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Effect Of Six-Week Hop Stabilization Exercise Program On Balance And Lower Limb Power In Amateur Volleyball Players: Randomized Controlled Trial

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Abstract

Background: Volleyball is one of the popular sports across the globe. The major actions carried out in volleyball sports are serving, forearm passing, setting the ball, jumping which are mainly influenced by the athlete's ability to control their dynamic balance. Hopping exercises are one of the many skilled controlled stability exercises effective in improving ability to control balance. Hence this study aimed to find the effect of Hop stabilization exercise program (HSEP) on balance and lower limb power in amateur volleyball players.
Objective: To find the effect of (HSEP) on balance and lower limb power in amateur volleyball players.
Methodology: After designing the study Institutional Ethical Approval was taken. Consent was obtained from all the participants. 58 samples were screened based on eligibility criteria, 6 were excluded and 52 were further divided into Group A (experimental group) and Group B (control group). Pre-assessment was done at Week 0. The experimental group received the HSEP and regular exercise program for 3 sessions per week for 6 weeks, receiving total 18 sessions. The control group received regular exercise program. Post-assessment was done at week 6. **Result:** The Shapiro-Wilk test was used to assess the normality of data distribution. Analysis of variance (ANOVA) was used for comparison of mean at different time intervals. One participant from the experimental group and one from the control group did not complete the study. After 06 weeks the mean between-group difference for the balance was -0.96 and vertical jump height was -0.12 at (95% CI).
Conclusion: The study concludes that 4 weeks of HSEP is effective in improving balance and lower limb power in volleyball players**.**
Trial Registration: *Clinical Trials Registry-India (CTRI) registration no is* ***CTRI/2023/04/051766****.*

Keywords: Stability, vertical jump test, dynamic balance, volleyball players, proprioception.

1. INTRODUCTION

Volleyball is an anaerobic sport in which explosive movements (both vertical and horizontal directions) are performed thoroughly and intermittently during short rallies.[1] Athletes must maintain body balance with a proper mechanic when dropping after the spike and block; In other words, they must keep strength while maintaining equilibrium.[2] Athletes are in continuous need of change of direction, speed and change of body posture, all within the confines of the volleyball court and hence needs an productive acceleration and deceleration through space in a very short period of time repetitively for a smooth performance.[3] Ankle sprains are the most common injury among volleyball players accounting for about 41% of all the volleyball associated injuries.[4] The inherent risk of injury must be managed and should serve as an essential component to the training plan for volleyball athletes.[5]
Balance training has been an integral part of conditioning in several sports as it has been a key factor in improving performance of players after sustaining ankle and knee injuries. The balance training had several reaction-time tasks which were simultaneously performed while challenging the balance by changing the base of support and varying the surface, namely foam and firm surface.[3] Although these exercises have a positive effect on the reaction time of the lower limb muscles.[6]
Vertical jumps are commonly used to evaluate the function of lower-body muscles due to the high reliability, validity, and sensitivity of their outcomes. Commonly, force platforms are used in the scientific literature to evaluate vertical jump performance.[7]
The hopping exercise program is one of the plyometric training programs used to improve balance. It is a modified and relatively adjusted plyometric exercise characterized by a stretch-shortening cycle and is used to measure the quality of the level of athlete's performance by stimulating the muscles and the pressure on the joint during sports and exercises. Power and balance are two essential components of hopping. Researchers have argued that hopping exercises create a link between power and coordination and directly enhance positive performance during competition, leading to the athletes' success in various sport branches.[8] Hence, we hypothesised that HSEP training based on specific hopping exercise prescribed with progressive levels may have significant improvement on balance and lower limb power in amateur volleyball players.

2. MATERIALS AND METHODS

2.1 Design

Participants involved in the group were blinded. Randomization of participants into 2 groups was performed using computer generated randomization method. All participants were asked to deeply read the study procedures and sign a detailed consent from before starting study procedures. The study has begun after the Ethical Clearance from the Institutional ethical committee. *The IEC no is* ***COPT/MPT/2023/26****. Clinical Trials Registry-India (CTRI) registration (****CTRI/2023/04/051766)****.*

2.2 Study Setting

It was main ground and volleyball court of PIMS (DU) Ahmednagar district Maharashtra, India.

2.3 Study Duration

April 2023 to Oct 2023.

2.4 Sample size calculation

Sample size was calculated using open Epi software, with 95% confidence interval and power of 80%. Grounded on the above-mentioned assumptions, the sample size needed for this study was 50 participants. We added 8 subjects to compensate for any dropout.

