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Three-Months of Neuromotor Fitness Program Affect the Body Composition and Physical Performance in Untrained Women

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ABSTRACT

International Journal of Exercise Science 12(4): 1346-1354, 2019. The purpose of this study was to investigate the effect of three months of neuromotor fitness on body composition and physical performance in untrained women. Nine untrained women (age: 38.1 ± 6.9 years; total body mass: 79.3 ± 10.7 kg; height: 161.5 ± 3.9 cm; body mass index: 30.4 ± 4.1) participated in the present study. Subjects attended the laboratory on twenty-seven occasions during a three-month period at least forty-eight hours in between sessions. Sessions 1 and 2 were used to measure morphology and body composition, and to familiarize all subjects with the experimental procedure and physical performance tests (muscle power, balance, muscular endurance, and flexibility). During sessions 3 to 26, all exercises were performed twice a week during 60-min in each session. All exercises were divided into three different circuit programs composed by 12 stations with one-min exercise and a passive recovery of thirty-sec. There were significant decreases ($p < 0.005$) for circumference in the right and left arm, pectoral, waist, abdomen, hip, and right and left calf. There were significant increases in lean body mass ($p < 0.005$) and total body weight ($p < 0.005$). There were significant decreases for body mass index ($p < 0.005$), fat mass ($p < 0.005$), and fat percentage ($p < 0.05$). There were significant decreases ($p < 0.005$) for skinfold in triceps, pectoral, subaxilar, shoulder blade, abdomen, hip, and thigh. There were significant increases for power test ($p < 0.005$), muscular endurance test ($p < 0.005$), and functional test ($p < 0.005$). There were no significant differences for flexibility ($p < 0.005$). The neuromotor fitness program affects the body composition and increases the physical performance in untrained women.

KEY WORDS: functional training, physical activity, body composition.

INTRODUCTION

The American College of Sports Medicine (ACSM) position stand (1) stance on physical fitness, with a focus on health, depends on many factors including body composition, and

cardiorespiratory, neuromuscular and neuromotor fitness. Furthermore, the ACSM¹ indicates that neuromotor fitness (functional training) is a stimulus involving skills such as balance, agility, speed, coordination, proprioception, endurance, strength and flexibility. Silva-Gligloreto et al. (25) explain that the neuromotor aptitude is based on the principle of functionality and presents integrated and multiplanar movements; such as acceleration and deceleration, stabilization and destabilization, as well as developing trunk region strength (CORE) and improving neuromuscular efficiency. In addition, D'Elia (12) indicates the purpose of neuromotor fitness is to rescue the movement pattern to develop the body in an integrated way and to improve the performance. Therefore, it must be applied in order to rehabilitate and/or condition the individual. The Brazilian Sport Diagnosis indicates that 45.9% of the Brazilian population is sedentary, and women are less active when compared to men (8). In contrast, regular physical activity can reduce the risk of developing chronic diseases, such as stroke, type II diabetes, and cancer (i.e. colon and uterus). Also, physical exercise is associated with a reduction in blood pressure and lipoprotein profile, as well as increased insulin sensitivity and body weight control (1).

Several studies described the neuromotor fitness in different populations (elderly, postmenopausal, physically inactive and active) (2, 18, 20, 21) and observed a positive response. Lustosa et al. (18) verified the effects of eight weeks of neuromotor fitness on the static balance and daily life activities performance for seven sedentary elderly women. Authors found an improvement in daily life activities and static balance, with an additional reduction in the risk of falls. Neves et al. (20) verified the effect of neuromotor fitness training on body composition in postmenopausal women and observed a significant reduction in overall body mass and fat mass, and an increase in neuromotor fitness performance, with an exception for flexibility. Pereira et al. (21) also observed the effect of neuromotor fitness training with additional reduction in body composition, body mass index, and total body mass in physically inactive women. Andrades and Saldanha (2) compared the effect of neuromotor fitness and traditional strength training in proprioception and balance in physically active women. This study presented a 294% of improvement in the neuromotor fitness group when compared to traditional strength training.

