

EFFECTUL ACTIVITĂȚILOR FIZICE PRACTICATE ÎN SĂLI DE FITNESS ASUPRA FORȚEI ȘI REZISTENȚEI MUȘCHILOR "CORE" LA FEMEII ADULTE

EFFECTS OF PHYSICAL ACTIVITY PRACTICED IN GYMS ON ADULT WOMEN'S CORE MUSCLE STRENGTH AND STABILITY

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Abstract

Aim: The aim of our study was to evaluate the strength and resistance of the muscles of the abdomino-lumbo-pelvic area in women and to evaluate the effect of physical activities performed in gyms on the strength and stability of the core muscles. *Hypotheses:* 1. The combined physical activity program (Pilates, step-aerobics and strength training) practiced in gyms, may increase the strength and stability of the core muscles. 2. The effects of the intervention program on the strength and stability of the core muscles are manifested differently depending on the age range. *Subjects and methods:* This study involved 95 adult women, who practiced physical activities in two gyms in Oradea, for 12 months, between February 2015 and June 2016. To test the strength and stability of the core muscles we used the functional test "Core Muscle Strength and Stability Test". The physical activity program consisted in combined training of Pilates, Step - aerobics and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months. *Results:* Results of the core muscle strength and stability test: at the initial assessment, 69 subjects (72.7%) were able to complete only the first stage of the test, 1 subject (1.1%) completed stage 2, 3 subjects (3.1%), stage 3, 4 subjects (4.2%) reached stage 4, 13 (13.6%), up to stage 5, and 5 subjects (5.3%) managed to complete the test. At the final evaluation, 20 subjects (21.1%) completed the first stage, 26 subjects (27.5%), the 3rd stage, 18 subjects (18.9%), the 5th stage, 3 subjects (3.1%), stage 6, 10 subjects (10.5%), stage 7, and 18 subjects reached stage 8 and completed the test. *Conclusions:* At the core muscle strength and stability test, almost all subjects improved their results: the number of subjects who received the excellent grade increased from 5 (5.3%) at the initial evaluation, to 31 (32.5%) at the final evaluation. So we can conclude that our hypothesis has been confirmed, the combined physical activity program (Pilates, step-aerobics and strength training) having a beneficial effect on the strength and stability of the core muscles.

Keywords: *core muscles, core muscle strength and stability, adult women, physical activity*

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Rezumat

Scop: Scopul studiului nostru a fost evaluarea forței și rezistenței mușchilor zonei abdomino-lombo-pelviene la femei și evaluarea efectului activităților fizice practicate în săli de fitness asupra forței și rezistenței mușchilor "core". *Ipoteze:* 1. Programul de activitate fizică combinat (Pilates, step-aerobic și antrenament de forță) practicat în săli de fitness, poate să crească forța și rezistența mușchilor zonei abdomino-lombo-pelviene (core muscles). 2. Efectele programului de intervenție asupra forței și rezistenței mușchilor zonei abdomino-lombo-pelviene (core muscles) se manifestă diferit în funcție de intervalul de vârstă. *Subiecți și metode:* La acest studiu au participat 95 de femei adulte, care au practicat activități fizice în două săli din Oradea, timp de 12 luni, în perioada februarie 2015 – iunie 2016. Pentru testarea forței și rezistenței mușchilor nucleului (core) am utilizat testul funcțional „Testul de stabilitate și forță musculară core”. Programul de exerciții a constat din antrenamente combinate între Pilates, Step – aerobic și antrenament în sala de fitness, de 3 ori pe săptămână câte 60-90 de minute, timp de 12 luni. *Rezultate:* Rezultatele testului de stabilitate și forță musculară „core”: la evaluarea inițială, 69 subiecți (72,7%) au putut completa numai prima etapă a testului, 1 subiect (1,1%), etapa a 2-a, 3 subiecți (3,1%), etapa a 3-a, 4 subiecți (4,2%) au ajuns la etapa a 4-a, 13 (13,6%), până la etapa a 5-a, iar 5 subiecți (5,3%) au reușit să finalizeze testul. La evaluarea finală, 20 subiecți (21,1%) au completat prima etapă, 26 subiecți (27,5%), etapa a 3-a, 18 subiecți (18,9%), etapa a 5-a, 3 subiecți (3,1%), etapa a 6-a, 10 subiecți (10,5%), etapa a 7-a, iar 18 subiecți au ajuns la etapa a 8-a și au completat testul. *Concluzii:* La testul de stabilitate și forță musculară core aproape toți subiecți și-au îmbunătățit rezultatele: numărul subiecților care au primit calificativul excelent crescând de la 5 (5,3%) la evaluarea inițială, la 31 (32,5%) la evaluarea finală. Deci putem concluziona că s-a confirmat ipoteza noastră, programul de activitate fizică combinat (Pilates, step-aerobic și antrenament de forță) având efect benefic asupra forței și rezistenței mușchilor "core".

