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Trial

Are core exercises important to functional training protocols?

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ABSTRACT

Objective: Our aim is to analyze the effects of 12 weeks of functional training with and without core exercises on core functional and performance indicators.
Method: This is a three-arm randomized controlled trial, which will take place over 12 weeks. Participants will be randomly grouped into three training programs, namely: functional training group, which will perform global, multi-articular, and functional exercises, with no exercises for the core; functional training + core group, which will perform a similar protocol to the functional training group, but with the inclusion of specific exercises for the core region; and core training group, which will only perform specific exercises for the core. In both moments, tests will be carried out in the following order: McGill's torso muscular endurance test battery, unilateral hip bridge endurance test, sit up test, isometric dead lift, push up, sit to stand, functional movement screen, handgrip test, countermovement maximal vertical jump test, one repetition maximum in bench press, row and leg press, T- run agility test, Yo-Yo test.
Discussion: These findings will provide new evidence to aid physical education professionals in decision-making regarding exercise prescription.
Conclusion: We hypothesize that the inclusion of exercises specifically targeting the trunk in functional training protocols will lead to higher functional and core performance.
Keywords: Low pain back, athletic performance, rehabilitation.

¿Es importante incluir ejercicios específicos del core en protocolos de Entrenamiento Funcional?

RESUMEN

Objetivo: Analizar los efectos de 12 semanas de entrenamiento funcional con y sin ejercicios específicos del core, sobre indicadores funcionales y de rendimiento.
Método: Este será un ensayo aleatorizado compuesto por tres grupos y con una duración de 12 semanas. Los participantes serán agrupados aleatoriamente en programas de entrenamiento funcional, a saber: grupo de entrenamiento funcional, que realizará ejercicios globales, multi-articulares y funcionales, pero sin ejercicios para el núcleo; entrenamiento funcional + grupo core, que realizará un protocolo similar al grupo de entrenamiento funcional, pero con ejercicios específicos para la región central; y grupo de entrenamiento de core, que sólo realizará ejercicios específicos para el core. En ambos momentos, las pruebas se realizar en el siguiente orden: Batería de prueba de resistencia muscular del tronco de McGill, prueba unilateral de elevación pélvica, *Sit Up test, Isometric dead lifth, push up, sit to stand, functional movement screen, handgrip test, countermovement maximal vertical jump test*, una repetición máxima en los ejercicios de press de banca, prensa y remada, teste T de agilidad y Yo-Yo.
Discusión: Estos hallazgos proporcionarán nuevas evidencias para la toma de decisiones por el profesional de la educación física en la prescripción de ejercicios.
Conclusión: Nosotros hipotetizamos que la inclusión de ejercicios focalizados específicamente para el core en protocolos de entrenamiento funcional producirá un mayor rendimiento funcional y del core.
Palabras-clave: dolor en la espalda, rendimiento atlético, rehabilitación.

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É importante incluir exercícios específicos do core em protocolos de Treinamento Funcional?

RESUMO

Objetivo: Analisar os efeitos de 12 semanas de treinamento funcional com e sem exercícios específicos do core sobre indicadores funcionais e de desempenho.
Método: Este será um ensaio randomizado composto por três grupos de intervenção e duração de 12 semanas. Os participantes serão agrupados aleatoriamente em programas de treinamento funcional, a saber: grupo de treinamento funcional, que realizará exercícios globais e multiarticulares e funcionais, mas sem exercícios para o núcleo; treinamento funcional + core, que realizará um protocolo similar ao grupo de treinamento funcional, mas com exercícios específicos para a região central; e grupo de treinamento básico, que só executará exercícios específicos para o núcleo. Em ambos os momentos, os testes serão realizados na seguinte ordem: bateria de teste de resistência muscular do tronco de McGill, teste unilateral de elevação pélvica, *sit up* test, isometric dead lifth, *push up, sit to stand, functional movement screen, handgrip test, countermovement maximal vertical jump test,* uma repetição máxima nos exercícios supinos reto, remada e *leg press*, teste T de agilidade e Yo-Yo.
Discussão: Esses achados fornecerão novas evidências para a tomada de decisões pelo profissional da Educação Física na prescrição de exercícios.
Conclusão: Nós hipotetizamos que a inclusão de exercício com foc especificamente no tronco em protocolos de treinamento funcional levará a um maior desempenho funcional e básico.
Palavras-Chave: Dor lombar crónica, desempenho atlético, reabilitação.

