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## Analysis of Symmetry of Weight-Bearing in Athletes With and Without Low Back Pain during Gait

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### ABSTRACT

**Background.** Low Back Pain (LBP) is a prevalent phenomenon in athletes and asymmetrical loading on the limbs has been proposed as a risk factor related to this disease. **Objectives.** The purpose of the present study was to compare the asymmetry of loading applied on the legs between men with and without LBP during gait. **Methods.** A total of 40 participants, comprising 20 men with non-specific LBP who practiced martial arts and 20 men without LBP, participated in the study. The participants walked in gait lab and forces applied on the legs were recorded in three dimensions using a force plate. Also, asymmetry of the forces applied on the dominant and non-dominant limbs was measured. **Results.** The Asymmetry Indexes (ASI) of the first, second, and third peaks of vertical forces were respectively 3.1%, 3.4%, and 4.1% for normal participants and 4.2%, 4.2, and 2.1 for the participants who had LBP ( $p>0.05$ ). **Conclusion.** It can be concluded that martial arts athletes with LBP apply symmetrical loads on the lower extremities, similar to healthy people.

**KEY WORDS:** *Low Back Pain, Asymmetry, Gait, Weight-Bearing.*

### INTRODUCTION

Among musculoskeletal dysfunctions, low Back Pain (LBP) is known as the most common health problem worldwide (1, 2). Depending on the population, annual prevalence is reported 15-45% (3). It accounts for 5 to 8% of athletic injuries, making it one of the most challenging to diagnose and treat injuries for the clinicians (4).

LBP in Iran, as with other countries, imposes heavy economic burden on the community, government, and family (5). Multifactorial risk factors, including bio-psychosocial, are associated with this syndrome (6). Among these risk factors, biomechanical factors have been proposed as the most important cause of the

disease (7). By identifying and correcting the impaired biomechanical situation, which are associated with LBP, clinicians would be able to help the LBP patients, especially those who do sport activities, to achieve healthy condition (6).

With regard to this, various mechanical characteristics have been suggested as causes of LBP, including impaired muscle endurance (8), uncontrolled lumbopelvic motion (9-11), lower limbs range of motion deficit (12-14), and prolonged sitting and standing (15). Some mechanical risk factors of LBP have also been investigated in Iran (16-19). Some of these

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contributing factors are also investigated in athletes who had LBP (4, 20).

The asymmetrical loading applied on the legs during functional activities is a biomechanical risk factor, which could contribute to developing symptoms in patients with musculoskeletal disorders (21-24). Some authors believe that asymmetrical loading on the limbs during functional and recreational activities, such as a sport activity, may be associated with asymmetrical loading applied on the lumbar spine tissues (21, 22, 25, 26). If applied on the tissues during habitual or functional activities, asymmetrical loading could lead to micro-trauma and eventually LBP. Therefore, study of the pattern of loads applied on the legs in athletes with musculoskeletal symptoms, especially LBP, seems to be critical.

Martial arts are sports activities which are popular among many around the world (27), especially among Iranian people. Although no exact statistics on the number of Iranian athletes who do these sports exist, a significant number of people participate in such activities in other countries (27). These sports are also among the fields of Olympic Games which normally win medals for Iran. Based on the clinical examination, LBP was found to be a prevalent musculoskeletal disorder among Iranian athletes who practice Martial arts.

Our literature review revealed that, like those suffering from LBP, some risk factors hypothesized to be related to the symptoms (28) were examined in people with LBP who practiced martial arts, as well. Based on our literature review, the pattern of loading in LBP patients was examined in three studies during standing and gait (22, 25, 26). In Zahraee et al. study, only women with LBP were enrolled (25). However, no reported study has yet investigated the pattern of forces applied on the legs in martial arts athletes who have LBP. The the present study was conducted to compare the asymmetry of loading applied on the legs between martial arts athletes with LBP and people without LBP during gait.

## MATERIALS AND METHODS

**Participants.** Two groups, one with persistent LBP and one without a history of LBP, participated in the current study: 20 men with non-specific, chronic LBP and 20 men with no previous LBP. All athletes with persistent LBP

had history of lumbar spine pain symptom for more than 3 months with non-specific LBP diagnosis (29) made by physicians. They were athletes who practiced martial arts at least two sessions in a week. The healthy participants were male students of Isfahan University. The control participants were examined by a physician for any symptoms or dysfunctions in their lumbar, pelvis, thoracic and lower extremities to rule out those who had lumbar spine impairments. The exclusion criteria for both groups were marked kyphosis or scoliosis, spinal tumor or other serious diseases, rheumatology or immunological diseases, discrepancy of legs' length (30), previous surgery, and/or degenerative joint disease in a lower limb or spine. Eligible individuals were enrolled after signing an informed consent and the study procedure was approved by Ethics Committee of Baqiyatallah University of Medical Sciences.

