Correlation between hamstring muscle tightness and incidence of low back pain in female students at Jouf University, Saudi Arabia

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Abstract. – OBJECTIVE: The current study aimed at determining the difference in hamstring tightness between dominant and non-dominant legs and to detect the correlation between LBP and hamstring tightness.

PATIENTS AND METHODS: One hundred females with hamstring tightness of at least 15 degrees have been included in the study. Hamstring shortening was examined by the Active Knee Extension test (AKE) and Straight Leg Raising test (SLR), whilst the functional disability' degree was measured by Oswestry Disability Index (ODI).

RESULTS: The straight leg raising and the AKE of the dominant leg were significantly more flexible than the non-dominant ones. There was a weak positive non-significant correlation between ODI and AKE of the dominant side (r = 0.162, *p* = 0.1) and the non-dominant side (r = 0.071, *p* = 0.48). There was a weak negative non-significant correlation between ODI and SLR of the dominant side (r = - 0.29, *p* = 0.77) and the non-dominant side (r = - 0.53, *p* = 0.6).

CONCLUSIONS: There was no relation between the degree of hamstring tightness and LBP in female students at Jouf University.

Key Words:
Hamstring tightness, Mechanical low back pain, Students, Straight leg raising test, Active knee extension test.

Introduction

The hamstrings are made up of three different elements that are all located in the region of the back of the thigh. They are semitendinosus, semimembranosus medially, and the long head of biceps femoris laterally. The hamstrings are located between the hip and the knee[1]. All of these muscles originate from the ischial tuberosity, semitendinosus and long head of biceps femoris have a common tendon. The length of the medial portions (semitendinosus and semimembranosus) reaches approximately 44.3 and 38.7cm, respectively[2].The semitendinosus inserts into the medial condyle of the tibia through the pes anserinus tendon, the semimembranosus inserts into the posterior aspect of the tibial medial condyle as well[3].

The predominance of tightness is greater in female 96% than in male 4%. Its incidence is high in university students from 18-25 years[4]. A risk factor for occurrence of tendinopathy in patella, hamstring pain in patella femoral injury and signs of muscle injury after eccentric exercise is reduced flexibility of the hamstring[5]. It can lead to disturbance of the knee biomechanics, as well as hip, ankle reaction forces and mechanics[6].

As a result of tightness of the hamstrings, tilting of the pelvis posteriorly and reduction in

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lumber lordosis can be elicited, which can cause low back pain (LBP)[7,8]. LBP induces hamstring muscle reflex tightness and is related to the everyday life practices of the patient or their work activities or posture. LBP patients generally have tightness in the hamstrings that are not correlated with work conditions and lifestyles with lack of physical activity[9]. The common term that relates to any form of back pain triggered by putting abnormal tension and stress on the vertebral column muscles is mechanical pain[10,11]. Mechanical discomfort usually arises from bad behaviours when the muscles of the lower spine and the hamstring muscles contract, such as poor posture, incorrectly constructed chairs, and improper bending and lifting movements[12,13]. In flexed position, the spinal curve in lumbar region is supported by the hamstrings. In case of tightness of the hamstrings, more flexion is produced at the spine in lumbar region during slumped position, which eventually results in LBP and reasonable injury[14].

Literature on whether the hamstring tightness related to mechanical LBP among students is limited. So, the current study was aimed to investigate the correlation between the degree of hamstring tightness and mechanical low back pain in female students of Jouf University and to detect if the dominant and non-dominant legs have different levels of hamstring tightness.

Patients and Methods

Participants

One hundred female students with shortening in the hamstrings were recruited from Jouf University to participate in the present study from February 2020 to August 2020. Participants were chosen according to the following inclusion criteria: their age ranged from 18 to 24 years, sedentary lifestyle, including prolonged sitting on the chair for 6 hours/day minimally for at least 5 days/week for minimum 6 months, and finally with at least 15° loss of the knee extension during AKE test and during active SLR test.

Participants with severe spinal disorders, such as disc prolapse and radiating pain, any systemic disease, history of hamstring injury within the last 2 years, previous knee injury, fracture in the spine or lower limb, infected spine, spinal surgery, pregnancy, congenital deformity, leg length discrepancy more than 2cm, psychological disorder or obesity were excluded from the study.

The present study was approved by the Ethical Committee of Jouf University (Saudi Arabia) (No: 08-06/41), it was performed according to the principles of the Declaration of Helsinki. All participants signed a written informed consent before the examination. Instructions, objectives, and steps of the procedure were explained for each participant.

