

RESEARCH ARTICLE

EFFECTS OF NEUROMUSCULAR TRAINING ON SINGLE LIMB STABILITY IN YOUNG FEMALE ATHLETES

1. PG Student, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University Lahore, Pakistan
2. Professor, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University Lahore Pakistan
3. Senior Lecturer, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University Lahore Pakistan

Correspondence

Mehwish Ikram

Senior Lecturer, Faculty of Rehabilitation & Allied Health Sciences, Riphah International University Lahore Pakistan
E-mail: mehwish.ikram@riphah.edu.pk

Received on: 02-02-2022

Revision on: 06-06-2022

Published on: 30-06-2022

Citation

Mujtaba SB, Rehman SS, Ikram M, Jalil M, Tariq K. Effects of neuromuscular training on single limb stability in young female athletes T Rehabil. J. 2022;06(02):357-360
doi: [10.525567/trj.v6i02.130](https://doi.org/10.525567/trj.v6i02.130)

Shah Bano Mujtaba¹: Conception, data collection, writing; Revised and accountable for all aspectsSyed Shakil ur Rehman²: Revised and accountable for all aspectsMehwish Ikram³: Analysis & interpretation of data, Revised and accountable for all aspectsMomina Jalil⁴: Interpretation of data, Revised and accountable for all aspectsKomal Tariq⁵: Revised and accountable for all aspects

ABSTRACT

Background: Lower limb injuries in sports affect postural stability and balance. Muscular imbalance, postural malalignments, and altered biomechanics occurred in athletes due to injuries. **Objective:** To determine the effects of the 6-week neuromuscular training program on single-limb stability in young female athletes. **Methodology:** A single-subject study design was used in which n=20 female athletes aged between 18 to 25 years with previous lower limb injuries that lead to impaired balance and postural instability participated in this study included by the convenience sampling from the Faisalabad sports complex. Athletes completed 6-week neuromuscular training program, with every session of 90 min and 3 times a week. Assessment of athletes was performed before and after the completion of the neuromuscular training program at 6 weeks, with a single-limb stance test, Stork balance stand test, and star excursion balance test. **Results:** The mean age of participants was 20.6±1.82 years. The pre-post analysis of Single limb stance test, stork balance test, Star excursion balance test right and left anterior, left medial, right and left lateral also showed significant results (p<0.01). But star excursion balance test right medial no significant change (p=0.234) in score observed after 6th week of training. **Conclusion:** Although 6-week neuromuscular training program showed a significant improvement on single-limb stability in young female athletes. But without control or comparative group we cannot establish its gender specific effectiveness.

Keywords: Neuromuscular training, static and dynamic balance, single limb stance test, stork balance stand test, star excursion test.

INTRODUCTION

Lower limb injuries are most common in sports that occurred during sports and competitions. If inadequate training sessions were done during practice or before a sports competition, it can cause lower limb injuries, and sometimes these injuries are very extensive and damage the muscle tissues or ligaments. Anterior cruciate ligament (ACL) injuries, patellofemoral, hamstring, and ankle lateral ligament injuries are common^{1, 2}.

Neuromuscular training includes balance training, and plyometric and resistance training. ACL, hamstring, and ankle injuries are mostly traumatic while the patellofemoral injuries are due to repetitive use. Previous injuries in sports can also give evidence for future injuries^{1, 3, 4}.

Neuromuscular training improves physical fitness and reduces the risk of future injuries. Muscle strength, power, agility, and balance are improved and increase the abilities of the athletes, functional assessment is very essential. Static and dynamic balance assessment is necessary because in sports it is very important to assess and it can lead to future problems, and muscle or ligament injuries that affect the athletes' life^{5, 6}.

Several factors contribute to lower limb injuries, including altered biomechanics, postural malalignments, physical inactivity, sedentary lifestyle,

improper landing and cutting, and improper sports technique⁷.