**Test.** Participants were asked to walk in the gait lab at the Faculty of Rehabilitation, Isfahan University of Medical Sciences. Participants walked a 20-m distance with comfortable speed from which six successful trails were selected for each leg (three trials for the dominant limb and three trials for the non-dominant limb) (26).

**Instrumentation and data processing.** To record the forces applied on the legs, the Kistler force plate was used in the Faculty of Rehabilitation, Isfahan University of Medical Sciences. The data were recorded at 120-Hz frequency. After data collection, all the data were filtered using a Butterworth low pass filter with a cut-off frequency of 10 Hz. Then, peaks of the forces in vertical, anterior-posterior, and medial-lateral directions were determined for each test of legs. The peaks of the forces were extracted using QTM software. The asymmetrical force applied on the legs in each direction was determined based on the asymmetry index (ASI) proposed by Herzog et al. (31) and others (24-26, 31). For the ASI calculation, we have:

$$ASI = \frac{X-Y}{1/2(X+Y)} \cdot 100$$

Where X represents the force applied on the dominant side and Y is the same force applied on the non-dominant side. Low value of ASI reveals that the asymmetry between sides is small and vice versa. Figure 1 indicates a sample of forces applied on the leg in one of the participants.

**Statistical analysis.** For all steps of data analysis, SPSS, version 21, was used. Initially, normality of data was evaluated running Kolmogorov-Smirnov test. Since the data were distributed normally, we used independent t-test for comparison between groups.

## RESULTS

As Table 1 shows, individuals with and without LBP were not different with regard to all demographic characteristics ( $p > 0.05$ ).

The results presented in Table 2 indicate that there was no significant difference between the two groups in stride length, velocity, and cadence of gait for the dominant leg ( $p > 0.05$ ).

Table 3 also summarizes the mean values of the ASI for the forces applied on the legs in three

directions. For the vertical direction, no significant differences in the ASI of the forces were observed between the groups during heel strike (Fz1), mid stance, and push off (Fz3) phases of the test ( $p > 0.05$ ). For anterior-posterior direction, the ASI of the anterior force (Fx1) applied on the ground was  $12.8 \pm 8.2$  in the healthy individuals and  $14.4 \pm 8.7$  in the patients ( $p = 0.577$ ). Also, the mean value of the ASI in the posterior direction (Fx2) in the patients was  $7.3 \pm 8.8$  vs.  $6.2 \pm 6.5$  in the healthy individuals ( $p = 0.670$ ).

The ASI of the peak of medial-lateral force (Fy) was calculated to be  $11.2 \pm 10\%$  and  $15.9 \pm 21.8\%$  in patients with non-specific LBP and healthy participants, respectively ( $p = 0.402$ ).

**Table 1. Demographic characteristics of People without and with LBP, n=20, and Mean ( $\pm$ SD)**

Variable	without LBP	with LBP	DF	p
Age (years)	30 ( $\pm 6.3$ )	29.1 ( $\pm 5.9$ )	38	0.628
Height (m)	1.76 ( $\pm 0.07$ )	1.76 ( $\pm 0.06$ )	38	0.791
Weight (kg)	76.8 ( $\pm 11.3$ )	74.6 ( $\pm 11.8$ )	38	0.561
MBI (kg/m <sup>2</sup> )	24.7 ( $\pm 3.2$ )	23.9 ( $\pm 3.6$ )	38	0.443
Duration of LBP (month)	NA	20 ( $\pm 18.2$ )		
Pain intensity	NA	2.7 ( $\pm 2.4$ )		
Oswestry score	NA	21.1 ( $\pm 7.8$ )		
Habitual physical activity score	NA	5.8 ( $\pm 1.3$ )		

**Table 2. Spatiotemporal variables in the two groups of study (dominant leg)**

	Patients group	Healthy group	P value
Stride length (m)	$1.2 \pm 0.8$	$1.28 \pm 0.12$	0.816
Velocity (m/s)	$1.1 \pm 0.12$	$1.1 \pm 0.2$	0.427
Cadence (steps/min)	$104.5 \pm 6.7$	$103.1 \pm 13.2$	0.732

