Thoraco-lumbo-pelvic alignment in adolescents who attend classical ballet classes

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Abstract

This study aimed to assess factors associated with altered thoraco-lumbo-pelvic alignment among adolescents who attend classical ballet class. 57 adolescents were distributed into a case group formed by student ballet dancers with altered thoraco-lumbo-pelvic alignment and a control group formed by student ballet dancers with neutral alignment. The adolescents were subjected to an anthropometric and postural evaluation (photographic record of posture in the lateral view analysed using the vector graphics editor software Corel Draw 3), abdominal muscle strength test and questionnaire. The practice of ballet through Royal Academy of Dancing (RAD) method was 10.47 times more likely to be associated with altered thoraco-lumbo-pelvic alignment than the practice through Vaganova method in adolescents, and muscle strengthening was 6.23 times more likely to be associated with altered alignment when controlling for the other study variables. RAD method combined with muscle strengthening was associated with altered thoraco-lumbo-pelvic alignments among adolescents who showed weak or normal abdominal muscle strength, performed another physical activity, danced ballet for five years or less, had a weekly training load over three hours and usually slept in the prone position. The practice of ballet by the RAD method, in addition to the practice of muscle strengthening, was a factor associated with altered thoraco-lumbar-pelvic alignment.

Keywords: Growth and development; Posture; Spine; Exercise; Dance.

Introduction

In adolescents, postural changes commonly occur as a result of various factors, including life habits, such as computer and TV time[1], use of high heels by girls[2], way to carry a backpack[3,4] and physical activity[5].

Classical ballet is an activity that requires dancers to perform a range of movements within a specified postural alignment in which the dancers during their practice adopts a position similar the posture considered by Kendall et al.[6] as a biomechanically adequate. In this posture, the anatomical points are close to the plumb line[7]. However, the extreme gestures and positions required for ballet dancing may also contribute to the adoption of inappropriate postural patterns[8,9].

Specific complementary exercises designed to improve physical fitness components, such as strength and flexibility, may serve as a protective factor against postural misalignment and/or injuries resulting from physical activity[10] and may also contribute to improving performance in dance or in any other activity[11].

Although the effects of ballet on the posture of professional dancers have been discussed by several authors[9,12], studies on adolescent dancers are scarce. It is known that

postural habits acquired in adolescence may have a negative impact on the musculoskeletal system in adult life[13]; therefore minimising the effects of postural misalignments is a noteworthy subject, because in addition to improving the quality of life of adolescents, it prevents postural changes from becoming definitive in adulthood[14,15]. Thus, elucidating the factors that affect the posture of adolescent ballet dancers may contribute to decreasing the risks of postural misalignments.

This study aimed to assess factors associated with altered thoraco-lumbo-pelvic alignment among adolescents who attend classical ballet class.

Methods

Study design

It is an observational study analysing a convenience sample of 57 adolescent girls aged from 11 to 14 years and enrolled in five classical ballet schools of the city of Recife, Pernambuco state (PE), Brazil, that agreed to participate in the study, according to the flowchart (FIGURE 1). Those classical ballet schools are not professional.

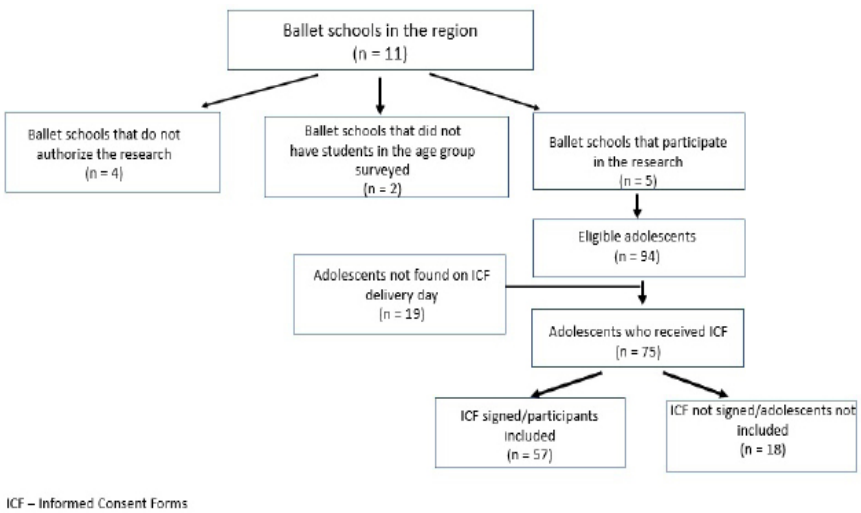

FIGURE 1 - Flowchart.

