CORRELATION OF SIT & REACH TEST AND INDIRECT INCLINOMETER MEASUREMENT OF HIP JOINT ANGLE IN HAMSTRING FLEXIBILITY TESTING IN INDIAN SCHOOL GOING GIRLS & BOYS

CORELAȚIA DINTRE TESTUL SIT & REACH ȘI MĂSURAREA INDIRECTĂ A UNGHIULUI DE FLEXIE A ȘOLDULUI ÎN TESTAREA FLEXIBILITĂȚII ISCHIOGAMBIERILOR LA ȘCOLARII BĂIEȚI ȘI FETE DIN INDIA

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Keywords: hamstrings, Sit & Reach Test, hip joint angle

Abstract

Background. Fexibility is most important component of movement. It is higher in children as compared to adults. But there is difference between girls and boy

Objective. To find out the prevalence and magnitude of relationship between Sit and Reach Test (SRT) & Hip Joint Angle (HJA) measurements and effect of gender on SRT & HJA among school going children.

Study design. Cross-sectional study and correlation design.

Methods. 140 (70 girls and 70 boys) children, girls mean age 9.5±1.8 yrs and boys 9.614±1.94 years old, were divided into two groups: girls (n = 70) & boys (n = 70). Hamstrings flexibility was measured using Sit and Reach Test (SRT) and Hip Joint Angle (HJA) measured using an inclinometer. Data analysis. Correlation between SRT & HJA was measured using Pearson's Correlation Co-efficient (r) and significance of difference between girls group and boys group was measured using t-test via SPSS (21st version). Significance level was set at $p \leq 0.05$.

Results. There was highly significant positive correlation between SRT & HJA in the whole sample. There was even higher significant positive correlation between SRT & HJA among the girls ($r = 0.604$ at $p \leq 0.05$) but weak positive among the boys ($r = 0.277$ at $p \leq 0.05$). On analysis of SRT & HJA scores among the girls versus boys the difference in the SRT scores ($t=7.281$ at $p \leq 0.0001$) were highly significant but HJA scores were less significant ($t=2.966$ at $p \leq 0.0001$).

Conclusion. Results of present study indicate that both SRT & HJA can reflect hamstring muscle length but relatively more effective in assessing girls than boys.

Cuvinte cheie: ischiogambieri, testul Sit & Reach, unghiul articulației șoldului

Rezumat

Introducere. Fexibilitatea este una dintre cele mai importante componente ale mișcării. Este mai mare la copii comparativ cu adulții. Dar sunt diferențe între băieți și fete.

Obiective. Stabilirea prevalenței și magnitudinii relației dintre testul Sit and Reach (TSR) & unghiul șoldului (US) și efectul vârstei asupra TSR & US la școlari.

Design-ul studiului. Design cros-secțional și de corelație.

Metodă. 140 (70 fete și 70 băieți) de copii, media de vârstă a fetelor de 9.5±1.8 ani și a băieților de 9.614±1.94 ani, au fost împărțiți în două grupuri: fete (n = 70) & băieți (n = 70). Flexibilitatea ischiogambierilor s-a măsurat folosind testul Sit and Reach (TSR) și unghiul șoldului (US).

Analiza datelor. Corelația dintre TSR & US s-a măsurat folosind coeficientul de corelație Pearson (r) iar pentru semnificația diferenței dintre grupul de fete și băieți s-a folosit t-testul, cu ajutorul SPSS (versiunea 21). Nivelul de semnificație a fost ≤ 0.05.

Rezultate. Există o corelație puternic pozitivă între TSR & US. Există o și mai mare corelație semnificativă între TRT & US la fete ($r = 0.604$ at $p \leq 0.05$) și o corelație pozitivă slabă la băieți ($r = 0.277$ at $p \leq 0.05$). La analiza scorurilor TRT & US la fete versus băieți, diferența la scorul TSR ($t=7.281$ at $p \leq 0.0001$) a fost puternic semnificativă dar scorurile US au fost mai puțin semnificative ($t=2.966$ at $p \leq 0.0001$).

Concluzii. Rezultatele acestui studiu indică faptul că TRT & US reflectă lungimea mușchiului dar sunt relativ eficiente în evaluarea la fete versus băieți.

