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Effect of Plyometric Training on Anterior Cruciate Ligament Injury among Female Volleyball Players

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ABSTRACT: *The purpose of this study was to evaluate the effectiveness of plyometric training on anterior cruciate ligament (ACL) injury after six weeks of an intervention program among female volleyball players. Twenty female athletes participated in this study. After the subject's demographic data were collected, they were divided randomly into experimental group EG (plyometric training) and control group CG (routine training), and both groups underwent different intervention programs for a total of 12 sessions for six weeks. The plyometric training involves two-foot ankle hop, side to side ankle hop, bilateral jump, unilateral jump, and jump truck. The effect of the intervention for both groups measured using the standing long jump. The result demonstrated a significant difference in post-test between EG and CG (p=0.022). There is a significant difference between pre-test and post-test for EG (p=0.001), but not in CG (p=0.081). The study concludes that plyometric training strengthens the lower limb and could prevent ACL injury among female athletes.*

Keywords: *Plyometric training, anterior cruciate ligament, standing long jump, volleyball*

I. INTRODUCTION

Anterior cruciate ligaments (ACL) injuries in women are estimated at 38,000 every year (Irmischer et al., 2004). Many of these knee injuries require either non-operative treatment, surgery, or both. The injury mechanism is because non-contact occurs when the athletes make a sudden stop, sharp cuts, or landing and pivoting (Meira & Brumitt, 2005).

Volleyball is one of the most popular sports in the world and has been in the

Olympic Games since 1964 (Wang & Cochrane, 2001). A successful player must jump high and quickly reach that height, which requires an ability to generate power in a brief time (Powers, 1996). For this reason, the optimal usage and transformation of the gained maximum muscle strength into the explosivity of the leading muscle group of the lower limbs, which take part in the take-off, require special power training (Lehnert et al., 2009). The correction landing error is the one risk of knee injury: landing with a straight or hyperextended knee, landing with varus or valgus knee position, and landing solely on the heels (Meira & Brumitt, 2005).

Plyometric training is widely applied in team sports based on jumping ability, such as volleyball. Plyometric training leads to muscle strength growth by proprioception reaction enhancement and inhibitory function debilitation of Golgi tendon organs (Augustyn & Bieniek, 2014). Powers (1996) studied that plyometric exercises have improved jump performance in many sports, combining strength with movement speed to produce power. This study aimed to evaluate the effectiveness of plyometric training on anterior cruciate ligament (ACL) injury after six weeks of an intervention program among female athletes.

II. Methodology

This cross-sectional study evaluates the effect of plyometric training on improving strength among female volleyball players after six weeks of plyometric training, as shown in Figure 1. All 20 athletes have undergone the

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randomization process. After that, one group was labelled as the experimental group (EG) and another control group (CG). The measurement for the strength of the lower limb was determined by using the standing long jump.

