



Research paper

Application and examination of the efficiency of a core stability training program among dancers[☆]Kovácsné Bobály Viktória^{a,*}, Szilágyi Brigitta^b, Kiss Gabriella^b, Leidecker Eleonóra^b, Ács Pongrácz^b, Oláh András^c, Járomi Melinda^b^a University of Pécs, Doctoral School of Health Sciences, Rétstreet 4, 7623 Pécs, Hungary^b University of Pécs, Faculty of Health Sciences, Institute of Physiotherapy and Sports Science, Hungary^c University of Pécs, Faculty of Health Sciences, Institute of Nursing Sciences, Basic Health Sciences and Health Visiting, Hungary

ARTICLE INFO

Article history:

Received 11 October 2016

Received in revised form 3 November 2016

Accepted 3 November 2016

Keywords:

Dance

Low back pain

Lumbar motor control

Posture

Dancers

Core stability

ABSTRACT

Introduction: One of the most common complaints in Hungary is low back pain, which typically occurs in adulthood, but affects professional dancers as early as during their dance studies. In most cases this is caused by the degenerative deformities of intervertebral discs, decreasing of the intervertebral gap, and dislocations in smaller joints. These issues could also mean the end of a dancer's career.

Methods: A total of 62 dancers participated in the study, 30 ballet dancers (average age: 12.7 ± 2.2 (9–18) years) and 32 hip-hop dancers (average age: 13.7 ± 2.9 years). The intensity of low back pain occurring during training was examined with the help of visual analogue scale, the dancers' habitual posture was observed with postural analysis grid chart examination, the static strength of core muscles was examined with the core test, and the lumbar motor control ability was assessed with the leg lowering test. Examinations were carried out prior to the 3-month core prevention training programme, and were repeated following the completion of the programme.

Results: The results indicated a significant improvement concerning the intensity of low back pain in case both of ballet dancers ($p = 0.004$), and hip-hop dancers ($p = 0.002$). Regarding habitual posture, the posture of both groups of dancers improved by a high percentage (ballet 52.17%, hip-hop 37.5%). The static strength of core muscles also showed significant improvement both in the case of the ballet dancer ($p < 0.001$), and also the hip-hop dancer group ($p = 0.015$). Significant improvement was also experienced in the lumbar motor control ability of the dancers (ballet $p < 0.001$, hip-hop $p < 0.001$).

Conclusion: As a result of the exercise programme, improvements were experienced for each of the examined parameters in the case of the representatives of both dance styles. The application of the core prevention exercise program and its integration into training programmes is necessary, as it can help mitigate against the mentioned complaints and the likelihood of injuries can be reduced.

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1. Introduction

In the USA, the frequency of low back pain among ballet dancers has increased from 8% to 23% in recent years [1]. According to Hungarian research, one of the most common complaints is low back pain, which more typically occurs in adulthood, but affects professional dancers early during their dance studies [2]. These complaints, injuries can mean the end of a dancer's career, especially in case of professional dancers. The possible causes of

low back pain occurring among dancers include: repeated hyperextension, intensive lordotic position while dancing, the lack of lumbar motor control ability, or intensive rotational movement, landing after jumps, lifting moves [3]. In the majority of the cases the pain is caused by the degenerative deformities of intervertebral discs, and the decreasing of the intervertebral gap, and dislocations in smaller joints [4,5].

As a result of the core prevention exercise programme, the intensity of low back pain and the frequency of injuries decreases, balance improves the relative strength of the limb increases [6].

The aim of the study was to examine the intensity of low back pain in case of dancers, the habitual posture and whether the posture was deemed correct, the lumbar motor control ability and the strength of core muscles. In addition, our aims included the

[☆] The present scientific contribution is dedicated to the 650th anniversary of the foundation of the University of Pécs, Hungary.

* Corresponding author.

E-mail address: viktoria.bobaly@gmail.com (K. Bobály Viktória).

creation of a core prevention training programme and the examination of its efficiency.