Cuvinte cheie: *mușchii core, forța și rezistența mușchilor core, femei adulte, activitate fizică*

Introduction

Core stability training has grown in popularity over 25 years, initially for back pain prevention or therapy. Subsequently, it developed as a mode of exercise training for health, fitness and sport. The scientific basis for traditional core stability exercise has recently been questioned and challenged, especially in relation to dynamic athletic performance.

Core strengthening has become a major trend in rehabilitation. The term has been used to connote lumbar stabilization, motor control training, and other regimens. Core strengthening is, in essence, a description of the muscular control required around the lumbar spine to maintain functional stability. Despite its widespread use, core strengthening has had meager research. [1]

Stability or increased strength of the abdomino-lumbo-pelvic region has become, since the late 1990s, a well-known trend in fitness, which has penetrated both in sports medicine and physical therapy. [2, 3, 4, 5]

The “core” has been described by Richardson et al. in 1999 as a box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom.

The "core" muscles can be generally defined as 29 pairs of muscles that support the abdomino-lumbo-pelvic complex and help stabilize the spine, pelvis and muscle chains that ensure functional movements [6]. Stabilization is given by the deep muscles, which are closer to the joint: the transversus abdominis and multifidus, in particular, but also the internal oblique, rotators, semispinal, psoas major and minor. The superficial muscles are usually larger and make the transfer and balance of external loads and perform ample movements: rectus abdominis, external oblique, spinal erectors (iliocostal, spinal, longissimus), latissimus dorsi, gluteus maximus and medius, hamstrings, rectus femoris and quadratus lumborum.

For women, this is a very important area, especially after pregnancy, but also before and during pregnancy as it is very important to tone the abdomino-lumbo-pelvic area. All women want a sucked abdomen, but most of them work only the rectus abdominis, possibly obliques and have not even heard of "core muscles".

Aim: The aim of our study was to evaluate the strength and resistance of the muscles of the abdomino-lumbo-pelvic area (core muscles) in women and to evaluate the effect of physical activities performed in gyms on the strength and stability of the core muscles.

Hypotheses:

1. The combined physical activity program (Pilates, step-aerobics and strength training) practiced in gyms, may increase the strength and stability of the core muscles.

2. The effects of the intervention program on the strength and stability of the core muscles are manifested differently depending on the age range.

Materials and methods

Subjects

This study involved 95 adult women, who practiced physical activities in two gyms in Oradea, for 12 months. The research included only those women who showed interest, accepted the measurements and agreed that their data be used in research.

Methods

To test the strength and endurance of the core muscles, we used the functional test "The Core Muscle Strength and Stability Test" after Mackenzie [7, 8].

Tong, Wu & Nie in 2014 evaluated the validity and reliability of the test in assessing the overall function of the core muscles. They suggest that the core muscle strength and stability test is a valid, reliable one and it is a practical method for assessing global core muscle endurance in athletes, especially if a trial to familiarize with the test takes place before the measurement.

The aim of the test is to monitor the development of the abdominal and lumbar muscles of the subjects. To perform the test we needed a flat, non-slip surface, a mat, a stopwatch. The test includes 8 stages, in each stage the subject must maintain certain positions for a predetermined time.

Description of the test:

Stage 1:

- a short warm-up is performed;
- the subject assumes the starting position using the mat to support their elbows and arms;
- once the subject reached the right position, the test administrator starts the timer;
- the subject holds this position for 60 seconds. (Figure no.1)



Figure no. 1. Stage 1 of the Core Muscle Strength and Stability Test

Stage 2:

- the subject lifts their left arm off the ground and extends it out in front of them parallelly with the ground (Figure no.2);
- the subjects holds the position for 15 seconds.



Figure no. 2. 2nd stage of the Core Muscle Strength and Stability Test

Stage 3:

- the subject returns to the starting position, raises the right arm from the ground, extends it parallelly to the ground (same as Figure no. 2, raises the other arm);
- the subjects holds the position for 15 seconds.