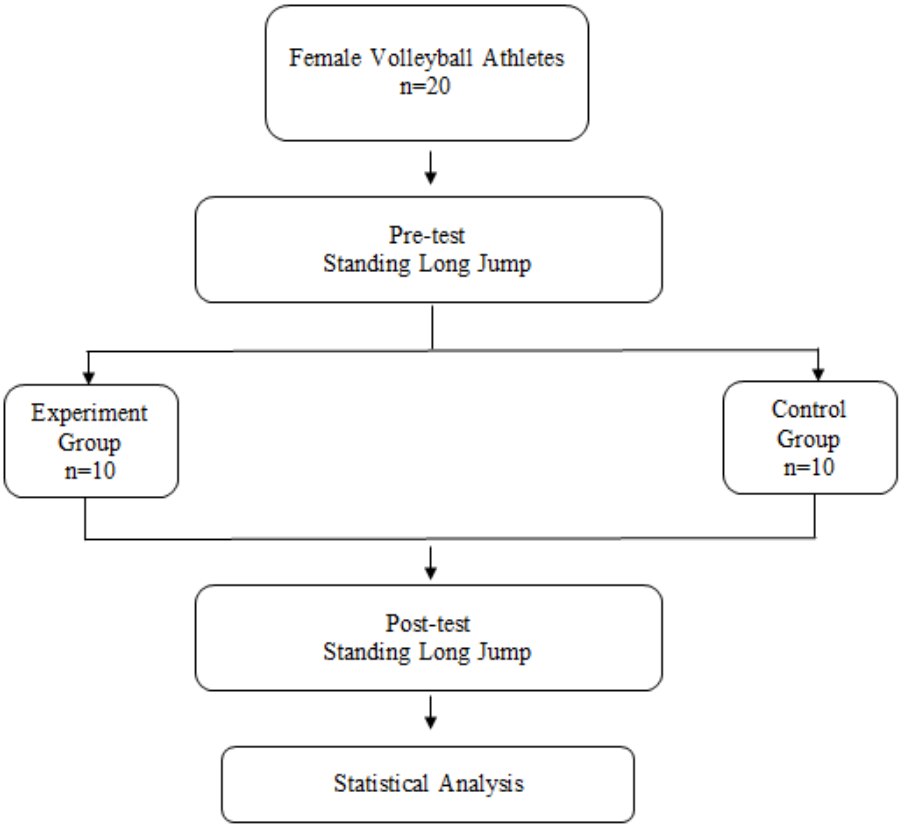

Figure 1: Flowchart of the research design

The population used in this study was Female Volleyball athletes for Higher Education Institute League (LIGA IPTA). Besides that, most athletes have adequate skill and experience due to enough training from their coaches. The sampling used in this study was purposely random. There were 20 female volleyball athletes age ranging between 19-25 years old volunteered in this study. In this study, the volunteers were undergoing a screening process base on inclusion and exclusion criteria. The subjects were excluded if they experienced ACL injury, were performing surgery, or pregnant.

The demographic data includes gender, age, height, weight, BMI, and any health problem state in inclusion and exclusion criteria. The demographic form contains two sections: section A about the personal information and section B about the health problem and injury information that the participants will fill. The plyometric training was performed twice a week for six weeks. Each training session included stretching and warm-up and cooled down after exercise. For the warm-up and cool-down, the subject was instructed to jog in five minutes on the field and stretch to their lower limbs such as hamstring, quadriceps, gluteals, adductors, gastrocnemius, and soleus.

Four exercises were incorporated into the intervention program, such as two-foot ankle hop, bilateral jumps, unilateral jump, and jumps trucks, as shown in Table 1. Subjects were instructed to perform all exercises with maximal effort. The progressive plyometric training program used principles of progression and overload can be accomplished by manipulating the volume dosage (reps, sets, and weight), as shown in Table 2. The post-test of standing long jump was collected after a six weeks intervention for both groups at the volleyball court.

Table 1: Protocol of Plyometric Training Program

Types of Exercises	Procedure
Two-foot ankle hop	1. Stand with feet shoulder-width apart, body straight up and down. 2. Using only ankles, hop continuously in place. 3. Extend ankles to the maximum range with each jump.
Bilateral squat jumps	1. Stand with feet shoulder-width apart. 2. Start by doing a regular squat, then engage the core and jump up explosively. 3. When land, lower body back into the squat position to complete one rep.
Unilateral squat jump	1. Stand with feet shoulder-width apart. 2. Start by doing a regular squat, then engage the core and jump up explosively. 3. When land, lower body back into the squat position to complete one rep.
Jumps truck	1. Stand on a flat surface that is cushioned and feet about hip-width apart. 2. Begin the exercise by getting down into a half squat position and exploding off the ground while bringing knees as close to the chest as possible. Swing arms upward as explode off the ground. 3. Try to land softly on the balls of feet with a bend in knees and then immediately explode back up. Repeat this as many times as prescribed.

Table 2: Intervention Program of Plyometric Training

Week	Types of exercise	Intensity (sets x reps)	Duration
1	Two-foot ankle hop Bilateral squat jumps Unilateral squat jump	3 sets x 10 reps	Rest 30 seconds between sets and 2 minutes between exercises
2	Two-foot ankle hop Bilateral squat jumps Unilateral squat jump	3 sets x 15 reps	Rest 30 seconds between sets and 2 minutes between exercises
3 - 4	Two-foot ankle hop Bilateral squat jumps Unilateral squat jump Jumps truck	4 sets x 10 reps 2 sets x 10 reps	Rest 30 seconds between sets and 2 minutes between exercises
5 - 6	Two-foot ankle hop Bilateral squat jumps Unilateral squat jump Jumps truck	5 sets x 15 reps 3 sets x 15 reps	Rest 30 seconds between sets and 2 minutes between exercises

The results were analyzed using the Statistical Package for Social Science (SPSS) (SPSS version 23). Descriptive statistics were used to analyze subjects' demographics. A paired samples t-test was also utilized to obtain the mean difference between the pre-test and post-test scores in each group. Next, an independent t-test was conducted to detect any significant difference between the control and treatment where the significant level was $p<0.05$.

III. Result & Discussion

There were 20 female volleyball players involved in this study and complete a self-report screening questionnaire. The demographic data collected include age, height, weight, and BMI. The demographic data reported were divided into two groups: the experimental group (EG) and the control group (CG), as shown in Table 3.

