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Prevention Program for Young Squash Players - Impacts on Physical Performance and Hamstring Injuries

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ABSTRACT

Hamstring injuries are more common among squash female players compared to male and also, more frequent in youths compared to older players. The aims of the present study were to investigate the effects of a prevention program on physical performance and hamstring injuries in youth female squash players between 16 and 18 years of age. Randomized controlled trial study. Seventeen girls from local squash club, were randomly assigned to either an experimental (EXP, n = 9) or control (CON, n = 8) group and assessed at baseline and 8 weeks on isokinetic and isometric strength protocols for the quadriceps and hamstrings, isometric hip adduction and abduction strength, countermovement jump (CMJ), and Illinois agility tests. The intervention is a 15-min program consisting of ten exercises for lower extremity strength, and core muscles, jumps and balance exercises and was performed 5 times a week for 8 weeks in connection with the warm-up before squash training. The control group performed its' usual training. There was difference between the intervention and control groups in the change in physical performance from the pre-to post-test for all of the tests used. In addition, the hamstring injuries per 1000 hours of training and playing squash was 5.7 in the intervention group and 7.5 in the control group, which equates to 20% fewer injuries in the intervention group. The greatest effects were observed for mild injuries and injuries incurred during training. An injury prevention program that was performed five times a week in connection with the warm-up was improving squash specific performance and reduces hamstring injuries, especially in youth female squash players.

Keywords: Physical performance, injury prevention, squash, youth, hamstrings injuries.

1. Introduction

Squash is a high participation sport world-wide. The World Squash Federation (WSF) estimated that about 50,000 courts in more than 185 nations worldwide. Previous research in female squash has shown that the overall injury rate for female players is nearly as high as that for male players. As a consequence, effective injury prevention methods are needed for both genders at all age and skill levels.

Unfortunately players get injured during squash play. Many researchers have shown a disparity in injury incidence between male and female soccer players and one of the major injuries, the anterior cruciate ligament injury, is more common among women, particularly teenage girls. Several studies have shown that the incidence of squash injuries can be reduced by adopting various injury prevention strategies including: warm-up, with an emphasis on stretching; proper medical attention for injuries; appropriate recovery methods and time; appropriate cool-down; use of protective equipment; good playing field conditions and adherence to existing rules (Blaser and Aeschlimann, Hawkins and Fuller, 1999).

An exercise program, the Prevention Program (PP), was design to prevent the most common injury types; knee and ankle sprains, hamstring and groin strains. The "PP" is a 10-min program consisting of 6 exercises focusing on core stability, lower extremity strength, balance, agility. The prevention training protocols are designed to not only prevent injuries, but to also increase player performance, this could potentially increase coach and athlete compliance. The main aim of this study was to assess the effect of the "PP" on injury risk and on physical performance variables in young female squash players.

2. Methodology

2.1 *Subjects*

Seventeen girls (mean ±SD: age 17.2 ± 0.9) from a local squash club. Players were randomly assigned to either an experimental (EXP, n = 9) or a control (CON, n = 8) group. Before the start of the investigation, the 17 players available received written and oral information about the study, and it was emphasized that participation in the ''PP'' was voluntary. Written consent was obtained. The players were screened for injuries using a questionnaire at the start of the study, and they had to be uninjured to be included. Two players had to be excluded because of injury.

2.2 *The Prevention Program*

The Prevention Program, the ''PP'' was which was developed by FMARC, the medical research centre of The Federation Internationale de Football Association (FIFA). The exercises were chosen based on previous research on injury prevention and established principles for rehabilitation of groin, hamstrings, knee and ankle injuries. The 10-min program includes 6 exercises focusing on hamstrings strength, neuromuscular control, core stability, and agility (Table 1). The prevention program was introduced to the players in the EXP group by a physical therapist. The ''PP'' was to be carried out five times a week for eight weeks during squash training at club. The players in the CON group warmed up as usual. More than 85% of the intervention sessions were supervised by the project coordinator. Player participation in all training sessions, as well as in the ''PP'' for the EXP group in particular, was recorded throughout the study period.