Introduction

Panjabi,[1,2] one of the first authors to define spine stability, suggested that this middle zone of the body is a complex, composed of passive, active, and neural systems whose purpose is to improve body stability. Kibler[3] expanded the concept of spine stability, applying it to sports training (denominated core stability), defined as the ability to control the movement or position of the trunk over the pelvis, aiming to optimize the production, control, and transfer of strength from the centrer to the extremities. The interaction between these subsystems (stability)[4] and correlates of the active subsystem, such as maximum and endurance strength or muscular activation, has been associated with improvements in sport performance,[5-11] jump strength,[12] the synergy between upper limb muscles,[13] and running capability.[5,11,14] Furthermore, deep muscles of the core e.g., the transverse abdominal muscle, seem to be preactivated during limb movements, even before activation of the main muscle groups.[15,16] However, this activation seems be later in low back pain patients compared to healthy people, indicating a potential association between low back pain and middle zone neuromotor deficits.[17]

In a recent systematic review, Cuellar et al.[18] showed that the amount of upper and lower limb muscles decreases around 1% per year after the age of 50, with higher decreases observed regarding abdominal muscles (around 36% and 48% between 20 and 86 years). In addition, given the relevance of the core for daily activities, rehabilitation, and sport performance, the use of core exercises in physical training programs appears logical. However, despite inclusion of core exercises, especially in protocols of functional training,[19,20] their effectiveness and the effects of these exercises on specific outcomes (e,g., functional or performance) are not clear.

Although electric activation of muscles leading to core exercises has been investigated in electromyography studies,[21-26] findings represent acute effects with specific conditions, such as angulation and exercise phase (ascending or descending). The so-called "functional exercises" related to motor skills commonly required in daily life (e.g., squatting, pushing, pulling) have been indicated as muscle core triggers.[27-32]. For instance, Comfort et al.[33] examined trunk muscle activity during middle zone (front plank and superman) and dynamic exercises (back squat, front squat, and military press) in active young adults, and found that the front plank exercise led to higher activation of the abdominal rectus compared to dynamic exercises, with no difference regarding erector spinal muscle activation. In contrast, Hamlyn et al.[34], observed that the front squat performed in six repetitions at 80% of one Maximum repetition (1-RM) was more effective to activate extensor muscles compared to the superman in trained young adults. However, these results do not allow any extrapolation to the chronic or long-term effects of core exercises.

In addition, although it seems clear that core muscles can be activated by both global and specific exercises, findings regarding the magnitude of this activation are still lacking. In addition, to the best of our knowledge, there are no studies on the chronic effects of core exercises within functional training protocols in relation to core, functional, and performance outcomes. Thus, our aim is to analyze the effects of 12 weeks of functional training with and without core exercises on core, functional, and performance indicators.

Method

Subjects

One hundred healthy and sedentary adults, aged between 18 and 40, will compose the sample. All participants will sign the Informed Consent Form. The exclusion criteria will be: a) low back pain in the previous six months; b) ankle instability; c) metabolic diseases (diabetes, hypertension, dyslipidemias); and d) osteoarticular and musculoskeletal diseases.

Design

This is a three-arm randomized controlled trial, which will take place over 12 weeks. Participants will be randomly grouped into three training programs, namely: functional training group (FT), functional training + core group (FTC), and core training group (CT). Each group will perform three training sessions per week totalling 36 training sessions over the 12 weeks. Randomization will be in blocks based on the means of performance and maximal strength tests at baseline. The study flow chart is displayed in figure 1. This research project was approved by the local Ethics Committee according to the Declaration of Helsinki.

