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Effect of Modified Holmich Exercises in Improving Hip Adductor Strength, Agility, Sprint Time Among Previously Groin Injured Football Players

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ABSTRACT

Background: Football is a high-impact game with high-load running, sprinting, agility, sudden direction-changing. Groin pain is a common injury in football players due to high-speed running, changes in direction, jumping and landing, and kicking. Isometric hip adduction strength is decreased in groin-injured players. The modified Holmich exercises help in hip adductors and pelvic muscles strengthening, and core stabilisation. The objectives of this study are to find out the effect of Modified Holmich Exercise in Improving Hip Adductor Strength, Agility, Sprint Time Among Previously Groin Injured Sub Elite Football Players.
Methods: On the basis of selection criteria, 30 subjects were selected and divided equally into Group A (Experimental Group) receiving modified Holmich exercises along with conventional treatment and Group B (Control group) receiving conventional treatment. Sprint time, agility and hip adductor strength were measured at the beginning and after 10-weeks of intervention using 30-meter sprint test, Illinois test, modified sphygmomanometer test respectively.
Results: Paired t test showed significant improvement in Sprint time, agility and hip adductor strength within the group. In unpaired t test, sprint time, agility and hip adductor strength expressed significant improvement in the experimental group than control group.
Conclusion: There was improvement in Sprint time, agility and hip adductor strength within experimental and control group. The experimental group shows more significant improvement than control group in all the three parameters.

Keywords: Agility, Football, Hip Adductor Strength, Modified Holmich Exercise, Sprint Time

INTRODUCTION

Football is the most popular sport with FIFA reporting 265 million players worldwide.[1] Football is a high-impact game with high-load running, sprinting, agility, sudden direction-changing, passing accuracy and kicking capacity. The sport places significant biomechanical stress on players.[2] Elite players typically cover a

substantial distance of 10-11 kilometers during a full match.[3]

Sprint time measures how quickly a player can cover a short distance. Agility is the ability to make quick turns, changing directions, stopping and starting movements. Sprint time and agility are crucial for a variety of on-field actions, from dribbling past defenders and tackling opponents to suddenly stopping to avoid a collision or sprinting away from an attacker. Beyond controlling the game, agility plays a vital role in injury prevention, optimal activation and inhibition of muscle fibers thereby preventing muscle tear and injury to joints. Agility training improves motor response, making them quicker and more reactive on the field.[4]

Muscle injuries account for one-third of all time-loss injuries in football. Research indicates that injuries to four key muscle groups in the lower extremities represent 90% of these muscle injuries. The hip adductor muscles are most commonly affected with an injury rate of 25%, followed by hamstrings, quadriceps, and calves.[5] At the elite level, approximately one in five male players experiences a groin injury that results in time loss during the season.[6]

The main function of the hip adductor muscle group is adduction of the hip in open chain motion and stabilization of the pelvis in closed chain motions of lower extremities.[7] Inadequate hip adductor strength is a primary cause of groin pain in athletes. It is the major modifiable risk factor of groin injuries. In groin-injured players, there is a significant reduction in the hip adductor-to-abductor strength ratio and hip adductor strength during the competitive season.[8] A common clinical symptom of groin pain is pain experienced on palpation during isometric contraction of hip adductors.[9]

The modified Holmich exercise protocol is a ten-week program that focuses on strengthening pelvic muscles, improving core stabilization, and hip adductor strengthening. High-intensity eccentric exercises of the hip adductors may have a considerable effect on pain, hip adductors-abductors muscle strength, hip range of motion, functional ability and return to sport.[10]

Research by Holmich et al. has shown that therapeutic exercises, particularly those focusing on strengthening the hip and abdominal muscles, are more effective than passive treatments like electrical stimulation, laser therapy, and massage for managing chronic groin pain.[11,12] Building upon this evidence, a modified version of the Holmich protocol was developed by Shadmehr et al. This updated approach incorporates a wider range of exercises, including stretching, strengthening with resistance band, core strengthening, and a progressive running program, while excluding sliding techniques.[10]

Limited research exists on the effectiveness of the modified Holmich exercise protocol in sub-elite football players with a history of groin injuries. Thus, the study aims to find out the effect of modified Holmich exercise in improving hip adductor strength, agility, and sprint time among previously groin injured sub-elite football players.

MATERIALS & METHODS

This was a two groups pre-test and post-test experimental study with a control group. The Institutional Ethics Committee Medical Trust Hospital, Cochin approved the study. The study settings were Muthoot football academy Ernakulam, Luca soccer club Malappuram, Basent line football club Kolencheri and MES college Kunnukara.