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Introduction

Human movement is not possible without a certain amount of the fitness component commonly called flexibility. Most exercise and sports programs incorporate activities for flexibility development because flexibility is thought to be important for safe and effective movement. [1] Children are more flexible as compared to adults as infant lie on his back can bring his feet to his mouth or a toddler sitting on the floor with his bent legs out to the side and perform complex yoga asanas very easily. Young children are naturally more active, but their activity level starts decreasing as their age increases. This decrease in physical activity results due to the sedentary behavior of the early age. [2]

Now days, there is a decrease in flexibility in individuals, who are spending their lives in a sedentary manner or those who exercise either don't exercise properly or don't take the time to stretch. [3]

Kendall et al (1948) proposed that, at the age of 5 years, 98% of girls and 86% of boys can touch fingertips to toes with knee straight but it sharply decline as only 30% of boys & girls can perform that at the age of 12 years or 13 years respectively. [3] Jozwiak et al. (1997) reported that in 10-year-old or above students in Denmark; 75% of male students and 35% of female ones were suffering from the short hamstring disorder. Jari and Esmaili (2001) conducted a study on 3 to 17 years old population in Iran and reported that 31.6% of girls suffered a from a similar problem. [4] Hamstring muscles cover the posterior thigh as they span the hip & knee posteriorly so that they can bend the knee and also extend the hip. [5]

Hamstrings are the muscles functionally important while walking, running; jogging, etc. but have a tendency to get shortened. Short hamstrings are associated with decreased flexion ROM of lumbar & pelvic angles, increased flexion ROM, and patellofemoral pain syndrome. [4,7,8]

Given the above-mentioned facts and findings, it is of crucial importance to diagnose short hamstring muscles early in children; that's why various methods have recently come to being to address this problem (Cormbleets and Woolsey, 1996; Kendall et al., 1993). [9]

Single joint static flexibility tests are common clinical measures in the medical professions (AAOS, 1965; AMA, 1988; Gajdosik & Bohannon, 1987; Norkin & White, 1995; Gerhardt & Russe 1975) and usually involve angular measurements (goniometers or inclinometers), rather than linear measurements common in field tests of flexibility. Single joint tests are considered better measurements of static flexibility than compound tests because they better isolate specific muscles and are less affected by anthropometric variation (Cornbleet & Woolsey, 1996; Leighton, 1942). [1]

SRT & Standing toe touch tests are few of the battery field tests for testing hamstring flexibility. SRT is more effective than standing toe touch test. As standing may be limited by unilateral pelvic tilt or by clockwise, or anti-clockwise rotation of pelvis in relation to thorax, the long sitting position eliminates all these and also allow better control of the knee joint position. [3,10]

SRT test enjoys medium criterion validity for measuring the length of the hamstring muscle but no validity whatsoever for back muscle (Jackson and Baker, 1986; Jackson and Langford, 1989; Martin et al, 1998). But factors like anthropometric and scapular abduction can affect the final results of SRT (Boline et al., 1992; William et al., 2000; Jackson and Langford, 1989; Kendall and Kendall, 1984; Hui et al., 1999; Martin et al.,1998). [1,9] SLR (Goeken & Holf, 1993), active knee extension (AKE) (Gajdosik & Lusin, 1983) and HJA measurement (Cardoso et al, 2007; Suxy & Nancy, 1996) are the criterion hamstring static flexibility tests used to validate SRT. [1,10,11] Urban (1981) suggested that the SLR had a dual function in measuring hamstring muscle length and assessing sciatic nerve mobility, also Lew & Peuntedura (1985) suggested that neural mobility limits the SLR test. Similarly, concerns have been expressed to AKE (Gajdosik & Lusin, 1983; Worrell et al., 1991). [12] Cardoso et al. (2007) found SRT reliable when measured by HJA and Suxy & Nancy (1996) proposed the use of the inclinometer to measure the HJA as an indicator of hamstring muscle length during the SRT

which is simple, yields reliable measurements, and is not influenced by anthropometric factors. [10,11]