Procedures

Before starting the test, information regarding the height, weight and the dominance of the lower extremity (by asking about the leg used for ball kicking) were collected. Examination performed by the same examiner, the same goniometer at the same examination environment and the same procedures for better accuracy.

AKE Test

It is a procedure that evaluate the tightness of hamstrings. Participants were asked to lie in the supine position on a plinth while keeping extension in both lower limbs. Pillows were used to adjust both the anterior superior iliac spines. The untested lower limb was secured to the plinth with one examiner by putting her hands over the lower third of the thigh. The participants were asked to flex the hip and knee to 90° until the thigh and leg came in contact with the pillows. Another examiner asked participants to raise the knee in extension position as much as possible and maintain it for approximately 5 seconds while keeping the foot relaxed. The joint axis was marked for the placement of a universal goniometer with its arms fixed parallel to the femur and tibia[15,16].

The examiner asked the participant to move their feet downward and maintain a relaxed plantar flexed position[17,18]. So, the pressure on the neural structures in the posterior aspect of the lower limb is decreased and the gastrocnemius passive insufficiency is avoided[19]. Measurement of this test was known as the knee flexion degree from the last knee extension. Each knee angle was measured for three times, with 1 minute rest between trials, calculating the mean to use it for the analysis of the AKE test[15].

SLR Test

To apply this test a table for examination was used. Participants were instructed to assume a supine position and maintain relaxed during the test. The participant actively flexed the tested limb, while keeping the knee extended and foot relaxed. The examiner secured the contralateral limb in full extension and hip in neutral rotation. As soon as the participant felt strong stretch along the posterior aspect of the thigh, the movement was stopped. Another examiner applied the goniometer over the hip's greater trochanter, with the movable arm aligned with the lateral femoral condyle and the stationary arm aligned parallel to the midaxillary line[20]. Measurement was done for three times, with 1 minute rest between trials and the mean value was included in the statistical analysis.

ODI Assessment

It is a self-assessment questionnaire formed of 10-items, each with 6 levels of responses that can be graded from 0 to 5. These items include pain, personal care, lifting and moving objects, walking, sitting, standing, sleep disorders, sex life, social life, and traveling. The total score represented by the percentage of disability can be calculated as (the obtained score divided by 50 and multiplied by 100). The following scores are used to measure the response to this scale: from 0 to 20% (minimal disability); from 20 to 40% (moderate disability); from 40 to 60% (severe disability); from 60 to 80% (crippled) and more than 80% (the subject is restricted to bed)[21].

The Arabic version of the ODI which has been adapted to the Saudi population has excellent metrological qualities. With a similar number of items as the original version, the appearance validity and structure validity were strong[22].

Statistical Analysis

Quantitative variables were summarized using mean and standard deviation while categorical variables were summarized using frequencies and percentage. Spearman correlation coefficient was conducted to investigate the correlation between ODI, AKE and SLR. Paired *t*-test was conducted for comparison of AKE and SLR between the dominant and non-dominant sides. The level of significance for all statistical tests was set at $p< 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 25 for windows (IBM Corp., Armonk, NY, USA).

Results

Subjects' Characteristics

100 female subjects participated in this study. The mean ± SD age and BMI of the study group were 20.87 ± 1.19 years and 23.43 ± 4.09 kg/m^2 respectively. 95% had the right side dominant and 5% had the left side dominant. Table I showed the subject characteristics.

AKE, SLR and ODI of the Study Group

The mean ± SD AKE of the dominant and non-dominant legs was 25.17 ± 7.1 and 25.93 ± 7.34 degrees, respectively. The mean ± SD SLR of the dominant and non-dominant legs was 19.83 ± 8.76 and 22.03 ± 9.23 degrees, respectively. The mean ± SD ODI was 4.84 ± 5.65 as detailed in Table II.

Comparison of AKE and SLR Between the Dominant and Non-Dominant Sides

There was a significant decrease in AKE and SLR of the dominant side compared with that of the non-dominant side ($p < 0.05$) as described in Table III and Figure 1.

