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PROSPECTS FOR THE USE OF THE "BIODEX BALANCE SYSTEM SD" DEVICE FOR TESTING THE BODY'S ABILITY TO MAINTAIN BALANCE ("CORE STABILITY") AND ITS TRAINING IN WRESTLING SPORT

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Annotation. Nowadays, sport requires maximum efforts, which is accompanied by an increase in the level of both acute and chronic injuries. Accordingly, many studies were conducted aimed at studying the factors affecting the injury rate, including investigations, showing the relationship between the core stability level and the injury rate. Different types of tests, measuring core stability, were created, attempting to predict the risk of injury and many training programs for different sports were developed, aimed to help to build the strong core. Wrestling is a sport highly demanding to core. Without improved core stability wrestlers are unable to show high performance and are predisposed to suffer from different acute and chronic traumas, so core stability in wrestling is of great interest in terms of injury prevention and results enhancement. The use of innovations, specially designed for this goal, such a **Biodex Stability System SD**, can significantly help in this.

Keywords: *core, core stability, trunk muscles, kinetic chain, neuromuscular control, wrestling sport.*

Core stability. Conception of core stability (CS) was introduced for the first time in 1990s by (Hodges and Richardson) during studying the trunk muscles activation pattern on patients with chronic low back pain [1].

Core stability and core strength definetion, integrating the following components such as core strength, endurance, power, static and dinamic balance, which based on the coordination of the spine, abdominal, and hip musculatures [2]. It includes the lumbo-pelvic-hip complex and can be explained as the ability to maintain balance of the vertebral column. It is also the base of the kinetic chain which is responsible for transferring the force between the lower and upper extremities for different types tasks of sport and daily living [3]. Panjabi explains mechanisms of core stabilization, dividing it at 3 subsystems: passive, active, and neural control. The passive subsystem is the static tissues, such vertebrae, intervertebral discs, ligaments, joint capsules, and the passive properties of muscles. The function of these tissues is to stabilize in the end range of motion as tensile forces increase and mechanical resistance to movement is produced, as well as to transmit position and load information to the neutral control subsystem via mechanoreceptors. The active subsystem consists of the core musculature and provides dynamic stabilization to the spine and proximal limb, and at the same time delivery information to the neural control subsystem. The neural subsystem is the main center for incoming and outgoing signals that produce and maintain core stability. No one subsystem acts or works separate from another; complex interaction among all 3 subsystems maintain stability [4].

Specific exercises can be recommended to use in training program to improve the function of one of these subsystems separately or together.

The definition of "core stability" is inextricably linked to definition of "core"

One of the world renowned authority in this field Akuthota V. described the abdominal core as 'a muscular box with the abdominal muscles in the front and sides, paraspinals in the back, diaphragm as the roof, and pelvic floor muscles as the bottom' [5].

In article "Core strengthening" he referred the "core" as the "lumbopelvic-hip complex, is a 3-dimensional space with muscular boundaries: diaphragm (superior), abdominal and oblique muscles (anterior-lateral), paraspinal and gluteal muscles (posterior), and pelvic floor and hip girdle (inferior)" [3].

Next structures create what we call "core"[3]:

Osseous and ligamentous structures of the vertebral column
Thoracolumbar fascia
Paraspinals muscles
Abdominals muscles
Hip girdle musculature
Diaphragm and pelvic floor

Therefore, definition "core" comprises passive and active subsystems and we can say, that core stability consists of "core" and neural component, which control the "core".

Osseous and ligamentous structures. Osseoligamentous structures of the lumbar spine create passive stiffness (tissue injury to any of these structures immediately cause functional instability. The main elements of the spine are the pedicle, lamina, zygapophyseal (facet) joints and pars interarticularis. These structures are flexible, but repetitive loading with excessive lumbar flexion and extension causes damage [6]. The structure of the intervertebral disk - annulus fibrosis, nucleus pulposus, and the endplates. The spinal ligaments provide stability, but no so much, especially in the neutral zone. Their more important role may be to provide afferent proprioception of the lumbar spine segments [7].

