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EFFECTS OF PILATES TRAINING ON MUSCULAR STRENGTH AND BALANCE IN BALLET DANCERS

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The purpose of this study was to determine the effects of a Pilates training programme on muscular strength and balance in ballet dancers. Fifteen ballet students were divided in experimental and control groups. Besides the daily technical classes, it was applied a Pilates training programme during 11 weeks in the experimental group. Groups were submitted at two moments of evaluation, before and after the programme. The muscular strength was evaluated through the time obtained in the maintenance of the performance of *penché* and *developpé*. Balance was evaluated using a Bertec force plate (4060-15). The migration area of the centre of pressure was calculated in the first position and in the *attitude derriére* skills. Results suggest that the Pilates training have a positive effect on muscular strength. No significant differences were obtained in ballet dancers' balance.

KEYWORDS: Ballet, Pilates Training Programme, Muscular Strength, Balance

INTRODUCTION: Dancers' physical conditioning is achieved through several training methods, among which we highlight the Pilates method, that despite the frequent use, it has not been sufficiently investigated in dance performances (Bernardo & Nagle, 2006). Pilates training intends to improve the general muscular strength (Sekendiz et al., 2007; Rogers & Gibson, 2009; Kloubec, 2010) and balance (Johnson et al., 2007; Rodrigues et al., 2010). Concerning to physical requirements in dance, optimal levels of muscular strength and balance are needed and associated to remarkable performances (Welsh, 2009). Therefore the aim of the present study was to access the effectiveness of a Pilates training programme to develop the muscular strength and balance in dance students.

METHODS: Fifteen ballet students (3 males and 12 female) with more than ten years of daily practice in classical and modern dance participated voluntarily in the study. Subjects were divided in experimental (n=8, 15.7±0.8 years old, 51.2±4.4 kg, 161±0.1 cm) and control groups (n=7, 16.3±0.9 years old, 59.3±7.8 kg, 167±0.1 cm). The subjects were fully informed about the purpose, procedures and risks associated with the study and gave their written consent after being informed. The study was approved by the Ethics Committee of the University. None of the dancers present, until the moment, any kind of injury that could influence their performances. Subjects of both groups were submitted at two moments of evaluation, before and after a Mat-Based Pilates Exercise. After the warm-up, which was individually selected by the ballet dancers, subjects were familiarized with the experimental procedures for data collection. The Pilates training programme begins with eight repetitions performed in a slowly and controlled way according to the principles of the method. One repetition was increased in each week, being the load stabilised in twelve repetitions until the end of the programme. Each section comprised basic and intermediate exercises; advanced exercises were added as technique and time of training progressed. The isometric muscular strength was evaluated in the lower limbs. The test consists in the maximal time obtained in the maintenance of the performance of the following technical skills: *developpé* (front, side and back, in the *barre*) and *penché* (in the center), according to the Physical Testing Program from the *Federation Internationale de Gymnastique* (2009). Balance was evaluated using a Bertec force plate (4060-15) with a sample frequency of 1000 Hz. After amplifying, all analog signals were converted to digital signals using a 16 bit A/D converter from Biopac. The first test consists in 30 seconds maintenance of the first position with arms in *bras bas*.

The second test consists in the performance of the *attitude derriére* with total support of the foot on the ground during five seconds, followed by a rise to half-toe and its maintenance during five seconds. The migration area of the COP was calculated using Matlab routines. The elliptical area of the stabilogram, was calculated through the product of the amplitudes of the standard deviations in the mediolateral and anteroposterior displacements of the COP. The measurements were performed on the right and left limb. Three successful trials were required for each technical skill evaluated. Data were collected in a random order. Means (± sd) were calculated for all parameters. To compare the differences between groups at each moment of evaluation, it was used the Mann-Whitney test. Differences between the first and second moment of evaluation of each group were assessed using the Wilcoxon test. The level of significance was $\alpha = 0.05$.

Figure 1: Technical ballet skills selected for the study: a) *developpé* front; b) *developpé* side; c) *developpé* back; d) *penché*; e) *attitude derriére*; f) first position with arms in *bras bas*.

