IBOM MEDICAL JOURNAL
Vol.18 No.3 | July - September 2025 | Pages 451-457
www.ibommedicaljournal.org

Comparison of the Degree of Hip Rotation Between Amateur Golfers With Low Back Pain and Matched Desk-Bound Individuals in Ebonyi State

Chukwuemeka, U. Mong[1], Uzunma, P. Imo[2]

[1]*Physiotherapy department, Evangel University Akaeze, Ebonyi State, Nigeria*
[2]*Department of Human Kinetics and Health Education, Ebonyi State University, Abakaliki, Nigeria.*

Abstract

Context: The indefinite results observed in different studies on the hip–low back pain association is alluded to be due to heterogeneous nature of their sample population hence, the need to address this constraint.
Objective: To determine degree of passive hip rotation of Amateur Golfers(AG) with low back pain (LBP) and compare them with Desk-Bound(DB) participants in Ebonyi State.
Methods: Forty-three male participants with LBP made up of 21 amateur golfers and 22 desk-bound individuals participated in the study. The two groups were equal with regards to LBP classification and physical characteristics but differ in activity level. Participants were recruited from Enugu and Ebonyi golf clubs and an Orthopedic hospital in Enugu, Nigeria. A comparative cross sectional study design was used to achieve the objectives of the study. Measurements of passive internal and external hip rotation range of motion were obtained in extension position with two-armed goniometer.
Results: Showed that the desk-bound group showed significant deficit in external rotation of left hip than the amateur golfers group (DB mean 34.939± 9.837; AG mean 41.127± 7.913, p = 0.029., 95% CI 0.674 - 11.704). There were no significant differences in left internal, right external and internal hip rotation between the two groups(p> 0.05). The difference in degree of rotation between left and right hip of AG and that within DB group was not statistically significant(p >0.05).
Conclusions: Low back pain is the source of hip rotation deficit between amateur golfers and desk-bound groups. Adequate categorising of sample population made the finding more definite thereby clarifying the ever evasive paradox of the hip function -LBP relationship.

Key words: Low back pain, Amateur Golfers, Desk-bound individuals, Passive Hip Rotation Range of Motion

Introduction

Diverse possible causes of low back pain (LBP) abide yet information indicating the possibility of hip rotation deficits being among the sources are on the increase. Different studies on the hip–low back pain association[1-7], have been carried out and findings from these studies showed that a link exists between the role of hip joints and low back pain but the uncertainty of the specific characteristics of this association have continued to linger. Some researchers in this field agreed that there is a possibility that an imbalance in hip movement may add or cause an individual's lower back issues where the person performed tasks that put constant rotational demand on the trunk and hip[8-13]. On the other hand some studies[14-17] have shown that patients who suffer from low back pain have compromised hip function irrespective of their physical activity level. They concluded that hip dysfunction are regular occurrence in individuals suffering from LBP and low back pain signs and

Corresponding Author:
Uzunma, P. Imo
Physiotherapy department, Evangel University Akaeze, Ebonyi State, Nigeria.

imoportia@yahoo.com

DOI: 10.61386/imj.v18i3.703

symptoms may eventually result into lack of full range of movement of hip joint.

Most researches that investigated this link[2,11,12,7,13] compared hip joint range of motion(ROM) between patients with low back pain and persons without low back pain thus introducing a cross-sectional limitation to their work, which some reported13 as being one of the hindrances that made their findings uncertain. They were not certain whether the observed hip rotation limitation was responsible for the LBP or that the abnormal posture/ motion usually employed by LBP patients to cope with LPB symptoms lead to hip rotation dysfunction. Harris-Hayes and colleagues(2009)[10] advocated that the rationale for the indefinite results observed is because essential features such as Low Back Pain categorizations, gender and activity demand that bring about differences in the population used for these studies were not sufficiently taken into consideration

Since hip function has been proposed to be related to low back pain (LBP) because of the anatomical proximity of the hip and lumbopelvic region, one good way of looking at this relationship is to study activities that put huge demand on hip rotation function. Therefore, another effective method to investigate the association between hip joint motion and low back pain would be to investigate low back pain individuals who place frequent rotational tension on the hips with persons with the same condition who are under-active due to lack of physical activity. This may help to determine more clearly if reduced degree of hip rotation linked to hip function could be correlated to low back pain. The aim of the study was thus to determine the hip rotation range of motion of right handed amateur golfers with low back pain and make comparison with those of sedentary individuals with low back pain.

