Acta Scientific Orthopaedics (ISSN: 2581-8635)
Volume 5 Issue 12 December 2022

Research Article

Lower Extremity Muscular Flexibility in Long Distance Athletes

TS Muthukumar*

Department of Physiotherapy, Revathi Institute of Physiotherapy, India

***Corresponding Author:** TS Muthukumar, Department of Physiotherapy, Revathi Institute of Physiotherapy, India

Received: June 22, 2022
Published: November 04, 2022

Abstract

Background: The present study is to assess the flexibility of the hamstrings, rectus femoris, gastrocnemius and soleus muscles in long distance runners. Range of motion measurements of four movements, including hip flexion with knee extended, hip extension with knee flexed, ankle dorsiflexion with knee extension, and ankle dorsiflexion with knee flexed, were measured to determine muscle tightness.

Objective: To find out the muscle tightness among running and non-running groups and to compare between them. To identify the factors responsible for decreased flexibility among these groups.

Methodology: 20 runners and 20 non-runners volunteered for the study. Male participants are preferred for this study. The convenient sampling is done in this study. The minimum study period was 3-6 weeks. The study setting choosen was Tiruppur District Sports Council for the assessment of runners and also Revathi Para Medical College for the assessment of non-runners. The means were compared between runners and non-runners only on dominant leg.

Participants: 20 Runners 20 Nonrunners.

Outcome Measures: Runners and Non-runners were tested for flexibility to assess the tightness with standard goniometer and to compare them.

Results: The runners were found to have tight hamstrings, and soleus muscles than non-runners and also gastrocnemius.

Conclusions: The long-distance runners appear to have posterior muscle tightness in the lower extremity compared to non-runner.

Keywords: Flexibility; Running; Joint Motion

Introduction

Running is one of the popular recreational activities and sporting events. However, it is also a major cause of musculoskeletal injuries in sports. The high prevalance of injury in runners is of great concern [1]. The majority of muscle injuries occur during sports activities, corresponding to 10 to 55% of all injuries. The most commonly affected muscles are the hamstrings, quadriceps and gastrocnemius. These muscles go across two joints and are more subjected to acceleration and deceleration forces. the Hamstring injuries present great variety of incidence and may correspond to 12 to 16% of injuries in athletes. Muscular injuries with many other factors tend to minimize flexibility.

Flexibility is operationally defined as “the range of motion (ROM) available in joints or group of joints” through its normal plane of motion. Flexibility can be broadly classified into two types they are, static flexibility and dynamic flexibility. The static flexibility is defined as the range of motion available to a joint or series of joints. The dynamic flexibility refers to the ease of movement within the obtainable range of motion [2].

“Muscle tightness” is considered to be a predisposing factor in muscle injuries. Many studies agree that there is a relationship between muscular flexibility and muscle tightness [2].

Muscle tightness may be due to a decrease in the ability of the muscle to deform, resulting in a decrease in the range of motion at the joint on which it acts [3]. In many cases the cause of muscle tightness is muscle weakness. Recent research defines 'fatigue induced muscle disorder' where an athlete reports a firm, muscle tight. An increase in intensity of training makes a muscle group to greater load, it fatigues and become tight. Sprains and Strains are also most common reasons for muscle tightness. Muscle tightness typically occurs after excercise, hard physical work, and also after periods of inactivity [4].

A number of factors that contribute to flexibility are gender, age, muscle size, and warm-up. Females said to be more flexible than males, with the differences in flexibility due to anatomic factors, such as the difference in pelvic anatomy that can result in females having a larger valgus angulation at the knee. Flexibility tends to decrease with age and changes in muscle size. Additionally, strength training is believed to cause muscle hypertrophy and limit the development of flexibility. Finally, formal warm-up program may also affect muscle flexibility [5].

Flexibility measurements can be static (end of ROM),dynamic passive(stiffness/compliance) or dynamic active(muscle contracted, stiffness/compliance).Dynamic measures of flexibility are less dependent on patient discomfort and are more objective [6].

Static flexibility can be easily measured with a goniometer at a joint or estimated by measurements of stretching. As dynamic flexibility is the resistance to movement of a joint, this is difficult to measure and so has not been dealt with to a great extent [7].

There are two methods in assessing flexibility and they are: 1. Direct methods 2. Indirect methods Direct flexibility methods measure angular displacements between adjacent segments or from an external reference. Direct methods involve the use of goniometer and a flexometer or inclinometer. Indirect flexibility tests usually involve the linear measurement of distances between segments or from an external object [8].

The use of Goniometry is to measure the joint angle or range of motion. It is assumed that the angle created by aligning the arms of a Universal Goniometer with bony landmarks truly represents the angle created by the proximal and distal bones composing the joint. The reliability of Goniometric joint motion measurements has been studied both within and between insruments/tehniques, as well as clinicians. Several reports have noted that joint range of motion can be measured with good to excellent reliability. Moreover, the reliability of the measurement also depends on the complexity of the joint and also difficulty in palpating anatomic landmarks. Reliability is different for each joint; the standard error of measurement can also differ for each joint [9].

