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ORIGINAL ARTICLE

POSTURE TREND ANALYSIS IN CLASSICAL BALLET DANCERS

ANÁLISE DE TENDÊNCIAS POSTURAIS EM PRATICANTES DE BALÉ CLÁSSICO

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ABSTRACT
The art of classical ballet requires repetition of technical movements that cause high stress on the musculoskeletal system. Considering that posture is influenced by the forces to which it is subjected, ballet practice can promote the acquisition of posture trends. Thus, the present study aimed to investigate the occurrence of posture changes in classical ballet dancers. The study group was composed by 10 ballerinas with more than three years of classical ballet practice. For posture analysis, the computerized photogrammetry method was used, through the Postural Assessment Software. It was verified posture trends within the group of studied dancers, such as pelvis anteversion and trunk extension, besides some trends related to a longer time of practice, such as valgus ankles. It was observed that the posture analysis is very important among such population, since the repetition of classical ballet movements may cause posture changes and injuries.
Keywords: Posture. Dance. Injuries.

INTRODUCTION

Dancing is an activity that has been carried out over the centuries and, nowadays, it is used as a profession, leisure, education or therapy, besides other purposes (BAMBIRRA, 1993). According to Pereira et al. (2008), there are several works that indicate dancing as a form of physical rehabilitation, effectively contributing to health. On the other hand, although dancing provides countless benefits to an individual, it can also be a source of posture changes and injuries.

Classical ballet is often cited as a source of injuries, because its movements require technically perfect performance, with extreme joint positions and great muscle exertion during the 90 degrees external rotation of the hip joint, besides knee hyperextension and extreme control of the ankle joint when dancers stand on tiptoes. These movement patterns, associated with various physiological characteristics, generate high mechanical stress on the bones and soft tissues (PICON; FRANCHI, 2007). Fração et al. (1999) claim that, despite the grace and delicacy in search of perfection and accuracy of movements, 56% of the ballerinas, at some point in their lives, suffer from musculoskeletal injuries.

The formation of a ballerina must start early, because she needs to develop physical skills, such as strength, flexibility, resistance, coordination, speed and balance for proper performance (FRAÇÃO et al., 1999). When maximum ranges of motions are demanded prematurely, the activity may act as pathogen of muscles, tendons, bones and joints. Thus, ballet can promote anatomical, biomechanical, morphological and physical changes capable of destabilizing the functional balance of the dancers over the years of practice, facilitating the appearance of posture changes (PICON et al. 2002).

According to Picon et al. (2002), posture is influenced by the forces to which it is subjected.

Based on such assertion, it is possible to infer that the history of physical activity – that is, the movements performed during ballet practice - may influence the posture of the ballerinas. These posture changes can increase the risk of injuries and muscle or joint pains, besides reducing technical performance during ballet trainings and efficiency of daily activities, affecting, thus, the ballerina's quality of life.

It is believed that physiotherapists and other health professionals have a duty to know deeply the physiology and the biomechanics of dancing, to acquire information about the benefits it provides the dancer with and to know when they should prescribe dancing as a form of rehabilitation or leisure. They also should be aware of the most frequent posture dysfunctions and injuries in dancers, in order to learn how to prevent and treat such changes. Therefore, this study aimed to investigate the presence of posture trends and the most frequent injuries in classic ballet dancers.

METHODS

This is a cross-sectional study that seeks to assess the existence of posture trends in ballerinas of Santa Maria city, Rio Grande do Sul state, Brazil. This study was approved by the Ethics and Research Committee of the Federal University of Santa Maria (CAAE - 0024.0.243.000-09 in April, 2009), in accordance with the requirements established by the Resolution 196/96, of the National Health Board on research involving humans.

The inclusion criteria were: having more than three years practicing classical ballet; being between 13 and 18 years-old, inclusive; having experienced menarche at least three years ago (this criterion was determined to minimize the influence of hormonal changes, such as growth spurt, which, according to CASTILHO and BARRAS (2000), can interfere with the posture condition of the ballerinas). The exclusion criterion was having undergone any treatment for correcting posture.

Three ballet schools of Santa Maria participated in the study, where 32 eligible ballerinas were found for the study group, and ten of them met the established criteria. These ones received the Informed Consent, which was signed by their parents or responsible, as a form of consenting to participate in the research voluntarily. The ballerinas were informed about their freedom to stop participating, as well as the secrecy that would be maintained to protect their identity.