The research study was approved by the Human Research Ethics Committee of the Federal University of Pernambuco (UFPE; Certificate of Presentation for Ethical Consideration (Certificado de Apresentação para Apreciação Ética - CAAE): 50166915.6.0000.5208). To participate in the research study, the guardians of the invited adolescents were required to sign the Informed Consent Form, and the adolescents signed the Informed Assent Form according to resolution 466/12 of the National Research Ethics Committee of the Ministry of Health of Brazil.

The schools in Recife traditionally used two classical ballet teaching methods: the Royal Ballet Academy of Dancing (RAD) and the Vaganova[16]. The main difference between these two methods is that in the RAD the exercise repetition is required to achieve a technical improvement of the movements, with no emphasis on work for increased strength and flexibility of lower limbs, whereas in the Vaganova method there

is a concern with a work for improvement strength and flexibility of the lower limbs[7].

Some schools also use complementary exercise associated with these classes, including stretching and strengthening. Stretching includes the hamstring, abductor and abdomen muscles in a static and dynamic manner. And the strengthening is focused on spine extenders, flexors of feet, and adductor performed, on average, 3 to 4 sets of 3 repetitions with the weight of the body itself. For both types of exercises, specific prescriptions are not followed. The objective is to prepare the body for class, aiming at the necessary postural alignment during exercise and increasing the amplitude in the movements performed[16].

The adolescents were allocated into two groups: a case group formed by dancers with altered thoraco-lumbo-pelvic alignment and a control group formed by dancers with neutral thoraco-lumbo-pelvic alignment. The case group included adolescents with the following postural clusters: sway, flat and hyperlordotic back postures. The control group included adolescents with a neutral alignment[17]. Obese adolescents, adolescents using controlled medicines and adolescents with musculoskeletal disorders, neurological disorders, vestibular changes or severe cognitive deficits that could hinder understanding of the research study were excluded from groups.

Data were collected from February to June 2016. The ballerinas were subjected to the following evaluations.

Personal information, development and sexual maturation self-evaluation and anthropometric evaluation (weight, height and body mass index (BMI))

The adolescents were subjected to a development and sexual maturation self-evaluation (Tanner Staging)[18] and an anthropometric evaluation (weight and height measurements) using a portable electronic scale with a capacity of 180 kg and accuracy to 100 g (Techline® scale). Height was measured in metres using a Teklife 2.0-meter inextensible tape measure. The cut-off points recommended by the World Health Organization (WHO) were used to classify the nutritional statuses of the adolescents by age. Accordingly, the nutritional status was classified as follows: low weight (< 3rd percentile), eutrophy (≥ 3rd percentile and < 85th percentile), overweight (≥ 85th percentile and < 97th percentile) and obesity (≥ 97th percentile) (World Health Organization [WHO][19].

Daily habits and ballet dancing

A 15-item questionnaire was administered to assess behaviour in daily activities and variables associated with classical ballet dancing. Screen time (number of hours per day watching television or using a computer, smart phone, video game or tablet) was classified as more or less than two hours per day. Based on the answers recorded about backpack, this variable was categorised as a backpack on both shoulders or a bag on one shoulder. The question on the use of high heels had the options: never, rarely, sometimes, often and always. The use of high heels was considered when the adolescent selected "often" and "always", and no use of high heels was considered when the adolescent selected the other options. The usual sleeping position of the adolescents was categorised as "supine or sideways" or "prone".

The number of years of ballet training was divided into two categories: five years or less or more than five years of ballet dancing, since the adolescents recruited presented a minimum training of one year. The weekly training load was defined as the total number of weekly hours the adolescent spent practising this activity and was categorised into three hours or less or more than three hours, since the adolescents recruited presented a minimum load of 2 hours and maximum of 5 hours per week. The adolescents were asked whether they performed complementary exercise for muscle stretching and/or strengthening before the class, as well as how often the teacher included this type of work in the lessons. Each question had four choices: always (every lesson), almost always (once a week or more), rarely and never. The presence of ballet dancing with muscle stretching or

strengthening was considered when the dancers selected the options "always" and "almost always", and its absence was considered when they chose "never" and "rarely".

