

CONTEMPORARY PERSPECTIVES OF CORE MUSCLE STRENGTH AND STABILITY TESTING

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Annotation. *This paper presents an overview of core muscle strength and stability testing. In comparison with traditional measurements of maximum isometric strength of the back muscles and their endurance, novel methods for assessment of power produced during lifting tasks and trunk rotations have become used in sports and rehabilitation practice. This new approach provides more specific conditions for detecting modest changes in core strength and stability after exercise programs and is more sensitive in distinguishing core performance in individuals of different ages and fitness levels.*

Keywords: *sports rehabilitation practice, back muscles, endurance, new methods of strength assessment, level of physical fitness.*

Assessment of core performance during lifting tasks

A deadlift to high pull exercise, which engages major muscle groups including the lower and upper back, erector spine, abdomen, gluteus maximus, quadriceps, and hamstrings, is used to assess the power produced during a lifting task. The exercise is performed with stepwise increasing loads using the Smith machine or free weights until the individuals reach their maximum values of power. The use of these values for assessing the lifting performance is considered to be a more appropriate alternative than the traditional 1RM approach. This test is reliable (Zemková et al., 2016) and sensitive in revealing within and between-group differences in power performance and its changes during exercise programs (Zemková et al., 2017d). The deadlift to high pull with free weights is also a specific exercise close to the lifting requirements of particular work and daily activities. It may be applied for functional testing of workers whose work involves lifting tasks, as well as healthy people engaging in sedentary behavior.

However, higher additional loads during the deadlift to high pull should be avoided in sedentary people. Instead, one can assess their ability to develop a high force in a short period of time during maximum voluntary isometric contraction (MVC) of the back muscles (Zemková et al., 2019b). While the peak rate of force development measured during MVC of the back muscles could predict a lifting performance at light loads, a greater isometric back muscle strength is needed for power production at heavier loads. Alternatively, the subjects' ability to differentiate the strength of back muscle contraction may be estimated (Zemková, Jeleň,

2020). We have found that force regulation during MVC of the back muscles under fatigue is more precise when force feedback is applied.

Assessment of core performance during trunk rotations

Assessment of velocity and power during trunk rotations using torso isoinertial dynamometers provides reliable data (Zemková, 2019) and is also sensitive in discriminating trunk rotational velocity in athletes of different sports. However, to simulate testing conditions specific to demands imposed by sports, a pulley system and an external dynamometer can be used for assessing the rotational power (Andre et al., 2012). This test is suitable for sports like canoeing, however, for many other sports including baseball, golf, tennis, hockey, or karate, trunk rotations performed in a standing position represent a more specific alternative. The test adapted from the standing cable woodchop exercise can be used for this purpose to avoid this shortcoming. Subjects perform single repetitions of this exercise with increasing weights up to the one at which maximal values of power are achieved. They perform a set of a predetermined number of repetitions at a previously established weight to assess the strength endurance of the trunk muscles. This test is both reliable and sensitive in discriminating trunk rotational power among physically active individuals (Zemková et al., 2017a).

Another alternative represents a test consisting of single repetitions of trunk rotations with a barbell of different weights placed on the shoulders. Subjects perform trunk rotations to each side per load, with maximal effort in the acceleration phase, up to the one at which

maximal values of power are achieved. This exercise, which closely replicates the upper/lower body rotation movements, makes it possible to assess the rotational power of the trunk under sport-specific conditions. The highest power is produced at higher velocities or at lower weights in ball sports players (golf, hockey, tennis) and combat sports athletes (tae kwon do, thai boxing, karate, boxing) who generate high force in a short period of time, whilst the highest power at higher weights are produced in grappling sports athletes (judo, wrestling) who require a great explosive power of the upper and lower body to lift and throw the opponent and water sports athletes (canoeing, kayaking) who exert a great force against the water (Zemková et al., 2020c). These variations in trunk rotational power in athletes of different sports may be ascribed to adaptations to specific training involving trunk rotations at various velocities under different load conditions.

The specificity of acrobatic and dance elements including trunk rotations at various velocities under different load conditions, in addition to genetic predispositions, in athletes of gymnastic (aerobic and acrobatic gymnastics) and dance sports (ballroom and rock & roll dancing) may contribute to significant between-gender differences in terms of higher trunk rotational velocity and power in males than females (Zemková et al., 2020b). While both of them perform repetitive rotational movements of the trunk, male athletes also need to exert high forces on their upper and lower body in order to lift their female counterparts during specific movements.

