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Occurrence of Weak Links of Biokinematics Chain and Pain Feeling in The Lumbar Spine in Kayakers and Female Rowers – Preliminary Observation

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Abstract

Objectives: Determination of weak links presence in musculoskeletal system and pain feeling in the lumbar spine in kayakers and female rowers.

Methods: 40 players from Championship Sports School were tested: 8 female kayakers (FK), 12 male kayakers (MK), 13 male canadians (MC) and 7 female rowers (FR). Low and high threshold Performance Matrix Tests were used to identify the weak links of the musculoskeletal system in the lumbar spine. The analysis of weak links occurrence in biokinematics chain was performed, pain feeling was indicated in lumbar spine, the location and direction of weak links occurrence in the lumbar spine were identified and it has been examined whether it depends on gender using t-test, analysis of variance ANOVA and Tukey multiple comparison test.

Results: The average age of players was 16.00±0.99 (mean±S.D.), average length of trending period was 4.92±2.20. It has been found that there are weak links in the lumbar section of spine among the players. It has been proved that the discipline has no any influence on the weak links value in low threshold but in high threshold yes. It was noticed that the low and high threshold activity values do not affect significantly the occurrence of pain and it does not depend on sex.

Conclusions: Weak links have been noticed in the lumbar spine in all directions except extension. It was found that the choice of discipline has no significant effect on the value of the weak links in the low threshold activity and has a significant impact on the value of the weak links in high-threshold activity. The presence of weak links does not depend on gender. There was no statistical relationship between the weak links presence of high threshold in the lumbar spine and pain feeling.

Keywords: Musculoskeletal weak links; Low back pain (LBP)

Introduction

Back pain is a major clinical and social problem and it affects different segments and arises from various causes, but the effects are always the same, it causes limitation of human performance [1,2]. Most back pain occurs in lumbar and cervical part [3]. Pain in the spine is divided into specific, caused by a particular disease in the musculoskeletal system, or coming from outside and the non-specific back pain, which has no a particular reason and may result from musculoskeletal disorders, or come from outside the musculoskeletal system. Non-specific back pain are connected with 90% of cases [4,5]. Due to the duration of pain, pain in the spine is divided into acute, subacute and chronic. A common phenomenon is the occurrence of relapses and exacerbations of symptoms in each subsequent pain episode [6]. The most common predisposing factors for low back pain are: weightlifting and frequent lifting, long-lost bending and twisting the trunk, whole body exposure to vibration. Risk factors for cervical spine is to keep it in the bending position, prolonged static shoulder and neck muscle tension, long sitting position, sitting with the torso twisted and tilted, continuous movement repetition of upper limbs. Most psychosocial factors favoring back pain are: stress, anxiety, low job satisfaction, low income, depression. Individual predisposing factors for this pain, among others things are sex, age, fitness [3,7,8].

Pain feeling changes the tension of individual muscle groups, leads to the figure changing, motor control weakening and disorders in movement patterns [9-11]. Impaired motor control translates into a improper movement pattern and affects negatively the quality of the performed movement, and consequently the final effect of sports training techniques. Abnormal motor pattern increases the risk of injury, which often precedes dysfunction of musculoskeletal system. So it is necessary to seek effective tools for the musculoskeletal system evaluation. Taking into consideration the practical importance of this problem, studies were undertaken to determine the usefulness of Matrix Performance tests for assessing the level of exposure the musculoskeletal system of players practicing canoeing to dysfunction occurrence of dysfunction.

Materials and Methods

The studies covered 40 players from Championship Sports School in Walcz (Poland) included the 9 female kayakers (FK), 12 male kayakers (MK), 13 male canadians (MC) and 7 female rowers (FR). This is the only school in Poland dealing with such training. The average age was 16.00±0.99, the average length of training 4.92±2.20. Low and high threshold Performance Matrix Test were used to assess the presence of weak links [10]. By analyzing and identifying the motion performed by a player, the weakest links of the musculoskeletal system were found in the lumbar spine. Players were tested symmetrically, only in underwear. Tests were always assessed by the same investigator. Before the testing, the players were explained and shown how to execute the

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test. After the test, the results were inscribed in to the sheet. Five low-threshold tests were covered (1-standing control on slightly bent leg, 2-spine dissociation, 3-control of shoulder joint in standing, 4-limbs control with bent knee joints, 5-limbs control in lean kneeling) and five high threshold tests (1-limbs loading lying back with knees joints bent, 2-activity in front support, 3-loading of shoulder in standing, 4-loading in stride, 5-quick bounce of a foot).

