

# THE CORRELATION BETWEEN FOUR CLINICAL TRIALS FOR MEASUREMENT OF HAMSTRING MUSCLE FLEXIBILITY

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**ABSTRACT:** Flexibility of hamstring muscles is very important in sports which can be measured in many tests. The relationship of each test for measuring on the hamstring muscles flexibility has not been verified. The aim of this study was to examine the correlation between the four tests. Ninety-six participants have received four methods of hamstring muscles flexibility tests consist of sit and reach test (SR), stand and reach test (ST), passive knee extension test (PKE), and passive straight leg raise test (PSLR). Pearson product-moment correlation analysis was used to analyze the relationship between the four tests. This study demonstrated a highly significant correlation between SR and ST ( $r=0.87$ ), a moderate significant correlation between SR and PSLR ( $r=0.50$ ), a moderate significant correlation between ST and SLR ( $r=0.46$ ), and a low significant correlation between PKE and SLR ( $r=0.33$ ). We conclude that SR and ST were a high correlation in the measurement of hamstring muscle flexibility which can be used interchangeably.

*Keywords: Hamstring Flexibility, Sit and Reach Test, Stand and Reach Test, Passive Knee Extension Test, Passive Straight Leg Raise Test*

## 1. INTRODUCTION

The flexibility of hamstring muscles is very important in sports which the reduction of hamstring flexibility is a risk factor for muscle injury [1]. Sit and reach test (SR), stand and reach test (ST), passive knee extension test (PKE), and passive straight leg raise test (PSLR) [1-5] were usually used to measure hamstring flexibility in the field test.

The previous study, Hopper, et al. studied the effect of two massage techniques on hamstring muscle length in competitive female hockey players by using PKE test and PSLR test for measured hamstring flexibility. The result showed that hamstring muscle length was significantly increased by using the PKE test but not the PSLR test [6].

However, Chu, et al. [7] studied about EMG activities between the SR test and the ST test: a pilot study, four healthy subjects were received the SR test and the ST test. Results showed that in recovery period ST test was relatively high on back muscle activity at 50 % MVC, but no significant difference found in flexibility performance between two tests.

Furthermore, Bakirtzoglou, et al. [8] studied about the evaluation of hamstring flexibility by using two different measuring instruments, forty men athletes and forty men non-athletes were received the SR test and the PSLR test. Results showed that athletes scored significant greater than non-athletes only when measured by the PSLR test.

That is hamstring flexibility measurement achieved by use of the PSLR test than the use of the ST test.

Many studied used deferent hamstring muscles flexibility test. The study results of the Barlow, et al. [9] about the effect of massage of the hamstring muscle group on the performance of the SR test indicated that a single massage of the hamstring muscle group was not associated with any significant increase in sit and reach performance immediately after treatment in physically active young men. Moreover, Forman, et al. [10] studied the effect of deep stripping massage alone (DSMS) or with eccentric resistance on hamstring length and strength. Eighty-nine subjects were received treatment and demonstrated hamstrings flexibility by the PKE test. Results showed that both DSMS with eccentric resistance (10.7%) and DSMS alone (6.3%) resulted in improved ( $p < 0.01$ ) hamstring flexibility. The improvement following DSMS with eccentric resistance was greater ( $p < 0.05$ ) than the following DSMS alone. While Rosario and Foletto [11] studied a comparative study of stretching modalities in healthy women: heating and application time. By choosing the ST test for measurement hamstring muscles flexibility.

It can be seen that using different instruments to measure hamstring flexibility achieved different results. Relationship of each test for measuring on the hamstring muscles flexibility has not been verified. The knowledge from this study can help the interested people choosing the appropriate measurement method.

## 2. MATERIAL AND METHOD

### 2.1 Design and Setting

The research design of this study was analytical research, one group with four parameters. This study was approved by The KhonKaen University Ethics Committee for Human Research (approval number 582221).

### 2.2 Participants

Ninety-six healthy college students aged between 18 - 25 years from Roi Et province, Thailand, were recruited in this study. Each of them signed informed consent and completed a

questionnaire to provide general information and history of injuries before participating in this study. The participants who get muscle injuries within 3 months ago and lower limb injury during the experiment were excluded from this study.

### 2.3 Procedure

All participants warmed up before the test begins for 5 minutes by jogging to prevent injuries but not received stretching the muscles. After that, all participants received the SR test [4], the ST test [3], the PKE test [2], and the PSLR test [5] which rest between the tests for 20 minutes. All tests were examined on the same day.