Methods

The study adopted a comparative cross sectional study design. A total of 43 males with low back pain made up of 21 amateur golfers and 22 desk-bound (sedentary) individuals were recruited to participate in the study. The sedentary subjects were consecutively recruited from Physiotherapy department of National Orthopaedic Hospital Enugu, Nigeria. They participated in the study before receiving physiotherapy services. They were rated as being insufficiently active according to Baecke Physical Activity Questionnaire (BPAQ)[18] index. The amateur golfers who frequently participated in golf game between two to five times weekly were recruited from Golf section of Enugu Sports club, Nigeria. The two groups were all males, suffered from chronic low back pain with comparable physical characteristics (Table 1). The amateur golfers' group exerted frequent golf swing mechanical forces on the hip especially the left one, while the desk-bound group are accustomed to habitually sitting down. Both groups had suffered from chronic Low Back Pain diagnosed as disc protrusion or prolapse, facet dysfunction and nonspecific low back pain. Pain intensity was not assessed but the Modified Oswestry Low Back Pain Disability Index was used to measure the level of functional disability as a result of their low back pain.

Only participants with chronic LBP were considered eligible. Participants with the following conditions were excluded from the study: hip disease, lower limb and spinal ailments, and severe neurological and medical conditions. All participants were able to tolerate measurement of their hip rotation passively without pain.

A simple two-arm goniometer manufactured by AUREUS Medical Group, USA with a 180° scale marked in 5º incremental was used for data collection (figure 1). Weighing scale and height meter were used to measure body weight and height respectively (Table 1). The sedentary persons were screened to identify suitable participants using Baecke Questionnaire for Measurement of a Person's Habitual Physical Activity(BPAQ)[18]. Modified Oswestry Low Back Pain Disability Index (ODI) was used to determine the functional disability of participants as a result of their low back pain. Concurrent validity of standard manual goniometers were good for hip rotation with high intraclass correlation

Figure 1: starting position with 2-arm goniometer

coefficient (ICC) of 0.94, and low systematic bias and random error[19,20].

All subjects had their hip rotation measured in prone lying position passively by the researcher. All range of motion (ROM) measurement were carried out on a firm treatment couch after a 5-minute warm-up exercise in form of cycling with a stationary bicycle or brisk walking. The participant was first placed face down on an investigation couch and hip kept in abduction and abduction neutrally, the knee flexed at ninety degrees and his pelvis firmly held in place with a belt, the participant's arms placed by the sides with head turned to the side of comfort. The seat belt strap was secured over the posterior superior iliac spine region of the subject, and completed with a loop under the couch. The lower limb that is not being assessed was put in minimal abduction. Prone position made it easier to sustain the subject in the required state. To enable the participants get accustomed to the method and to ensure that the lower limb movements were not painful, the lower limb under assessment was passively moved only one time into internal rotation and external rotation by the researcher. Thereafter measurements of passive internal and external hip rotation were taken with a goniometer by the researcher with the help of two assistants who helped to stabilize the goniometer sleeve along the tibia shaft to ensure that no perceptible pelvic movement interfered with measurement. Three measurements were taken for each movement in both hips and the mean determined and recorded in degrees. This research was approved by National Orthopaedic Hospital Enugu Institutional Review Board. This work also complied with the Declaration of Helsinki. The participant's privacy and the confidentiality of their data were protected. The data contained no identifying information that could associate it with the participants.

Method of Analysis

IBM SPSS version 23.0 Armonk (NY; IBM Corp) was used for data analysis. Quantitative data that were normally distributed were summarized as mean and standard deviation. Independent and paired sample t-test were used to assess the mean difference of values between the 2 groups at a level of significance of $p<0.05$. Paired sample t-test was used to compare the mean difference within each of the two groups while independent t-test was used to test for significant difference between the 2 groups namely the amateur golfers and Desk-bound group.

Results

The two groups who suffered from chronic low back pain were all males with comparable physical characteristics (Table 1). The mean Baecke Physical Activity Questionnaire (BPAQ) index score of desk-bound (sedentary) participants for work was 3.75(±0.43), sport; 2.08 (±0.40) and leisure; 2.75 (±0.83). The mean Oswestry Disability Index (ODI) score of amateur golfers was 15.24% (±3.66) while that of the control group was 30.18% (±13.54).