Thoracolumbar fascia. The thoracolumbar fascia a "nature's back belt." It works as a strong fibrosis strap of the core muscles. This structure consists of 3 layers: the anterior, middle, and posterior layers. The posterior layer, which consists of 2 laminae: a superficial lamina, which, in turn, is the aponeurosis of the latissimus dorsi muscle, with fibers passing downward and medially and a deep lamina with fibers passing downward and laterally, has the most important role in supporting the lumbar spine and abdominal musculature[8]. In point of fact, the thoracolumbar fascia provides a link between the lower limb and the upper limb [9]. With contraction of the corresponding muscles, the thoracolumbar fascia acts as an activated proprioceptor, like a back belt and provide feedback in lifting activities.

Anatomy of the Core Muscles

Tab. 1 Akuthota V, Nadler SF. Core strengthening. Arch Phys Med Rehabil. 2004;85(3)(suppl 1):S86-S92 [PubMed]

Muscles of the Lumbar Spine	
Global Muscles (dynamic, phasic, torque producing)	**Local Muscles (postural, tonic, segmental stabilizers)**
Rectus abdominis	**Multifidi**
External oblique	**Psoas major**
Internal oblique (anterior fibers)	**Transversus abdominis**
Iliocostalis (thoracic portion)	**Quadratus lumborum**
	Diaphragm
	Internal oblique (posterior fibers)
	Iliocostalis and longissimus (lumbar portions)

Paraspinals muscles. We distinguish 2 parts of the lumbar extensors: the erector spinae and the local muscles (intertransversi, rotators, multifidi). The erector spinae in the lumbar region is consist of 2 major muscles: the longissimus and iliocostalis[10].

The multifidi works as segmental stabilizers.

The quadratus lumborum is large muscle and has 3 major components: the inferior oblique, superior oblique, and longitudinal part. The longitudinal and superior oblique fibers designed as secondary respiratory muscles and stabilize the twelfth rib during respiration. The inferior oblique fibers are the additional lateral flexors of the lumbar vertebrae. The quadratus lumborum is a major stabilizer of the spine and work mostly isometrically [12].

Abdominals. The abdominals are a most important component of the core, especially the transversus abdominis. Isolated activation of the transversus abdominis looks like “hollowing in” of the abdomen. The transversus abdominis has to be activated before limb movement in healthy people to stabilize the lumbar spine, whereas patients with LBP have a delayed activation [13]. Together, the internal oblique, external oblique, and transversus abdominis increase the intra-abdominal pressure thus providing functional stability of the lumbar spine [10]. The external oblique, the largest abdominal muscle controls anterior pelvic tilt. It also acts eccentrically in lumbar extension and lumbar torsion [14]. Rectus abdominis and internal oblique development often incorrectly overemphasized, as we can see in most training programs, thus creating an imbalance with the relatively weaker external oblique [15]. The external oblique can be stimulated by some of the exercises, particularly those that emphasize isometric or eccentric trunk twists [16].

Hip girdle musculature. The hip musculature plays a significant role in all types activities, slow and fast, espesially in stabilization of the trunk and pelvis, and in transferring force from the lower extremities to the pelvis and spine [17]. Poor endurance and delayed response of the hip extensor (gluteus maximus) and abductor (gluteus medi us) muscles have been observed in people with lower-extremity instability or LBP [18]. Nadler et al showed a significant asymmetry in hip extensor strength in female athletes with reported LBP and a significant negative association between hip strength and imbalance of the hip extensors measured during the preparticipation physical and the occurrence of LBP in female athletes [19]. Also, the hip appears to play a significant role in transferring forces from the lower extremities to the pelvis and spine, acting as maybe the most important link within the kinetic chain.

The psoas major is a long muscle which primarily actions as flexor of the hip. But, its attachment sites into the lumbar spine give it the potential to participate in spinal biomechanics. The psoas muscle has 3 proximal attachment sites: the medial half of the transverse processes from T12 to L5, the vertebral body adjacent to the disk and the intervertebral disk [6]. The psoas does not likely provide much stability to the lumbar spine (exception is the increased lumbar flexion) [10]. But increased stability requirements or a tight psoas will cause increased, compressive, injurious loads to the lumbar disks.

