

Effects of Dynamic Strength Training to Prevent Lower Limb Injuries Among Novice Long Distance Runners: An Experimental Study

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ABSTRACT

Background/Purpose: Novice long distance runners may contribute to develop common lower limb injuries related to running. Strengthening hip or knee alone does not appear to prevent these injuries. Correction of running mechanics along with proper plan of regime for strengthening of lower limb is needed. The purpose of the current study was to investigate the effects of 6 weeks dynamic strength training to prevent lower limb injuries among novice long distance runners.

Methods: This was an experimental study including novice runners (n=30, 18-60 years old, <2 years running experience) to evaluate the effects of dynamic strength training program specially designed under the supervision of expert physiotherapists to minimize lower limb injuries and pain. Participants were engaged in a 6-week extensive training program, three times per week using guided program comprising of various forms of exercises to strengthen their lower limb for prevention of common running injuries. Pre and Post “Knee Outcome Survey (KOS)” was measured to evaluate outcome.

Results: Knee Outcome Survey Activities of Daily Living Scale (ADLS) pre training mean score was found to be 24.29 ± 5.9 whereas post training effects was 39.19 ± 2.45 with significant p-value of 0.000. In ADLS of KOS Pain variable outcome measure asked symptom that affects activity moderately the responses were 36.7% in pre whereas 0% after training. Weakness was responded mostly affecting activity moderately in 30% patients while after training it was reduced to 0%.

Conclusion: A six-week dynamic strength training program may help to reduce lower limb injuries among novice long distance runners under the supervision of skilled physical therapist.

Keywords: Novice runners; Lower limb injuries; Dynamic strength training

INTRODUCTION

Running persuade many people as a best form of physical activity and its health benefits is widely defined by many health physicians. Worldwide, running has become a popular exercise over the past three decades because of its low cost and convenience. There are countless health benefits of running and other forms of exercises are well documented [1,2]. Clinicians regularly suggest running for preventing many pathological conditions like diabetes, heart disease, obesity, hypertension, and osteoporosis. Men and women easily adapt running as their lifestyle modification because of its convenience and minimal required equipment. Despite of its various benefits, running may increase the risk of some

musculoskeletal injuries especially in less experienced runners. In comparison to recreational runners, novice runners face a significantly greater risk of lower limb injuries [3].

The popularity of running is growing day by day, number of individual's participation increases which also rise the number of running-related injuries. Any history of injury, increased BMI, and previous sports participation are principal predictors for lower limb injuries in long distance runners [4].

Novice runners are inactive before they start running and have less information regarding running biomechanics and injuries [5-7]. Their musculoskeletal systems are not used to the repetitive

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and high-impact forces followed running [8]. This makes them more prone to lower limb injuries as these muscles are not trained before for extra force and enhance provocation of running injuries. Patello femoral syndrome is the most recurrent injury among long distance runners after many other lower limb injuries like Achilles Tendinopathy, Iliotibial Band Syndrome and Plantar Fasciitis [9]. A systematic review shows that common running related injuries are tibial stress syndrome, tendinopathy and fasciitis. While runners who take part in marathon races are most likely to have Achilles tendinopathy and patella femoral syndrome [10].

Strength training program can directly influence performance of runners by giving many physiological health benefits important for long distance running [11]. Strengthening only hip or knee is not sufficient to prevent running injuries for long term outcome and better performance of novice runners planned lower limb dynamic strength training seems to prevent common injuries experienced by them.

Patello femoral pain syndrome was found to be the most common injury among runners after many other knee injuries [12]. Women who have BMI less than 21 kg/m² are at higher risk for spinal injuries and tibial stress fractures. Runners including both sex who possess less than eight years of experience are more associated with tibial stress syndrome.