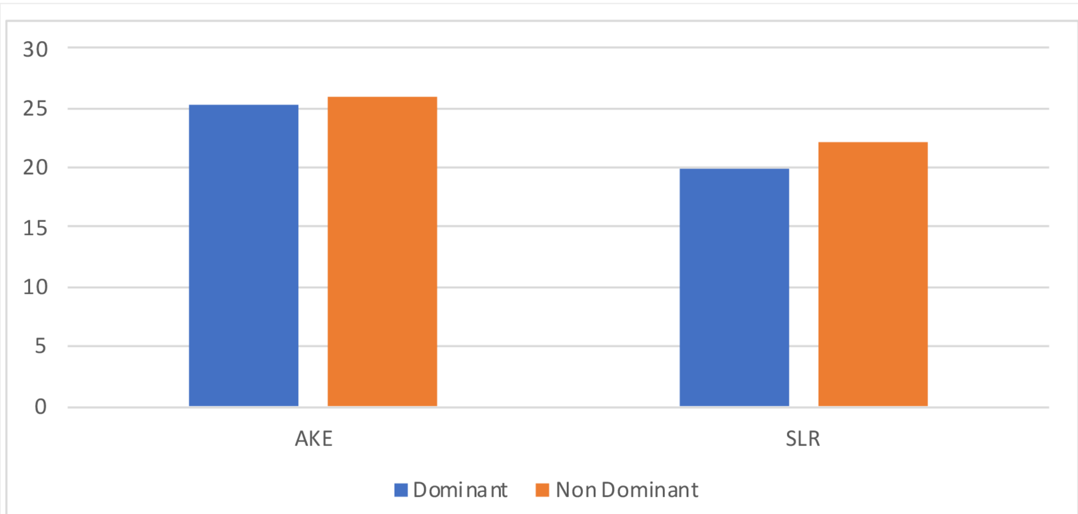

Figure 1. Comparison of AKE and SLR between the dominant and non-dominant sides.

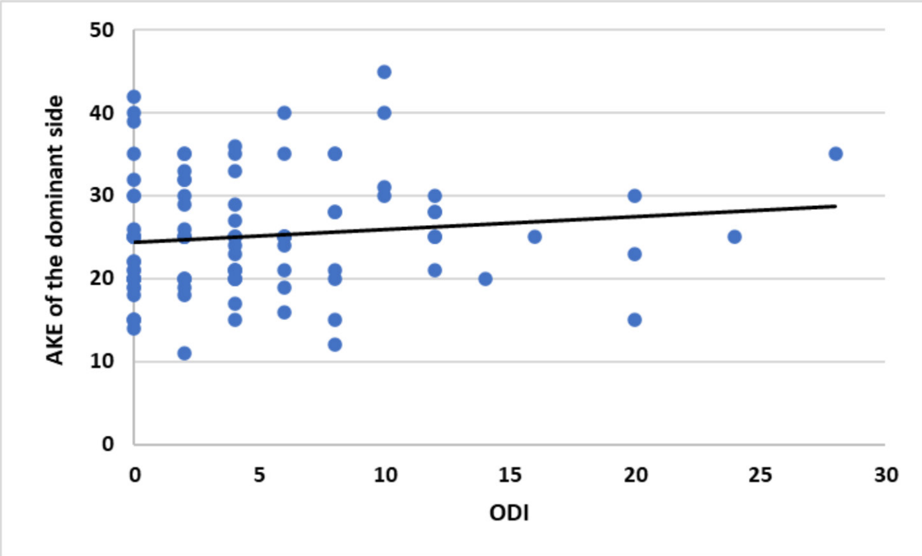

Figure 2. Correlation between ODI and AKE of the dominant side.

Relationship Between ODI, AKE and SLR

There was a weak positive non-significant correlation between ODI and AKE of the dominant side (r = 0.162, p = 0.1) and the non-dominant side (r = 0.071, p = 0.48) as shown in Figures 2 and 3. There was a weak negative non-significant correlation between ODI and SLR of the dominant side (r = -0.29, p = 0.77) and the non-dominant side (r = -0.53, p = 0.6). as described in Table IV and Figures 4 and 5.

Discussion

The hamstrings are located on the posterior aspect of the thigh and connect the lower pelvis to the lower extremity; its action is extension of hip joint and flexion of knee joint. The upper portion of the pelvis is connected to the vertebral column by different muscle groups[23]. These muscles are present along the spine and are responsible for spine posture, stabilization and motion. Tightness of the hamstrings limit the motion in the pelvis. As a result of pelvic motion limitation, low back muscles will become tight as well, eventually contributing to LBP[24].

