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# Isokinetic peak torque and flexibility changes of the hamstring muscles after eccentric training: Trained versus untrained subjects

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ABSTRACT

*Objective:* The aim of this study was to examine the effect of eccentric isotonic training on hamstring flexibility and eccentric and concentric isokinetic peak torque in trained and untrained subjects.
*Methods:* Sixty healthy subjects (mean age: 21.66 ± 2.64) were divided into three equal groups, each with 20 voluntary participants. Two experimental groups (untrained and trained groups) participated in a hamstring eccentric isotonic strengthening program (five days/week) for a six-week period and one control group that was not involved in the training program. The passive knee extension range of motion and hamstring eccentric and concentric isokinetic peak torque were measured at angular velocities 60° and 120°/s for all groups before and after the training period.
*Results:* Two-way analysis of variance showed that there was a significant increase in the hamstring flexibility of the untrained and trained groups (25.65 ± 6.32°, 26.55 ± 5.99°, respectively), ($p < 0.05$) without a significant increase in the control group (31.55 ± 5.84°), ($p > 0.05$). Moreover, there was a significant increase in eccentric isokinetic peak torque of both the untrained and trained groups (127.25 ± 22.60Nm, 139.65 ± 19.15Nm, 125.40 ± 21.61Nm, 130.90 ± 18.71Nm, respectively), ($p < 0.05$) without a significant increase in the control group (109.15 ± 20.89Nm, 105.70 ± 21.31Nm, respectively), ($p > 0.05$) at both angular velocities. On the other hand, there was no significant increase in the concentric isokinetic peak torque of the three groups (92.50 ± 20.50Nm, 79.05 ± 18.95Nm, 92.20 ± 21.96Nm, 79.85 ± 18.97Nm, 100.45 ± 25.78Nm, 83.40 ± 23.73Nm, respectively), ($p > 0.05$) at both angular velocities. The change scores in the hamstring flexibility (06.25 ± 1.86°) and eccentric peak torque of the untrained group (16.60 ± 4.81Nm, 17.45 ± 5.40Nm, respectively) were significantly higher ($p < 0.05$) than those of the trained group (03.40 ± 1.14°, 9.90 ± 5.14Nm, 9.80 ± 7.57Nm, respectively), and the control group (00.90 ± 2.10°, 0.60 ± 2.93Nm, 1.40 ± 3.53Nm, respectively), at both angular velocities. Meanwhile, the change scores of the concentric peak torques of the three groups (1.15 ± 1.50Nm, −0.15 ± 2.16Nm, 1.35 ± 1.63Nm, 0.20 ± 2.95Nm, 0.60 ± 2.28Nm, −0.30 ± 2.25Nm) were statistically insignificant ($p > 0.05$).
*Conclusion:* After a six-week period of eccentric isotonic training, the hamstring eccentric peak torque and flexibility of trained and untrained groups improved without changes in the concentric peak torque. Moreover, the improvement of untrained subjects was higher than trained subjects. These findings may be helpful in designing the hamstring rehabilitation program.


## Introduction

During the late swing phase of sprinting, there is a rapid change of muscle contraction from eccentric to concentric that has been suggested as the underlying mechanism for hamstring strains. Hamstrings are maximally loaded and lengthened during this phase of rapid contraction mode change.[1] Because hamstring strains commonly occur during the eccentric phase of a muscle

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contraction, overloading these muscles with eccentric training could potentially prevent hamstring strains.[2]

A hamstring strain is a complex injury, so no one single approach can be considered the ideal method for prevention.[3] Nonetheless, eccentric-based intervention has been shown to be a hopeful technique in reducing the risk of hamstring strain injuries.[4–6] Eccentric training is recognized as a powerful stimulus to hypertrophy and increased strength because it promotes greater neural activation compared to isometric and concentric modes of contraction.[7,8]

Brockett et al[2] reported that eccentric loading adds sarcomeres in series that shift the length-tension curve, so peak tension is generated at longer muscle lengths. Given the length-dependent nature of muscle damage in hamstring strains near end of range, this structural adaptation optimizes the angle of peak torque to reduce the risk for potential injury.[9] Static stretch and eccentric training are equally effective in improving hamstring muscles flexibility without a significant difference between both methods,[10,11] and static stretching increases the concentric torque and flexibility of the hamstring.[12]

Static stretching increased the eccentric and concentric plantar-flexor peak torque in trained and untrained individuals and improved the flexibility of untrained individuals more than trained individuals.[13] Hamstring injuries appear to occur as a result of weakness at the muscle's lengthened state.[14] So, an inability to increase an athlete's eccentric strength may predispose an athlete to subsequent injury. Combining eccentric training with a hamstring rehabilitation program may help to reduce the rate of recurrent injury.

