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Comparison of back saver sit and reach test and modified back saver and reach test as a measurement of hamstring flexibility in female college student

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Abstract. An observational study was done to compare two different Sit and Reach Test as a measurement of hamstring flexibility in the female college students. The purpose of the study was to determine the relationship between the two different types of Sit and Reach tests and hamstring flexibility because the test is used as a measure of hamstring flexibility in young females. *Methods*: Goniometric measurements, Back Saver Sit and Reach Test and Modified Back Saver Sit and Reach Test, were performed and scores were recorded. After that, subjects were asked to perform a 5 minute warm up and static stretch routine in which subjects had to do 2 minutes of jogging followed by rest period for one minute and again subjects were asked to do jogging for next 2 minutes, emphasizing lower body. Immediately after which, the flexibility tests were performed a counter-balanced design. Flexibility tests were performed on the same day with rest period of 20 minutes in between tests. After demonstration, one practice trial and three tests were performed for each of the measures. Average of three tests was used for all tests. *Results*: The results indicate that this Back Saver Sit and Reach Test produce reasonably accurate and stable measures of hamstring flexibility. Moreover, it appears that this test is safe and acceptable alternative to the Sit and Reach test as a measure of hamstring flexibility in young females. *Conclusion*: Our analysis indicated that the BSSR tests were highly related to hamstring flexibility. In contrast, the MBSSR test was not related to hamstring flexibility for either the right or left leg (r= 0.38 and 0.40 respectively). These findings show that BSSR test is valid for measuring hamstring flexibility. The MBSSR test detected individual differences in the flexibility of hamstrings of these female students. Thus, the results confirm that BSSR test measures hamstring flexibility better than MBSSR in young female subjects.
Key words: *testing, hamstring, flexibility.*

Introduction

The word flexibility is derived from the Latin word, flectere or flexibilis, to bend, and is defined as the ability to bend, pliable (1). In physical education, sports medicine and allied health sciences, perhaps the simplest definition of flexibility is the range of motion available in a joint or group of joints (1).

Flexibility is the absolute range of movement in a joint or series of joints that is attainable in a momentary effort with the help of partner or a piece of equipment. This definition tells us that flexibility is not something general but is specific to a particular joint or a set of joints. Being flexible in one particular area or joint does not imply being flexible in another (1).

The ability to readily adapt to change in position or alignment may to express as normal, limited or excessive (2). Flexibility is the ability to move a single joint or series of joints smoothly and easily through an unrestricted, pain free range of motion(3). Determinants of musculoskeletal flexibility (4): viscoelastic properties, cross-sectional area, EMG and stretch tolerance.

Differences among flexibility, hypo-mobility, joint laxity and joint instability (1-4): *flexibility* - commonly refers to range of motion of a joint; *laxity* - refers to the stability of a joint. Excessive joint laxity can be result of a chronic injury or a congenital or hereditary condition, such as Ehlers-Danlos Syndrome (EDS); *joint instability* - refers to as joint derangement and dysfunction resulting from a loss of joint stability. It is characterized by increased or normal range of motion, increased proportion or aberrant translational movements and aberrant coupled movements; *joint hyper-mobility* – is associated with an increased range of motion, normal ratio of translational movements and normal coupled movements.

Different types of flexibility are (1): *dynamic flexibility*/*kinetic flexibility* – Is the ability to perform dynamic / kinetic movements of the muscles to bring a limb through its full range of

motion in the joints; *static- active flexibility/ active flexibility* – is the ability to assume and maintain extended positions using only the tension of the agonists and synergists while the antagonists are being stretched. For example, lifting the leg and keeping it high without any external support (other than your own leg muscles); - is the ability to assume extended positions and then maintain them using only *static - passive flexibility / passive flexibility* your weight, the support of your limbs, or some other apparatus (such as a chair).

Research has shown that active flexibility is more closely related to the level of sports achievements than is passive flexibility. Active flexibility is harder to develop than passive flexibility; not only does active flexibility require passive flexibility in order to assume an initial extended position, it also requires muscle strength to be able to hold and maintain that position (1).