In this way, previous scientific literature confirmed the suggestion of training specificity and indicated that neuromotor fitness training might be effective in improving several motor skills and reducing body composition (i.e. body mass index and total body mass). Therefore, the present study has two purposes: 1) to investigate the effects of three-months of neuromotor fitness training on body composition in untrained adults' females, and 2) to investigate the performance of several fitness tests after three-months of neuromotor fitness training in untrained adults' females. It was hypothesized that neuromotor fitness will improve physical performance (muscle force and power) and will reduce fat mass and body fat percentage.

METHODS

Participants

The number of subjects was determined by a sample size calculation (4) using G*Power (14) (effect size =1.2; $1-\beta = 0.80$; $\alpha = 0.05$) found that 6 subjects would be sufficient to investigate the

question posed. Effect sizes were calculated based on baseline anthropometric values. Nine untrained women were recruited to this study (age: 38.1 ± 6.9 years; total body mass: 79.3 ± 10.7 kg; height: 161.5 ± 3.9 cm; body mass index: 30.4 ± 4.1), with no previous surgery or history of musculoskeletal injury with residual symptoms (pain) in the upper limbs within the last year. Women were recruited for convenience and to reduce the gender disparity in sports and exercise medicine research. Subjects were instructed to not perform any lower body exercise or strenuous activity throughout the duration of the study, and for 48 hours before each testing session. Prior to this study all subjects received a verbal explanation about the experimental procedure and responded negatively (without cardiovascular diseases) to Physical Activity Readiness Questionnaire (PAR-Q). All procedures were in accordance with the Declaration of Helsinki.

Protocol

The present study followed a crossover within-subject design (Figure 1). All subjects attended the laboratory on twenty-seven occasions during a period of three-months with at least forty-eight hours between each session. All exercises were divided into three different programs following the principle of progression. The level of physical effort in each exercise was controlled by the rating of perceived effort (RPE) (RPE: 6-8).

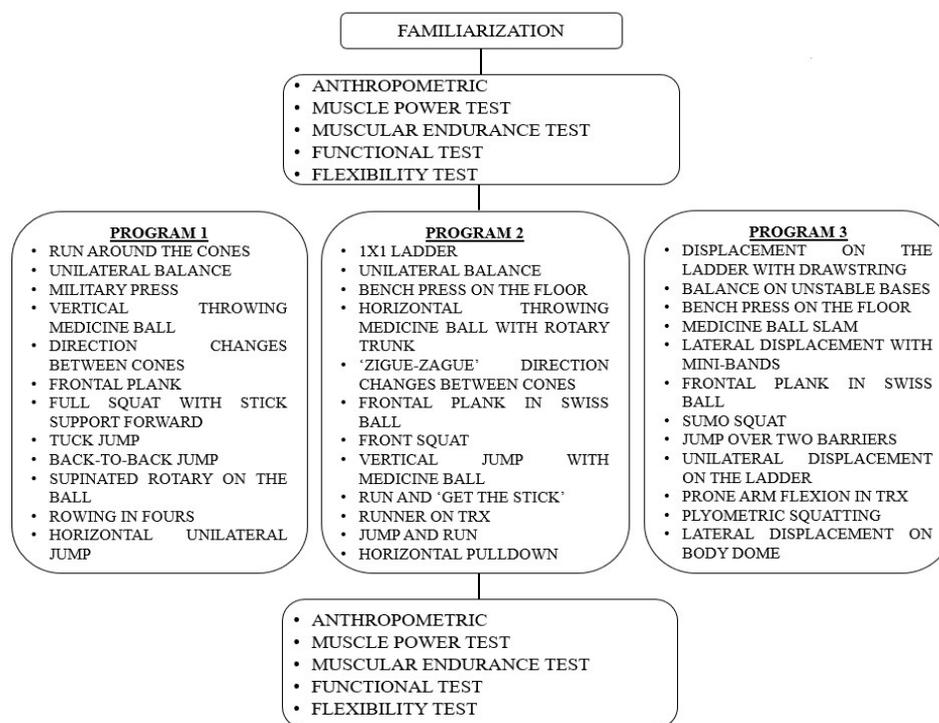


Figure 1. Experimental Procedures. Program 1 = between the third and eleventh visits; Program 2 = between the twelfth to nineteenth visits; Program 3 = between the twentieth and twenty-sixth visits.