The ballet method used by the adolescents was classified as RAD or Vaganova.

Thoraco-lumbo-pelvic alignment assessment

The thoraco-lumbo-pelvic alignment was analysed in the right-side sagittal plane[20]. To assess alignment, adolescents were asked to stand barefoot looking straight ahead. Photographs were taken using a digital camera (Cannon PowerShot A800 10.0 Mega Pixels). The photographs were uploaded to the vector graphics editor software Corel Draw X3 for postural assessment and analysed by two raters at different times. Subsequently, the Kappa coefficient was used to analyse the inter-rater agreement on the classification of posture and interpreted according to Landis & Koch[21]. In addition, 3-cm Styrofoam hemispheres taped to the body with VHB double-sided tape were used to mark the following anatomical points: C7 spinous process, T12 spinous process, posterior inferior iliac spine (PIIS), anterior superior iliac spine (ASIS), greater trochanter of the femur, fibular head and lateral malleolus[20]. These markings helped to classify the pelvis, trunk, and global body posture. In order to be able to perform the posture evaluation, a line was drawn parallel to the ground. Then the plumb line was drawn, perpendicular to the ground, passing close to the external lateral malleolus marker toward the top of the head. The image was calibrated when necessary, so that the horizontal line formed an angle of 90 ° with the plumb line. From this the pelvis was classified and then the trunk after. The pelvis position was classified as neutral, anteversion or retroversion. The neutral position of the pelvis is one where the ASIS lies in the same horizontal plane as the PSIS, or slightly superior or slightly inferior (up to 1cm). If the ASIS is higher than the PSIS it will be considered pelvic retroversion. If the ASIS is lower than the PSIS it will be considered pelvic anteversion[6]. The trunk was classified as neutral, anteriorly tilted (forwards) or posteriorly tilted (backwards). Regarding the positioning of the trunk, it was considered neutral when the plumb line passes through the axillary midline of the thorax. Preceded when the axillary midline of the thorax is to the right of the plumb line, and posteriorized when it is on the left. After classifying the pelvis and trunk, it was possible to classify the global body posture based in thoraco-lumbo-pelvic alignment.

The alignment was classified into four postural clusters: neutral, sway, flat and hyperlordotic. A posture is considered sway when the pelvis is neutral or slightly posteriorly tilted (pelvic retroversion) and the trunk is posteriorly tilted. Conversely, a posture is considered flat when the pelvis is retroverted and the trunk is neutral or tilted forwards (trunk anteversion), and a posture is considered hyperlordotic when the pelvis is anteriorly tilted (pelvic anteversion) and the trunk is neutral or tilted forward[17]. Finally, a neutral posture in which the acromion, great trochanter of the femur and lateral malleolus aligned to form an angle of approximately 180°[17].

Abdominal muscle strength test

The abdominal muscle strength test was used to assess abdominal muscle strength because it was adequate for the age range of the studied sample[22]. Depending on the number of repetitions of sit-ups performed in 1 minute according to age, the abdominal strength was classified into three categories (weak, normal and good) according to the reference values proposed by the Brazilian Sports Project (PROESP-BR)[22].

Statistical analysis

The data were processed and analysed using the SPSS20 software and expressed as percentages and absolute numbers or means and standard deviations. The Kolmogorov–Smirnov test was performed for quantitative variables, and all variables showed normal distributions (age, weight, height and BMI).

Significant associations between quantitative variables were analysed using Pearson's Chi-square or Fisher's exact test at a 5% significance level.

Prevalence ratios (PRs) and their respective

confidence intervals were calculated. A log-binomial multivariate regression analysis was performed to assess the effect of independent explanatory variables. In the univariate statistical analysis, a significance level of $p<0.30$ in the Chi-square test was used to select variables for inclusion in the final multivariate analysis model and variables that might affect posture in the conceptual model.

Results

Characteristics of the participants

In this study, 57 ballet dancers were evaluated, including 44 from the case group and 13 from the control group. The groups were homogeneous in terms of age, weight, height, nutritional status and sexual maturation (TABLE 1).

TABLE 1 - Sample characterisation.

