RESEARCH PAPER

Effect Of Integrative Neuromuscular Training Vs Hop Stabilization Training ON Injury Risk and Performance in Female Badminton Players

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ABSTRACT

Background: ACL injury is one of the most common injuries that happen in badminton players, and its strength is important to prevent the recurrence of ACL injuries. Studies have proven a significant difference between INT and hop stabilization training in subjects among female badminton players.

Method: The study design was an experimental study; 28 subjects were selected. They were divided into two groups: Integrative Neuromuscular Training (INT) (GROUP A) and Hop stabilization training (GROUP B). **Results:** The statistical analysis done using an unpaired 't' test with the values of Group A and Group B shows a significance of ($p< 0.0001$). It has been concluded that the mean difference of Group A shows impact on increasing sports performance and prevention of injury than Group B among female badminton players.

Conclusion: The study concluded that INT shows a beneficial effect on sports performance and injury prevention when compared with hop stabilization training on female badminton players after 6 weeks of intervention.

Keywords: Anterior cruciate ligament (ACL), Integrative neuromuscular training (INT), hop stabilization training (HST), Functional movement screen (FMS), Southeast Missouri agility test (SEMO Agility).

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INTRODUCTION

Badminton is one of the world's most popular racquet sports, attracting both recreational and competitive players. "Jumps, lunges, quick changes of direction, rapid arm movements, rapid eye-hand coordination," and a good awareness of body position are all required in badminton [1]. The badminton players need to make a decision based on the prediction of the opponent's moving direction, and the flight trajectory of the badminton is very short [2].

It's a high-metabolism sport that demands both anaerobic and aerobic fitness. Due to the strong physical demands of badminton, players may sustain ailments related to the game frequently [3]. Sports-related activities can result in anterior cruciate ligament (ACL) injuries, with non-contact injuries accounting for up to 70% of all cases. With 1–5% of all sports injuries occurring in badminton, it is the sport with the greatest acute injury rate [4]. The primary causes of knee joint injuries are changing direction or cutting motion when decelerating, jumping to the ground when the knee is nearly fully extended, pivoting, and standing from a firm surface while the knee is nearly fully extended are [5].

Existing studies have demonstrated the risk of injury in badminton to be 0.85 injuries per year, 1.6 to 2.9 injuries per 1000 hours of play, 2 to 5 injuries per 1000 players, and 1% to 5% of all sports injuries. The injury rate was higher in training than in competition [6].

Neuromuscular training (NT) is a strength and fitness training method that combines sport-specific and fundamental movements, including resistance, balance, core strength, dynamic stability, agility exercises, and plyometrics, to improve skills and health-related fitness. Integrative neuromuscular training is a safe and effective conditioning method. The exercises were selected based on the participants' maturation level and training experience (i.e., training age) [7].

One plyometric exercise that encompasses a variety of plyometric workouts is hopping. Exercises for hop stability are a dynamic and essential activity in many different sports. Individuals who participate in training programs that prioritize hop stabilization improve their function and postural control [8].

The FMS was developed to evaluate trunk stability and motion quality of fundamental movement patterns with the ultimate goal of predicting non-contact injuries in athletes.

Fundamental movements are basic movements that can simultaneously assess a range of motion, stability, and balance. This test is currently used in many pre-season screening protocols in different sports [9].

Agility is defined as the ability to move and control the body as quickly as possible during required accelerations, decelerations, and direction changes. However, in most sports, fast body movement is preceded by the selection of where to run [10]. Hence, successful sports performance depends not only on movement time but also on the athlete's ability to quickly and effectively define the direction in which he or she should run [11]. However, more recently, it was argued that agility requires not only the ability to change direction with speed but also some perceptual skill [12].

So, with the review and analysis of the above treatment approaches, it was effective in injury prevention and sports performance. Hence, the purpose of the study is to compare the effect of integrative neuromuscular training vs hop stabilization training for injury prevention and sports performance for female badminton players.