**Table 3. The means of asymmetrical values of spatiotemporal and force parameters of healthy and patient groups**

variable	Fz1	Fz2	Fz3	Fy	Fx1	Fx2
Patients group	$4.2 \pm 2.82.8$	$4.23 \pm 3.9$	$2.1 \pm 1.8$	$11.6 \pm 9.8$	$14.4 \pm 8.7$	$7.3 \pm 6.8$
Healthy group	$3.3 \pm 2.7$	$3.8 \pm 3$	$2.2 \pm 1.8$	$7.6 \pm 5.8$	$12.3 \pm 9.4$	$10.6 \pm 10.0$
p	0.445	0.749	0.956	0.131	0.474	0.279

## DISCUSSION

The LBP has a bio-psychosocial nature (6), with associated environmental and individual factors (2). Mechanical risk factors have been proposed as the most contributing factor (7, 15, 32, 33) and are therefore addressed in many studies.

Asymmetrical load bearing is a mechanical risk factor which has already been investigated in people

with musculoskeletal disorders (22-25). A significant asymmetrical loading on the limbs could be associated with an asymmetrical stress in bilateral tissues, which could lead to tissue injuries and therefore musculoskeletal pain syndrome. In LBP, significant difference in load applied on the lower limbs is likely to result in symmetrical stress in the lumbar spine tissues. If this situation is

frequently repeated, the LBP will happen. Although kinematic variables reveal asymmetrical characteristics of motions in LBP patients as compared to healthy people (28, 34-36), little information has been obtained about the symmetry of kinetic characteristics of motion in LBP patients.

Gait is an important functional activity repeated frequently throughout daily activities. Asymmetrical loading on the limbs during gait may result in different musculoskeletal pain syndromes such as LBP (21, 24, 25). To date, symmetry of loading in people with LBP, to the best of our knowledge, has been investigated only in two studies (25, 26). Zahraee et al. compared symmetry of load-bearing between women with and without LBP (25), and Sadeghisani et al. investigated the loading pattern in men with chronic LBP in comparison to men who were healthy (26). However, no study has yet investigated symmetrical load applied on the legs during gait in LBP athletes who practice martial arts.

In the present study, no significant difference was observed between the two groups in walking speed, cadence, and stride time when they walked with the dominant limbs. This reveals that the patients walked nearly similar to healthy people with respect to spatiotemporal gait pattern. These findings are different from those reported by Khodadade et al., Keefer, and Hill, who observed that patients with LBP tend to walk slower than healthy people. But, in Zahraee et al. study, similar findings were achieved (25). They observed that women with LBP walk similar to healthy women with regard to spatiotemporal parameters. Our results are also consistent with those obtained in Zahraee et al. study; when ASI of loads applied on the legs were compared between the groups, no significant difference was observed.

Childs et al. demonstrated that people with LBP stood with more asymmetry of weight-bearing in bilateral lower limbs compared with healthy individuals (22), while Burnett et al. demonstrated that healthy individuals walk with symmetrical load bearing pattern (21). So, we hypothesized that asymmetrical loading on the legs could be demonstrated in people with LBP, especially athletes who practice martial arts. But, the results of our study did not prove the hypothesis, because no significant difference was observed in the amount of ASI of the loads applied on the legs between the groups. Although,

the exact reasons for obtaining these results are not obvious, some arguments can be considered.

Zahraee et al. argued that, based on avoidance-endurance model, patients with LBP can ignore their pain and participate in physical performance without any limitation (25). This could have been a reason to observe no difference between the groups. In addition, our patients' pain intensity and level of disability were low, which could have affected the results; it is not clear whether similar results could be achieved with patients with higher pain intensity and disability. Furthermore, participants' fatigue might have affected the pattern of loading on the legs. All in all, no significant difference was observed in the pattern of forces applied on the legs between the two groups. Based on the results obtained in the present study, we also need to examine other mechanical risk factors which may be related to LBP in patients who practice martial arts sports activities.

The present study suffers from some limitations, which should be considered prior to generalizing the findings. First, we evaluated pattern of loading only during gait. Future studies are recommended to investigate pattern of loading during other activities, too. Secondly, only men were included in our study and no study, to the best of our knowledge, has yet examined the differences in symmetrical load-bearing between men and women. Thirdly, the current study failed to consider the healthy participants' sport activities. Specific activities are effective on mechanical variables (10), which may be task specific. These limitations should be addressed in future researches.

## CONCLUSION

Based on the obtained results, it can be concluded that martial arts athletes with LBP apply symmetrical loads on the lower extremities during gait similar to healthy people.

## APPLICABLE REMARKS

- Asymmetrical loading on the limbs applied by athletes who practice martial arts may be unrelated to their LBP symptoms.
- Other biomechanical risk factors which may be related to the problem of martial arts athletes must be examined carefully.

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