Diaphragm and pelvic floor. The diaphragm is the roof of the core. It plays role in core stability by increasing the intra-abdominal pressure while contraction. Some studies have indicated that people with sacroiliac pain have impaired recruitment of the diaphragm and pelvic floor. Likewise, ventilatory challenges on the body lead to further diaphragm dysfunction and create more compressive loads on the lumbar spine [20]. Therefore, diaphragmatic breathing techniques may be an important part of a core-strengthening program.

- **The pelvic floor musculature** consists of several muscles like Coccygeus, Iliococcygeu, Pubococcygeus, Puborectalis and also is coactivated with transversus abdominis contraction [21].

Core stability assessment. It is very difficult task to assess the core with just one test, taking into account that the musculature of the core consist of intricate, integrating elements, working synergistically to provide stability to the spine. Researchers often used an array of tests to measure parameters of the core (strength, endurance, power) [22]. Measurement of core stability is more challenging than only core muscles parameters as it requires incurporating coordination and balance. Selecting the single test to fully evaluate core stability is very difficult because of complex interaction of all structures.

During the past decades a lot of tests was developed in attempt to assess core stability. It is possible to divide them into several groups – measuring the strength of core muscles, measuring the endurance, flexibility, motor control and functional tests.

These are the most known examples:

Strength tests – measure the maximum force, produsedby the relevant core muscles

flexion (a), extension (b) and lateral flexion (c).

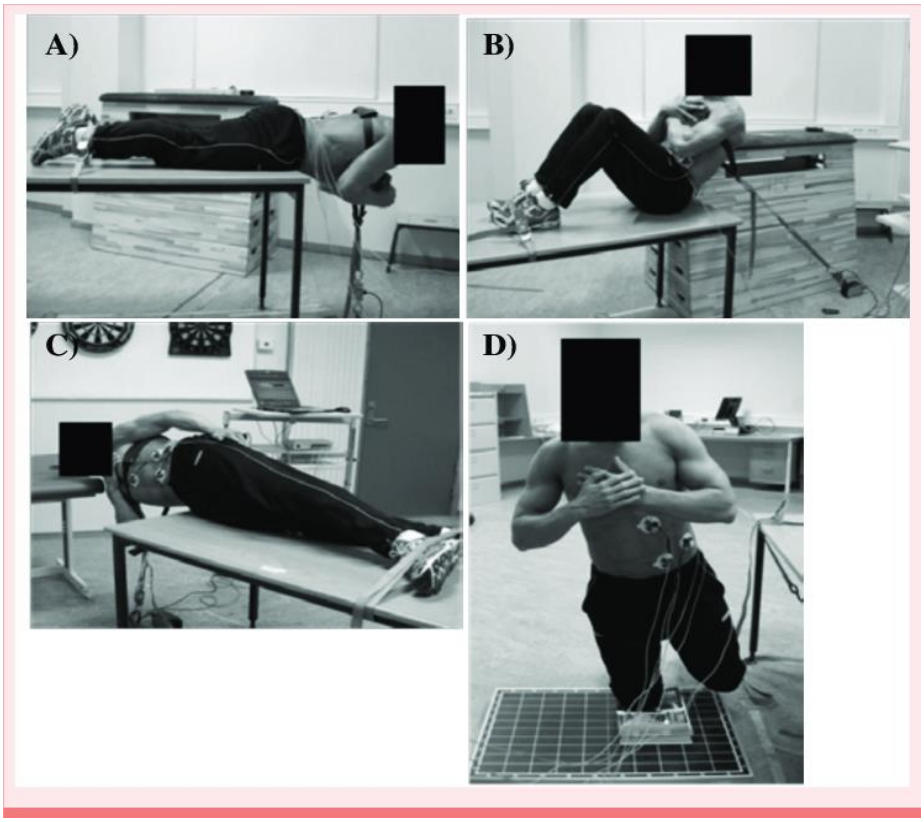

Figure 1. Saeterbakken, Atle & Fimland, Marius & Navarsete, Jonas & Kroken, Trine & Tillaar, Roland. (2015). Muscle Activity, and the Association between Core Strength, Core Endurance and Core Stability. Journal of Novel Physiotherapy and Physical Rehabilitation. 2. 55-61. 10.17352/2455-5487.000022.

