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Does Pilates Training Change Physical Fitness in Young Basketball Athletes?

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ABSTRACT

Cruz TMF, Germano MD, Crisp AH, Sindorf MAG, Verlengia R, Mota GR, Lopes CR. Does Pilates Training Change Physical Fitness in Young Basketball Athletes? **JEPonline** 2014;17(1):1-9. This study determined the effects of a 6-wk Pilates training program on body composition and physical fitness in young basketball athletes. Fifteen male athletes were randomly allocated to two groups: a Pilates training group (PG; n = 8) and a control group (CG; n = 7). The PG performed a Pilates training program that consisted of 7 exercises of 2 to 3 sets with 15 to 20 repetitions each with a 45-sec rest interval twice a week for 6 wks (in addition to basketball team training). The CG performed only the basketball team training. Before and after the 6-wk intervention, the subjects' body composition, flexibility, agility, anaerobic power and endurance, and lower limb power were determined. The results showed no statistically significant differences ($P > 0.05$) between the PG and the CG. The findings indicate that 6 wks of Pilates training program was not sufficient to change physical fitness and body composition in young basketball athletes.

Key Words: Pilates, Physical Fitness, Body Composition

INTRODUCTION

The Pilates training method is based on the key principles of management of the center of gravity, concentration, control, precision, flow, and breathing (11). Pilates training can be performed with an apparatus (Reformer, Wunda Chair, and Barrel) or without an apparatus (mat-work). The increasing popularity of Pilates as an exercise method has caught the attention of researchers who are interested in the potential health benefits (5,11,22,29,30). In fact, while a number of studies have looked at the benefits of Pilates-based exercises for low back pain (20,25,26), maintenance of functional capacity, and improvement of a person's quality of life (1,3,7,16,24,27,28), only a few studies have evaluated the effectiveness of Pilates training on the physical fitness of athletes (4,13,19,25).

Independent of the training method, the manipulation of acute training variables (i.e., intensity, volume, and rest intervals) might influence the adaptive response and increase sports performance (16). While several previous studies demonstrated that Pilates training promotes improvements in the physical fitness of young athletes (4,13,19), the study by Pertile et al. did not (25). It is difficult to compare these studies because of the differences in manipulation of training variables (i.e., intensity and volume in particular), Pilates training methods (mat exercises vs. apparatus), and the fact that some studies with athletes did not use a control group (13,19).

It is expected that the Pilates apparatus exercises would be better when compared to Pilates mat exercises since there is a better control of the training intensity, which is considered a key variable for inducing neuromuscular adaptations (23). Up to now, only one study used Pilates training with an apparatus in athletes (19). The purpose of this study was to evaluate the effects of a 6-wk Pilates training program (with apparatus exercises) on body composition and physical fitness in young basketball athletes. We hypothesized that the Pilates training would improve athletes' performance parameters.

METHODS

Subjects

Fifteen young athletes participated in this study. They had the following attributes: mean age, 15.7 ± 0.8 yrs; body mass, 82.5 ± 18.4 kg; and height, 1.8 ± 0.1 m. All of the subjects were members of the men's basketball team in state level competitions and were involved in regular physical training sessions 5 to 7 sessions·wk⁻¹. The inclusion and exclusion criteria for participation were: (a) had practiced basketball for at least 2 yrs; (b) had no previous injury that could interfere with the study; and (c) was not currently using nutritional supplements. All the subjects completed a health questionnaire and signed an informed consent form after receiving instructions regarding the experimental protocol. The study was approved by the local research ethics committee (protocol 80/12).