In 1952, Wells and Dillon introduced the sit and reach flexibility test as a field test. This test is present in most health related fitness test batteries. There are many versions of the sit and reach test, including Back Saver Sit and Reach Test and Modified Back Saver Sit and Reach Test. All Sit and Reach Test protocols yield moderate validity for hamstring flexibility and poor validity for lower back flexibility. The most common assumption when interpreting sit and reach flexibility test results is that subjects with better scores possess a higher degree of trunk and hip flexibility than those with lower scores.

The interest in researching the hamstring muscle and the measurement of its length is due to the possible dysfunctions and lesions caused by alteration in its flexibility. Not only are there injuries caused by the muscle itself, there are also biomechanical alterations that may lead to femoro - patellar dysfunctions, pubic and lumbar pain, acute and chronic musculoskeletal injuries, gait limitations, tendonitis, postural deviations and risk of falling. Although the two variations of sit and reach test; Back Saver Sit and Reach Test and Modified Back Saver Sit and Reach Test; are generally considered acceptable filed test measures of hamstring flexibility for most age groups, there are no studies of which is the best technique (5).

Material and Methods

A sample of 40 healthy females was taken as a part of the study. The subjects for this study were taken from various colleges and institutes.

Inclusion Criteria: age group 20-24 years; no musculoskeletal disorders; no history of low backache in last 3 months; asymptomatic healthy females; no neurological disorders; no psychiatric and psychological disorders. *Exclusion Criteria*: subjects with musculoskeletal disorders that would limit performance in these tests; subjects with low backache that would limit performance in these tests; all contraindications of stretching; subjects having apparent and true length shortening; athletes.

Design. study was observational in nature to compare two different Sit and Reach Test as a measurement of Hamstring flexibility in the female college students. *Instrumentation*: sit and Reach box; measuring scale; a 12 inch high table or bed; universal goniometer; wrist watch

Protocol

1. Back saver sit and reach test (BSSR)

The test was administered using a Sit Reach Box. The participant sat at the sit and reach box and fully extended one leg so that the sole of the foot was flat against the end of the box. Subject then bent the other leg so that the sole of the foot was flat on the floor and 7 – 10 cm to the side of the straight knee. With the extended leg as straight as possible, hands on top of each other (tips of the middle fingers even) and palms down, the participant slowly reached forward sliding the hands along the box scale as far as possible. The physiotherapist recorded the average of the three trials on each leg.

2. Modified back saver sit and reach test (MBSSR)

Participant sit on a 12 inch high table with shoes off and keep one leg extended (whose hamstrings length is to be measured) on the table such that 15 inch mark came at heel level, and other leg below the table such that its sole touches the floor. Now participant keeps her hands on top of each other with palms down and slides her fingertips along the measuring stick or scale that is set on the table. MBSSR of right side is considered when right leg is extended. MBSSR of left leg is considered when left leg is extended. The physiotherapist recorded the average of the three trials on each leg.

Procedure

The purpose of the study was explained to the subjects. The subjects were encouraged to participate in the study. Subjects were taken into the study only if they met the inclusion criteria. The study was initiated only after taking an informed consent from the subjects.

Verbal description of the procedure was given to the subjects.
Demographic data was collected which included age, height and weight.
Goniometric measurements, Back Saver Sit and Reach Test and Modified Back Saver Sit and Reach Test, were performed and scores were recorded.
After that, subjects were asked to perform a 5 minute warm up and static stretch routine in which subjects had to do 2 minutes of jogging followed by rest period for one minute and again subjects were asked to do jogging for next 2 minutes, emphasizing lower body. Immediately after which, the flexibility tests were performed a counter-balanced design. Flexibility tests were performed on the same day with rest period of 20 minutes in between tests. After demonstration, one practice trial and three tests were performed for each of the measures. Average of three tests was used for all tests. Data collected was recorded in data collection form.
The pre and post intervention outcome measures (BSSR RT, BSSR LT, MBSSR RT, MBSSR LT, SLR RT and SLR LT) were summarized in table I and also shown graphically from graphic 1 to graphic 9.

