Original Article

Effectiveness of the Prevent Injury Enhance Performance (PEP) Training Program in Reducing Injury Incidence Rates among Adolescent Female Sepak Takraw Players: A Randomised Controlled Trial

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Background: Female adolescent Sepak takraw players have a 3 times higher incidence of knee injury than male. The Prevent Injury Enhance Performance (PEP) program have the potential to significantly reduce knee injury incidence rate via biomotor ability improving. It was applied to train in various group but the effectiveness in adolescent female athlete rarely knew.

Objective: To examine the effectiveness of the PEP in reducing injury incidence rates among adolescent female Sepak takraw players.

Materials and Methods: The PEP and control group was fifty-two female adolescent Sepak takraw players aged 14 to 19 years who were randomly assigned into 2 groups. During warm up period, PEP group was trained 3 times in a week for 8 weeks; in contrast, control group was trained no specialized program. Their muscle power and strength, agility, and flexibility were assessed at baseline, at 4 weeks, and 8 weeks. At 6 months after training, number and characteristics of injuries in both groups were measured by the Orthopedics.

Results: Incidence rate on average of PEP and control groups was about 5.32 and 15.96/100,000 AEs. The highest injury was killer, followed by server and feeder. Chondromalacia patella was mostly found, followed by complete tear of ACL, muscle soreness, and higher than control group. Hyperextension and twist mechanism were causative factor for both groups. The result of biomotor ability was found PEP group had a significantly different peak power and jump height higher than control group (p<0.001). There was the significant difference of conventional concentric knee ratios between groups (p<0.001).

Conclusion: Our findings indicated the PEP program effectively reduce knee injury, resulting from the strategy could improve the biomotor ability.

Keywords: Incidence rate of knee injury, Biomotor Ability, Female adolescent Sepak takraw player

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Sepak takraw is an interesting sport established at national and international levels but is also a popular inclusion in local competitions. An unusual feature of this sport is that the ball is attacked entirely with the use of a player's feet. The sport is undoubtedly very strenuous, as the player, in jumping, often elevates his feet above his head height for maximum advantage in contacting the ball. Perhaps unsurprisingly, data from previous study has reported knee injury rates associated with Sepak takraw was to be as high as 50%[1]. In play, competing team members jump in the air, using their feet to propel the ball over the net. In this maneuver, the knees are generally projected high in the air to allow the feet sufficient height, generally well above the plane of the body, to contact the ball. Righting the body, which may well be upside down, requires very rapid changes in movement and direction in order to (ideally) land feet first. Such gyrations, requiring an extraordinary degree of agility executed within a very short timeframe, impose significant biomechanical forces on the lower limbs, often resulting in players suffering significant muscle and tendon injuries.

Epidemiological studies of sporting injuries indicate that female players exhibit injury rates approximately three (3) times greater than that of males[2]. Possibly because of the relationship between sex hormones which influences knee laxity; females, aged between 15 to 19 years, or high school

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age, also have injury incidence rates higher than for other ages[3,4]. It is also apparent that not only do contact sports in general have significant impacts upon competitors with respect to risk of injury, but also non-contact sports. Therefore, there are clear indications of the risk factors associated with knee injury. Since, however, somatic factors such as hormonal, anatomical and gender cannot be changed, alternative factors such as biomotor abilities and skill levels, among others, are eligible for consideration in any approach for reducing and preventing injury rates. Bompa[5] regards muscle strength and power, flexibility, balance and agility as important components in injury avoidance strategies.

Currently, many training programs have been developed for the prevention of knee injuries, such as Prevention of Injury and Performance Enhancing Programs (PEP), Sportmetrics, 11+, KLIP, and Myklebust. Rating their comparative effectiveness with regard to results from previous studies suggests that only PEP and Sportmetrics have the potential to significantly reduce knee injury incidence rates[6]. Normally, Sepak takraw teams follow training programs specifically related to required skill levels of this sport, as well as biomotor abilities. While such training undoubtedly develops the latter, it places little or no emphasis upon specific preventive approaches for knee injury. A more effective training program, incorporating a warm-up period before skills training each day, could potentially reduce injury rates and enhance performance.