(Table 1)
Guidelines for Physical Performance of "The PP"

Exercise Name	Guidelines
Core stability	
The bench	Hold for 15s each leg X 4 repetitions
Balance	
Cross-country skiing	15 s X 2 repetitions on each leg
Chest pass in single-leg stance	15 s X 3 repetitions on each leg
Strength	
Hamstrings	5 repetitions
Plyometrics	
Jumps over a line (sideways, forwards-backwards)	15 jumps of each type
Zigzag shuffle (forwards and backwards)	2 repetitions in each direction (20 m)

2.3 *Physical Tests*

After a familiarisation session, participants performed the following tests, before and after a 8 week intervention: 1) isokinetic and isometric strength protocols for the quadriceps and hamstrings; 2) isometric hip adduction and abduction strength; 3) countermovement jump (CMJ); 4) Illinois agility tests. A standardized ten minute football-specific warm-up was conducted prior to each battery of physical tasks. The test battery included four test stations and was completed within 3-4 hours. The tests were conducted in the same order for each player for the pre- and the post-tests. One week before the pre-test, all players participated in a test run to familiarize themselves with the testing procedures. The test run and the pre- and post-tests were led by the same experienced lab personnel. Pre- and post-tests were performed at the same time of day (16:00 ± 0.4hrs), in the same indoor venue.

2.3.1 *Lower Extremity Isokinetic and Isometric Torque Test*

The players warmed up for 5 min on a bicycle with an intensity of 70–100 W. When the players underwent the test run, the dynamometer position, seat position and attachment arm length were recorded to ensure test replication. Straps were used to minimize movements of the torso and the thigh segment of the tested extremity. The arms were held across the chest. The hip angle was 90^0. The axis of rotation of the dynamometer was aligned with the knee joint, and the angular movement of the knee joint was 90^0. Concentric isokinetic quadriceps and hamstring torques were measured at a test angular velocity of 60 and 240^0/s, while eccentric isokinetic torque was tested at 60^0/s only. After four warm-up repetitions, the players were instructed to perform three maximal concentric and four maximal eccentric contractions for both hamstring and quadriceps at each angular velocity. There was a rest period of 1 min between the different angular velocities.

The quadriceps: hamstring ratio was calculated for all angular velocities for concentric torque, and for concentric quadriceps torque vs eccentric hamstring torque at 60^0/s. The isometric quadriceps and hamstring torques were measured at 30^0, 60^0 and 90^0 of knee flexion. The players performed a 5-s maximal contraction at each knee flexion angle (Figure 1). Between two contractions at the same angle, the players had a 10-s pause, while they were given a 20-s rest between contractions at different angles. Strength was reported as the peak torque recorded (N m), and the best of three concentric, four eccentric and two isometric repetitions were used in the data analysis.