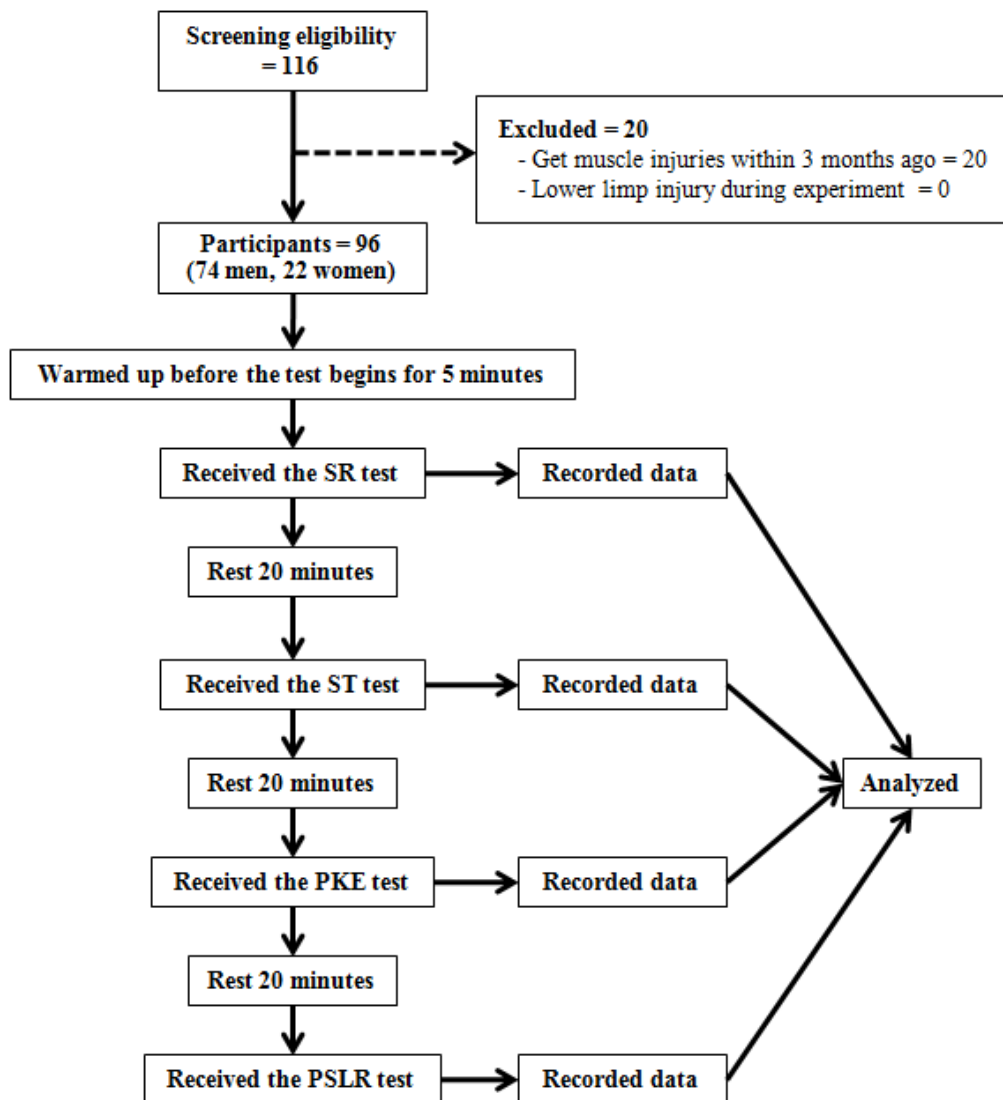


Fig.1 Flow chart for study participation and procedure

## 2.4 Outcome Measurements

### 2.4.1 Sit and reach (SR) test

The participants sit with straight leg, soles of the feet against the box, bent hip about 90 degrees, and then, the participants bent forward, without bending the knee and tried to reach out as much as possible and hold for 3 s., 3 repetitions. After that, record the values in centimeters which the highest value was used for statistical analysis. [4] (Fig.2).

### 2.4.2 Stand and reach (ST) test

The participants stood on a box, which is placed on a chair. Then bend down straight leg, without bending the knee and tried to reach the hands down as much as possible and hold for 3 s., 3 repetitions. After that, record the values in centimeters which the highest value was used for statistical analysis [3] (Fig.3).