Pain Numeric Rating Scale was used for the evaluation of low back pain [12]. Players determined the sensation of pain in the lumbar spine on this scale. 0 result stands for no sensation of pain, little pain 1-3, 4-6 moderate pain, 7-10 means maximum pain felt by the player.

The research has been done with the approval of the Local Ethics Committee in Poznan (Poland) and with the consent of the persons involved, and in case of underage with the consent of their parents or guardians.

Statistical Analysis

Because the samples have small numbers of observations, data were analyzed using the Student's t-test, the analysis of variance ANOVA test and Tukey multiple comparisons test. $P<0.05$ (*) was considered statistically significant; <0.01 (**) highly statistically significant; and <0.001 (***) very highly statistically significant. All statistical analyses were performed in R [13].

Results

Weak links for a low and height threshold

Carried out low and high threshold concept Performance Stability Tests have given the information, that in a group of 40 players weak links have occurred in lumbar part of spine. Low threshold activity tests show that the most weak links in lumbar part have been observed in direction of rotation 38 (41.76%), next lateral flexion 31 (34,07%), in direction of flexion 22 (24.18%). The weak link in upright direction was not noticed.

However for high threshold activity tests the highest number of weak links was recorded in the direction of rotation and lateral flexion, 39 (29.12%), for flexion movement weak links occurred in 38 (41.76%) players. For the extension motion in the lumbar spine, there was no weak links.

Figure 1 shows a preliminary statistical analysis of the weak links of low and high threshold activity within each group of players including the median, first and third quartile, min, max and outliers.

The next stage of analysis was to compare the weak links of low and high threshold in the highlighted group (Table 1) and ANOVA for weak links of low and a high threshold with regard to discipline (Table 2).

P values in the Table1 indicate if weak links of low threshold differ significantly from weak links of high threshold within a group.

As you can see, the value $Pr(>F) = 0.062$ in Table 2a indicates that the choice of discipline has no significant effect on weak links of low threshold. But the value $Pr(>F) = 0.00011$ in Table 2b indicates that the choice of discipline has a significant impact on the weak links values in high threshold.

Analysis of low back pain (LBP)

Among 40 players 24 felt pain in the lumbar spine. Among 8 female kayakers 4 felt the pain (50.00%), while from the seven female rower group 6 rowers felt the pain (85.71%). Also, the 7 (53.85%) from 13 kayakers involved in the study felt the back pain. However, among 12 canoeists only 7 (58.33%) reported pain.

If we evaluate the presence of back pain taking into account the 10th progressive numerical scale 16 (40.0%) players have indicated no pain, no player has assessed the pain as 1 or 2, 10 (25.0%) rated the pain as 3, 3 (7.5%) identified pain sensation in a numerical scale as 4, 6 and 7, 2 (5.0%) marked feeling of pain as 5 and 8, one player (2.5%) described the back pain as 10.

The next stage has been to check whether there is a relationship between the presence of weak links and occurrence of pain in the lumbar spine and whether it depends on gender.

Comparison of weak links occurrence of low and high threshold in the lumbar spine in women and men was verified by Mann-Whitney test. For women p-value = 0.008**, while for men p-value <0.0001***.

ANOVA analysis was performed for the weak links of low and high threshold in regard to LBP for men and women (Table 3).

Because the value Pr(>F) in the last column of Table 3a are equal to 0.184 and 0.818 it should be noted that the values of the weak links of low and high threshold for women do not affect significantly the value of LBP. However, because the value Pr(>F) in the last column of Table 3b are equal to 0.182 and 0.765 so it should be noted that the weak links of low and high threshold for men do not affect significantly the value of LBP.

In order to determine the value of LBP according to sex and the weak links of low and high threshold ANOVA variation has been performed simultaneously (Table 4).

The values presented in the last column of Table 4 indicate that there is no gender influence on LBP value.

The next step of statistical analysis was to conduct Tukey multiple comparison test (Figure 2).

Figure 2 shows that for the low threshold comparing discipline using Tukey test, it has not been received any pair which differs significantly. Next, for the high threshold comparing discipline: FK vs. MC and FK vs. MK are statistically significant.

