Comparative Analysis of Lower Limb Alignments in Healthy Subjects and Subjects with Back Pain

[1]Ramin Balouchy*

- Department of Sport Injuries and Corrective Exercises, Faculty of Physical Education and Sport Science, Allameh Tabataba'i University, Tehran, Iran.

BSTRACT

The objective of the present study was to comparatively analyze the clinical status of the lower limbs in healthy subjects and subjects with back pain. Forty three (43) male and female subjects with average age of 36.91 ± 3.97 were selected as the statistical sample of the study. This population was recognized intelligently by utilizing the Nordic Musculoskeletal Questionnaire (NMQ). Furthermore, the NMQ was used to designate 43 male and female subjects with average age of 37.88 ± 4.12 and similar anthropometric characteristics with the statistical population as the research control sample. In the next phase, tibial torsion and femoral torsion angles were measured using a goniometer. Foot typicality was designated using a foot arch index while intercondylar and intermalleolar distances were measured using a clinical caliper. The results depict that the size of the foot arch is steeper in people with back pains compared to those with flat foot arch ($p<0.05$). It also indicates that there is no significant correlation between the tibia, femur torsion, knee condition of the healthy subjects and subjects with back pain. Therefore, it is deduced that steep foot arch can be a key component in the generation of back pains.

Key Words: Back Pain, Foot Arch, Lower Limp Alignments.

Corresponding Author:
Ramin Balouchy
E-mail: ram_b81@yahoo.com

INTRODUCTION

Back pain is considered as one of the key factors in infirmity of people who are less than 45 years old (1). It is the second reason for most clinical visits (2) and the third reason for most surgical procedures (3). Although there is no reliable record of the prevalence rate of back pain as a clinical malady in numerous age and sex categories of Iran, Mousavi *et al.* (2011) stated that in Iran, the prevalence rate of back pain among students and pregnant women are 14.4 and 84.1%, respectively and for the group aged between 15 to 69, back pain is regarded as the third clinical reason behind their partial or absolute infirmity (4). Furthermore, they deduced that the most prevalent clinical excuse behind occupational absences and generally national malady rate (more than 7.5%) is the emergence of back pain symptoms. They believe that the prevalence rate of back pain malady is concomitant with the rate of circumstantial maladies of severe accidents (4). In developed countries, the therapeutic costs of back pain treatment constitute more than 1.7% of their GDP rate (5). Although in most cases, back pains improve therapeutically on their own, most people with back pains have clinical history of suffering from long-spell back pains or intermittent periods of enduring back pain (6). In total, 80% of the aforementioned subjects allocated 80% of the total sum of expenses on back pain treatments to themselves (7). Numerous studies depict that about 90% of back pains require no surgical procedure for its therapy and can be cured with simple clinical recommendation and treatments (3). Unfortunately, most subjects with back pain, being unaware of primary recommendations of health maintenance procedures, undergo surgical operations and suffer from the clinical and financial consequences of such risky procedures.

Foot alignment in the lowest extremity of the human body and a key support in preservation of body balance plays a key role in maintaining an individual's standing and walking postures (8). The natural performance of an individual's foot is the result of preservation of the natural structure of bones, joints, muscles and knee ligaments. Therefore, any variable that affects the natural performance of one of the aforementioned components will alter the mechanical performance of the foot as well. The natural biomechanical characteristics of the foot can be disturbed due to the clinical disturbance of subtalar joints.

One sided inversion of the foot or two sided inversion of the calcaneus can result in a pathological disorder of the vertebral column (3, 6). Numerous researches indicate that in the closed kinetic chain activities of a healthy person, foot hyperpronation can result in internal rotation of the tibia and femur as well as excessive increase in femoral anteversion (7). As a result of unconventional kinetic alteration, such a clinical condition can implement detrimental pressure on the vertebral column in various body postures such as running, walking and scaling postures. Rothbart and Estabrook (1998) stated that if subjects with severe back pain have steep flat foot arch, manipulation of foot orthoses can improve their back pain efficiently. Heller *et al.* (2001) deduced that as a result of excessive increase in femoral anteversion angle, 28% increase in weight on hip joints can be implemented in waking and scaling postures (9). O'Leary *et al.* (2013) and Bird and Payne (1999) stated that knee anomalies play a key role in the generation of severe back pains (10, 11). However, they have not represented any comprehensive mechanical scheme for identifying the main clinical reasons of back pain maladies. They only analyzed the importance of lower limps in the natural biochemical function of the vertebral column. Therefore, it is necessary for more researches to be conducted

regarding this issue, so that proper action can be utilized in recognition of risk factors of back pain malady, mitigation and prevention of clinical consequences of back pain, official exhortation for administration of preventive actions against back pain malady and facilitation of general awareness of back pain malady and its consequences. Therefore, the present study analyzed the relationship between risk factors of back pain malady and lower limbs in staff members of Allameh Tabataba'i University.