As noted above, the basic movements of Sepak takraw include rapid changes in movement in jumping and rapid decelerations in landing, all of which can predispose to knee injury, as does a player's age and gender. Although researchers have attempted to address the issue of injury prevention in general[7], and detailed prevention programs have shown that PEP can indeed help prevent or reduce injury, Sepak takraw players have not been studied in this regard. To our knowledge, there is no current research investigating the detailed effects of PEP training on Sepak takraw players. There is, consequently, a dearth of information allowing comparative evaluation of the effectiveness of injury prevention programs for young female Sepak takraw players. The aim of this study, therefore, is 1) to investigate the effects of the 'Prevent Injury Enhance Performance Program' (PEP) on the reducing injury incidence rates, and 2) to investigate the effect of PEP on biomoter ability of adolescent female Sepak takraw players.

Materials and Methods

Study design

Study design was a randomised controlled trial, dividing into 2 groups and measuring the biomotor ability 3 times; baseline, in week 4 and 8. PEP and control groups were determined following the coached procedure throughout 8 weeks; besides, a 6-months prospective incidence rate of knee injury was sequentially assessed. During the study, the rehearsal and completion schedules of both groups were similar. PEP group implemented the PEP program in warm up period; while, control group had no specialized warm up training protocol. Control group regularly warm up by jogging and stretching about 20 minute.

Population and sample

A cohort of 52 female sepak takraw players was recruited from a sports school in Thailand, one of 12 schools operating under the authority of the Ministry of Tourism and Sports. All subjects were aged between 14 to 19 years and participated in the study voluntarily. Players who had been seriously injured and were not allowed to train as per an orthopedic physician's direction and who had signs and symptoms of knee joint effusion, inflammation or instability were excluded.

The sample size was calculated with G Power Software (version 3.1.9.2). The investigator attempts to realize via regarding the study design, outcome measuring, and statistic for calculating the sample size. The numbers used consisted of the amount of group (group = 2), the effect size which research use the minimum of Biomotor ability (muscle power) = 0.2, number of measurement in this research = 2, α-error probability = 0.05, and the power of test = 0.80. The total of sample size computed was 42 (21 per group). The researcher increasingly computed to drop out 20%, thus this study collected 26 participants per group.

Subjects recruitment

Subjects were enrolled via advertising within schools. For subjects who were interested, the researcher was sufficiently informed the detail consisted of procedure, risk and benefits, compensation, impact, and voluntary decision and termination to participants at their sport school before enrolling. Only subjects being under 18 years old, the information letter was sent to their parent consisted of information sheet and consent form, these was agreed from either subject or their parent.

After enrolling, subjects were randomly assigned to either the PEP or control group (26 participants). The testing personnel remained blind to the assignment of these groups throughout the three testing sessions, and all subjects were unaware of the details of the alternative training program. These were organized by a co-investigator who was not involved in testing and/or training. If the participant had adverse and/or serious adverse reactions during the study period, it was documented and realized by the physician and investigator. The participants could be discontinued based on their voluntary decision. The Khon Kaen University Ethics Committee in Human Research was appraised of the study aims, methods and procedures for consideration according to the declaration of Helsinki (HE582380).

Experimental procedures

Prevent Injury and Enhance Performance (PEP) consisted of a warm-up procedure, stretching, strengthening, plyometrics and sport-specific agility training to address actual and potential deficits in the strength and coordination of the stabilizing muscles circumlocated around the knee joint[8]. Duration of PEP program was 20 minute,

demonstrated in Table 1.

Measurement and instrumentation

Subject preparation

Athletes were requested not to perform strenuous exercise 24 hours prior to testing. The 2 groups performed a standardized warm-up of 10 to 15 min that included general exercises such as jogging, shuffling, sprinting, multi-directional movements, and dynamic stretching exercises. To certify there was no influence on any of the testing sessions, especially baseline values, the PEP program was not used as the warm-up before any of the testing sessions. Performance was assessed in a single session with the tests completed in the following order: sit and reach, CMJ, t-test. Athletes performed two trials of each test with the best score used for statistical analysis. Before the test, the researcher explained and demonstrated the procedure to the athlete.