Our hypotheses assumed that in case of dancers aged 9–18:

- Low back pain occurs during and also after training.
- The habitual posture of dancers does not correspond to physiological posture.
- The correct posture of dancers deemed does not correspond to the physiological posture.
- The lumbar motor control ability is not sufficient.
- The static strength of core muscles is not sufficient despite the regular training.
- That following a spine prevention exercise programme, the posture, core muscle strength and lumbar motor control ability of dancers improves, and their low back pain decreases.

2. Methods

2.1. Study design and target group

This was a non-randomised longitudinal study design, using a convenience sample.

A longitudinal examination was carried out, which was not random, but was performed though sampling among the dancers, and was repeated following a three-month core prevention exercise programme.

Inclusion criteria dancers: aged between 9 and 18 years a background of minimum three years of regular ballet dancers from Relevé Dance Group and hip-hop dancers from T-Dance Group.

Exclusion criteria dancers: Those with a spinal condition that required treatment, previous spinal surgery, sports injury in the last 3 months, participation in core prevention programme in the last six months.

2.2. Number of participants

A total of 62 classical ballet and hip-hop dancers were examined during the course of the research. The number of the participants in the classical ballet group was 30, average age: 12.7 ± 2.2 (9–18) years. The ballet dancers had been dancing for an average of 4.5 ± 2.51 years, with 3 ± 1.06 trainings per week, where the length of the training is an average of 96 ± 12.2 min, and have an average of 1.3 ± 1.7 (pcs), 35.1 ± 26.1 min performances per month. The number of the participants in the hip-hop group was 32, average age: 13.7 ± 2.9 years. They had been dancing for an average of 5.0 ± 3.1 years, with 2.4 ± 0.6 (pcs), 115.7 ± 45.3 min training per week, complemented by an average of 1.7 ± 0.7 (pcs), 44.8 ± 27.8 min long performances per month.

The examinations were carried out at University of Pécs, Faculty of Health Sciences, Institute of Physiotherapy and Sport Sciences (7623 Pécs, 4 Rét Street.), between the 1st of November 2015 and the 1st of April 2016.

2.3. Examination methodology

Research Ethics approval for the study, issued by the Regional and Local Research Ethics Committee of the Clinical Centre of the University of Pécs (number: 6143).

2.4. The examination of low back pain

The intensity of low back pain was examined with 0–100 visual analogue scales. 0 meant no pain, 100 meant unbearable intensity of pain. Subjects were asked about their low back pain occurring

during, (VAS1) experienced while (VAS2) and after training (VAS3) [7].

2.5. The examination of habitual posture

Three photographs were taken of each examined subject, one front view, and two side-view pictures. It was important that the participants were barefoot, wearing tight-fitting clothes, and in case of girls with long hair, it was required that the hair should not cover the neck and the shoulders. The photographs were taken in front of a symmetry grid surface attached to the wall, from the distance of 2 m, with NIKON COOLPIX L21 camera (focal length = 6,72 mm, flash: Flash fired, sensitivity: ISO 200, normal exposure function, F-number: 3,1). The height of the symmetry grid surface was 2 m, width was 1 m, the grid size was: $6,5 \times 6,5$ cm.

The examination of habitual posture: In this examination we asked the dancers to stand normally.

The parameters determining the posture were defined through scoring. If in the frontal plane the line of the shoulders and of the pelvis were parallel, 2 points, if they were not symmetrical, 1 point was given. If the frontal plane median intersected the line of the nose and navel, and reaches the ground in the middle between the two feet, then 2 points were given for physiological frontal median, if the median did not intersect these points – non-physiological median – 1 point was given. In the sagittal plane, if the bends of the spine were of physiological size, 3 points were awarded, if non-physiological, 2 points were given. In the sagittal plane, the median should intersect the ears, the lumbar 1st and 5th vertebrae, and finally reach the ground in the line of the lateral malleolus, in case of which 2 points were given. If the median did not intersect with either of the above lines, 1 point was given [8].