Table 1. Pre and post intervention summary (Mean ± SD, n=40) of different outcome measures

Outcome measures	Pre intervenetion	Post intervenetion	Mean change (Post-Pre)	t value	p value	% mean change (Post-Pre)
BSSR RT	6.18 ± 2.91 (0.58-10.21)	7.38 ± 3.03 (1.41-12.00)	1.20 ± 0.78 (0.10-3.10)	9.71	p<0.0001	19.5%
BSSR LT	6.01 ± 2.82 (0.66-11.20)	7.11 ± 2.98 (0.91-12.33)	1.09 ± 0.61 (0.03-2.77)	11.30	p<0.0001	18.2%
MBSSR RT	13.89 ± 2.73 (7.36-17.92)	15.25 ± 2.91 (8.26-19.96)	1.36 ± 1.29 (0.30-7.95)	6.64	p<0.0001	9.8%
MBSSR LT	13.57 ± 2.56 (8.86-18.51)	14.74 ± 2.60 (9.23-19.38)	1.17 ± 0.80 (0.20-4.02)	9.29	p<0.0001	8.6%
SLR RT	59.91 ± 13.71 (32.33-80.66)	67.20 ± 13.59 (39.66-88.32)	7.29 ± 2.98 (2.66-14.56)	15.49	p<0.0001	12.2%
SLR RT	58.98 ± 13.21 (31.00-86.30)	65.74 ± 12.09 (43.00-88.33)	6.76 ± 4.05 (0.66-15.36)	10.55	p<0.0001	11.5%

*Numbers in parenthesis represents the data range

Table I showed that pre intervention BSSR RT levels of all 40 subjects ranged from 0.58-10.21 with mean (± SD) 6.18 ± 2.91 while at post intervention it ranged from 1.41-12.00 with mean (± SD) 7.38 ± 3.03. Table 1 and Fig. 1 both showed that BSSR RT level increased after the intervention. On comparing, BSSR RT level was found to be significantly high at post intervention as compared to pre intervention (6.18 ± 2.91 vs. 7.38 ± 3.03, t=9.71; p<0.0001). In other words, after intervention, BSSR RT level increased by 19.5% (1.20 ± 0.78) as compared to pre intervention.

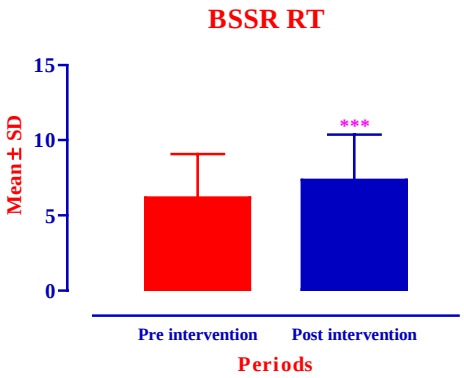

Figure 1. Pre- and post intervention BSSR RT levels (p<0.001)

Table I showed that pre intervention BSSR LT levels of all 40 subjects ranged from 0.66-11.20 with mean (± SD) 6.01 ± 2.82 while at post intervention it ranged from 0.91-12.33 with mean (± SD) 7.11 ± 2.98.

Table 1 and Fig. 2 both showed that BSSR LT level increased after the intervention. On comparing, BSSR LT level was found to be significantly high at post intervention as compared to pre intervention (6.01 ± 2.82 vs. 7.11 ± 2.98, t=11.30; p<0.0001). In other words, after intervention, BSSR LT level increased by 18.2% (1.09 ± 0.61) as compared to pre intervention.

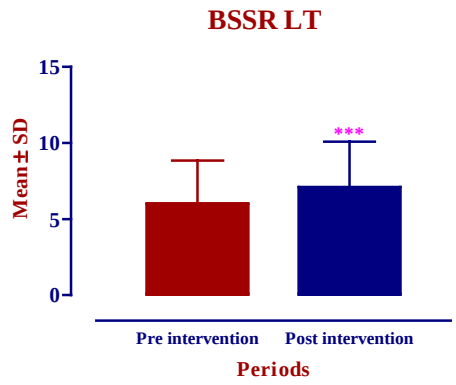

Figure 2. Pre and post intervention BSSR LT levels (p<0.001)

From table I it was evident that BSSR RT (19.5%) improved slightly more (1.07 times) than the BSSR LT (18.2%). On comparing, the improvement of both BSSR RT and BSSR LT was found to be similar (1.20 ± 0.78 vs. 1.09 ± 0.61, t=0.76; p=0.4844) i.e. did not differed significantly (fig. 3).