Non-contact sports are the major contributors to ligamentous injuries in female players, especially during the stop, jumping, landing, and changing directions. Several risk factors are responsible including anatomical and hormonal factors. For the prevention of knee injuries by the development of effective training programs were introduced that focus on modifying risk factors causing knee injuries in women⁸. A study was conducted in 2012 in Brazil in which female athletes were more prone to be injured during training especially involved the lower limb (Hip, Knee and Ankle injuries)⁹.

Prevention strategies based on current understanding have been developed to increase grip over neuromuscular coordination and lower limbs to lessen the rates of lower limb injuries. A range of training courses, extending from injury awareness to multi-component exercise, have been utilized in these attempts. Lower limb mobility patterns are altered by several training programs^{10, 11}.

In this study prevention of postural instability and balance that occurred after lower limb injuries in athletes was treated with neuromuscular training. Best preventive strategies and treatment plans can improve the efficiency of the female athletes because the prevalence rate is high in female

athletes as compared to males. The purpose was to find out the effects of neuromuscular training protocols to improve the balance.

METHODOLOGY

A single subject study design was used, and study was carried out at Faisalabad Sports Complex, Faisalabad. The study was completed in six months after the approval of the research ethical committee, Ref. No. REC/Lhr/21/0414. The study was clinically registered by ClinicalTrials.gov ID: NCT04967937. The Study duration was from November 2020 to April 2021. The sample size was n=20, the female Athletes with an age range from 18-25 years with postural instability and impaired balance after lower limb injuries. The participants with malignancy, infection, systemic illness, and trauma are excluded from the study. A convenience sampling technique was used for sample selection. The single-limb stability was assessed with Single Limb Stance Test for postural balance^{12, 13}. The Star Excursion Balance Test for Dynamic Balance and the Stork balance stand the test for static balance. Before the start of data collection written informed consent was taken from all the participants^{14,15}.

The neuromuscular training program consisted of 90-minute training per session and a total of 3 sessions per week for 6 weeks. The 3 components of the dynamic neuromuscular training protocol were used in this study, including *The Balance training and hip/pelvis/trunk strengthening* including Superman pose, crunches, single leg hop, 180-degree jump stick landing and Medicine ball catch/Slam. *The Plyometric and dynamic movement training* including Zigzag jumps, Barrier jumps (Front to back), Barrier jumps (Side to side), Wall

jumps, squat jumps). *The Resistance training* which included Leg curls, Lunge circuit, Leg press, Lunges, Ankle eversion, Inversion exercises.

Each participant was assessed at the baseline and after 6th week of the training program^{6, 8, 16-18}. The paired sample t-test was used to determine changes between pre-training and post-training readings. The data was analyzed by using the statistical tool SPSS version 25. The level of significance was set at $p < 0.05$ and to determine the effect size Cohen's d was used.

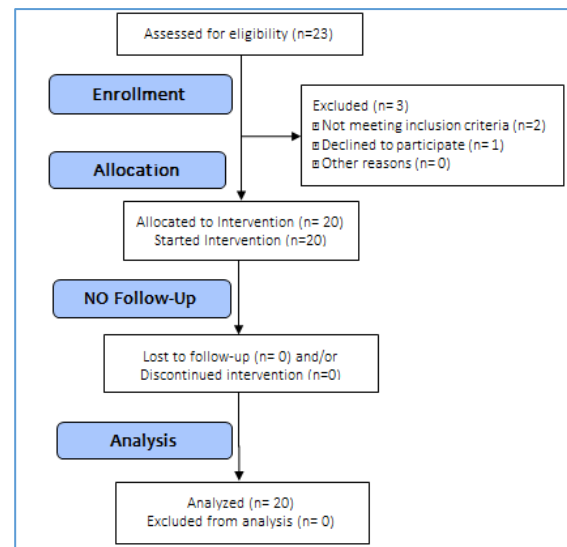


Figure.1 Flow diagram

RESULTS

The mean age of female participants was 20.6 ± 1.82 years. The average BMI was 20.37 ± 3.52 , which showed that majority of participant were in normal BMI range.