Subjects were recruited from these colleges and football academies using convenient sampling. This comprised of 30 male sub-elite football players between 18 and 35 years of age. A signed written consent was obtained from each individual. The criteria for selection included Groin injured players based on the HAGOS questionnaire; with groin injury within 3 months and BMI of 18.5 kg/m^2 – 24.5 kg/m^2. Players with any chronic diseases, recent injuries, fractures or

surgeries, who cannot attend full protocol were excluded.

Group A (Experimental Group; n=15) received modified Holmich exercises along with conventional treatment and Group B (Control group; n=15) received conventional treatment. Subjects were evaluated by HAGOS questionnaire as a part of inclusion criteria to check the severity of the injury. The outcome measures included Modified sphygmomanometer test, 30 meters sprint test and Illinois test. A pre-test was done before the intervention and a post-test was done after 10 weeks of intervention.

The Copenhagen Hip and Groin Outcome Score (HAGOS) is an outcome measure for assessing hip and groin health in young aged athletes and is also recommended for use in football players. Lower scores in HAGOS subscale scores indicate a high risk of hip and groin injuries.[13]

Modified sphygmomanometer test (MST) is effective to measure the hip adductor muscle strength. It records pressure from 0 mmHg to 300 mmHg. The cuff was folded into one-third and pre-inflated to 20 mmHg. Subjects were positioned in supine with their arms across their chest, knees at 90^0 flexion and hips at 45^0 flexion. This position has the greatest degree of adductor activity. The center point of the cuff was placed between the knees at the most prominent points of each femoral condyles. The subject was then instructed to squeeze the cuff with a maximal force for 5 seconds and to stop squeezing once they feel pain in the adductor region.[14] If injury was present, subject elicited pain during the test.

The 30-Meter Sprint Test aims to determine acceleration and speed. A measuring tape, stopwatch, cone markers, and clear ground of at least 50 meters are required. A warm-up was given before the test. The test starts with the subject in a stationary position, with one foot in front of the other. This position is held for 2 seconds and then runs a single maximum sprint over 30 meters, with a time record. The test finish when the chest crosses the finish line.[15]

The Illinois Test is used to measure the agility. Materials required are a ground of 10 meters length and 5 meters width, four cones to mark the start, finish, and two turning points, another four cones to be placed at the center each at 3.3 meters apart. Participants should lie on their front (head to the start line) and their hands by their shoulders. On the "GO" command the stopwatch is started, and the subject gets up as quickly as possible and runs forward 10 meters to run around a cone, then back 10 meters, then runs up and back through a slalom course of four cones. Finally, the subject runs another 10 meters up and back past the finishing cone, at which timer is stopped.[16]

The control group received the following conventional physiotherapy treatment for 3 days per week.

1. Ball squeezes / isometric hip adduction at 45°
2. Ball squeezes isometric hip adduction at 0°
3. Isometric standing hip adduction using TheraBand
4. Normal plank
5. Side plank
6. Copenhagen plank with down leg hold in hip and knee flexion at 90°

Table 1 shows the exercise protocol received by the Experimental group

Day	**Exs.no.**	**Intervention**	**Repetition**
WEEK 1 First Day	1	Skipping	30s 5 sets (30s rest in between sets)
	2	Ball squeezes / isometric hip adduction at 45°	10 s hold 10 reps 2 sets
	3	Ball squeezes isometric hip adduction at 0°	10 s hold 10 reps 2 sets
	4	Isometric hip adduction on contralateral side lying	10s hold 10 reps 2 sets