RESULTS AND DISCUSSION: Significant results can be analysed in the following tables (Table 1 and Table 2).
No studies had assessed the effects of Pilates programmes in the performance of ballet dancers; nevertheless in other samples some studies show a positive influence in strength capacity (Sekendiz et al., 2007; Rogers & Gibson, 2009; Kloubec, 2010). In the present study the participation of the ballet students in Pilates training programme for 11 weeks led's to a positive influence in their performance, inducing significant changes in the initial muscular strength, especially in the technical skills *penché* and *developpé* back. The constant gluteal

Table 1
Muscular strength measures (seconds) at pre- and post-Pilates training

	Experimental group		Control group	
	Pre-pilates training x ± sd	**Post-pilates training** x ± sd	**Pre-pilates training** x ± sd	**Post-pilates training** x ± sd
Penché				
Right limb	25.1 ± 11.3	47.6 ± 22.3[1,2]	24.9 ± 4.3	26.8 ± 3.2
Left limb	35.1 ± 13.4	49.4 ± 17.8[1,2]	24.5 ± 8.1	24.4 ± 7.7
Developpé front				
Right limb	12.9 ± 5.1	19.9 ± 6.2[1,2]	14.8 ± 4.1	14.3 ± 4.2
Left limb	17.7 ± 7.1	23.9 ± 8.2[1,2]	12.3 ± 2.7	12.4 ± 3.1
Developpé side				
Right limb	15.0 ± 4.0	22.9 ± 11.0[1,2]	14.0 ± 4.2	14.1 ± 4.6
Left limb	16.6 ± 8.9	24.7 ±6.5[1,2]	12.5 ± 2.9	12.8 ± 2.4
Developpé back				
Right limb	29.3 ± 11.9	49.0 ± 14.9[1,2]	24.9 ± 7.4	25.0 ± 6.0
Left limb	40.9 ± 9.2	52.7 ± 12.6[1,2]	26.9 ± 4.8	26.9 ± 5.7

[1]significant difference between pre- and post-Pilates training ($p<0.05$)
[2]significant difference with the control group ($p<0.05$)

Table 2
Balance measures (migration area of the centre of pressure – in cm^2) at pre- and post-Pilates training

	Experimental group		Control group	
	Pre-pilates training	**Post-pilates training**	**Pre-pilates training**	**Post-pilates training**
	x ± sd	x ± sd	x ± sd	x ± sd
Attitude derriérre – right limb				
Right limb	2.5 ± 0.9	0.7 ± 0.7[1]	2.5 ± 1.0	1.0 ± 1.9
Left limb	5.2 ± 3.4	1.3 ± 1.0[1]	5.2 ± 3.5	1.5 ± 2.6
Attitude derriérre – left limb				
Right limb	4.3 ± 2.1	0.5 ± 0.4[1]	2.7 ± 1.0	0.3 ± 0.1[1]
Left limb	7.6 ± 3.1	2.0 ± 2.5[1]	5.6 ± 3.8	1.2 ± 1.9[1]
First position (arms bras bas)				
Right limb	1.1 ± 0.5	0.9 ± 0.5	0.9 ± 0.5	0.8 ± 0.4

[1]significant difference between pre- and post-Pilates training ($p<0.05$)

muscles contraction required by Pilates exercises, is probably de main cause for the greatest improvements on muscular strength in this technical skills. According to the results, students were capable to maintain during more time the selected technical skills, which are determinant for an accurate technical performance (Welsh, 2009). Regarding to balance, experimental group decreased significantly the values of the COP area in all parameters of the technical skill *attitude derriére*, which indicate that this group improved their balance. However, improvements in balance are also attended by the control group. This facts leads to a question: what did happen to be balance improvements in both groups? By analysing the usual dance classes performed by both groups, it was state that over the last four weeks of the study, both groups changed the stereotype and intensity of the usual dance classes, performing only choreographies using the point shoes. Using a point shoe, the dancer decreases the base of support which require a great neuromuscular and coordinative effort. Thus, the use of the point shoe during 4 weeks is probably the main reason for balance improvements stated in both groups. Previous research has produced non-uniform results concerning the effects of Pilates training on balance improvement (Johson et al., 2007; Kloubec, 2010). It has been suggested that balance may be affected by several factors (Duarte and Freitas, 2010). This is the probable reason for the huge results diversity of the present data. Nevertheless, some assumptions should be considered. It has been used in previous research permanency time on force plate superior a 20 seconds. In the present study the dancers only performed on the force plate the technical skill *attitude derriére* during 5 seconds, which probably was not enough for stabilise the CP signal (Freitas and Duarte, 2006).

CONCLUSION: The present data demonstrated that Pilates training can significantly improve ballet dancers' muscular strength being a promise tool to be used as a complementary strength training. Nevertheless the present study cannot state if Pilates training benefits the ballet dancers' balance. More research should be done in this area and future studies should include more subjects for analysis.

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