MATERIALS & METHODS

PARTICIPANTS:

Ages ranging from 18 to 28 years old, both genders male and female, Subjects who have 3 years of sporting training, functional movement screen scoring between 5-18, and players with SEMO agility test scoring greater than 12.5 seconds were included in this study. Players who have undergone surgery in the lower limb in the past 6 months, any lower limb fractures & dislocations, and elite players were excluded from this study. The materials used were a Swiss ball, marker cones, a stopwatch, and measuring tape.

STUDY PROCEDURES:

The study was conducted at Badminton Academy in Gorimedu, Puducherry. It was an experimental study. 28 players were taken within the sporting experience, subjects for this study based on sample size calculation. The Purposive Sampling Method was used. The players signed consent forms after being separated into groups (GROUP A and GROUP B), each with 14 players. GROUP A received Integrative neuromuscular training, and GROUP B received Hop stabilization training for 6 weeks. The outcome measures were the Functional Movement Screen test and the SEMO agility test.

INTERVENTIONS:

GROUP A: INTEGRATIVE NEUROMUSCULAR TRAINING

Table 1: INT PROGRAM

INT PROGRAM	SETS AND REPETITION
BALANCED AND COORDINATION ACTIVITY: • Bosu ball lifts medicine ball on one leg twist • Bosu globular bridge lift • Balance board stands on one foot to catch the ball • Balance board stand with eyes closed on one foot • Swiss ball elbow plank • Swiss ball side plank • Swiss ball kneel catch	2 SETS 2 Rep \ Day, 10 Rep\Week
PLYOMETRIC TRAINING: • Throw the ball with both hands on one side • Throw the ball forward with both hands • Turning and throwing a medicine ball	2 SETS 2 Rep \ Day, 10 Rep\Week
SPEED AND SENSITIVITY: • Agility ball exercise • Reverse sprint on your back • Lie on your back, heel push	2 SETS 2 Rep \ Day, 10 Rep\Week
CORE STABILITY: • Elastic hip bridge • Lie on your back and twist • Hip bridge support on one leg • Reverse abdominal curl and knee lift on stool	2 SETS 2 Rep \ Day, 10 Rep\Week

RESISTANCE TRAINING: • Burpee • The climbing steps • Jumping jacks • Hundred push-ups • Russian abdominal rotation exercise	2 SETS 2 Rep \ Day, 10 Rep\Week

GROUP B: HOP STABILIZATION TRAINING

Table 2: HOP STABILIZATION PROGRAM

TRAINING PROGRAM	SETS & REPETITION
HOP STABILIZATION EXERCISE: • Hopping side to side • Hopping forward and backward • Hopping in a figure 8 • Hopping in Zig-Zag pattern • Hopping in a 4-square pattern	2 SETS 2 Rep \ Day, 10 Rep\Week

STATISTICS & RESULTS:

In this study, "Effectiveness of integrative neuromuscular training vs hop stabilization training for injury prevention and sports performance in female badminton players," the pre- and post-interventional differences within the group were analysed using paired 't' t-tests, and the interventional differences between the two groups were analysed using unpaired t-tests for each of the outcomes. Statistical analysis was set at $p<0.05$.

Table 3.1: Pre- and Post-test values of group A (paired t-test value)

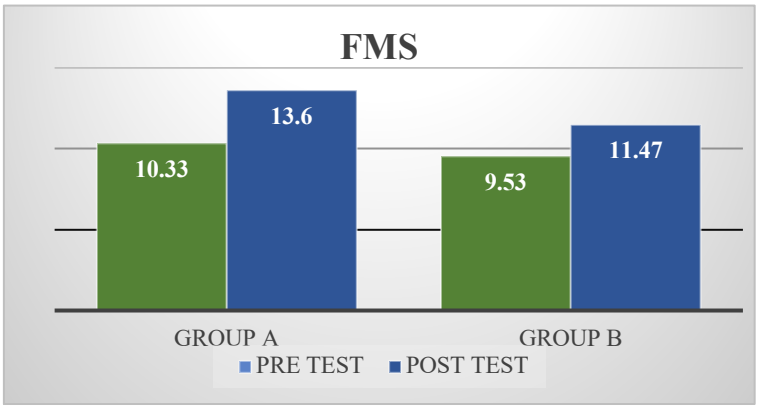
GROUP-A	MEAN	SD	t-value	p-value
PRE TEST	10.33	1.877	7.586	<0.00001
POST TEST	13.6	2.261		