At both moments, tests will be carried out in the following order (aiming to avoid variability effect of the order): McGill's Torso Muscular Endurance Test Battery, unilateral hip bridge endurance test, Sit Up test, Isometric dead lift, push up, sit to stand, functional movement screen, handgrip test, countermovement maximal vertical jump test, 1-RM of Bench Press, Row and leg press, T- run agility test, and Yo-Yo test. The core tests will be

performed in the Physiology Laboratory of the Federal University of Sergipe (Brazil) and all other tests in a multi-sports court. The reproducibility of the tests will be calculated before the intervention until the interclass correlation coefficient (ICC) is from 0.80

McGill's Torso Muscular Endurance Test Battery

Core static endurance will be assessed through the McGuill's protocol. This battery is composed of four tests, which demonstrate excellent ICC, namely: trunk flexion (0.97), trunk extension (0.97), and trunk lateral muscles (0.99)[35]. The same assessors will be responsible for all these tests aiming to ensure the quality of execution and encouraging the participants to give maximal performance.[26] Participants will perform one attempt at each test and the result will be obtained in seconds. During the tests only two assessors and a volunteer will be in the assessement room.[8,35]

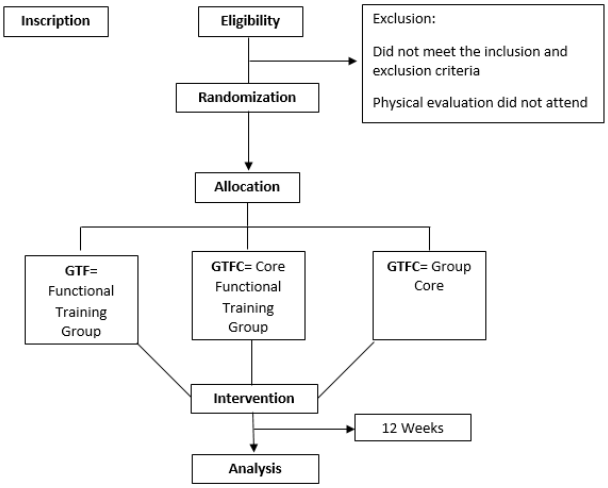

Figure 1. Study flowchart

Trunk flexors

For the assessment of trunk flexors, participants will be seated in *sit up* position (knees and hips at 90°), with their back lying on a platform at 60° in relation to the ground, hands crossed on the shoulders and feet restrained by the assessor. Participants will be notified that the test is beginning, the back support platform will be removed (10 cm back) and participants will be required to maintain the isometric position for as long as possible. The test is finalized when the participant is unable to maintain their trunk at 60° in relation to the ground.[7,33]

Trunk extensors

The modified Biering-Soensen test[7] will be used to assess the trunk extensors. Participants will be in the dorsal decubitus position on a stretcher one meter in height, with the trunk outside the stretcher in a cavalier position. The lower limbs will be fixed to the stretcher with four adhesive tapes located just below the gluteal fold, between the gluteal fold and knees, at the midpoint of the legs, and on the ankles. During this process, participants will be supported by hands in order to avoid early fatigue of the extensor muscles. At a signal from the assessor, the participant will place their hands on the opposite shoulder and the trunk will remain parallel to the ground, in a horizontal position (initial position). Participants will be encouraged to maintain this position for as long as possible. The test is finalized when the participant is unable to maintain their trunk in a horizontal position.[35]

Side bridge_left_and_right

For assessement of lateral muscles of the trunk, participants will be in the lateral decubitus position (right and left, separately). The legs will be extended and the foot of the upper leg will be placed in front of the supported leg, maintaining a straight line between the head and feet. Participants will be required to lift their hips supported by their elbows and feet. The arm not involved in the movement will be kept on the opposite shoulder. The test is finalized when the participant is unable to maintain the body alignment or the hips/leg touch the ground.[8,35]

Unilateral hip bridge endurance test (UBET)

Lumbo-pelvic stability will be assessed by the Unilateral Pelvic Elevation test, which has been validated against the Unstable Seat Paradigm test (r = -0.56). The lower velocity of centre of gravity shifting (instability), the longer the participant can remain in unilateral pelvic elevation (stability).[36]

Sit up test (SUT)

The sit up test will be adopted to assess the dynamic resistance of the trunk and hip flexor muscles. For this purpose, participants will be in dorsal decubitus with knees bent at 90°, hands touching opposite shoulders, and elbows pointing forward (initial position). From the initial position, participants will perform trunk and hip flexion. A repetition will be counted when elbows touch the knees (during trunk and hip flexion) and return to the scapula touching the ground. The maximal number of repetitions in one minute will be considered as the test indicator.[37]

Isometric Dead lift

Paravertebral muscle strength will be evaluated through a lumbar dynamometer (Sammons Preston Rolyan, Jamar Hydraulic Hand Dynamometer, Canada). Participants will be positioned with the feet on a platform (standardised length), knees bent at 100°, and hips slightly bent. Participants will perform the maximal extension strength of hips and knees with a gradual and constant movement. Two attempts will be conducted and the highest value will be considered. Chulvi-Medrano et al.[27] adopted the dead lift to assess the maximal isometric contraction and observed that this movement led to muscle activation of 107.7% in some trunk extensors, such as the multifidus and spinal erectors.