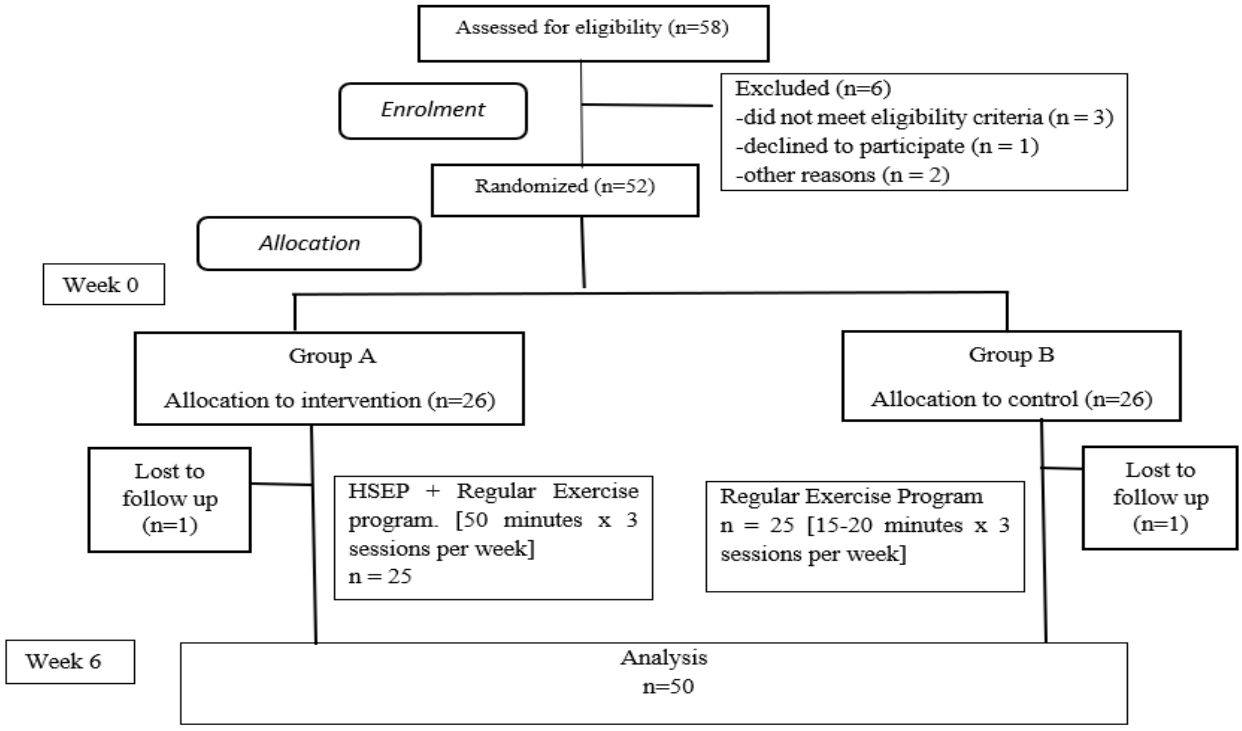
2.5 Participant recruitment

Participants who play volleyball with age ranging from 18 to 30 years-old, both male and female amateur volleyball players who qualified PARQ questionnaire, ready to sign the consent were included in the study. The players suffering from any recent injuries, any type of systemic illness, players who are irregular and for involved in any other type of personal training methods, or taking any medications that may affect alertness or balance were excluded from the study.

2.6 Randomization Allocation

The codes obtained from randomization were maintained in opaque sealed envelope until the intervention begins. The allocation was concealed by sequentially numbered, opaque, sealed envelope (SNOSE).

Figure 1: Design and flow of participants through the trial



2.7 Procedure

Prior to the tests, the participants executed a standardized warm-up protocol. The intervention group performed HSEP, while the control group performed the regular balance training program. The sessions were held on Mondays, Wednesdays, and Fridays. Both the groups were assessed at week 0 and week 6. Before the intervention protocols, demographic data were collected. Balance was assessed using Wii-fit balance and lower limb power were assessed using vertical jump test.

