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PHYSICAL FITNESS EXERCISES AND THE CORE MUSCLE ELECTROMYOGRAPHIC ACTIVITY

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ABSTRACT:

The purpose of this study was to conduct a comprehensive review of the existing literature on electromyographic (EMG) activity of six core muscles, namely the rectus abdominis, internal and external oblique, transversus abdominis, lumbar multifidus, and erector spinae. The exercises that were examined were core physical fitness exercises that were performed on healthy adults. We looked for articles that were published between the years 2012 and 2020 in the following databases: Cochrane, EBSCO, PubMed, Scopus, and Web of Science. There was a strict adherence to the guidelines of PRISMA, which is an acronym that stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The following are the requirements for inclusion: a) The text is provided mostly in the English language. b) The research will most likely be conducted using either a cross-sectional or longitudinal design, as well as an experimental or cohorts arrangement. c) The electromyographic activity is provided in millivolts or microvolts, representing the percentage of maximum voluntary contraction (% MVIC) of the muscle group being studied. d) The rectus abdominis (RA), the transversus abdominis (TA), the lumbar multifidus (MUL), the erector spinae (ES), and the internal or external oblique (IO) muscles are observed and evaluated. e) Exercises that focus on core strength are evaluated. The participants are adults who are in good health. The key findings indicate that the RA, EO, and ES muscles were the ones that underwent the greatest active engagement during the freeweight workouts that the subjects participated in. Conventional workouts were shown to evoke the highest amounts of MUL activation, whereas core stability activities were found to elicit the highest levels of IO activity. In spite of this, there are not many research that have been conducted to evaluate the activation of the TA during core physical fitness workouts, and the approaches that have been utilised to quantify EMG activity in the various investigations have been inconsistent.

Keywords: *EMG, muscle activation, abdominal muscles,*

INTRODUCITON

A person is considered to be in a state of fitness when they are able to participate in regular physical exercise without having any adverse effects associated with their health. As a result, the primary objective of strength and conditioning coaches is to assist their athletes and clients in

accomplishing their fitness goals by providing recommendations for the most efficient physical fitness programmes. Multiple studies have demonstrated that testing and core training are essential for enhancing performance and lowering the risk of injury in a variety of populations, including individuals who are prone to injuries to their lower extremities and back. Core fitness activities may also help minimise the risk of acquiring other musculoskeletal disorders brought on by poor posture and lack of movement. These problems include lumbar spine strain, hip extensor imbalance, and paraspinal muscular atrophy. Core fitness activities might help lower the likelihood of developing these problems. Something that is referred to as the core is an anatomical box that is composed of a number of different muscle groups. The rectus abdominis that is located in the front, the internal and external obliques that are located on the sides, the erector spinae, the lumbar multifidus, and the quadratus lumborum that are located in the back, the diaphragm that is located on top and the pelvic floor, and the iliac psoas that is located at the bottom are all included in this group. The abdominal muscles are the origin of the majority of the body's kinetic chains, which are responsible for transmitting force to the limbs. This is a completely practical observation.

According to those who are knowledgeable about health and fitness, the quadratus lumborum, transversus abdominis, and lumbar multifidus are the three core muscles that are considered to be the most significant. Surface electromyography (sEMG) has undergone significant advancements in recent years, which have made it possible to measure active muscle patterns. It is essential to take into consideration these patterns of muscle activation when selecting and recommending fitness regimens. This is due to the fact that the strength of the muscular contraction is determined by the number of motor units that are engaged. Additionally, the intensity of the activity impacts whether low-threshold or high-threshold motor units are called upon for recruitment. As a consequence of this, the amplitude of the surface electromyography (sEMG) signal, which is often represented as raw (millivolts) or relative to the maximal voluntary isometric contraction (% MVIC), can be used to evaluate the degrees of muscle activation and fatigue. It has been suggested that core exercises that increase electromyographic (EMG) activity could be good for strengthening the core. This is due to the fact that higher EMG activity poses a greater challenge to the neuromuscular system.

