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Original Article

Comparison of the muscular electrical activity and hip–knee joint amplitude during bent-knee sit-up movement and abdominal exercises using a five-minute shaper device: a case study on an unconditioned subject

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Abstract:
Problem statement: Different fitness devices that stimulate the abdominal muscles to improve sports performance or body image have been reported in the literature. Many of these devices are used by subjects without physical conditioning which, together with bad use of the devices, can generate serious musculoskeletal injuries. **Purpose**: This study compares the Five-minute Shaper (FMS) device and traditional bent-knee sit-up (BKS) exercise through hip–knee joint amplitudes and muscle electrical activity parameters. **Materials and methods:** A healthy volunteer participated in this study. This subject performed ten repetitions using the two exercise modalities. FMS is analyzed through three different levels (i.e., easy, medium, and extreme), and the traditional exercise is performed on a mat. We analyzed the knee and hip joint movement and performed surface electromyography (sEMG) of external abdominal oblique, internal abdominal oblique, upper rectus abdominis, erector spinae, rectus femoris, and biceps femoris muscles. The movements were performed in the sagittal plane in a 2D capture, and EMG was recorded using an eight-channel electrophysiographic measurement with bipolar surface electrodes. The joint amplitude was computed using Kinovea and processed by MATLAB. The muscle activation was processed by Root Mean Square (RMS) and normalized by Dynamic Peak Activity (PDA). **Results**: The obtained results show that the BKS exercise activates fewer muscles or at a lower intensity than FMS. Consequently, the FMS device presented greater muscle activation and better biomechanical posture than the traditional BKS exercise. The device has greater ergonomics than the traditional BKS exercise and is associated with a decrease in back injury. Nevertheless, there were significant differences ($P < 0.05$) in muscle activation for each level of FMS and traditional exercise. **Conclusion**: This study allows to conclude that the use of the FMS device may increase muscle strength in the abdominal and lower limb areas. Additionally, FMS presents a lower risk of suffering spine injuries in people who are not accustomed to regular exercise because flexion–extension angles are not exceeded.
Key Words: **Electromyography; Physical conditioning device; Traditional exercise; Biomechanics; Movement comparison; Kinematic variables**

Introduction

Different physical conditioning devices stimulate the abdominal muscles to both improve sports performance, body image, increase strength, power, endurance, and flexibility and to reduce low back pain (Massó et al., 2010; Youdas et al., 2008). Electromyography allows to identify muscle electrical activation patterns during or after physical activity performed by a person (Turker & Sze, 2013; Grațiela-Flavia et al., 2009). Many traditional exercises [e.g., normal crunch (López-Valenciano et al., 2013; Moraes et al., 2009) or bent-knee sit-up (BKS) (Escamilla, Babb, et al., 2006)] generate significant muscle activation in the core area. Currently, new alternatives to improve muscle activation and strength in the core area have appeared. Several uncommon methods, which are based on devices such as Hanging knee-up with straps, Power Wheel roll-out, and Reverse crunch flat (Escamilla, Babb, et al., 2006), have been introduced. These new techniques have generated a considerable increase in the production of physical conditioning devices.

Many of these devices allow to perform movements that place a subject in forced postures that elevate muscle activation. Several previous studies compared the muscle activation of traditional workouts and different devices such as Ab Roller, Torso Track, Ab Twister (Escamilla, McTaggart, et al., 2006), Ad circle (Willardson et al., 2010), Ab Slide (Youdas et al., 2008), and Five-minute Shaper (FMS) (Silva et al., 2020). These studies allow us to understand muscle activation when using several different devices. However, most of these studies do not provide a complete analysis of the kinematic parameters, mainly for the Five-minute Shaper devices. It is important to mention that these devices are commonly used by people who want to improve their physical condition or appearance. Typically, most of the users of these devices do not have previous physical

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conditioning; thus, most of them have a high tendency to suffer lumbar injuries when performing the exercise (Barreras, 2009; Vidal Oltra, 2015).

Previous studies quantified the electrical muscle activity and kinematic variables of the movements performed by the FMS device. (Silva et al., 2020) compared the muscle activity quantified through the Root Mean Square (RMS) value of the Normal Crunch exercise against the exercise performed on the Five-minute Shaper device. They used muscles located in the abdominal area and the right lower limb by normalizing EMG signals through the Maximum Voluntary Isometric Contraction (MVIC). (Guerrero-Mendez et al., 2021) characterized the kinematics of movement in 2D recordings exerted by the FMS device in men and women without physical conditioning. To our knowledge, it is still necessary to evaluate the use of this type of device compared to other types of traditional movements (to evaluate other types of normalization methods because the movement in the device can be cyclic) and to evaluate the change in the electrical and kinematic parameters throughout the movement cycle.