Push up

The push-up is a standard measure of upper limb endurance.[21] This exercise will be performed on the ground with the hands placed shoulder-width apart and fingers forward (initial position). Males will be supported by their feet and females by their knees. Participants will perform an elbow flexion, maintaining a neutral spine/posture with no changes in the lower limb (feet or elbows) point of support during movement. Instructions will be given to lower the body while flexing elbows until a 90° angle, and thus returning to the initial position. Two repetitions will be conducted for familiarization, followed by the official attempt, during which participants will be encouraged to perform a maximum number of repetitions in one minute.

Sit to Stand (STS)

As an important daily task regarding autonomy and functionality, the sit-to-stand test will be used to assess sit down and get up from a chair ability. Participants will begin in a seated position with feet placed shoulder-wide apart, arms crossed touching opposite shoulders and elbows bent. The chair will be 38 cm from the ground and participants will sit down and stand up as many times and as fast as possible during one minute. A repetition will be counted when hips touch the chair (flexion) followed by a complete hip extension. Two repetitions will be performed for familiarization, followed by the official attempt.[38]

Functional Movement Screen

The Functional Movement Screen (FMS) was developed by Cook to evaluate quality of movement.[8,39,40] This task consists of seven basic movements: deep squat (DS), Hurdle Step (HS), (SM), in Line lunges (ILL), Active straight-leg, raises (ASLR), Rotary stabilities (RS), Shoulder mobility, and Trunk-stability (TS). For each movement individuals receive one of the following scores: 0 (unable to perform the movement or reported pain when executing it), 1 (able to perform the movement with many adjustments), 2 (able to perform the movement with few adjustments), and 3 (able to carry out the movement with no adjustment). In order to provide a qualitative evaluation of movements, the criteria proposed by Okada et al.[8] will be adopted.

Handgrip Test

The isometric hand-grip strength will be measured using a 5-position handgrip dynamometer (Oswaldo Friziola, Crown Dorsal, São Paulo, Brazil), with the second position being adopted for all participants. The test will be performed with the participant sitting in a chair (with no armrests) and knees and elbows bent at 90°. Participants will perform maximum hand-grip force, which will be gradual and constant. Two attempts for each hand (right side first) alternately will be performed.[41,42]

Countermovement Maximal Vertical Jump Test (CMJ)

The CMJ test will, indirectly, evaluate the power of the lower limbs. Participants will be positioned on a contact platform (Probiotics Inc., 8502 ESSLINGER, CT, HUNTSVILLE) and will begin the jump with a downward movement (squatting), immediately followed by a concentric action upwards, resulting in a maximum vertical jump. During the jump, the hands will be placed on the hips and the depth of the descending movement freely chosen to allow a natural movement. Three attempts will be performed, with a rest period of 1 min between attempts. The highest jump will be considered. The CMJ demonstrates excellent reproducibility (ICC = 0.98).[43]

Maximum dynamic force

In order to evaluate the maximum dynamic force, a maximum repetition test (1-RM) will be applied to assess three different movements according to the following devices: Bench Press, Leg Press, and Pull Row. Initially, for all three tests a warm-up will be performed, consisting of 15 repetitions with a pre-established load: 10 kg for women and 15 kg for men in bench press; 150 kg for both women and men in leg press; 15 kg for women and 25 kg for men in row. One minute after this dynamic warm-up, the 1-RM will be tested.