MATERIALS AND METHODS

The present study is categorized under casual researches with experimentation methodology.

Participants. The statistical population of the study consists of 329 female and 311 male staff members of Allameh Tabataba'i University. Forty-three (43) male and female subjects with average age of 36.91± 3.97 were selected as the statistical sample of the study. On the other hand, 43 subjects with average age of 37.88 ± 4.12 and similar anthropometric characteristics with the statistical sample were selected as the research control sample. It must be noted that the control sample presented no back pain symptoms.

Research Instrumentation. The Nordic Musculoskeletal Questionnaire (NMQ) is a standardized questionnaire that records personal information of participants (e.g. sex, height, weight) alongside a series of clinical indices such as the level of neck pain, back pain, elbow pain, wrist pain and headache. Furthermore, it pays attention to the physiotherapeutic activities of participants. In order to analyze the level of pain, Quebec Back Pain Disability Scale was utilized. This questionnaire includes twenty-five (25) five-option questions and scales about the level of pain from zero to four. The total sum of statistical value of the questionnaire is scaled from zero to 100.

Measurement Protocols. By measuring femur intercondylar and intermalleolar distances with a customized caliper of 1.10 mm precision, the degree of genu varum and genum valgum of feet postures were recognized. By utilizing Stuberg's method, Craig's Test and universal goniometer, the internal rotation of the tibia and femur was measured with a precison rate of 1 (12, 13). Foot typicality is designated by utilizing the Staheli's Plantar Arch Index. In this method, relative ratio of width of middle section of one' footprint and width of foot print heel section was measured, so that the Staheli's Plantar Arch Index can be recognized statistically (14) (Figure 1).

Statistical Analysis. Chi-Squared Test and t Test were utilized to monitor the research sample. The collected data was analyzed using the SPSS software with statistical significance of p<0.05.

RESULTS

After data analysis, there was significant correlation between the levels of frequency of foot typicality in healthy subjects, as well as subjects with back pain malady. At the same time, there was no significant correlation between frequency rate of knee typicality and level of rotation in healthy subjects and subjects with back pain malady (Table 1).

After data analysis, a statistical correlation was found between foot arch indexes in healthy subjects and subjects with back pain malady (Chart A). At the same time, there was no statistical significance between femur intercondylar and intermalleolar distances as well as rotation degrees of subjects with back pain maladies and healthy subjects.
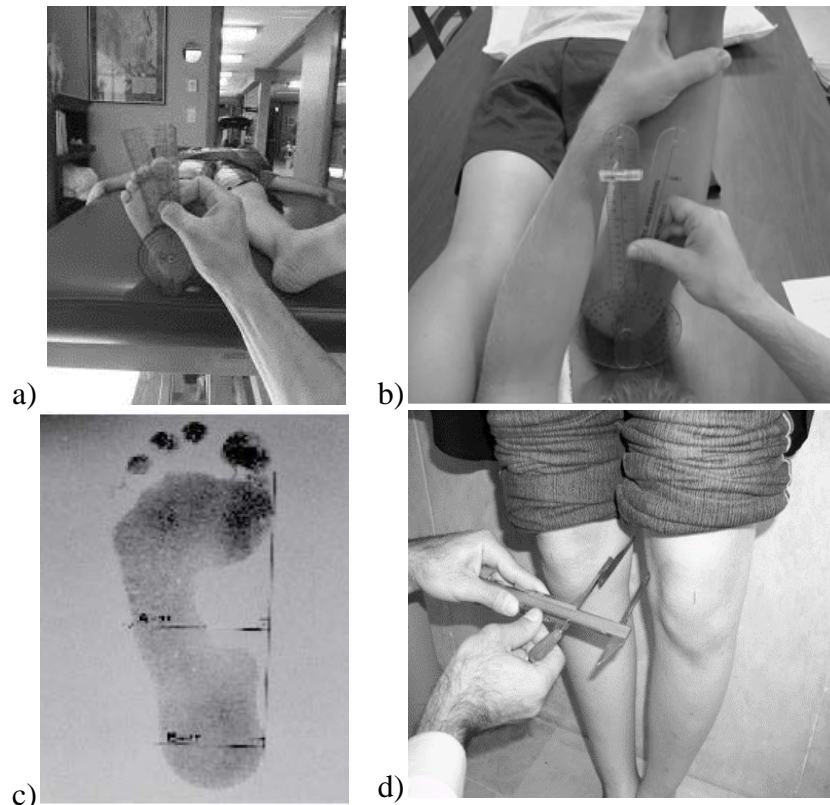
Figure 1. *Measurement Protocols.* a) Staheli Test; b) Craig's Test; c) Measurement of Staheli's Plantar Arch Index; d) Measurement of Femur Intercondylar and Intermalleolar Distances