Sample characteristic	Adolescent ballet dancers		Total (n=57)	p value
	Altered posture (n=44)	Neutral posture (n=13)		
Age	12.68 (± 0.93)	12.62 (± 0.96)	12.67 (± 0.93)	0.824
Weight	45.84 (±7.53)	46.38 (±8.35)	45.96 (±7.65)	0.827
Height	1.56 (±0.73)	1.57 (±0.84)	1.56 (±0.75)	0.719
BMI	18.65 (±2.49)	18.64 (±2.07)	18.65 (±2.38)	0.982
Nutritional status N (%)				0.514†††
Eutrophic	36 (81.8)	11 (84.6)	47 (82.5)	
Low weight	1 (2.3)	1 (7.7)	2 (3.5)	
Overweight	7 (15.9)	1 (7.7)	8 (14)	
Sexual maturation - breasts N (%)				0.548
Prepubescent	27 (61.4)	10 (76.9)	37 (64.9)	
Pubescent	17 (38.7)	3 (23.1)	20 (35.1)	
Sexual maturation - pubic hair N (%)				0.520
Prepubescent	29 (65.9)	10 (76.9)	39 (68.4)	
Pubescent	15 (34.1)	3 (23.1)	18 (31.6)	

Characteristics of ballet and daily habits

Univariate analyses (TABLE 2) comparing the characteristics of ballet dancers and their daily habits between groups with altered and neutral postures showed that 52.3% of the adolescents with altered posture practised ballet using the RAD and without stretching.

TABLE 2 - Characteristics of ballet dancing and daily habits.

Variables	Posture		Univariate analysis			
	Altered N (%)	Neutral N (%)	PR	85% CI		p value*
Ballet method						
RAD	23 (52.3)	1 (7.7)	1.5	1.15;	1.97	**0.01 †**
Vaganova	21 (47.7)	12 (92.3)	1	-	-	
Muscle stretching						
No	23 (52.3)	1 (7.7)	1.50	1.15;	1.97	
Yes	21 (47.7)	12 (92.3)	1	-	-	**0.01 †**
Weekly training load						
More than 3 hours	16 (36.4)	9 (69.2)	0.35	0.12;	1	
3 hours or less	28 (63.6)	4 (30.8)	1	-	-	0.07 †
Training time						
5 years or less	26 (59.1)	4 (30.8)	1.3	0.96;	1.76	0.13 †
More than 5 years	18 (40.9)	9 (69.2)	1	-	-	
Muscle strengthening						
No	30 (68.2)	11 (84.6)	0.46	0.11	1.8	
Yes	14 (31.8)	2 (15.4)	1	-	-	0.31††
Abdominal muscle strength						
Weak	20 (45.5)	2 (15.4)	2.08	0.94;	4.61	
Normal	11 (25)	5 (38.5)	1	0.43;	2.36	0.15†††
Good	13 (29.5)	6 (46.2)	1	-	-	
Use of high heels						
Yes	32 (72.7)	10 (76.9)	0.95	0.70;	1.29	1.0 ††
No	12 (27.3)	3 (23.1)	1	-	-	
Screen Time						
More than 2 hours	33 (75)	10 (76.9)	0.92	0.29;	2.88	1.0 ††
Up to 2 hours	11 (25)	3 (23.1)	1	-	-	
Schoolbag carriage						
Bag on one shoulder	30 (68.2)	7 (53.8)	1.59	0.62;	4.08	
Backpack on both shoulders	14 (31.6)	6 (46.2)	1	-	-	0.51 ††
Sleeping position						
Prone	16 (36.4)	6 (46.2)	0.73	0.28;	1.90	0.50 †
Supine or sideways	28 (63.6)	7 (53.8)	1	-	-	
Other physical activity						
Yes	14 (31.8)	6 (46.2)	0.86	0.62;	1.20	0.50 ††
No	30 (68.2)	7 (53.8)	1	-	-	

* † Yates's correction for continuity; †† Fisher's exact test; ††† Pearson's Chisquare test.

The presence of altered posture in the ballet dancers was significantly associated with RAD method and muscle strengthening when controlling for the other variables in the model (TABLE 3).

TABLE 3 - Adjusted analysis of the characteristics of ballet dancing and daily habits.

