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**PHYSICAL FITNESS EXERCISES AND THE CORE MUSCLE ELECTROMYOGRAPHIC ACTIVITY**

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**ABSTRACT**

*During core physical fitness activities in healthy people, electromyographic (EMG) activity of six core muscles was measured. These muscles included the rectus abdominis, the internal and external obliques, the transversus abdominis, the lumbar multifidus, and the erector spinae. Cochrane, EBSCO, PubMed, Scopus, and Web of Science are some of the electronic databases for research that were combed through in order to perform a systematic review of the relevant literature. We followed the parameters outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) document. The following criteria were utilized for inclusion: a) the complete text being made available in English; b) the research design being either cross-sectional or longitudinal (experimental or cohorts); c) the reporting of electromyographic activity as a percentage of maximum voluntary contraction (% MVIC), millivolts or microvolts; d) an analysis of the rectus abdominis (RA), transversus abdominis (TA), lumbar multifidus (MUL), erector spinae (ES According to the primary findings, freeweight workouts were shown to stimulate the RA, EO, and ES muscles more than any other type of exercise.*

**Keywords:** *EMG; muscle activation; abdominal muscles; resistance exercises; strength; fitness*

**INTRODUCTION**

The term "fitness" refers to a person's condition of health and well-being, and it is distinguished by the individual's capacity to engage in regular exercise and other forms of physical activity. Therefore, the major responsibility of strength and conditioning coaches is to advise their athletes and/or clients on the most effective physical activities to perform in order to accomplish a variety of predetermined fitness objectives. Several studies have provided information on the significance of core training and testing in order to enhance performance and lessen the risk of damage (for example, injuries to the back and lower extremities). In addition, core physical fitness activities have the potential to reduce the risk of various musculoskeletal problems, such as excessive load on the lumbar spine, imbalance of hip extensors, and atrophy of paraspinal muscles. These disorders are the result of incorrect postures and sedentary lifestyles, and core physical fitness exercises may help reduce this risk.

The term "core" refers to an anatomical box that is made up of several different muscle groups. These muscle groups include the rectus abdominis at the front, the internal and external obliques on the lateral sides, the erector spinae, lumbar multifidus, and quadratus lumborum at the back, the diaphragm at the upper edge and the pelvic floor, and the iliac psoas at the bottom. From a purely functional standpoint, the core muscles make up the center of the body,

which is the point at which the majority of the kinetic chains transfer forces to the limbs. However, the transversus abdominis, lumbar multifidus, and quadratus lumborum muscles are the ones that fitness and health specialists consider to be the most important core muscles. We are now able to assess the patterns of muscle activation in our bodies thanks to the development of surface electromyography (sEMG) in recent years.

When selecting and prescribing exercises for physical fitness, these patterns of muscle activation should be taken into consideration. This is because the force of the muscular contraction is governed by the total number of motor units that are engaged throughout the activity. In addition, the intensity of the exercise determines whether or not low- or high-threshold motor units are recruited throughout the activity. Therefore, the amplitude of the surface electromyography signal, which is generally given as raw (millivolts) or relative to the maximal voluntary isometric contraction (% MVIC), is typically used to examine the degrees of muscle activation and tiredness in the body. It has been hypothesized that the core workouts that enhance electromyographic activity (EMG) may be beneficial for core strengthening. This is due to the fact that the more the EMG activity, the greater the challenge that is placed on the neuromuscular system. For a considerable amount of time, sit-ups and curl-ups have held the title of being the most popular core physical training exercises. However, new exercises have been produced by using elements such as unstable surfaces, such as Swiss balls, BOSU balls, or wobble balance board platforms, in order to raise the proprioceptive demands of the exercises. These new exercises have been designed in order to increase the proprioceptive demands of the activities.

In addition, a recent systematic study on the EMG activity that occurs during core physical fitness workouts addressed the possibility that free-weight exercises may be advised. This is due to the fact that these multi-joint exercises take up less time than core exercises performed on unstable surfaces or on the floor. However, research to this point has been restricted on which core exercises should be performed depending on the activity patterns of the muscles, and there is a noticeable lack of consensus about this topic. The one and only review that has been conducted on the topic of core muscle activity in physical fitness exercises for healthy adults was published seven years ago. The authors of this review came to the conclusion that fitness professionals should concentrate more on free weight exercises (such as the squat or the deadlift) than on other specific core exercises in order to train these muscles. However, only studies that assessed the activation of three core muscles (the transversus abdominis, the lumbar multifidus, and the quadratus lumborum) were included in this review.