Stage 4:

- the subject returns to the starting position, lifts the left leg off the ground, extends the knee, parallelly with the ground (Figure no.3);
- the subjects holds the position for 15 seconds.



Figure no. 3. Stage 4 of the Core Muscle Strength and Stability Test

Stage 5:

- the subject returns to the starting position, lifts the right leg off the ground, extends the knee, parallelly with the ground (same as Figure no.3, raises the other leg);
- the subjects holds the position for 15 seconds.
-

Stage 6:

- the subject returns to the starting position, lifts the left leg and right arm off the ground, extends them to be parallelly with the ground (Figure no. 4);
- the subjects holds the position for 15 seconds.



Figure no. 4. Stage 6 of the Core Muscle Strength and Stability Test

Stage 7:

- the subject returns to the starting position, lifts the right leg and left arm off the ground, extends them to be parallelly with the ground (same as Figure no.4, with the opposite arm and leg);
- the subjects holds the position for 15 seconds.

Stage 8:

- the subject returns to the starting position (Figure no. 1);
- the subjects holds the position for 30 seconds.

Application of the test: before the start of the test, all positions must be demonstrated to the subjects, and the test administrator must ensure that each subject adopts the position specific to the corresponding stage. Throughout the test, the head, neck, back and pelvis should be kept in the correct plank position (Figure 1). If the subject is unable to maintain this position then the test must be stopped.

The stage at which the subject is no longer able to maintain the correct body position or can no longer continue the test, is recorded.

If the subject is able to complete the test it means that she/he has good endurance and strength of the core muscles. If the resistance of the core muscles is weaker, the subject cannot complete the test and will move his torso unnecessarily during the test, which causes energy loss. The interpretation of the test is made in accordance with the score awarded according to Table no.1. Scoring is based on the phase completed with the correct postural alignment. The score will be recorded and will represent the stage that the subject completed before falling to the floor or having an inappropriate posture.

Table1. The Core muscle strength and stability test scoring

Stage	Time	Grade/Qualifying
Stage 1	60 sec	Needs improvement
Stage 2	75 sec	Needs improvement
Stage 3	90 sec	Needs improvement
Stage 4	105 sec	Good
Stage 5	120 sec	Good
Stage 6	135 sec	Excellent
Stage 7	150 sec	Excellent
Stage 8	180 sec	Excellent

The data obtained were statistically analyzed with the IBM SPSS program, version 23 (descriptive analysis, frequency).

Applied physical activity program

Following the new recommendations of the American College of Sports Medicine - ACSM (2018) [9] on performing physical activities in adults aged 18-64, in addition to aerobic physical activities of moderate intensity (150 minutes/week) or vigorous (75 minutes/week) and muscle

toning (2 times/week), there were recommended endurance exercises 2-3 times/week, exercises to increase flexibility 2 times/week, and the practice of neuromotor exercises, which involve balance, agility and coordination, was also recommended. Our physical activity program was in line with these recommendations, being a combined program: aerobic physical activities of moderate or vigorous intensity were completed by step-aerobic classes and High Intensity Interval Training (HIIT), muscle toning and resistance exercises were performed for major muscle groups, and exercises to increase flexibility, balance, agility and coordination were addressed in Pilates classes.

The physical activity program consisted in combined training of Pilates, Step - aerobics and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months. The weekly division was as follows: 2 Pilates sessions of 60 minutes each, followed by 30 minutes of toning in the gym and 1 step-aerobics session/week of 60 minutes, followed by 30 minutes in the gym.

There were used: dynamic, repetitive exercises, with large muscles groups; hard resistive exercises; functional exercises; high intensity interval training; balance exercises (Pilates); circuit training; stretching exercises.

Muscle strengthening was conducted mainly in the following muscle groups: upper limb muscles, back muscles, abdominal muscles, lower limb muscles.

Results

The analysis of the data of the subjects participating in the study reveals that their average age was 28.45 (8.75) years, the minimum age being 18 years, and the maximum 52 years. The descriptive analysis, by age range, is presented in Table 2.

Table 2. Distribution of subjects according to age range (N = 95)

Age Interval	Frequency	Percent	Valid Percent	Cumulative Percent	Minimum	Maximum	Mean	StDev
<25	41	43,2	43,2	43,2	18	24	21,10	1,828
25-34	31	32,6	32,6	75,8	25	34	28,42	2,527
35-44	14	14,7	14,7	90,5	35	43	37,79	2,887
>44	9	9,5	9,5	100,0	45	52	47,56	2,068
Total	95	100,0	100,0		18	52	28,45	8,746

Of the 95 subjects, 41 (43.2%) were under the age of 25 years, 31 (32.6%) in the age range of 25-34 years, 14 (14.7%) in that of 35-44 years, and 9 (.5%) were over 44 years.