The linear and angular parameters (e.g., position, velocity, acceleration, and joint amplitude) as well as the exercise's dynamics and internal and external forces can be obtained from the 2D and 3D motion analysis (Massó et al., 2010; Turker & Sze, 2013). To capture the motion, it is necessary to place markers on specific parts of the body (Ceseracciu et al., 2014). These parameters are essential because they describe the movement generated by a device or exercise, and these data can be used to prevent musculoskeletal and lumbar injuries (Lu & Chang, 2012). The information acquired from movement analysis can benefit patients and therapists in the development of physical activity using a fitness device (van den Bogert et al., 2013) owing to the lack of scientific evidence on the use of the Five-minute Shaper device, the unclear recommendations for its use, and the effects that the poor execution of this movement can have. This study presents a characterization and comparison of the joint amplitude and muscle activation patterns using the Five-Minutes Shaper device (FMS) and a Bent-knee sit-up (BKS). The obtained results were used to identify and quantify the Five-minute shaper's movements; it was determined that the correspondent kinematics and muscle activation parameters were better than traditional ones. To evaluate this, a healthy subject without physical conditioning was chosen. The muscle activity of the external abdominal oblique (OE), internal abdominal oblique (OI), upper rectus abdominis (RA), erector spinae (ES), rectus femoris (RF), and biceps femoris (BF) was analyzed. Furthermore, the kinematic parameters of knee and hip joint amplitude were analyzed for the three levels (i.e., easy, medium, and extreme).

It was hypothesized that during physical conditioning, Functional Training Equipment (such as FMS) could produce higher muscular activation and reduce the risk of injury than traditional movements such as BKS. This article is structured as follows. Section I presents the materials and methods, and the description of the protocol, signal processing, and statistical analysis are addressed. Section II presents the results through figures and tables. Section III presents the discussion of the results. Finally, the conclusions and future work are presented.

Materials and methods

A Case Study

The outline of the developed protocol in this study is shown in Fig. 1. This study case was performed with a healthy but physically unconditioned volunteer with the following characteristics: age – 22 years old, height – 170 cm, and weight – 60 kg. The volunteer did not practice any regular physical activity and did not have previous experience with FMS. The volunteer was requested to perform two types of exercises, i.e., BKS and use FMS device. The volunteer signed an informed consent under the guidelines of the Declaration of Helsinki; the Antonio Nariño University Research Ethics Committee approved this study.

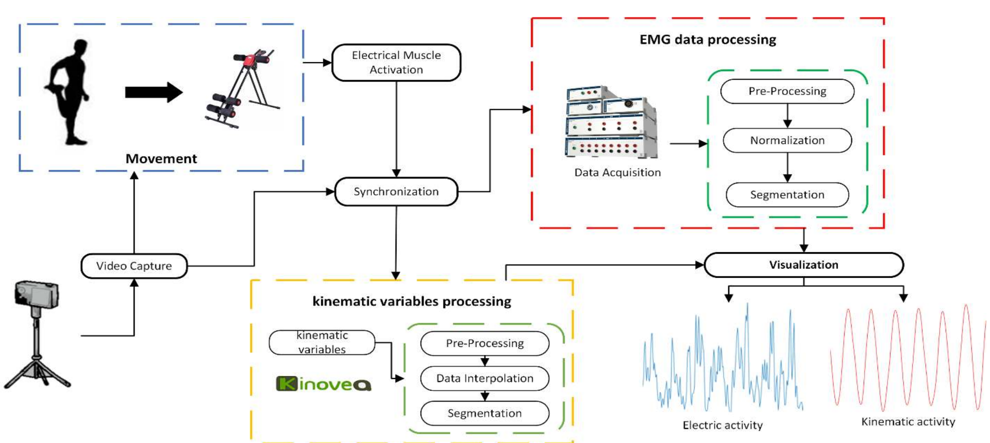

Figure 1. Block diagram of the acquisition, processing, and visualization of electromyography and kinematic data. It was recorded for three levels of FMS device and BKS exercises on the mat.

FMS Device

The FMS device is an all-in-one body sculpting equipment that combines cardio exercise and muscle toning. This device promises to produce a toned body with just 5 min of use per day. It has six adjustable intensity levels, which are set by widening the inclination angle with respect to the floor; these intensity levels are classified as easy, intermediate, medium, difficult, advanced, and extreme. This device uses the subject's weight to tone the abdomen, arms, and legs. The volunteer was placed in a ventral decubitus position in the device, supporting the arms and knees on the machine's supports. The subject was instructed to move the lower train towards the part of the trunk according to the knee's support and then return to the initial position. The easy, medium, and extreme levels considered in this study corresponded to the inclination of 15, 30, and 45° with respect to the ground, respectively (Fig. 2A).