Endurance tests – measure the time of holding positions, relevant to the core muscles
Flexibility test - sit and reach test

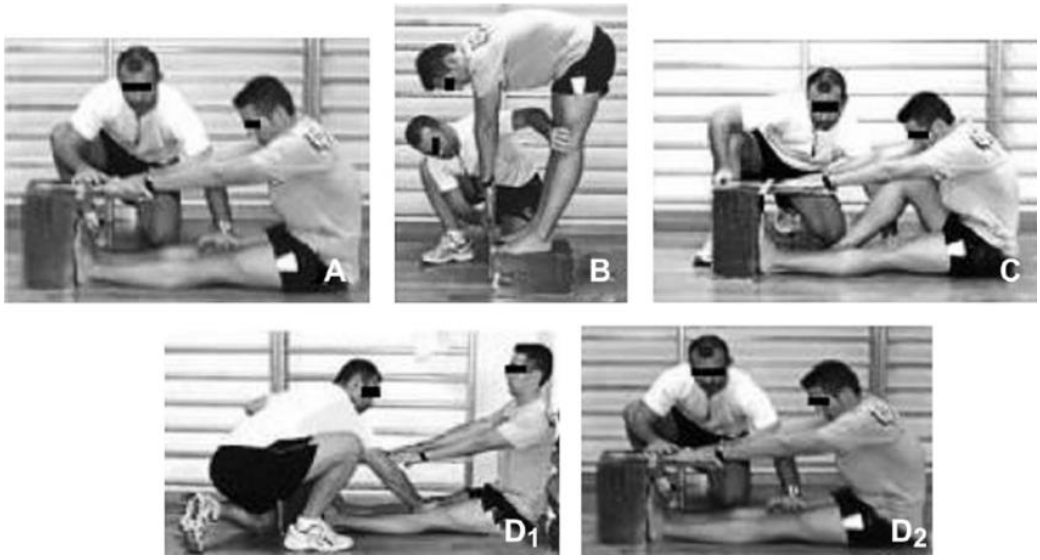

Figure 2. Ayala, Francisco & Sainz de Baranda, Pilar & De Ste Croix, Mark & Santonja, Fernando. (2011). Criterion-related validity of four clinical tests used to measure hamstring flexibility in professional futsal players. Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine. 12. 175-81. 10.1016/j.ptsp.2011.02.005.

Functional movement screening (FMS) - a battery of tests, aimed to predict injury rate.
Functional movement screening (FMS)