	Multivariate analysis			
	PR	95% CI		p value
Ballet method				
RAD	10.47	1.84;	59.51	-
Vaganova	1	-	-	**< 0.01***
Muscle strengthening				
Yes	6.23	1.62;	23.9	**< 0.01***
No	1	-	-	-
Muscle stretching				
Yes	1	-	-	1
No	1	-	-	-
Abdominal muscle strength				
Weak	1.35	0.40;	4.48	0.63
Normal	1.38	0.47;	0.05	0.56
Good	1	-	-	-
Other physical activity				
Yes	1.66	0.54;	5.15	0.38
No	1	-	-	
Training time				
5 years or less	1.32	0.53;	3.27	
More than 5 years	1	-	-	0.55
Weekly training load				
More than 3 hours	1.42	0.40;	5.04	
3 hours or less	1	-	-	0.58
Sleeping position				
Prone	1.68	0.67;	4.23	
Supine or sideways	1	-	-	0.26

The model included the following variables: ballet method used, muscle strengthening, muscle stretching, abdominal muscle strength, other physical activity, training time, weekly training load and sleeping position. A p<0.01 significance level and 95% confidence interval were used.

TABLE 4 presents the relationships between the postural clusters adopted by the adolescent ballet dancers and the study variables. A weekly training load greater than three hours was associated with a hyperlordotic posture in 56% (14/25) of the dancers. The results also showed that five years or less of number of years of training was associated with a hyperlordotic posture in 66.7% (20/30) of the study adolescents, whereas more than five years of training was associated with a predominance of a sway posture (37%) (10/27).

50% (11/22) of the adolescents who showed weak performances in the abdominal muscle strength test were classified with a sway posture. None of the adolescents had their posture classified as flat. For all the analysis the Kappa coefficient was one.

TABLE 4 - Classification of the global body posture of adolescents into three categories.

N (%)	Altered posture			p value*
	Yes		No	
	Sway posture	Hyperlordosis posture	Neutral posture	
Ballet method				
RAD	14 (58.3)	9 (32.5)	1 (4.2)	**< 0.001**
Vaganova	2 (6.1)	19 (57.6)	12 (36.4)	
Muscle stretching				
Yes	2 (6.1)	19 (57.6)	12 (36.4)	**< 0.001**
No	14 (58.3)	9 (37.5)	1 (4.2)	
Muscle strengthening				
Yes	0 (0)	14 (87.5)	2 (12.5)	**0.001**
No	16 (39)	14 (34.1)	11 (26.8)	
Weekly training load				
3 hours or less	14 (43.8)	14 (43.8)	4 (12.5)	**0.006**
More than 3 hours	2 (8)	14 (56)	9 (36)	
Training time				
5 years or less	6 (20)	20 (66.7)	4 (13.3)	**0.01**
More than 5 years	10 (37)	8 (29.6)	9 (33.3)	
Abdominal muscle strength				
Weak	11 (50)	9 (40.9)	2 (9.1)	**0.04**
Reasonable	2 (12.5)	9 (56.3)	5 (31.3)	
Good	3 (15.8)	10 (52.6)	6 (31.6)	
Use of heels				
Yes	3 (20)	9 (60)	3 (20)	0.59
No	13 (31)	19 (45.2)	10 (23.8)	
Screen Time				
Up to 2 hours	4 (28.6)	7 (50)	3 (21.4)	0.99
More than 2 hours	12 (27.9)	21 (48.8)	10 (23.3)	
Schoolbag carriage				
Backpack on both shoulders	3 (15)	11 (55)	6 (30)	0.24
Bag on one shoulder	13 (35.1)	17 (45.9)	7 (18.9)	
Sleeping position				
Supine or sideways	10 (28.6)	18 (51.4)	7 (20)	0.81
Prone	6 (27.3)	10 (45.4)	6 (27.3)	
Other physical activity				
Yes	5 (25)	9 (45)	6 (30)	0.63
No	11 (29.7)	19 (51.5)	7 (18.9)	

Discussion

Although many authors have focused on understanding postural changes in adolescents who attend classical ballet class, this study is one of the first aimed at assessing factors associated with altered thoraco-lumbo-pelvic alignment in adolescent classical ballet students.

The results of this study showed that most adolescents with some types of postural change were practitioners of the RAD method and failed to perform muscle stretching when training. When controlling for the variables abdominal muscle strength, other physical activity, number of years of training, weekly training load and sleeping position, the results showed that adolescents who used the RAD were 10.47 times more likely to have altered posture than those who used the Vaganova method. When controlling for the same variables, the results also showed that ballet dancers who performed muscle strengthening were 6.23 times more likely to show altered thoraco-lumbo-pelvic alignment. Furthermore, the sway posture was more frequently adopted among adolescents using the RAD method.