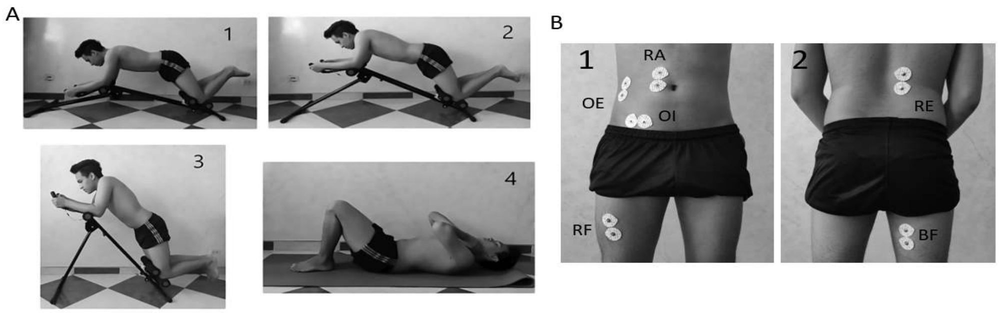

Figure 2. **A)** Exercise performed using three level of FMS device and the traditional exercise. 1) Easy 2) Medium 3) Extreme 4) Bent-knee Sit-Up. **B)** Location of electrodes used for sEMG. 1) Frontal view: upper rectus abdominis (RA), external abdominal oblique (OE), internal abdominal oblique (OI), and rectus femoris (RF) 2) Posterior view: erector spinae (ES) and biceps femoris (BF)

EMG Electrode Placement

In surface electromyography (sEMG), the electrodes must be placed at a proper location and orientation across the muscle. This is necessary to acquire the best possible signal and avoid or minimize possible crosstalk areas (Blanc & Ugo, 2010). In this study, the muscles evaluated by EMG are Abdominal External Oblique (EO), Abdominal Rectum (RA), Abdominal Internal Oblique (OI), Erector Spinae (ES), Femoral Biceps (BF), and Femoral Rectum (RF). The electrodes were placed by following SENIAM recommendations (Stegeman & Hermens, 2007). Figure 2B shows the placement of the electrodes used for EMG data acquisition.

Bent-knee Sit-up (BKS)

Sit-ups are one of the traditional forms of abdominal training. When performed correctly, a sit-up activates, tones, and efficiently strengthens the abdominal muscles. For the BKS exercise, the subject was placed in a supine position on a mat, with hip and knees flexed, feet held on the ground, and hands placed on the neck. During the execution, the subject flexed the trunk and hip until the elbows touched the knees. Then, the subject returned to the initial position (Escamilla, Babb, et al., 2006) (Fig. 3A).

Data Collection Protocol

Before collecting both the EMG and kinematic data, a questionnaire was first conducted to identify possible exclusion criteria. This questionnaire was signed and included the following information: the history of fractures and surgical procedures, frequency of the development of physical activity, level of physical conditioning, and informed consent. The data were registered for three FMS device levels: easy, medium, and extreme (Fig. 3A). Ten trials per level were performed for each test with break intervals of 5 min before changing the levels. Then, data were acquired corresponding to the BKS exercise on a mat with ten trials. The six selected muscle activities were recorded, and electrodes were placed following the SENIAM recommendations. A video recording in the sagittal plane was performed to quantify joint amplitudes. The joints selected for analysis were the knee and the hip. Markers were placed and labeled following the recommendations of the International Society of Biomechanics (ISB) (Wu et al., 2002). The EMG electrodes were placed on the subject's right side.

Instrumentation and Synchronization

The EMG data were recorded using six channels of the PowerLab 8/30 Electrophysiograph from AD Instruments. The electrodes were located in a bipolar position, and the sampling frequency for each EMG channel was 1000 Hz. The data were visualized through the LabChart 7 software (AD Instruments) and stored in a file .mat extension compatible with Matlab (version R2020b, MathWorks Inc.).

The electrodes used were Vitrode L-150, Ag/AgCl, containing adhesive gel with a foam tape. The raw data were stored and processed in Matlab. The 2D video was recorded in the sagittal plane using a Basler AG scA640-70gc high-speed camera system, with a capture frequency of 70 fps. The camera was located at a distance of 2 m from the subject, and reflective markers were placed on the elbow, shoulder, hip, knee, and ankle joints, which have a diameter of approximately 2 cm. To synchronize the EMG data and the 2D video, an electronic device was implemented using a PC mouse. Each time that the left click was pressed, a high-intensity LED lit up. This indicated the moment when the EMG data recording began. Of note, video recording was started a few seconds before the LED was turned on. Then, the registered video was cut, and the kinematic data were analyzed from the frame when the LED lit up.