2.8 Outcome measures

2.8.1 Balance measurement

Wii-fit balance was used to assess the balance. At each assessment, the subjects were instructed to take up each of the four stances and attempt to complete three trials for each [10] The Wii-fit was connected to the custom software to measure center of pressure coordinates. [11] A total of three successful trials (maximum of three unsuccessful attempts) were conducted for each task and device with 15 s of rest between trials and a minimum of 60 s between-device or task. Data were collected for 10 s during single limb trials and for 30 s during double limb trials [10]

The four stances:

1. Double-leg Stance with Eyes Open and feet a comfortable distance apart (DSEO)
2. Double-leg Stance with Eyes Closed and feet together (DSEC)
3. Unilateral-leg Stance with Eyes Open (USEO)
4. Unilateral-leg Stance with Eyes Closed (USEC)

2.8.2 Lower limb power measurement

The assessment required that each participant, positioned sideways to the wall on which a meter was posted, touched the wall at the highest possible point with his preferred or dominant hand (height 1). Then, each participant was asked to perform a Counter vertical jump and to touch the wall at the highest point reachable with the fingers of the hand (height 2). VJ height was calculated as the difference between the two points (height 2—height 1) measured in cm. Each participant performed 3 VJ trials with 60 s of recovery between them and the best of the 3 trials was considered for statistical analysis.

2.9 Statistical analysis

Analyses were conducted using IBM, SPSS V.20 software. The Shapiro-Wilk test was used to assess the normality of data distribution. Analysis of variance (ANOVA) was used for comparison of mean at different time intervals. Post hoc test was used to identify between group differences. Quantitative variables were reported as mean and standard deviation. The mean between-group difference between the experimental and control groups were calculated with unpaired data and reported with a 95% confidence interval.

3. RESULTS

At the baseline, there were no-significant differences between the groups in respect to age, height, weight, BMI as $p>0.05$. Apart from two participants who withdrew from the study there were no deviations from the study protocol. The registered study question was addressed, all participants were prescribed their randomly allocated intervention and both registered outcomes were measured at scheduled time points. . After 06 weeks the mean between-group difference for the balance was -0.96 and vertical jump height was -0.12 at (95% CI). All participants in each group who were followed up at end of the study reported no adverse events during the intervention period.

TABLE 1: Demographic and physical characteristics of participants at the baseline are shown in Table 1

Characteristics	**Experimental (n=25)**	**Control (n=25)**
Age, mean (SD)	21.68 (5.23)	21.04 (2.98)
Height, mean (SD)	166.90 (6.51)	166.76 (11.56)
Weight, mean (SD)	63.24 (13.92)	59.92 (12.30)
BMI, mean (SD)	22.57 (4.09)	21.50 (4.02)

TABLE 2: Content and progression of the experimental group intervention.

Exercise	**Levels**	**Volume**
Warm up	Active range of motion, Spot marching, Jogging, Jumping Jacks (7 mins) for 6 weeks	
Week 1		
Side to side hop on both legs	Level 1	

Forward and backward on both legs	Level 2	1 set x 8 reps
Hopping in figure 8 shape on both legs.	Level 3	
Week 2		
Hopping side to side on 1 leg	Level 1	2 sets x 10 reps
Hopping forward and backward on 1 leg	Level 2	
Hopping in Figure of 8 shape on both legs	Level 3	
Week 3		
Hopping forward on both legs	Level 1	2 sets x 10 reps
Hopping Zig Zag on both legs	Level 2	
Hopping Figure of 8 shape on 1 leg	Level 3	
Week 4		
Hopping forward on 1 leg	Level 1	2 sets x 10 reps
Hopping on Zig Zag shape on 1 leg	Level 2	
Hopping 4 square shape on both legs	Level 3	
Week 5		
Hopping forward and backward on both the legs	Level 1	2 sets x 10 reps
Hopping Zig Zag Shape on 1 leg	Level 2	3 sets x 10 reps
Hopping 4 Square shape on 1 leg	Level 3	2 sets x 10 reps
Week 6		
Hopping Figure of 8 shape on 1 leg	Level 1	2 sets x 8 reps
Hopping Zig-Zag shape on 1 leg	Level 2	
Hopping 4 square shape on 1 leg	Level 3	
Cool down	Stretching of major group of muscles and gentle walking (5 mins) for 6 weeks.	

Duration 50-60 minutes, frequency of 3 days per week. With each level's exercises will be performed first with hands free, then with arms cross the chest, and then with Hands behind the head.