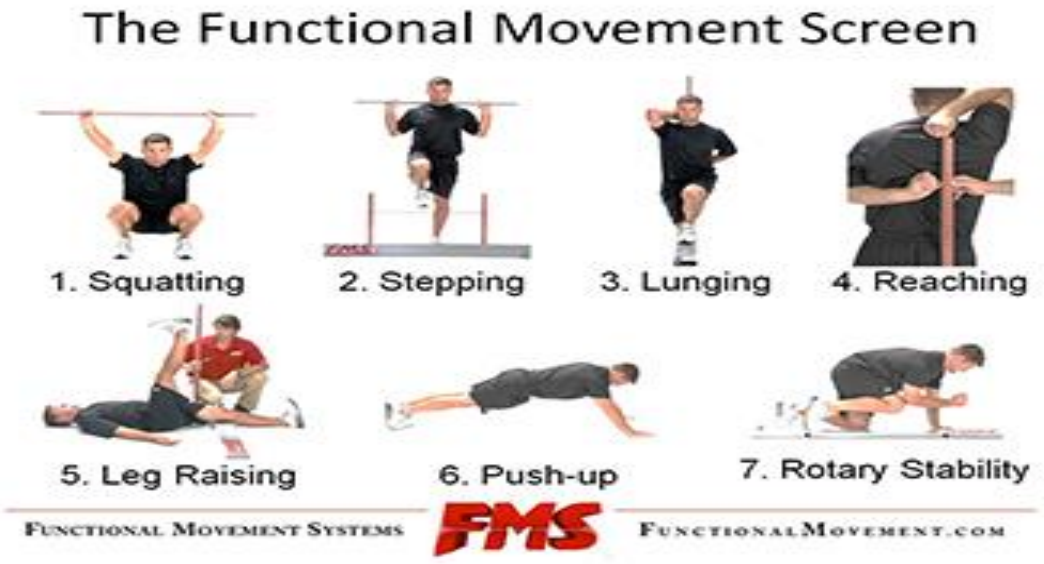

Figure 3 Cook G, Burton L, Hoogenboom BJ, Voight M. Functional movement screening: the use of fundamental movements as an assessment of function-part 2. International Journal of Sports Physical Therapy. 2014 Aug;9(4):549-563. PMID: 25133083; PMCID: PMC4127517.

We can also mention newly developed 2 tests - The Prone Plank Test (PPT) and Closed Kinetic Chain Test (CCT), which both demonstrated good test–retest reliability and acceptable error measurement [24].

Andy Waldhelm in his dissertation "Assessment of core stability: developing practical models." tried to make comparison between 35 chosen widely used tests, divided in several groups.

Table 2. Groups of tests related to core stability (Waldhelm, Andy. "Assessment of core stability: developing practical models." (2011).)

Strength	Endurance	Flexibility	Motor control	Functional
Trunk flexion Trunk extension Right hip extension Left hip extension Right abduction Left abduction Right hip ER Left hip ER	Trunk flexion Trunk extension Right Side Bridge Left Side Bridge	Sit and Reach Trunk flexion Trunk extension Right trunk rotation Left trunk rotation Right hip extension Left hip extension Right hip IR Left hip IR Right hip ER Left hip ER	Right SLB vision Left SLB vision Right SLB blindfold Left SLB blindfold Right hip reposition Left hip reposition	Squat Right hop distance Left hop distance Right hop timed Left hop timed

He found the all tests to be reliable with the core endurance tests were the most reliable measurements, followed by the flexibility, strength, motor control, and functional tests.

The Biodex Balance System SD is newly developed device, which has been designed for diagnoses of core stability's level and also to improve balance, increase agility, develop muscle tone and treat a wide variety of pathologies. It is also a tool in the growing field of Fall Prevention. It has several futures:

Visual Biofeedback - real-time biofeedback prompts patients

into proper postural and balance control

- Six Training Modes and Five Testing Protocols

– for extreme and standardized testing

- Standardized Fall Screening and Athlete Knee Injury

Screening Tests - to identify fall candidates and athletes predisposed to knee injury.

- Twelve Levels of Platform Control as well as Static Force

settings – allows testing, training and rehabilitation programs for diverse populations

- Balance Training – includes proprioception and stabilization

exercise, range of motion and weight shift exercises

- Objective Documentation – printed color reports track progress and document outcomes
- Locking Surface – ensures safe "on and off" patient movement
- Adjustable Support Handle – locks in placefor safety or swings away foran unobstructed open environmentallowing a variety of training activities

It has several applications for testing and training:

For testing

The Postural Stability Test
- The Limits of Stability Test
- Athlete Single Leg Stability Testing
- Performing a Fall Risk Test

Training Modes:

- Postural Stability Training
- Limits of Stability (LOS) Training
- Weight Shift Training
- Maze Control Training
- Random Control Training
- Percent Weight-Bearing Training

Four test protocols, six training modes allows testing and training in both static and dynamic formats. Using this device, clinicians can assess neuromuscular cotrol by by quantifying the ability to maintain dynamic bilateral and unilateral postural stability on a static or

unstable surface. The degree of surface instability is controlled by the system's microprocessor-based actuator. It is possible to selects the test duration, stability level and protocol.

Validity and reliability of the tests protocols of Bidex Balance System (BBS) was assessted in many investigations. Arifin N et al found that intrarater agreement was very good or excellent (ranged from 78% to 85% and 65% to 77% during static and dynamic condition, respectively) and made conclusion that the BBS is a reliable tool for postural assessment [25]. According to Zarko Krkeljas al BBS should be used for rehabilitation and assessment of lower limb injuries, especially relating to the lower limb [26]. The results of Cachupe, Wendy J.C. justify that despite of small sample size, the reliability estimates observed for BBS measures of dynamic balance at a spring resistance level of two at least among healthy, athletic adults are very high [27]. The study of U Lindemann et al indicates that athlethes can improve balance, using computer-assisted balance training, given by BBS and focusing on motor skill[28].