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MATERIALS AND METHODS

This was an experimental study with non-probability purposive sampling. Sample size was drawn from online software openepi.com with 95% confidence interval and 5% margin of error. Total required sample size was derived to be 30. Novice runners 18-60 years old, <2 years running experience were recruited in this program after taking consent. Our primary outcome was to evaluate the effects of a 6 weeks dynamic strength training program specially designed for novice runners under the supervision of expert physiotherapists to minimize lower limb injuries and pain. This program consists of "Dynamic warm-up exercise" before starting of training sessions followed by "Cool down stretches". Pre and Post "Knee Outcome Survey (KOS)" was measured by each subject. Pre and Post analysis demonstrate the effectiveness of intervention on lower limb pain and injuries provided to experimental group for 6-weeks. Each training session start by doing "Dynamic warm-up exercises" followed by "Dynamic strength training exercises". After this a structured week by week running program was guided to all the subjects followed by "Cool down stretches" for 6-weeks. This program was designed to help them gradually build up from alternating running and walking to running continuously for specified amounts of time without having any lower limb injuries and to prevent lower limb pain. This training session was repeated three times per week means 18 number of training sessions performed followed by these protocols:

- **Dynamic warm-up exercises:** 15 reps × 2 sets (including forward leg swings, lateral leg swings, hip circles, diagonal hand cross-over, and arm-circles)
- **Dynamic strength training exercises:** 15 reps × 2 sets (including forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise, single-leg Bridge, side-lying leg lift, three-way leg raises, squats, single leg squats, butt-kickers)

- **Cool down exercises:** After running 15 reps × 2 sets (Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf, leg swings hamstrings and hip flexors, side lunge, quad stretch, lower back stretch)
- Info graphics providing information regarding biomechanics of running, stance and swing phase of running, common running injuries and their prevention, load management and role of physiotherapy.
- To improve their endurance and pace therapist usually change ground surface on which they were running (like sand, grass, concrete etc.) (Table 1).

RESULTS

A total of 30 Novice runners were included in this study. Mean age of participants was 30.52 ± 6.9 years.

Knee Outcome Survey (KOS) Activities of Daily Living Scale (ADLS) pre training mean score was found to be 24.29 ± 5.9 whereas post training effects was 39.19 ± 2.45 with significant p-value of 0.000. Functional Limitations with Activities of Daily Living pre training mean score was 31.90 ± 3.7 whereas post training results were 45.24 ± 2.7 with significant p-value of 0.000 (Table 2).

Table 1: Exercise progression utilized during 6-week dynamic strength training program. Subjects received personal instruction and verbal and visual instructions performed by physical therapist. Subjects performed “Dynamic warm-up exercises” followed by “Strength Training” and “Cool down stretches”. All exercises were performed independently at home an additional two times/week.

Week	Warm-Up+Exercises+Stretches	Volume	Strength Training	INSTRUCTIONS
ONE	>>Forward leg swings+lateral leg swings, hip circles, diagonal hand cross-over, and arm-circles >>Forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf	3 × 10 reps	Run 6 minutes, walk 1 minute, repeat five times	All subjects were advised to follow this sequence each time before running to prevent any injuries: 1. Dynamic Warm-up 2. Dynamic Strength training 3. Cool-down stretches after running
Two	>>Forward leg swings+lateral leg swings, hip circles, diagonal hand cross-over, and arm-circles >>Forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf		Run 8 minutes, walk 1 minute, repeat four times	
Three	>>Forward leg swings+lateral leg swings, hip circles, diagonal hand cross-over, and arm-circles >>Forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf	(30 Seconds-each side) 10 (5 each side) 10 × 2 reps	Run 10 minutes, walk 1 minute, repeat three times	
Four	>>Jog (1 mint), High Knees, Butt Kicks, High Kicks, Lateral Shuffles >>Lateral Lunges, Body Weight Squats, Alternating Forward Lunges, Push Ups, Single Leg Reaches, Glute Bridges >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf	(30 Seconds-each side) 10 (5 each side) 10 × 1 reps 10 × 2 reps	Run 12 minutes, walk 1 minute, repeat two times	
Five	>>Jog (1 mint) >>High-knee Skips, forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise, single-leg Bridge, side-lying leg lift, three-way leg raises, squats, single leg squats, butt- kickers >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf	(30 Seconds - each side) 10 (5 each side) 10 × 1 reps 10 × 2 reps	Run 15 minutes, walk 1 minute, Run 10 minutes	
Six	>>Jog (1 mint) >>High-knee Skips, forward lunge, walking lunge, plank, bridging, single-leg hip extension, push-up, leg-raise, single-leg Bridge, side-lying leg lift, three-way leg raises, squats, single leg squats, butt- kickers >>Lunge-stretch, calf raise, gluteus and piriformis stretch, hamstring stretch, ankle and calf		Run 20 minutes, walk 1 minute, Run 5 minutes	