People working in jobs that include lifting heavy loads have the highest frequency of LBP (50.00%), people with sitting jobs (19.09%), standing jobs (16.36%), then squatting for long time (14.54%). The spine bends only about 45 degrees forward during lifting, with the rest of the range occurring at the pelvic level. As a result, when straightening the spine to carry the objects, the pelvis must roll backward while the spine remains flexed[25].

Our results revealed that there is negative correlation between shortening of the hamstring muscles in female students and low back pain, as this may be explained by the nearly ideal body mass index of these students. As additional weight accumulates around the belly abdomen, an increase in the lumbar spinelordosis develops to keep the upright posture and the centre of weight moves posteriorly and travels through the facet joints. There is also stretching of the anterior longitudinal ligament, proximity of pedicles and facet joints to each other, entrapment of nerve roots and eventually low back pain. Despite the fact that the current study found no relation between hamstring tightness and low back pain, regular physical exercise would help to improve rotation of the pelvis and the range of trunk flexion by promoting healthy hamstring muscle function.

Table I. Participant characteristics.

	Mean ± SD
Age (years)	20.87 ± 1.19
Weight (kg)	58.22 ± 11.36
Height (cm)	157.58 ± 5.19
BMI (kg/m²)	23.43 ± 4.09

SD: Standard deviation.

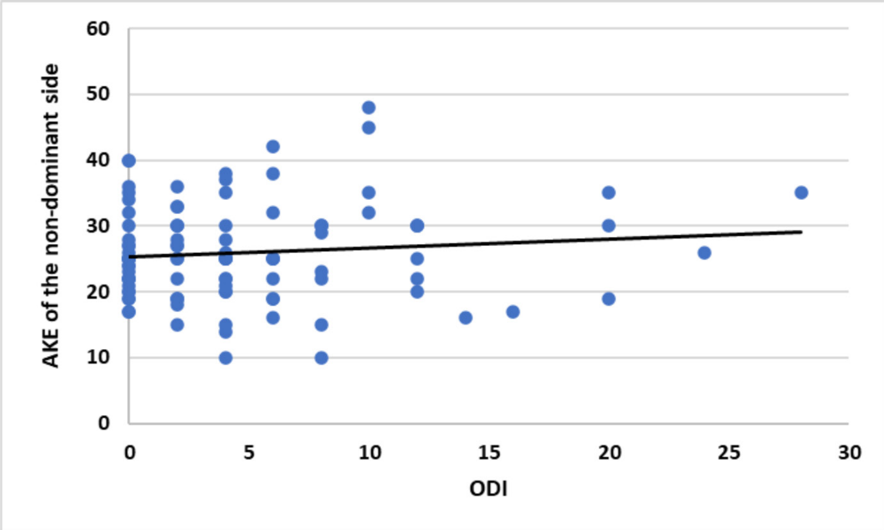

Figure 3. Correlation between ODI and AKE of the non-dominant side.

The results of the present study showed that there was a significant difference between dominant and non-dominant side for both AKE (p =0.02) and SLR (p =0.001) tests, with the dominant side having less hamstring tightness than the non-dominant side at the level of knee and hip. Our results come in accordance with the results of Radwan et al[26], who found that the hamstring of the non-dominant lower extremity was tighter than that of the dominant lower extremity[26].

The relationship between ODI and AKE of the current study showed a weak positive and non-significant correlation in the dominant and non-dominant sides. Similar to our result, a study by Koley and Likhi[27] who investigated the link between hamstring tightness and LBP, found that there is no link between hamstring flexibility and LBP, while sufficient physical activity could promote healthy hamstring muscle function for improved pelvic rotation and forward bending range. Successful knee extension of both the right and left legs had negative associations with LBP and impairment percent. These correlations were not statistically significant[27].

Table II. AKI, SLR and ODI of the study group.

	Mean ± SD
AKE of the dominant side	25.17 ± 7.1
AKE of the non-dominant side	25.93 ± 7.34
SLR of the dominant side	19.83 ± 8.76
SLR of the non-dominant side	22.03 ± 9.23
ODI	4.84 ± 5.65

SD: Standard deviation.

In addition, the relationship between ODI and SLR showed a weak negative non-significant correlation in both sides. A study by Kellis et al[28], supported these results, in which they found that the correlation between ODI and SLR was moderate negative and non-significant.