Procedures

The athletes were randomly divided into two groups: (a) Pilates training group (PG; n = 8); and (b) control group (CG; n = 7). The PG performed a Pilates training program (7 exercises: 2 to 3 sets, 15 to 20 repetitions with 45 sec rest intervals) twice a week during the 6-wk period in addition to training for the basketball team. The CG only performed the basketball team training (3 sessions·wk⁻¹). All subjects were familiarized with the test protocols and each subject attended the laboratory on 3 separate days with a 24-hr interval between visits for the following procedures: (a) anthropometric measures and sit-and-reach test; (b) a shuttle run test; and (c) a vertical jump and Wingate test. After 6 wks, the same evaluations were repeated. During the

evaluations the training load (technical and tactical training) expected of the subjects (athletes) was reduced. The subjects were also asked to participate in the tests in a rested, fed, and hydrated state. They were verbally encouraged and motivated to make maximum efforts during the tests, which were performed between 15:00 and 17:00. All the athletes continued to perform their regular technical and tactical training on the court during this study (~2 hr-session⁻¹). The athletes also did resistance training twice a week (Monday and Wednesday; ~1 hr-session⁻¹). The resistance training sessions included 3 sets of 10 to 12 repetitions (leg press, bench press, lat pulldown, shoulder press, and calf raise) with 1 min rest intervals between sets and 2 to 3 min between exercises. The research protocol had no influence on team training.

Anthropometric Measurements

The subjects' body mass was measured using a mechanical balance (Welmy[®]) precise to within 100 g. Height measurements were obtained using a stadiometer (Altura Exata[®]) precise to within 0.1 cm. Body composition was determined by skinfold thickness measurements taken with a Lange skinfold caliper. A 3-site skinfold assessment (triceps, suprailiac, and abdomen) was obtained using the equation developed by Guedes (17) to estimate body fat percentage. All skinfolds were measured by the same evaluator.

Sit-and-Reach Test

To measure the lumbosacral and hip joint (hamstring) flexibility, a sit-and-reach box (Cardiomed[®], São Paulo, Brazil) was used (4). During this test, the subjects sat on a mat with both feet against the testing box. They kept their legs extended and placed the right hand over the left and slowly flexed the trunk forward as far as they could by sliding their hands along the measurement board with an extension of 23 cm. Each subject performed three attempts. The highest value was recorded. Prior to testing, all subjects followed a warm-up procedure that included 3 min of jogging at a comfortable speed. A high reliability (ICC = 0.94) was observed between trials.

Shuttle Run Test

The shuttle run test was performed on a basketball court to measure the subjects' agility. Two lines were drawn on the ground 9.14 m (10 yd) apart; two wood blocks (5 x 5 x 10 cm) were placed 30 cm apart on the line opposite the start-line. Subjects sprinted from the starting line to the other line where they picked up one block. Then, they sprinted to the start-line and placed the block on the floor behind the start line. Without pause, they ran to retrieve the second wood block and carried it across the original start-line. The time to completion was recorded using a digital stopwatch. Prior to the test, the subjects followed a warm-up procedure that included 3 min of jogging at a comfortable speed. Two trials were performed with 2 min of rest between trial and the best performance was recorded. A high reliability (ICC = 0.89) was observed between trials.

Vertical Jump Test

Three different jumps (squat jump, counter movement jump without the use of the arms, and counter movement jump with use of the arms) were performed to measure lower limb explosive strength using an accelerometer (Myotest[®] [MYO], Myotest Inc., Switzerland) that was previously validated with basketball athletes (6). The device was fixed to the subject with an elastic band around the hip on the left side of the body. After a beep sound, the subjects performed a jump with an effort to attain a maximal jump height. Each jump was performed 3 times and the Myotest device provided data for the variables of height (cm), power (W), force (N·kg⁻¹), and velocity (cm·sec⁻¹). The jumps were performed in the following order: squat jump,

counter movement jump without use of the arms, and a counter movement jump with use of the arms. The rest interval between jumps was 2 min.

Prior to the test, the subjects performed a warm-up procedure consisting of 3 min of jogging at a comfortable speed. Briefly, the squat jump was performed with the subject starting from a half-squat position (approximately 120° knee angle), with the trunk straight, both hands on the hips, and after a beep sound the subject jumped with no counter movements. For the counter movement jump without the use of the arms the subject started in a standing position with the trunk straight and both hands on the hips. After a beep sound, the subject performed a vertical jump counter movement. For the counter movement jump with use of the arms, the subject started in standing position with a straight trunk and after a beep sound, the subject performed a vertical jump with an earlier fast counter movement with the arms.