### 2.4.3 Passive knee extension (PKE) test

The participants lay supine on the bed, bend one side of hip and knee joint 90° degree. Then, the examiner raised the tested leg straight up to the point of feeling tight and hold for 3s., 3 repetitions [2]. The test used a goniometer pro (trial version) program on the Smartphone, which was placed above the ankle for measured hamstring flexibility. Record the values in centimeters which the highest value was used for statistical analysis. In-house tests have shown tolerances of the device between  $\pm 0.2^\circ$  and  $\pm 0.3^\circ$ . [11] (Fig.4).

### 2.4.4 Passive straight leg raise (PSLR) test

The participants lay supine on the bed and then raised the one leg without bending the knee to the point of feeling tight and hold for 3s., 3 repetitions. The testing is done by the examiners [5]. Hamstring flexibility was measured by using the goniometer pro (trial version) program on the Smartphone as same as PKE test [12] (Fig.5).

## 2.5 Statistical Analysis

The data were presented as mean  $\pm$  SD. Kolmogorov - Smirnov test was used to verify the normality of the data. Pearson product moment correlation coefficient was used to analyze the relationship between the four tests. The significance level was set at the  $p \leq 0.5$ .

## 3. RESULTS

Ninety-six participants (74 men, 22 women) aged average  $21.61 \pm 1.06$  years, weight average  $64.78 \pm 10.85$  kg., and height average  $170.09 \pm 6.93$  cm. None of them had sustained hamstring injuries in the last 3 months (Table 1). All participants were tested for all tests. In each test, the participants repeated 3 times and the highest value was used for statistical analysis.



Fig.2 Sit and reach test (SR)



Fig.3 Stand and reach test (ST)



Fig.4 Passive knee extension test (PKE)



Fig.5 Passive straight leg raise test (PSLR)

Table 1 Characteristics

Characteristics	Mean ± SD
Age (years)	21.61 ± 1.06
Weight (kg)	64.78 ± 10.85
Height (cm)	170.09 ± 6.93
Past hamstring injuries (number)	0

Mean and standard deviation of each test showed that the SR tests average 14.32 ± 6.33 Cm., the ST tests average 13.81 ± 5.35 Cm., the PKE tests average 89.34 ± 1.85 Degrees, and the PSLR tests average 112.32 ± 12.19 Degrees (Table 2).

Table 2 Mean and standard deviation of four tests

Tests	Mean ± SD
SR (Cm.)	14.32 ± 6.33
ST (Cm.)	13.81 ± 5.35
PKE (Degrees)	89.34 ± 1.85
PSLR (Degrees)	112.32 ± 12.19

The results of this study showed that the highest correlation was between SR and ST ( $r=0.87$ ,  $p<0.001$ ), the relationship between SR and PSLR ( $r=0.50$ ,  $p<0.001$ ), ST and SLR ( $r=0.46$ ,  $p<0.001$ ) found a moderate correlation and low correlation was found between PKE and SLR ( $r=0.33$ ,  $p=0.001$ ). This study showed no correlation between SR and PKE ( $r=0.14$ ,  $p=0.17$ ), and ST and PKE ( $r=0.14$ ,  $p=0.19$ ) (Table 3).

Table 3 Correlation between four tests

	SR	ST	PKE	PLSR
SR	1.00			
ST	0.87*	1.00		
PKE	0.14	0.14	1.00	
PSLR	0.50*	0.46*	0.33*	1.00

Note: SR=sit and reach test, ST=stand and reach test, PKE=passive knee extension test, PSLR=passive straight leg raise test

#### 4. DISCUSSION

This study found that SR and ST tests were the most correlated probably due to both tests required the flexibility of back and leg muscles which can be used interchangeably. However, Chu et al. [7] demonstrated that hamstring (semitendinosus and biceps femoris) and lumbar erector spinae had higher activity in ST test than in SR test. Therefore, ST test may not be suitable for some individuals, such as the elderly or who had a problem with the lower back muscle.

PKE test was only correlated with PSLR test because the participants were similar in the test posture (hip flexion) which was an isolate the joint measurement. The reliability coefficients for this test and retest measurements were .99 for both extremities. The test should provide therapists with an objective and reliable tool for measuring hamstring muscle tightness [11].

PSLR test was correlated to all tests. Maybe due to the test posture was similar to PKE test but PKE test performed by bend the hip joint at 90 degrees. The PSLR test could bend the hip joint more than 90 degrees until it feels tight which it involved lower back muscles as same as SR and ST tests.

#### 5. CONCLUSIONS

This study showed that SR and ST were significant relationships in a high correlation. The tests can be used interchangeably. PKE and PSLR were significant relationships in a low correlation. The moderate correlations were found between SR and PSLR, and ST and PSLR. PSLR had a correlated with all tests.

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