INFLUENCE OF AGE ON HAMSTRING TIGHTNESS IN APPARENTLY HEALTHY NIGERIANS

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SUMMARY
Purpose: Hamstring tightness has been documented in apparently healthy Nigerian adults and in those with musculoskeletal problems, but the influence of age on hamstring tightness has not been studied. This study was therefore designed to determine the influence of age on hamstring tightness in apparently healthy subjects.
Methods: Hamstring tightness was measured using the active knee extension test (AKET) in 240 apparently healthy male and female subjects, aged 5-59 years. The subjects were recruited into 6 age groups using the purposive sampling technique. Hamstring tightness was compared across the age groups using one-way analysis of variance (ANOVA). The independent t-test was used to compare hamstring tightness on both lower limbs in male and female subjects.
Results: Subjects' mean age was 29.63 ± 16.72 years. All subjects had hamstring tightness (absolute extension lag) and this increased with age up to age group 40-49 years. The male subjects had significantly higher hamstring tightness than the females in all the age groups.
Conclusion: This study suggests that hamstring tightness increases in apparently healthy Nigerians from childhood up to age 40-49 years and it is higher in males than females.

Key words: hamstring tightness, age, active knee extension test

INTRODUCTION

Muscle tightness is caused by 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.[1] The term has also been used to denote a slight to moderate decrease in muscle length; usually the movement in the direction of the elongating muscle is limited.[2] Muscle tightness usually results from inadequate or improper rehabilitation following sustained muscle injury or low levels of physical activity in individuals.[3] It could make the musculo-tendinous unit more susceptible to injury, increase resistance to various anatomical structures, which may lead to overuse syndrome.[4] It could also lead to some pathological conditions at the joint on which the muscle acts, especially on a muscle like the hamstrings which passes over two joints.[3]

The hamstrings comprise three large muscles, namely semitendinosus, semimembranosus and biceps femoris which originate from the ischial tuberosity. They are located in the posterior compartment of the thigh and span the hip and knee joints. Hence, they are extensors of the hip and flexors of the knee.[5] Hamstring tightness may be measured using the active unilateral SLR test,[6] the passive unilateral SLR test;[7] the sit and reach test,[8] and the active knee extension test (AKET).[9] Apart from being used to measure hamstring tightness, the SLR tests are also widely used as neurological tests; hence they do not give valid measures of hamstring tightness because of pelvic rotation that occurs during the tests.[10] The AKET measures hamstring tightness by the angle subtended by knee flexion after a maximum active knee extension, with the hip stabilized at 90 degrees. The test-retest reliability co-efficient for the AKET was reported to be 0.99 for both lower limbs and this has been attributed to the strict body stabilization method, the well-defined end point of motion and accurate instrument placement of the test.[9]

Previous studies have defined hamstring tightness at different arbitrarily set levels of active extension lag. Some researchers have defined it as at least 15° loss of active knee extension while others have defined it as equal to or greater than 30° loss of active knee extension with the femur held at 90 degrees of hip flexion.[9,11-13] There seems to be no general agreement on the level of active extension lag that should be regarded as hamstring tightness. It has also been documented that maximum popliteal angle (180 degrees) is measurable from birth to age 2 years after which it decreases steadily to an average of 155 degrees by age 6 years, and then remains steady.[13]

Tight hamstring muscles increase the patellofemoral compressive force because of the increased passive resistance during the swing phase of ambulation and running.[4] Hamstring tightness has been reported to be the cause of posterior pelvic tilting, reduced lumbar lordosis and exacerbation of existing pain in patients with low back pain.[14] It has been reported to play a role in different forms of lumbar inter-vertebral disc pathology.[15,16] It's occurrence has also been found to be significantly higher in Nigerian adults with low back pain than in those without low back pain.[17]

The aim of the present study is to determine whether or not age and gender would have significant influence on hamstring tightness in apparently healthy individuals. We proposed two hypotheses, which are that, age would have significant effect on hamstrings tightness and that hamstrings tightness would differ significantly in male and female subjects.