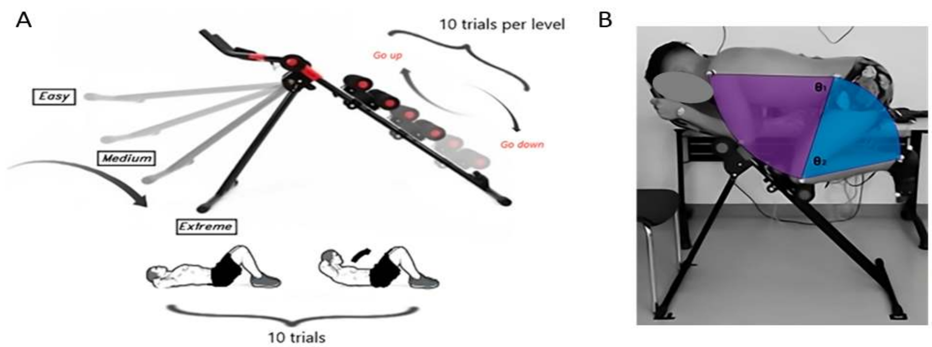

Figure 3. A) Experimental design of the protocol performed during data acquisition. Top: Five-minutes Shaper device; Bottom: traditional BKS exercise. **B)** Quantification of the knee and hip joint amplitudes

Pre-processing

The raw EMG data were preprocessed with an eight-order Butterworth bandpass filter (20–490 Hz) to remove noise during data collection. For the experiment, the participant was asked to perform ten trials for each exercise. However, the initial and final trials were removed from the kinematics and EMG data to measure stationary state and avoid transients in the movement. Data analysis was performed to reject outliers of the EMG signals; thus, a trial was rejected when the EMG signal was outside the range of 0–10 mV. Finally, in this study, six trials were analyzed after the preprocessing was applied.

Processing

Kinematics: The captured videos were processed using the Kinovea software. Kinovea is a free 2D motion analysis software that is widely used in sports science and clinical analysis to measure kinematic parameters (Puig et al., 2019); Kinovea was applied to extract the markers' positions. The markers' position coordinates were processed in Matlab with a self-made algorithm to compute and graph the knee and hip joint amplitude. For this, two vectors per joint were formed to calculate the joint amplitude (Fig. 3B).

EMG Data: EMG data were normalized using the Dynamic Peak Activity (PDA) method. The PDA method consists of taking all trials performed by the exercises for each muscle and normalizing the data by the maximum peak value of these signals per muscle (Ghazwan et al., 2017). This normalization method is frequently used for repetitive movements such as cycling and gait analysis (Ball & Scurr, 2013; Sousa & Tavares, 2012), and high reliability for cycling movement has been demonstrated. Some authors conclude that this method helps to reduce the specific subject conditions and situations that can increase signal variation (Ghazwan et al., 2017; Sousa & Tavares, 2012). Data segmentation was performed in a time window of 100 ms overlapped by 50% (Burden & Bartlett, 1999; Sullivan et al., 2015). The EMG amplitude was estimated in the time domain using the Root Mean Square (RMS) and was normalized with respect to the peak RMS value.

Statistical analysis: An analysis of variance (ANOVA) was used to identify significant muscle activation differences for each exercise in the six trials. Matlab (version R2020b, MathWorks Inc.) was used to determine the type of distribution and homogeneity of data variance; the Shapiro–Wilk and Levene's tests were applied. The ANOVA test was applied after verifying that the data follow normal distribution values and homogeneous variances.

Results

In this study, the exercise using the FMS device generates hip extension and flexion movement by the knee joint moving linearly in the FMS device to generate the movement. In this type of exercise, the hip acts as the center for stabilizing the trunk (Endo & Sakamoto, 2014). In contrast, during the BKS exercise, the knee remains static where hip flexion–extension is generated.

In Figs. 4A, 5A, 6A, and 7A, trials are presented as broken lines, and the average is shown as a solid black line for each exercise. The cyclograms are presented for the hip and knee joints. Simultaneously, in Figs. 4B, 5B, 6B, and 7B, the relative hip angle and the electrical variables are presented around each exercise's movement cycle. The muscle activities are found between the range 0–1 and are classified in terciles for each analyzed muscle, where terciles are shown for each 10% of the movement cycle. The first tercile must be below the 0.33 value; the second tercile must be within the 0.33–0.66 value, and the last tercile must be greater than the 0.66 value. The first tercile is not graphed; the second tercile is an unfilled circle, and the third tercile is a black box.