The t value of the FUNCTIONAL MOVEMENT SCREEN SCORE in group A is 7.586 with 13 degrees of freedom and is considered statistically significant($p<0.00001$)

Table 3.2: Showing the pre- and post-test values of group B (paired t-test value)

GROUP-B	MEAN	SD	t-value	p-value
PRE TEST	9.53	2.065	8.4730	<0.00001
POST TEST	11.47	2.133		

The t value of the FUNCTIONAL MOVEMENT SCREEN SCORE in group B is 8.4730 with 13 degrees of freedom and is considered statistically significant($p<0.00001$)



Graph 1: WITHIN-GROUP ANALYSIS OF FMS

Table 3.3: Pre- and post-test values of group A: (paired t-test value)

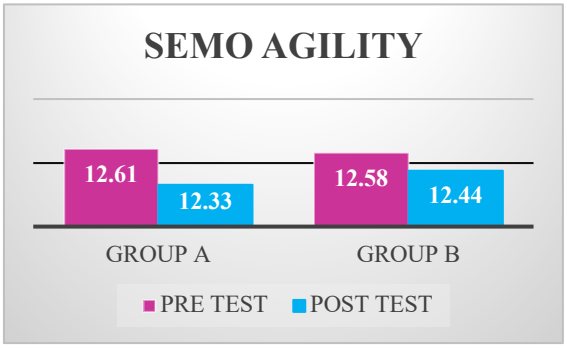
GROUP-A	MEAN	SD	t-value	p-value
PRE TEST	12.61	0.418	6.312	<0.00001
POST TEST	12.33	0.716		

The t value of the SEMO AGILITY TEST of group A is 6.312 and is considered statistically significant (p<0.00001)

Table 3.4: Pre- and post-test values of group B: (paired t-test value)

GROUP-B	MEAN	SD	t-value	p-value
PRE TEST	12.58	0.402	7.81175	<0.00001
POST TEST	12.44	0.362		

The t value of the SEMO AGILITY TEST of group B is 7.81175 and is considered statistically significant (p<0.00001)

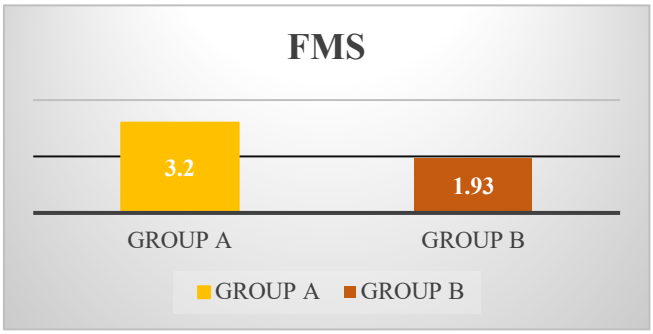


Graph 2: WITHIN-GROUP ANALYSIS OF SEMO AGILITY

Table 3.5: Mean differences of groups A & B: (unpaired t-test values)

	MEAN	SD	t-value	p-value
GROUP-A	3.2	1.65	2.61338	<0.0071
GROUP-B	1.93	0.88		

The t value of the FUNCTIONAL MOVEMENT SCREEN SCORE between the groups is 2.61338 with 26 degrees of freedom and is considered statistically significant (p<0.00001)

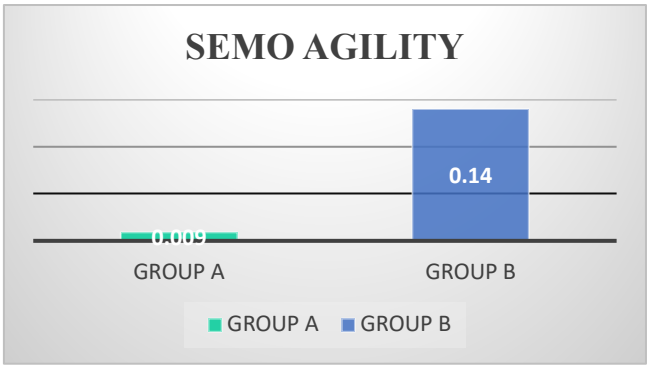


Graph 3: BETWEEN THE GROUP ANALYSES OF FMS

Table 3.6: Mean differences of groups A & B: (Unpaired t-test values)