	5	Isometric standing hip adduction using TheraBand	10s hold 10 reps 2 sets
	6	Abdominal sit-ups in both straight and oblique directions	15 reps 2 sets
	7	Unilateral glute bridges	10s hold 10 reps 2 sets for each leg
	8	Normal plank	30 s hold 3 sets
	9	Side plank	30s hold 2 sets each side
WEEK 1 Second Day	1	Skipping	30s 5 sets (30s rest in between sets)
	2	Ball squeezes / isometric hip adduction at 45°	15sec hold 12 reps 2 sets
	3	Isometric hip adduction on contralateral side lying	15 sec hold 10 reps (2sets with weight 1 or 2 kg)
	4	Isometric standing hip adduction using TheraBand	15 sec 12 reps 2 or 3 sets
	5	Abdominal sit-ups in both straight and oblique directions	15 reps 4 sets
	6	Unilateral glute bridges	15 sec hold 12 reps 2 or 3 sets for each leg
	7	Wall squats	30 sec hold 5 sets
	8	Normal plank	45 sec hold 3 sets
	9	Side plank	30 sec hold 3 sets each side
	10	Bosu ball training start with both legs and then progress to single leg	15 sec for single leg
WEEK 1 Third Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Ball squeezes/ isometric hip adduction at 45°	30 sec hold 10 reps 2 sets
	3	Isometric hip adduction on contralateral side lying	30 sec hold 10 reps 2 sets with weight 2kg
	4	Isometric standing hip adduction using TheraBand	20 sec hold 12 reps 2or3 sets
	5	Abdominal sit-ups in both straight and oblique directions	15 reps 6 sets
	6	Unilateral glute bridges	20 sec hold 12 reps 2 or 3 sets
	7	Wall squats	30 sec hold 7 sets
	8	Normal plank	1 min hold 2 sets
	9	Side plank	45 sec hold 3 sets each side
	10	Bosu ball training start with both legs and then progress to single leg	15 sec for single leg
WEEK 2 First Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Ball squeezes/ isometric hip adduction at 45°	30 sec hold 12 reps 3 sets
	3	Isometric standing hip adduction using TheraBand	20 sec hold 15 reps 2 sets
	4	Abdominal sit-ups in both straight and oblique directions	15 reps 6 sets
	5	Unilateral glute bridges	20 sec hold 12 reps 3 sets
	6	Wall squats	30 sec hold 7 sets
	7	Normal plank	1 min hold 2 sets
	8	Side plank	45 sec hold 3 sets each side
	9	Bosu ball training start with both legs and then progress to single leg	15 sec for single leg
WEEK 2 Second Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Ball squeezes/ isometric hip adduction at 45°	30 sec 15 reps 3 sets
	3	Isometric standing hip adduction using TheraBand	20 sec hold 15 reps 4 sets

	4	Abdominal sit-ups in both straight and oblique directions	15 reps 8 sets
	5	Unilateral glute bridges with knee flexion and extension	15 sec 12 reps 3 sets
	6	Wall squats	30 sec hold 7 sets
	7	Normal plank	1 min hold 3 sets with ball in between knees
	8	Side plank	45 sec hold 3 sets each side
	9	Bosu ball training on single leg	30 sec hold each side
WEEK 2 Third Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Ball squeezes/ isometric hip adduction at 45°	30 sec 15 reps 3 sets
	3	Isometric standing hip adduction using TheraBand	20 sec hold 15 reps 5 sets
	4	Abdominal sit-ups in both straight and oblique directions	30 reps 5 sets
	5	Unilateral glute bridges with knee flexion and extension	15 sec 12 reps 5 sets
	6	Wall squats	30 sec hold 8 sets
	7	Normal plank	1 min hold 3 sets with ball in between knees
	8	Side plank	45 sec hold 3 sets each side
	9	Bosu ball training on single leg	30 sec each side
WEEK 3 First Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Unilateral glute bridges with knee flexion and extension	20 sec 12 reps 3 sets
	3	Wall squats	45 sec hold 5 sets
	4	Abdominal sit-ups in both straight and oblique directions	30 reps 5 sets
	5	Side plank with opposite leg abduction	30 sec hold 2 sets for each side
	6	Standing hip abduction adduction exercise using TheraBand	10 reps 2 sets for each side
	7	Normal plank with lifting of each limb (first upper then lower)	6 sec each (total hold for 30 sec 3 sets)
	8	Copenhagen plank with down leg hold in knee flexion at 90°	30 sec hold 2 sets each
	9	Bosu ball training with perturbations for ball catching against a wall	
WEEK 3 Second Day	1	Skipping	30 sec 7 sets (30 sec rest in between sets)
	2	Unilateral glute bridges with knee flexion and extension	20 sec 15 reps 3 sets
	3	Wall squats	45 sec hold 7 sets
	4	Abdominal sit-ups in both straight and oblique directions	45 reps 5 sets
	5	Side plank with opposite leg abduction	30 sec hold 4 sets for each side
	6	Standing hip abduction adduction exercise using TheraBand	15 reps 2 sets for each side
	7	Normal plank with lifting of each limb (first upper then lower)	10 sec each (total hold for 45 sec 3 sets)
	8	Copenhagen plank with down leg hold in knee flexion at 90°	45 sec hold 2 sets each
	9	Bosu ball training with perturbations for ball catching against a wall	
WEEK 3 Third Day	1	Jogging	5-10 min
	2	Unilateral glute bridges (on movement) with knee flexion and extension	20 sec 15 reps 3 sets

