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EFFECTS OF INJURY PREVENTION TRAINING PROGRAM ON H/Q RATIO, 3-WAY STAR EXCURSION BALANCE TEST IN HIGH SCHOOL MALE BASKETBALL PLAYERS

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ABSTRACT

The purpose of study was to determine whether the Sports Injury Prevention Training Program (SIPTP), trained 3 times per week for 6 weeks was effective in terms of improving flexibility, isokinetic H/Q ratio, balance and muscle power which were the implication for the risk of lower extremity injuries. A total of 26 high school male basketball players, age range between 13-18 years, were randomly divided into 2 equal groups: (the intervention and the control groups). The intervention group was instructed to follow the 6 parts of the SIPTP (20 minutes), while the control group performed their regular training program. Both groups were tested with sit-and- reach test, isokinetic H/Q ratio, star excursion balance test (SEBT) and vertical jump test before and after the 6- week period. This study was a randomized controlled trial study in which two-way repeated measures ANOVA was used for analysis between and within groups, respectively. Statistical significance was considered at $p< 0.05$. The result showed that SEBT and flexibility value were significantly higher in intervention group than control group. Moreover, the values of SEBT, vertical jump, and H/Q ratio in the intervention group were significantly increased after 6 weeks of SIPTP. This study found that increased isokinetic H/Q ratio, SEBT and vertical jump test after 6 weeks of the SIPTP in high school male basketball players indicated that the program may help to prevent the injuries of lower extremity in young basketball players.

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Keyword: Injury Prevention Program / Anterior cruciate ligament / Lower extremity injury

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ผลของโปรแกรมการฝึกเพื่อป้องกันการบาดเจ็บในการวัดอัตราความสมดุลของกล้ามเนื้อต้นขาด้านหน้าเทียบกับต้นขาด้านหลัง การทรงตัวในนักกีฬาบาสเกตบอลชายระดับมัธยมปลาย

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บทคัดย่อ

การศึกษาวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของการฝึกด้วยโปรแกรม SIPTP 3 ครั้งต่อสัปดาห์ เป็นเวลา 6 สัปดาห์ โดยตัวแปรที่วัดประกอบด้วย ความอ่อนตัว,อัตราความสมดุลของกล้ามเนื้อต้นขาด้านหน้าเทียบกับด้านหลัง, การทรงตัวและ กำลังกล้ามเนื้อ ซึ่งมีความเกี่ยวข้องกับการบาดเจ็บของระยางค์ส่วนล่าง โดยอาสาสมัครผู้รับการวิจัยเป็นนักกีฬาบาสเกตบอลชาย จำนวน 26 ราย ช่วงอายุระหว่าง13-18 ปี โดยแบ่งออกเป็นสองกลุ่ม กลุ่มทดลองและกลุ่มควบคุม โดยกลุ่มทดลองจะได้รับการฝึก 6 ส่วนของโปรแกรม SIPTP เป็นเวลา 20 นาที ในขณะที่กลุ่มควบคุมเป็นการอบอุ่นร่างกายแบบทั่วไป ทั้งสองกลุ่มจะถูกวัดค่าความอ่อนตัว ,ความสมดุลของกำลังกล้ามเนื้อต้นขาด้านหน้าเทียบกับด้านหลัง, ค่าการทรงตัว และค่าการกระโดดสูง ก่อนและหลังการฝึก 6 สัปดาห์ การวิเคราะห์ทางสถิติใช้ two way repeated ANOVA ในการวิจัยพบว่าค่าการทรงตัว และค่าความอ่อนตัว ในกลุ่มที่ได้รับการฝึกมีค่าที่เพิ่มขึ้นแตกต่างจากกลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ นอกจากนั้นกลุ่มที่ได้รับการฝึกยังพบว่าค่าการทรงตัว ค่าการกระโดดสูง และอัตราความสมดุลของกล้ามเนื้อต้นขาด้านหน้าเทียบกับด้านหลังเพิ่มขึ้นอย่างมีนัยสำคัญ หลังได้รับการฝึกด้วยโปรแกรม SIPTP เป็นเวลา 6 สัปดาห์ จากการศึกษาสรุปได้ว่าการฝึกด้วย โปรแกรม SIPTP เป็นเวลา 6 สัปดาห์ สามารถเพิ่มค่าอัตราสมดุลของกล้ามเนื้อต้นขาด้านหน้าเทียบกับด้านหลัง, ค่าการทรงตัว,ค่าการกระโดดสูง เป็นผลให้ช่วยลดการบาดเจ็บของระยางค์ส่วนล่างของนักกีฬาบาสเกตบอลระดับมัธยมปลาย