Anthropometric Data: All subjects were instructed to stand in the central position on the scale/stadiometer to measure the total body mass and height (Techline BAL - 150 digital scale, SP, Brazil). Subjects were instructed to remain in the upright position with arms extended along the body, feet joined, head oriented according to the Frankfurt plane and in inspiratory

apnea. The data from lengths and circumferences were measured using a tape metric (Sanny®, Sao Paulo, Brazil) in the following segments/areas: arm (highest point of the biceps without muscle contraction), pectoral (above the breasts), waist (lower circumference of the trunk - above the umbilicus and below the xiphoid process and floating ribs), abdomen (umbilical scar), hip (largest circumference of the hip - above the gluteal fold), thigh (largest circumference of the thigh), and calf (largest circumference of the leg). Each measurement was taken three times, and the average was used for further analysis. All measurements were taken on both sides of the subjects' bodies. Assessment of body composition (lean body mass, fat mass, and fat percentage) was measured by a compass (CESCORF®, Porto Alegre, Brazil), and all data were inserted in the Jackson and Pollock's equation (16). The following points were measured: triceps (average distance between the acromion and the olecranon), pectoral (one-third of the anterior axillary line and the nipple), subaxilar (two centimeters below the lower angle of the scapula), shoulder blade (point of intersection between the median axillary line and an imaginary line transverse to the xiphoid process), abdomen (two centimeters to the right of the umbilical scar), hip (above iliac crest), and thigh (average distance between the inguinal ligament and the patella). Each measurement was taken three times and the average was used for further analysis.

Power test: The countermovement jump (CMJ) test was performed based on Salles et al (24) and Bui et al (9). All subjects performed each jump with the feet positioned in a shoulder-width apart, standing approximately 30 cm from the wall with their arms straight out front at shoulder height. The first phase of the CMJ consisted of hips and knees flexion, trunk forward, subjects had to move their arms to approximate waist or hip height. After the countermovement phase, the subjects started to extend the hips, knees, and trunk synchronically. They flexed the shoulders, elevating them back up over shoulder height as they reached as high as possible to touch the wall with the hand nearest to the wall. The highest value of three attempts was recorded for further analysis.

Muscular endurance: The muscular resistance for upper limbs was assessed by the prone arm flexion, following by Pollock and Wilmore's protocol (22). Subjects in a prone position with the legs close, forming a 90 degrees angle between the knees and feet. Additionally, subjects positioned their hands and knees resting on the floor and the body weight sustained by them. Subjects were instructed to move the body downward (eccentric phase: flexing elbows and horizontally abducting their shoulders until 90 degrees of elbows flexion); and to move upward (concentric phase: returning to the initial position). Three attempts were allowed with 4-minutes rest interval. The highest value of three attempts was recorded for further analysis.

Functional Test: The functional reach test was used to measure the dynamic balance proposed by Duncan et al (13). The subjects were positioned with their feet parallel (barefoot), shoulder-width apart, perpendicular to the wall and near the tape. With neutral wrists position, elbows fully extended, and shoulders flexed at 90 degrees, all subjects were instructed to lean forward without touching the tape and from that position move the tape over it. The average of three attempts was calculated and used for further analysis.

Flexibility: Flexibility test assessed through the Adapted Flexitest proposed by de Araujo (3). Subjects were evaluated by the same researcher who measures the maximum passive range of movement in different positions. A score from 0 to 4 was evaluated after each position. Flexibility test was analyzed by eight different movements (hip: flexion, extension, and abduction; trunk: flexion and posterior extension) always by the same researcher.

Statistical Analysis

Normality and homogeneity of variances were confirmed with the Shapiro-Wilk and Levene's tests, respectively. Paired t-test was used to compare the values between the pre- and-post the complete physical program. Additionally, the non-parametric Wilcoxon test was used to compare the adapted flexitest values. Furthermore, the magnitudes of the differences were examined using the standardized differences based on Cohen's d units by means of effect sizes (d) (10). The d results were qualitatively interpreted using the following thresholds: small (≥ 0.2), medium (≥ 0.5), and large (≥ 0.8). An alpha level of 0.05 was used. All analyses were performed using SPSS version 21 (SPSS Inc., Chicago, IL, USA).