In the bench press, participants will be in dorsal decubitus on a bench and will keep the back supported on it, with their hands on the second mark of the barre near the acromion. A repetition will be considered when participants go down the barre up to 90° of elbow flexion (eccentric phase) and go up it fully (concentric phase). In the leg press, participants will sit on the device and place their feet at the hip line on the platform. The eccentric phase will be established until the hip reaches an angle of 90° and the concentric phase when the knees are fully extended. In the row, participants will be asked to sit on the device by placing their feet on the support provided by the machine (adjusted according to the height of the individual - hip and knee at 90° to the ground). The exercise will be performed with the hands in a prone position. A maximum repetition will be considered when the participant performs the pull (concentric phase) until the elbow reaches 90°. If participants perform two maximal repetitions, according to each exercise, a formula[44] will be applied to establish their 1-RM. However, if more than two repetitions are performed, the participant will rest for two minutes and one more attempt will be made until the maximum repetition is found. In all exercises a velocity of 2x2 s will be maintained.

At least four assessors will be present during the test administration: the first to explain the exact procedures and supervise the execution; the second to control the angulation in the concentric and eccentric phases; and the remaining two to adjust the load. All assessors will be responsible for providing auditory stimuli for participants to perform the maximum effort.[45]

T- Run Agility Test (TAT)

The TAT test will be applied to assess agility and speed. A previous study has shown the validity and reproducibility of this test (ICC = 0.98).[46] Participants will run 9.14 m as fast as possible, which corresponds to the distance between cones A and B. They will touch cone B with their right hand and make a lateral shift to the left until touching cone C 4.57m away from cone B. Next, the participant will move laterally to the right until touching cone D 9.14 m from cone B. After reaching cone D, the participant will return to cone B (with lateral displacement) before returning to cone A, forming a "T". Participants will complete a familiarization test followed by three official attempts. The time of each attempt will be recorded through a photocell device (Timing System, Salt Lake City, UT), which will be positioned approximately 0.75 m above the ground on each side of the cone. Time will be registered when the participants pass through the electronic sensors and interrupted when they pass the sensor again, also being interrupted if the participant does not touch the cones or crosses their feet when performing the lateral displacements.[46, 47]

Yo-Yo Test (Yo-Yo IR1)

The Yo-Yo IR1 test will evaluate the ability to perform an intermittent exercise leading to activation of the aerobic system. This test has a high correlation with VO_2peak, with an ICC of 0.95 ($p < 0.01$) and coefficient of variation of 8.7%. The test consists of a sprint of 2 x 20m with increased speed and a 10-second active rest period (controlled by a beep) The test is divided into stages and when the subject is not able to maintain the speed, the last complete stage is considered. Each stage represents a distance in meters, which will be used for statistical purposes.[46,47]

Training protocols

A macrocycle of 12 weeks composed of three mesocycles (initial, and after four and eight weeks of training) and 36 sessions of training will be applied. Each microcycle, or training week, will be composed of three training sessions of 50 to 60 minutes (view tables 1,2,3,4,5 and 6). In order to vary the stimulus of the training, two distinct routines (A and B) will be planned. Each participant will be supervised by the same coach throughout the intervention period. Coaches will be responsible for groups of up to five participants. Exercises will be adjusted by the coaches according to the functional capacity of the participants. The intervention groups will be: 1) Functional Training (FT), who will perform global, multi-articular, and functional exercises, with no exercises for the core; 2) Functional and Core Training (FTC), who will perform a similar protocol to FT, but with the inclusion of specific exercises for the core region; and 3) Core Training (CT), who will only perform specific exercises for the core, allowing greater muscular activation of this region (Figure 2). All groups will perform two weeks of familiarization with their respective training protocols. All training programs will be carried out in the same multi-sports court where the physical evaluations will be performed. The participants will be accompanied by Physical Education professionals with experience in this type of training.

Functional Training

The FT and FTC groups will perform high-intensity functional training. Each training session will be divided into four parts, namely: preparation for movement (joint mobility and core muscle activation), neuromuscular I, neuromuscular II, and cardiometabolic. The joint mobility will take place for five minutes and be composed of dynamic mobility of the cervical,