As we can conclude, BBS is the reliable and innovative tool, appropriate for both testing, training and rehabilitation of the athletes.

To date, despite of wrestling is very popular Olympic category sport, which widely distributed all around the world and demanding very high level of core muscles strength and core stability development, there are a few investigations, concerning core stability and performance in wrestling. We can only mention investigation of Dande, Jahnavi, in which they, using static core stability tests (Bliss test protocol) and dynamic core stability tests (isoinertial tests) found the relationship between core stability and low back pain (LBP) [29].

Taking it all into account, it is possible to say, that BBS has shown great promise as tool for assessment and training of core stability in wrestling sport.

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GÜLƏŞ İDMAN NÖVÜNDƏ BƏDƏNİN TARAZLIĞI SAXLAMAQ QABİLİYYƏTİNİN SƏVİYYƏSİNİN ("KOR" SABİTLİYİ") ÖLÇMƏSİ VƏ ONUN MƏŞQ EDİLMƏSİ ÜÇÜN "BIODEX BALANCE SYSTEM SD" CİHAZININ İİSTİFADƏSİ PERSPEKTİVLƏRİ

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Annotasiya. Bu günlərdə idman maksimum səy tələb edir ki, bu da həm kəskin, həm də xroniki zədələrin səviyyəsinin artması ilə müşayiət olunur. Bədənin tarazlığı saxlama qabiliyyəti və zədə arasında əlaqə də daxil olmaqla, zədələnmə dərəcələrinə təsir edən amilləri araşdıran bir çox tədqiqatlar aparılmışdır. Zədələnmə riskini qiymətləndirmək üçün müxtəlif növ testlər yaradılmış və bir çox məşq proqramları hazırlanmışdır. Güləş tarazlığı saxlama qabiliyyətinə xüsusi tələb qoyur. Tarazlığı saxlama qabiliyyəti zəif olarsa güləşçilər yaxşı çıxış edə bilməz və müxtəlif kəskin və xroniki zədələrə meyllidirlər, buna görə də güləşdə bu göstərici zədələrin qarşısının alınması və nəticələrin yaxşılaşdırılması baxımından böyük maraq doğurur. Biodex Stability System SD kimi bu məqsəd üçün xüsusi olaraq hazırlanmış innovasiyaların istifadəsi buna çox kömək edə bilər.

Açar sözlər: *"core", "core" sabitliyi, gövdə əzələləri, kinetik zəncir, sinir-əzələ nəzarəti, güləş idman növü.*

ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ АППАРАТА «BIODEX BALANCE SYSTEM SD» ДЛЯ ТЕСТИРОВАНИЯ СПОСОБНОСТИ ТЕЛА СОХРАНЯТЬ РАВНОВЕСИЕ («СТАБИЛЬНОСТЬ КОРА») И ЕГО ТРЕНИРОВКИ В СПОРТИВНОЙ БОРЬБЕ

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Аннотация. В наши дни спорт требует максимальных усилий, что сопровождается увеличением уровня как острых, так и хронических травм. Было проведено множество исследований, направленных на изучение факторов, влияющих на уровень травматизма, в том числе показывающих взаимосвязь между способностью тела поддерживать баланс и травматизмом. Были созданы различные типы тестов с целью оценки риска травм, и было разработано множество программ тренировок. Борьба - это спорт, требующий больших усилий. Без улучшенной устойчивости борцы не могут показать высокие результаты и предрасположены к различным острым и хроническим травмам, поэтому этот показатель в борьбе представляет большой интерес с точки зрения предотвращения травм и улучшения результатов. В этом может существенно помочь использование специально разработанных для этой цели инноваций, таких как Biodex Stability System SD.

Ключевые слова: *«кор», устойчивость «кора», мышцы туловища, кинетическая цепь, нервно-мышечный контроль, спортивная борьба.*