	MEAN	SD	t-value	p-value
GROUP-A	0.009	0.04	2.52972	<0.0086
GROUP-B	0.14	0.07		

The t value of SEMO AGILITY TEST between the groups is 2.52972 with 26 degrees of freedom and is considered statistically significant (p<0.0001)



Graph: 4 BETWEEN THE GROUP ANALYSIS OF SEMO AGILITY

The statistical analysis done using an unpaired t-test with the values of Group A and Group B shows a significance of ($p< 0.0001$). The effect size of 28 players taken from the Gorimedu badminton academy, with the included criteria which have been mentioned above, in group A INT significantly shows the difference in the results.. Between the group analysis of posts, values show that Group A, who had received the integrative neuromuscular training, is more significant than Group B. The statistical analysis shows that there is an improvement in sports performance and prevention of injury in Group A (INTEGRATIVE NEUROMUSCULAR TRAINING) than in Group B (HOP STABILIZATION TRAINING) among female badminton players. According to the mean difference, Group A showed more significance**.**

DISCUSSION

This study was selected to find out the effectiveness of integrative neuromuscular training vs hop stabilization training for injury prevention and sports performance in female badminton players. In this study, the sample size is relatively small; however, the power analysis revealed that 28 participants are sufficient to obtain a statistically significant interaction effect for an investigation of sports performance and injury prevention. Improved sports performance and reduced injury prevention for female badminton players after the INT training and hop stabilization training.

Most female badminton players experience injury before or during the events due to various directional play factors that may affect their performance in the sport. An injury may decrease an athlete’s performance and energy level during events, but it goes unnoticed. Most female badminton players experience injury before or during the events due to various directional play factors that may affect their performance in the sport. An injury may decrease an athlete’s performance and energy level during events, but it goes unnoticed.

The study by Wei Zhao et al. (2021), integrated neuromuscular training can successfully reduce limb asymmetry in female badminton players, reduce the risk of sports injuries, and enhance the players' performance [13]. Prior to the intervention, the functional asymmetry, speed, and agility test scores were significantly lower, but the vertical jump, strength, balance, and batting test against a wall scores were much higher.

Hop training may help forecast an athlete's lower extremity strength and power, according to R. Tyler Hamilton et al. (2008) [14]. Compared to static balance, this training is more sensitive in identifying postural deficiencies because it measures dynamic postural stability. It provides the necessary postural balance to guarantee that the body stays in the best possible posture over the base of support during each single-leg landing phase, allowing the body to go forward and vertically with maximum muscle efficiency to reach the greatest distance.

Borja Sanudo et al. (2019) suggest that integrative neuromuscular training programs can enhance performance and injury prevention in young athletes [15]. The purpose of this study was to identify the INT components that best support young athletes' performance and injury prevention. As long as the training regimen is followed, INT programs can help young athletes perform better and avoid injuries

In the study by Erik A. Wikstrom et al. (2019) suggests that a hop-stabilization training program altered jump-landing biomechanics in male collegiate basketball players [16]. This may provide a potential mechanistic explanation for improvements in patient-reported outcomes and reductions in injury risk. This technique reduced ground reaction forces, increased hip and knee flexion angles, and reduced knee valgus and varus torque. These are associated with reductions in lower extremity joint injury risk factors and improvements in self-reported function.

CONCLUSION

From the above result and discussion, the study concluded that integrative neuromuscular training (GROUP A) shows a beneficial effect on agility, balance, coordination, and reduces the injury when compared with hop stabilization training (GROUP B) on female badminton players after 6 weeks of intervention. Therefore, the null hypothesis is rejected.

LIMITATIONS & RECOMMENDATIONS

Immediate effects have been studied in this research, and the research was conducted only with female badminton players whose has a lack in their agility performance. Only

two outcome tools are taken. Other components affecting the endurance and strength must be addressed. The Significance of INT could be studied in detail. The study can be conducted for a large population, and males could also be included.