No studies were found in the literature relating the classical ballet teaching method with postural changes. The RAD method is characterised by constant repetition of the same movements every class to improve the technique[7]; however, in contrast to the Vaganova, the RAD fails to focus on lower limb strength and flexibility work towards improving performance[16]. The inclusion of lower limb strengthening exercises most likely causes adaptation and affects posture[23].

More studies involving classical ballet teaching methods and thoraco-lumbopelvic alignment are necessary to assess whether postural clusters in adolescents who attend classical ballet class result from RAD or whether this method is insufficient in improving postural patterns adopted by adolescents, because postural changes may precede ballet dancing.

Extensive of joint mobility is one of the skills that stands out in classical ballet, particularly external rotation of the hip and plantar flexion of the ankle[24]. Prati & Prati[10] assert that because ballet movements demand high amplitudes of movement, ballet training itself is sufficient for a good ballerina performance and there is no requirement for complementary work to develop flexibility. However, our study showed that muscle stretching was associated with decreased the likelihood of adolescent ballet dancers showing altered thoraco-lumbo-pelvic alignment.

The univariate analysis showed that adolescents who failed to stretch were more likely to show altered thoraco-lumbo-pelvic alignment; however, when controlling for the other variables, no significant differences in altered alignment were found between ballet dancing with or without stretching. When considering the type of posture adopted, the results showed that the neutral posture was more frequent among adolescents who stretched than among those who did not.

As shown in the literature, traditionally, few studies have focused on paravertebral muscle stretching. Conversely, these muscles remain contracted during the most common classical ballet movements, which further can strengthen and thus aggravates the imbalance between the paravertebral and abdominal muscles. This factor can contribute to the hyperlordotic posture[25]. Therefore, in our study, stretching may have been associated with decreased muscle imbalances.

Ballet dancing combined with muscle strengthening significantly increased the likelihood of adolescents showing altered thoraco-lumbo-pelvic alignment in our study. In particular, muscle strengthening was related to the hyperlordotic posture. Although the literature indicates that decreased spine muscle strength is a possible cause of increased lumbar lordosis[26], muscle strengthening was related to the hyperlordotic posture in our study. This finding may have resulted from the type of muscle strengthening performed among the participants in this study who focused only on the performance of the ballet technique with a disregard for improvement of postural alignment by strengthening specific muscle groups, such as the paravertebral muscles, over the abdominal muscles. This factor may lead to postural imbalance, as previously highlighted.

Muscle strengthening with an increased focus on the abdominal region could be an

alternative for improved postural balance and injury prevention. The abdominal strength work conducted by adolescents should be more specific, because in addition to seeking good execution of ballet movements, adolescents must maintain body balance both in muscle harmony and in compensation due to the overload of specific body regions[26].

Adolescents with altered thoraco-lumbo-pelvic alignment showed the worst results in the abdominal muscle strength test. Most adolescents with a weak result in this test had a sway posture; in turn, improved abdominal muscle strength was associated with a hyperlordotic posture. Good abdominal muscle strength should be a protective factor for hyperlordotic posture because lumbar hyperlordosis is associated with abdominal muscle weakness[6]; however, our results showed the opposite trend. This trend most likely occurred because the values considered to represent a good result in the abdominal strength test for the general population were insufficient for the population of adolescents who attend classical ballet class due to the excessive dorsal muscle demand of specific ballet movements. This factor was also identified in another study using the same test, in which the authors found that although the ballerinas of their sample reached adequate levels of abdominal muscle strength, the predominantly observed postural trend was a prominent abdomen. The authors highlighted that although the results from the test were positive, the work performed to increase abdominal muscle strength was insufficient for ballerinas due to dorsal muscle overload[10].

The training load effects of a specific physical activity on the posture of adolescents are mostly overlooked in the literature, although some authors indicate that greater training loads increase the time of exposure to specific repetitive movements of the activity, which may be a risk factor for altered thoraco-lumbo-pelvic alignment[27,28]. In our study, we identified an association between the weekly ballet dancing load and altered thoracolumbo-pelvic alignment. Ballet dancing more than three hours per week was associated with the adoption of a hyperlordotic posture in most adolescents. This adoption may occur because higher weekly hours of ballet dancing result in a longer period during which the adolescent is subjected to specific movements of this activity, such as cambré and arabesque, which require hyperextension of the spine. This repetitive spine arching found in some activities and/or sports contributes to lumbar hyperlordosis[29].