	3	Wall squats	60 sec hold 5 sets
	4	Abdominal sit-ups in both straight and oblique directions	45 reps 5 sets
	5	Side plank with opposite leg abduction	45 sec hold 3 sets for each side
	6	Standing hip abduction adduction exercise using TheraBand	25 reps 2 sets for each side
	7	Normal plank with lifting of each limb (first upper then lower)	10 sec each (total hold for 45 sec 5 sets)
	8	Copenhagen plank with down leg hold in knee flexion at 90°	45 sec hold 4 sets each
	9	Bosu ball training with ball catching against a wall	
WEEK 4 First Day	1	Jogging	5-10 min
	2	Unilateral glute bridges (on movement) with knee flexion and extension	20 sec 15 reps 3 sets
	3	Wall squats	60 sec hold 5 sets
	4	Abdominal sit-ups in both straight and oblique directions	45 reps 5 sets
	5	Side plank with opposite leg abduction	45 sec hold 3 sets for each side
	6	Standing hip abduction adduction exercise using TheraBand	25 reps 2 sets for each side
	7	Normal plank with lifting of each limb (first upper then lower)	10 sec each (total hold for 45 sec 5 sets)
	8	Copenhagen plank with down leg hold in knee flexion at 90°	45 sec hold 4 sets each
	9	Bosu ball training with ball catching against a wall	
WEEK 4 Second Day	1	Jogging	10 min
	2	Wall squats	60 sec hold 5 sets
	3	Abdominal sit-ups in both straight and oblique directions	60 reps 3 sets
	4	Side plank with opposite leg abduction	60 sec hold 2 sets for each side
	5	Standing hip abduction adduction exercise using TheraBand	30 reps 2 sets for each side
	6	Normal plank with lifting of each limb (first upper then lower)	15 sec each (total hold for 60 sec 3 sets)
	7	Copenhagen plank with down leg hold in knee flexion at 90°	45 sec hold 6 sets each
	8	Bosu ball training with ball catching against a wall or mild single leg squats	
	9	Unilateral glute bridges (on movement) with knee flexion and extension	20 sec 15 reps 3 sets
WEEK 4 Third Day	1	Jogging	12 min
	2	Wall squats	60 sec hold 5 sets
	3	Abdominal sit-ups in both straight and oblique directions	60 reps 5 sets
	4	Side plank with opposite leg abduction	60 sec hold 4 sets for each side
	5	Standing hip abduction adduction exercise using TheraBand	30 reps 4 sets for each side
	6	Normal plank with lifting of each limb (first upper then lower)	15 sec each (total hold for 60 sec 5 sets)
	7	Copenhagen plank with down leg	60 sec hold 6 sets each

		hold in knee flexion at 90°	
	8	Bosu ball training with ball catching against a wall or mild single leg squats	
	9	Unilateral glute bridges (on movement) with knee flexion and extension	20 sec 15 reps 3 sets
	10	Towel slides towards each side	10 reps 2 sets each
WEEK 5 First Day	1	Jogging	15 min
	2	Unilateral glute bridges (on movement) with knee flexion and extension	20 sec 15 reps 3 sets
	3	Towel slides towards each side	12 reps 3 sets each
	4	Copenhagen plank with down leg in motion (hip flexion extension)	30 sec hold 2 reps each side
	5	Side plank with contralateral leg in abduction adduction	30 sec hold 2 sets for each side
	6	Cross country skiing exercise on single leg	10 reps 3 sets each
	7	Jumping jacks	30 sec 2 sets
	8	Single leg squat on wobble board	10 each side 2 sets
	9	Bosu ball training with ball passing off opposite leg	15 sec on one leg
WEEK 5 Second Day	1	Jogging	15 min
	2	Unilateral glute bridges (on movement) with knee flexion and extension	30 sec 12 reps 3 sets
	3	Towel slides towards each side	15 reps 3 sets each
	4	Copenhagen plank with down leg in motion (hip and knee flexion extension)	30 sec hold 4 reps each side
	5	Side plank with contralateral leg in abduction adduction	30 sec hold 4 sets for each side
	6	Cross country skiing exercise on single leg	15 reps 3 sets each
	7	Jumping jacks	30 sec 5 sets
	8	Single leg squat on wobble board	15 each side 2 sets
	9	Bosu ball training with ball passing off opposite leg	30 sec on one leg
WEEK 5 Third Day	1	Jogging	20 min
	2	Towel slides towards side and front	15 reps 3 sets each
	3	Copenhagen plank with down leg in motion (hip and knee flexion extension)	30 sec hold 5 sets each side
	4	Copenhagen plank with down leg in adduction kicks	30 sec 2 sets each
	5	Side plank with contralateral leg in abduction adduction	45 sec hold 3 sets for each side
	6	Cross country skiing exercise on single leg	20 reps 3 sets each
	7	Jumping jacks	45 sec 5 sets
	8	Single leg squat on wobble board	20 each side 2 sets
	9	Bosu ball training with ball passing off opposite leg	30 sec on one leg
WEEK 6 First Day	1	Jogging	20 min
	2	Jumping jacks	45 sec 5 sets
	3	Towel slides towards side and front	20 reps 3 sets each