Discussion

The results obtained from tests of low and high threshold activity provided information that weak links occur in players (Figure 1). Most of weak links of the musculoskeletal system were recorded in the lumbar spine in a direction toward the rotation in 38 competitors in low threshold tests and in 39 players in high threshold tests (Figure 1). The direction of lateral flexion in low threshold tests in 31 players and high threshold tests in 39 sportsmen. Weak link has been observed in low threshold tests in the direction of bending in 22 competitors and in high threshold in 38 (Figure 1). The comparison of weak links in a particular group and ANOVA indicate that the trained discipline has no significant effect on the value of weak links in low threshold activity (Table 1, Table 2). For a value of high threshold activity trained discipline has a significant impact (Table 1, Table 2). It can be assumed that the Performance Matrix tests are reliable diagnostic tool to evaluate musculoskeletal system [14,15]. Their application allows for proper

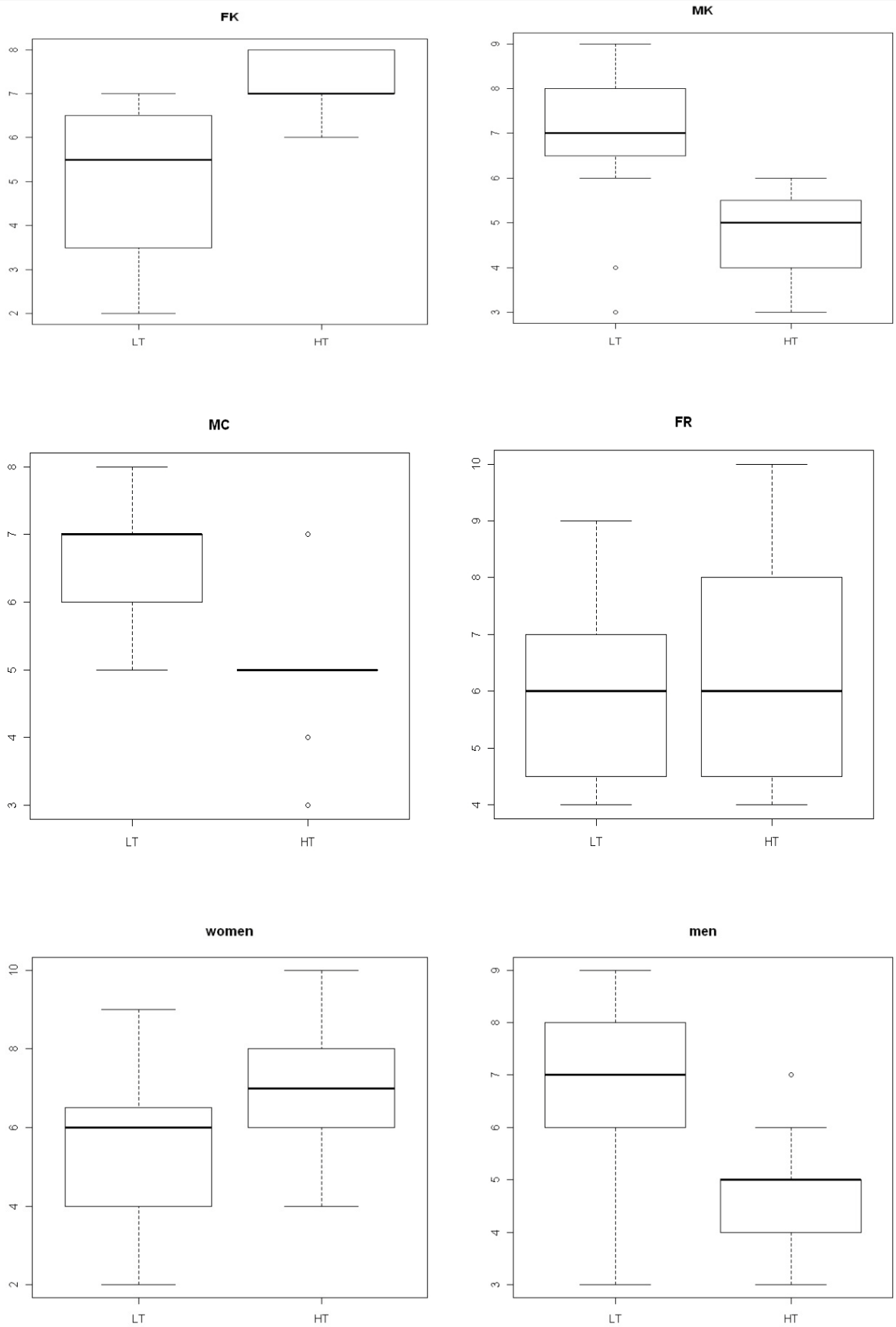

Figure 1: Weak links for a low (LT) and high (HT) threshold group [FK female kayakers, MK male kayakers, MC male canadians, FR female rows].