Counter-movement jump (CMJ)

Procedure: Counter-movement jump height was determined by using an electronic timing mat. The subject starts with a prepared-standing position, then they do a squatting action followed immediately by a jump for as maximal a height as possible. Their hands remain on the side of their body for the whole movement to reduce any error of arm swing. The timing mat was collected the time during flight. The researcher will carefully examine to eliminate any influence by leg and arm position. While the subject is jumping, they should keep their legs straight during flight and their hands should remain on their hips.

Scoring: The researcher collected the flight time and calculated to jump height.

Agility t-test

Procedure: Four (4) cones are set out as T alphabet (5 yards = 4.57 m, 10 yards = 9.14 m). The subject begins at cone A. At the command, the subject will sprint to cone B and use their right hand to touch the base of the cone. They then turn left and invert sideways to cone C, while touching the cone with their left hand. They then turn sideways to the right of cone D, touching the base with their right hand. Then they shuffle back to cone B, touching it with their left hand, and then run backwards to cone A. The time was stopped when they pass back to cone A.

Scoring: The test will not be calculated if the subject crosses one foot in front of the other while inverting, misses the base of the cones, or does not face forward throughout the test. This calculated best time will be eradicated as an error, as in the above.

Sit and reach

Procedure: This test will use the flexmeter. Fist, the tester will start at a sitting position on the floor with legs stretched ahead. They should remove their shoes. Their feet should be placed flat against the box. Both knees should remain placed flat to the floor. Then, they should put the hands in pronation, and try to their hands on top of the flexmeter. The tester then tries to reach onward along the measuring line as far as possible.

Scoring: After some practice, their hands should remain at the same level and then hold that position for about two seconds for eliminated jerky movement while reaching. The highest length is then recorded.

Isokinetic measurement

Procedure: Before beginning the experiment, subjects stretched, warmed up, then sat in a seat upright whereby their thighs, trunk, and pelvis were restrained with straps. During the test, the subjects, encouraged by the investigator, were asked to kick out and pull back as fast as possible. The rest time was 1 minute between tests at each angular velocity.

Table 1. Detail of Prevent Injury and Enhance Performance (PEP)

Phase of exercise	Practice	Duration of exercise
1) Warm-up (1.30 minutes)	Jog line to line, shuttle run and backward running	30 seconds for each activity
2) Stretching (5 minutes)	Calf, quadriceps, figure four hamstring, inner thigh, and hip flexor stretch	30 seconds x 2 sets for each muscle group
3) Strengthening (3 minutes)	Walking Lunges, Russian Hamstring, and Single Toe Raises	3 sets x 10 repetitions for each
4) Plyometrics (2.30 minutes)	Lateral hops over cone	20 repetitions
	Forward/backward hops over cone	20 repetitions
	Single-leg hops over cone	20 repetitions
	Vertical jumps with headers	20 repetitions
	Scissors jump	20 repetitions
5) Agilities (3 minutes)	Shuttle run with forward/backward running	1 minute
	Diagonal runs	1 minute
	Bounding runs	1 minute
6) Alternative (5 minutes)	Bridging with alternating hip flexion	30 repetitions on each side
	Abdominal crunches	30 repetitions x 2 repetitions
	Single and double knee to chest (supine)	30 second x 2 repetitions

Scoring: Concentric values for extension and flexion of the dominant and non-dominant legs were measured using a calibrated Biodex System 3 dynamometer (Biodex Medical Systems, Inc., Sirley, NY, USA), examined at velocities of 60, 180, and 300°. s^{-1} respectively.

Data collection

Data was collected during February to October 2016. Counter movement jump, sit and reach, agility t-test assessment were tested at sport schools. Isokinetic measurement was collected at department of sport science, the sport authority of Thailand.

Statistical analysis

Baseline characteristics and biomotor ability variable were presented by descriptive statistic, describing the frequency, percentage, mean, and standard deviation (SD). Knee injury was examined using frequency, percentage, incidence rate, and 95% confidence interval. Multivariate analysis comparing mean of jump height, peak power, flight time, sit and reach, and agility T-Test between PEP and control group was analysed by Analysis of Covariance (ANCOVA), described by mean difference, *p*-value, and 95% CI of mean difference [mean dif]. The difference between groups and repeatedly measure 3 times was analysed using generalized estimating equations (GEE) for repeated measurement implemented under generalized linear model frameworks.