Easy level FMS

The obtained results for the easy level are shown in Fig. 4. The joint amplitude in the extension is greater than 90° (Hip = 150° − Knee = 100°) and less than 90° in the flexion (Hip = 62° − Knee = 58°). The presented movement in the cyclogram is a clockwise direction presenting a proportional increase in flexion for the two joints, in-phase (Fig. 4A). For electrical variables, the greatest muscle activation is found in the second tercile. The abdomen is the area with the greatest muscle activation. The OE muscle is activated when the subject performs hip flexion; OI muscle activation is greater at the beginning of the movement, and the RA muscle activation is distributed along the movement cycle. The other analyzed muscles presented low activation, i.e., distributed in the first tercile. The RF muscle presents an activation classified in the second tercile at the beginning and in the flexion hip movement (Fig. 4B).

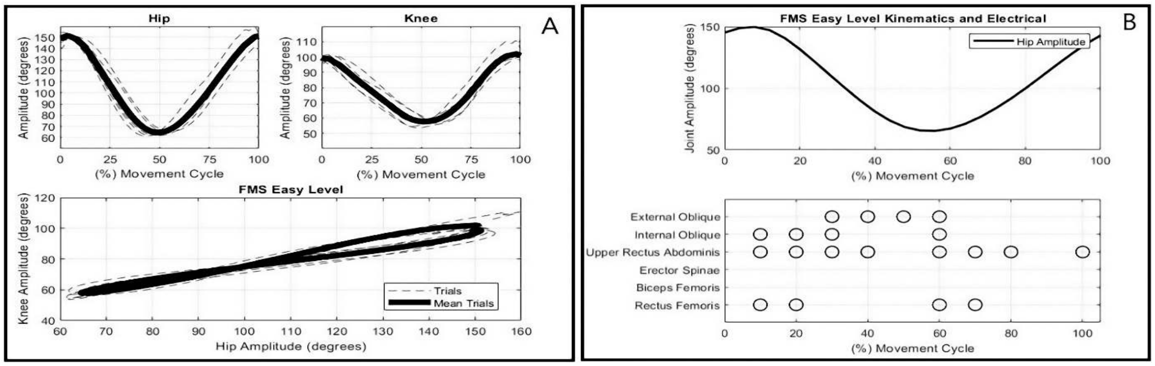

Figure 4. A) Relative angle and cyclogram of hip and knee joint amplitude with respect to the motion cycle for the easy FMS level. B) Hip joint amplitude and muscle activation for the tercile classified according to each tenth of the movement cycle for the medium level of FMS

Medium level FMS

The kinematic and muscular parameters for the medium level of the FMS device are shown in Fig. 5. At this level, the knee has greater amplitude during flexion (Knee < 60°), while the hip joint flexion decreases (Hip = 67°). During the extension, both joints continued with the same joint amplitude at the easy level. This level presents a proportional increase in joint amplitude for both joints during extension; however, during flexion, the increase is out of phase (Fig. 4A). The activation is equal to or greater than the second tercile for all muscles, except for the ES muscle. The activation of BF and RF muscles is more significant during flexion and extension compared to the other muscles during the movement cycle (Fig. 5B).

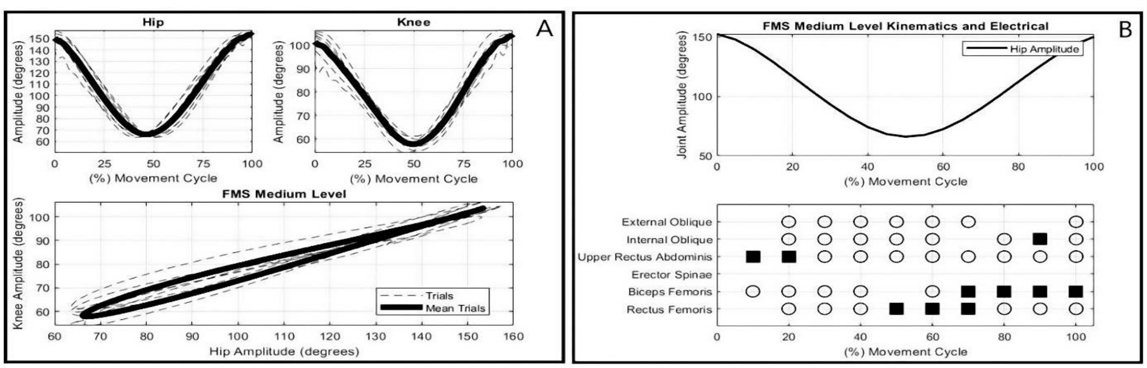

Figure 5. A) Relative angle and cyclogram of hip and knee joint amplitude with respect to the motion cycle for the medium FMS level. B) Hip joint amplitude and muscle activation for the tercile classified according to each tenth of the movement cycle for the extreme level of FMS

Extreme Level FMS

At this level, the hip and knee flexion decrease compared to other FMS device levels (Hip = 72 ° − Knee = 60°). For extension, the hip's amplitude remains the same as at the previous levels; however, in the knee joint, the amplitude increases by 10° (Knee = 90°). The increase of joint amplitude at this level is proportional to the movement's two sequences (Fig. 6A). At the extreme level of FMS, muscle activation is more significant than at previous levels. The OE muscle presents greater activation when the subject reaches maximal flexion. The OI and RA muscles show greater activation at the beginning and during hip flexion. In the lower limbs, the BF muscle maintains constant electrical activation, and the RF muscle has its most significant activation at the beginning and end of the movement. At this level, the ES muscle activation remains in the third tercile during hip flexion and at the end of the movement cycle (Fig. 6B).