evaluation of the system players and in a further practical application for the selection of the proper physiotherapy procedure. These tests are characterized by their reliability and easiness of implementation, assessing player holistically. There are standardized protocols used in players. These include: Extended Nordic Musculoskeletal Questionnaire developed by Dawson and coauthors, Initial Screening Questions prepared by Berg-Rice and coauthors [16].

In sports training, it is important to use the protocol or pain rating scale. Because the pain factor is often an integral part of players. In practice, Visual Analogue Scale and the protocol of The Orebro Musculoskeletal Pain Screening Questionnaire are often used to assess pain [16,17].

Comparisons groups	t	p-value	95% confidence interval
FK	-3.334	0.012*	(-3.846; -0.654)
MK	5.000	0.0004***	(1.166; 3.000)
MC	4.811	0.0004***	(1.052; 2.794)
FR	-0.452	0.667.	(-2.747; 1.890)
Women	-2.333	0.035*	(-2.687; -0.113)
Men	7.071	<0.00001***	(1.416; 2.584)

Table 1: Comparison of the weak links of low and high threshold in the highlighted group [FK female kayakers, MK male kayakers, MC male canadians, FR female rows].

(a)

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Discipline	3	20.426	6.809	2.665	0.062
Residuals	36	91.974	2.555		

(b)

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Discipline	3	42.618	14.206	9.272	0.00011***
Residuals	36	55.157	1.5321		

Table 2: ANOVA for weak links of low (**a**) and high (**b**) threshold according to discipline.

(a)

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
WLLT	1	21.233	21.233	1.992	0.184
WLHT	1	0.591	0.591	0.055	0.818
Residuals	12	127.909	10.659		

(b)

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
WLLT	1	13.642	13.642	1.903	0.182
WLHT	1	0.657	0.657	0.092	0.765
Residuals	22	157.701	10.659		

Table 3: ANOVA for LBP in regard to weak links of low and high threshold for female (**a**) and male (**b**), where the WLLT denote weak links for a low threshold and the WLHT denote weak links for high threshold.

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sex	1	7.04	7.04	0.886	0.353
Low threshold	1	34.43	34.43	4.331	0.045*
Height threshold	1	1.15	1.15	0.145	0.071.
Residuals	36	286.157	7.949		

Table 4: ANOVA investigating the impact of gender, weak links of low and high threshold on LBP values.

Among the respondents (n = 40) 24 people reported pain feeling in the lumbar spine. In a subjective study participants reported no root pain and any injuries in the lumbar spine. The rate of pain feeling reported by the respondents indicates a sensation of pain as small, moderate and even the maximum. Depending on the sports specialization, most described pain feelings have been reported by kayakers and female rowers.

Motor system is the most common source of pain in human body. Pain sensations contribute to reducing the function of the musculoskeletal system. Canoeists and female kayakers training is characterized by maximum training loads, which often exceeds the possibilities of players adaptability. Overloaded changes are signalized by pain. It prevents not only from obtaining the master results, but also decreases participation in physical activity. Pain warns the body of the harmful factors and function disorders. The mechanism of pain sensations corresponds to peripheral and spinal mechanisms [18]. It is difficult to answer precisely, what causes the sensation of pain in obtained results of pain assessment by the players. Muscle pain caused by exercise is short and results from impaired blood flow to working muscles [19].

Obtained values Pr(>F) from low and high threshold tests have not proved, both in women and men, that weak links occurrence has an influence on back pain presence (Table 3a, Table 3b). The data obtained from the analysis of variance ANOVA has indicated no effect of gender on the pain perception in the lumbar spine (Table 4). Comparison of values by Tukey test has not indicated the presence of pair which differs significantly in trained discipline (Figure 2)

Perhaps pain feeling in the lumbar spine among respondents was associated with a transverse abdominal muscle and multifidus muscle's weakness. These muscles are attributed to a particularly important role in the segmental stabilization of lumbar spine [20,21]. Female kayakers trunk during rowing is tilted towards the front, long-term maintenance of the trunk in a flexion makes multifidus muscle function weaker as a local stabilizer of the lumbar spine [22].