Regarding the number of years of training, some authors have indicated that postural changes, such as thoracic kyphosis and lumbar hyperlordosis, are associate with a longer cumulative time spent in a specific physical exercise[30,31]. Furthermore, when initiated at an excessively young age, the activity has a greater risk of causing postural changes in the individual, because the longer number of years of training also entails higher technical and performance demands; therefore, the activity will increasingly require greater effort from the athlete, causing muscle adaptations that may contribute to postural changes[32]. However, in our study, as noted by other authors[33,12], the ballet dancing time was not a significant factor for the presence of altered thoraco-lumbo-pelvic alignment.

Regarding daily habits, the sleeping position showed no significant association with altered thoraco-lumbo-pelvic alignment. Other authors also found an association between sleeping in the prone position and lumbar hyperlordosis[34,35].

Regarding the practice of other physical activities, according to Bosso & Golias[35], each activity or sport has a unique set of specific characteristics to which the body must adapt, and these characteristics may affect the onset of postural changes. In our study, the practice of another physical activity was not associated with altered thoraco-lumbopelvic alignment. Factors such as the weekly training load and number of years of training of the physical activity or sport may affect the type of musculoskeletal response to this activity[31,36]; however, in our study, these aspects were not investigated, which limited further analysis of this issue. Other habits, such as using high heels, type of school bag and screen time, also showed no significant associations with altered thoraco-lumbo-pelvic alignment.

In this study the strength of the lumbar extension or the extensibility of the lumbar extensors were not tested, being characterized as a possible limitation of this study. Also, it was

not addressed muscle coordination/activation differences or dynamic control in this study, as a suggestion, other studies should investigate these factors for better understanding of the factors that affect the occurrence of altered thoraco-lumbo-pelvic alignment among adolescent ballet dancers. Knowledge about postural changes among adolescent ballet dancers is relevant, especially for professionals responsible for planning and managing activities for this public.

Conclusion

Most adolescents who showed some altered thoraco-lumbo-pelvic alignment trained in ballet using the RAD and failed to combine muscle stretching with ballet dancing. Adolescents who practiced ballet using the RAD method were more likely to show altered thoraco-lumbo-pelvic alignment than adolescents who practiced using the Vaganova method, and those who performed muscle strengthening were more likely to show altered thoraco-lumbo-pelvic alignment when controlling for the following variables: abdominal muscle strength, another physical activity, number of years of training, weekly training load and sleeping position. The postural clusters (neutral, sway or hyperlordotic) was significantly related to the ballet dancing method used, muscle stretching, muscle strengthening, weekly training load and abdominal muscle strength. Thus, the results showed that combining of the ballet practicing using the RAD method with muscle strengthening was associated with altered thoraco-lumbo-pelvic alignment among adolescents.

Resumo

Alinhamento toraco-lombo-pélvico em adolescentes que frequentam aulas de balé clássico.

O objetivo do estudo foi avaliar fatores associados ao alinhamento toraco-lombo-pélvico alterado em adolescentes que frequentam a aula de balé clássico. Foram distribuídas em um grupo de casos de 57 adolescentes formado por estudantes de balé com alinhamento toraco-lombo-pélvico alterado e um grupo controle com alinhamento neutro. As adolescentes foram submetidas a avaliação antropométrica e postural (registro fotográfico da postura na vista lateral analisada pelo Corel Draw 3), teste de força muscular abdominal e questionário. A prática de balé através do método Royal Academy of Dancing (RAD) teve uma probabilidade 10,47 vezes maior de estar associada a um alinhamento toraco-lombo-pélvico alterado do que a prática através do método Vaganova em adolescentes, e o fortalecimento muscular 6,23 vezes mais associado ao alinhamento postural alterado ao controlar as demais variáveis do estudo. O método RAD combinado ao fortalecimento muscular esteve associado a alterações no alinhamento toraco-lombo-pélvico em adolescentes que apresentaram força muscular abdominal fraca ou normal, aquelas que realizaram outra atividade física, dançaram balé por cinco anos ou menos, tiveram uma carga semanal de treinamento por três horas e geralmente dormem na posição de bruços. A prática do balé pelo método RAD, acrescida à prática de fortalecimento muscular, foi um fator associado ao alinhamento toraco-lombo-pélvico alterado.

Palavras-chave: Crescimento e desenvolvimento; Postura; Coluna; Exercício físico; Dança.

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