Wingate Test

The Wingate anaerobic test (WAnT) was conducted using a cycle ergometer (Biotec® 2100, Cefise, Nova Odessa, Brazil). Subjects were seated on the ergometer and adjustments were made to ensure an optimal cycling position. The WAnT was conducted according to the accepted recommendations for standardization (2). The load was 0.75 g·kg⁻¹ for 30 sec. All data were recorded using software (Ergometric 6.0). Prior to testing, the subjects performed a warm-up on the cycle ergometer for 5 min (without load). After a 5-min rest interval, the test was started. Peak relative power (highest attained), mean relative power (mean value over 30 sec), and the fatigue index [(peak relative power - minimum relative power) / peak relative power] x 100] were determined.

Pilates Training

The subjects in the PG performed Pilates training twice a week (Tuesday and Thursday; ~1 hr hr-session⁻¹) for 6 wks. The Pilates exercise sessions involved 7 Pilates Method Alliance (PMA) exercises. Pilates training consisted of: (a) Reformer apparatus and platform jumps, unilateral footwork, prehensile footwork; (b) Cadillac apparatus and shoulder bridge, shoulder bridge with hip flexion and extension movements, and hip opener; and (c) the Wunda Chair and the forward lunge. The rest interval between sets and exercises was 45 sec. The average duration of each repetition was 3 to 4 sec, taking into account the concentric and eccentric phases of the movement. The volume of training was progressively increased every 2 wks. Exercise intensity was adjusted according to the number of repetitions (Table 1). All subjects were encouraged to make maximal efforts during the Pilates exercise sessions, all exercise sessions were coordinated by the same PMA certified Pilates teacher.

Table 1. Pilates Training Program Followed by the Pilates Group (PG) Subjects.

Week	Sets	Repetitions	Rest Interval (sec)
1	2	15	45
2	2	15	45
3	3	15	45
4	3	15	45
5	3	20	45
6	3	20	45

Statistical Analyses

Normality and homogeneity of data variances were confirmed by the Shapiro–Wilk and Levene’s test, respectively. Two-way repeated measures of analysis of variance (ANOVA) analyzed and compared the intra- and intergroup changes. Independent *t*-tests were used to compare age, body mass, and height between groups at the start of the study. A Cohen’s (9) analysis was employed to measure the effect size (ES). The thresholds for small, moderate, and large effects were 0.20, 0.50, and 0.80, respectively. The level of significance was set at $P \leq 0.05$.

RESULTS

Independent *t*-tests revealed no significant differences between the groups for age (PG = 15.5 ± 0.9 yrs; CG = 16 ± 0.9 yrs; $P = 0.46$), body mass (PG = 84.4 ± 11.2 kg; CG = 86.7 ± 26.0 kg; $P = 0.54$), and height (PG = 1.8 ± 0.1 m; CG = 1.8 ± 0.1 m; $P = 0.72$) at the beginning of the study. In relation to performance parameters, there were no statistically significant difference ($P > 0.05$) in body composition, Wingate, and sit-and-reach tests for the CG and PG groups before and after 6 wks of intervention (Table 2). Both groups did not exhibit significant differences ($P > 0.05$) for vertical jump performance tests (Table 3).

Table 2. Body Composition, Wingate Test, Shuttle Run, and Sit-and-Reach Tests for the Pilates Group (PG) and the Control Group (CG).

Body Composition	Pre	Post	ES
Body Mass (kg)			
PG	84.4 ± 11.2	83.6 ± 11.1	0.07
CG	86.1 ± 26.0	88.0 ± 25.1	0.07
Body Fat (%)			
PG	16.2 ± 6.0	15.6 ± 5.5	0.10
CG	18.8 ± 7.7	18.8 ± 6.4	0.00
Wingate			
Peak Relative Power ($W \cdot kg^{-1}$)			
PG	8.9 ± 1.8	9.4 ± 1.5	0.30
CG	9.1 ± 1.3	9.4 ± 0.7	0.29
Mean Relative Power ($W \cdot kg^{-1}$)			
PG	6.7 ± 1.4	7.0 ± 1.4	0.21
CG	7.1 ± 0.8	7.1 ± 0.4	0.00
Fatigue Index (%)			
PG	33.8 ± 7.2	41.7 ± 22.8	0.47
CG	32.3 ± 6.6	42.4 ± 7.1	1.47
Shuttle Run (sec)			
PG	9.9 ± 0.9	9.9 ± 0.7	0.00
CG	9.8 ± 0.4	9.9 ± 0.2	0.32
Sit-and-Reach Test (cm)			
PG	35.2 ± 7.0	35.4 ± 5.7	0.03
CG	30.1 ± 5.6	30.1 ± 5.0	0.00

Values are expressed as mean \pm SD. PG = Pilates group; CG = Control group; ES = Effect Size.