Result showed that within the amateur golfers' group neither the internal nor external rotation of left hip was significantly different from that of the

Table 1: Physical Characteristics of Male Amateur Golfers and Desk-bound Participants

Physical Characteristics	Amateur Golfers (N=21) Mean ±SD	Desk-bound Participants (N=22) Mean ±SD	t-value	p-value
Age (yrs)	43.0 ± 18.6	47.3 ±12.7	0.88	0.39
Height (m)	1.71 ±0.1	1.74 ±0.1	1.21	0.23
Weight (kg)	76.0±15.9	81.7 ±14.7	1.20	0.24
ODI	15.24%(± 3.66)	30.18% (± 13.54)	-	-
BPAQ	Not applicable	Work; 3.75(±0.43); sport: 2.08(± 0.40; leisure: 2.75(±0.83)	-	-

Keys: N= number of participants, SD=Standard Deviation

Table 2: Comparison of mean of Hip Rotation range of motion between left and right hip of Amateur golfers

Rotation	Left Hip Mean (SD)	Right Hip Mean (SD)	t-value	p-value	95% CI LL	95% CI UL
Internal	41.67(9.16)	39.83(9.79)	0.912	0.373	-2.372	6.055
External	41.13(7.91)	38.52(8.12)	1.39	0.18	-1.305	6.511

Table 3: Comparison of mean of Hip Rotation range of motion between Left and Right hip of Control group

Rotation	Left hip mean(SD)	Right hip mean(SD)	t-value	p-value	95% CI LL	95% CI UL
Internal	38.06(9.57)	39.50(10.96)	-0.739	0.468	-5.495	2.615
External	34.94(9.84)	34.50(6.95)	0.199	0.844	-4.146	5.024

Table 4: Comparison of Hip Rotation range of motion between Amateur Golfers and Control group

Rotation	Left hip mean(SD)	Right hip mean(SD)	t-value	p-value	95% CI LL	95% CI UL
left internal	41.67 (9.16)	38.06 (9.57)	1.262	0.214	-2.166	9.386
left external	41.13 (7.91)	34.94 (9.84)	2.267	0.029	0.674	11.704
right internal	41.67 (9.16)	38.06 (9.57)	0.103	0.919	-6.082	6.735
right external	38.52 (8.12)	34.45 (6.95)	1.748	0.088	-0.625	8.674

right hip (table 2)

Result showed that within the Desk-bound individuals there was no significant mean difference between the left and right hip in both internal rotation and external rotation (table 3).

Result also showed that the amateur golfers had a higher internal rotation mean than the of desk-bound subjects in the left hip with a mean difference of 3.61º but the difference was not statistically significant (table 4). Result also showed that the external rotation of right hip was higher in amateur golfers (38.524 SD 8.12) than desk-bound group (34.450 SD 6.953) by mean difference of 4.025º but the different was not statistically significant (t-value 1.748, p-value 0.088, 95% CI -0.625 - 8.674).

Result revealed that the amateur golfers had a significant higher external rotation range of motion than and the desk-bound group in the left hip indicating that the left hip external rotation of desk-bound group was limited by 6.19º (table 4: AG mean 41.127, SD 7.913; Control Mean 34.939 SD 9.837, t-value 2.267, p-value 0.029., 95% CI 0.674 - 11.704).

Discussion

The aim of this study was to determine the passive hip rotation range of motion of right handed amateur golfers with low back pain and if they were significantly different from that of desk-bound individuals with low back pain. The result showed evenness of both internal and external rotation between the left and right hip of amateur golfers implying that the rotational demand the golf game imposed on the left hip did not cause any difference. The findings as well demonstrated uniformity of both internal and external rotation between the left and right hip of the desk-bound group. We confirmed that the amateur golfers had more external rotation in left hip in comparison to desk-bound group. This meant that desk-bound group had significant deficient external rotation of 6.19º in the left hip less than the amateur golfers' group. Findings from previous works [14 17]-reported that LBP patients had compromised hip function irrespective of their physical activity level with significant limitations occurring more in external hip rotation when compared to control group of healthy participants. This significant deficiency therefore may be because of severe functional disability of the sedentary group as against the amateur group with moderate severity. Left hip internal rotation, right hip internal and external rotation revealed no statistically significant range of motion difference between the two groups.