Table 3. Results of the core muscle strength and stability test at the initial and final evaluation (N=95)

Stages	Completed seconds	Grade/Qualifying	Initial assessment		Final assessment	
			Nr. subjects	Percentage	Nr. subjects	Percentage
Stage 1	60 sec	Needs improvement	69	72,6%	20	21,1%
Stage 2	75 sec	Needs improvement	1	1,1%	-	-
Stage 3	90 sec	Needs improvement	3	3,1%	26	27,4%
Stage 4	105 sec	Good	4	4,2%	-	
Stage 5	120 sec	Good	13	13,6%	18	18,9%
Stage 6	135 sec	Excellent	-		3	3,1%
Stage 7	150 sec	Excellent	-		10	10,5%
Stage 8	180 sec	Excellent	5	5,3%	18	18,9%
TOTAL			95	100%	95	100%

The results of the core muscle strength and stability test from the initial and final evaluations, for the whole group can be consulted in Table no.3. We notice that at the initial evaluation, 69 subjects (72.7%) could complete only the first stage of the test, 1 subject (1.1%), the 2nd stage, 3 subjects (3.1%), the 3rd stage, 4 subjects (4.2%) reached the 4th stage, 13 (13.6%), up to the 5th stage, and 5 subjects (5.3%) managed to complete the test . At the final evaluation, 20 subjects (21.1%) completed the first stage, 26 subjects (27.5%), the 3rd stage, 18 subjects (18.9%), the 5th stage, 3 subjects (3.1%), stage 6, 10 subjects (10.5%), stage 7, and 18 subjects reached stage 8 and completed the test.

Table 4. Initial and final evaluation results of the core muscle strength and stability test at the age range <25 years (N = 41)

Stages	Seconds	Qualifying	Initial assessment		Final assessment	
			Nr. subjects	Percentage	Nr. subjects	Percentage
Stage 1	60 sec	Needs improvement	28	68,3%	5	12,3%
Stage 2	75 sec	Needs improvement	1	2,4%	-	-
Stage 3	90 sec	Needs improvement	1	2,4%	15	36,6%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	8	19,6%	8	19,5%
Stage 6	135 sec	Excellent	-	-	2	4,8%
Stage 7	150 sec	Excellent	-	-	5	12,2%
Stage 8	180 sec	Excellent	3	7,3%	6	14,6%
TOTAL			41	100%	41	100%

At the age range <25 years at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 28 subjects (68.3%) completed the first stage, 1 subject (2.4 %), stage 2 and 3, 8 subjects (19.6%), stage 5, and 3 subjects (7.3%) reached stage 8 and completed the test. At the final evaluation, 5 subjects (12.3%) completed the first stage, 15 subjects (36.6%), the 3rd stage, 8 subjects (19.5%), the 5th stage, 2 subjects (4.8%), stage 6, 5 subjects (12.2%), stage 7, and 6 subjects (14.6%) completed the test (Table no.4).

Table 5. Initial and final evaluation results of the core muscle strength and stability test at the age range 25-34 years (N=31)

Stages	Seconds	Qualifying	Initial assessment		Final assessment	
			Nr. subjects	Percentage	Nr. subjects	Percentage
Stage 1	60 sec	Needs improvement	24	77,5%	7	22,6%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	-	-	8	25,9%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	5	16,1%	7	22,6%
Stage 6	135 sec	Excellent	-	-	1	3,2%
Stage 7	150 sec	Excellent	-	-	3	9,6%
Stage 8	180 sec	Excellent	2	6,4%	5	16,1%
TOTAL			31	100%	31	100%

At the age range 25-34 years at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 24 subjects (77.5%) completed the first stage, 5 subjects (16.1 %), stage 5 and 2 subjects (6.4%) reached stage 8 and completed the test. At the final evaluation, 7 subjects (22.6%) completed the first stage, 8 subjects (25.9%), the 3rd stage,

7 subjects (22.6%), the 5th stage, 1 subject 3.2%), stage 6, 3 subjects (9.6%), stage 7, and 5 subjects (16.1%) completed the test (Table no.5).