	4	Copenhagen plank with down leg in motion (hip and knee flexion extension)	45 sec hold 3 sets each side
	5	Copenhagen plank with down leg in adduction kicks	45 sec 2 sets each
	6	Side plank with contralateral leg in abduction adduction motion	45 sec hold 5 sets for each side
	7	Cross country skiing exercise on single leg	20 reps 5 sets each
	8	Single leg squat on wobble board	20 each side 3 sets
	9	Bosu ball training with ball passing off opposite leg	30 sec on one leg
WEEK 6-10	Continue the above-mentioned exercises for first 6 weeks then progress to each week with increasing reps and sets along with a comfortable and possible range of increasing weights.		

Table 1: Modified Holmich Exercise protocol for experimental group

STATISTICAL ANALYSIS

The statistical analysis of the results was performed by using the SPSS Software (SPSS.20). Students t - test was used for the calculation of the results. Paired t test was used for the intra group comparison of pre and post test results. Independent t test was used for the inter group comparison. Significant level was kept at $p \leq 0.05$.

RESULT

The mean and standard deviation of age were 23.07±1.95 and 22.35±2.03 and 22.51 ± 1.49 and 21.75 ± 1.53 in Group A and B respectively (Table 2). While comparing the pre-test scores of hip adductor strength, agility, and sprint time between both groups, there were no differences in baseline values of between the two groups (Table 4).

Group	Age	Height	Weight	BMI
Experimental group	23.07 ± 1.95	166.13 ± 5.85	62.06 ± 4.2	22.51 ± 1.49
Control group	22.35 ± 2.03	168 ± 7.73	61.33 ± 5.06	21.75 ± 1.53
BMI= Body Mass Index				

Table 2: Mean and standard deviation of age, height, weight, BMI of subject in experimental and control group

On comparison of pre-test and post-test values of 30 meters sprint test in group A and B, the t-values were 12.77 and 7.95 respectively, which shows $p < 0.001$. Thus, there is a significant difference existing between the pre-test and post-test sprint time scores within group A and Group B. On comparison of pre-test and post-test values of agility time in group A and B, the t-values were 18.04 and 16.83 respectively, which shows $p < 0.001$. Thus, there is a significant difference existing between the pre-test and post-test scores of agility time within group A and Group B. On comparison of pre-test and post-test values of hip adductor muscle strength scores in group A and B, the t-values were 9.77 and 9.07 respectively, which shows $p < 0.001$. Thus, there is a significant difference existing between the pre-test and post-test hip adductor muscle strength scores within group A and Group B. Hip adductor strength, agility, and sprint time showed significant improvement within the groups in both experimental and control group (Table 3).

Outcome measure	Group	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	p value
Hip adductor muscle strength	Group A	94.33 ± 11.93	127.06 ± 5.48	32.73	0.0000001*
	Group B	94.86 ± 14.58	119.93 ± 7.09	25.06	0.0000003*
Agility	Group A	21.05 ± 0.722	17.62 ± 0.28	3.42	0.00000000004*
	Group B	20.96 ± 0.481	18.12 ± 0.488	2.84	0.0000000001*

Sprint time	Group A	4.23 ± 0.14	3.74 ± 0.07	0.49	0.000000004*
	Group B	4.21 ± 0.11	3.90 ± 0.14	0.311	0.000001*
* shows significance SD= Standard Deviation					

Table 3: Comparison of pre-test and post-test scores within group

While comparing the post-test sprint time scores between group A and group B, the t-value 3.83 shows p-value < 0.001, there is a significant difference in post-test sprint time scores between the groups (Figure 1). While comparing the post-test agility scores between group A and group B, the t-value 3.36 shows p-value < 0.005, there is a significant difference in post-test agility scores between the groups (Figure 2). While comparing the post-test hip adductor muscle strength scores between group A and group B, the t-value 3.08 shows p-value < 0.01, there is a significant difference in post-test hip adductor muscle strength scores between the groups (Figure 3). Hence, all the three outcome measures were found to be improved in the experimental group (Table 4).