glenohumeral, thoracic, hip, and ankle joints, providing thus a warm-up of 10 repetitions per joint. In preparation for the movement, core muscle activation will last five minutes, aiming to provide better performance in the activities that will be performed during the training. In this phase three exercises will be used Front Plank, Bird Dog, and Bridge Supine Side. During these exercises, coactivation of the bracing abdominal musculature will be adopted providing greater activation of the middle zone.[48] The neuromuscular I and II will consist of two high-intensity circuits composed of six stations. Prior to the neuromuscular I circuit, coordinated gait movements will be performed in the sagittal and frontal planes with displacements in the anterior-posterior and lateral-lateral directions, respectively, after which a circuit composed of six stations will be performed for both groups (FT and FTC). In the FT group four of the six stations will be power exercises, two for the lower limbs and two for the upper limbs. In addition, one station will require agility and the other coordination. However, in the FTC group, of the two stations designed to train the power of upper limbs, one will be replaced by a core power exercise. In the neuromuscular II circuit, the FT group will perform four stations which represent functional actions of daily life (two for the squat action and two for the pull action). In addition, a push station and a transport station will be added, totalling six stations. The FTC group will follow a similar protocol, but two stations (one of the carry movement and the other of push) will be replaced by core-specific exercises. Finally, in the cardiometabolic phase both FT and FTC groups will perform the same protocol. Two games will be used: Tug of war and intermittent running, both characterized as high intensity interval exercises. The aim of this phase will be to provide a maximum effort followed by adequate rest periods. This part of the session will last 5 minutes.

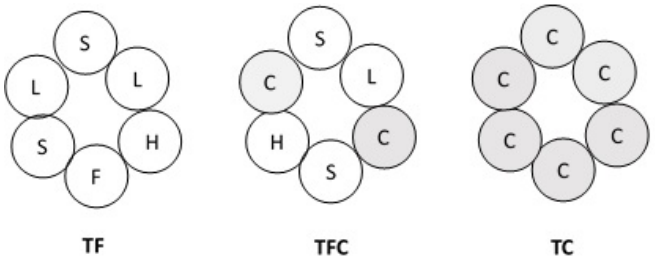

Figure 2: Organization of exercise in the training: S- squat; L-pull; H-push; F-Farm Walk; C- Core. TF: Functional Training; TFC: Functional Training Core; TC: Core Training

In the first and second sessions of the neuromuscular circuits I and II, participants will perform two sets (turns) in each circuit, each station consisting of one minute (initial density 30:30, which will be progressively modified). The interval between the first and second sessions will be 48 hours. In the third session, the subjects will perform three sets with a rest of 72 hours. In addition, after each training session, participants will report their rating of perceived exertion (Borg's scale), expected values being between 8 and 10. The intensity will also be controlled by the number of repetitions (8-10) performed by the participant in each exercise and the maximum heart rate assessed through a system wireless (Polar Team™).

Core Training

The core training (CT group) will follow a similar structure to the functional training in terms of session duration (50 minutes) and training cycles. The training will also be composed of preparation of movement (joint mobility and core activation) using the same exercises as the other groups. The main part of the training will be composed of two circuits, one for muscle strength and one for muscle endurance. In the first, exercises with moderate to high intensity levels will be used (higher than 60% of the maximum voluntary isometric contraction) or high neuromotor complexity.[23,49] Considering the current approach, the exercises used will be focused on pelvic and scapular waist muscles, the pelvic floor, external rotators of the hip (e.g. gluteus medius), in addition to flexors, extensors, and rotators of the trunk.[50] For the muscle endurance circuit, exercises targeting strength/endurance will added[23,49], mostly dynamic (e.g., curl up, sit up) which require action from the flexors, extensors, and rotators of the trunk. Like the other groups, the CT group will have two changes in the training circuits (mesocycle). The training density will be the same as the FT and FT+C groups. On the first, second, and third day of the training session there will be two sets in each circuit. In addition, the intensity range will also be between 8 and 10 of the effort perception scale, and like the other groups, participants will report their rating of perceived exertion just after each training circuit.

Table 1
Core group training from the first to fourth weeks of intervention

	Weeks 1-4 Density 30": 30"
Strength	1. Bird dog 2. Opposite leg movement (cross pattern) without touching the foot on the floor. 5 plays each side 3. Single leg squat 4. In double, arms outstretched, performed force unlike the partner (sagittal plane) 5. Front Plank (With support of both legs) 6. Bridge in supine unilateral 7. Side Plank (With knee support and hip abduction) 8. Unilateral hip bridge. 9. Sit Twist 10. Superman dynamic 11. Clamshell
Endurance	1. Hip flexion (flexed leg) 2. Curl-up 3. Crush 4. Sit up (Holding the foot) 5. Curl up-twist 6. Curl touching heels