The results of this present work could not be justifiably compared to the numerous studies conducted to seek the correlation between hip function and low back pain[1-4,5-7,11-13,21-25] because these studies investigated low back pain subjects with subjects without low back pain thereby introducing a cross-sectional limitation to their work which this current work eliminated by investigating two groups of subjects with low back pain. These researchers generally reported limitation of hip function in low back pain subjects when compared to those without low back pain. For instance Van-Dillen and colleagues(2008)[13] examined passive hip rotation ROM between sportsperson involved in rotation-related sports who suffered from LBP and compared them with their counterparts who do not have any LBP symptoms. They reported reduced hip rotation in the LBP group in contrast to those without low back pain signs and symptoms. Within the LBP group they found out that the left hip was more limited compared to the right hip but this finding was not observed in the group without LBP. Van-Dillen et al(2008)[13] were not able to come to a clear conclusion as whether the hip function limitation was responsible for the LBP or vice versa. This they attributed to the cross-sectional design of their study. Differences in sample characteristics were one of the main reasons the various research works done on hip rotation-LBP relationship were not conclusive. Haris-Hayes, Sahrmann and Van Dillen(2009)[10] in their work that addressed this concern concluded that features like gender, LBP categorizations and activity demand, ought to be contemplated in sample selection. It was thus not unexpected that our findings were in variance with these past studies probably due to heterogeneous nature of their research samples.

Our study is slightly similar to that of Vad and colleagues (2004)[12] who investigated hip rotation ROM in professional golfers with and without low back pain symptoms. They compared hip rotation within each group and reported reduced internal rotation of lead hip in comparison to non lead hip within the LBP group but no hip rotation range of

motion (ROM) difference between lead and nonlead hip within the group without LBP symptoms. Our result showed no discrepancy in both internal and external hip rotation between the left (lead) and right(non-lead) hip of the amateurs golfers. We don't know if playing at professional level which should require more vigor and severity of LBP symptoms contributed to this difference. In our study the amateur golfers had moderately severe LBP (ODI score was 15.24%) that didn't affect their game while the subjects used in Vad et al (2004) study had severe LBP symptoms that affected the quality of their play.

This current research could be justifiable compared to work of Nekoie and colleagues (2023)[17] who investigated hip rotation ROM in different low back pain subjects based on Movement System Impairment syndrome(MSI) classifications. They found out that all MSI categories of LBP had restricted external rotation of both hips when compared with subjects without LBP but found no such hip rotation ROM disparity among the MSI subgroups. Their finding is consistent with the findings of this present work. The work of Nekoie and colleagues (2023)[17] showed that the established deficiency in external rotation of all MSI groups when compared with subjects without LBP was not observed when the LBP groups were compared within themselves. This may also suggest that comparing LBP subjects with subjects without LBP could introduce a bias that cue low back pain subjects towards a more ROM hip deficit.

Going by the principal hypothesis of research of the hip motion–LBP Association which opines that deficiency of hip ROM may bring about changes in the mechanics of lumbopelvic area that could eventually lead to LBP[26,27,28] people like amateur golfers should be prone to hip function deficiency because of the frequent rotational demand encountered during golf play. This result is insinuating that the frequent rotational force the left hip of AG is subjected to did not affect their hip rotation range of motion when compared with subjects with LBP who notwithstanding do not frequently engage in any activity that put undo rotational demand on the hip. This is suggesting that perhaps the limited hip rotation ROM was a consequence of the LBP. It has been shown that LBP symptoms could in the long run lead to limitation of hip ROM[14]. Functional limitation of muscles originating or attaching to the hip have also been postulated as cause of rotation dysfunction[16]. Abnormal posture following LBP may affect these muscles with consequence of hip ROM dysfunction.

Other studies[14-17] have shown that patients who suffer from LBP have compromised hip function irrespective of their physical activity level. A study[17] on participants who were not engaged in any sporting activities showed that as a result of the low back pain, notwithstanding the type of MSI a significant limitations occurred in lateral hip rotation when compared to control group of healthy participants but reported no significant differences among the LBP subgroups. Even when golfers with LBP are compared to golfers without LBP[12] findings have shown that the LBP group have hip ROM deficit suggesting that LBP may be primarily contributing to the hip deficit and not really the hip dysfunction initially causing the LBP. This current study has shown that the desk-bound group with severe LBP symptoms (ODI score =30.18%) had a statistically significant external rotation ROM deficit of left hip than the amateur golfers with moderate severe LBP symptoms of 15.24% ODI score. Avman, Osmotherly, Snodgrass and Rivett (2019)[29] carried a system review to ascertain if there is any relationship between hip movement and Non specific LBP and concluded that there were not enough evidence to support the hip mobility - LBP relationship hypothesis. They however reported a link of hip internal rotation ROM deficit to nonspecific LBP participants in comparison to physically fit persons. These researchers concluded that hip dysfunction are regular occurrence in individuals suffering from low back pain.