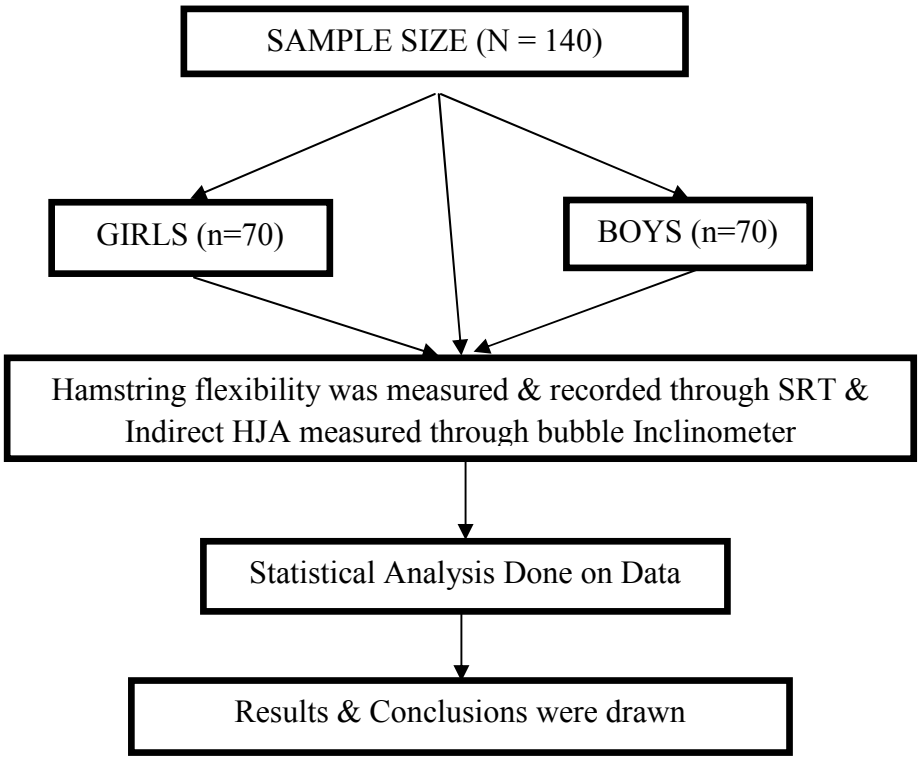
Here few questions arise; those need to be answered i.e. is there any significant relationship exist between the way of method incorporating an inclinometer measurement of HJA and the SRT method for hamstrings length testing in school going children?; which of these two is more appropriate for assessing the hamstrings length in accordance with gender? Moreover, which of the two i.e. boys or girls have more hamstring flexibility? Answers to these questions could give informative results concerning the best possible way to assess the degree of flexibility of hamstring muscle in school going girls and boys. So the aims of this study are to find out the prevalence and magnitude of the relationship between SRT & HJA and effect of gender on SRT & HJA among school going, Indian children.

Methodology

The present study was a randomized control trial. The samples were selected from Government senior secondary schools, Panipat. The inclusion criteria for the present study was a school going children; age between 5 years to 12 years old. The exclusion criteria for the present study were: musculoskeletal impairments affecting spine, upper extremities or lower extremities, any systemic impairments such as cardiovascular disease, cerebrovascular disease, respiratory disorder and metabolic or GIT disorder; any psychological or psychiatric disorder; any communication disorder.

After fulfilling the selection criteria, a total of 140 school going children were categorized into two groups i.e. girls (n=70) and boys (n=70) with mean (SD) age 9.5±1.86 yrs. & 9.614±1.936 yrs. Respectively on the basis of convenience. Informed consent was taken from subject's parents, and the school principal, and the whole study protocol was approved by Departmental ethical committee. Hamstring flexibility was measured using SRT & HJA. The instruments used were standardized sit & reached box and bubble inclinometer.

Protocol



Protocol of the study

Sit and Reach Test [10,13]

Each child seat on the floor with knees fully extended and ankle in neutral dorsiflexion against the box. The child was instructed to place one hand on the top of the other and slowly reach forward as far as possible while keeping the knees extended. The hands were kept aligned evenly as the subject reached forward along the surface of the box. Each child practiced the movement twice and on the third repetition the SRT score was recorded (in centimeters) as the final position of the fingertips.

Inclinometer placement & HJA measurement [10]

During the same trial, an inclinometer (circular fluid filled) was set so that 00 represented the horizontal, or 00 of hip flexion. The inclinometer was placed vertically on the sacrum so that its center was aligned at the level of the posterior superior iliac spines, and the HJA was measured and recorded.

Statistics

Data analysis was performed using software package SPSS 21 version for windows. Mean (S.D.) of SRT & HJA was calculated. Correlation between SRT with HJA was studied using Pearson's Correlation coefficient and SRT& HJA performance difference among boys and girls was studied using a t-test. Significance level was set at $p < 0.05$.