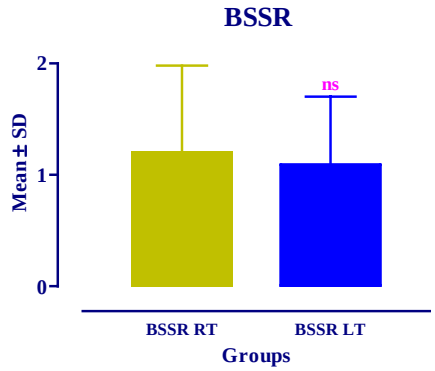

Figure 3. The improvement in BSSR RT and BSSR LT (p>0.05)

Table I showed that pre intervention MBSSR RT levels of all 40 subjects ranged from 7.36-17.92 with mean (± SD) 13.89 ± 2.73 while at post intervention it ranged from 8.26-19.96 with mean (± SD) 15.25 ± 2.91. Table 8.1 and Graph 4 both showed that MBSSR RT level increased after the intervention. On comparing, MBSSR RT level was found to be significantly high at post intervention as compared to pre intervention (13.89 ± 2.73 vs. 15.25 ± 2.91, t=6.64; p<0.0001). In other words, after intervention, MBSSR RT level increased by 9.8% (1.36 ± 1.29) as compared to pre intervention.

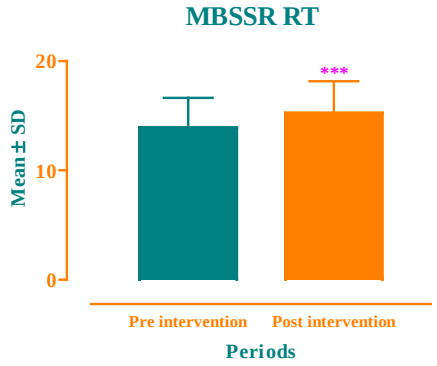

Figure 4. Pre- and Post intervention MBSSR RT levels (p<0.001)

Table I showed that pre intervention MBSSR LT levels of all 40 subjects ranged from 8.86-18.51 with mean (± SD) 13.57 ± 2.56 while at post intervention it ranged from 9.23-19.38 with mean (± SD) 14.74 ± 2.60. Table 1 and Graph 5 both showed that MBSSR LT level increased after the intervention. On comparing, MBSSR LT level was found to be significantly high at post intervention as compared to pre intervention (13.57 ± 2.56 vs. 14.74 ± 2.60, t=9.29; p<0.0001). In other words, after intervention, MBSSR LT level increased by 8.6% (1.17 ± 0.80) as compared to pre intervention.

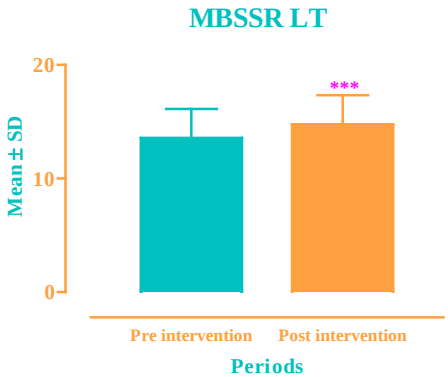

Figure 5. Pre- and post intervention BSSR LT levels (p<0.001)

From Table 1, it was evident that MBSSR RT (9.8%) improved slightly more (1.13 times) than the MBSSR LT (8.6%). On comparing, the improvement of both MBSSR RT and MBSSR

LT was found to be similar (1.36 ± 1.29 vs. 1.17 ± 0.80, t=0.79; p=0.4310) i.e. did not differed significantly (Graph 6).

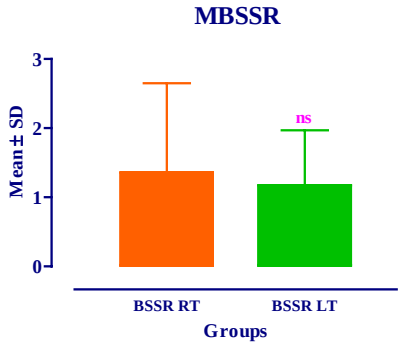

Figure 6. Improvement in MBSSR RT and MBSSR LT (p>0.05)

Table I showed that pre intervention SLR RT levels of all 40 subjects ranged from 32.33-80.66 with mean (± SD) 59.91 ± 13.71 while at post intervention it ranged from 39.66-88.32 with mean (± SD) 67.20 ± 13.59. Table 1 and Graph 7 both showed that SLR RT level increased after the intervention. On comparing, SLR RT level was found to be significantly high at post intervention as compared to pre intervention (59.91 ± 13.71 vs. 67.20 ± 13.59, t=15.49; p<0.0001). In other words, after intervention, SLR RT level increased by 12.2% (7.29 ± 2.98) as compared to pre intervention.