The occurrence of weak links in the musculoskeletal system among kayakers indicates a need to introduce segmental stabilization exercises to sports training as a therapeutics program which would protect against dysfunction and injury. It has been proved that the implementation of segmental stabilization training in a process of players training reduces the number of weak links and protect the players from pain in the lumbar spine [23]. It is assumed that the deep myofascial system increases the joints stiffness of the lumbar spine and pelvis. This condition is necessary for physical activity. Efficiently working cylinder (trunk muscles) allows to proper load transfer [22]. Impaired stability and weak links in musculoskeletal system cause muscle tension disorders. Appearing muscle imbalance affects the joint biomechanics leading to deterioration of its function. Muscle imbalance is a situation in which some muscles are reflexively inhibited and attenuated, while other muscles become overly active, tense and inflexible [14].

Rheumatology key messages

In players weak links occur in the lumbar spine. In low and high

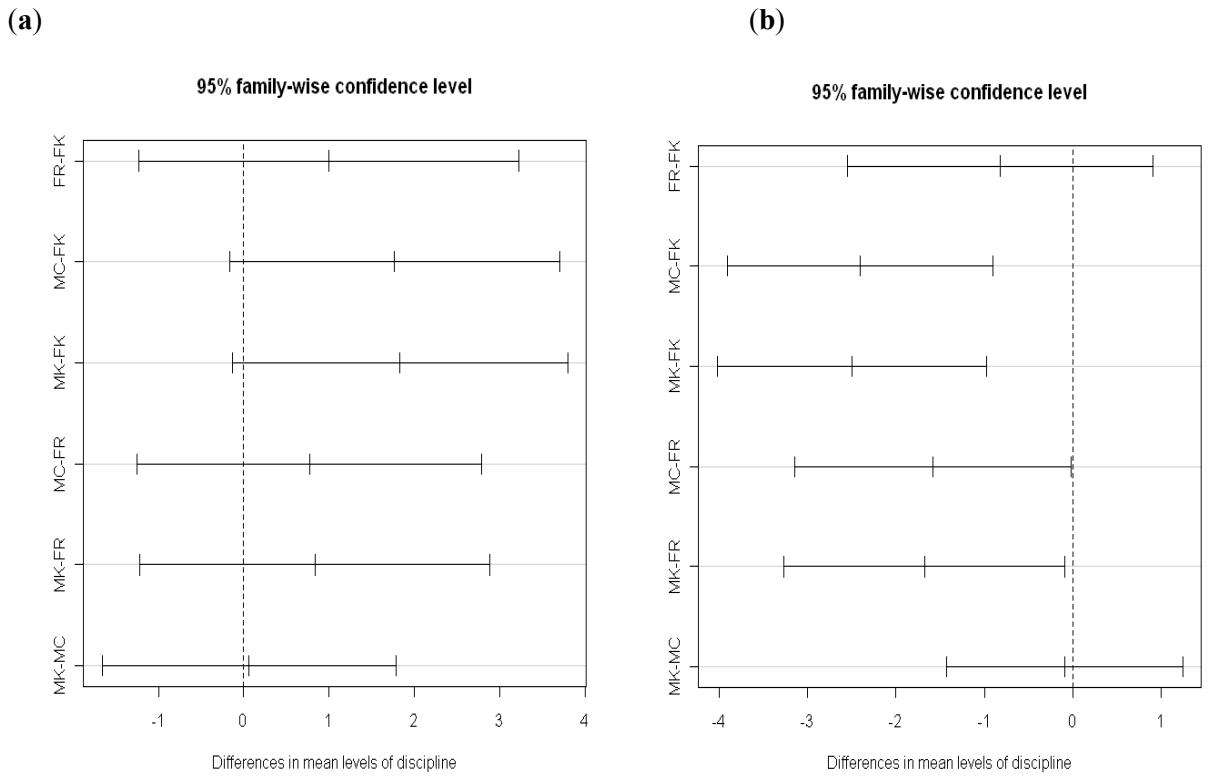

Figure 2: Tukey multiple comparisons for (a) low and (b) high threshold.

threshold activity tests weak links have been noticed in the direction of rotation, lateral bending, in the direction toward the bend. There were no weak links in the lumbar spine in the direction of extension.

- The presence of weak links does not depend on gender.
- In tested players reported the presence of pain in the lumbar spine.
- The choice of discipline has a significant impact on the value of weak a links in high threshold activity.

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