Table 6. Initial and final evaluation results of the core muscle strength and stability test at the age range 35-44 years (N=14)

Stages	Seconds	Qualifying	Initial assessment		Final assessment	
			Nr. subjects	Percentage	Nr. subjects	Percentage
Stage 1	60 sec	Needs improvement	10	71,5%	5	35,7%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	2	14,3%	2	14,3%
Stage 4	105 sec	Good	1	7,1%	-	-
Stage 5	120 sec	Good	1	7,1%	2	14,3%
Stage 6	135 sec	Excellent	-	-	-	-
Stage 7	150 sec	Excellent	-	-	2	14,3%
Stage 8	180 sec	Excellent	-	-	3	21,4%
TOTAL			14	100%	14	100%

At the age range 35-44 years at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 10 subjects (71.5%) completed the first stage, 2 subjects (14.3 %), the 3rd stage and 1 subject (7.1%), reached the 4th stage, respectively the 5th one. No one managed to pass the 5th stage. At the final evaluation, 5 subjects (35.7%) completed the first stage, 2 subjects (14.3%), reached the 3rd stage, the 5th stage, respectively, the 7th stage, and 3 subjects (21.4%) completed the test (Table no. 6).

Table 7. Initial and final evaluation results of the core muscle strength and stability test at the age range >44 years (N=9)

Stages	Seconds	Qualifying	Initial assessment		Final assessment	
			Nr. subjects	Percentage	Nr. subjects	Percentage
Stage 1	60 sec	Needs improvement	7	77,8%	3	33,4%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	-	-	1	11,1%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	2	22,2%	1	11,1%
Stage 6	135 sec	Excellent	-	-	-	-
Stage 7	150 sec	Excellent	-	-	-	-
Stage 8	180 sec	Excellent	-	-	4	44,4%
TOTAL			9	100%	9	100%

At the age range >44 years, at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 7 subjects (77.8%) completed the first stage, 2 subjects (22.2 %) stage 5. No one managed to pass the 5th stage. At the final evaluation, 3 subjects (33.4%) completed the first stage, 1 subject (11.1%), the 3rd stage, respectively the 5th stage, and 4 subjects (44.4%) completed the test (Table no.7).

Discussions

At the core muscle strength and stability test, in the initial evaluation only 5 subjects (5.3%) managed to complete the test, so we can say that very few received the excellent grade and had a corresponding strength and stability of the core muscles. Instead, at the final evaluation, 18 subjects (18.9%) completed the test and another 13 (13.6%) received the excellent grade (they reached the

6th and 7th stages, respectively). We must also remember that the test was designed for athletes, but there is no other functional test that examines the overall strength and stability of the core muscles.

A recent study from 2018 by Clark et al. interviewed 241 athletes, coaches, sport science and sports medicine practitioners about their perceptions on anatomy and function of the core, their views on effectiveness of various current and traditional exercise training modes [10]. Respondents were asked to identify the most effective method of measuring core stability in a healthy, uninjured person. Almost a quarter (22%) reported that there was no effective method to test core stability. A number (43%) of the respondents proposed subjective assessment of core stability through observation. Of these, 17% suggested observation of sport-specific movement or exercise technique and 26%, observation of ground-based loaded barbell exercises. Objective assessments were proposed by 32% and included the timed isometric plank (19%), functional movement screen (9%) and isometric trunk bracing with biofeedback (4%).

A 2008 study by Endleman and Critchley provided the first evidence that specific Pilates exercises activate deep abdominal muscles [11]. The researchers used ultrasound scanning to measure the change in thickness of the abdominal transverse and internal oblique when the subjects performed a set of classic Pilates exercises: imprint, the hundred, rolling up, foot circles. They found a significant increase in thickness, representing muscle activity, both in the abdominal transverse and in the internal oblique, during all Pilates exercises performed correctly.

The Pilates method has been shown to improve core endurance [12, 13]

In 2018, Wood's book entitled "Pilates for Rehabilitation - Recover from injury and optimize function" appeared, which presents the science behind the Pilates method for recovery and which claims that the method focuses on the nucleus, center of the body or core [14].

Conclusions

At the core muscle strength and stability test, almost all subjects improved their results: the number of subjects who received the excellent grade increased from 5 (5.3%) at the initial evaluation, to 31 (32.5%) at the final evaluation. So we can conclude that our hypothesis has been confirmed, the combined physical activity program (Pilates, step-aerobics and strength training) having a beneficial effect on core muscle strength and stability.

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