MATERIALS AND METHODS

Two hundred and forty apparently healthy subjects, aged between 5 and 59 years participated in this study. Forty subjects were recruited for each age group (5-12) years; 13-19 years; 20-29 years; 30-39 years; 40-49 years and 50-59 years) using the purposive sampling technique. Subjects with health problems that might contribute to muscle tightness, such as deformities, contractures, spastic paralysis, and those involved in exercise training or active sports participation which might enhance muscle flexibility were not allowed to take part in the study. Pregnant women were also excluded. Subjects in the 5-12 year age group were recruited from a nursery/primary school in Ibadan and only children whose parents gave written consent participated. Subjects in age group 13-19 years were recruited from a secondary school in Ibadan. Subjects in other age groups were students and staff of the College of Medicine, University of Ibadan and those of the University College Hospital (UCH), Ibadan. All subjects older than 12 years gave their consent.

The procedure was explained to the subjects and their ages were recorded as at last birthday to allow for consistency. The following measurements were taken for each subject:

1. *Body weight* was measured using a portable weighing scale (Seca, Vogel and Halka, Germany). Each subject mounted the scale barefooted with minimal clothing, looking straight ahead. Weight was recorded to the nearest kilogramme. The accuracy of the scale was checked using a known metal weight after every 10 measurements. The scale was also checked and corrected for zero before each measurement.

2. *Height* was measured on a height meter (INVICTA Plastics Ltd, Leicester, England). Each subject stood barefooted and upright with feet flat on the ground, arms by the side, looking straight ahead. The movable arm of the height meter was adjusted to touch subject's vertex without exerting undue pressure. The height was recorded to the nearest 0.1 centimetre.

3. *Limb length* was measured, using an inelastic tape measure (Butterfly Brand, China) from the anterior superior iliac spine to the tip of the medial malleolus while subject lied supine. The measurements of both lower limbs were taken and recorded to the nearest 0.1 centimetre. The purpose of measuring limb length was to ascertain that there was no limb length discrepancy.

4. *Body mass index* (BMI) was calculated by dividing the subject's weight by the square of his or her height:

$$\text{BMI (kg/m}^2) = \frac{\text{Weight (kg)}}{\text{Height}^2 \text{ (m}^2)}$$

Hamstring tightness was measured using the active knee extension test (AKET).[9] The AKET apparatus comprised a metal frame and a crossbar which had an adjustable height. The AKET apparatus was fabricated locally and attached firmly to a wooden plinth (plate 1). Each subject wore a pair of shorts or stretches and lied supine on the plinth to which the AKET apparatus was attached. The pelvis and the lower limb that was not being measured were stabilized using canvas straps (plate 1). For ease of reading range of motion at the knee during testing, a pliable universal goniometer (Olfen, England) was strapped to the lateral aspect of the knee with two Velcro fasteners. The fulcrum of the goniometer was placed over the lateral epicondyle of femur. Its proximal arm was aligned with the lateral midline of the femur (greater trochanter as the reference point) and the distal arm was aligned with the head of the fibula and lateral malleolus. Subject was asked to bend the leg to be tested and the height of the crossbar was adjusted such that it was in contact with the distal anterior surface of the thigh (plate 1). The range of hip flexion was measured using another goniometer to ensure that it was 90 degrees. The crossbar prevented further flexion at the hip. The subject actively held this position with the knee in flexion and the ankle in plantar flexion.

Plate 1. Starting Position of the Active Knee Extension Test (AKET).

