ORIGINAL ARTICLE

Influence of long and short term ballet practice on balance and pelvic stabilization

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ABSTRACT

Objective: To identify whether the practice time of ballet influences the postural balance (PB) and pelvic stabilization capacity (PSC). **Methods:** Ballerinas were assigned to two groups: group 1, who practiced the ballet for a minimum of one year and a maximum of two years and eleven months (N = 11) and group 2, those who practiced ballet for more than three years (N = 10). The PB was evaluated by computerized dynamic posturography, with sensory organization tests (SOT). The PSC was assessed by the unilateral knee extension test. **Results:** Longer time of practice of ballet influenced the PB of teenage girls, once the more experienced dancers obtained higher vestibular system related values, but there was no difference on the pelvic stabilization between both groups. **Conclusion:** Longer ballet time improved PB in dancers.

Keywords: Postural Balance, Pelvis, Dancing

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INTRODUCTION

Ballet represents a physical activity that requires musculoskeletal conditioning by the use of complex movements of high impact and extreme articular amplitudes, and it plays a role on the development of some variables, such as postural balance (PB).[1] This is defined as the maintenance of the projection of the center of gravity within the area of support of the body, which requires constant adjustments of muscle activity and joint positioning.[2] Such control depends on the integration of sensory information of the vestibular, visual and somatosensory systems, whereas the corrections of the body posture are regulated by the central nervous system.[3]

Postural control is a fundamental skill for dancers, since movements such as turns or "pirouettes" are performed over reduced base,[4] and these movements have received attention from researchers, especially in the area of motor behavior.[5] Therefore, to analyze the behavior of the sensorial systems responsible for PB in dancers becomes relevant, from the perspective of performance in dance.

Dore and Guerra[6] emphasize that postural compensations, in addition to jeopardizing performance, can lead to the development of injuries, such as functional alterations in the stabilizing muscles of the trunk, since lumbosacral pain represents one of the most prevalent lesions among dancers.[7]

In this context, Prati and Prati8 indicate that there are implications in the balance between the anterior and posterior trunk muscles, and this imbalance of forces can affect the performance of motor gestures in the ballet, as pointed out by Wilson et al.[9] This study identified that dancers with better performances in the pitouette, presented greater activation of the stabilizing muscles of the trunk during the rotations. Therefore, evaluating the pelvic stabilization capacity (PSC) in dancers becomes relevant, and one of the tests used for this purpose is the unilateral knee extension bridge test.[10]

OBJECTIVE

The objective of this study is to identify whether the ballet practice time influences the postural balance (PB) and the pelvic stabilization capacity (PSC) in young ballerinas.

METHOD

This cross-sectional and comparative study included a convenience sample of classical ballet dancers. They were included if they were female, and if they practiced ballet for a minimum of one year, with a minimum frequency of two classes per week. Those with inability to perform the tests proposed in the present study, and those with presence of neurological and orthopedic injuries, confirmed by medical report were not included. The study was conducted per Brazilian National Health Council resolution 466/12 and the Helsinki declaration of 2000. The study was approved by the institutional Ethics Review Board (reg. 1.504.462), and the Informed Consent Form was signed by the voluntaries' parents or legal responsible.

In order to characterize the sample, the girls answered a questionnaire that included their age and the time of practice of ballet (in years), so that they could be allocated in two groups: group 1 (G1), those who practiced ballet for a minimum of one year and maximum of two years and 11 months, and group 2 (G2), those who practiced ballet for a period of more than three years. Thus, 11 girls were allocated in the G1 and 10 girls the G2 (with a minimum of three years and a maximum of five years of practice).