Recently, Lovell et al[15] reported that an eccentric hamstring strengthening program increased the strength and electromyographic activities to a similar magnitude irrespective of its schedule before or after football training sessions. However, architectural adaptations to support the strength gains differed according to the timing of the injury prevention program. Moreover, eccentric hamstring exercise increased fascicle length and reduced pennation angle in biceps femoris without significant changes in muscle thickness. So, this type of exercise counteracts multiple hamstring injury risk factors in physically active young adults.[16]

To the best of our knowledge, although previous studies have reported that eccentric training increases muscle strength,[7–9] decreases injury rates, increases flexibility,[10,11] and improves athletic performance,[6,17–19] no studies have been performed to compare the effects of eccentric isotonic training on the isokinetic strength profile of the hamstring muscles in trained and untrained subjects. Therefore, this study was conducted to compare the effects of eccentric isotonic training on the hamstring concentric and eccentric peak torque and hamstring flexibility between trained and untrained subjects. The present study hypothesized that the eccentric hamstring training would improve the concentric and eccentric peak torque and flexibility in both trained and untrained subjects.

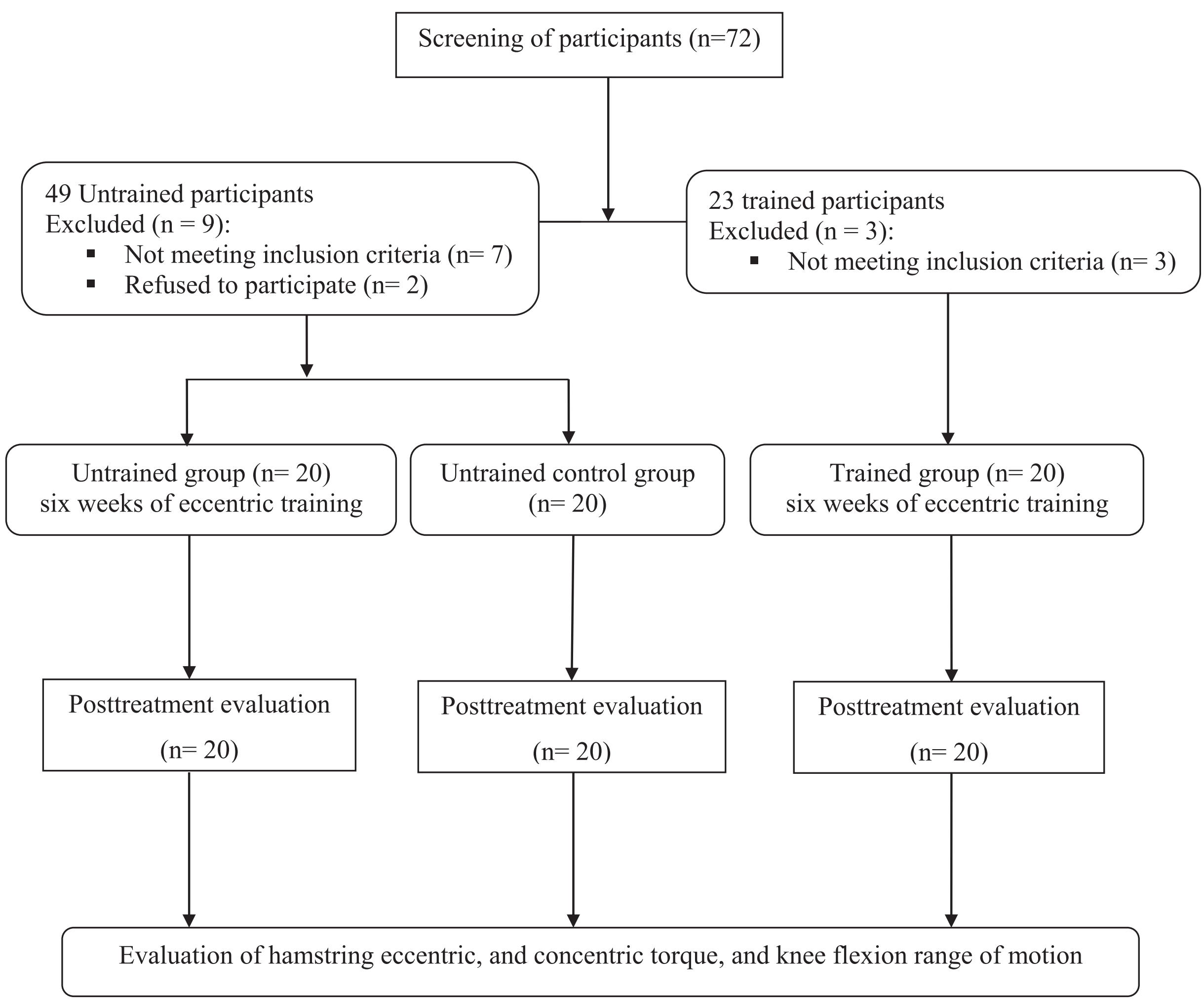


**Fig. 1.** The participants' flowchart in the present study.

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