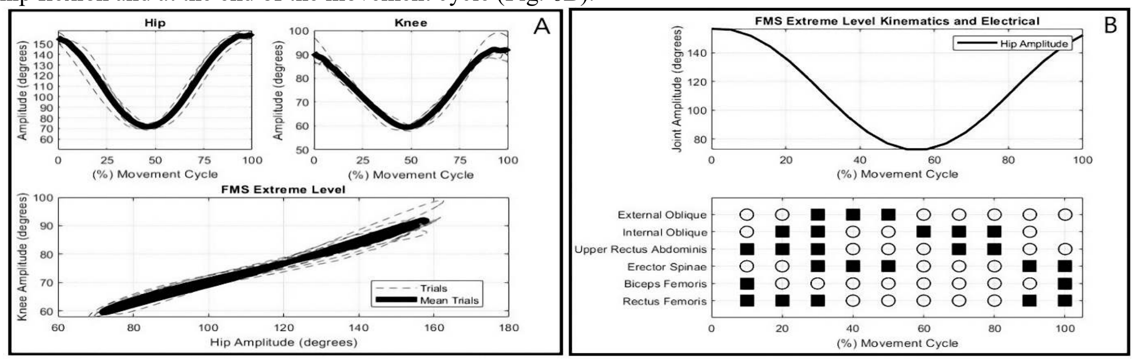

Figure 6. A) Relative angle and cyclogram of hip and knee joint amplitude with respect to the motion cycle for the extreme FMS level. B) Hip joint amplitude and muscle activation for the tercile classified according to each tenth of the movement cycle for the extreme level of FMS

BKS

The BKS exercise is based on the trunk flexion, which differs from the exercise using the FMS device. This exercise is performed on a mat, and the knee joint remains motionless. The joint amplitude during hip extension is greater (Hip = 120°) owing to the lower limbs' position, and hip flexion is more significant than FMS levels (Hip = 43°) owing to the type of biomechanical movement in the exercise. The subject does not maintain stability in the lower limbs owing to the joint knee change angle. The trials in this exercise are performed at a constant speed, not very fast (Fig. 7A).

The most significant muscle activation in BKS is in the abdominal area, and it remains greater than or equal to the second tercile throughout the movement cycle. BKS results in a more significant muscle activation than the medium level of FMS, but the BF and RF muscle activation are more significant at the medium level. The muscle activation during the BKS exercise is below the device's extreme level throughout the movement cycle (Fig. 7B).

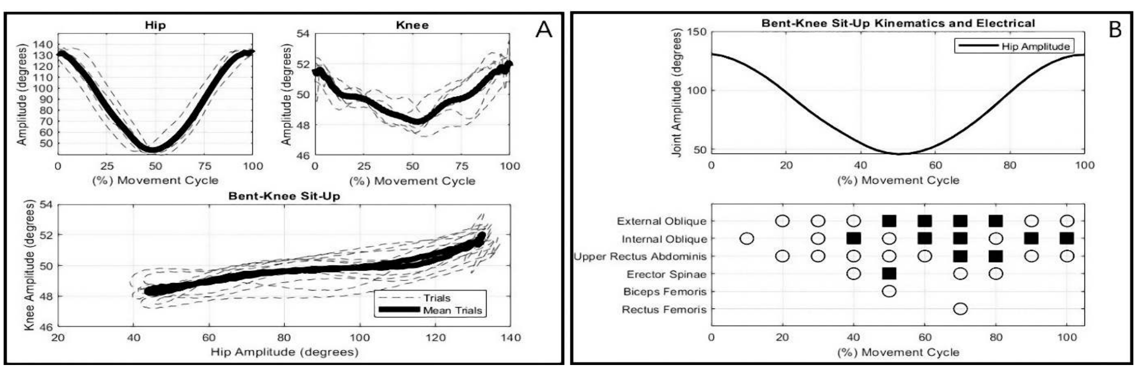

Figure 7. A) Relative angle and cyclogram of hip and knee joint amplitude with respect to the motion cycle for BKS exercise. B) Hip joint amplitude and muscle activation for the tercile classified according to each tenth of the movement cycle for the BKS exercise

Comparison of electrical activation in each muscle

Figure 8 shows electrical activation for each muscle for three FMS levels and the BKS exercise. For each muscle activation, the confidence interval was established at the 95% level. The values are normalized RMS (%PDA). For each muscle, an ANOVA statistical significance analysis is performed, taking into account each trial. Table 1 shows the significant statistical differences between the exercises after the Bonferroni post hoc test with a significance level of less than 0.05. Table 1 shows the differences for each analyzed muscle through the boxes representing the exercises performed by FMS and BKS; each box is associated with an exercise.