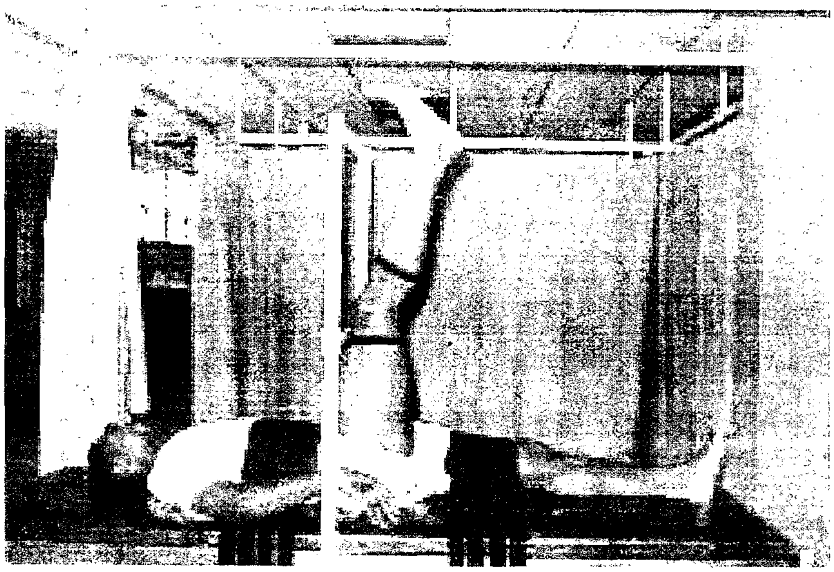

Plate 2. End Point of Active Knee Extension Test (AKET).

The subject was then asked to actively extend the knee while maintaining firm contact with the cross bar (plate 2). At the point at which temporary myoclonus (alternating contractions and relaxation of the quadriceps and hamstring muscles) occurred, the subject was told to slightly flex the leg till the myoclonus stopped. He was also instructed not to force the leg past the initial point of mild resistance in the attempt to carry on with the active knee extension. At the first point where myoclonus was noticed to have stopped, the angle of knee flexion was observed on the goniometer that was attached to the knee. The complementary angle to the knee flexion, which is the knee extension lag, was computed by subtracting the knee flexion from 180°. This was recorded as hamstring tightness, rather than either of the arbitrary values of ≥15°[11] and ≥30°[9,12] extension lag used in previous studies because there seems to be no consensus on the value of knee extension lag that should be regarded as normal.

DATA ANALYSIS

Data were summarized using mean and standard deviation. One-way analysis of variance (ANOVA) was calculated to determine whether significant differences existed or not in hamstring tightness across the different age groups. A post-hoc analysis was used to determine which pairs differed in cases where ANOVA indicated significant difference. The independent t-test was used to determine if there was significant difference in hamstring tightness between males and females and between the right and left lower limbs. Level of significance α (alpha) was set at 0.05).

RESULTS

The subjects comprised one hundred and twenty two males and one hundred and eighteen females. They were aged 29.6 ± 16.7 years. The subjects' mean weight and height were 57.4 ±19.1kg and 1.59 ± 0.18m respectively. The physical characteristics of the subjects in different the age groups are shown in table 1.

Figure 1 shows that hamstring tightness gradually increased from age group 5-12 years (38.00 ± 8.96 and 40.25 ±8.61 for the right and left lower limbs respectively) to age group 40 - 49 years (53.65 ± 5.08 and 54.85 ± 5.51 for the right and lower limbs respectively) after which it decreased slightly (51.45 ± 5.18 and 52.60 ± 5.15 the right and left lower limbs respectively for the age group 50-59 years). Hamstring tightness did not differ significantly in both lower limbs in any age group. Hamstring tightness in males (49.03 ± 7.50 and 50.30 ± 7.25 for the right and left lower limbs respectively) was significantly higher (p=0.05) than in females (40.48 ±9.24 and 41.63 ±8.63 for the right and left lower limbs respectively) (table 4).

One-way analysis of variance showed that hamstring tightness differed significantly across the age groups (p=0.00) (table 3). Burkett's post-hoc analysis showed that hamstring tightness differed in many paired groups, except age groups 5-12 and 13-19 years, 5-12 and 20-29 years, 13-19 and 20-29 years and 40-49 and 50-59 years for both limbs (table 4).