The data collection was conducted in the Evaluation Laboratory of the Physiotherapy course, and the dancers were evaluated, according to the following protocol:

- Anthropometric evaluation - Body mass (with an analog calibrated scale by Filizola®, with capacity of 150 kg at increases of 100 g), and height (with a stadiometer coupled to the scale).
- PB evaluation - Computerized dynamic posturography, with the system Smart EquiTest® version 4.1 (NeuroCom International, Inc), by a previously trained researcher. The evaluation met the criteria established by NeuroCom, Equitest's manufacturing company,[11] including sensory organization tests (SOT). These tests provide information on the integration and proportion of the visual, proprioceptive, and vestibular components responsible for maintaining BP.[12]

Sensory conditions assessed by SOT include the condition I (opened eyes, stable surface), II (closed eyes, stable surface), III (opened eyes and sight referenced by the movement of the environment and stable platform), IV (opened eyes, instable platform), V (closed eyes, unstable platform), VI (opened eyes and sight referenced by the movement of the environment and stable platform).[13] Conditions I, III and VI evaluate the proprioceptive, visual and vestibular system, conditions II and V evaluate the proprioceptive and vestibular system and condition IV evaluates the proprioceptive system. The whole test also provides a general balance index when the SOTs are combined (composite).[14]

Posturography performs a sensory analysis of the PB by the ratio between the means of one condition over the other, for example, somatosensory system (SOT II / SOT I), visual system (SOT IV / SOT I) and vestibular system (SOT V / SOT I), multiplied by 100 to form percentage values. Steindl et al.[15] propose reference values of SOT conditions according to age. Therefore, applying the reference values of these authors, our present study considered "normal" classification when the dancer reached the proposed reference values, or "deficit" classification when the SOT value was lower than the reference.

- PSC evaluation with unilateral knee extension bridge test, according to the guidelines proposed by Andrade et al.[16] On a stretcher, a 10 mm foam marker was placed on each anterosuperior iliac spine of the dancer, and the patient was instructed to lift the pelvis and perform extension of one of the knees, keeping the lower limb raised at the same height as the thigh of the contralateral limb, for 10 seconds.

The test was filmed with a Fuji digital camera (resolution of 14 mega pixels), positioned on a tripod at a distance of 80 cm from the end of the stretcher and analyzed by the software SkillSpector, where the inclination of the line from the anterosuperior iliac spines to the horizontal in the transverse plane of the pelvis during the test was observed. A 30-cm calibration was pre-determined before the beginning of the test. The highest pelvic dealignment observed during the test was classified as mild pelvic fall (0-25% of the possible fall excursion), moderate (25-75% of the possible fall excursion) or marked (> 75% of the possible fall excursion).[16] The guidelines for the execution and analysis of the test were standardized and given by a previously trained evaluator. The evaluation protocol of this study

may be seen in Figure 1.

For the statistical analysis, the SPSS software, version 20.0, was used firstly for descriptive analysis (mean and standard deviation). After testing for normality with the Shapiro-Wilk test, a parametric distribution was found. Therefore, the differences between the groups (G1 and G2) were evaluated by the student t test for independent samples. The chi-square test was used to analyze the association between the classification of SOT (normal and deficit) and time of practice of ballet. A significance level of ≤0.05 was considered for all analyzes.

RESULTS

The baseline characteristics of the study sample are described in Table 1, in which it is observed that both samples were homogeneous.

The postural balance of the ballerinas, according to the six conditions of the SOT and the combined value, is shown in table 2 shows, in which it is observed there was no statistically different between the groups in the variables analyzed. When the neural systems responsible for the maintenance of PB were analyzed, there was a borderline difference between the groups regarding the vestibular system, evidencing higher values of this system in G2 (P=0.05).

The results concerning the association between the classification of the SOT (normal and deficit) and the time of practice of ballet (G1 and G2) are shown in Table 3. It was possible to analyze that there was no statistical difference in the percentages of SOT between both groups, however, we emphasized there were more observations of deficit in the six conditions of the SOT and the value of composite in G1, when compared to G2.

Regarding the PSC (Figure 2), it was possible to evidence that there was no statistically significant difference between both groups, and that both presented moderate pelvic inclination (25 to 75% of inclination).[17]

1A – Computer aided postural balance evaluation by posturography.
1B – Unilateral knee extension bridge test for evaluating the pelvic stabilization.

Figure 1. Evaluation protocol.