Findings

Table-1 Showing relationship between SRT & HJA scores (N=140)

Variables	SRT	HJA	Result
SRT	1	0.480	Strong positive
HJA	0.480	1	

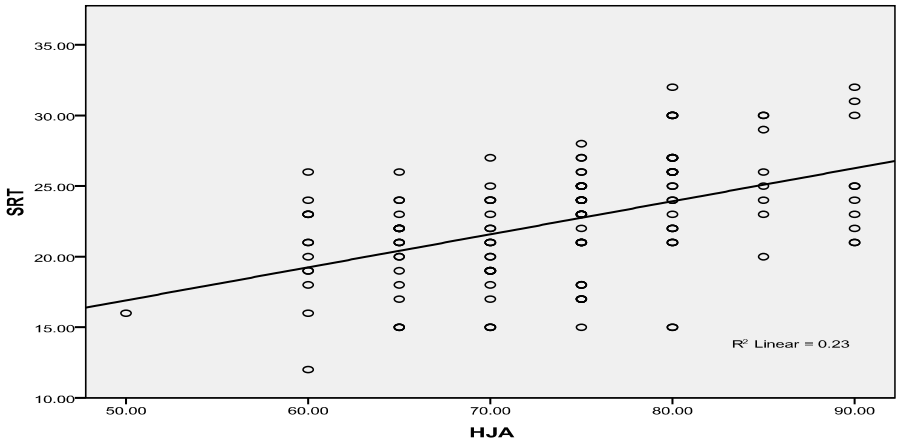


Figure-1 Showing correlation between SRT & HJA scores in raw sample (N=140

Table-2 Showing relationship between SRT & HJA in girls (n=70)

Variables	SRT	HJA	Result
SRT	1	0.604	Very Strong positive
HJA	0.604	1	

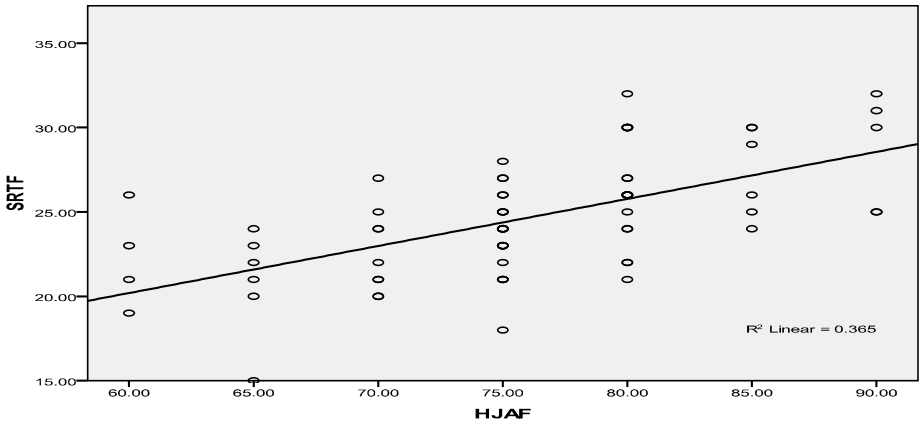


Figure-2 Showing correlation between SRT & HJA scores among girls (n=70)

Table-3 Showing relationship between SRT & HJA scores in boys (n=70)