They answered a questionnaire related to their physical characteristics (age, menarche, weight and height) and ballet practice (time practicing classical ballet, time using pointe shoes, hours of training per week, presence of pain and/or injury when practicing ballet, anatomical landmark affected by pain and/or injury and, in case of pain and/or injury, they also answered if they underwent pharmacological or physiotherapy treatment). Subsequently, they were subjected to posture assessment through photographs in orthostatic posture, in anteroposterior/posteroanterior and right/left lateral positions.

The photographic record was made with a Sony camera, positioned 3.5 meters away from the ballerina being evaluated, on a 1 meter high tripod. For spatial reference, a plumb line was positioned laterally 1 meter away from the ballerina, who was wearing swimsuits. Prior to the images acquisition, the subject was marked with reflective indicators on the following anatomical landmarks: right and left tragus, right and left acromia, right and left anterior superior iliac spines, greater trochanter of the left and right femurs, joint line of the right and left knees, medial point of the right and left patellae, right and left medial malleoli, inferior angle of the right and left scapulae, C7 spinous process, T3 spinous process, right and left posterior superior iliac spines, point on the midline of the right and left legs, right and left lateral malleoli and right and left heel bones.

After the images acquisition, the photos were scanned in order to acquire angles from

the reflective markers, in accordance with the protocol of the Postural Assessment Software (PAS), version 0.67 (DUARTE et al., 2007). The obtained angles provide information about the horizontal alignment of the head, the horizontal alignment of the acromia, the horizontal alignment of the ASIS, the front angle of the right lower limb, the front angle of the left lower limb, the horizontal alignment of the tibial tuberosity, the horizontal alignment of the scapula in relation to T3, the angle of the right leg/hindfoot, the angle of the left leg/hindfoot, the vertical alignment of the trunk, the horizontal alignment of the pelvis and the angle of the knees. By convention, when the value of the angle was different from zero, it was considered that there were changes, which were identified by the value of the angle (positive or negative); and when the angle was zero, it was considered that there were no posture changes within the studied segment.

The analysis of the obtained variables was conducted through percentage distribution, values of central tendency (mean, standard deviation) and dispersion (median and 25th and 75th percentiles). For statistical analysis the SPSS (Statistical Package for Social Science), version 13.0, was used. The correlations were analyzed through the Pearson's Coefficient Correlation, and the adopted significance level was 5% ($p < 0.05$).

Table 1 displays the characteristics of the ballerinas in the study group.

Characteristics	Mean ± SD	Median (P25 -75)
Age (years)	15,7 ± 2,2	16,0 (14,0 - 17,8)
Menarche (years)	11,7 ± 1,7	11,0 (11,0 – 12,0)
BMI (kg/m^2)	20,4 ± 0,8	20,3 (19,6 - 20,8)

BMI: Body Mass Index; SD: Standard deviation; P 25-75: 25th and 75th percentile of distribution.

The time of classical ballet practice, for most of the ballerinas, was more than seven years, and most of them had already been using pointe shoes for more than two years. The results referring to the variables related to the classical ballet practice are presented in Table 2.

Table 2 - Parameters related to classical ballet practice.

Parameters	Mean ± SD	Median (P25 -75)
Time practicing classical ballet (Years)	9,1 ± 3,1	9,5 (8,3 - 11,5)
Time using pointe shoes (Years)	4,3 ± 2,8	3,5 (2,1 – 5,7)
Time of practice until using pointe shoes (years)	4,8 ± 2,2	4,0 (3,2 – 6,7)
Time of training (hours/week)	3,6 ± 1,1	4,3 (2,5 – 4,3)

SD: Standard deviation.

Regarding any lesions, only one ballerina reported having suffered from injury during a rehearsal, which was distension on the thigh. As for pain, nine dancers reported feeling pain more than three days a week, more frequently in the thighs (7 times), followed by the knees (6 times) and lumbar spine (3 times). Because of that, two of the interviewed ballerinas were taking analgesics more than three days a week. None of the ballerinas had tried physical therapy.

RESULTS

The quantitative variables in relation to the angles obtained through PAS indicate posture

trends presented by the ballerinas, which are illustrated in Tables 3, 4 and 5.