Table 1: Comparison of Foot Typicality, Lower Limb Alignment of Healthy Subjects and Subjects with Back Pain Malady

Variables		Groups		X^2	p
		Healthy	Back Pain		
Foot Typicality (%)	Pes Cavus	18.6	16.3	7.67	0.02[*]
	Natural Foot	58.1	32.6		
	Flat Foot	23.3	51.1		
Knee typicality (%)	Genu Varum	16.3	23.3	1.24	0.54
	Natural Knee	62.8	51.2		
	Genum Valgum	20.9	25.6		
Status (%)	Internal Rotation	11.6	20.9	1.36	0.24
	Natural Rotation	88.4	79.1		
	External Rotation	0.0	0.0		
Femur Rotation Status (%)	Anteversion	11.5	16.3	.82	0.66
	Natural Rotation	65.1	55.8		
	Retroversion	23.3	27.9		

*: significant at $p<0.05$.

DISCUSSION

Research findings depict that there is a significant correlation between foot typicality of healthy subjects and subjects with back pain symptoms. On the other hand, it has been shown that more than

14.3% of healthy subject participants acquire pes cavus, 71.4% acquire natural foot typicality and 14.3% have flat foot typicality. In subjects with back pain malady, frequency rate of foot typicality are 17.1%, 42.9% and 40% in respect to the categories represented above. Recognition of foot typicality as a significant variable is a scholarly result which is in line with the results of Kosashvili *et al.* (7) and Salehi and Salehi and Babaei (15). At the same time, it is not in line with studies of Menz *et al.* (16) and Brantingham *et al.* (17). In a retrospective survey on 97 thousand soldiers, Kosashvili *et al.* (2008) regarded a 16% rate for effectuality of foot typicality on emergence of back pain. He believed that the chance of emergence of back pain symptoms is two times higher in subjects with pes cavus and average pes cavus, in comparison with healthy subjects who acquired normal foot typicality (7). Salehi and Babaei (2004) stated the statistical correlation between femoral torsion angle, halux valgus, halux limitus, foot typicality, soloeus shortness and the emergence of chronic back pain. At the same time, there is no statistical significance between foot dimension, gasterocenimus shortness and chronic back pain emergence (15). In a six (6) month long survey, Root, Orien, and Weed (1977) detected a significant correlation between foot typicality and the emergence of chronic back pain (18). In contradiction with Brantingham *et al.* earlier studies (17), he and his colleagues started working on a preliminary survey of 58 participants in the 16-70 age group who were inflicted with chronic back pain and acquired no prior clinical background of back pain symptoms. They deduced that there is no correlation between foot typicality and biomechanical emergence of back pain. It is worth mentioning that the limited nature of the sample, low statistical efficiency, heterogeneous age range and low efficiency of frequency level of foot typicality and back pain syndromes (with a navicular drop of 10 mm) will affect the results of Brantingham *et al.* studies negatively. Menz *et al.* (2013) analyzed the relationship between body postures, foot performance and back pain of 1930 research participants. In their study, while participants were aligned statistically, foot posture was recognized through the use of arch index and then, participants were categorized into natural, flat and pes cavus foot typicality groups. At the same time, dynamic foot pressure index was utilized so that the foot typicality of participants can be categorized into three natural, pronated and supinated divisions (16). The results of this study show that there is no statistical significance between foot posture and back pain syndromes. However, it was deduced that foot pronated performance correlated with less intense back pain in women. The reason for the partial discordance of Menz's study and the present research is their utilization of divergent indexes. Ogon *et al.* (1999) stated that in comparison with flat foot typicality, pes cavus acquires more capacity to bear neurological shocks. When the heels administer the walking posture, the latter rotated steeper than the former and therefore, reduced the generated neurological shocks on the vertebral column (19). Generally, walking posture impacts the vertebral column neurologically and biomechanically. Such impacts should be neutralized before affecting delicate body structures negatively. By distributing the effects of neurological shocks in the entire body, their detrimental impacts can be mitigated and therefore, it is proposed that if there is any kind of malfunction in the lower body limbs, it is probable that the vertebral column will be damaged fundamentally (20). In subjects with flat foot, two factors can facilitate the emergence of back pain syndromes. These factors can appear synthetically or individually. The first factor is the high level internal rotation of lower body limbs while the second factor is the