Variables	SRT	HJA	Result
SRT	1	0.277	Weak positive
HJA	0.277	1	

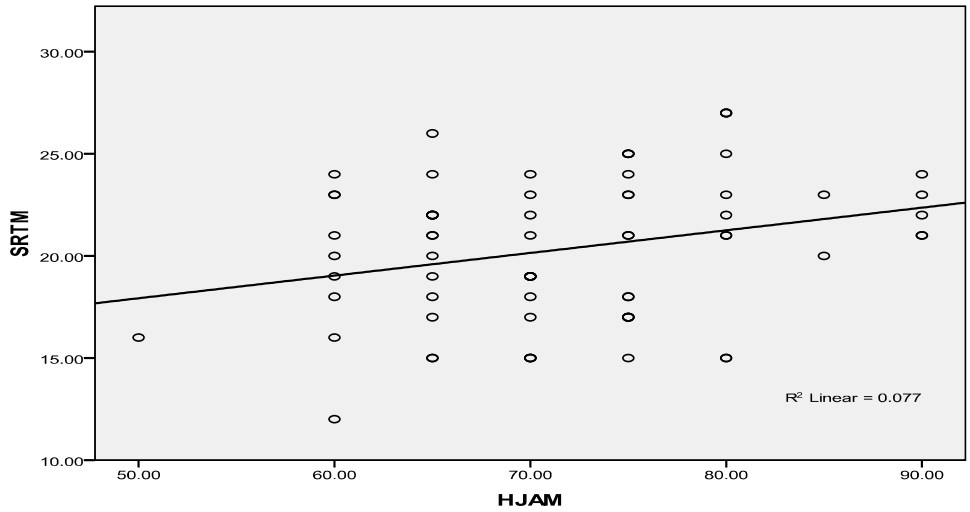


Figure-3 Showing correlation between SRT & HJA scores in boys (n=70)

There was a highly significant positive correlation between SRT & HJA (r = 0.480 at p≤0.05) in the whole sample (ref table-1, figure-1). There was even higher significant positive correlation between SRT & HJA among the girls (r = 0.604 at p≤0.05) (ref table-2, figure-2) but the correlation became weak positive among the boys (r = 0.277 at p≤0.05) (ref table-3, figure-3).

On analysis of SRT & HJA scores among the girls and boys the difference in the SRT scores (t=7.281) (ref table-4, figure-4) was highly significant at p≤0.0001 but comparative less significant in HJA scores (t=2.966) (ref table-5, figure-5).

Table-4 Showing difference of SRT score between males and females

	N	Mean	t-value	Sig. (2-tailed)	Result
Girls	70	24.614±3.448	7.281	0.0001	Significant
Boys	70	20.343±3.493			

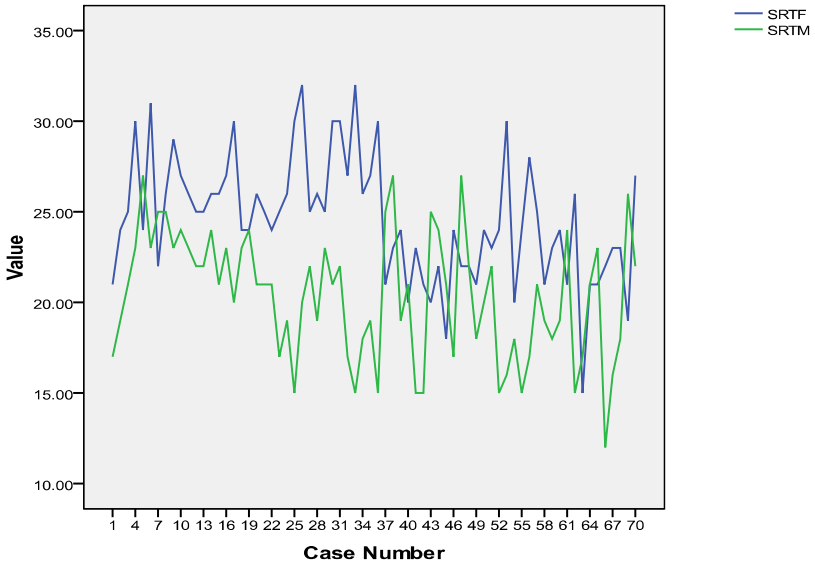


Figure-4 Showing difference of SRT scores between boys and girls

Table-5 Showing difference of HJA scores between boys and girls

	N	Mean	t-value	Sig. (2-tailed)	Result
Girls	70	75.857±7.468	2.966	0.004	Significant
Boys	70	71.786±8.724			