REFERENCES

1. Indora, N.K., Manoj, M., and Jaspreet, K., 2022. Efficacy of exercise protocols on balance in badminton players systematic review & meta-analysis. Central European Journal of Sport Sciences and Medicine, 40(04).
2. Lu, Z., Zhou, L., Gong, W., Chuang, S., Wang, S., Guo, Z., Bao, D., Zhang, L., and Zhou, J., 2022. The effect of 6-week combined balance and plyometric training on dynamic balance and quickness performance of elite badminton players. International Journal of Environmental Research and Public Health, 19(3), p.1605.
3. Zafar, Q., Nawaz, S., Saeed, T., Mehmood, W., Khan, A.S., Rashid, K., and Akhtar, H., Comparative effects of plyometric exercises and drills on power performance, agility, and coordination in badminton players.
4. Liu, H., Leng, B., Li, Q., Liu, Y., Bao, D., and Cui, Y., 2021. The effect of eight-week sprint interval training on the aerobic performance of elite badminton players. International Journal of Environmental Research and Public Health, 18(2), p.638.
5. Kimura, Y., Ishibashi, Y., Tsuda, E., Yamamoto, Y., Tsukada, H. and Toh, S., 2010. Mechanisms for anterior cruciate ligament injuries in badminton. British journal of sports medicine, 44(15), pp.1124-1127
6. Zhao, W., Wang, C., Bi, Y., and Chen, L., 2021. Effect of integrative neuromuscular training for injury prevention and sports performance of female badminton players. BioMed Research International, 2021.
7. Akbar S, Soh KG, Jazaily Mohd Nasiruddin N, Bashir M, Cao S, Soh KL. Effects of neuromuscular training on athletes' physical fitness in sports: A systematic review. Frontiers in physiology. 2022 Sep 23; 13:939042.
8. Hamilton RT, Shultz SJ, Schmitz RJ, Perrin DH. Triple-hop distance as a valid predictor of lower limb strength and power. Journal of Athletic Training. 2008 Mar 1;43(2):144-51.
9. Frost DM, Beach TA, Callaghan JP, McGill SM. Using the Functional Movement Screen to evaluate the effectiveness of training. The Journal of Strength & Conditioning Research. 2012 Jun 1;26(6):1620-30.
10. Parenteau-G E, Gaudreault N, Chambers S, Boisvert C, Grenier A, Gagné G, Balg F. Functional movement screen test: A reliable screening test for young elite ice hockey players. Physical Therapy in Sport. 2014 Aug 1;15(3):169-75.
11. Mondal S, Nayek B, Chatterjee K. A comparative study on strength, agility, and dynamic balances between volleyball and basketball players. International Journal of Physiology, Nutrition, and Physical Education. 2016;1(2):81-4.
12. Loureiro LD, de Freitas PB. Development of an agility test for badminton players and assessment of its validity and test-retest reliability. International journal of sports physiology and performance. 2016 Apr 1;11(3):305-10.
13. Zhao W, Wang C, Bi Y, Chen L. Effect of integrative neuromuscular training for injury prevention and sports performance of female badminton players. Biomed Res Int. 2021;2021:5555853. doi:10.1155/2021/5555853. PMID:33987438; PMCID:PMC8093055.
14. Hamilton RT, Shultz SJ, Schmitz RJ, Perrin DH. Triple-hop distance as a valid predictor of lower limb strength and power. J Athl Train. 2008;43(2):144-51. doi:10.4085/1062-6050-43.2.144. PMID:18345338; PMCID:PMC2267326.
15. Sañudo B, Sánchez-Hernández J, Bernardo-Filho M, Abdi E, Taiar R, Núñez J. Integrative neuromuscular training in young athletes, injury prevention, and performance optimization: a systematic review. Appl Sci (Basel). 2019;9(18):3839. doi:10.3390/app9183839
16. Ardakani MK, Wikstrom EA, Minoonejad H, Rajabi R, Sharifnezhad A. Hop-stabilization training and landing biomechanics in athletes with chronic ankle instability: a randomized controlled trial. J Athl Train. 2019;54(12):1296-1303. doi:10.4085/1062-6050-550-17. PMID:31618073; PMCID:PMC6922560.