Statistical analysis

Sample size was calculated by Granmo software (version 5.2 for Windows, IMIM, Barcelona, Spain). Considering an 80% statistical power, fifteen participants will be needed for each group. However, 20% will be added to this value, foreseeing possible sample losses. Fifteen participants will be required for each group in order to identify a moderate effect size ($d > 0.4$). Means and standard deviation will be used for data description. Homogeneity and sphericity of variances will be tested by the Levene's test and Mauchly's test, respectively. The Greenhouse-Geisser correction will be adopted if sphericity is violated. Covariance analysis (ANCOVA GLM) 3x2 will be performed for group comparisons throughout the 12 weeks of the intervention (effects of group, time, and interaction group vs time) followed by Sidak pairwise comparisons (post-hoc) to identify potential differences. Data will be processed using SPSS version 22.0 for Windows with a statistical significance of $p < 0.05$

Results

The current study will analyze the real importance of the inclusion of specific core exercises in functional training protocols, that is, the extent to which the global exercises used in functional training could bring about adaptive improvements in the functionality and performance of the core without the need to

include specific exercises. In addition, the effects of core-specific training on functional and core performance as well as other domains of performance and functionality will be assessed. These findings will provide new evidence to aid decision-making by physical education professionals in exercise prescription.

Conclusion

This study will address the methodological deficits in the literature, controlling, for example, the exercise velocity and training density. We hypothesize that the inclusion of exercise specifically targeting the trunk in functional training protocols will lead to higher functional and core performance.

Authotship. All the authors have intellectually contributed to the development of the study, assume responsibility for its content and also agree with the definitive version of the article. **Funding.** Grant from Coordination of Superior Level Staff Improvement (CAPES) **Acknowledgements.** We thank you so much Functional Training Group members **Conflicts of interest.** All the authors report no conflicts of interest. **Provenance and peer review.** Not commissioned; externally peer reviewed. **Ethical Responsabilities.** *Protection of individuals and animals:* The authors declare that the conducted procedures met the ethical standards of the responsible committee on human experimentation of the World Medical Association and the Declaration of Helsinki . *Confidentiality:* The authors are responsible for following the protocols established by their respective healthcare centers for accessing data from medical records for performing this type of publication in order to conduct research/dissemination for the community. *Privacy:* The authors declare no patient data appear in this article.

Table 2
Core group training from the fifth to the eighth weeks of intervention.

Weeks 5-8 Density 40": 20"	
Strength	1. 6 dog 2. Opposite leg movement (cross pattern) without touching the foot on the floor. 5 plays each side 3. Single leg squat 4. Squat overloading and maintaining the tension of a mini band 5. Bilateral flexion of the shoulder using elastic overload 6. Front Plank (With support of one arm) 7. Bridge in supine unilateral 8. Side Plank (With knee support and hip abduction) 9. Side Plank one on top of the other. 10. Unilateral hip bridge. 11. Superman dynamic 12. Clamshell
Endurance	1. Hip flexion (extended leg) 2. Curl-up 3. Crush 4. Sit up (Holding the foot) 5. Curl up-twist 6. Curl touching heels 7. Extension of the trunk on top of the swim ball (isometric) 8. Bilateral pelvic elevation with overload

Table 3
Core training group from the ninth to the twelfth intervention week.

Weeks 9-12 Density 45": 15"	
Strength	1. Bird Dog 2. Unilateral pull with elbow flexion and without abduction of the shoulder (neutral hand) 3. Single Leg Squat 4. Squat overloading and maintaining the tension of a mini band 5. Front Plank (with elbows resting on a mini disc) 6. Bridge in supine unilateral 7. Side Plank (with knee support and hip abduction) 8. Unilateral hip bridge 9. Bridge in supine bilateral 10. Superman isometric 11. Side plank (fingers of the supporting leg next to the heel of the front leg) 12. Clamshell
Endurance	1. Hip flexion (extended leg) 2. Curl-up 3. Crush 4. Sit up (Holding the foot) 5. Curl up-twist 6. Curl touching heels 7. Extension of the trunk on top of the swim ball (dynamic) 8. Bilateral pelvic elevation with overload 9. Push up (Foot support). 10. Curl-up student lying on the side doing trunk flexion

Table 4
Intervention from the first to fourth weeks for functional training group (TF) and functional training group + Core Group (TFC).