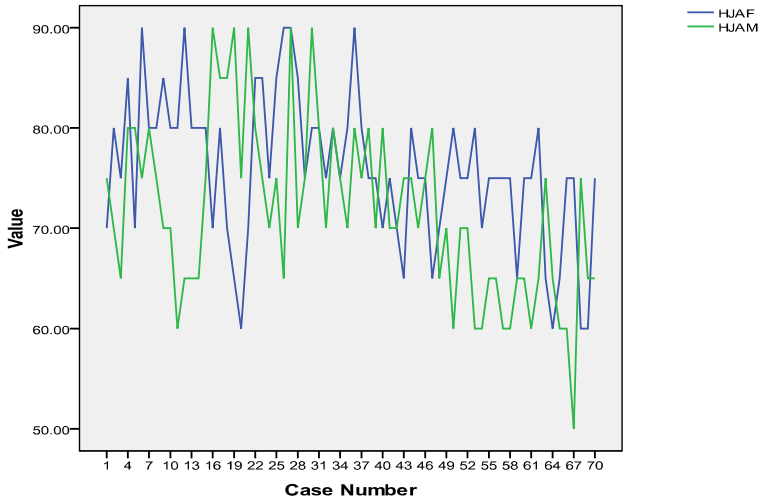


Figure-5 Showing difference of HJA scores between boys and girls

Discussion

The characteristic of the study was to establish a random order of flexibility testing variables (SRT & HJA), in order to setup the selection biasing with reference to gender (girls/boy) in primary school going children. The present study indicates that there is a highly positive correlation exists between SRT & HJA, suggesting both can show hamstring muscle length. Results of this study (Pearson r 0.480 at $p \leq 0.05$) show that SRT has a strong positive correlation with HJA measurements. It may be because of our small sample size (N=140), and lower raw mean values of SRT (22.48±4.07) & HJA (73.82±8.35). But our study trial completed gap left by Suzy & Nancy (1996) as they didn't highlight the variation in the correlation of SRT & HJA in accordance with gender. Results from our study reveals that SRT & HJA could be better correlated in girls (Pearson r 0.604 at $p \leq 0.05$) than boys (Pearson r 0.277 at $p \leq 0.05$) suggesting that SRT & HJA can more effectively reflect hamstring muscle flexibility in girls

than boys. These findings are in contrast to the results of Abdolali et al. (2013) study done with 120 students within the age range of 9 to 12 yrs in Iran showed that there is no significant relationship between the obtained results of SRT and SLR tests in terms of measuring the length of hamstring muscles in female students (0.059) however; there was a negative significant relationship between the results of these two tests in male primary students (0.043). However our findings are somehow in accordance with Pedro et al. (2009) who reported the correlation coefficient of the angle of the thigh's joint and SLR test as 0.47 to 0.59 in men and 0.51 to 0.69 in women [9] but differ as SRT & HJA are our outcome variable which have considered more reliable.

Andrew Rolls & Keith George (2004) reported estimates of apparent hamstring muscle length differ dependent on the test employed & found some alternates to SRT & HJA to test hamstring muscle flexibility. [12] However Sit-and-Reach test was adopted in this study as it is still a test widely used in many fitness batteries (Guariglia et al, 2011; Abdolali et al, 2013) [12,13] moreover Jackson & Baker (1986) and Chang & Boen (1999) concluded that the flexibility of hamstring only could be assessed by the traditional SRT test. [9] SRT is better than some of the other field tests (Kendall et al, 1948; Suzy & Nancy, 1996) with moderated criterion validity for measuring the length of the hamstring muscle but no validity whatsoever for back muscle (Jackson and Baker, 1986; Jackson and Langford, 1989; Martin et al, 1998). [1,3,9,10] Simple inclinometer readings of HJA during the SRT yields reliable measurements, and is not influenced by anthropometric factors (Suxy & Nancy, 1996; Cardoso et al., 2007). [10,11]

The present study also indicates that girls have better hamstring flexibility than boys as shown by the performance of SRT (t 7.281 at $p \leq 0.05$) and HJA (Pearson t 2.966 at $p \leq 0.05$) measurements. This is in limelight of Abdolali et al. (2013), Suzy & Nancy (1996) & Youdas et al. (2005) findings of gender influence on hamstring muscle length as evidence suggested that females have greater muscle flexibility than males and hamstring muscle length is not influenced by age.

Some of the limitations of present study were; a) a small sample size which may limit generalization of results; b) lumbar spine motion was not measured as a limited spinal flexibility can prevent the children from reaching toes during SRT;c) nutritional status was not measured & d) physical activity of the sample was not measured or recorded which adds more limitation. further Taylor et al. (1995) suggested that girls progressing through childhood to adolescence can have reduced flexibility as they become less active than boys.

But still significance of the study lies in the fact that the school is an ideal setting for assessing flexibility as it deals with a large number of units of a community. As our study shows, both SRT & HJA can reflect hamstring muscle length in school going children but relatively more reflective in girls than boys in India. And Indian school going girls have more flexibility than boys. Hence, it is recommended to establish a random order of flexibility testing variables (SRT & HJA), in order to setup the selection biasing with reference to gender (girls/boy) in primary school going children.

