. Abernethy L, Bleakley C. Strategies to prevent injury in adolescent sport: a systematic review. Br J Sports Med 2007;41(10):627-38.
17. Pachruddin I, Rusly H, Nasaruddin F (eds). Effect of proprioceptive neuromuscular facilitation (PNF) on standing balance control among post stroke patients. In: Journal of Physics: Conference Series. IOP Publishing, 2020.
18. Klein DA, Stone WJ, Phillips WT, Gangi J, Hartman S. PNF training and physical function in assisted-living older adults. J Aging Pys Act 2002;10(4):476-88.
19. Jull GA, O'Leary SP, Falla DL. Clinical assessment of the deep cervical flexor muscles: the craniocervical flexion test. J Manipulative Physiol Ther 2008;31(7):525-33.
20. Kim EK, Lee DK, Kim YM. Effects of aquatic PNF lower extremity patterns on balance and ADL of stroke patients. J Phys Ther Sci 2015;27(1):213-5.
21. Gauchard GC, Gangloff P, Vouriot A, Mallié JP, Perrin PP. Effects of exercise-induced fatigue with and without hydration on static postural control in adult human subjects. Int J Neurosci 2002;112(10):1191-206.
22. Kurz A, Lauber B, Franke S, Leukel C. Balance Training Reduces Postural Sway and Improves Sport-specific Performance in Visually Impaired Cross-Country Skiers. J Strength Cond Res 2021;35(1):247-52.
23. Pasanen K, Parkkari J, Pasanen M, et al. Neuromuscular training and the risk of leg injuries in female floorball players: cluster randomised controlled study. BMJ 2008;337(7661):a295.
24. Bonato M, Benis R, La Torre A. Neuromuscular training reduces lower limb injuries in elite female basketball players. A cluster randomized controlled trial. Scand J Med Sci Sports 2018;28(4):1451-60.
25. Hrysomallis C. Balance ability and athletic performance. Sports Med 2011;41(3):221-32.
26. Karimizadeh Ardakani M, Soroush Fard Z, Amirizadeh F, Naderifar H. Effect of Thoracic Hyper-Kyphosis Posture on Upper Extremity Function of Female Students. J Rehabil Sci Res 2022;9(1):30-5.
27. Ryan EE, Rossi MD, Lopez R. The effects of the contract-relax-antagonist-contract form of proprioceptive neuromuscular facilitation stretching on postural stability. J Strength Cond Res 2010;24(7):1888-94.
28. Minoonejad H, Barati AH, Naderifar H, Heidari B, Kazemi AS, Lashay A. Effect of four weeks of ocular-motor exercises on dynamic visual acuity and stability limit of female basketball players. Gait Posture 2019;73:286-90.
29. Harrison L. Understanding the influence of stereotypes: Implications for the African American in sport and physical activity. Quest 2001;53(1):97-114.
30. Collins DR, Collins RD, Hodges PB. A comprehensive guide to sports skills tests and measurement. Scarecrow Press, 2001.
31. Brzycki M. Strength testing—predicting a one-rep max from reps-to-fatigue. J Phy Edu Recreat Dance 1993;64(1):88-90.
32. Arifin N, Abu Osman NA, Wan Abas WA. Intrarater test-retest reliability of static and dynamic stability indexes measurement using the Biodex Stability System during unilateral stance. J Appl Biomech 2014;30(2):300-4.
33. Naderifar H, Minoonejad H, Barati AH, Lashay A. Effect of a neck proprioceptive neuromuscular facilitation training program on body postural stability in elite female basketball players. J Rehabil Sci Res 2018;5(2):41-5.
34. Boccolini G, Brazzit A, Bonfanti L, Alberti G. Using balance training to improve the performance of youth basketball players. Sport Sci Health 2013;9(2):37-42.
35. Dukarić V, Rupčić T, Feng L, Cigrovski V, Knjaz D. Determining asymmetry using specific unilateral tests in young basketball players. SportLogia 2020;16(1):67-79.
36. Canli U. Effects of Neuromuscular Training on Motoric and Selected Basketball Skills in Pre-Pubescent Basketball Players. UJER 2019;7(1):16-23.
37. Edwards T, Spiteri T, Piggott B, Bonhotal J, Haff GG, Joyce C. Monitoring and Managing Fatigue in Basketball. Sports (Basel) 2018;6(1):19.
38. Taylor K, Chapman D, Cronin J, Newton MJ, Gill N. Fatigue monitoring in high performance sport: a survey of current trends. J Aust Strength Cond 2012;20(1):12-23.
39. Gabbett TJ. Influence of fatigue on tackling technique in rugby league players. J Strength Cond Res 2008;22(2):625-32.
40. Bressel E, Yonker JC, Kras J, Heath EM. Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. J Athl Train 2007;42(1):42.
41. Rosendahl E, Littbrand H, Lindelöf N, Lundin-Olsson L, Yngve G, Nyberg L. A high-intensity functional exercise program is applicable for older people with cognitive impairment, 2007.
42. Mattacola CG, Lloyd JW. Effects of a 6-week strength and proprioception training program on measures of dynamic balance: a single-case design. J Athl Train 1997;32(2):127.
43. Kim K, Lee D-K, Jung S-I. Effect of coordination movement using the PNF pattern underwater on the balance and gait of stroke patients. J Phys Ther Sci 2015;27(12):3699-701.