Table 3. Squat Jump, Counter Movement Jump Without Arms, and Counter Movement Jump With Arms for the Pilates Group (PG) and the Control Group (CG).

Squat Jump				Counter Movement Jump Without Arms				Counter Movement Jump With Arms			
Height (cm)	Pre	Post	ES	Height (cm)	Pre	Post	ES	Height (cm)	Pre	Post	ES
PG	29.7 ± 5.2	30.4 ± 5.8	0.12	PG	34.3 ± 5.5	36.2 ± 6.9	0.30	PG	39.9 ± 7.2	40.5 ± 7.1	0.08
CG	30.1 ± 4.8	29.1 ± 5.0	0.20	CG	33.9 ± 6.4	33.2 ± 5.8	0.11	CG	39.4 ± 5.4	40.1 ± 5.3	0.13
Power (W)	Pre	Post		Power (W)	Pre	Post		Power (W)	Pre	Post	
PG	45.6 ± 7.9	45.1 ± 11.4	0.05	PG	31.5 ± 8.9	44.1 ± 7.1	1.56	PG	40.8 ± 11.4	45.8 ± 9.5	0.48
CG	45.2 ± 9.1	46.7 ± 10.9	0.15	CG	34.7 ± 13.4	42.6 ± 13.0	0.60	CG	40.2 ± 14.9	54.0 ± 10.8	1.06
Force (N·kg ⁻¹)	Pre	Post		Force (N·kg ⁻¹)	Pre	Post		Force (N·kg ⁻¹)	Pre	Post	
PG	25.2 ± 4.4	26.4 ± 4.2	0.28	PG	22.9 ± 3.4	25.1 ± 2.7	0.72	PG	29.9 ± 5.8	29.1 ± 3.9	0.16
CG	25.8 ± 3.1	26.6 ± 3.2	0.25	CG	24.2 ± 3.9	25.0 ± 3.9	0.20	CG	28.6 ± 4.8	29.2 ± 2.3	0.16
Velocity (cm·sec ⁻¹)	Pre	Post		Velocity (cm·sec ⁻¹)	Pre	Post		Velocity (cm·sec ⁻¹)	Pre	Post	
PG	247.7 ± 19.7	232.0 ± 26.4	0.67	PG	182.4 ± 40.3	226.6 ± 17.6	1.42	PG	214.0 ± 50.3	215.0 ± 34.0	0.02
CG	235.3 ± 29.2	237.0 ± 39.7	0.04	CG	199.0 ± 48.5	223.0 ± 51.1	0.48	CG	203.4 ± 47.5	242.1 ± 36.5	0.91

Values are expressed by mean ± SD. PG = Pilates group; CG = control group; ES = effect size.

DISCUSSION

The purpose of this study was to evaluate the effects 6 wks of Pilates training on body composition and physical fitness in young basketball athletes. The main finding of this study was that Pilates training did not produce significant changes in athletes' performance parameters. These findings are similar to results obtained by Pertile et al. (25) who found no significant improvement in flexibility (sit-and-reach test) and muscle isometric strength (trunk dynamometer) after 4 wks of Pilates training without apparatus (mat-work) in young soccer athletes.

Alternatively, three studies found a significant influence in athletes' physical fitness (4,13,19). El-Sayed et al. (13) observed significant improvements in vertical jump with young volleyball players after Pilates mat-work training in association with specific volleyball team training. Additionally, Hutchinson and colleagues (19) investigated the improvements in leaping ability of elite female rhythmic gymnasts by using Pilates training with apparatus in association with pool training over a 4-wk period and found an improvement in ground reaction time, height jump, and power. However, the results of these studies may not be conclusive with respect to the efficiency of a Pilates training program since both studies (13,19) did not use a control group.