For a very long time, the two exercises that were most commonly used to strengthen the core were curl-ups and sit-ups. However, in order to make the exercises more difficult for the proprioceptive system, a number of variations have been developed that make use of unstable surfaces. These variations include wobbling balance board platforms, Swiss balls, or BOSU balls. According to a recent systematic analysis of EMG activity during core physical fitness activities, free-weight workouts, which include many joints, are more effective over time than core exercises performed on the floor or other unstable surfaces. This is especially true when compared to exercises performed on unstable surfaces. There is a distinct lack of consensus among academics regarding the most effective core exercises to perform based on the patterns of muscle activity, and the research that is currently available is few and far between. The core muscles should be trained with free weight exercises (such as the squat or the deadlift) rather than with other specific exercises, according to fitness professionals.

The lone review on core muscle activity in physical fitness routines for healthy individuals that was published seven years ago came to this conclusion. The review was conducted by the authors of the study. Nevertheless, it is important to keep in mind that the only core muscles that were examined in this analysis were the transversus abdominis, the lumbar multifidus, and the quadratus lumborum. Due to the fact that new exercises have been reviewed since then, such as the pike, knee tuck, suspended plank, body saw, and roll-out, it is required to conduct an updated systematic examination of the existing literature. As a result, the purpose of this research was to conduct an exhaustive literature review on the electromyographic activity that occurs in six core muscles (erector spinae, lumbar multifidus, transversus abdominis, internal and external oblique, and rectus abdominis) during core fitness exercises performed by adults.

Strength Training Routines for the Core

The following categories were used to classify the exercises associated with the core: (a) traditional core exercises, which are typically performed on the floor and have a low load; (b) stability exercises, which have a low load and a limited range of motion; (c) ball/device exercises, which combine stability and traditional core exercises and may include unstable surfaces or devices; and (d) free-weight exercises, which have greater loads and activate the upper and lower body as well as the core muscles; some examples of these forms of exercises include the squat, the deadlift, and the shoulder press.

Assessment of Evidence Summary—Strength of Evidence

The level of evidence was only reviewed for comparisons between different types of exercise; there was no summary provided for differences that occurred within the same activity type. The criteria that were initially intended to be utilised in randomised controlled trials (RCTs) have been updated in order to determine the quality of the evidence. The following is a summary of the evidentiary grades, which are as follows: strong, moderate, limited, or none at all: There is sufficient evidence when there are three or more high-quality studies that reveal outcomes that are typically consistent. There have been at least three studies of moderate quality that have produced results that are consistent with one another on many occasions. There is insufficient evidence, which can be either a single study of different quality or inconsistent results from four or more investigations. There is no documentation since there are no research to support the claim.

Quality Assessment

For the purpose of determining the amount of evidence presented in each study, the EPHPP scale, which is an acronym for the Effective Public Health Practice Project, was utilised. At present time, there is no defined approach that can be used to evaluate the methodological quality of EMG observational research. As a result of the fact that previous research with the same objectives has used the EPHPP scale as a standard instrument to measure the quality of the methodology, this is the approach that was used to evaluate each study. Moreover, the utilisation of this scale has the potential to lessen the influence of bias in the interpretation of the results of this systematic survey. The EPHPP scale is used to evaluate six different aspects: the research design, the selection bias, the confounding factors, the blinding method, the data collection method, and the withdrawals and dropouts. It ranges from weak to powerful in terms of the scores. Regarding the

amount of evidence that is presented in the publications, it is possible that they may be categorised as weak, moderate, or strong. The inclusion of each study in this systematic review was followed by an evaluation by two different reviewers. Oversight (final decision: strong), numerous criteria interpretations (final decision: moderate), and diverse study interpretations (final decision: weak) were all addressed in the event that there was any uncertainty or worry associated to one of the components that were evaluated.

The free-weight exercises that induced the highest electrical myogram (EMG) activity in the RA were the unstable Bulgarian squat and the regular back squat. Both of these exercises were performed with a maximum of six repetitions each. It is possible to draw the conclusion that the difference between the Bulgarian squat and the ordinary back squat would enlarge when muscle weariness set in. This is because the demand for RA increased with each repetition. The biomechanics of the workouts or the fact that they employed heavy weights, which led to exhaustion, could be possible explanations for the highest EMG activity in the RA. Both of these factors could have contributed to excessive fatigue. The EMG activity increases during the squat phase because the trunk tilts forward to compensate for the hip going further rearward. This causes the front of the trunk to tilt forward. Core exercises that are performed on a ball or another device, such as the roll-out plank or the suspended front plank, were proposed as an additional method for achieving maximal RA activation. Through the utilisation of suspension training equipment, an element of instability is introduced into the exercise, which may result in an increase in the activity of the electromyogram (EMG). In addition, it is essential to emphasise the fact that various suspension training regimens may result in a variety of EMG activity. Pulley-based suspension systems were found to be the most effective in activating RA compared to any other form of device, according to one study. You might require more strength and postural control than you would with other suspension systems in order to perform the exercise effectively when using this particular suspension system. Also, take into consideration the point at when the instability is introduced. For example, one study found that the EMG activity was highest on the feet and the lower back when the BOSU was added to the sit-up exercise. This was the case when the exercise was performed with the BOSU. On account of the fact that the RA is a trunk muscle, it would require a greater amount of activity to produce instability in the upper body and maintain postural control.