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คำสำคัญ: โปรโตคอลป้องกันการบาดเจ็บ/ เอ็นไขว้หน้า/ การบาดเจ็บของระยางค์ส่วนล่าง

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INTRODUCTION

Basketball is considered as a very popular team sport, defined by short and explosive efforts, rapid changes of direction, jumping and landing movements. Specific motor skills such as jumping and landing ability of the players play role elements in the successful performance. The key factors related to the lower extremity injury are; 1) flexibility which defined as the ability of a joint to move through a full range of movement[1]. The sit and reach test is a typical measure of lower back and hamstring muscles flexibility; 2) the conventional hamstring/quadriceps ratio (H/Q) which characterized the muscular balance between knee extensors and knee flexors strength of each leg[2]. The Isokinetic dynamometer (Biodex) is commomly used to measure the H/Q ratio; 3) balancing which is the capacity to keep up the focal point of gravity within the base of support and vertical jump[3]. 3 way SEBT is the typical instrument to measure the balancing; 4) vertical jump is the parameter used to measure the muscular power of the lower extremity[4] by using the Vertex™ instrument. Moreover, short muscle and tight joint connective tissue may predispose an athletes to either muscle strain or joint injuries, especially in lower extremity[8]. However, most commonly associated mechanism with lower extremity injuries are excessive knee and hip adduction during jumping, and squatting movement[5]. The most frequent injured parts are ankle/foot, knee, head/face/neck, arm/hand, and hip/thigh/upper leg, respectively. Ligament sprains, muscle/tendon strains, contusions, fractures, and concussions are frequently injury diagnoses[6]. Many ACL injury prevention programs have been studied and implemented. Mandelbaum's Prevent Injury and Enhance Performance (PEP) program is one of the largest ACL injury prevention program in the United States[7]. The program is implemented in soccer, targeting young female soccer players. However, ACL injury mechanism in soccer is somewhat different from basketball. Therefore, the training for the injury prevention should also be different. Longo et al (2012)[8] studied the effect of The FIFA 11+ program on preventing injuries in Elite Male Basketball Players in 11 teams of a same club. Seven teams were allocated to the intervention group and 4 teams were allocated to the control group. They conducted a FIFA 11+ program during a 9-month season and founded a total of 31 injuries (14 in the intervention group and 17 in the control group). In the intervention group, injury rates per 1000 athlete-exposures were lower than those in the control group, with statistical significance in lower extremity injuries (LEIs). The intervention group also had statistically significant lower injury rates for leg, hip and groin compared with the control group. Lim Bo et al (2009)[9] studied the effect of the Sports Injury Prevention Training Program (SIPTP) modified from Mandelbaum's PEP program aiming to improve biomechanical properties related with ACL injury in female basketball Players. SIPTP is also used to increase active knee stabilization in the laboratory, to decrease the incidence of ACL injuries among female athletes and to [9] improve athletic performance measures.[10] To date, no existing lower extremities prevention program for male basketball players has been reported. The favorable results from SIPTP program, although implemented in female basketball players, can potentially benefit male basketball players. The purpose of study was to determine whether the Sports Injury Prevention Training Program (SIPTP). The clinical parameter measuring included in this study are the flexibility, the isokinetic H/Q ratio, balance and vertical jump using sit and reach test,

Biodex, 3 way SEBT and Vertex™, respectively. In this study, trained 3 times per week for 6 weeks was effective in terms of improving flexibility, isokinetic H/Q ratio, balance and vertical jump which were the implication for the risk of lower extremity injuries.