Discussion

The results obtained in this study characterize muscular activation and joint amplitude during an exercise session using the FMS device at three different levels and the traditional BKS exercise. This study aimed to compare the FMS device with the traditional BKS exercise through kinematic and EMG parameters. It was determined that the FMS device produced better muscle activation and kinematics movement than the traditional BKS exercise.

This study supports the hypothesis proposed by (Silva et al., 2020), which states that the FMS device enhances muscle activation compared to traditional exercises. However, the results obtained in this study disagree with the conclusions reported by (Silva et al., 2020), who found that the traditional Normal Crunch exercise produces equal or better results in terms of muscle activation when using the FMS device. The most significant differences between both studies are the normalization method of EMG signals and the physical conditions of the subject. Specifically, the normalization method used by (Silva et al., 2020) is the Maximum Voluntary Isometric Contraction (MVIC), while this study uses the Dynamic Peak Activity (PDA) method.

Table 1. Significant statistical differences for each muscle for the FMS levels and BKS exercise

Muscles	Significant Differences					Boxes
OE	Easy / Medium	Easy / Extreme	Easy / BKS	Medium / Extreme	Medium / BKS	*Easy level* (white)
OI	Easy / Medium	Easy / Extreme	Easy / BKS	Medium / Extreme	Medium / BKS	*Medium level* (black)
RA	Easy / Medium	Easy / Extreme	Extreme / BKS			*Extreme level* (checkered)
ES	Easy / Extreme	Easy / BKS	Medium / Extreme	Medium / BKS	Extreme / BKS	*BKS exercise* (hatched)
BF	Easy / Medium	Easy / Extreme	Medium / BKS	Extreme / BKS		
RF	Easy / Medium	Easy / Extreme	Medium / BKS	Extreme / BKS		

These differences in the EMG calculation method directly affect the results owing to the modification of the procedure for signal processing. Compared to the MVC normalization method, the PDA normalization method has been widely used for the normalization of repetitive movements such as cycling and walking (Ball & Scurr, 2013; Sousa & Tavares, 2012). However, this method allows to determine at which moment of the activity a muscle is most active, i.e., activation changes can be observed at each percentage of the movement cycle. In addition, this method is not affected by the posture of the subject or the muscular synergies to perform the movement, as is the case with the MVC method (Sousa & Tavares, 2012). In contrast, in this study, it was considered that the movement generated by the FMS device is a cyclic movement because there is a displacement of the limbs in the same direction, and the limbs always pass through the same starting point to generate the flexion–extension movement and muscle contraction.

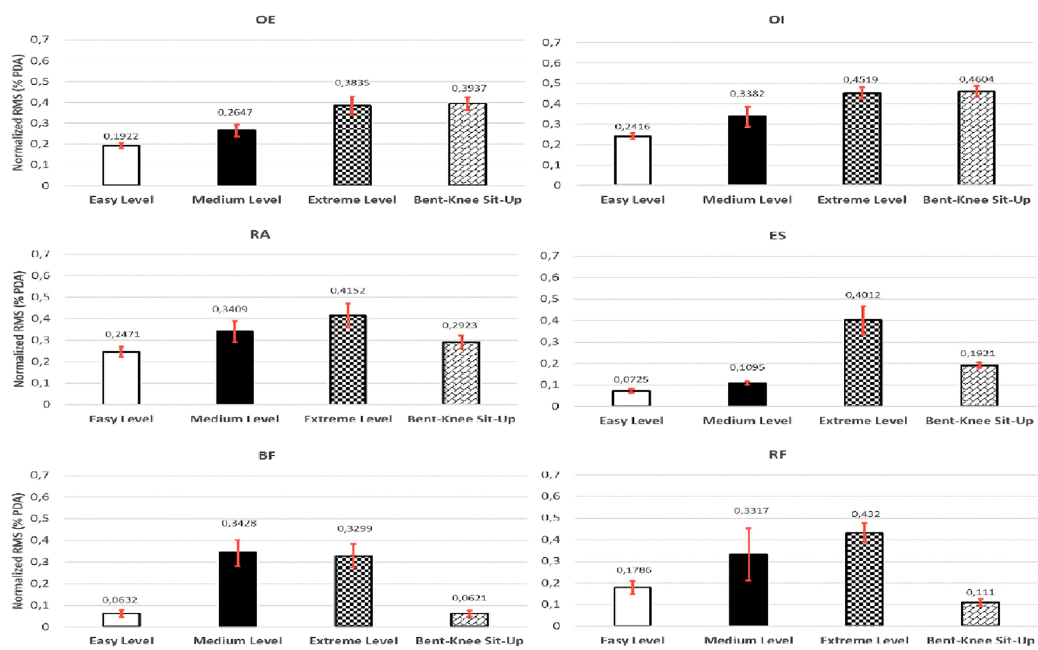

Figure 8. Comparison of normalization by RMS (%PDA) for each muscle analyzed in this study, for the FMS device (easy, medium, and extreme) and BKS, presenting the confidence interval for each movement executed by all muscles