Table 2: Mean pre and post score achieved through knee outcome survey activities of daily living scale (ADLS).

		N	Mean	Std. deviation	p-value
Knee Outcome Survey Activities of Daily Living Scale (ADLS)	Pre	30	24.29	5.91	0
	Post	30	39.19	2.45	
Functional Limitations with Activities of Daily Living	Pre	30	31.9	3.76	0
	Post	30	45.24	2.74	

*Paired sample t-test was applied to see the significance

*p-value ≤ 0.05 considered to be statistically significant

KOS Sports Activities Scale (SAS) Symptoms mean baseline score was 28.42 ± 8.6 and after training 46.85 ± 4.3 with significant p-value of 0.000. Functional Limitations with Sports Activities (SAS) baseline mean score was 19.09 ± 4.21 and post training effect mean was 32.91 ± 2.3 with significant p-value of 0.000 (Table 3).

Figure 2 indicates SAS of KOS Pain variable outcome measure was asked affects my sport activity slightly there were 40% patients in pre training group whereas 0% after training. Buckling or full giving way asked as affects sports activity moderately there were 36.7% patients in pre training after training it was reduced to 20%. Run straight ahead is somewhat difficult was observed pre in 56.7% patients while 0% after training. Jump and land on your involved leg is fairly difficult in 40% respondent’s pre training and reduced to 6.7% after training.

Table 3: Mean pre and post score achieved through knee outcome survey sports activities scale (SAS).

		N	Mean	Std. deviation	p-value
Knee Outcome Survey Sports Activities Scale (SAS)	Pre	30	28.42	8.6	0
	Post	30	46.85	4.37	
Functional Limitations with Activities of Daily Living	Pre	30	19.09	4.21	0
	Post	30	32.91	2.31	

*Paired sample t-test was applied to see the significance

*p-value ≤ 0.05 considered to be statistically significant

Figure 1 indicates ADLS of KOS Pain variable outcome measure was asked symptom affects my activity moderately the responses were 36.7% in pre whereas 0% after training. Stiffness that affects activity was 43.3% which respondents fall in pre group and 0% in post training. Swelling that is present but does not affect activity in pre training was 23.3% and post training was 0% respondents. Weakness was responded mostly in symptom affects my activity moderately was seen in 30% patients while after training it was reduced to 0%. Squat was asked as activity is fairly difficult 30% patients were in pre group while it was reduced to 6.7%. Sit with your knee bent was asked activity is fairly difficult there were 50% patients in pre group while only 3.3% after post training.

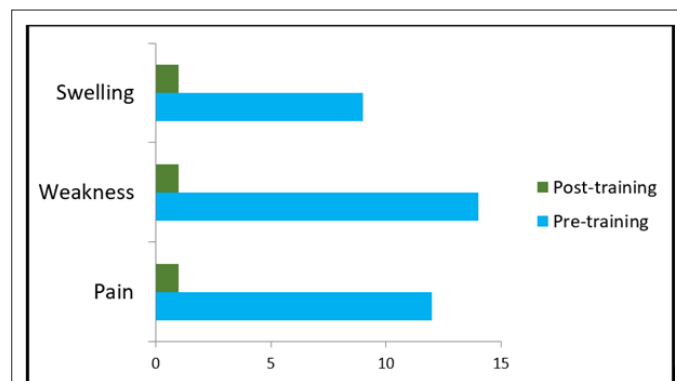


Figure 2: Knee Outcome Survey (Sports Activity Scale).