Table 1. Baseline characteristics

Variable	G1	G2	p-value
N	11	10	
Age (years)	11.55±2.29	12±2.82	0.68
Weight (Kg)	43.10±11.41	43.99±7.81	0.83
Height (m)	1.48±0.14	1.49±0.09	0.85

G1, Group of those who practiced ballet for a minimum of one year and maximum of two years and 11 months; G2, Group of those who practiced ballet for a period of more than three years.

DISCUSSION

In the present study, it was observed that the time of practice of the ballet influenced the PB of the evaluated girls, since the most experienced group obtained superior values related to the vestibular system, when compared to the less experienced. It is suggested that this factor is associated with the ability of young women to perform the component known as "spot" or "eye mark", which is fundamental for performing turns.

This component refers to the movement of turning the head, keeping the eye fixed as long as possible in a spatial reference, or a spot, so that the eyes are the last to move, after the trunk and head leave the original direction, and the first to mark the spot again, while trunk and head are still completing the movement of turn.[17] In fact, Durward, Baer and Rowe[18] reiterate that the "eye mark" is tied to the vestibular system.

Considering that the function of the vestibular system is the input to the central nervous system about the position of the head in relation to gravity and to stabilize the visual image when the individual is moving,[19] we can infer that this system is fundamental for performing ballet turns.[20] Therefore, this factor seems to explain the data we found, in which girls who practiced ballet for longer time, and consequently trained the movements of the turn movement for longer time than the less experienced girls, presented a greater ability to use the vestibular system, possibly because of its direct relation to the development of the "eye mark" component.

In our study, the more experienced girls had lower frequencies of deficits regarding PB, when compared to those with less experience, what suggests a possible contribution of ballet practice to their postural stability. Better skills related to postural control in more experienced dancers compared to less experienced dancers were also found in other studies.[21-24] In addition, studies report a better pattern of PB in dancers when compared to non-dancers.[25-27]

The central stabilizing muscles provide stability, which allows generating and distributing forces, what results in controlled and efficient body movements.[28] In addition to the performance context, its evaluation becomes relevant and allows the identification of risk factor for the development of injuries in dancers.[29] Therefore, the present study found that the time of practice of ballet did not affect

Table 2. Results of sensory organization and neural systems of postural balance

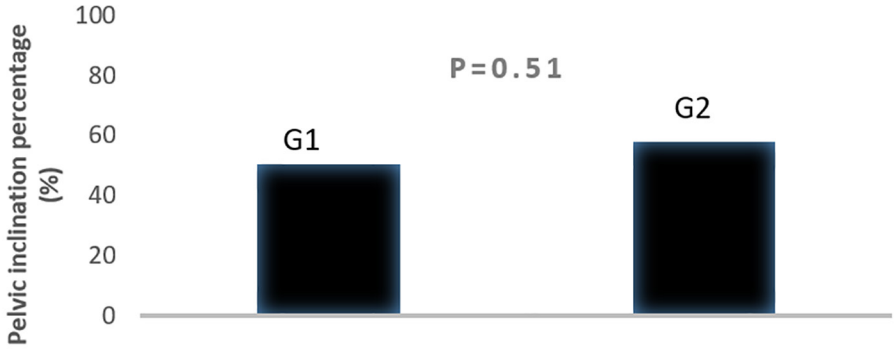
Variable	G1	G2	p-value
Sensory organization tests			
SOT I	93.08±3.51	93.06± 2.42	0.98
SOT II	91.66± 3.94	91.69± 2.78	0.98
SOT III	89.17± 7.09	90.03± 4.32	0.74
SOT IV	78.75±12.22	81.03±5.93	0.60
SOT V	54.81±16.93	66.42±10.29	0.07
SOT VI	53.14±19.15	58.46±16.63	0.50
Composite SOTs	72.45±10.69	76.70±6.54	0.29
Sensory systems analysis			
Somatosensory system	98±0.04	97±0.03	0.83
Visual system	84±0.11	86±0.06	0.52
Vestibular system	57±0.17	70±0.10	0.05*

G1, Group of those who practiced ballet for a minimum of one year and maximum of two years and 11 months; G2, Group of those who practiced ballet for a period of more than three years; SOT, sensory organization tests in the conditions I – VI, and the composite index. Data is shown in mean and standard deviation (±DP); *P=0.05 shows a borderline statistical significance.