From the point of view of the test specificity, it is also necessary to take into account the position of subjects during trunk rotations. The rotational power of the trunk is significantly higher when standing than when sitting, with more pronounced differences at higher weights (Zemková et al., 2017c). This may be attributed to a greater range of trunk motion while standing as compared to sitting, which allows subjects to accelerate the movement more forcefully at the beginning of the rotation. As a result is a greater trunk rotational velocity and consequently overall power outputs.

Similarly, the slower velocity of trunk rotations performed in the seated position by para table tennis players compared to able-bodied athletes may be due to their limited range of trunk rotational motion (Zemková et al., 2018b). Rotational velocity values are associated with lumbar curvature and pelvic tilt angle in

para-table tennis players, indicating that decreased posterior concavity could also contribute to these lower values.

Significantly lower velocity in the acceleration phase of trunk rotation in late middle-aged than young adults is also most likely due to their limited range of trunk rotational motion (Zemková et al., 2018a). This may be ascribed to increased trunk stiffness with age, which may reduce the trunk range of motion, resulting in compromised velocity and power production during trunk rotations.

Applications of core muscle strength and stability tests in practice

Assessment of core performance during lifting tasks and trunk rotations may provide useful information on within and between-group differences in power produced during exercises involving trunk muscles, as well as on the effectiveness of exercise programs focused on improvements of core muscle strength and stability. For example, mean power in the acceleration phase of trunk rotations increased significantly after both a 6-week preparatory and 6-week competitive period in tennis players, whereas its values increased significantly only after a 6-week preparatory period in ice-hockey players and canoeists (Poór, Zemková, 2018). This reflects the specificity of their training programs when using different training loads in the preparatory and competitive periods.

Presumably, some core test variables can potentially predict back problems in individuals lifting heavy loads due to spinal overload (Zemková et al., 2020a; Zemková, Zapletalová, 2021) or, conversely, in those with predominantly sedentary lifestyles. This assumption may be corroborated by our findings, which showed a significantly higher trunk rotational power on the dominant than the non-dominant side in golfers, tennis players, and ice-hockey players at lower and/or higher weights and no significant side-to-side differences in the control group of physically active subjects (Zemková et al., 2019e). Though this parameter may be considered specific to their asymmetric loading during trunk rotations, further studies are needed to investigate whether these asymmetries/dysbalances expressed by the dominant/non-dominant power ratio could identify the likelihood of low back pain.

A better understanding of core performance in sport-specific training of athletes (Kumar, Zemková, 2022; Zemková, 2022; Zemková, Zapletalová, 2022) and prevention or

rehabilitation programs of the general population (Zapletalová et al., 2020; Zemková, 2021; Zemková, 2022) could help us to design smart exercise programs tailored to their needs. Therefore, core muscle strength and stability tests (Zemková, 2017; Zemková et al., 2017b; Zemková, 2018; Zemková et al., 2021) should also be included in the Long-Term Sport Diagnostic Model (Zemková, Hamar, 2018), in addition to frequently used strength tests for upper and lower limbs.

Annotatsiya. Mazkur maqolada mushaklarning asosiy kuchi va barqarorligini tekshirish haqida umumiy ma'lumot berilgan. Orqa mushaklarning maksimal izometrik kuchini va ularning chidamliligini an'anaviy o'lchash bilan taqqoslaganda, sport va reabilitatsiya amaliyotida og'irliklarni ko'tarish va gavda aylanishi natijasida hosil bo'lgan quvvatni baholashning yangi usullari qo'llanilgan. Ushbu yangi yondashuv mashqlar dasturlaridan so'ng mushaklar kuchi va barqarorligidagi kichik o'zgarishlarni aniqlash uchun aniqroq shart-sharoitlarni ta'minlaydi va turli yoshdagi va jismoniy tayyorgarlik darajasidagi odamlarda asosiy ko'rsatkichlarni aniqlashda sezgirroqdir.

Kalit so'zlar: sport va reabilitatsiya amaliyoti, orqa mushaklar, chidamlilik, quvvatni baholashning yangi usullari, jismoniy tayyorgarlik darajasi.

Аннотация. В данной статье представлен обзор методов тестирования основной мышечной силы и стабильности. По сравнению с традиционным измерением максимальной изометрической силы мышц спины и их выносливости, в спортивной и реабилитационной практике начали применяться новые методы оценки мощности, вырабатываемой при подъеме тяжестей и вращениях туловища. Этот новый подход позволяет более точно выявлять небольшие изменения в силе и стабильности мышц после выполнения упражнений и является более чувствительным при определении ключевых показателей у людей различного возраста и уровня физической подготовки.

Ключевые слова: спортивно-реабилитационная практика, мышцы спины, выносливость, новые методы оценки силы, уровень физической подготовленности.

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