Table 3: Demographic data of female volleyball players

Variable	Experimental Group (μ ± SD)	Control Group (CG) (μ ± SD)
Age (years)	21.9 ± 1.27	20.9 ± 1.90
Height (cm)	159.9 ± 6.05	159.9 ± 9.2
Weight (kg)	55.7 ± 6.96	57.3 ± 9.11
BMI (kg/m^2)	21.8 ± 2.65	22.4 ± 2.52

The result indicated a significant difference for EG pre-test and post-test after the six weeks intervention ($p=0.018$), as shown in Table 4. There was no significant difference between the CG pre-test and post-test ($p=0.074$). However, there was a significant difference in post-test between EG and CG after six weeks of intervention ($p= 0.001$) indicated that this intervention provides effects to strengthen the lower limb.

Table 4: Results after intervention using Standing Long Jump Test

Group	Pre-test (μ ± SD)	Post-test (μ ± SD)	p-value
EG	171.89 ± 16.94	181.89 ± 10.18	0.018
CG	143.00 ± 14.78	145.00 ± 16.00	0.074
p-value	0.001	0.001	

*significant value when $p<0.05$

There are 2,200 ACL injuries reported annually towards female collegiate athletics (Irmischer et al., 2004). The severity of the situation is compounded by the fact that ACL injuries require surgery more often in women than in men. Non-contact mechanisms have been identified as the leading causes of ACL injuries in female athletes (Arendt, Agel & Dick, 1999). The plyometric training also decreases muscle reflex inhibition, increases the sensitivity of the Golgi tendon organs, improves the sensitivity of the muscle spindles, increases muscle tension and at the same time can decrease the risk of injuries (Zatsiorsky & Kraemer, 2006).

The result indicated a significant difference for EG pre-test and post-test after the six weeks intervention ($p= 0.018$). Luebbers (2003) stated that the training programme's duration is one of the mechanisms in ensuring the training's effectiveness the duration of training for six weeks and above will enable neuromuscular adaptability to happen. A plyometric training program should consider the goal of the training for a particular period should respect basic training principles, first of all, the principle of individualization, a progressively increasing load (from low intensity to high-intensity exercises over several years and during the annual training cycle), the principle of specificity

(advanced athletes with plyometric method experiences should prefer specific exercises).

It is essential to have in mind their participation in the training cycles based on their actual health condition, competitions, jump load and possible combination with other training exercises (Scates & Linn, 2003). There was significantly different for post-test between EG and CG after the six weeks intervention (p= 0.001) indicated that this intervention provides effects to strengthen the lower limb. The intensity of the exercise was increasing by changing the intensity of exercise every session. The different configuration of training volume and intensity result forms physiological stress, which in turn induce different neural and muscular adaption (Lesinski, Prieske & Granacher, 2016). In conclusion, the experimental group which applied plyometric training improved the performance and prevent ACL injuries after six weeks of intervention programs.

IV. REFERENCES

1. Augustyn, K. & Bieniek, P. (2014) Efficacy and Legitimacy of Plyometric Training Application in Volleyball Players. Scientific Review of Physical Culture, 4(1), 22-26.
2. Arendt, E.A., Agel, J. & Dick, R. (1999) Anterior cruciate ligament injury patterns among collegiate men and women. J Athl Train. 34(2):86-92.
3. Irmischer, B.S., Harris, C., Pfeiffer, R.P., DeBeliso, M.A., Adams, K.J. & Shea, K.G. (2004) Effects of a knee ligament injury prevention exercise program on impact forces in women. J Strength Cond Res. 18(4):703-7.
4. Lehnert, M., Lamrova, I., Elfmark, M. (2009) Changes in speed and strength in female volleyball players during and after a plyometric training program. Acta Universitatis Palackianae Olomucensis Gymnica. 39(1):59-66
5. Lesinski, M., Prieske, O. & Granacher, U. (2016) Effects and dose–response relationships of resistance training on physical performance in youth athletes: a systematic review and meta-analysis. British Journal of Sports Medicine. 50:781-795.
6. Luebbers, P.E., Potteiger, J.A., Hulver, M.W., Thyfault, J.P., Carper, M.J. & Lockwood, R.H. (2003) Effects of plyometric training and recovery on vertical jump performance and anaerobic power. J Strength Cond Res. 17(4):704-9.
7. Meira, M. & Brumitt J (2005) Plyometric Training Considerations to Reduce Knee Injuries. Strength and Conditioning Journal, 27(2): 78-80
8. Powers, M. (1996) Vertical Jump Training for Volleyball. Strength and Conditioning Journal 18(1):18-23
9. Scates, A., & Linn, M. (2003). Complete conditioning for volleyball. Champaign, IL: Human Kinetics.
10. Wang, H.K., & Cochrane T. (2001) A descriptive epidemiological study of shoulder injury in top level English male volleyball players. Int J Sports Med. 22(2):159-63.
11. Zatsiorsky, V. & Kraemer, W. (2006) Science and Practice of Strength Training. Second ed. Human Kinetics.