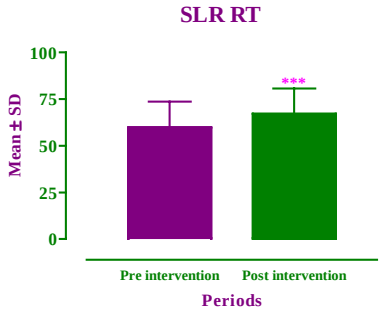

Figure 7. Bar graph shows pre and post intervention MBSSR RT (<0.001)

Table I showed that pre intervention SLR LT levels of all 40 subjects ranged from 31.00-86.30 with mean (± SD) 58.98 ± 13.21 while at post intervention it ranged from 43.00-88.33 with mean (± SD) 65.74 ± 12.09. Table 1 and Graph 8 both showed that SLR LT level increased after the intervention. On comparing, SLR LT level was found to be significantly high at post intervention as compared to pre intervention (58.98 ± 13.21 vs. 65.74 ± 12.09, t=10.55; p<0.0001). In other words, after intervention, SLR LT level increased by 11.5% (6.76 ± 4.05) as compared to pre intervention.

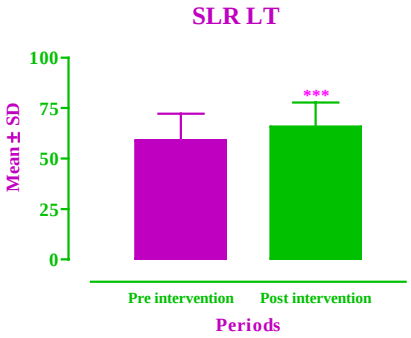

Figure 8. Bar graph shows pre and post intervention BSSR LT levels (p<0.001)

From table I, it was evident that SLR RT (12.2%) improved slightly more (1.06 times) than the SLR LT (11.5%). On comparing, the improvement of both SLR RT and SLR LT was found to be similar (7.29 ± 2.98 vs. 6.76 ± 4.05, t=0.67; p=0.5070) i.e. did not differed significantly (fig. 9).

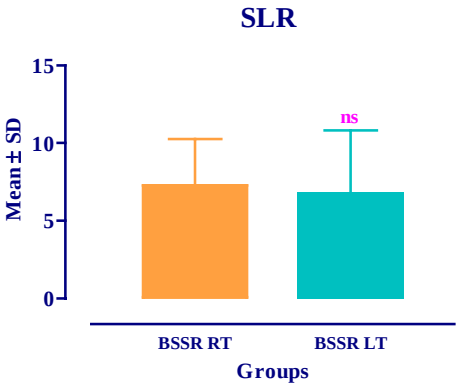

Figure 9. Bar graph shows improvement in SLR RT and SLR LT (ns- p>0.05)

To find out intervention effect of BSSR and MBSSR on SLR, a correlation between outcome measures were done and summarized in Table 8.2. Table 8.2 showed that BSSR RT intervention positively and significantly correlated with both SLR RT (r=0.61, p<0.001) and LT (r=0.65, p<0.001). Similarly, BSSR LT intervention also correlated positively and significantly with both SLR RT (r=0.64, p<0.001) and LT (r=0.68, p<0.001). In contrast, MBSSR RT intervention did not correlate well with both SLR RT (r=0.28, p>0.05) and LT (r=0.26, p>0.05).
However, MBSSR LT intervention showed positive and significant correlation with both SLR RT (r=0.37, p<0.05) and LT (r=0.42, p<0.01).