Table 3 – Posture trends found in anterior view.

Posture trends	Frequency	Mean SD	Median (P25 - 75)
Head inclined to the right	80% (n = 8)	1,1° ± 1,9°	1,15° (0,7° - 1,9°)
Elevated left shoulder	80% (n = 8)	1,6° ± 1,8°	1,45° (0,7° - 2,9°)
Elevated left ASIS	70% (n = 7)	0,4° ± 2,1°	1,1° (-1,3° - 1,8°)
Valgus knees	70% (n = 7)	-1,9° ± 3,0°	-1,2° (-3,9° - 0,5°)

ASIS: Anterior superior iliac spines; SD:. Standard deviation; P 25-75: 25th and 75th percentile of distribution.

From these tables, it is possible to observe that most of the ballerinas present some posture alignment change in anterior view. Except for ASIS, the average was higher than one degree of inclination.

Table 4 – Posture trends found in posterior view.

Posture trends	Frequency	Mean f SD	Median (P25-75)
Retracted scapulae	70% (n = 7)	9,1° ± 13,2°	12,2° (-1,2° – 15,8°)
Valgus ankles	70% (n = 7)	3,1° ± 6,6°	3,9° (-1,1° – 6,8°)

SD: Standard deviation; P 25-75: 25th and 75th percentile of distribution

Regarding the scapulae and ankles, it was observed a high standard deviation in the values of the angles, which shows that there was no homogeneity in this change, although a greater number of ballerinas have presented retracted scapulae and valgus ankles.

Table 5 – Posture trends found in lateral view**.**

Posture Trends	Frequency	Meana ± SD	Median (P25 - 75)
Trunk extension	100% (n = 10)	-1,8° ± 3,5°	-1,4° (-2,6° - 0,5°)
Trunk antepulsion	80% (n = 8)	0,88° ± 1,3°	1,2° (0,1° - 1,7°)
Pelvis anteversion	100% (n = 10)	-13,2° ± 6,8°	-11,2° (-17,9° - -8,9°)
Semi-flexed knees	60% (n = 6)	-0,9° ± 3,7°	-0,3° (-1,2° - 1,7°)

SD: Standard deviation; P 25-75: 25th and 75th percentile of distribution.

It is observed that all the ballerinas presented trunk extension and pelvis anteversion; nevertheless, in contrast, only six presented the same trend in the knee joint. The Pearson's Coefficient Correlation test was performed in order to verify the existence of correlation among the variables related to the characteristics of the ballerinas and the angles obtained with the posture assessment. Those with significant value ($p < 0.05$) are displayed in Table 6.

Table 6 – Correlation among characteristics of the ballerinas and posture trends.

Correlation	*r*	*P*
Time practicing classical ballet x valgus ankle	0,69	0,025*
Age x Semi-flexed knees	0,81	0,004*

r: Pearson's Coefficient Correlation; *: Statistically significant ($p<0.05$).

It was found statistically significant variables among the variables of classical ballet practice time and age of the ballerinas, besides trends to valgus ankles

and presence of semi-flexed knees. The Pearson's Coefficient Correlation indicated a positive association, from what it is possible to infer that the variables are directly proportional.

DISCUSSION

This study suggests that ballet practice can influence body posture, since there are posture trends adopted by most of the studied ballerinas, such as trunk extension and pelvis anteversion. There are also correlations indicating that, over the years of practice, the ballerina may acquire posture patterns, such as valgus ankles. This may be due to the fact that muscles, tendons, bones and joints are repeatedly subjected to limits of stress during ballet practice, which may change the posture condition of the ballerina (PICON et al., 2002; PRATI; PRATI, 2006).

The ballerinas average age was 15.7 (± 2.2) years-old, similar to those studied by Luke et al. (2002), who had an average of 15.8 (± 1.0) years-old. According to Castilho and Bars (2000), until menarche a girl has already reached 95% of her final height; therefore, the ballerinas of the present study were undergoing a phase of slow growth, because most of them experienced menarche when they were 11.7 (± 1.7) years-old, on average.

Regarding body mass index (BMI), the ballerinas presented mean of 20.4 (± 0.8) kg/m^2, suggesting that they were within the pattern suitable for their age (SLAUGHTER et al., 1998), as the ballerinas studied by Prati and Prati. (2006), whose average age was 19.9 (± 1.60) kg/m^2.

