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Research Protocol

Physiotherapy Section

Effect of Kettlebell Training versus Plyometric Training on Agility, Static Balance and Dynamic Balance in Volleyball Players: A Research Protocol of an Experimental Study

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ABSTRACT

Introduction: Volleyball is a dynamic sport that places high demands on an athlete's ability to move quickly and efficiently. Kettlebell training utilises a unique offset weight, challenging core stability, and multijoint coordination, potentially mimicking movements in volleyball. Plyometric training, on the other hand, focuses on rapid muscle contractions to develop power. Despite their popularity, limited research directly compares the effectiveness of these methods for enhancing the skills crucial for volleyball players.

Need of the study: Lower limb injuries are common in volleyball players, and improving agility and balance can help in reducing the risk of these injuries. The purpose of the research is to bridge this information disparity by investigating the effects of both kettlebell training and plyometric training. By analysing the results, the authors can gain valuable insights into how each training approach influences these fundamental movement skills. This knowledge can ultimately help in the development of targeted training programs specifically designed to enhance performance and training strategies for volleyball athletes.

Aim: To assess the subjects' agility, static balance, and dynamic balance in volleyball players treated with kettlebell training and plyometric training.

Materials and Methods: This two-arm parallel randomised experimental study will be conducted at the Department of Sports Physiotherapy of Ravi Nair Physiotherapy College, Wardha, Maharashtra, India, from July 2023 to July 2024. A total of 50 participants will be assigned to 2 groups, with one group receiving kettlebell training (Group-A) and the other group receiving plyometric training (Group-B). Assessments will be conducted on the first day of intervention and at the end of the sixth week of treatment, respectively. To evaluate the inequality in effect size between the groups, statistical significance will be assessed using either a parametric test or non parametric test at a 5% level of significance. For normally distributed values, a t-test (Unpaired) will be used and for non normally distributed data, non-parametric tests (Chi-square, Mann-Whitney U, and Wilcoxon's test) will be utilised.

Keywords: Balance error scoring system, Modified southeast missouri test, Sports, Y-balance test

INTRODUCTION

Volleyball is a challenging sport that requires skill, strategy, and athleticism [1]. During a volleyball match, repeated maximal or nearly maximal jumps, running, diving, dunks, or blocking are common motions [2]. Volleyball is one of the most widely played sports globally, and numerous research studies have been conducted to better understand the training regimens needed to develop a volleyball player's all-around success [2-4]. The ability to execute explosive movements during attacks and blocks is a key component of volleyball players' success, as the objective of the game is to make the ball cross the 2.43-metre net (for male players) and land on the ground while maintaining balance [4]. Various complex factors, such as body morphology, psychological state, and physical conditions, may impact an athlete's performance [5]. To play volleyball efficiently, one must achieve their maximal strength and power. Athletes must develop their maximum strength in the early stages of training and then effectively transfer that strength to power as competitions approach [6]. Lower limb strength is crucial in sports for enhancing balance, agility, and generating the force required for forceful movements. The gluteal, adductors, abductors, hamstrings, and quadriceps are the main lower limb muscles necessary for everyday tasks or sporting activities. Strength in the lower body is essential as it enables faster and more precise footwork. Muscular lower body strength allows for quick stops and path shifts and increases speed on the court. Additionally, powerful lower limb muscles facilitate powerful smashes by transferring energy from the lower limbs to the upper body [7]. Strengthening is recommended as an effective way to prevent injuries, build muscle mass, and enhance overall well-being in terms of volleyball performance. This type of exercise helps maintain good lower body alignment and muscle recruitment by targeting the hip, thigh, core, and abdominal muscles. It is particularly important for younger volleyball players as injuries can negatively impact their training, game performance, and athletic careers [8]. A kettlebell is a handle-equipped cast-iron weight shaped like a ball. There are commercial kettlebells available in weight ranges of 3 to 100 pounds [9]. Kettlebells have numerous therapeutic uses, such as power training and dynamic flexibility exercises [10]. George Kessler is credited with creating the kettlebell, which has an essentially hollow body and an angled grip arm securely fastened to the frame at two points at the top of the body. The grip arm designates a grab area that is farthest from the body. There is less of a handle, with the part closest to the handle coupling areas being the most stretched out and the section closest to the holding zone being the tightest. The design enhances the condition of the cross-section where the grip and body meet [11].

Plyometrics is a training strategy that uses explosive workouts and is utilised by athletes in various sports [12]. In plyometric exercises, a muscle is first prestretched during an eccentric motion, and then the same muscle and connective tissue are

immediately pulled inward during a concentric action. This process is referred to as the "stretch-shortening cycle," which combines power with quickness of movement. When a person runs or jumps, their muscles contract in essentially two periods-stretching and contraction. By performing these workouts, the interval between both phases is shortened. A quick cycle time facilitates substantial energy transfer between the stretching and contraction stages, allowing for more force to be produced than in a concentric motion alone by utilising the elastic energy stored within the muscle [13]. Following the concentric stage, the muscle utilises the preserved elastic energies from the stretch to generate more effort. Plyometric exercises may promote central and peripheral neuronal changes that enhance joint sense of position and kinaesthetic sensitivity. Eccentric loading may lead to desensitisation of the Golgi tendon organs and increased sensitivity of the muscle spindles due to fast stretching and shortening actions [14]. Plyometric workouts are popular among athletes as they help increase strength and jumping ability. Studies have assessed the benefits of plyometrics on power, running economy, quickness, and sprinting [14-16]. Researchers have shown that plyometric training can yield improved performance results in athletes compared to conventional resistance exercises [16].