Results

Baseline characteristic

Prior to training, participants in both groups exhibited generally similar characteristics; ages were 15.50±1.10 and 15.19±1.26 years, body mass index 19.79±1.70 and 20.38±2.46 kg/m^2 in PEP and control groups. The PEP group consisted of 10 servers, 5 feeders and 11 killers; the other group consisted of 9 servers, 7 feeders and 10 killers.

Incidence rates of knee injury

Within the period April to October 2016, 12 knee injuries occurred for incidence rate on average of PEP and control groups was about 5.32 and 15.96/100,000 AEs, respectively. Incidence rate presented in math was 3.55/100,000 AEs and in training was 17.73/100,000 AEs. Incidence rate for type of injury presented in Chondromalacia patella 7.09, complete tear of ACL 5.32, partial tear ACL 1.77, muscle soreness ACL 5.32 and muscle strain 1.77 (per100,000 AEs). The position of injury was killer 10.64, followed by server 5.32 and feeder 3.55 (100,000 AEs). Cause to injury was overuse 14.19 and trauma 7.09. Mechanism of injury was hyperextension and twist (Table 2).

The biomotor ability

After training, peak power was significantly increased in PEP group compared with the control group (mean dif = -2.67; 95% CI: -3.72 to -1.61; *p*-value <0.001). The average of peak power between group was statistically different higher at week 4 ([38.53±2.94 vs. 37.20±3.54]; mean dif = -1.68; 95% CI: -3.17 to -0.19; *p*-value = 0.027) and week 8 than baseline ([41.09±2.41 vs. 37.80±3.52]; mean dif = -3.6; 95% CI: -4.94 to -2.37; *p*-value <0.001(Table 1).

Table 2. Characteristics of knee injuries between PEP and control group

Characteristics of knee injuries	PEP (n = 26) (%)	Control (n = 26) (%)	Incidence rate (95 CI) (%) (per 100,000 athlete-exposure)
Overall	3 (11.5)	9 (34.6)	
Number of injury			
Match	0 (0)	2 (7.7)	3.55 (0.42 to 12.81)
Training	3 (11.5)	7 (26.9)	17.73 (8.5 to 32.61)
Type of injury			
Complete tear of ACL	0 (0)	3 (11.5)	5.32 (1.11 to 15.58)
Partial tear of ACL	1 (3.8)	0 (0)	1.77 (0.44 to 9.88)
Chondromalacia patella	1 (3.8)	3 (11.5)	7.09 (1.93 to 18.16)
MCL	0 (0)	0 (0)	-
PCL	0 (0)	0 (0)	-
Muscle soreness	1 (3.8)	2 (7.7)	5.32 (1.11 to 15.58)
Muscle strain	0 (0)	1 (3.8)	1.77 (0.44 to 9.88)
Position of injury			
Server	0 (0)	3 (11.5)	5.32 (1.11 to 15.58)
Feeder	1 (3.8)	1 (3.8)	3.55 (0.42 to 12.81)
Killer	2 (7.7)	4 (15.4)	10.64 (3.91 to 23.16)
Cause of injury			
Overused	2 (7.7)	6 (23.1)	14.19 (6.12 to 27.95)
Trauma	1 (3.8)	3 (11.5)	7.09 (1.93 to 18.16)
Mechanism of injury			
Hyperextension	2 (7.7)	6 (23.1)	14.19 (6.12 to 27.95)
Twist	1 (3.8)	3 (11.5)	7.09 (1.93 to 18.16)

The comparison of flight time between PEP and control had no a significant difference (mean dif = -0.003; 95% CI: -0.013 to -0.005; *p*-value = 0.554). At week 4, there were no significant change between groups in term of flight time ([0.481±0.025 vs. 0.477±0.028]; mean dif. = -0.002; 95% CI: -0.017 to 0.013; *p*-value = 0.784). There were no significant differences between PEP and control as well ([0.493±0.029 vs. 0.485±0.025]; mean dif. = -0.005; 95% CI: -0.017 to 0.013; *p*-value = 0.485) (Table 3).