In addition, additional exercises have been tested since the literature was last reviewed, such as the suspended plank, roll-out, body saw, pike, and knee tuck. Because of this, an updated systematic evaluation of the research is necessary. Therefore, the purpose of this study was to conduct a comprehensive review of the existing research on the electromyographic activity in six core muscles (the rectus abdominis, internal and external oblique, transversus abdominis, lumbar multifidus, and erector spinae) in healthy adults while they performed core physical fitness exercises.

The abdominal muscles are particularly significant since they have a direct correlation with body posture, the containment of viscera, assistance with exhalation, feces, urine, and

vomiting, as well as assistance with the delivery process. The rectus abdominis muscle is associated to body posture since it is indirectly responsible for the lumbar spine curvature. This muscle is vital for the location of the pelvis and plays a role in body posture. Ptosis, low back discomfort, and respiratory problems are just some of the posture-related conditions that can be brought on by a lack of strength in the rectus abdominis muscle. The rectus abdominis muscle is the primary muscle that makes up the anterior wall of the abdomen. It is long and wide, like a lane, and it originates from the symphysis and the pubic crest. It inserts into the cartilages of the fifth, sixth, and seventh ribs, as well as the xiphoid process of the sternum bone. The alba line separates the rectus abdominis muscle from its homonym. Increases in intra-abdominal pressure, trunk flexion, and retroversion of the torso are some of the effects of the rectus abdominis muscle's contractions. The reason why exercises that aim to develop the abdominal muscles are so popular is not only because they entail aesthetic aims, but also because they may prevent and heal low back discomfort, enhance athletic performance, and increase resistance and trunk strength for daily tasks. Exercises that are beneficial in boosting the activity of the abdominal muscles, particularly the rectus abdominis muscle, have not, however, yet been able to garner widespread agreement among experts.

Establishing a consensus on this subject would make it easier to disseminate and implement standardized training for strength training and physical conditioning. This could lead to more efficient multisite training programs, which in turn would improve performance and reduce the risk of injury in athletes and/or patients. Opinions, personal experiences, and publications that may or may not be founded on scientific facts are frequently used as the foundation for decisions regarding which exercises should be performed throughout a training program. The decision-making process on which exercises are appropriate under various circumstances has led to the utilization of a broad array of fundamental training approaches, with little or no consistency, among strength training specialists. This is because of the nature of the decision-making process.

As a consequence of this, the discussion about the exercises that are most effective for engaging the abdominal muscles and building trunk strength continues, despite the fact that there is no evidence-based agreement. Therefore, in order for specialists in physical conditioning and strength to be able to prescribe proper protocols and recommendations to their athletes and patients, it is required for there to be a systematic review that includes a consensus on the activity of the rectus abdominis muscle when it is being used during physical activities. This systematic review was conducted with the purpose of analyzing the activation of the rectus abdominis muscle based on the results obtained in electromyographic analyses during the execution of various physical exercises. Additionally, the morphological and functional characteristics of the volunteers and the technique used in the normalization of the electromyographic signal were also taken into consideration.

### **Core Physical Fitness Exercises**

Traditional core exercises are low-load exercises that are usually performed on the floor in order to activate superficial muscles (for example, the sit-up and the back extension); stability exercises are low load and low range of motion in order to activate deep core muscles (for example, the front plank and the side plank); ball/device exercises are a combination of

stability and traditional core exercises that might add unstable surfaces; and finally, the exercises were based on prior classifications.

## **TRANSVERSE ABDOMINIS**

### **Moderate Evidence.**

The EMG activity of the transverse abdominis is quite comparable between core stability exercises and activities using balls or devices. One study of moderate quality, three studies of low quality, and one study of moderate quality all came to the conclusion that there was no difference in the EMG activity of the transverse abdominis between core stability exercises and ball/device exercises. However, one study of moderate quality discovered that the EMG activity of the transverse abdominis was higher during ball/device exercises than during core stability exercises.