The aim of the present study is to assess the agility, static balance, and dynamic balance in volleyball players trained with kettlebell and plyometric training.

The main objectives of the study are to evaluate the effect of kettlebell training on agility, static balance, and dynamic balance in volleyball players, to evaluate the effect of plyometric training on agility, static balance, and dynamic balance in volleyball players and to compare the effect of kettlebell training and plyometric training on agility, static balance, and dynamic balance in volleyball players.

REVIEW OF LITERATURE

The protocol aims to evaluate the efficacy of kettlebell training versus plyometric training in volleyball players. Before commencing the training, the outcome scores of all subjects will be assessed. A randomised controlled trial from 2023 concludes that one plyometric training session per week for eight weeks is adequate to achieve noticeable improvements in sprint running speed, service speed, and jump performance. These results are comparable to the effects of two weekly sessions of plyometric training. Therefore, among young male volleyball players, the frequency of one or two sessions per week does not show statistically significant differences in the physical performance of volleyball players [17]. A 2020 study found that a differential jump training program successfully led to complementary improvements in postural control, which is a crucial indicator of injury risk, particularly for high-risk groups such as volleyball players, and sport-specific jump performance. The program does not impose excessive physiological demands, and regular training does not need to be compromised. This suggests that it could be utilised to enhance performance and prevent injuries during the competitive season without risking overtraining [18]. A 2022 study revealed that volleyball players experienced a significant increase in muscular endurance but no discernible improvement in speed as a result of kettlebell training [19]. Another study in 2022 found that among handball players, an eight-week kettlebell circuit training program significantly enhanced explosive power and strength endurance [20].

MATERIALS AND METHODS

A randomised controlled experimental study will be conducted in the Department of Sports Physiotherapy, Outpatient Department (OPD) of Ravi Nair Physiotherapy College, Wardha, Maharashtra, India from July 2023 to July 2024. The institutional ethical approval number has been obtained with reference number DMIHER(DU)/IEC/2023/1065. The trial has been registered on the Clinical Trials Registry-India (CTRI) website, and the registration number is CTRI/2023/08/056671. All subjects will sign a paper form confirming confidentiality and providing informed consent.

Inclusion and Exclusion criteria: The inclusion criteria for the trial will be athletes aged 15 to 25 years, both male and female, athletes with a minimum playing experience of 12 months, and athletes engaged in regular practice for the last three months. Exclusion criteria will exclude athletes participating in other training activities, athletes with recent injuries, athletes who have had any fractures in the last six months, athletes with structural deformities, and athletes with any musculoskeletal, neurological, or cardiovascular disorders. The Modified Southeast Missouri (SEMO) Test will be used as the assessment tool for agility, the Balance Error Scoring System for the assessment of static balance, and the Y-balance test will be used to assess dynamic balance.

Sample size calculation: Formula using mean difference

$$n1=n2=2\frac{(Z_\alpha+Z_\beta)^2\sigma^2}{(\delta)^2}$$

Primary Variable: Modified SEMO Test

Mean±SD. (Pre) result on modified SEMO test for experimental group=13.37±0.37

Mean±SD. (Post) result on modified SEMO test for experimental group=13.06±0.38

Difference=0.31

Std Dev.=(0.37+0.36)/2=0.375 [21].

Clinically relevant superiority=10%=(25.89*10)/100=2.589

$N1=2*\{(1.96+ 0.84)^2(0.375)^2\}/(0.31)^2=23$

Total samples required=25 per group

Considering 10% drop out=5

Exercise	Week 1 to 3	Week 4 to 6
Kettlebell swings	3 sets×6 reps	4 sets×6 reps
Accelerated swings	4 sets×4 reps	6 sets×4 reps
Goblet squats	4 sets×6 reps	4 sets×6 reps

[Table/Fig-1]: Kettlebell training [22].