Eight weeks after training, jump height of PEP group had a significantly higher mean than control group difference (mean dif = -1.04; 95% CI: -1.97 to -0.11; *p*-value ≤0.001). In terms of comparison of PEP and control at week 8 also had a significant difference ([29.92±2.44 vs. 28.34±2.26]; mean dif = -1.56; 95% CI -2.85 to -0.27; *p*-value = 0.018). At week 4, there were no significant between groups ([28.27±2.10 vs. 27.73±2.83]; mean dif = -0.51; 95% CI -1.60 to 0.57; *p*-value = 0.347) (Table 3).

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After training, the result of sit and reach exhibited significantly increase in the PEP groups as compare with the control group (mean dif = -0.62; 95% CI: -1.87 to 0.63; *p*-value <0.001). There was no significant change between two groups at week 4 and 8 (Table 2).

After eight weeks, the agility t-test had no significantly decreased in between the PEP and the control group (mean dif = 0.22; 95% CI: -0.05 to 0.50; *p*-value = 0.281). At week 4 and 8, the comparison of mean also had no a significant difference (Table 3).

Conventional concentric knee ratios

Table 4 presented mean values for concentric knee ratios and comparison between and within group for $60°s^{-1}$, $180°s^{-1}$, and $300°s^{-1}$ at baseline, 4 and 8 weeks after training. Comparisons between groups found a significant difference (mean dif = -0.39; 95% CI: -0.05 to -0.02; *p*-value <0.001)

Table 3. Description and comparison of biomotor ability variable between PEP and control groups at baseline, week 4, and week 8 by Analysis of Covariance and generalized estimating equations (GEE)

Biomotor ability	Group	Baseline	Post trained		Overall
			Week 4	Week 8	
1) Muscle power					
Peak power	PEP	35.99±2.88	38.53±2.94	41.09±2.41	
	Control	36.62±3.94	37.20±3.54	37.80±3.52	
	Mean difference	NA	-1.68	-3.6	-2.67
	95% CI	NA	-3.17 to -0.19	-4.94 to -2.37	-3.72 to -1.61
	p-value	NA	0.027	<0.001	<0.001
Flight time	PEP	0.473±0.034	0.481±0.025	0.493±0.029	
	Control	0.478±0.030	0.477±0.028	0.485±0.025	
	Mean difference	NA	-0.002	-0.005	-0.003
	95% CI	NA	-0.017 to 0.013	-0.021 to 0.010	-0.013 to -0.005
	p-value	NA	0.784	0.485	0.554
Jump height	PEP	27.26±2.18	28.27±2.10	29.92±2.44	
	Control	27.23±2.90	27.73±2.83	28.34±2.26	
	Mean difference	NA	-0.51	-1.56	-1.04
	95% CI	NA	-1.60 to 0.57	-2.85 to -0.27	-1.97 to -0.11
	p-value	NA	0.347	0.018	<0.001
2) Sit and reach	PEP	19.51±3.91	19.95±2.37	22.21±2.70	
	Control	19.24±2.58	19.68±3.23	21.00±3.42	
	Mean difference	NA	-0.12	-1.11	-0.62
	95% CI	NA	-1.39 to 1.13	-2.72 to 0.49	-1.87 to 0.63
	p-value	NA	0.839	0.171	<0.001
3) Agility t-test	PEP	12.64±0.71	12.26±0.41	12.04±0.83	
	Control	12.62±0.80	12.44±0.59	12.31±0.65	
	Mean difference	NA	0.17	0.27	0.22
	95% CI	NA	-0.10 to 0.46	-0.15 to 0.69	-0.05 to 0.50
	p-value	NA	0.222	0.205	0.281

* Mean difference (PEP) adjusted for baseline measurements, for each visit using analysis of covariance (ANCOVA) and for overall using generalized estimating equations implemented under generalized linear model frameworks