The main intention of this study is to evaluate the muscle flexibility of the hamstrings, rectus femoris, gastrocnemius, and soleus muscles in male long-distance runners on dominant leg and compare them to a non-running group [10].

Methodology

Methods of collection of data

- **Study design:** Epidemiological study
- **Sample:** long distance runners and non-runners around Tiruppur District
- **Sampling Technique:** Convenient Sampling
- **Study period:** 6-8 weeks
- **Study size:** 40 subjects

Selection criteria

Inclusion criteria

- 40 subjects with age group ranging from 16-22 years are included that is 20 runners and 20 non-runners.
- The non-runners must not participate in any long-distance running.
- Runners from local clubs are preferred.
- The runner's group must run atleast 3000mtr or greater in races.

Exclusion criteria

Subjects excluded are

- History of experience in gymnastics, dance, yoga or martial arts.
- History of ankle, knee or hip surgery and recurrent ankle sprains were also excluded.
- Non-co-operative subjects
- Pathological condition.

Outcome measures

Procedure

- A willing consent form approved by the Tiruppur district sports council was signed by all the subjects.
- The subjects who were voluntarily willing to participate and going to the sports school were preferred.
- A questionnaire was distributed among the subjects, and they were asked to complete the questionnaire.
- Long distance runners were asked questions regarding running, such as miles per week, years involved in running.
- The subject who fulfilled the selection criteria were selected.
- Prior to collection of data, each subject was asked to undergo a general warm-up program, including stretching of the hamstring, quadriceps and posterior calf muscles. Each muscle group was stretched for 30 seconds prior to ROM measurements.
- ROM was measured by a goniometer.
- The flexibility of each muscle was measured by passively moving the limb prior to the muscle action.
- Prior to data collection, subjects were also asked to kick a ball, hop on one leg, and step on a stool with one leg.
- The dominant leg was determined to be the leg used to perform two out of three of the above tests.
- The stabilization was given wherever necessary.
- The observed means was compared between runners and non-runners, males and females on only the dominant leg.
- Hamstring muscle tightness was determined by passive hip flexion with knee extended (a modified straight leg raising test). Subjects were positioned supine, and their opposite side was stabilized by a Velcro belt. The knee to be measured was maintained in extension with a knee brace. The goniometer was placed with the stationary arm parallel to the midline of the trunk, the moving arm along the lateral midline of the thigh, and the central axis over the superior half of the greater trochanter. The leg to be evaluated was raised in the range where a small amount of pelvic rocking movement was palpated. Measurements were recorded at the point where the onset of pelvic tilt was detected. The subjects were instructed to relax the hamstring during the procedure.
- Rectus femoris muscle tightness was measured by hip extension with the knee flexed to 90 degrees (a modified Thomas test). Subject was positioned supine on the table with the leg to be evaluated hanging over the table. The knee of the leg to be measured was stabilized in 90 degrees of flexion with the Bledsoe knee brace. The opposite hip and knee were flexed to the point where the subject's back was flat on the table. The subjects were instructed to maintain this hip and knee flexion position with the fingers of both hands interlocked over the anterior tibia to assist in the maintenance of the posterior pelvic tilt. The goniometer was placed with the stationary arm parallel to the midline of the trunk, the moving arm along the lateral midline of the thigh, and the axis over the superior half of the greater trochanter. The subject was instructed to maintain a flat back during the measurement.
- Gastrocnemius muscle tightness was measured by ankle dorsiflexion with the knee in full extension. Subject was positioned prone on the table with their foot and ankles hanging over the edge of the table. The goniometer was placed with the stationary arm parallel to the lateral midline of fifth metatarsal bone, and the axis shifted superiorly and inferiorly until the two arms of the goniometer were parallel to the surface landmark given. Passive ankle ROM was performed, dorsiflexing the ankle to the end of the range, and then the measurement was recorded.
- Soleus muscle tightness was measured by ankle dorsiflexion with the knee flexed to 90 degrees. The procedure was the same as for the gastrocnemius muscle, except that the knee was maintained in 90 degree of knee flexion.

Materials required

- Pen and pencil
- Data collection sheet
- A standard goniometer
- A Ball (to determine the dominant leg).

Data analysis

Subjects	Runners (n = 20)	Non runners (n = 20)
1	18	20
2	19	18
3	18	21
4	20	22
5	21	24
6	18	20
7	22	18
8	21	18
9	19	20
10	20	19
11	20	21
12	22	18
13	18	18
14	20	20
15	18	22
16	21	18
17	20	19
18	22	20
19	18	21
20	19	18
Mean	20+-2	21+-2

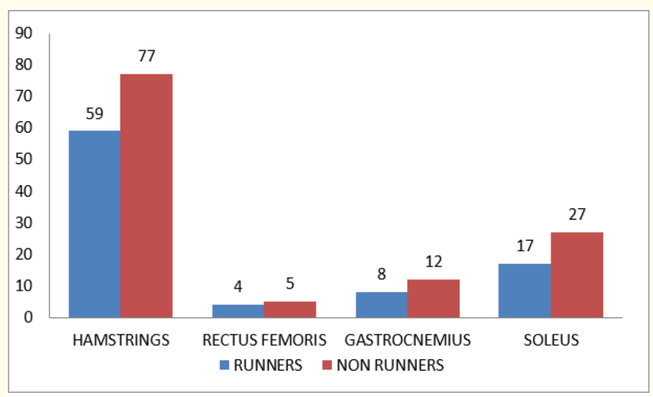
Table 1: Mean age of the subjects.