Internal Oblique

In the collection of exercises known as core stability exercises, the front plank with scapular adduction and posterior pelvic tilt is an example of an activity that has the potential to assist with the activation of the internal organs. It is possible that the influence of the thoracolumbar fascia was responsible for the fact that this particular isometric exercise displayed the greatest activation values in the IO. Attachment of the IO to the thoracolumbar fascia is an essential component in the process of transferring weights from the trunk to the arm and from the shoulder to the arm. It is worth noting that the exercise that involved maximum laughter exhibited the highest mV measurements, which were approximately 0.11 mV. The IO EMG activity was significantly higher than it was in the crunch exercise, which indicates that this exercise requires a great deal of control over one's own muscles. As a core stability exercise, it is highly recommended due to the beneficial benefits it has on mental health, hormone levels, and the activation of the internal

organs' functions. Despite the fact that only a small number of studies have evaluated the activation of internal organs in free-weight exercises, the EMG activity that was produced by kettlebell swings employing the "Kime" variation was the highest. At the apex of each kettlebell swing, which is referred to as the "Kime phase," you will learn to swiftly contract and relax your muscles by means of a muscular pulse. As a result of the high shear compression load ratio that occurs on the lumbar spine during the swing phase, individuals who have a sensitivity to shear loads on their spines would not be able to perform this exercise. This hypothesis is supported by the findings of the same study.

External Oblique

It was during free-weight activities, such as the Bulgarian squat, that the majority of the electromyographic activity was triggered. It is possible that the high EO activity observed in this unilateral exercise can be attributed to the fact that the objective of this trunk rotation muscle is to prevent lateral joint flexion. It is necessary for you to perform this exercise by placing one foot in front of the other. In order to prevent yourself from swaying from side to side, you will experience less support from your parallel legs as the axial distance between your legs grows. You will also feel increased resistance from your EOs. An additional unilateral exercise, the standing unilateral dumbbell press, was also responsible for producing the highest observed mV of electromyographic activity. The contralateral action of the EO in stabilising the core and postural sway throughout the workout may be the explanation for the results, according to the findings of another study that came to a similar conclusion. This leads one to the conclusion that free-weight exercises, particularly those that are carried out unilaterally, are favourable for EO activation. This conclusion is based on the fact that EO activity has been increasing. One additional alternative that is suggested by this review is to incorporate a ball or some other object into the core workouts programme. For example, it suggested practicing front planks on a Swiss ball with the modification of continuously moving the wrists in a clockwise direction (stir-the-pot) or executing a hip extension while maintaining stability as exceptionally demanding exercises under the EO category. There is an increase in the EMG values when stability balls are included. In addition, several researches have discovered that the EMG activity in the EO increases when the front plank exercise is combined with suspension training systems or whole-body wobble boards. Because these instability systems target both proximal stability and distal mobility, two exercises that could be good additions to core training programmes are front planks on a Swiss ball and stir-the-pot. Both of these exercises are examples of exercises that target instability.

CONCLUSIONS

During this extensive evaluation of the relevant literature, we investigated the electromyographic (EMG) activity that occurred in six core muscles during core fitness sessions. During activities that involved free weight, the muscles that showed the highest amount of activity were the RA, EO, and ES. Conventional workouts were shown to evoke the highest amounts of MUL activation, whereas core stability activities were found to elicit the highest levels of IO activity. On the other hand, there were not many research that investigated the activation of TA during core physical fitness workouts. Furthermore, the methodology that was utilised to assess EMG activity was inconsistent. Because the majority of the studies that were included had a moderate level of

evidence, there is a need for additional research of a high quality in order to make findings that are reliable about core muscle activation and to reduce the possibility of bias.

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