RESULTS

For circumference values, there were significant decreases for right ($p = 0.014$, $d = -1.18$) and left arm ($p = 0.020$, $d = -1.10$), pectoral ($p < 0.001$, $d = -0.62$), waist ($p = 0.007$, $d = 0.43$), abdomen ($p = 0.001$, $d = -0.41$), hip ($p < 0.001$, $d = -0.90$), and right ($p = 0.006$, $d = 0.29$) and left calf ($p < 0.001$, $d = 1.45$). There were no significant differences for right ($p = 0.63$) and left thigh ($p = 0.235$) (Figure 2).

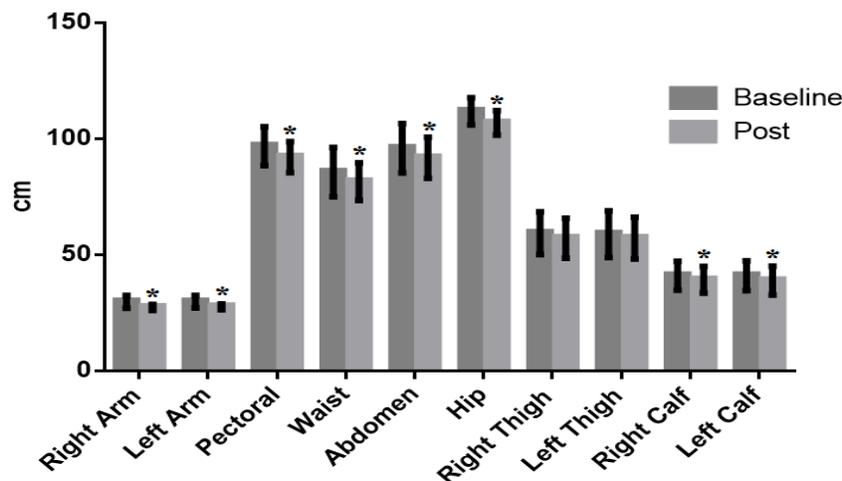


Figure 2. Mean \pm standard deviation of circumference before and after the complete fitness program. *Statistical difference ($p < 0.05$).

For anthropometric measures, there were significant increases in lean body mass ($p < 0.001$, $d = 0.32$) and decreases in the total body weight ($p < 0.001$, $d = -0.17$), body mass index ($p < 0.001$, $d = -0.16$), fat mass ($p < 0.001$, $d = -0.58$), and fat percentage ($p < 0.001$, $d = -0.90$) (Table 1).

Table 1. Mean \pm standard deviation of the anthropometric assessment.

	Baseline	Post-test
Total Body Weight, <i>kg</i>	79.34 \pm 10.76	77.55 \pm 9.97*
Body Mass Index, <i>kg/m²</i>	30.41 \pm 4.19	29.73 \pm 3.87*
Fat Mass, <i>kg</i>	27.16 \pm 6.34	23.75 \pm 5.35*
Lean Body Mass, <i>kg</i>	52.17 \pm 5.48	54.05 \pm 6.00*
Fat Percentage, %	33.93 \pm 4.11	30.28 \pm 4.00*

*Statistical difference from baseline ($p < 0.05$).

For physical tests, there was significant increase in power test ($p = 0.049$, $d = 0.62$), muscular endurance ($p = 0.002$, $d = 0.72$), and functional test ($p = 0.004$, $d = 0.73$). There were no significant differences for flexibility ($p > 0.05$) (Table 2).

Table 2. Mean \pm standard deviation of the neuromotor fitness assessment.

Tests	Baseline	Post-test
Power test, <i>cm</i>	22.22 \pm 5.90	25.77 \pm 5.40*
Muscular Endurance, <i>repetitions</i> .	24.33 \pm 6.38	28.66 \pm 5.50*
Functional Test, <i>cm</i>	111.11 \pm 8.52	117.11 \pm 7.73*
Flexibility, <i>score</i>	6 (5-6)	6 (5-6)

*Statistical difference from baseline ($p < 0.05$).