Table 4. Description and comparison of biomotor ability variable between PEP and control groups at baseline, week 4, and week 8 by Analysis of Covariance and generalized estimating equations (GEE)

Angular velocity	Leg	Group	Baseline	Post trained		Overall
				Week 4	Week 8	
60° s^{-1}	Dominant leg	PEP	0.53±0.06	0.56±0.06	0.59±0.06	
		Control	0.53±0.07	0.54±0.06	0.55±0.07	
		Mean Dif.	NA	-0.02	-0.05	-0.39
		95% CI	NA	-0.04 to -0.008	-0.07 to -0.02	-0.05 to -0.02
		p-value	NA	0.004	<0.001	<0.001
	Non-dominant leg	PEP	0.52±0.09	0.54±0.08	0.55±0.09	
		Control	0.54±0.07	0.55±0.07	0.54±0.07	
		Mean Dif.	NA	-0.01	-0.01	-0.03
		95% CI	NA	-0.03 to 0.004	-0.03 to 0.005	-0.03 to 0.001
		p-value	NA	0.118	0.125	<0.001
180° s^{-1}	Dominant leg	PEP	0.59±0.08	0.60±0.08	0.63±0.08	
		Control	0.58±0.09	0.60±0.09	0.61±0.07	
		Mean Dif.	NA	0.01	-0.01	-0.004
		95% CI	NA	-0.01 to 0.03	-0.04 to 0.01	-0.02 to 0.01
		p-value	NA	0.483	0.196	<0.001
	Non-dominant leg	PEP	0.57±0.08	0.59±0.08	0.63±0.08	
		Control	0.58±0.08	0.59±0.08	0.61±0.07	
		Mean Dif.	NA	-0.0008	-0.01	-0.006
		95% CI	NA	-0.02 to 0.02	-0.04 to 0.02	-0.03 to 0.01
		p-value	NA	0.939	0.457	<0.001
300° s^{-1}	Dominant leg	PEP	0.61±0.10	0.64±0.11	0.67±0.11	
		Control	0.58±0.12	0.61±0.12	0.62±0.12	
		Mean Dif.	NA	-0.01	0.03	-0.02
		95% CI	NA	-0.03 to 0.01	-0.06 to 0.006	-0.04 to 0.006
		p-value	NA	0.394	0.102	<0.001
	Non-dominant leg	PEP	0.60±0.10	0.63±0.09	0.66±0.16	
		Control	0.57±0.13	0.60±0.11	0.60±0.13	
		Mean Dif.	NA	-0.01	-0.05	-0.03
		95% CI	NA	-0.02 to 0.02	-0.12 to 0.02	-0.08 to 0.01
		p-value	NA	0.391	0.187	<0.001

* Mean difference (PEP) adjusted for baseline measurements, for each visit using analysis of covariance (ANCOVA) and for overall using generalized estimating equations implemented under generalized linear model frameworks

only dominant leg at 60°s^{-1}. At week 4 and 8, both groups also had a significantly different mean value ([0.56±0.06 vs. 0.54±0.06]; mean dif = -0.02; 95% CI: -0.04 to -0.008; *p*-value = 0.004; ([0.59±0.06 vs. 0.55±0.07]; mean dif = -0.05; 95% CI: -0.07 to -0.02; *p*-value <0.001). After 8-weeks period, there were a significantly different mean value regard to concentric knee ratio between two groups either dominant or non-dominant leg for the angular velocity at 180°s^{-1} and 300°s^{-1}. At week 4 and 8, there were no a significant difference of mean between the PEP and the control group for dominant and non-dominant leg at 180°s^{-1} and 300°s^{-1}.

Discussion

As for results, the highest of knee injury was chondromalacia patella injury presented incidence rate 7.09 (95% CI = 1.93, 18.16). The previous study mostly presented knee injury in sport was largely due to jumping[9], causing from dynamic overload, mainly eccentric, of the extensor mechanism of the knee joint. Repetitive jumping, kicking, or running associated with Jumper' knee[10,11]; weight-baring activity and training and playing on hard surface as well[12]. These reasons explained the high incidence rate of Sepak takraw players who normally are playing with jump and kill (kick). Other injury rates found ACL injury presenting 5.32 and 1.77 of complete and partial tear ACL respectively. The epidemiology of ACL injury was exceedingly found in either contact or non-contact sport. We considered only non-contact sports because the technique of sport was similar due to characteristics of jumping, stop and go movement, and changing direction causing ACL tear. The findings of the previous study supported ACL tear in non-contact, appearing when the knee was nearly extended during the landing maneuver[13]. Our finding agreed and supported knee injury occurring in killer position (IR = 10.64 athlete-exposure time), exceedingly exerting to spike the ball and landing, then hyperextension mechanism may occur.