Previous studies[29,30] found no correlation between hamstring tightness and mechanical LBP as well. Nourbakhsh and Arab[29] investigated the relationship between 17 mechanical factors and the onset of LBP. LBP was discovered to be unrelated to the length of the abdominal, hamstring, and iliopsoas muscles. Hellsing[30]assessed the

Table III. Comparison of AKE and SLR between the dominant and non-dominant sides.

	Dominant Mean ± SD	Non-dominant Mean ± SD	MD	*t*-value	*p*-value
AKE	25.17 ± 7.1	25.93 ± 7.34	-0.76	-2.21	0.02
SLR	19.83 ± 8.76	22.03 ± 9.23	-2.2	-4.11	0.001

SD: standard deviation; MD: mean difference; p-value: probability value.

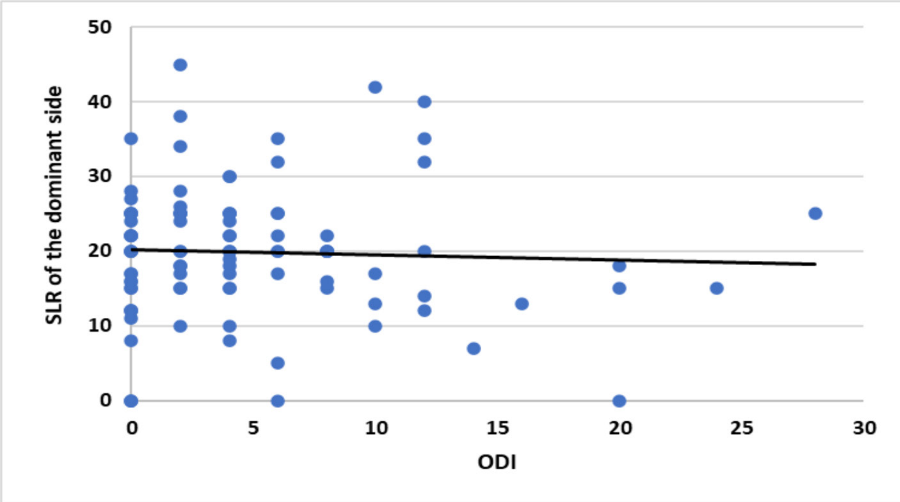

Figure 4. Correlation between ODI and SLR of the dominant side.

tightness of 600 young men's hamstrings. This group was discovered to have a lot of tight hamstring muscles. Over all exams, the test of muscular tightness showed considerable test-retest reliability. Tight hamstring or psoas muscles were not found to be associated with current back pain or the occurrence of back pain over time[30].

Stutchfield and Coleman[31] examined the relationship between LBP, hamstring flexibility, and lumbar flexion in rowers. A total of 26 male collegiate rowers competed. An adjusted SLR technique was used to test hamstring flexibility. LBP patients had decreased lumbar flexion. Although the findings of this study confirm that rowers have a high rate of LBP, they were unable to find a link between this condition and hamstring flexibility[31]. While hamstring flexibility is associated with pelvic rotation and forward bending range, it may not have any influence on lumbar problems, since Bellew et al[32] showed only a non-significant negative connection between hamstring flexibility and LBP.

Johnson and Thomas[33] evaluated the relationship between the tightness of hamstring, hip and lumbar joint movements. They revealed that people with LBP have much tighter hamstrings than people without LBP, implying that hamstring