According to Prati and Prati (2006), in order to generate a high technical development that can lead to the acquisition of certain posture trends, it is required more than seven years of classical ballet practice. Thus, it can be stated that most of the ballerinas involved in the present study had maturity in dance, because their time of practice was, on average, 9.1 (± 3.1) years.

Regarding pointe shoes, most of the studied ballerinas started using them after 4.8 (± 2.2) years practicing classical ballet. Literature has not reached consensus about the right age to start working with pointe shoes, but Bambirra (1993) states that it should start when the lower legs are strong enough to maintain balance without the assistance provided by the contact of the whole foot on the ground.

The average weekly training of the ballerinas of the present study was 3.6 (± 1.1) hours, which is below the training time of the ballerinas studied by Luke et al. (2002), who performed, on average 6.4 hours of training per week. The aforementioned authors investigated the incidence of injuries in 39 dancers and found a high number of occurrences: 122 injuries in a period of nine months of research. These results suggest that the volume of training may be a predisposing factor for injuries, which is in accordance with the findings of McNeal et al. (1990) who observed, in their study, the largest number of injuries in dancers subjected to overtraining.

Injuries resulting from ballet practice have been investigated by several researchers (GREGO et al., 2006; GROER; FALLON, 1993, GUIMARÃES; SIMAS, 2001; LUKE et al., 2002; MACINTYRE, 1994; MCNEAL et al., 1990 ; SCIALOM; GONÇALVES; PADOVANI, 2006; SOLOMON et al. 1999; TWITCHETT et al. 2008), who reported that the rate of injuries in dancers is high; however, in the present study it was found that the rate of injuries was low, as only one ballerina was affected. Furthermore, no ballerina of the sample sought physiotherapy treatment, contrarily to what was found by Scialom; Gonçalves; Padovani (2006) in the study carried out with 30 ballerinas, which reported that 22 of them underwent treatment with physiotherapist, both for rehabilitation after injury and for the prevention of new injuries, which is of great importance for the maintenance of physical integrity of the dancer, critical to the continuity of

ballet practice (MACINTYRE, 1994).

Although the rate of injuries among the ballerinas of this study was low (10%), algetic symptoms were frequent, having been manifested in nine ballerinas (90%). In these cases, the most frequently mentioned body region was the thigh, which may be due to overload of training exerted on the muscles in that region. Bennell et al. (2001) argue that the external rotators and hip abductors are muscles of great importance to the fundamental movements of classical ballet, because the external abduction and rotation demand from them high flexibility. In addition, hip adductors assist in stabilizing the pelvis during unipodal support (SIMAS; MELO, 2000).

Other regions with algetic symptoms - cited by 60% of the ballerinas - were the knees, information also found in the study of GREGO et al. (2006), in which 70% of the studied classical ballet dancers reported feeling pain in at least one of the knees at some point during the years of practice. About such fact, the mentioned authors observe that the ballerinas usually report diffuse pain in the patellar region, being aggravated by specific activities, particularly when performing jumps and other basic movements of classical ballet, such as the *plié* and *arabesque*.

The *plié* is a movement in which the dancer bends his knees slowly in the same line of his feet, which will be in full external rotation (*en detours*), along with the hip (MACHADO, 2006). The *arabesque* is a movement in which the dancer, with his weight supported by only one leg, will stand on tiptoes (*en pointe*) or on half point (*demi* pointe), *en detours* position (MEEREIS et al., 2009).

Regarding the posture trends observed through quantitative posture assessment by means of photogrammetry, which provides precision and agreement among different examiners (IUNES et al., 2009), it was found that most of the ballerinas presented head inclined to the right (80%), elevated left shoulder (80%) and elevated left ASIS (70%), corroborating the findings of Simas and Melo (2000), who identified that 38% out of the 50 studied ballerinas presented head inclination, 78% had uneven shoulders and 58% had uneven ASIS. These authors suggest that during the training of specific movements the ballerina repeats the motor gesture according to the side of her best technical performance, which causes muscle to develop disproportionately, producing muscle pain and even posture changes, such as those identified in this study.