Table II. Correlation (n=40) between outcome measures at post intervention

Variables	BSSR RT	BSSR LT	MBSSR RT	MBSSR LT	SLR RT	SLR LT
BSSR RT	1.00					
BSSR LT	0.93***	1.00				
MBSSR RT	0.64***	0.53***	1.00			
MBSSR LT	0.73***	0.70***	0.80***	1.00		
SLR RT	0.61***	0.64***	0.28ns	0.37*	1.00	
SLR LT	0.65***	0.68***	0.26ns	0.42**	0.88***	1.00

ns- p>0.05,*- p<0.05, **- p<0.01, ***- p<0.001

Key words tables and graphs: SLR (R) – Straight Leg Raise Test of Right Leg; BSSR (R) – Back Saver Sit & Reach Test of Right Leg; MBSSR (R) – Modified Back Saver Sit & Reach Test of Right Leg; SLR (L) – Straight Leg Raise Test of Left Leg; BSSR (L) - Back Saver Sit & Reach Test of Right Leg; MBBR (L) – Modified Back Saver Sit & Reach Test of Right Leg

Discussion

Although the Sit and Reach Test, Back Saver Sit, Reach Tests are the most commonly used field measures of hamstring flexibility in current fitness test batteries, the Sit and Reach Test, Back Saver Sit, Reach Tests have inherent limitations for adults with low back problems or who have difficulty sitting on a level surface with legs extended. Therefore, the MBSSR test was proposed as an alternative for assessing hamstring flexibility in elderly people.

The purpose of this study was to determine the relations between the two different types of Sit and Reach tests and hamstring flexibility because the test is used as a measure of hamstring flexibility in young females.

Our analysis indicated that the BSSR tests were highly related to hamstring flexibility. In contrast, the MBSSR test was not related to hamstring flexibility for either the right or left leg (r= 0.38 and 0.40 respectively). These findings show that BSSR test is valid for measuring hamstring flexibility. The MBSSR test detected individual differences in the flexibility of hamstrings of these female students. These results support the findings of Jackson and Baker and Chung and Yuen. However, they concluded that hamstrings flexibility can only be measured by the traditional SR test, but we have provided evidence that the BSSR test measure hamstring flexibility better than MBSSR in young female subjects.

G Baltaci et all (5) showed that the Back Saver Sit and Reach Test for the left (p<0.01) and right (p<0.05) leg was significantly associated with hamstring flexibility (r=0.37 and 0.25 for the left leg and 0.50 and 0.40 for the right leg respectively). They concluded that the Back Saver Sit and Reach Test produce reasonably accurate and stable measures of hamstring flexibility. Moreover, it appears that this test is a safe and acceptable alternative to the traditional and chair sit and reach test as a measure of hamstring flexibility in young women.

However, Hui SS and Yuen PY (6) studies have shown that the classical sit and reach test (CSR), the modified sit and reach test (MSR) and the newly developed Back Saver Sit and Reach Test (BSSR) have poor criterion related validity in estimating low back flexibility but yield moderate criterion related validity for hamstring flexibility. MBS yielded significant and highest ‘r’ with low back and hamstring flexibility for men (r=0.47-0.67) and women (r=0.23-0.54). The low back and right hamstring validity for MBS for men were significantly (P<0.01) higher than those from BSSR and CSR, whereas no differences in criterion related validity were found between the MBS and other protocols in women.

From multiple regression analysis, Jackson and Langford (7) suggested that the combination of flexibility in both hamstrings and lower back contributed to the reported variation in test scores. However, testing subjects of a wide age range, as was done by Jackson and Langford, is questionable.

The low MBSSR reliability values for the young women in this study were not similar to the SR and BSSR values reported in other studies, with ‘r’ coefficients for the left and right leg in all cases consistently being 0.23 and 0.16 respectively.

No participants were eliminated because of their inability to perform the MBSSR test. Also, because of our emphasis on careful checking of the participants in this study, none fell backwards during the tests or were in an incorrect position. No injuries occurred during MBSSR testing. Careful monitoring is recommended when assessing frail participants or those with balance problems.

Conclusion

The results indicate that this Back Saver Sit and Reach Test produce reasonably accurate and stable measures of hamstring flexibility. Moreover, it appears that this test is safe and acceptable alternative to the Sit and Reach test as a measure of hamstring flexibility in young females. Therefore, results have proved the alternative hypothesis as positive.

Limitation of the study

Due to practical circumstances, I was unable to observe larger age group sample. Motivation of subjects played a very important role in the treatment. Subjects who had musculoskeletal problems majorly low back ache patients did not follow the treatment regime properly. Sample of study is small and taken from a limited area. Study also did not include male subjects and athletes.

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