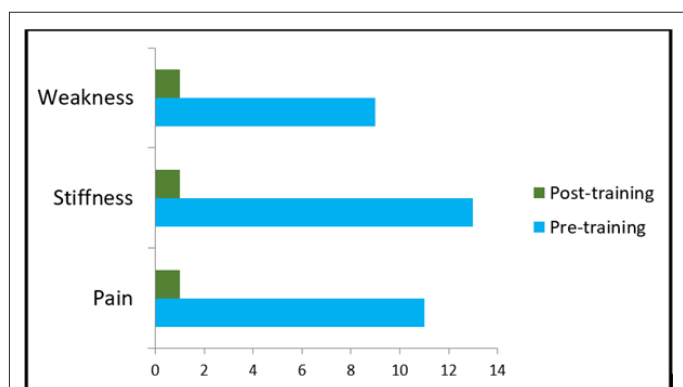


Figure 1: Knee Outcome Survey (Activity of Daily Living).

DISCUSSION

Over the last 30 years recreational running at present is the vital mode of exercise for many adults because of its numerous health benefits. It has gained more interest among children and adults because of its convenience and health benefits. With more adults engaged in pleasure and competitive running the incidence of injuries has rapidly increased. Most of the injuries related to running can be prevented through supervised training and proper evaluation. Most likely all the running injuries are preventable through conventional training programs by a specialized trainer can minimize the risk of injury. Training errors are the reason that develop most running related injuries above and below knee.

With customized rehabilitation program most of the runners experiencing hip pain can be managed successfully [13].

Many studies regarding recreational runners have estimated that up to 70% of them suffer overuse injuries during one-year period. Several authors suggested that overuse running injuries are misalignment of musculoskeletal that contribute to limitation of running speed, duration and distance [8,14,15]. Most of the commonest examples of overuse injuries in running may involve many disorders related to lower limb including hip, knee and foot [8,15].

Doctors at the Allan Mc Gavin Sports Medicine Centre collected data for two years to identify risk factors among both sexes related to running. Quantitative assessment was included like age, weight, height, body mass index, weekly history of previous activities and injuries. A significant high frequency of some injuries occurred in one sex. Patellofemoral pain syndrome seems to be significantly higher among runners less than 35 years after Iliotibial band friction syndrome, patellar tendinopathy, and tibial stress syndrome [16].

A retrospective survey revealed that about 60% of the patients were men, but women under the age of thirty years had the greatest risk of overuse running injuries. Most commonly injured area is the knee and patella femoral pain syndrome among the most common injury [17]. A carefully designed training program can effectively prevent lower limb injuries in novice runners who has less experience and learning about musculoskeletal and mechanics [18]. Knee injuries are the most common injury seen in marathon runners [10].

A randomized control trial shows that customized supervised training program is more effective to decrease injuries among novice runners in comparison standard training program [19]. Control group were given standard 8-week training program and experimental group 13-week training program to novice runners preparing for an event. This randomized controlled trial showed no effect of a 13-week training on the incidence of running related injuries as compared with a standard 8-week training program.

An experimental study investigates the effects of muscle stretching during warm-up on the risk of exercise-related injury [20]. Total of 1538 male army recruits were randomly allocated for twelve weeks of stretching before performed active warm-up exercise and physical training. The intervention group performed 20 second static stretch under supervision for each of six major leg muscle groups during every warm-up as compared to control group. 333 lower-limb injuries were recorded during the training period which concludes that typical muscle stretching protocol does not produce significant reductions exercise-related injury in army recruits. However, Fitness may be an important, modifiable risk factor.

CONCLUSION

Dynamic strength training amongst novice runners seems to be effective after six weeks in reducing lower limb injuries and

pain. Novice runners should be trained under the supervision of trained physical therapist to evaluate running injuries and their physical therapy management. Info graphics, counselling and biomechanics education play a vital role in preventing lower limb injuries. Future studies should involve large sample size to authenticate the results. Resistant training will be added with dynamic strength training to compare the effectiveness.

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