METHODS

Participants

Participants: A total of twenty six high school male basketball players, between 13-18 years of age, were recruited and randomly divided into 2 groups (the intervention group and the control group, 13 participants each). Written informed consent was obtained from each of the study participants and from their parents or guardians. The protocol was approved by Human Research Ethics Committee of Mahidol University. Pre-training data were collected before the training sessions in both groups, and post training data were collected after completion of the 6 weeks of training period. Participants were given an instruction on Sports Injury Prevention Training Program (SIPTP)[9] consisting of 6 parts (1. warm-up; jogging line to line, shuttle run (side to side), backward running, 2. Stretching; calf, quadriceps, hamstring, inner thigh, hip flexor static stretch, 3.Strengthening ; walking lunges, Russian hamstring, single toe raises, 4.Plyometrics; lateral hops, forward/backward, single-leg hops over cone, vertical jumps with headers, scissors jump, 5..Agilities; shuttle run with forward/backward running, diagonal runs, bounding runs 6..alternative exercise–warm down; bridging with alternating hip flexion, abdominal crunches, single and double knee to chest (supine), piriformis stretch–supine, seated butterfly stretch) for 2 days before the experiment started. The intervention group performed the SIPTP (20 minutes for 3 times per week for 6 weeks) while the control group performed their individual regular warm-up and basketball practice. On the first visit, participants were screened by asking their previous injury history and assessing the exercise readiness using Physical Activity Readiness Questionnaire (PAR-Q) and Health questionnaire. Before the test day, participants were asked for alcohol and caffeine restriction for 24 hours. On test was done day at physical fitness testing unit room (at College of Sport Science and Technology, Mahidol University).The general data was collected by interview. Details of tests that consisted of sit and reach test[11], 3- ways Star Excursion Balance Test (3 way SEBT)[3], vertical jump test (Vertex ™)[13]and isokinetic device (Biodex)[11] were instrumental to the participants. Data analyses was done by Two-way repeated measures ANOVA and post-hoc with Bonferroni test for the results between the groups (control and intervention groups) and testing time (pre- and post-test) as the between and within factors, respectively ($p< 0.05$)

RESULTS

From the participants screening session by use the PAR-Q, the participants have to pass the criteria of 7 health questionnaires in both intervention and control groups even characteristics, health and physical activity readiness.

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The general characteristics of subjects

Twenty six subjects participated in this study. Characteristics of subjects were shown in Table 1. The Demographics data consisted of age, height, leg length and body weight which, there was no significant difference between intervention and control groups ($p < 0.05$).

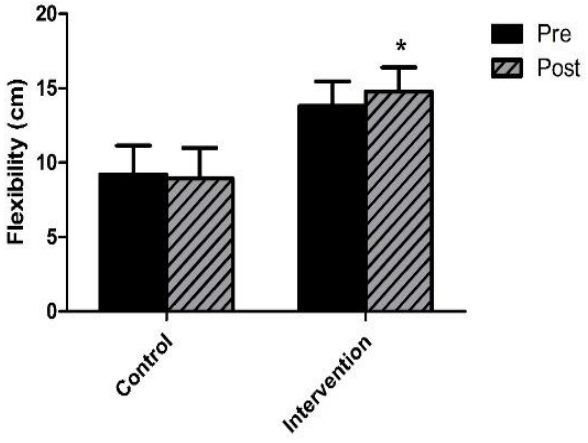
Table 1. Demographics of participants of the control and intervention group

Characteristic	Intervention Group (n=13)	Control Group (n=13)	*p* Value
Age, y	14.38 ± 1.04	15.15 ± 1.21	0.096
Height, cm	175.61 ± 5.77	177.07 ± 8.05	0.691
Bodyweight, kg	66.69 ± 15.16	68.92 ± 13.04	0.599
Leg length, cm	93.58 ± 4.30	94.96 ± 4.48	0.429

Sit and reach test

Main effect of Time F (1, 24) = 0.044), p=0.836, Main effect of Group F (1, 24) = 7.431, p = 0.012, and an interaction between time and group F (1, 24) =19.510, $p < 0.001$

Figure 1. Comparison of mean (± SEM) values of sit and reach after training program between control and intervention group.