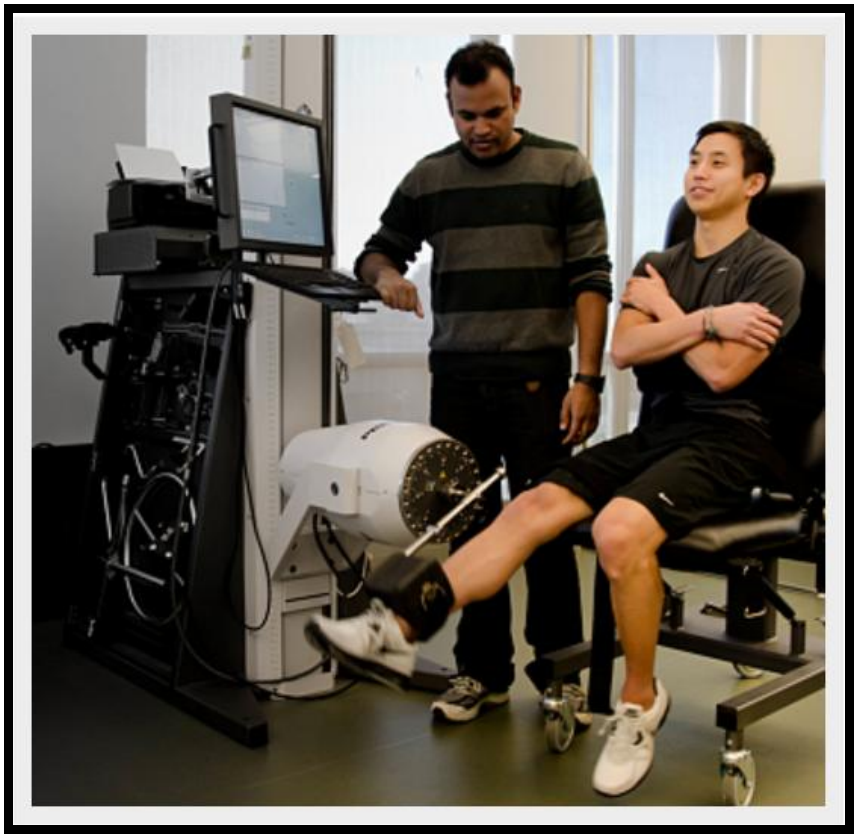

Figure 1. Lower Extremity Isokinetic and Isometric Torque Test

2.3.2 *Isometric Hip Strength*

Before the isometric strength tests for hip abductors and adductors, the players warmed up for about 5 min using a bicycle at an intensity of 70–100 W. The isometric strength of the adductor and abductor muscles was tested with a handheld dynamometer, similar to Krause et al. (2007). The tests were conducted with the players lying in a supine position on a bench **(**Figure 2). For the adductor muscles, tests were conducted with the knee in extended and flexed positions. When testing for adduction strength with the leg extended, the dynamometer was positioned 5 cm proximal to the medial ankle malleolus, while it was placed 5 cm proximal to the joint line of the knee on the medial side for testing in the flexed position. Isometric abduction was measured with the leg in the extended position only.

The dynamometer was positioned 5 cm proximal to the lateral ankle malleolus. The arms were held across the chest during the test. Both legs were tested, with two maximal contractions for each test variable and a 10-s rest period between the two attempts. The highest value for each of the three tests was registered. The dominant leg for each player was recorded in order to analyze the values for the kicking and standing foot, respectively.

Figure 2. Isometric Hip Strength Test

2.3.3 *Vertical Jump*

Maximum vertical jump height was measured using a maximal double-leg counter-movement jump, accompanied by an arm swing, using a contact mat system (Figure 3). The contact mat system measures jump height, flight time and ground contact time and has been shown to demonstrate high reliability (flight time r = 0.95; contact time r = 0.99) when compared to a force platform (Cronin and McLaren, 1999). Participants positioned their feet approximately shoulder width apart on the contact mat before attempting the jump. Steps or run-ups into the jumping action were not permitted and the landing had to occur on the contact mat. Jump height was determined to the nearest 0.1 cm using the following formula:

$$\text{Jump Height (m)} = 0.5 \times g \, (t/2)^2 \quad \text{Eq 1}$$

Where g represents acceleration due to gravity (9.81 m·s-1); and t represents the flight time of the jump in seconds.

Participants performed three jump trials in succession, with approximately 15 to 30 s recovery between jumps. Jumps were considered void if the participant 1) went into extreme (>45 degrees) hip flexion during the flight time of the jump; 2) flexed the knees to the extent that the heel nearly touched the gluteal muscles; and/or 3) did not land centrally on the contact mat.

Figure 3. Counter-Movement Jump Test

2.3.4 *Agility*

Agility was determined using the Illinois agility test (Figure 4). Participants start the test lying face down, with the hands at shoulder level. Times were recorded to the nearest 0.01 s, using the aforementioned timing gate system, and the mean of the best two times recorded. Reliability of this test has been reported to be high, ICC = 0.88 (Gabbett, 2002).

Figure 4. Illinois Agility Test

2.4 *Statistical Analysis*

The primary hypothesis, that there would be a difference between groups in the change in performance from pre- to post-tests, was analyzed using unpaired t-tests. The results from pre- and post-tests are reported as means with SD, while the changes within the EXP and CON from pre- to post-tests are given as means with a 95% confidence interval. An intention to- treat analysis was performed including all players who completed the pre- and post-tests, as well as a per-protocol analysis restricted to players who participated in the pre- and post-tests and completed more than 18 training sessions with the ‘‘PP’’ The best result obtained in each of the performance tests was used in the statistical analysis. Incidences of injury were compared by calculating z-values. The level of significance was chosen to be $P < 0.05$ and all tests were two-tailed.