Table 3. Results of the association between the SOT classifications and the time of practice of ballet

	G1		G2		p-value
	Normal	Deficit	Normal	Deficit	
SOT I	8 (72.7%)	3 (27.3%)	8 (80%)	2 (20%)	0.69
SOT II	8 (72.7%)	3 (27.3%)	8 (80%)	2 (20%)	0.69
SOT III	7 (63.6)	4 (36.4)	9 (90%)	1 (10%)	0.15
SOT IV	8 (72.7%)	3 (27.3%)	8 (80%)	2 (20%)	0.69
SOT V	6 (54.5%)	5 (45.5)	9 (90%)	1 (10%)	0.07
SOT VI	5 (45.5)	6 (54.5%)	7 (70%)	3 (30%)	0.25
Composite	6 (54.5%)	5 (45.5)	9 (90%)	1 (10%)	0.07

G1, Group of those who practiced ballet for a minimum of one year and maximum of two years and 11 months; G2, Group of those who practiced ballet for a period of more than three years; SOT, sensory organization tests in the conditions I – VI, and the composite index; N (%).



G1, Group of those who practiced ballet for a minimum of one year and maximum of two years and 11 months; G2, Group of those who practiced ballet for a period of more than three years.

Figure 2. Pelvic inclination percentage of both groups.

the PSC, since both groups presented moderate pelvic inclination, what agrees with, Aquino et al.[30] who found that lumbopelvic muscular imbalances are frequent in classical dancers.

Bronner[31] found differences related to PSC during the arabesque movement among experienced, advanced and intermediate dancers, suggesting that this control seems to be a key area, that requires prolonged practice of dominance. This factor seems to explain the results found in the present study, in which we did not observe statistically significant differences between both groups, considering that the time of practice of the most experienced dancers did not exceed five years, and therefore, does not represent an extended period, enough to promote greater pelvic stabilization ability.

We emphasize that the results of the present study found an expressive pelvic inclination in both groups of dancers, what can lead to performance loss during dance practice and risk for injuries. Hence, training programs, addressing central stabilizing muscles, should be inserted in the regular training of ballet practice.

Consistent with these considerations, the study by Kline et al.[32] identified that an exercise protocol, with emphasis on central stabilizer muscle control, provided improvements in muscle strength and functionality in dancers who reported back pain. Consequently, they concluded that the work of these muscles is necessary for performing either basic or complex dance movements, and that this practice can prevent injuries and even extend the career time of a dancer.

Similarly, Kovácsné Bobály et al.[33] identified that a three-month central stabilizer strengthening exercise program was effective in increasing the strength of the abdominal and trunk muscles, as well as reducing lumbar pain and improving the posture of young dancers. The authors complement that low back pain is frequent in dancers, and one of the ways to reduce this symptom is by strengthening the central stabilizing muscles.

In the present study, we observed that both groups of dancers had a moderate pelvic inclination, possibly indicating some degree of weakness in the central stabilizing muscles, and therefore, an important risk factor for the development of low back pain and compensatory postures. hence, in the clinical context, the relevance of adding training programs for these muscles is emphasized in order to prevent injuries, especially in the lumbar spine.

The study's limitations include a relatively small sample, and the lack of a more experienced group of dancers, especially with a ballet practice time of more than five years, in order to allow more conclusive results, especially in relation to the pelvic stabilization variable.

CONCLUSION

In the present study, it was observed that the longer time of practice of the ballet influenced positively the PB of girls, more specifically regarding the ability to use the vestibular system. However, this factor did not influence PSC in these girls, since both groups presented moderate pelvic inclination, indicating a possible weakness in the central stabilizing muscles.

As contributions, the study presents an analysis of the neural systems responsible for the maintenance of PB in a sample of young dancers, and it also addresses preventive measures to be adopted, especially in relation to the insertion of exercise programs focusing on the central stabilizing muscles, in the context of ballet practice.

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