Considering the fact that the two groups that were employed in this present work were all males, of similar physical characteristics and suffered from chronic LBP but differ only in activity demand the hip joints were subjected to, the restricted external hip rotation ROM observed in desk-bound subjects may have been the consequence of the low back pain. The result of our research is therefore suggesting that the hip ROM deficits observed in LBP subjects when compared with subjects without LBP in most other studies evaluating the hip deficit - LBP Association could be as a result of the already

existing low back pain. Since past researchers were not certain whether the observed hip rotation limitation was responsible for the LBP or that the abnormal posture/motion usually employed by LBP patients to cope with LPB symptoms lead to hip rotation dysfunction, future studies to investigate this association should avoid comparing LBP subjects with subjects without LBP but rather consider using subjects that are precisely similar in key variables like LBP categories, physical characteristics but differ in just one key independent variable like type of activity the hip is usually subjected to. We opined that using desk-bound low back pain subjects as control in this present research has assisted in eliminating the cross sectional limitations that affected past studies thereby further clarifying the ever evasive paradox of the hip function -LBP relationship.

Limitation

Among the limitation encountered during the course of this work is the relatively small sample size of 43 participants used in this study. Improving on sample size may raise the potential to recognize variations that presently did not show statistical difference and further improve confidence of the research outcome. Another limitation is the disparity of ODI score between the two groups. ODI mean score was 15.24% for amateur golfers' group and 30.18% for Desk-bound control group indicating difference severity level of LBP symptoms between the two groups. We did not investigate if this difference has any significance to the outcome of the result. It is therefore suggested that future research should be carried out using subjects who are more equivalent even in ODI score.

Conclusion

Findings revealed that the desk-bound group had a significant deficit in external rotation of the left hip compared to the amateur golfers, suggesting that LBP may be the cause of hip rotation limitations rather than the rotational forces experienced by the amateur golfers. The sample population used in this present research has assisted in eliminating the limitations that affected past studies thereby further clarifying the ever evasive paradox of the hip function -LBP relationship. Researchers in this field should investigate diagnosed LBP sports persons that engage in rotation-related sports with matched inactive participants with LBP, equivalent in ODI score, gender and physical characteristics to authenticate this finding.

Conflict of Interest Disclosure.

We have no conflicts of interest to disclose.

References

1. Barbee-Ellison J, Rose SJ, Sahrmann SA. Patterns of hip rotation range of motion: a comparison between healthy subjects and patients with low back pain. Phys. Ther. 1990; 70: 537-541.
2. Chesworth BM, Padfield BJ, Helewa A, Stitt L. A comparison of hip mobility in Patients with low back pain and matched healthy subjects. PHYSIOTHER CAN 1994; 46:267-274.
3. Cibulka M, Sinacore D, Cromer G, Delitto, A. Unilateral hip rotation range of Motion asymmetry in patients with sacroiliac joint regional pain. The Spine Journal 1998; 23:1009-1015.
4. Cibulka M. Low Back Pain and its relation to the hip and foot. Journal of Orthopaedic and Sports. Phys. Ther 1999; 29:595–601.
5. Mellin G. Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients. The Spine Journal 1988; 13:668–670.
6. Mellin G. Decreased joint and spinal mobility associated with low back pain in young adults. J. Spinal Disord. 1990; 3:238–243.
7. Wong T, Lee, R. Effects of low back pain on the relationship between the movements of the lumbar spine and hip. Hum. Mov. Sci. 2004; 23:21–34
8. Gulgin H. Hip Rotation Range of Motion Asymmetry in Elite Female Golfers. Ph.D. Thesis 2005; MI: Grand Valley State University MI
9. Gulgin H, Armstrong C, Gribble P. Passive hip rotation of motion in LPGA golfers. Clinical Kinesiology 2008; 62(2): 9-15.
10. Harris-Hayes M, Sahrmann S, Van Dillen L. Relationship between the Hip and Low Back Pain in Athletes Who Participate in Rotation-Related Sports: J. of Sport Rehabil. 2009;