The evaluation of movements using joint amplitude allows to determine the Range of Motion (ROM) of the joints involved in the exercise, which allows to identify possible musculoskeletal alterations that are associated with exceeding the ROM. In addition, in the exercises evaluated in this study, hip and knee flexion–extension movements are presented; thus, it is important to quantify the degree of flexion and extension presented in the movement to compare them with the muscle activation data quantified by the amplitude of the signal through the RMS value. However, a relationship is determined between the FMS levels and muscle activation because if the angle of the device is small (15°), muscle activation is lower, and the movement will be easier to perform owing to the distance between the rotation axis and the subject weight. In contrast, if the angle is large (45°), muscle activation increases, and the movement is more difficult to perform.

The knee and hip joint amplitude are related according to the Pearson Correlation Coefficient (0.65). This shows that while the hip joint flexes, so does the knee joint. The EMG results allow to determine for which moment the muscle activation is most significant. In addition, this study allows to validate different hypotheses, e.g., 1) when the knee and hip flexion is performed, and 2) when the muscle activation increases the most with the use of the FMS device or with the traditional exercise. However, it is important to take into account the biomechanical posture during the workout to determine which muscle activation is greater regarding the exercise performed.

The study performed by (Escamilla, McTaggart, et al., 2006) agrees with the results reported in this study, that the RA muscle activation achieved by Ad slide and Torso Track devices is greater than that achieved by the traditional BKS exercise. The opposite is observed for the OE muscle activation, which is more significant in the traditional BKS exercise than when using devices. The results reported in (Escamilla, Babb, et al., 2006) are similar, i.e., the RA muscle activation is more significant when using the Power Wheel pike, Power Wheel knee-up, and Power Wheel roll-out devices than when performing the traditional BKS exercise.

The high muscular activation, recorded for the FMS's extreme device level compared with BKS, can be explained by the device's inclination angle; other biomechanical studies have reported that abdominal area muscle activation increases on inclined planes (López-Valenciano et al., 2013). High activation in the lower limb muscles may be due to leg flexion and extension. The high ES muscle activation may be associated with the trunk and spine forced flexion in the exercise (Drake et al., 2019). In subjects without physical conditioning, the extreme level of the device may trigger lumbar problems owing to high ES muscle activation because lower limb movements increase muscle activation, which generates compression in the lumbar column region (Vidal Oltra, 2015). The traditional BKS exercise involves a high turnover movement in the spine that can trigger intervertebral disc and ligament injuries; BKS puts the hip flexor muscles in a shortened position, increasing the pressure on the lumbar region during knee and hip flexion, presenting high RF muscle activation (Escamilla, Babb, et al., 2006; López-Valenciano et al., 2013). Therefore, it is suggested that subjects without physical conditioning first learn to perform hollowing or bracing abdominal exercises, as reported by (Vidal Oltra, 2015). Finally, according to the results obtained in this study, it is recommended to use the FMS device but below the advanced level. For traditional full body and core workout routines, it is recommended to first perform Normal Crunch and then BKS exercise because this approach does not generate high spine movement.

Conclusions

Using the EMG and kinematic data, it was possible to compare the physical conditioning when using the FMS device and the traditional exercise. The results show that the BKS exercise activates fewer muscles or in a lower intensity than the FMS. Consequently, the FMS device presented greater muscle activation and better biomechanical posture than the traditional BKS exercise. This fact suggests that this device's use could increase muscle strength in the abdominal and lower limb areas. Additionally, FMS presents a lower risk of suffering spine injuries in people who are not accustomed to regular exercise due to flexion-extension angles are not exceeded. Additionally, it was possible to observe how the electrical muscle activation changes throughout the movement cycle by comparing the flexion–extension of the knee and hip joints with the electrical activation of all muscles. In addition to the kinematic study, cyclograms are presented for each level of the device and for the traditional exercise, which allowed to determine that the knee and hip joints at the time of the exercise were in phase for the device, but were not in phase for the traditional exercise. Future studies should focus on increasing the population sample, analyzing muscle fatigue, study cardiac activation, and implement classification methods to improve motion characterization.

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