Bertolla et al. (4) evaluated the effect of 4 wks of Pilates mat-work training and observed significant changes in flexibility (sit-and-reach test) in futsal athletes with no significant changes in the control group. These findings are different from the results obtained in the current study, and a possible explanation may be related to the differences in Pilates-based exercises (i.e., mat exercises vs. apparatus), manipulation of training variables (intensity and volume), and the athletes' physical fitness levels.

One may speculate on the data of the current study and suggest that the short time (4 to 6 wks) of Pilates training was insufficient to demonstrate significant chronic adaptations, thus, a longer training period (>6 wks) may be necessary to detect physical fitness changes. Additionally, it is important to recognize that the subjects' neuromuscular adaptations were already well adapted in the athletes. Hence, the stimulus and adaptations from Pilates training were minimal and could not be detected. This is a possibility since all athletes in this study (PG and CG) were already involved in regular physical training sessions (5 to 7 sessions·wk⁻¹).

The neural and muscular adaptations associated with improvements in power and muscle strength occur predominantly in type II muscle fibers (12,23). Therefore, considering that the Pilates method is not a high-intensity exercise (i.e., low number of maximum repetitions), the stimulus and adaptations for muscle fiber recruitment of high threshold fibers (type II) was not reached in these athletes. This could be a crucial factor for improving performance on shuttle runs, vertical jumps, and Wingate tests. Also, it is important to consider that the studies with healthy subjects that reported Pilates training significantly improved flexibility (20,26,27, 28), abdominal muscle strength (5,14,18,22), and muscular endurance (20,27) were sedentary and physically active subjects (20,27) of which the results cannot be reflective of the athletic population.

Limitations

We acknowledge that our study has some limitations. First, the short duration of Pilates training (6 wks) may not be sufficient to improve physical fitness in athletes. Second, sit-and-reach tests only evaluated lumbosacral and hip joint flexibility. Perhaps other flexibility tests could be used to identify the effects of Pilates on other joints since previous studies have reported significant improvements for this variable.

CONCLUSION

This study found that 6 wks of Pilates training was not sufficient to cause significant changes in physical fitness and body composition in young basketball athletes. Future research is required to assess the influence of time of the Pilates training programs in young athletes and various sports performance parameters.

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REFERENCES

1. Aladro-Gonzalvo AR, Machado-Diaz M, Moncada-Jimenez J, Hernández-Elizondo J, Araya-Vargas G. The effect of Pilates exercises on body composition: A systematic review. *J Body Mov Ther.* 2012;16:109-114.

2. Bar-Or O. The Wingate anaerobic test: An update on methodology, reliability and validity. **Sports Med.** 1987;4:381-394.
3. Bernardo LM. The effectiveness of Pilates training in healthy adults: An appraisal of the research literature. **J Body Mov Ther.** 2007;11:106-110.
4. Bertola F, Baroni BM, Junior ECPL, Oltramari JD. Effects of a training program using the Pilates method in flexibility of sub-20 indoor soccer athletes. **Braz J Sports Med.** 2007;13:222-226.
5. Blum CL. Chiropractic and Pilates therapy for the treatment of adult scoliosis. **J Manip Physiol Ther.** 2002;25:E3.
6. Cardinale M, Newton R, Nosaka K. **Strength and Conditioning Biological Principles and Practical Applications.** Chichester, UK: Wiley-Blackwell, 2011.
7. Carneiro JÁ, Silva MS, Vieira MF. Effects of Pilates method and weight training in kinematic march of obese women. **Braz J Biomec.** 2009;10:33-43.
8. Casartelli N, Muller R, Maffiuletti NA. Validity and reliability of the Myotest accelerometric system for the assessment of vertical jump height. **J Strength Cond Res.** 2010;24:3186-3193.
9. Cohen J. **Statistical Power Analysis for the Behavioral Science.** (2nd Edition). Hillsdale, NJ: Erlbaum Associates, 1988, p. 567.
10. Cormie P, McGuigan MR, Newton RU. Developing maximal neuromuscular power: Part 2 - training considerations for improving maximal power production. **Sports Med.** 2011;1:125-146.
11. Cruz-Ferreira A, Fernandes J, Laranjo L, Bernardo LM, Silva A. A systematic review of the effects of pilates method of exercise in healthy people. **Arch Phys Med Rehabil.** [Review]. 2011;92:2071-2081.
12. Delextrat A, Cohen D. Strength, power, speed, and agility of women basketball players according to playing position. **J Strength Cond Res.** 2009;23:1974-1981.
13. El-Sayed SL, Mohammed MS, Abdullah HF. Impact of Pilates exercises on the muscular ability and components of jumping to volleyball players. **Sport Sci.** 2010;3:712-718.
14. Emery K, Serres SJ, McMillan A, Cote JN. The effects of the Pilates training program on arm-trunk posture and movement. **Clinical Biomechanics.** 2010; 25:124-130.
15. Erkal A, Arslanoglu C, Behdari R, Senel O. Effects of eight week Pilates exercises on body composition of middle aged sedentary women. **Ser Physical Edu Sport.** 2011;11:86-89.
16. Eyigor S, Karapolat H, Yesil H, Uslu R, Durmaz B. Effects of Pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: A randomized controlled study. **Eur J Phys Rehabil Med.** 2010;46:481-487.
17. Guedes DP. Study of body fat by measuring the values of body density and skinfold thickness in college. **Federal University of Santa Maria.** Santa Maria, 1985.