DISCUSSION

The purpose of the present study was to verify the effect of three months of neuromotor fitness on body composition and physical performance in untrained women. The main results indicated a reduction in anthropometric and body composition data (i.e. decrease in fat mass and fat percentage), and an increased lean body mass. The main hypothesis corroborated with previous findings (2, 18, 20, 21) that indicated important physical and morphological changes after neuromotor programs in untrained individuals.

Pereira et al (21) studied a circuit neuromotor fitness program combining single and multi-joint exercises for upper limbs, lower limbs and trunk in untrained women for 12 weeks. They observed that a neuromotor fitness program was effective in reducing body fat and increasing total body mass. In contrast, Neves et al (20) performed a circuit neuromotor fitness program combining muscular endurance and neuromotor skills for 16 weeks. The body composition was measured by DEXA. The results indicated a significant reduction in fat mass, fat mass percentage, total body mass, and body mass index. The present result is in agreement with Neves et al (20) who showed a significant increase in muscle mass of the lower limbs and neuromotor abilities. The positive effect in strength evidenced by the present study and Neves et al (20) might be attributed to different ways of conducting the physical programs in comparison to Pereira et al (21). Additionally, the load distribution may affect differently each physical program. The present study and Neves et al (20) did not find significant differences in flexibility.

The circuit training program was used in several studies with a volume higher than 60-min. In this way, this volume may induce a priority of the aerobic system and consequently a possible reduction of fat. According to Powers and Howley (23), in longer periods of exercises (≥ 30 -min) and moderate intensity, can be observed a higher mobilization of the lipases. The lipases can be activated by some hormones (i.e. adrenaline, noradrenaline, and glucagon) which are able to increase the hormonal level with low intensity and high volume in favor of lipolysis and β -oxidation. To date, the scientific literature has indicated that high volumes of training may produce an important dose-response adaptation (15). In contrast, Madsen et al. (19) analyzed the effect of eight weeks of low volume and high intensity interval training (3 weekly sessions: 10*60-sec) on circulating diabetes-related cytokines, and free fatty acids in adults with type 2 diabetes. Authors observed significant decreases in free fatty acids circulating levels after of low volume high intensity interval training.

This additional study from Sperlich et al (26) compared the effect of two neuromotor fitness program using a circuit program with two different loads in untrained women. The first load was based on high intensity and low volume, and the second load based on high volume and low intensity. After nine-weeks, they found reductions in body mass, fat mass and an increase in lean body mass only for the high intensity and low volume circuit group, while the high volume and low intensity circuit group did not present any differences in body composition. The results of the present study corroborate with Sperlich et al (26) in which observed reduction in fat mass, fat percentage, and total body weight, and an increase in lean body mass after high volume and low intensity loads.

The present study verified an increase in neuromotor measures, which corroborate with Neves et al (20). Neves et al (20) found increases in muscle resistance in untrained subjects. The results indicated increases in balance as suggested by previous studies (2, 5-7, 11, 17, 18). Lustosa et a (18) analyzed the effects of the neuromotor fitness program in elderly subjects for eight-weeks (three times per week for 50-minutes) and found improvements in daily life activities. Andrades and Saldanha (2) compared the effects of six-weeks (three times per week with 60-minutes) of neuromotor fitness program and a strength training program in physically active women. They found an increase in all dependent variables after the neuromotor fitness program ($\Delta\% = 294\%$) when compared to a strength training program. Finally, the present study observed an increase in power performance and did not observe differences in flexibility corroborating with Neves et al (20) study.

This study had some limitations. Some tests, such as flexibility, may not be considered as a gold standard, so we suggest that other studies investigate the variable using goniometry. In addition, our study did not use a control group for comparisons and all measurements were performed only before and after the complete program. We suggest that further investigations be carried out to control and evaluate nutrient and calorie intake in order to better observe the effects of training on body composition. In conclusion, the neuromotor fitness program affects positively the body composition and physical performance. This research may be useful for coaches/athletes because neuromotor fitness programs can be considered throughout a resistance training prescription to improve physical performance and morphological aspects.

Our results have implications for neuromotor fitness program in untrained women, therefore these results cannot be generalized to other population or training goals.

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