### **Limited Evidence**

When opposed to free weight workouts, the transverse abdominis's EMG activity is much higher when performing noncore free weight activities. According to the findings of one study of mediocre quality, the EMG activity of the transverse abdominis is significantly higher during noncore free weight activities compared with free weight exercises.

The EMG activity of the transverse abdominis remains consistent during both standard core workouts and core stability activities. There was no significant difference in the EMG activity of the transverse abdominis between standard core workouts and core stability activities, according to the findings of two studies of intermediate quality. When comparing the EMG activity of the transverse abdominis during traditional core workouts to that produced by ball or gadget activities, researchers discovered conflicting data. There was one study of low quality that found that transverse abdominis EMG activity is greater during traditional core exercises compared with ball or device exercises. On the other hand, there were two studies of moderate quality that found that transverse abdominis EMG activity is greater during ball or device exercises compared with traditional core exercises. There was no significant change in the EMG activity of the transverse abdominis between traditional core workouts and ball or device activities, according to one research of low quality (8) and two studies of intermediate quality.

### **No Evidence**

Comparing traditional core exercises with free weight exercises, traditional core exercises with noncore free weight exercises, core stability exercises with free weight exercises, core stability exercises with noncore free weight exercises, ball/device exercises with free weight exercises, and ball/device exercises with noncore free weight exercises yielded no evidence of EMG activity in the transverse abdominis.

## **OBJECTIVES**

1. The Study Physical Fitness Exercises.
2. The Study Core Muscle Electromyographic Activity.

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## RESEARCH METHODOLOGY

The electronic databases Cochrane, EBSCO, PubMed, Scopus, and Web of Science were combed through in order to carry out a systematic review of the relevant research literature. This review focused on papers published between 12 January 2012 (the date of the previous systematic review) and 5 March 2020. We followed the procedures outlined in the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) document. The protocol for this systematic review may be seen in its entirety on the National Institute of Health Research website; it was submitted to PROSPERO and given the registration number CRD42020176876. The search strategy utilized the following words as keywords: ("core" OR "trunk" OR "abdominis" OR "abdominal" OR "low back" OR "rectus abdominis" OR "transversus abdominis" OR "multifid\*" OR "lumbar" OR "quadratus lumborum" OR "erector spinae" OR "external oblique" OR "internal oblique") AND ("re

### Core Physical Fitness Exercises

Traditional core exercises are low-load exercises that are usually performed on the floor in order to activate superficial muscles (for example, the sit-up and the back extension); stability exercises have a low load and a low range of motion in order to activate deep core muscles (for example, the front plank and the side plank); ball/device exercises are a combination of stability and traditional core exercises that might add unstable surfaces.