TABLE 3: Conventional group exercises

Conventional treatment	**Volume**
Warm up	5-7 minutes
Jumping jacks	10 repetitions * 2 sets
Push-ups	
Lunges	
Side running	
Free hits	
Cool down	5 minutes

Duration 40-50 minutes,

TABLE 4: Mean (SD) of groups, mean (SD) within-group difference and mean (95% CI) between-group difference

Outcome	**Groups**				**Within Groups**		**BetweenGroups**
	Week 0		**Week 6**		**Week 6 minus Week 0**		**Week 6 minus Week 0**
	Exp	**Control**	**Exp**	**Control**	**Exp**	**Control**	**Experimental minus Control**
Wii-fit balance	3.92 (0.75)	4.2 (0.64)	1.36 (0.49)	2.6 (0.57)	-2.56 (-0.26)	-1.6 (-0.07)	-0.96 (-0.19)
Vertical jump test	41.4 (5.34)	36.4 (4.98)	46.88 (4.93)	42.0 (3.99)	5.48 (-0.41)	5.6 (-0.99)	-0.12 (0.58)

4. DISCUSSION

This study aimed to estimate the effect of 6 week hop stabilization exercise program on balance and lower limb power in amateur volleyball players. Results of this study estimated that hop stabilization exercise program is more beneficial than conventional training for several outcomes including balance and lower limb power in amateur basketball players. Several underlying mechanisms for these effects of Hop stabilization exercise program are been proposed.

Hop stabilization exercise program have shown positive effect on the biomechanical profile that is, it has been useful in reducing the magnitude of lower extremity injury risk factors in healthy participants.[12] Especially, the evidence hop stabilization exercise program lessen ground reaction forces, increased hip and knee flexion angles and reduced knee valgus and varus torque.[13]

Balance:
Balance is defined as maintaining the centre of gravity within the base of support. With regard to the hopping exercises used in this study, individuals need to maintain balance during the disturbances caused by hopping, to achieve stability after hopping and also maintain balance for sequential hopping. Based on the theories of motor control, motor cortex maps change by repeating motor patterns and these patterns replace the previous ones and enable the individuals to maintain better balance and stability.[6] Dynamic balance is the ability to maintain stability while body is in motion from one point to another. Reduced functional reach distance may be due to diminished ability to maintain balance because of line of gravity shifted outside the base of support in fatigued state. This may be because the eccentric and isometric muscle activity by both type 1 and type 2 muscle fibers were affected in fatigued state. Studies reported that effects of fatigue were condition specific.[14]

Lower limb power:
Measured by the vertical jump test has given general importance to ability in athletic performance and in the assessment of human muscle power capabilities.[15] Being the statistically significant, the estimated improvement of the vertical jump test is practically evident. The specific effects of hopping exercises on vertical jump test could be of particular importance. It has been suggested that the vertical jump test has influence on the ability of subjects to use the elastic and neural benefits. [16]

Hopping exercises has shown improvement in time to stabilization and the perception of instability in athletes with chronic ankle instability.[6] It is important to gain faster post-landing stability for prevention of the ankle injury. Many studies have reported that the patients with chronic ankle instability are deficient in the time to stabilization and the results of this study suggests that this factor has improved after hopping exercise.[17] Although evaluating effectiveness and providing insights into the underlying mechanisms are important, the motor learning principles used in the current and previous intervention programs resulting in observed changes are the most pertinent to clinical practice. Maximizing the benefits of such interventions requires the patient to understand the movement goals (i.e., how a task should be completed) and the purposeful manipulation of task and environmental demands as he or she progresses through the rehabilitation program. For example, to progress in a hop stabilization training program, the task demands should be increased from simple to more complexes (i.e., double to single limb). Both task and environmental demands should be progressed in the context of sport-specific demands as the patient demonstrates movement proficiency (i.e., achieves the movement goal) at each level. Such a progression is clinically important because the ability to perform a task in a controlled laboratory or rehabilitation environment may not translate to the field of play, where additional dynamic challenges, such as reacting to player and ball movement and adjusting for player-to-player contact occur.[12]
According to the discussion, the co-contraction of the surrounding and operating muscles rely on the joints of the lower limb, proper range of motion, the deep receptor activity and the neuromuscular control to maintain the balance while assessing and obtaining the greatest distance are of particular importance

5. Conclusion

From the results of present study both the group showed improvement in balance and lower limb power. When compared between the groups the HSEP group was estimated to be more effective than control group and effect appeared to be more significant at week 6.

Implication
We recommend that HSEP program can be used as one of training methods in regular exercise sessions by coaches and physical teachers to enhance balance and lower limb power in volleyball players.
Limitation: Study is limited to one center. The gender co-relation for the outcome variables is not done.
Future scope: Same study can be conducted at various levels like semiprofessionals, professional, volleyball players by varying the intensities.
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Disclosure of Interest: The Authors declares that they have no competing interest

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