3. Results and Discussion

There were significant differences between the EXP and CON group in all of the results on the pre-tests. Maximal concentric, eccentric and isometric hamstring torques were change from pre- to post-test within EXP group, it was a significant increase in isometric quadriceps torque at 90 degree ($P<0.01$), but there was no significant within the CON group. However, significant differences were observed between groups in the change from pre- to post-test for the hamstring or quadriceps strength tests. In addition, there were significant between-group differences in the quadriceps: hamstring ratio change. P-values for these lower extremity strength variables ranged from 0.01 to 0.02.

Also, isometric hip strength results shown there were significant differences between the EXP and CON group in the change from the pre- to the post-test of the three tests ($P<0.01$) for kicking foot extended, $P<0.03$ for kicking foot flexed, ($P<0.01$) for standing foot). In addition, jumping ability results shown there were significant differences between the EXP and CON group, the analysis showed increase mean jumping performance values in the EXP group for maximal countermovement jump test. The significant between-groups differences in the change from the pre- to the post-test observed ($P<0.01$) for countermovement test). Furthermore there was a significant difference between the EXP and CON group in agility to improve in EXP group from the pre- to the post-test observed ($P<0.01$) (Table 2).

(Table 2)

Results from the pre-test (mean ±SD) and change (Δ, mean ± 95% CI) from pre- to post-tests within the intervention and control groups, as well as between-group differences in the change from the pre- to the post-test (ΔG, mean ±95% CI).

Variables	EXP group (*n* =9)		CON group (*n* =8)		Between-group ΔG (95% CI)
	Pre-test	Δ	Pre-test	Δ	
Lower extremity isokinetic torque					
■ Q_{con} 60^0 S^{-1} (N m)	147.0 (11.2)	12.8	145.6 (13.4)	1.4	10.6 (26.1 to 0.8)
■ Q_{eon} 60^0 S^{-1} (N m)	184.5 (17.3)	13.5	188.4 (13.8)	0.8	12.4 (6.7 to 24.2)
■ Q_{con} 240^0 S^{-1} (N m)	95.7 (9.6)	15.4	97.3 (6.8)	-1.6	15.2 (5.3 to 22.7)
Lower extremity isometric torque					
■ Q_{iso} 30^0 (N m)	97.8 (11.5)	11.8	99.2 (15.7)	0.4	10.7 (7.3 to 21.8)
■ Q_{iso} 60^0 (N m)	155.9 (23.6)	14.3	159.4 (12.5)	-2.5	14.1 (5.6 to 23.6)
■ Q_{iso} 90^0 (N m)	151.6 (18.5)	15.7	154.4 (20.7)	-1.8	15.5 (8.1 to 20.3)
Ratio (Q:H)					
■ $Q:H_{con}$ 60^0 S^{-1} (%)	59.4 (6.2)	10.9	61.5 (8.1)	-4.1	10.5 (4.3 to 28.5)
■ $Q:H_{eon}$ 60^0 S^{-1} (%)	58.6 (3.5)	12.3	60.7 (8.5)	-1.6	11.8 (6.8 to 18.9)
■ $Q:H_{con}$ 60^0 S^{-1} (%)	73.7 (4.1)	11.9	75.4 (6.2)	-2.3	10.7 (3.2 to 16.8)
Isometric hip strength					
■ Kicking foot extended (kg)	14.9 (5.3)	16.3	15.3 (7.1)	0.4	15.9 (5.3 to 24.7)
■ Kicking foot flexed (kg)	15.4 (2.5)	14.7	16.1 (4.1)	-2.1	13.7 (7.2 to 17.8)
■ Standing foot (kg)	11.9 (3.7)	15.4	12.5 (2.3)	-3.5	14.8 (4.9 to 28.1)
Jumping ability					
■ Countermovement jump (cm)	172.5 (6.4)	10.9	175.1 (3.1)	-4.5	9.8 (3.9 to 18.3)
Illinois agility					
■ Agility (sec)	11.22 (0.47)	9.7	10.78 (0.72)	-3.7	10.3 (5.7 to 25.2)