Outcome measure	**Mean ± SD**	**Group A**	**Group B**	**Mean Difference**	**p value**
Hip adductor muscle strength	Pre-test	94.33 ± 11.93	94.86 ± 14.58	0.533	0.913
	Post-test	127.06 ± 5.48	119.93 ± 7.09	7.13	0.004*
Agility	Pre-test	21.05 ± 0.72	20.96 ± 0.48	0.088	0.698
	Post-test	17.62 ± 0.28	18.12 ± 0.48	0.49	0.002*
Sprint time	Pre-test	4.23 ± 0.14	4.21 ± 0.11	0.01	0.721
	Post-test	3.74 ± 0.07	3.90 ± 0.14	0.16	0.0006*
* shows significance SD= Standard Deviation					

Table 4: Baseline homogeneity of pre-test scores in experimental & control group and comparison of post-test scores between groups

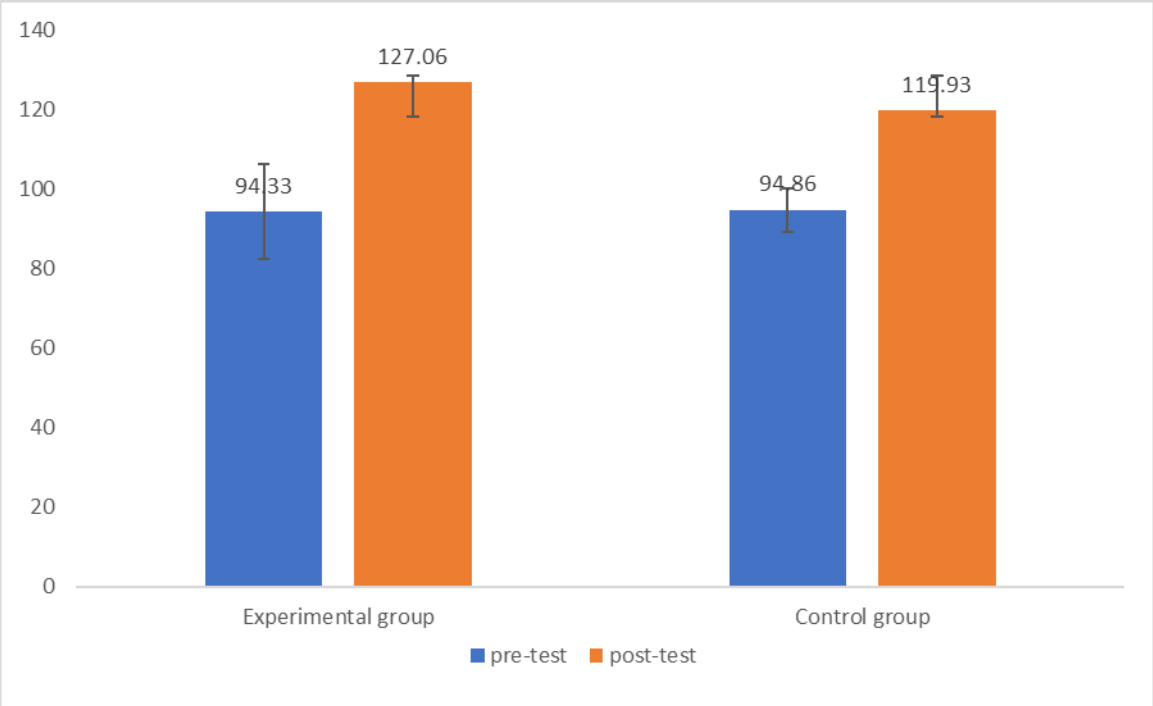

Figure 1: Graphical representation of comparison of hip adductor muscle strength scores between experimental & control groups. Error bars represent Standard Deviation.