18(1): 60-75. doi: 10.1123/jsr.18.1.60.
11. Vad V, Gebeh A, Dines D, Altchek D, Norris B. Hip and shoulder internal rotation range of motion deficits in professional tennis players. JSAMS 2003; 6:71–75
12. Vad V, Bhat A, Basrai D, Gebeh A, Aspergren D, Andrews J. Low back pain in professional golfers. The role of associated hip and low back range-of-motion deficits. AJSM 2004; 32:494-497.
13. Van-Dillen L, Bloom N, Gombatto S, Susco T. Hip Rotation Range of Motion in People With and Without Low Back Pain Who Participate in Rotation-Related Sports. Phys Ther Sport 2008; 9(2): 72 - 81
14. Van Dillen LR, Gombatto SP, Collins DR, Engsberg JR, Sahrmann SA. Symmetry of timing of hip and lumbopelvic rotation motion in 2 different subgroups of people with low back pain. Arch Phys Med Rehabil. 2007;88:351–60.
15. Lee S, Kim SY. Comparison of chronic low-back pain patients hip range of motion with lumbar instability. J Phys Ther Sci. 2015; 27(2):349 -351.
16. Prather H, Cheng A, Steger-May K, Maheshwari V, Van Dillen L. Hip and Lumbar Spine Physical Examination Findings in People Presenting With Low Back Pain, With or Without Lower Extremity Pain. J Orthop Sports Phys Ther. 2017;47:163–72
17. Nekoie FK, Mohammadi HK, Afshari-Safavi A, Jalali HM, Taheri N. Assessment of Hip Range of Motion Limitations in Cases with Low Back Pain Based on the Classified Movement System Impairment. Adv Biomed Res. 2023;12:169.
18. Baecke J, Burema J, Frijiters E. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. American Journal of Clinical Nutrition 1982; 36: 936- 942.
19. Nussbaumer S, Leunig M, Glatthorn J, Stauffacher S, Gerber H, Maffiuletti N. (2010). Validity and test-retest reliability of manual goniometers for measuring passive hip range of motion in femoroacetabular impingement patients, 2010; URL http://creativecommons.org/licenses/by/2.0, accessed 6th April 2023
20. Ono R, Hirata S, Yamada M, Nishlyama T, Kurosaka M, Tamura Y. (2007). Reliability And validity of the Baecke physical activity questionnaire in adult women with hip disorders, 2007; URL http://www.biomedcentral.com/1471-2474/8/61. accessed 20th March 2023
21. Fairbank JC, Pynsent PB, Van Poortvliet JA, Phillips H. Influence of anthropometric factors and joint laxity in the incidence of adolescent back pain. Spine 1984; 9(5):461–464.
22. Grimshaw PN, Burden AM. Case report: reduction of low back pain in a professional golfer. Med Sci Sports Exerc. 2000; 32(10):1667–1673.
23. Coplan JA. Ballet dancer's turnout and its relationship to self-reported injury. J Orthop Sports Phys Ther. 2002; 32(11):579–584.
24. Murray E, Birley E, Twycross-Lewis R, Morrissey D. The relationship between hip rotation range of movement and low back pain prevalence in amateur golfers: An observational study. Phys Ther Sport. 2009; 10:131–5.
25. Mohan Kumar G, Karthick M, Senthil Nathan CV, Aravind S. Hip Rotation Range Of Motion In People With And Without Low Back Pain Who Participate In Rotation-Related Sports. Journal Of Physiotherapy & Occupational Therapy. 2015; Vol. 1, Issue 2, 33-38
26. McGill SM. The biomechanics of low back injury: implications on current practice in industry and the clinic. J Biomech. 1997;30:465–475.
27. Sahrmann SA. Diagnosis and Treatment on Movement Impairment Syndromes, 2002; St Louis, MO: Mosby
28. Adams MA, Bogduk N, Burton K, Dolan P. The Biomechanics of Back Pain, 2002; Edinburgh, England: Churchill Livingstone
29. Avman MA, Osmotherly PG, Snodgrass S, Rivett DA. Is there an association between hip range of motion and nonspecific low back pain? A systematic review. Musculoskelet Sci Pract. 2019;42:38-51.