The main finding of this investigation was that significant performance differences were observed in all the variables tested between an EXP using the prevention program and a CON warming up as usual. The most likely explanation is that the training volume and intensity for each of the exercises were suitable to result in performance improvements (Myer et al., 2005). In addition, the test battery available may have detected all potential improvements in performance. The results of the comparison of injuries rates for the EXP and CON groups are then reported. Comparison of the EXP and CON groups revealed that significantly fewer injuries occurred in the EXP group (Table 3).

(Table 3)
Comparison of Exposure Time and Incidence of Injury in the Experimental and the Control Groups

Variable	EXP Group (N=9) N (%)	CON Group (N=8) N (%)
Injuries	7 (100)	11 (100)
Injured players	5 (21.3)	7 (36.2)
	Mean (SD)	**Mean (SD)**
Training hours	8.6 (1.4)	13.5 (3.2)
Match hours	6.2 (3.9)	9.5 (1.6)
	Injuries in relation to exposure time	
All injuries per 1000 hours of exposure	0.6	0.8
Overuse or training injuries per 1000 training hours	0.2	0.5
Matches injuries per 1000 match hours	0.9	2.1

The number of injured players was 20% lower, and the rate of injury per player was 33% lower. When the incidence of injuries per player per year was analyzed with regard to different grades of severity, circumstances, and location of injury, specific effects of the PP could be demonstrated. Almost all types of injuries were less frequent in the EXP group compared with the CON group. In the control group of the present study, the incidence of injuries, especially of overuse injuries and injuries during training, was higher

The differences were statistically significant for mild injuries, overuse injuries, noncontact injuries, injuries incurred during training, and injuries of the groin. However, even when the incidence of injury was calculated per 1000 hours of training and matches, the EXP group still demonstrated 20% fewer injuries than the CON group The incidence of overuse injuries and injuries during training as related to the amount of time spent in training was 30% lower in the EXP group, and the incidence of match injuries related to the time spent in matches was 20% lower in the EXP group than in the CON group (McLean et al., 2005). The results of the present study clearly indicate that the incidence of soccer injuries in youth amateur squash players can be reduced by a prevention program. This outcome is in agreement with results of previous studies in female high school players.

4. Conclusions

Significant effects were observed on different performance variables among young female squash players participating in a 8-week prevention program, the ‘‘PP’’ compared with players who trained as usual. In addition, the prevention program was effective in reducing squash injuries, especially among young female players.

References

Blaser, K.U. and Aeschlimann, A. (1992). Unfallverletzungen beim Fußball. Schweizer Zeitschrift für Sportmedizin. 40, 7-11.

Cronin, J. and McLaren, A. (1999). Functional measurement of leg extension musculature: protocols, research and clinical applications. New Zealand Journal of Sports Medicine 27, 40-43.

Gabbett, T.J. (2002). Physiological characteristics of junior and senior rugby league players. British Journal of Sports Medicine 36, 334-339.

Hawkins, R.D. and Fuller, C.W. (1999). A prospective epidemiological study of injuries in four English professional football clubs. British Journal of Sports Medicine. 33, 196-203.

Krause DA, Schlagel SJ, Stember BM, Zoetewey JE, Hollman JH. (2007). Influence of lever arm and stabilization on measures of hip abduction and adduction torque obtained by hand-held dynamometry. Arch Phys Med Rehabil .88: 37– 42.

McLean SG, Walker K, Ford KR, Myer GD, Hewett TE, van den Bogert AJ. (2005). Evaluation of a two dimensional analysis method as a screening and evaluation tool for anterior cruciate ligament injury. Br J Sports Med 39: 355–362.

Myer GD, Ford KR, Palumbo JP, Hewett TE. (2005). Neuromuscular training improves performance and lower extremity biomechanics in female athletes. J Strength Cond Res. 19: 51–60.