2.6. The examination of the static strength of core muscles

2.6.1. Core-test

Muscle activation of the different core exercises were assessed according to the method used by Oliver et al. [9]. Subjects were asked to get into a push up position with elbows on the ground (forearm support), making sure the whole body, from top to heel, is in a straight line (plank position). It was important to ensure that the shoulders are above the elbows, the head was straight as the elongation of the spines, and the hip was neither tilted, nor lifted too high, so that the lumbar lordosis was not increased. After fixing the exact position time – the length of time subjects could hold the position – was measured by a stopwatch (max 120 s). The test was over when the subject could no longer sustain the position and the lumbar region control was lost. In every case the actual second was recorded, then evaluated based on a core test table (Table 1).

2.7. The examination of lumbar motor control ability

2.7.1. Leg lowering test

The test was performed with the help of the Stabilizer Pressure Bio-Feedback (Chattanooga 92101DDJO) tool [10]. During the test, dancers were asked to lie on their back on the floor so that the cushion of the instrument was positioned under their waist, pull their feet to the ground, and hold their arms straight beside the

Table 1
Evaluation of the Core-test.

Seconds	Level
>120 s	excellent
75–120 s	good
45–75 s	average
<45 s	poor

Table 2

The results of the examination for low back pain.

Examined parameters	Ballet (n = 30)			Hip-hop (n = 30)		
	Average	Deviation	p-value	Average	Deviation	p-value
Pre VAS1	9,0	18,2	0,004	8,0	10,9	0,002
Post VAS1	1,3	3,3		2,8	8,7	
Pre VAS2	7,6	14,0	0,011	5,8	10,6	0,001
Post VAS2	2,3	5,5		2,8	7,2	
Pre VAS3	10,1	16,8	0,005	16,2	14,9	0,000
Post VAS3	2,1	4,1		6,4	12,6	

VAS1: the intensity of low back pain occurring during training, VAS2: the level influence of low back pain on performance during training, VAS3: the frequency of low back pain occurring after training, Pre: examination before the exercise programme, Post: examination after the exercise programme.

body. After the correct posture was reached, we started to pump up the cushion to 40 Hg mm, and then the subjects were asked to press down the cushion with the help of their abdominal muscles to 45 Hg mm, then they were instructed to bend and pull their right and then their left knees to their chest, while try to keep the equipment at 45 Hg mm. With the help of the tool the minimum and maximum value of the displacement at 45 Hg mm was recorded in case of both legs. Based on the literature 5 Hg mm difference from the 45 Hg mm was considered to be an appropriate lumbar motor skill, the higher the difference meaning the more inappropriate were the lumbar motor skills.

In the examination two measurements were performed for each of the dancers. The first measurement (Pre) was a survey of the condition of core muscles, with the aim of exploring the differences between the representatives of the different dance styles. Following the examination of the condition of core muscles, a three-month dance-specific exercise programme was applied both to the ballet group and the hip-hop group. The measurements were repeated following the intervention (Post) with the aim of comparing the results with those received before the programme to explore whether improvements could be observed in the examined parameters. The ballet group (n=30) and the hip-hop group (n=32) participated in the spine prevention exercise programme.

2.8. The applied exercise programme

We developed a three-month spine prevention programme, with the aim of preventing the occurrence of low back pain in dancers. The programme was created in accordance with international principles (adjusting posture, motor control exercises, stabilization therapy, progressive preliminary training) and with the special needs of the dancers [11–13]. The programme consists of three units:

1st–2nd months: raising awareness to and automatizing the correct posture, core muscle strengthening and stretching exercises to facilitate sufficient muscle balance, exercises to improve lumbar motor control ability.

The 3rd month: the muscle balance and lumbar motor control exercises include dance-specific exercise material [14].

2.9. Statistical methods

SPSS 20.0. was used for the statistical evaluation, and the average value and standard deviation was calculated, and paired-sample *t*-test, normality test and Wilcoxon test were also performed. Throughout the test we examined whether there was a significant difference between the representatives of the two dance styles concerning the parameters determining the core muscle conditions of the examined groups, and whether significant improvement could be observed concerning the examined

parameters following the three-month intervention. The value of significance was determined at the value of $p < 0,05$.