Table 1. Age and Physical Characteristics of Subjects

	All Subjects	Age Groups					
	(N=240)	5-12 yrs (n=40)	13-19 yrs (n=40)	20-29 yrs (n=40)	30-39 yrs (n=40)	40-49 yrs (n=40)	50-59 yrs (n=40)
Age (yrs)	29.6 ± 16.7	7.2 ± 1.4	13.8 ± 1.3	23.3 ± 2.0	34.5 ± 2.3	44.7 ± 2.7	54.2 ± 2.3
Weight (kg)	57.4 ± 19.1	22.1 ± 3.0	48.6 ± 9.4	60.6 ± 0.1	69.8 ± 6.1	71.5 ± 7.8	71.8 ± 6.6
Height (m)	1.6 ± 0.2	1.2 ± 0.1	1.6 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1
BMI (kg/m²)	21.7 ± 4.5	14.48 ± 1.2	19.3 ± 2.4	21.4 ± 2.1	24.8 ± 2.4	25.0 ± 2.8	25.6 ± 2.0
RLLL (cm)	86.7 ± 11.5	64.7 ± 4.6	90.8 ± 7.7	89.3 ± 5.4	90.6 ± 5.4	92.9 ± 5.9	95.6 ± 5.4
LLLL (cm)	86.7 ± 11.5	64.7 ± 4.6	90.8 ± 7.7	89.3 ± 5.4	90.6 ± 5.4	92.9 ± 5.9	95.6 ± 5.4

Notes: N= sample size; BMI = body mass index; RLLL = right lower limb length; LLLL = left lower limb length.

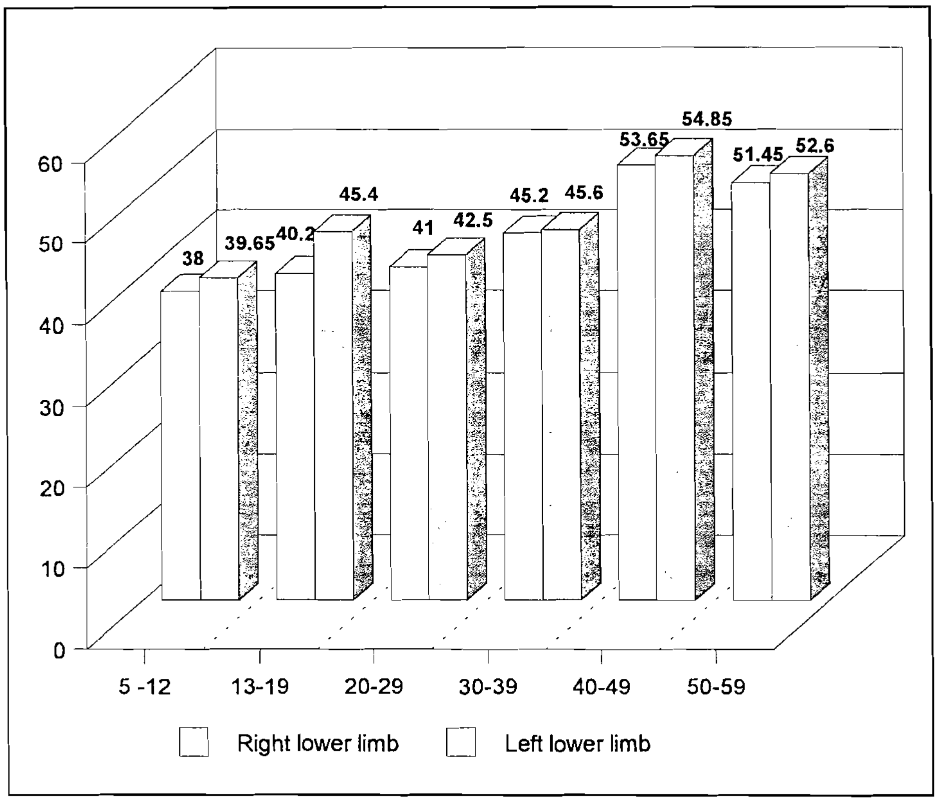

Figure 1. Hamstring Tightness Across Age Groups in Both Lower Limbs

Table 2. Comparison of Hamstring Tightness on Right and Left Lower Limbs in Different Age Groups