PEP was the program having the potential to significantly improve muscle strength,

In this study, there were a rising of concentric knee ratios computed by dividing eccentric hamstring (peak torque) by concentric quadriceps[14]; thus, the strength of hamstring or quadriceps were more equal. Thigh muscles were important role to control the balance as well as the knee stability while the player was landing and pivoting. The previous study was found balancing of H/Q ratio could support to reduce knee injury[15]; because, hamstring strengthening could reduce anterior shear force during knee loading[16]. PEP consisted of strengthening maneuvers, plyometric, and sport-specific agility also improved neuromuscular control which could thereby compromise functional joint instability[17]. The proprioceptive consisted of the receptor (muscle spindle and golgi tendon organ), these were the essential of feedback system. The effective counter the stimuli response to central nervous system, being the one of protective factors could decrease the injury during movement.

The results of the study indicate that peak power and jump heights increased from pre- to post-training within the PEP group, with significant differences between PEP and control groups, but with no change in flight times. The differences between the PEP and control groups were not consistent with any previous study, but were found to improve for CMJ height from baseline to post-trained results[18]. However, some studies developing a training program based on PEP found differences involving 57% of the athletes, who showed improvements after training[19]. As a result, we might well suggest that Sepak takraw players fundamentally require highly developed biomotor abilities within the sport in order to demonstrate the peak skills necessary, for example, to jump, block, kick and serve effectively. Several studies investigating the effects of plyometric training on vertical jump ability found that this can be improved by means of plyometric jumps[20,21]. This arguably explains the improvements in jump heights and peak power when players are trained with plyometric exercise routines. From the literature, plyometric exercises that involve stretching an active muscle prior to its shortening cycle have been shown to enhance performance during the concentric phase of muscular contraction. The purpose of plyometric exercising is to improve the power of a subsequent movement by using both the natural elastic components of muscle and tendon and the stretch reflex[22]. To date, plyometric exercises have been adopted for training players in sports performance[23].

From the results, the significant differences found for the agility t-test within groups are consistent with results from previous studies[19]. However, this result was not replicated in female football players measured by pro-agility and the Illinois agility test[18].

Our finding presented incidence rate in trained group less than untrained group. We can explain the effectiveness of PEP program decreasing the knee injury. These discoveries undertaken by Filipa et al[24] investigated that the protective components were neuromuscular training, consisting of plyometric and technique training. It also was able to reduce the incidence of knee injuries by up to 27[25]. PEP in this study was accordingly trained, focusing on muscle strength, balance, and flexibility. These definitely showed the effectiveness of PEP to prevent knee injury.

Conclusion

Our findings appear to support the desirability of incorporating the PEP program in training for preventing or reducing injury in Sepak Takraw players by improving their biomotor abilities.

Limitation

We did not control the life style of any of the participants, for instance sleep and exhaustion from study, which may affect on plenary train.

What is already known on this topic?

Nowadays, many researchers have found the effectiveness of PEP can indeed help prevent or reduce injury. Sepak takraw players had not been studied in this regard. To our knowledge, there is no current research investigating the detailed effects of PEP training on Sepak takraw players. There is, consequently, a dearth of information allowing comparative evaluation of the effectiveness of injury prevention programs for young female Sepak takraw players.

What this study adds?

This study presents the effectiveness of PEP to prevent knee injury in Sepak takraw player, an exciting sport in Thailand. It is a non-contact sport similar to volleyball, tennis, badminton, etc. However, the characteristic of Sepak takraw was not totally similar. Hyperextension and twist caused the majorly of injuries in Sepak takraw players.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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