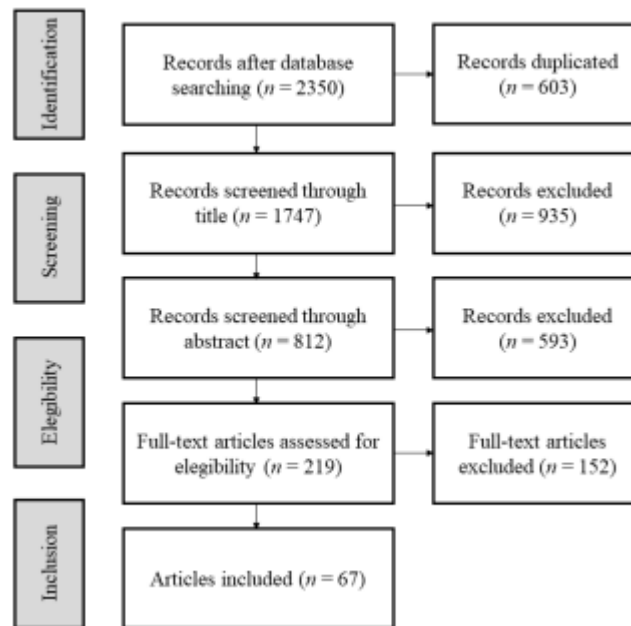
### Methodological Quality Assessment

The Effective Public Health Practice Project (EPHPP) scale was used in order to evaluate the amount of evidence that was present in each research. At the moment, there is no universally accepted scale for judging the level of methodological rigor present in observational studies on EMG. On the other hand, each study was evaluated using the EPHPP scale, which is a standardized instrument that has been used in prior research with comparable purposes to evaluate the level of methodological quality in the research. When it comes to the interpretation of the findings from this systematic review, the use of this scale may reduce the likelihood of experiencing bias. On the EPHPP scale, each of the six components (selection bias, research design, confounders, blinding, data collecting technique, and withdrawals/dropouts) are rated on a scale from weak to strong, with weak being the lowest rating and strong being the highest rating. It is possible for any piece of writing to have a degree of evidence that is either weak (two or more weak ratings), moderate (one weak rating), or strong (no weak ratings). After the studies were selected for inclusion in this systematic review, each research was given a rating by two different reviewers. The subject of discussion among the evaluators, if there was any uncertainty or concern regarding one of the aspects that was being graded, was oversight (final decision: strong).

## DATA ANALYSIS

were exactly the same. After they were taken out of the equation, the titles and abstracts were reviewed, and out of those, 219 were chosen for full-text screening. Because 152 of these studies did not match the inclusion requirements (for example, the majority of these studies did

not meet the criterion for healthy adult participants), only 67 of these studies were chosen to be included in the research (Figure 1).



**Figure 1. Flowchart of the selection process.**

When it comes to the traditional core exercises, the static curl-up with the hands behind the neck, the hip flexed at 60 degrees, and the knees flexed at 90 degrees was the exercise that elicited the highest EMG activity of the RA (81.00 10.90% MVIC). This was followed by the static curl-up with the arms crossed over the chest, the hip flexed at 60 degrees, and the knees flexed at 90 degrees (67. The sit-up was the exercise that had the most RA activation based on the EMG activity that was reported as mV. The lower RA activation was greater than the upper RA activation (0.54 0.24 mV vs. 0.27 0.11 mV), indicating that the lower RA activation was more effective.

V-sits, front planks with scapular adduction and posterior pelvic tilt, and side planks with maximum expiration were the workouts for core stability that had the highest percentage of maximal voluntary inspiratory capacity (MVIC) in the RA (V-sits: 80%; Front plank: 78%; Side plank: 75%). Additionally, the largest mV (0.25 mV) was seen in the RA during the front plank with increased weight (20% BW). The following core exercises on a ball or device were reported to have the highest EMG related to % MVIC in the RA: the suspended roll-out plank (Upper RA: 145.00 22.00% and Lower RA: 122.00 32.00%), the suspended front plank (Upper RA: 145.00 22.00% and Lower RA: 140.00 89.00%), and the upper RA: 67.00 78.00% and lower RA The experiments that recorded EMG activity in mV found that the greatest values were achieved for sit-ups performed on a BOSU ball with upper instability (Upper RA: 0.33 0.14 mV; Lower RA: 0.65 0.33 mV). This was the case for both the upper and lower RAs. Free-weight exercises with the greatest EMG activity were the unstable Bulgarian squat and the standard back squat with a maximum of six repetitions each.

muscle of the RA. Following an examination of the titles and abstracts of the available research, 146 papers with the potential to be useful were chosen. Following review of the

complete texts, we have determined that 13 of the papers meet our criteria for eligibility and have included them in our study. There were a total of 133 studies that were deemed ineligible, and 42 of those studies were excluded because they did not study common exercises in physical training. More specifically, 19 of these studies did not clearly analyze the EMG of the RA muscle, 14 of these studies measured muscle activity with ultrasonography or magnetic resonance imaging, and they were not published in the English language. Additionally, 2 volunteers reported lesions or pain, and 54 of these studies did not normalize their EMG signals.

## CONCLUSION

Core workouts focus on strengthening the abdominal and back muscles. Free-weight workouts were shown to provide the highest level of activity in the RA, EO, and ES muscles. Core stability exercises exhibited the most IO activity, while conventional workouts showed the largest MUL activation. Both types of exercises were beneficial. On the other hand, there was a dearth of study on the activation of the TA during core physical fitness activities, and there was a lack of consistency across studies when it came to the use of methodologies to quantify EMG activity. In addition, the degree of evidence provided by the included studies was, for the most part, considered to be moderate. This shows that more research of a higher quality is required in order to eliminate the possibility of bias and arrive at sound conclusions on the activity of the core muscles.

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