18. Herrington L, Davies R. The influence of Pilates training on the ability to contract the transversus abdominis muscle in asymptomatic individuals. *J Body Mov Ther.* 2005;9:52-57.
19. Hutchinson MR, Tremain L, Christiansen J, Beitzel J. Improving leaping ability in elite rhythmic gymnasts. *Med Sci Sports Exerc.* 1998;30:1543-1547.
20. Kloubec JA. Pilates for improvement of muscle endurance, flexibility, balance, and posture. *J Strength Cond Res.* 2010;24:661-667.
21. Kuo Y, Tully E, Galea M. Sagittal spinal posture after Pilates-based exercise in healthy older adults. *Spine.* 2009;34:1046-1051.
22. Lange C, Unnithan V, Larkam E, Latta P. Maximizing the benefits of Pilates-inspired exercise for learning functional motor skills. *J Body Mov Ther.* 2000;4:99-108.
23. Noyes FR, Barber-Westin SD, Smith ST, Campbell T, Garrison TT. A training program to improve neuromuscular and performance indices in female high school basketball players. *J Strength Cond Res.* 2012;26:709-719.
24. Otto R, Yoke M, McLaughlin K, Jaclyn M, Anthony V, Andrea L, Michael L, John W. The effect of twelve weeks of Pilates vs. resistance training on trained females. *Med Sci Spor Exerc.* 2004;36 (Suppl):356-357.
25. Pertile L, Vaccaro TC, De Marchi T, Rossi, RP, Grosselli D, Mancalossi JL. Comparative study of the method Pilates® and therapeutic exercises on muscle strength and flexibility in trunk of soccer players. *ConScientiae Saúde.* 2011;10:102-111.
26. Phrompaet S, Paungmali A, Pirunsan U, Sitilertpisan P. Effects of pilates training on lumbo-pelvic stability and flexibility. *Asian J Sports Med.* 2011;2:16-22.
27. Rogers K, Gibson AL. Eight-week traditional mat Pilates training program effects on adult fitness characteristics. *Res Quart Exer Sport.* 2009;80:569-574.
28. Segal NA, Hein J, Basford JR. The effects of Pilates training on flexibility and body composition: An observational study. *Arch Phys Med Rehabil.* 2004;85:1977-1981.
29. Sekendiz B, Altun Ö, Korkusuz F, Akin S. Effects of Pilates exercise on trunk strength, endurance and flexibility in sedentary adult females. *J Body Mov Ther.* 2007;11:318-326.
30. Shedden M, Kravitz L. Pilates exercise: A research-based review. *J Dance Med Sci.* 2006;10: 111-116.
31. Sheppard JM, Young WB. Agility literature review: Classifications, training and testing. *J Sports Sci.* 2006;24:919-932.

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