Age Group (yrs)	Hamstring Tightness		t-value	P-value
	Right lower limb	Left lower limb		
5 - 12	38.00 ± 8.96	40.25± 8.61	0.16	0.85
13 - 19	39.65 ±9.66	40.40± 8.71	0.05	0.96
20 - 29	41.00 ± 7.13	42.50 ±7.14	0.14	0.88
30 - 39	45.20 ± 7.13	45.60± 5.33	0.05	0.96
40 - 49	53.65 ± 5.08	54.85± 5.51	0.16	0.87
50 - 59	51.45 ± 5.18	52.60 ±5.15	0.15	0.87

Table 3. Analysis of Variance of Hamstring Tightness Across the Age Groups

	Source of Variation	DF	Sum of Squares	Mean of Squares	F-ratio	P-value
Right lower limb	Between groups	5	8396.15	1679.23	30.72*	0.00
	Within groups	234	12788.5	54.65		
Left lower limb	Between groups	5	7948.33	1589.67	32.01*	0.00
	Within groups	234	11619.4	49.66		

Table 4. Burkett's Post-Hoc Analysis for Hamstring Tightness

Age Groups	t-value	
	Right LL	Left LL
1 vs. 2	-	-
1 vs. 3	-	-
1 vs. 4	3.98	3.17
1 vs. 5	9.61	9.04
1 vs. 6	8.22	7.79
2 vs. 3	-	-
2 vs. 4	2.92	3.06
2 vs. 5	8.11	8.87
2 vs. 6	7.62	7.62
3 vs. 4	2.64	2.05
3 vs. 5	9.14	8.66
3 vs. 6	7.5	7.25
4 vs. 5	6.1	6.97
4 vs. 6	4.48	5.43
5 vs. 6	-	-

Values shown only where t is significant ($p < 0.05$).

KEY

1 = 5 - 12 years
2 = 13 - 19 years
3 = 20 - 29 years
4 = 30 - 39 years
5 = 40 - 49 years
6 = 50 - 59 years

Table 5. Comparison of Hamstring Tightness in Male and Female Subjects

	Right lower limb		Left lower limb	
	Males (n=122)	Females (n=188)	Males (n=122)	Females (n=188)
Mean hamstring tightness	49.03 ± 7.50	40.48 ± 9.24	50.30 ± 7.25	41.63 ± 8.63
t	7.89*		8.44*	
p	0.00		0.00	

Note: Significant t-value at p=0.05.

DISCUSSION

The results showed that hamstring tightness was present in all age groups studied and that it tended to increase with age. However, there was no significant difference in hamstring tightness in subjects in age groups 5-12, 13-19 and 20-29 years. In age groups 30-39 and 40-49 years, hamstring tightness was higher than that for any of the younger age groups. It was significantly lower in age group 50-59 years when compared with age group 40-49 years. It was significantly lower in age group 50-59 years when compared with age group 40-49 years. These findings suggest that in this environment, hamstring tightness occurs in early childhood and it tends to increase with age. However, it does not significantly increase until the 30-49 years age range, after which it seems to fall. This corroborates the observations that hamstring tightness in juveniles is less than that in adults.[18] The progressive decline in flexibility with age has been attributed to changes in elasticity and decreased level of physical activity.[19,20] Results also showed that males recorded higher values of hamstring tightness compared to their female counterparts across the age groups. This supports the finding that females of most ages have greater trunk/hip flexibility than males.[21,13]

These findings suggest the need to teach routine stretching of the hamstring muscles to all age groups, especially before age 30 when the tightness seems to increase greatly. School teachers, especially physical education teachers can help in this wise. Physiotherapists should also include hamstring stretching exercises into the treatment programmes of patients suffering from musculoskeletal disorders of the lower limbs and the lower back. This may reduce the possible contribution of hamstring tightness to these disorders, especially low back pain syndrome.