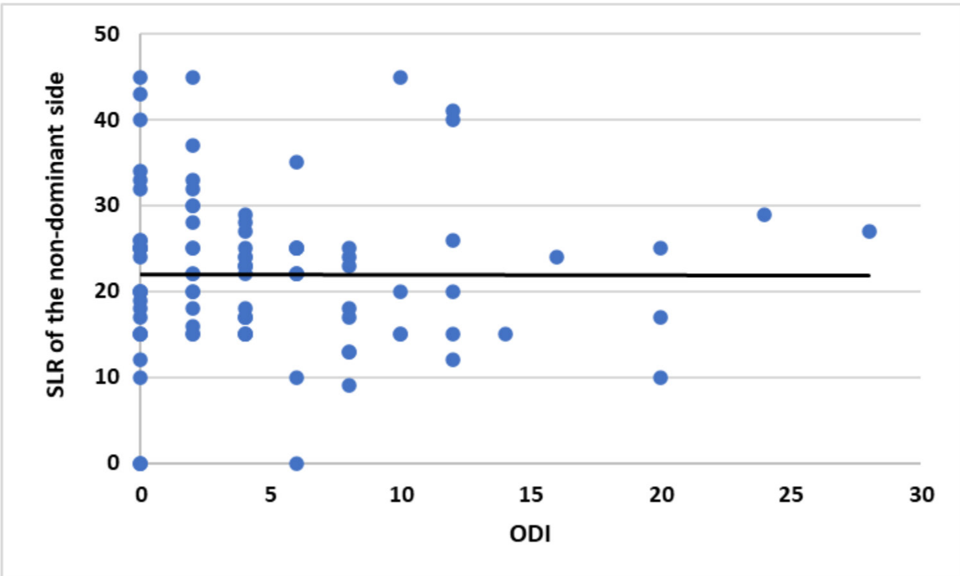

Figure 5. Correlation between ODI and SLR of the non-dominant side.

Table IV. Correlation between ODI, AKE and SLR.

		r	*p*-value
ODI	AKE of the dominant side	0.162	0.1
	AKE of the non-dominant side	0.071	0.48
	SLR of the dominant side	-0.29	0.77
	SLR of the non-dominant side	-0.53	0.6

SD: standard deviation; MD: mean difference; *p*-value: probability value.

flexibility is unrelated to the amount of lumbar flexion required to perform these tasks in these people[33].

Tafazzoli and Lamontagne[34] revealed that the amount of hamstring tightness in people with LBP was significantly higher than in people without LBP. As a result, it is fair to conclude that hamstring tightness and LBP are linked. The stiffness and normalized trunk flexion of the two groups were markedly different. However, there was no difference in the outcome of the SLR and hip damping coefficient between the two groups[34].

In contrast to our findings, previous studies[8,35] show that reduced hamstrings flexibility and the incidence of LBP are correlated. A study by Thakur and Rose[8] explained that in a standing position, the hamstring is associated with pelvic posterior rotation, because it is attached to the ischial tuberosity. Hamstring tightness result in reduced lumbar lordosis by causing a posterior pelvic tilt, which eventually result in LBP[8].

Srinivasan and Nandi[35]compared the flexibility of hamstrings between patients who had LBP and patients who did not. They compared the flexibility between both legs, which provides high clinical significance[35]. The dominant leg mean angle of knee flexion was higher, meaning less flexibility, suggesting it was due to the overuse of the dominant side. The hamstring flexibility was also significantly less in non-specific LBP patients[35].

Pope et al[36]examined the characteristics of 321 males from the age of 18 to 55. He divided them into three groups, 106 never had LBP, 144 experienced moderate LBP, and 71 experienced severe LBP. Patients with LBP frequently had greater limitations with SLR[36].

A study by Esola et al[37], evaluated the forward bending in two groups of subjects. The first group composed of 20 subjects experienced LBP, while the second group composed of 21 subjects didn't experience LBP. The purpose of the study was to measure the amount of motion of lumbar spine and hip during forward bending, then detect the differences between the two groups. They found that hamstring flexibility and motion were significantly related in LBP patients, but not in healthy subjects[37].

Batool et al[38]evaluated the relationship between chronic LBP and tightness of hamstring muscle in workers. They found that subjects with LBP are associated with different jobs, i.e., (high-grade or low-grade jobs, housewife or househusband, peon and sweepers etc.) usually have hamstring tightness[38]. Radwan et al[26]evaluated the difference in hamstring flexibility between the subjects and its association with the severity of LBP. There was a positive correlation between the hamstring tightness and ODI scores, which means the tighter the hamstring muscle the higher the grade of ODI[26].

The present study was limited by different factors: the study included female students only and was limited of age group. In addition, the study did not measure other variables as lumber lordosis and pelvis stability as it may be affected by tightness of hamstring. Further studies are recommended to compare between male and female students at different age groups. Also, different measuring variables as lumbar lordosis and pelvis stability should be recommended in future studies.

Conclusions

The results of the current study showed a non-significant relation between LBP and tightness of hamstring at the level of knee and hip joints. So, stretching to hamstring muscle may not have a role in rehabilitation of students with mechanical LBP.

Conflict of interest
The authors declare no conflict of interest.

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Ethics Approval
The present study was approved by the Ethical Committee of Jouf University (Saudi Arabia) (No: 08-06/41) and it was performed according to the principles of the Declaration of Helsinki.

Informed Consent
All participants signed a written informed consent before the examination. Instructions, objectives, and steps of the procedure were explained for each participant.

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