3. Results

3.1. The results of the examination of low back pain

The intensity of low back pain occurring during training dropped from the value of 9,0 to 1,3 in case of ballet dancers, and among hip-hop dancers it decreased from 8 to 2,8, thus the condition improved significantly ($p = 0,004$, $p = 0,002$). The occurrence of low back pain influences performance during training, but the negative effect of low back pain on training decreased significantly ($P = 0,011$, $P = 0,001$). The intensity of pain occurring after training also decreased significantly after the exercise programme ($p = 0,005$, $p = 0,000$) (Table 2).

3.2. The examination of habitual posture

In the postural analysis grid chart procedure in case of examining the habitual posture from the frontal view, improvements were observed in the case of 34.8% for the ballet dancers and 29.2% for the hip-hop dancers, as a result of which their posture could be deemed symmetrical in frontal view. However, no changes occurred after the three-month intervention in case of 65.2% of the ballet dancers and 70.8% of the hip-hop dancers. With regard to the habitual lateral posture, improvement could be observed concerning the physiological posture in case of 52.2% of the ballet dancers and 37.5% of hip-hop dancers. The posture of 47.8% of the ballet dancers and 62.5% of the hip-hop dancers remained unchanged (Table 3).

3.3. Static strength of core muscles

3.3.1. Core test

During the course of the examinations of core muscle strength, in the case of both ballet dancers ($p < 0,001$) and hip-hop dancers

Table 3

The results of the postural analysis grid chart examination of habitual posture.

Examined parameters		Ballet (%) (n = 30)	Hip-hop (%) (n = 30)
Post Habitual posture in frontal plane			
1	unchanged	65,2	70,8
2	improved	34,8	29,2
Post Habitual posture in sagittal plane			
1	unchanged	47,8	62,5
2	improved	52,2	37,5

Post: examination following the exercise programme.

Table 4

The results of the Core-test following the exercise programme.

Examined parameters	Ballet (n = 30)			Hip-hop (n = 30)		
	Average	Distribution	p-value	Average	Distribution	p-value
Pre Core-test (s)	58.9	30.5	0,000	67.6	32.5	0,015
Post Core-test (s)	88.7	21.3		83.7	25.7	

Pre: prior to the exercise programme, Post: after the exercise programme.

($p = 0,015$) significant improvement was experienced following the core prevention exercise programme. Prior to the three-month prevention programme the ballet dancers could hold the plank position for an average length of 58.9 s, on the basis of which they were ranked in the “average” category, however, after the programme, the group could hold the plank position for an average of 88.7 s, which, in accordance with the evaluation table, ranks in the “good” category. Before the intervention the hip-hop group could hold the requested position for an average of 67.6 s, which also ranked them in the “average” category, however, this result increased to 83.7 s following the programme, on the basis of which they were also ranked in the “good” category (Table 4).

3.3.2. Lumbar motor control ability, leg lowering test results

In case of the leg lowering test for lumbar motor control, both the ballet group ($p < 0,001$), and the hip-hop group ($p < 0,001$) showed significant improvement concerning both legs. With regard to the right leg, both groups were within the range of the acceptable 5 Hg mm difference, which numerically meant 3.8 ± 0.4 Hg mm in case of ballet dancers, and 3.9 ± 1.0 Hg mm in case of hip-hop dancers. Compared to the pre-intervention values, the ballet group showed a larger improvement, as in that case the average values of the group exceeded the acceptable 5 Hg mm difference, the value of the difference being 5.3 ± 0.3 Hg mm, while in case of the hip-hop dancers the value of the difference was 4.0 ± 1.3 Hg mm. Concerning the left leg, the received results also showed that examination results of both the hip-hop and the ballet group fell within the acceptable range. The average difference in case of ballet dancers was 4.7 ± 0.3 Hg mm before the programme, and it was 4.2 ± 0.3 Hg mm following the exercise programme, in case of the hip-hop dancers the value prior to the programme was 4.5 ± 1.7 Hg mm, and following the programme it was 4.3 ± 1.5 Hg mm. On the basis of the above, it can be said that the lumbar motor control ability improved in case of both legs in accordance with the results of the leg lowering test (Table 5).