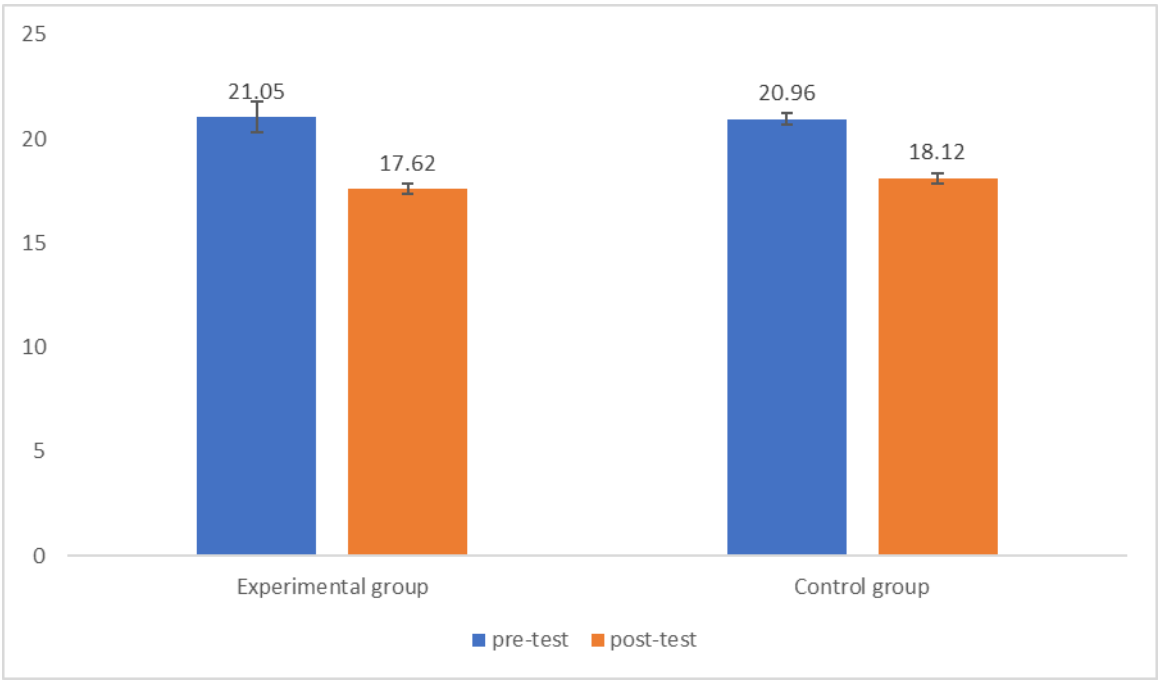

Figure 2: Graphical representation of comparison of agility scores between experimental & control groups. Error bars represent Standard Deviation.

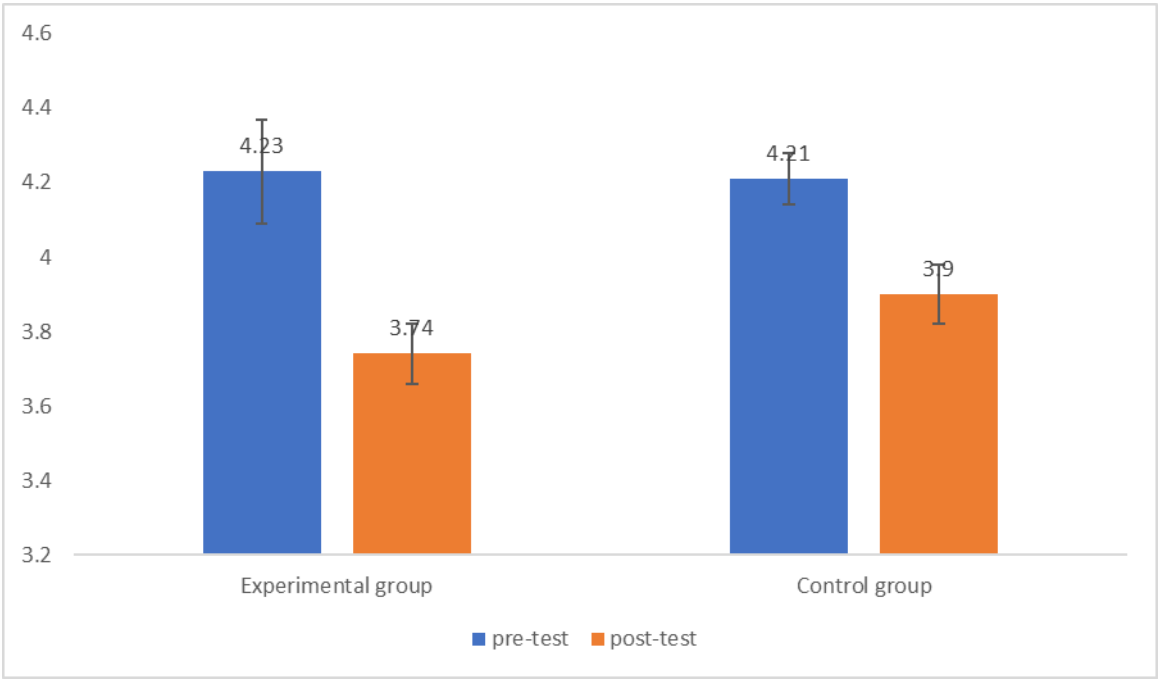

Figure 3: Graphical representation of comparison of sprint time scores between experimental & control groups. Error bars represent Standard Deviation

DISCUSSION

Groin injuries are more likely to occur in football players with weak hip adductor muscles and this can be avoided with hip adductor strengthening exercises.[17] Hip adductor strength, Agility and Sprint time being important factors in football, it was necessary to assess them. Hence, this study examined the effect of modified Holmich exercises on these factors in previously groin-injured football players.