* Significant difference between intervention group and control group, p value < 0.05.

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3 way Star Excursion Balance Test (3- way SEBT)

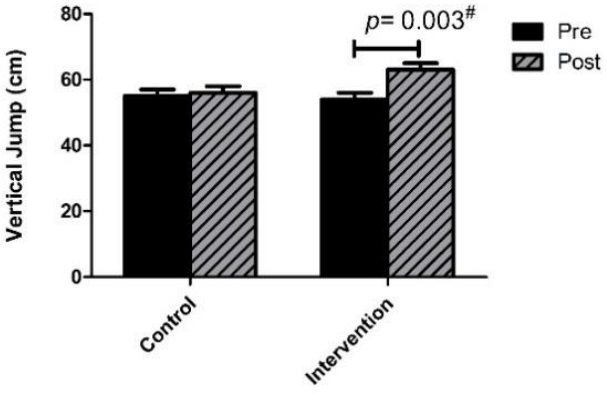
Table 2. 3 -way SEBT Comparison of mean (± SEM) values of 3- way SEBT after training program between control and intervention group

Parameters	Invention		Control	
	Pre	Post	Pre	Post
Anterior Left (AL)	128.72±3.49	139.07±2.62#	130.83±2.55	129.50±2.57*
Posteromedial Left (PML)	135.52±2.53	142.84±2.37#	130.94±2.89	129.01±3.02*
Posterolateral Left (PLL)	114.63±3.44	129.16±2.89#	111.18±3.00	112.87±2.70*
Anterior Right (AR)	136.98±3.06	143.67±2.61#	133.09±2.76	131.12±3.04*
Posteromedial Right (PMR)	137.06±1.89	144.83±1.26#	133.66±2.98	132.72±3.24*
Posterolateral Right (PLR)	115.75±4.03	129.13±3.21#	115.24±4.55	116.50±3.73*

significantly difference between pre-post within groups at $p < 0.05$

* Significantly difference between intervention group and control group, $p < 0.05$

Figure 2. Comparison of mean (± SEM) values of vertical jump after training program between control and intervention group for both pre and post-test.



In the within groups comparison of the vertical jump, Intervention group shown significantly higher values in post-test than pre-test at $p < 0.05$.

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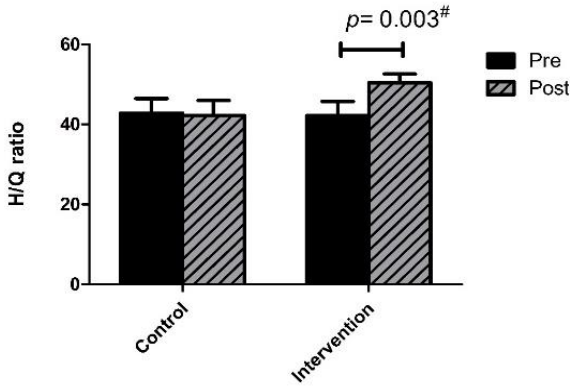
Figure 3. Comparison of mean (± SEM) values of H/Q ratio after training program between control and intervention group for both pre and post-test. In the within groups comparison of the H/Q ratio, Intervention group was shown significantly higher values in post-test than pre-test at $p < 0.05$.