Conclusion

Results of the present study indicate that both SRT & HJA can reflect hamstring muscle length but is relatively more effective in assessing girls than boys. Also, girls have more flexibility than boys in healthy school going children between 5 to 12 years of age.

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Ethical Clearance: Ethical Clearance was provided by the departmental ethical committee of GJUS&T, Hisar, Haryana.

References

[1] Knudson et al., (2000) *Current Issues in Flexibility Fitness*, President's Council on Physical Fitness and Sports- Research Digest, series 3, no. 10, June.
[2] Bandy W.D, J.M Irion, Michelle Briggler (1994) The effect of time and frequency of static stretching on the flexibility of the hamstring muscles: *Journal Of Physical Therapy;* 74(9): 845-850.
[3] Henry o. Kendall, Florence P. Kendall, George E. Bennett (1948) Normal flexibility according to age groups: *Journal of Bone and Joint Surgery Am*; 30:690-694.
[4] Richard Gajdosik, Gray Lusin (1983) Hamstring muscle tightness: *Journal Of Physical Therapy July*; 63:7: Lynn S. Lippert, Clinical kinesiology & anatomy, F. A. Davis, edition 4th:2006, 243-44
[5] Knudson et al. (2000), *Current Issues in Flexibility Fitness*, President's Council on Physical Fitness and Sports- Research Digest, series 3, no. 10.
[6] Bandy W.D, J.M Irion, Michelle Briggler (1994) The effect of time and frequency of static stretching on the flexibility of the hamstring muscles: *Journal Of Physical Therapy*; 74(9): 845-850.
[7] Henry o. Kendall, Florence P. Kendall, George E. Bennett (1948) Normal flexibility according to age groups: *Journal of Bone and Joint Surgery Am*; 30:690-694.
[8] Richard Gajdosik, Gray Lusin (1983) Hamstring muscle tightness: *Journal Of Physical Therapy*; 63:7:
[9] Lynn S. Lippert (2006) *Clinical kinesiology & anatomy,* F. A. Davis, edition 4th: 243-44.
[10] Brent F. Taylor, Christopher A.Waring, Teresa A. Brashear (1995) The effects of therapeutic application of heat or cold followed by static stretch on hamstring muscle length: *Journal Of Orthopaedics And Sports Physical Therapy*; 21(5):283-286.
[11] Lisa C. White, Philippa Dolphin, John Dixon (2009) Hamstring muscle length in patellofemoral pain syndrome: *Journal Of Physiotherapy*; 95:24-28.
[12] Richard L. Gajdosik, Carla R. Albert, John J. Mitman (1994) Influence of hamstring length on the standing position and flexion range of motion of the pelvic angle, lumbar angle, and thoracic angle: *Journal Of Orthopaedics And Sports Physical Therapy* 1994; 20:213-219.
[13] Abdolali Banaeifar, Morteza Rash, Yahya Sokhangoiee (2013) The correlation of SRT test and the hips joint's goniometer angle index in terms of measuring the hamstring muscle's length in Kraj's primary school students, *International Journal of Sports Studies*. Vol., 3 (12), 1307-1312
[14] Suzy L. Combleet, Nancy B. Woolsey (1996) Assessment of hamstring muscle length in school-aged children using the sit and reach test and the inclinometer measure of hip joint angle: *Journal Of Physical Therapy*; 76:850-855.
[15] Cardoso et al. (2007) Intra and interobserver reliability of angular kinematic analysis of the hip joint during the sit-and-reach test to measure the hamstrings length in university students. *Rev Bras Fisioter*, 11: 133 – 138
[16] Andrew Rolls & Keith George (2004) The relationship between hamstring muscle injuries and hamstring muscle length in young elite footballers, *Physical Therapy in Sport*: 5 179–187.
[17] Guariglia et al. (2011) Time-of-Day Effect on Hip Flexibility Associated with the Modified Sit-and-Reach Test in Males, *Int J Sports Med*; 32: 947–952.
[18] Youdas JW, Krause DA, Hoilman JH, Harmsen WS, Laskowski E (2005) The influence of gender and age on hamstring muscle length In healthy adults: *Journal Of Orthopaedics And Sports Physical Therapy*;35(4);246-252.