Exercises	The first stage (1-2 weeks)	The second stage (3-4 weeks)	The third stage (5-6 weeks)
Front barrier jump (6 hurdles)	Double-leg front barrier jump (15 cm) (3 sets: 10 reps/set)	Single-leg front barrier jump (15 cm) (3 sets: 5 reps/leg/set)	Single-leg front barrier jump (30cm) (4 sets: 5 reps/leg/set)
Lateral high-knees with hurdles	4-hurdle (15 cm) (3 sets: 2 reps/set)	6-hurdle (30 cm) (3 sets: 4 reps/set)	6-hurdle (30 cm) (3 sets: 6 reps/set)
Lateral barrier jump	Double-leg jump (15 cm) (3 sets: 10 reps/set)	Double-leg jump (30 cm) (3 sets: 12 reps/set)	Single-leg jump (30cm) (3 sets: 15 reps/leg/set)
Depth jump	Jump with 20 cm box (3 sets: 8 reps/set)	Jump with 30 cm box (3 sets: 8 reps/set)	Jump with 40 cm box (3 sets: 8 reps/set)
Multidirection jumps with hurdles	Triangle jump with double-leg (3 hurdles) (3 sets: 6*3 reps/set)	Square jump with single-leg (4 hurdles) (3 sets: 8*3 reps/set)	Hexagon jump with single-leg (6 hurdles) (3 sets: 12*3 repS/set)
Intensity and number of contacts with ground	Low intensity 144	Middle intensity 234	High intensity 325

[Table/Fig-2]: Plyometric training [21].

Total sample size required=50 (25 per group) where, Z_α = 1.96, α = Type I error at 5%, Z_β = 0.84 (1-b)=Power at 80% σ = std. dev

Study Procedure

A total of 50 participants will be assigned to 2 groups, with one group receiving kettlebell training (Group-A) and the other group receiving plyometric training (Group-B). Description of stages of both the groups has been presented in [Table/Fig-1,2] [21,22].

Randomisation sequence: Participants will be assigned random numbers using opaque sealed envelopes. Allocation to the intervention will be based on the number drawn from the envelope.

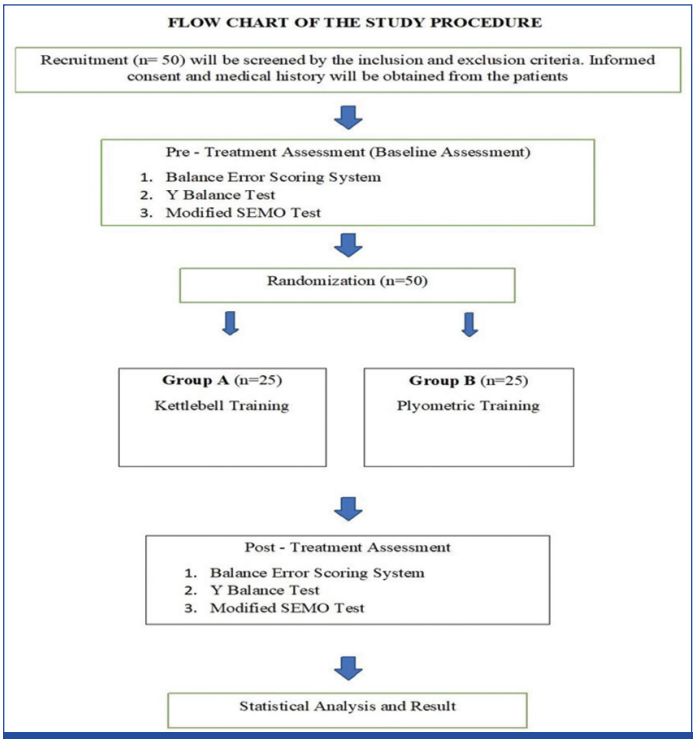
Allocation: Numerated, sealed, opaque envelopes with sequential numbers will be used for the allocation process.

Implementation: The primary investigator and study coordinator will oversee the randomisation process.

Blinding: The investigator will be blindfolded to assign participants to the groups. Subjects will be instructed not to provide any information about their training to the investigator to maintain blinding.

Dependent variables: Agility and balance.

Independent variables: Kettlebell and Plyometric training [Table/Fig-3]. Flowchart of the study procedure has been cited in [Table/Fig-3].



[Table/Fig-3]: Showing flowchart of the study procedure.

The outcome measures are as follows:

Primary outcomes: The Modified Southeast Missouri Test will be used to evaluate agility. This test assesses the ability to make quick changes of direction, perform forward sprints, diagonal backpedalling, and side shuffling, which are common movements during matches [23].

Secondary outcomes: The Balance Error Scoring System evaluates static balance on firm and foam surfaces. It includes three different stances: single-leg stance, tandem stance, and double-leg stance [24]. The Y-Balance test will assess dynamic balance. Participants will balance themselves on one foot barefooted. During the test, the subject places their hands on their hips and reaches as far as possible by pushing the board with the reaching limb in the anterior, posteromedial, and posterolateral directions before returning to the original start position [25].

STATISTICAL ANALYSIS

The statistical software used for the study will be Statistical Package for the Social Sciences (SPSS), version 27.0, and GraphPad Prism 7.0. To assess the difference in effect size among the groups, statistical significance will be evaluated using either a parametric test or a non parametric test at a 5% level of significance. If the values are normally distributed, a t-test (unpaired) will be used to determine whether the difference in mean values between two groups is statistically significant. If the data is not normally distributed, normal distribution will be achieved by transforming the data using mathematical techniques. Alternative non parammetric tests (Chi-square, Mann-Whitney U, and Wilcoxon test) will be utilised if the data for the main variables still exhibit non normal distribution.

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