DISCUSSION

This study found that sit-and-reach test result at post-trained period were significantly different when compared between intervention and control group. The significant increase of 3- way Star Excursion Balance Test (3-way SEBT) of pre- and post- test in all directions of the intervention group may be from effective muscle stretching components in the program that included calf muscles, quadriceps muscles, hamstring muscles, inner thigh muscles, and hip flexor muscles. Since stretching of hamstrings increase the overall flexibility of the leg and lower back muscle, as seen from the improved sit-and-reach test, it may also help in reducing the risk of injuries related to those relevant muscles.[15] The 3-way SEBT was tested to determine the dynamic balance and postural stability control.[3] This is because poor balance and postural stability control induces more stress to ligament and joint capsule. Many injuries have occurred when athletes lose their body control during rapid dynamic motion,[16] including ACL injuries.[3] Improved SEBT following the 6-week SIPTP from this study may generally promote the injury prevention. In terms of sports performance, the vertical jump was significantly higher in post-test than pre-test in the intervention group, which it may be from plyometric and agilities training such as shuttle run, forward/backward running, diagonal runs, and bounding runs. These practices can increase the power of- muscle and tendon and the stretch reflex. Plyometric or jump training has been prescribed to enhance mechanical deficits seen in the lower extremity following ACL reconstruction.[17] Plyometric training consists of dynamic and rapid stretching of muscles (eccentric action) immediately followed by a concentric of shortening action of similar muscles and connective tissues. Plyometric training can also enhance neuromuscular capacity and improve performance in explosive and endurance at these versatile changes in neuromuscular capacity are likely the aftereffect of: (I). An expanded neural drive to the agonist muscles; (ii). Enhanced intermuscular coordination, (iii). Changes in the mechanical attributes of the muscle-ligament complex of plantar flexors.[18] The H/Q ratio after training program was also found to be significantly different between control and intervention groups($p < 0.05$), in which in the intervention group, the H/Q ratio post-test was significantly higher than pre-test ($p < 0.05$). It has been found that, in female soccer players

lower H/Q ratio and lower postural sway of the leg are the most essential risk factor for traumatic leg injury.[19] From the results of H/Q ratio showed significant increase from strengthen such as walking lunges, Russian hamstring and single toe raises. The normal range of the H/Q ratio is 0.5–0.8, which implies that hamstrings must develop a maximum muscle joint moment of 50%–70% of the maximum quadriceps moment.[20] Lower concentric hamstring to quadriceps strength ratio is also one of the significant risk factors of hamstring strain injury.[21] Lim Bo *et al.* 2009 demonstrated that the sports injury prevention training program (SIPTP) can improve the strength, flexibility and biomechanical properties related with injury as compared with pre- training parameters of the female basketball players.

CONCLUSION

The goal of this study was fundamentally to investigate and the effects of the injury prevention program (SIPTP) on H/Q ratio and balance (3-way SEBT) which are the implication for the risk of lower extremities injury in high school male basketball players. The findings of this study are: 1).The balance measurement using 3-way SEBT of the intervention group was significantly higher after SIPTP compared with the control group. 2). The H/Q ratio measurement using isokinetic test (Biodex) of the intervention group was significantly higher when compared within group but not different between two groups. Implementing SIPTP in high school male basketball players was satisfactorily successful. Therefore, implementing SIPTP in professional athletes is recommended.

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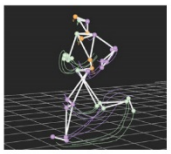
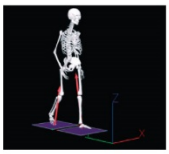
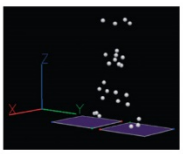




BIODEX

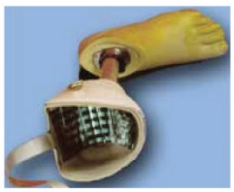
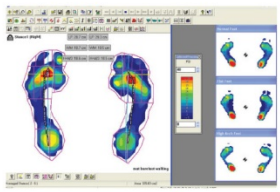


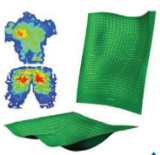

Neuromuscular evaluation & therapeutic exercise





Excellence in wireless EMG system solution cometa



Insole Plantar Pressure Analysis: Barefoot Pressure Analysis: Seating & Positioning Pressure Analysis

Tekscan

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