It was found that 70% of the ballerinas presented valgus knees, as well as the ones studied by Prati and Prati (2006) and contrarily to the ballerinas analyzed by Simas and Melo (2000), who presented varus knees. Most of the ballerinas presented valgus ankles (70%). According to Hamilton et al. (1992), this may be due to the great joint mobility, because the dancers must possess a high degree of ankle dorsiflexion to perform the *plié* position and support the landings of jumps. Problems in the ankle and foot are common among dancers, because the exertion to achieve external rotation of lower limbs because biomechanics changes in the ballerinas, which may contribute for the appearance of injuries during the performance of classical ballet movements (SCHON; WEINFELD , 1996).

Most ballerinas had retracted scapulae (70%). According to Bristot et al. (2009), scapulae stabilization with slight retraction is of great importance during the movements of the arms in classical technique, leading to hyperextension of the pectoralis major and minor muscle. This can often cause trunk extension, a consequence presented by 100% of the studied ballerinas. According to the aforementioned authors, this posture leads to an anterior displacement of the gravity center, as a result of compensation of the thoracic and cervical curvatures due to an increase of the lumbar lordosis, which may explain the occurrence of trunk antepulsion found in 80% of the studied ballerinas.

In addition, 100% of them had pelvis anteversion. In relation to this, Dezan, Sarraf and

Rodacki (2004) argue that the disproportional physical exertion among the hip flexor and extensor muscles may favor the development of unbalances of the forces generated by the muscles that work in this joint and in the lumbar spine, changing the pelvis inclination angle.

The present study revealed that 60% of the ballerinas had semi-flexed knees, possibly due to the fact that they have adapted their posture towards a better development of ballet practice, since knee hyperextension means less joint mobility, which harms the absorption of the rotational forces applied over it, causing difficulties when using pointe shoes (KLEMP; LEARMONTH, 1984).

According to Picon et al. (2002), the parts of the human body are fully interconnected so that any musculoskeletal imbalance interferes with the whole standard posture, that is, a muscle imbalance may be associated with compensations in adjacent joints. Given such premise, the correlation among the posture trends of a joint and another were investigated; however, there were not statistically significant associations in this study.

From the findings and investigations, it was possible to observe that posture changes of ballerinas are common. Among these studies, only Bittencourt (2004) indicated low occurrence of posture changes in ballerinas. Given such results, it was found that the posture analysis is of great importance. This is also stated by Simas and Melo (2000), who add that this analysis is important because it raises the dancer's awareness about their body alignment, asymmetry and movement restrictions, allowing them to use their full physical capacity.

Therefore, it is important to carry out preventive actions, specially the stretching of the most worked muscle groups, symmetrical training and preventive posture work, in which breathing and static muscles are worked, in order to obtain balance of forces among the anterior and posterior muscle chains, because, according to Macintyre (1994), imbalance among these chains can generate a faulty postural alignment, causing increased biomechanical stress on the joints, which often results in injuries.

Among the limitations of our research, we can consider the fact that the study group was relatively small, which may influence the results of the statistical tests; and also the fact that we have not investigated the dominant or preferred side of the ballerina, the intensity of the classes and the habits of ballet practice, because, due to the few hours of weekly training, other factors could be influencing their posture.

CONCLUSIONS

It could be observed that there are certain posture trends within the studied group of ballerinas, such as pelvis anteversion and trunk extension, some of which were related to a longer exposure time to classical ballet, such as valgus ankles.

It was verified that the kinesiological and biomechanical aspect deserve great attention in planning dance programs. This should be discussed in a multidisciplinary way, among dance teachers, physiotherapists and other health professionals, in order to avoid repetitive overload in certain muscle groups and thus reduce the incidence of injuries and posture changes, which would mean a greater contribution of the dance to the ballerina's health.

It is concluded that the posture analysis is of great need, since deviations of postural alignment can cause injuries and harm the daily life activities of the ballerinas. Thus, preventive actions in order to improve awareness of body alignment and facilitate the use of the physical capacity of the ballerinas, without compromising their musculoskeletal system, are of high importance for classical ballet dancers.

In this regard, it is suggested that other studies, including longitudinal ones, are conducted using a larger number of participants, looking for the homogeneity of the study group, to verify the

influence of the movements performed during the practice of classical ballet in the posture of the ballerinas.

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