Table 1: Pre-post analysis (SLST, SEBT, SBST)

	Pre	Post	MD	p-value	Cohen's d
Single Limb Stance Test Score Eyes Open	27.70±13.85	40.75±16.45	13.05	.000***	5.01
Single Limb Stance Test Score Eyes Closed	13.35±8.28	16.60±8.46	3.25	.000***	18.05
Stork Balance Test Score	28.40±17.25	38.85±14.54	10.45	.000***	3.85
Star Excursion Balance Test Right Anterior	45.91±6.62	50.84±7.06	4.94	.000***	11.2
Star Excursion Balance Test Left Anterior	44.02±6.30	49.97±10.15	5.95	.000***	1.54
Star Excursion Balance Test Right Medial	25.76±12.25	27.84±9.15	2.08	.000***	0.66
Star Excursion Balance Test Left Medial	22.84±4.63	26.47±4.32	3.63	.000***	12.1
Star Excursion Balance Test Right Lateral	37.02±3.70	43.61±3.45	6.59	.000***	25.3
Star Excursion Balance Test Left Lateral	38.18±4.81	41.90±4.63	3.72	.000***	21.8
Star Excursion Balance Test Right Posterior	39.41±8.27	44.39±8.15	4.98	.000***	41.5
Star Excursion Balance Test Left Posterior	36.18±7.37	41.055±8.33	4.87	.000***	5.07

Single Limb Stance Test (SLST), Star Excursion Balance Test (SEBT), Stork Balance Stand Test (SBST)

Significance level: $p < 0.05$ *, $p < 0.01$ ***, $p < 0.001$ ***

The paired t-test was used to assess the pre and post readings of the groups. The pre-post analysis of single limb stance test score with eyes open and closed showed significant results (27.70 ± 13.85 Vs 40.75 ± 16.45 , $p < 0.001$) with large effect size. The stork balance test also showed significant improvement (28.40 ± 17.25 Vs 38.85 ± 14.54 , $p < 0.001$) with large effect size. The star excursion balance test right and left anterior, left medial, right and left lateral also showed significant improvement ($p < 0.001$) after 6 weeks of training with large effect size. But the star excursion balance test (right medial) did not show significant improvement ($p = 0.234$) after 6th weeks training. (table 1)

DISCUSSION

The purpose was to find out the effect of neuromuscular training program on balance in young female athletes. Neuromuscular training program with standardized protocols were adopted and balance was assessed with three balance tests including both dynamic and static balance. There are many training protocols. Balance and other training methods or exercise programs showed significant improvement. A study in 2017 was conducted on plyometric training and balance training; an eight-week program improved the different physical components of physical fitness including muscle power, strength, speed, and balance in adult male soccer athletes but in the current study only balance was assessed in athletes¹⁹.

In 2021 a study was conducted to see the effect of neuromuscular training on ACL injury risk factors. It was done during the rehabilitation process after the reconstruction of the ACL in post-operative rehabilitation and in this study after injury neuromuscular training was done that produced significant results²⁰. A systematic review in 2020 was done. Ankle sprains are a common sports-related injury, and female athletes are more likely to sustain this injury than their male counterparts. The reviews have evaluated the efficacy of prevention programs in reducing ankle sprains in athletes, but no reviews have specifically focused on female athletes. The objective of this systematic review was to examine the sex-specific effectiveness of neuromuscular training programs in reducing the risk of ankle sprains in female athletes²¹.

A randomized controlled trial was conducted in 2018 to evaluate the effects of eight-week neuromuscular training program on dynamic postural control in elite junior skiers. Neuromuscular training proved to be an effective intervention in increasing lower limb joint awareness and postural control showed results like the current study²². The limitation of this study was that it was a single group study with small sample size, in future further extension of this work can be done based on its limitation.

CONCLUSION

The 6-week neuromuscular training program showed a significant improvement on single-limb stability in young female athletes. But without control or comparative group we cannot establish its gender specific effectiveness. So, future study must be incorporated to find gender-based differences and with longer duration and multiple comparisons.

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Disclaimer: None to declare.

Conflict of Interest: None to declare.

Funding Sources: None to declare.