Subject	No. of years run	Miles run per week
1	2	25
2	1	30
3	4	32
4	6	25
5	5	28
6	5	36
7	3	34
8	4	25
9	7	26
10	4	27
11	3	25
12	5	30
13	2	28
14	2	31
15	6	27
16	3	25
17	4	26
18	5	29
19	8	34
20	7	30
Mean	4	28

Table 2: Descriptive summary of long-distance runners.

Parameters	Runners	Non-runners
Hamstrings	59	77
Rectus femoris	4	5
Gastrocnemius	8	12
Soleus	17	27

Table 3: Mean value of rom measurements on the dominant leg of male non-runners and runners.



Graph 1: Graphical representation showing muscular flexibility in long distance runners.

Result

The mean age of the non-runners in the study was 21+-2. The mean age of runners 20+-2 respectfully.

Most of the runners performed running program daily, while non-runners did not. The non-running group participated in other sports activities.

- **Hamstring muscles:** The observed means for each group of hip ROM in the modified straight leg raise test are summarized in the table. The results indicated a significant difference in the effects of running (runners vs. Non-runners). The runners had tighter hamstrings than non-runners. The mean value is calculated both in runners and non-runners and showed a significant difference. The mean value of runners obtained is 59 and of non-runners is 77. This shows that tightness is more found in runners.
- **Gastrocnemius muscle:** The mean value of runners obtained is 8 and nonrunners is 12. The results indicates a significant difference in running effects. Of course, these effects are due to a slight tightness found and the ROM is also reduced in relation to tightness.
- **Soleus muscle:** The mean value of runners obtained is 17 and non-runners is 27. The result shows a significant difference between runners and non-runners in soleus ROM. No other significant differences were found in the soleus.
- **Rectus Femoris:** In addition, no significant differences were found in the rectus femoris.
    - There by the tightness is shown by hamstrings, gastrocnemius and soleus. These significant differences were found between runners and non-runners. Tightness of these muscles could be the result of their long-term use in long distance running.
- **Number of Years run:** The mean value of the years run has been calculated. The demographic data is as presented in table 1.2. And the mean value obtained is 4 years.
- **Miles run per week:** The mean value of miles run per week has been calculated. And the obtained mean value is 28 miles per week. The demographic data is as presented in table 1.2. The miles were calculated according to the distance run in 5 days per week.

Discussion

The results of this study generally agree with other studies. For hip movements, the results obtained were similar to those of Bach., *et al.* who found significant muscle tightness of the hamstrings in runners. Ekstrand., *et al*. found tightness for all hip muscles in soccer player. These differences may be shown as a result of different activity performed.

But the result was inconsistent with the study done by Stevenson., *et al.* among the college sports student in Wuhan city in which the runners showed more fexibility than non-runners. This study was in concordance with other studies. This study shows that hamstrings, rectus femoris and gastrocnemius is more flexible in non-runners than in runners whereas, there was no significant difference in the muscle flexibility obtained for soleus between runners and non-runners. According to Ying Zhao., *et al*. this difference is shown as a result the hamstrings, rectus femoris and gastrocnemius are more prone to injury.

The mileage plays an important role in flexibility. Thus, the effect of mileage may also have contributed to lack of flexibility in the hamstring muscle group. The questions regarding mileage were asked to the runners and two groups were made in order to distinguish between runners who ran high weekly miles and the other group which consisted of runners that ran fewer miles per week and the tightness were compared for these muscles in both the groups in order to understand that who suffers more tightness.

The results show that there is a significant difference between runners and non-runners in hamstrings, gastrocnemius, and soleus muscle tightness. Most of this tightness occurs as a result of their long-term use in long distance running. There is no significant difference found in the rectus femoris when comparing the runners with non-runners [11-18].

Conclusion

Range of motion in hip and ankle joint were determined by measuring with a standard goniometer and compared between both runners and non-runners.

When compared to a non-running population, the long-distance runners tested had less hamstring, gastrocnemius, and soleus ROM as measured by the hip flexion with the knee extended, ankle dorsiflexion with the knee extended and ankle dorsiflexion with the knee flexed 90^0 methods. Runners in this study did not have tighter rectus femoris muscle as measured by the modified Thomas test.

Thus, it can be concluded that the long-distance runners suffer more muscle tightness than non-runners.

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