CONCLUSION

The findings of this study suggest that hamstring tightness is present in early childhood and increases with age in apparently healthy Nigerian subjects.

REFERENCES

1. Zachezeweski JE. Improving flexibility. In *Physical Therapy*. Sally RW and Barnes MR (Eds.) Philadelphia: J.P. Lippincott Co., 1989; 698-699.
2. Gossman MR, Sahrmann SA, Rose SJ. Review of length-associated changes in muscle. *Physical Therapy* 1982; **62:** 1799-1807.
3. Bohannon RW. Effect of repeated 8 minutes loading on the angle of straight leg raising. *Physical Therapy* 1984; **64:** 491-497.
4. Davies JG, Malone T, Basset FH. Knee examination. *Physical Therapy* 1980; **60:** 1565-1573.
5. Moore KL. Lower limbs. *Clinically Oriented Anatomy*. 3rd Edition. Baltimore: William and Wilkins, 1992; 421-423.
6. Markos PD. Ipsilateral and contralateral effects of proprioceptive neuromuscular facilitation techniques on hip motion and electromyographic activity. *Physical Therapy* 1979; **59:** 1366-1373.
7. Moore MA, Hutton RS. Electromyographic investigation of muscle stretching techniques. *Medical Science Sports* 1981; **12:** 322-329.
8. Chung PK, Yuen CK. Criterion related validity of sit-and reach test in university women in Hong Kong. *Perpetual and Motor Skills* 1999; **88(1):** 304-316.
9. Gajdosik RL, Lusin G. Hamstring muscle tightness: Reliability of an active knee extension test. *Physical Therapy* 1983; **63:** 1083-1090.
10. Bohannon RW. Cinematographic analysis of the passive straight leg raising test for hamstring muscle length. *Physical Therapy* 1982; **62:** 1269-1274.

11. Webright WG, Randolph BJ, Perrin DH. Comparison of non-ballistic active knee extension in neural slump position and static stretch techniques on hamstring flexibility. *Journal of Orthopaedic and Sports Physical Therapy* 1997; **26(1):** 7-13.
12. Bandy WD, Irion JM, Briggler M. The effect of time and frequency of static stretch on flexibility of the hamstring muscles. *Physical Therapy* 1997; **77:** 1090-1096.
13. Kuo L, Chung W, Bates E, Stephen J. The hamstring index. *Journal of Paediatric Orthopaedics* 1997; **17(1):** 78-88.
14. Christine E. Back pain re-visited. *Journal of Orthopaedics and Sports Physical Therapy* 1987; **8(12):** 230-234.
15. Marras WS. Flexibility and velocity of the normal and impaired lumbar spine. *Archives of Physical Medicine and Rehabilitation* 1986; **67:** 1865-1869.
16. Wendell L. Unresolved controversies in back management. *Journal of Orthopaedic and Sports Physical Therapy* 1988; **9(7):** 1213-1216.
17. Akinpelu AO, Sokunbi OG. Hamstring tightness and low back pain. *Journal of Clinical Sciences* 2002; **3(1):** 7-12.
18. Barry O, Peter F, Michael K. Steven S. *Sports Injuries*. 2nd Edition. Boston: Pitman. 1985; 43-35.
19. Heyward VH. *Advanced Fitness and Exercise Prescription*. 2nd Edition. London: W.B. Saunders Co. 1991; 23-27.
20. De Veries HA. *Physiology of Exercise for Physical Education and Athletics*. 4th Edition. Dubuque: A. William and C. Brown Co. 1986; 47-52.
21. Relly T. *Sports Fitness and Sports Injuries*. London: Butterworth and Heinemann. 1992; 38-43.