weak anti-shock characteristics of foot typicality, as a result of its hyperpronation (11). Such hyperpronation in walking postures will cause emergence of a series of nefarious body functions that inflict severe back pains. Foot hyperpronation in participants with flat foot typicality generate excessive internal rotations and detrimental anterior pelvic tilts. Such a clinical condition increases the level of muscle strain on iliopsoas, piriformis and gluteus maximus muscles, resulting in the displacement of a small portion of the back. This displacement is called scoliosis. It is believed that due to displacement of the sacroiliac joint, sudden dynamic shifts in vertebral column are possible after scoliosis and therefore, emergence of back pain will be a chronic consequence. Due to the sudden decrease of muscle tension on iliopsoas, the subject contract erectors of the vertebral column and leans the body in the backward direction. This will wear off the back muscles and intensify severe back pains (10).
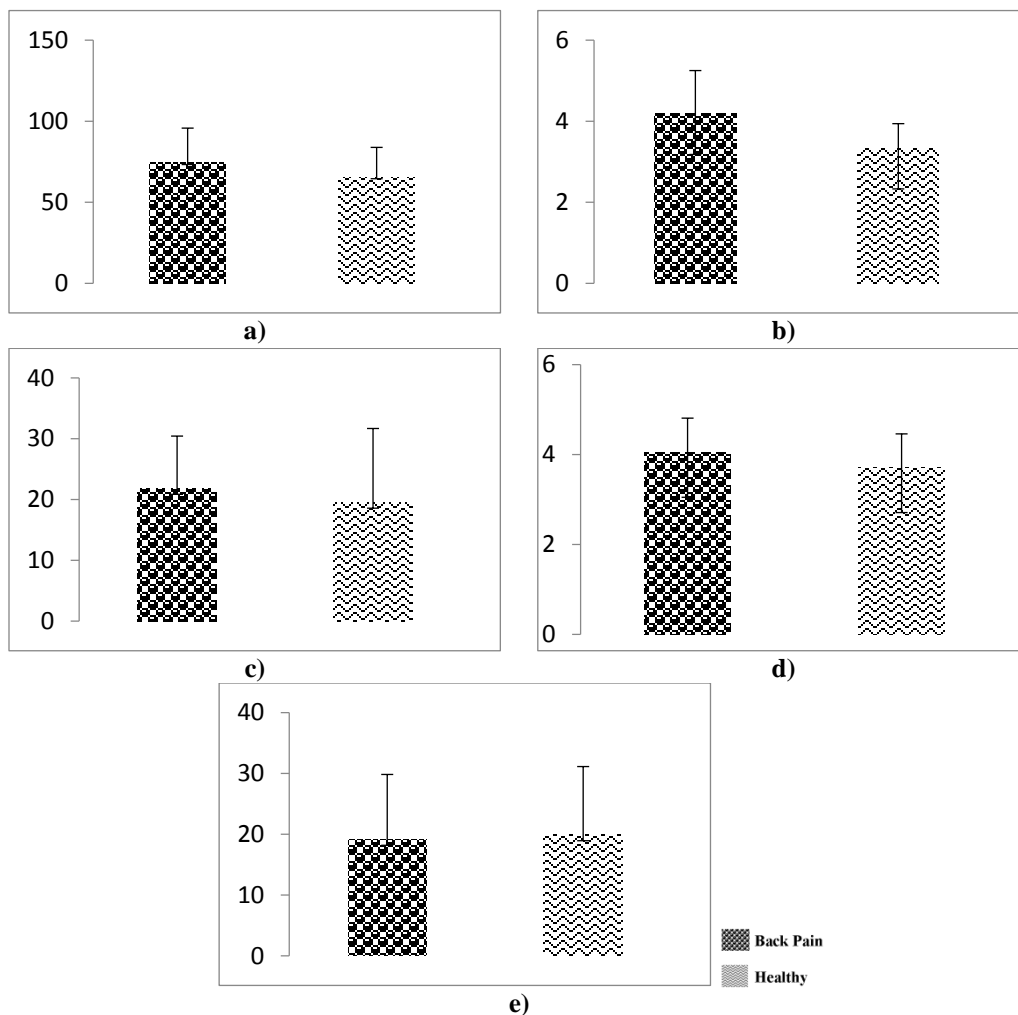
Graph 1. *Mean and SD of variables in two groups.* a) Foot Typicality of Healthy Subjects and Subjects with Back Pain; Chart b) Femur Intercondylar and Intermalleolar Average Distance Rates of Healthy Subjects and Subjects with Back Pain; c) Rotation Degree in Healthy Subjects and Sugjects with Back Pain; d) Femur Intercondylar and Intermalleolar Average Distance Rates of Healthy Subjects and Subjects with Back Pain; e) Rotation Degree in Healthy Subjects and Subjects with Back Pain