Weeks 1-4 Density 30": 30"		
	TF	TFC
Neuromuscular 1	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, medium (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprint 20 m with recovery of 20 m (a) / ZigZag displacement passing in front of cone (b) 5. Rope Training in line/ ZigZag (b) 6. Jump rope (a) / jumping jacks (b)	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, medium (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprint 20 m with recovery of 20 m (a) / ZigZag displacement passing in front of cone (b) 5. Rope Training in line/ ZigZag (b) 6. Rotational with elastic, arms flexed (a,b) #
Neuromuscular 2	1. *Dead lift* (a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. *Farm walk bilateral* (a,b) 4. Forward lunge (a) / Forward Reverse (b) 5. *Push up* (a) / Push one-sided with elastic keeping one foot in front and one behind (b) 6. Unilateral pull with elastic, keeping one foot in front and one behind (a) / Unilateral pull with Kettlebell (b)	1. *Dead lift* (a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. Front Plank (a) / Side Plank one foot on top of the other (b) # 4. Forward lunge (a) / Forward Reverse (b) 5. *Push up* (a) / *Push up* (a) / Push one-sided with elastic keeping one foot in front and one behind (b) 6. Bilateral hip bridge external overload (a)/ Superman bilateral isometric (b). #

Table 5
Intervention from the fifth to eighth weeks for functional training group (TF) and functional training group + Core Group (TFC).

Weeks 5-8 Density 40":20"		
	TF	TFC
Neuromuscular 1	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, high (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprinter with side direction change (a) / ZigZag displacement passing behing of cone (b) 5. Skip Barrier giving 2 clicks/ Robe Training Rotational (b) 6. Rope Training in line With small squats (a) / burpee (b).	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, high (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprinter with side direction change (a) / ZigZag displacement passing behing of cone (b) 5. Skip Barrier giving 2 clicks/ Rope Training Rotational (b) 6. Rotational with elastic, arms extended (a, b).#
Neuromuscular 2	1. *Dead liftlh* (a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. *Farm walk bilateral* (a,b) 4. Bulgarian Squat (a) / Forward walking (b) 5. Pull up (a) / Push one-sided united feet (b) 6. *Pull* (a) / (b) *pull with kettlebell*	1. *Dead liftl*- (a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. *Front Plank talking off hand* (a,b)# 4. Bulgarian Squat (a) / Forward walking (b) 5. Pull up (a) / Push one-sided united feet (b) 6. Unilateral hip bridge Without overload (a) / *Superman*(b)#

Table 6
Intervention from the ninth to twelfth weeks for functional training group (TF) and functional training group + Core Group (TFC).

Weeks 9-12 Density 45":15"		
	TF	TFC
Neuromuscular 1	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, high (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprinter with side direction change (Color stimulation for decision making; increased lateral displacement distance (a) / ZigZag Passing in front of the cone (b) 5. Skip Barrier giving 1 clicks/ Rope Training Rotational (b) 6. RopeTraining in line With small squats (a) / burpee (b).	1. Frontal displacements (a)/ Side on the ladder of agility (b) 2. Vertical jump (box) super low, high (a, b) 3. Meddle in the Wall (a) / ground (b) 4. Sprinter with side direction change (Color stimulation for decision making; increased lateral displacement distance (a) / ZigZag Passing in front of the cone (b) 5. Skip Barrier giving 1 clicks/ Rope Training Rotational (b) 6. Rotational with elastic, arms extended, with increased elastic overload. (a, b).#
Neuromuscular 2	1. *Dead lift* Holding the kettlebell with one Hand(a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. *Farm walk unilateral* (a,b) 4. Bulgarian Squat (a) / Forward walking (b) 5. Pull up (a) / Push one-sided united feet (b) 6. Pull (a) / (b) pull with kettlebell	1. *Dead lift* Holding the kettlebell with one Hand(a) / *Front Squat* (b) 2. Pull neutral foot grip (a) / prone (b) Using suspension tape 3. *Front Plank Removing one leg* (a,b) 4. Bulgarian Squat (a) / Forward walking (b) 5. Pull up (a) / Push one-sided united feet (b) 6. Unilateral hip bridge With overload (a) / *Side Plank*

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