4. Discussion

4.1. Low back pain

With the help of the examination carried out using the visual analogue scales (VAS), complaints related to low back pain occurring among dancers at a relatively young age could affect the dancers' performance during training and rehearsals, and also

occurs during and after training. Quinlan and colleagues have examined 13-year-old female dancers, who developed spinous process apophysis due to hyperextension, which causes low back pain among dancers as early as in adolescence [15]. Hagins and colleagues carried out a questionnaire survey using the Oswestry Disability Index which determines low back pain. They retrospectively examined 37 professional female dancers, over a 5 year period, studying the occurrence of complaints and injuries which led to the loss of function in the spine and to the degenerative deviations of the T12-L1 spine sections. Each of the dancers reported that 5 months passed before the full functionality of the injured musculoskeletal segment recovered and the pain ceased completely. During the examinations, the dancers carried out spine stabilizer exercise programme, after which the initially measured 48% probability of injury dropped to 26% [16].

4.2. Habitual posture

Using the postural analysis grid chart examination of the habitual posture, in case of both examined groups a high percentage of intensive lumbar lordosis was observed. The increased bending occurred in the highest percentage in case of ballet dancers. The literature also reports the same facts. Lúnes and colleagues carried out an examination with fifty-two 24-year-old female ballet dancers using photogrammetry, to determine lumbar lordosis. The dancers were compared with a control group consisting of 59 non-dancers of similar age. The measurements continued over a 3 year period, and their aim was to examine the changes in lumbar lordosis. The results showed that in case of ballet dancers the frequency of intensive lumbar lordosis increased significantly over time [17].

4.3. The static strength of core muscles

With the help of the core-test, we were able to obtain information concerning the scale of the strength of the core muscles, which, on the basis of the received results could generally be considered good in the case of both examined groups. In the literature similar examinations among dancers can be found by studying the endurance of core muscles with similar, sideways plank test. The results of these examinations also showed that the endurance of the core muscles of dancers is insufficient. In the case of sideways plank tests significant differences can often be

Table 5

The comparison of the results of the leg lowering test before and after the exercise programme.

Examined parameters	Ballet (n = 30)			Hip-hop (n = 30)		
	Average	Distribution	p-value	Average	Distribution	p-value
Pre leglow. Right	5.3	0.3	0,000	4.0	1.3	0,000
post leglow. Right	3.7	0.3		3.9	1.0	
Pre leglow. Left	4.7	0.4	0,000	4.5	1.7	0,000
post leglow. Left	4.2	0.3		4.3	1.5	

Pre: prior to the exercise programme, Post: following the exercise programme.

observed between the two sides, but this is a natural phenomenon which is experienced by everyone [18].

4.4. Lumbar motor control ability

In view of the results of the leg lowering test, the lumbar motor control ability was insufficient for either of the examined groups. In the literature, similar examinations have been carried out among athletes also indicate the necessity of improving the lumbar motor control ability, and similar studies have been performed among dancers with the same aim [16]. Roussel and colleagues have performed a similar examination among dancers with the aim of comparing the lumbar motor control ability, the extensibility of muscles, and the occurrence of sacroiliacalis (pain occurring in the joints) in the case of dancers suffering from and those not suffering from low back pain. The results indicated that those dancers whose case history already included low back pain, had significantly weaker lumbar motor control than those who did not suffer from low back pain [19].

4.5. The limitations of the study

Limitations of the study includes the small sample size, the absence of control group and the method of sampling.

5. Conclusion

As a result of regular training, the posture, lumbar motor control ability, static core muscle strength is not sufficient and need improving. These factors are in fact the risk factors of the occurrence of low back pain. With core prevention exercise programme, the risk factors for low back pain, the frequency of spinal injuries, and the intensity of low back pain can be reduced. Such core prevention exercise programmes exist among athletes and the representatives of other professions, and the application is frequently used [20–23]. However, dancers need special core prevention exercise programmes due to the specific movement material of the different dance styles and such interventions should be implemented [24–26].

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