Another research finding is the fact that there is no statistical significance between knee typicality in healthy subjects and subjects with back pain syndromes. This observation is in correlation with the results of Arab, Nourbakhsh, and Salavati (21). However, it is not in line with the findings of O'Leary *et al.* (11), and Bird and Payne (10). Arab, Nourbakhsh, and Salavati (2004) stated that the endurance level of back muscles had the highest significant correlation with emergence of back pains. At the same time, they believe that other factors such as muscle length, strength, flexibility and erection of hip joints acquire weal correlation with emergence of back pains (21).

Regarding the correlation between knee maladies and back pain, Salehi and Babaei (2004) stated that such a correlation cannot be substantiated. Although O'Leary *et al.* (2013) and Bird and Payne (1999) have shared efficient observations on the correlation between back pain and knee maladies (10, 11), they did not propose any comprehensive mechanism, regarding the clinical causes of back pain. In their studies, only biochemical data regarding lower body limbs and vertebral column are represented. They believe that the biochemical shortcoming of lower limbs can have a negative impact on the supportive joints of the foot such as ankle and back bones (10, 11).

The results of the present study show that there is no significant correlation between average rotation degree and possibility of emergence of back pain symptoms in healthy subjects and subjects with back pain maladies. Khamis and Yizhar (2007) analyzed the physiotherapeutic role of foot pronation level on lower limb alignment and hip joint (22). They found that high pronation level (more than 10 degrees forward titling) causes tilted pelvis. A tilted pelvis will increase spine curvature radically and result in chronic back pains (22). Various researches have shown that in the pronation posture, tibial torsion and femoral torsion angles face internal rotation. This will result in lack of muscular balance, hip and back malfunctions and severe back pains (23). Shayesteh Azar *et al.* (2010) comparatively analyzed lumber lordosis and lumbosacral angles in healthy subjects and subjects with back pain symptoms (24). They deduced that there is no significant correlation between lumber lordosis and lumbosacral angles, in healthy subjects and subjects with back pain symptoms. They also observed that there is no correlation between the spine curvature of healthy subjects and subjects with chronic back pain maladies. They were of the opinion that the theory of spine curvature causality on back pain maladies should be reconsidered, for every ineffective and conservative treatment of spine curvature is based on this inefficient theory (24). In another study, Heller *et al.* (2001) observed that due to excessive increase of the femoral anteversion angle, 28% increase of weight on hip joints was implemented in waking and scaling postures (9). Bedi *et al.* (2010) believed that excessive increase of femoral anteversion angle results in chondromalacia patellae of the upper femur cartilage, acetabulum, foot joint capsules and ilipsoas tendon (25). In their studies, physiotherapeutic analysis of femoral anteversion angle is of key importance in recognition of back pain and malfunction of lower limbs (25). According to Betsch's studies (6), it is indicated that excessive increase of femoral anteversion angle will generate pelvis tilt and steep spine curvature. However, they believe that even small

pelvis tilts will affect performance efficiency of back muscles and bones.