The statistical analysis of pre-test and post-test values of each group using paired t test showed that sprint time, agility and hip adductor strength expressed significant improvement within the group. Whereas, on

comparing the post-test values of both groups using unpaired t test showed significant improvement in all outcome measures of experimental group than of control group.

Groin injury can be a strain where the hip adductor muscles are stretched or torn beyond the range. [18,19] This cause tenderness, muscle weakness and decreased range of motion. Modified Holmich exercises focus on isometric strengthening of hip adductors. Isometric contractions activate the muscle fibers and improves neuromuscular efficiency. These repeated contractions increase the number and size of the fibers. Hence, these exercise makes significant improvement in hip adductor muscle strength.

Agility and certain dynamic movements of lower limb are achieved by the concentric and eccentric action of hip adductor muscles. They are also involved in the open kinematic and closed kinematic movements of lower limb.[7] The improvement seen in agility score was probably because of the strengthening effect of the exercises on adductor muscles. This enhanced the speed of muscle contraction (concentric) and controlled slowing of muscle lengthening (eccentric). During agility test involving rapid changes in direction with single leg support, the adductor muscles, particularly the adductor longus and magnus, play a crucial role in supporting the weight and stability of the body.[20,21] The hip adductor muscles assist in a variety of hip movements, including flexion, extension, internal and external rotation. This multifaceted role contributes significantly to the athlete's ability to react quickly to change in play, jumping, change in directions, kicking, reaching. [21,22]

Football players rarely achieve maximum speed during play, but the acceleration phase is of higher value in football performance. Biomechanical studies have demonstrated that the backswing of an instep kick does not solely consist of hip extension. It also utilizes considerable upper body rotation in conjunction with hip rotation and hip abduction and adduction.[23] Along with supporting muscles including hip adductors, abductors and abdominal muscles, primary hip flexion and extension muscles are used in sprinting. The hip flexor training exercises in the protocol used in this study was effective in improving the acceleration time of a sprint and shuttle run time.[24] Also, hip adductors help in bringing the femur towards midline of body and provide stability to pelvis during swing phase and open kinematic movements.[6] High intensity eccentric exercise of the hip adductors in the protocol increases muscle strength, leading to improvement in sprinting.[25] So, the marked progress in sprint time in the study was probably because the exercise strengthened the musculature and was capable of stabilizing the joint during sprint. This made effective sprints with less time for the quick runs.

The subjects also reported decrease in pain and improvement in muscle strength after the training. This shows that Modified Holmich exercises particularly, hip adductor strengthening may have significant impact in injury prevention and may reduce the prevalence of groin injury. Hence, the exercises help the players to return to the sport and to have better health. The effects of the exercise improve the quality of their play and prevent injuries.

The majority of athletes are unaware of the benefits of hip adductor strengthening therefore, raising the risk of groin injury. Previous injury to the hip adductor muscle group will also increase the risk of groin injury. Players suddenly start to play after a break, without proper exercises and training, thereby increasing risks of muscle injury and adversely affecting their career.

The study demonstrates that the Holmich exercise effectively strengthens hip muscles in athletes. Football players gain particularly, as it enhances agility and sprint speed. As it is cost-effective and can be implemented easily, it is a highly practical and convenient treatment option.

The study had some limitation too. The measurements taken manually might have introduced human errors, which could threat the reliability of the study. The study focused only on sub elite football players.

To enhance the study's outcomes, a larger sample size and a longer treatment period are recommended. A follow-up study can be done to evaluate the long-term effects of the treatment program. The effectiveness of this training can be explored in other athletic populations. Furthermore, a separate study could investigate the impact of adductor strengthening program on performance metrics in healthy, active football players.

CONCLUSION

The sprint time, agility, hip adductor muscle strength shows improvement within the group as well as between the groups. But the Experimental group shows significantly higher improvement in all the three parameters when compared to the control group. Hence, the study concluded that the Modified Holmich exercises is effective in improving sprint time, agility, hip adductor muscle strength among previously groin injured sub elite football players.

Declaration by Authors

Ethical Approval: Approved

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