CONCLUSION

There was significant difference between foot arch of back pain patients and healthy subjects; but, there was no significant difference between the rotation of the tibia, femur anti-version and knee position of healthy individuals and patients with back pain. Therefore, it is likely that the foot arch position of people to be involved in back pain.

APPLICABLE REMARKS

- To be considered the abnormalities of the foot as a risk factor to prevent or treat back pain.
- People with flat feet should be using corrective exercises during the day and work to improve and prevent the development of the abnormality.

REFFRENCES

1. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. Arthritis and rheumatism. 2012;64(6):2028-37.
2. Lambeek LC, van Tulder MW, Swinkels IC, Koppes LL, Anema JR, van Mechelen W. The trend in total cost of back pain in The Netherlands in the period 2002 to 2007. Spine. 2011;36(13):1050-8.
3. Eklund A, Axen I, Kongsted A, Lohela-Karlsson M, Leboeuf-Yde C, Jensen I. Prevention of low back pain: effect, cost-effectiveness, and cost-utility of maintenance care - study protocol for a randomized clinical trial. Trials. 2014;15:102.
4. Mousavi SJ, Akbari ME, Mehdian H, Mobini B, Montazeri A, Akbarnia B, et al. Low back pain in Iran: a growing need to adapt and implement evidence-based practice in developing countries. Spine. 2011;36(10):E638-46.
5. Forouzanfar MH, Sepanlou SG, Shahraz S, Dicker D, Naghavi P, Pourmalek F, et al. Evaluating causes of death and morbidity in Iran, global burden of diseases, injuries, and risk factors study 2010. Archives of Iranian medicine. 2014;17(5):304-20.
6. Betsch M, Schneppendahl J, Dor L, Jungbluth P, Grassmann JP, Windolf J, et al. Influence of foot positions on the spine and pelvis. Arthritis care & research. 2011;63(12):1758-65.
7. Kosashvili Y, Fridman T, Backstein D, Safir O, Bar Ziv Y. The correlation between pes planus and anterior knee or intermittent low back pain. Foot & ankle international. 2008;29(9):910-3.
8. Farokhmanesh K, Ghasemi MS, Saeedi H, Roudbari M, Emadifar R. Effect of foot hyperpronation on spine alignment, in standing position. Modern Rehabilitation. 2012;6(2):65-70 [Article in Farsi].
9. Heller MO, Bergmann G, Deuretzbacher G, Claes L, Haas NP, Duda GN. Influence of femoral anteversion on proximal femoral loading: measurement and simulation in four patients. Clinical biomechanics (Bristol, Avon). 2001;16(8):644-9.
10. Bird AR, Payne CB. Foot function and low back pain. The Foot. 1999;9(4):175-80.
11. O'Leary CB, Cahill CR, Robinson AW, Barnes MJ, Hong J. A systematic review: the effects of podiatrical deviations on nonspecific chronic low back pain. Journal of back and musculoskeletal rehabilitation. 2013;26(2):117-23.
12. Piva SR, Fitzgerald K, Irrgang JJ, Jones S, Hando BR, Browder DA, et al. Reliability of measures of impairments associated with patellofemoral pain syndrome. BMC Musculoskeletal Disorders. 2006;7:33-.
13. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R. Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. Clinical orthopaedics and related research. 1991(272):208-12.
14. Staheli LT, Chew DE, Corbett M. The longitudinal arch. A survey of eight hundred and eighty-two feet in normal children and adults. The Journal of bone and joint surgery American volume. 1987;69(3):426-8.
15. Salehi H, Babaei GH. Study of relationship between low back pain relation and foot disorders. koomesh. 2004;6(1):1-6 [Article in Farsi].
16. Menz HB, Dufour AB, Riskowski JL, Hillstrom HJ, Hannan MT. Foot posture, foot function and low back pain: the Framingham Foot Study. Rheumatology (Oxford, England). 2013;52(12):2275-82.

17. Brantingham JW, Adams KJ, Cooley JR, Globe D, Globe G. A single-blind pilot study to determine risk and association between navicular drop, calcaneal eversion, and low back pain. Journal of manipulative and physiological therapeutics. 2007;30(5):380-5.
18. Root ML, Orien WP, Weed JH. Normal and Abnormal Function of the Foot - Clinical Biomechanics Volume II: Clinical Biomechanics Corporation; 1977. 478 p.
19. Ogon M, Aleksiev AR, Pope MH, Wimmer C, Saltzman CL. Does arch height affect impact loading at the lower back level in running? Foot & ankle international. 1999;20(4):263-6.
20. McGregor AH, Hukins DW. Lower limb involvement in spinal function and low back pain. Journal of back and musculoskeletal rehabilitation. 2009;22(4):219-22.
21. Arab AM, Nourbakhsh MR, Salavati M. Relative Effects of Mechanical Factors on Low Back Pain. Kowsar Medical Journal. 2004;9(1):67-76 [Article in Farsi].
22. Khamis S, Yizhar Z. Effect of feet hyperpronation on pelvic alignment in a standing position. Gait & posture. 2007;25(1):127-34.
23. Levine D, Whittle MW. The effects of pelvic movement on lumbar lordosis in the standing position. The Journal of orthopaedic and sports physical therapy. 1996;24(3):130-5.
24. Shayesteh Azar M, Talebpour F, Alaee AR, Hadinejad A, Sajadi M, Nozari A. Association of low back pain with lumbar lordosis and lumbosacral angle. Journal of Mazandaran University of Medical Sciences. 2010;20(75):9-15 [Article in Farsi].
25. Bedi A, Dolan M, Leunig M, Kelly BT. Static and dynamic mechanical causes of hip pain. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2011;27(2):235-51.

مقایسه راستای اندام تحتانی در افراد مبتلا به کمردرد با افراد سالم

‎۱رامین بلوچی*

– دانشیار گروه آسیب‌شناسی ورزشی و حرکات اصلاحی، دانشکده تربیت‌بدنی و علوم ورزشی، دانشگاه علامه طباطبائی، تهران، ایران.

چکیده

هدف از تحقیق حاضر مقایسه راستای اندام تحتانی در کارمندان مرد و زن مبتلابه کمردرد و سالم بود. آزمودنی‌های مبتلابه کمردرد را ۴۳ مرد و زن با میانگین سنی۳/۹۷ ± ۳۶/۹۱ سال تشکیل می‌داد که از طریق پرسشنامه درد نوردیک به‌صورت هدفمند انتخاب‌شده بودند، ۴۳ مرد و زن سالم با میانگین ۴/۱۲ ± ۳۷/۸۸ سال که دارای ویژگی‌های انتروپومتریک مشابه با گروه کمردرد بودند نیز به به‌عنوان گروه کنترل در نظر گرفته شدند. سپس زاویه پیچش درشتنی و زاویه پیچش استخوان ران با استفاده از گونیامتر، نوع پا توسط شاخص قوس کف پا، فاصله بین دو کندیل و فاصله بین دو قوزک توسط کالیپر اندازه‌گیری شد. داده‌های جمع‌آوری‌شده توسط نرم‌افزار spss نسخه ۱۹ و آزمون‌های آماری t مستقل، خی دو تجزیه‌وتحلیل شد. تمام داده‌ها در سطح معنی‌داری ۰/۰۵ تجزیه‌وتحلیل شد. نتایج تحقیق نشان داد که؛ بین وضعیت کف پای افراد مبتلابه کمردرد با افراد سالم تفاوت معنی‌داری وجود دارد ($p<0/05$). درحالی‌که بین میزان چرخش درشتنی، میزان آنتی ورژن استخوان ران و وضعیت زانوی افراد سالم و مبتلابه کمردرد تفاوت معنی‌داری وجود ندارد ($p>0/05$). لذا، احتمال می‌رود که وضعیت کف پای افراد در بروز کمردرد نقش داشته باشد.

واژگان کلیدی: کمردرد، قوس کف‌پایی، راستای اندام تحتانی.

* – نوسنده مسئول:

رامین بلوچی

پست الکترونیک: ram_b81@yahoo.com