

**UNIVERSITY OF PÉCS,
FACULTY OF HEALTH SCIENCES
DOCTORATE SCHOOL**

Head of Doctoral School: Prof. Dr. József Bódis

Programme Manager: Dr. habil. Erzsébet Rétsági, Dr. habil. Pongrác Ács

Supervisor: Dr. Melinda Járomi

**The survey of conditions of the trunk and the application of core prevention
exercise program among dancers**

Thesis for the doctor's degree

(Ph.D)

Viktória Bobály Kovácsné

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Introduction

According to Hungarian research, one of the most common complaints is low back pain, which more 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, and the decreasing of the intervertebral gap, and dislocations in smaller joints. Low back pain is frequently caused by rotational movements, spins, landing after jumps, lifting moves. (Cupisti 2004) International publications reveal that dancers frequently suffer from low back pain. The main cause thereof is that the different dance styles often require extreme lumbar extension or permanent, intensive lumbar lordosis position from the dancers. Due to these moves neuromuscular alterations occur in the affected areas which can lead to frequent sensation of pain. In addition, they have a negative effect on habitual posture due to the ingrained lordotic position. In more recent research we can encounter aspirations directly aimed at the restoration of these deformities among dancers. (Smith 2009) Dancers, just like gymnasts and ice-skaters, perform core extension moves more than other athletes. Twisted positions and moves involve the limits of extension movement range which constitute an essential part of the aesthetics of the dance. The most common example thereof is the move of leaning back or *cambré*. In addition to different moves, hip extension is also present, such as the arabesque, and these increase the number of moves performed at the ends of unilateral lumbar extension and hip extension movement ranges. If the emphasizing leg twists outward, like in the case of the arabesque or the attitude, a rotational movement can be observed in the pelvis and spine on the side of the „working” leg. (Masci 2006, Rajnics 2002, Bolin 2001)

Thus, injuries of the lower section of the spine are quite frequent among dancers. These changes can influence the career of professional dancers in a negative way. (Mády 1998, Gupta 2004)

Thus, the application of different complementary, preventive exercises in the area of dance can be highly significant in terms of avoiding various injuries. The use of these exercises is already an established method in case of notable foreign companies, however, in Hungary it is in its infancy. In Hungary, those skill development exercises which specifically prepare the movement system especially for dancing are only present, integrated in the curriculum, as part of dance education from lower years at the Hungarian Dance Academy, and these are mainly strengthening and pilates-style exercises. In addition, a similar, complementary exercise program (pilates) is also applied by the Hungarian National Ballet company with preventive purposes, but this only involved adult, professional dancers. In the case of younger dancers who have yet to begin their dance career, no such complementary exercise forms are applied incorporated in the curriculum neither at elementary institutions of performance art education, nor at secondary schools of performing art, saying there is „no time” for these exercises, and besides, the ballet masters are not prepared for instructing their students to perform these exercises. While the movement material of dance education is built in a way to load the body gradually, complemented by knowledge of other dance genres (acrobatics, folk dance, ballroom dance, lifting, tiptoe technique), it still does not protect prospective dancers from the dangers of injuries resulting from the extreme movement material. Thus, it would be practical

to incorporate the preventive, complementary exercises into the curriculum from as young age as possible.

Examination aims

The aim was to examine the intensity of low back pain during performance and training in the case of the dancers of different dance styles, and the extent to which it negatively affects their performance on stage and during training.

We wished to survey the habitual posture of dancers and the posture they consider correct, in addition of the intensity of low back pain and the functional condition of the spine.

We also wished to examine the lumbar motor control ability,

To examine the strength and extensibility of core muscles necessary for correct posture,

We aimed at the creation of a core prevention exercise programme which helps to reduce low back pain, to ameliorate the posture of dancers and their lumbar motor ability, the strength and extensibility of core muscles.

We wished to survey the efficiency of the spine prevention exercise programme in terms of low back pain, muscle strength and extensibility.

Hypotheses

H1: It is assumed that in case of dancers aged 9-18 low back pain has a negative effect on their performance during training.

H2: It is assumed that in case of dancers aged 9-18, low back pain occurs during and also after training.

H3: It is assumed that in case of dancers aged 9-18 low back pain has a negative effect on their performance on stage.

H4: It is assumed that in case of dancers aged 9-18 low back pain occurs during and after stage performances.

H5: It is assumed that a certain extent of loss of function can be detected in the condition of the spine at the age of 9-18.

H6: It is assumed that the habitual posture of dancers does not correspond to the biomechanically appropriate posture.

H7: It is assumed that the posture of dancers deemed correct does not correspond to the biomechanically appropriate posture.

H8: It is assumed that in case of the age group of 9-18 year-olds, the lumbar motor control ability is not sufficient.

H9: It is assumed that in case of the age group of 9-18 year-olds the strength and extensibility of core muscles is not sufficient

H10: It is assumed that following a spine prevention exercise programme, low back pain occurring during training and performance decreases, the posture, lumbar motor control ability and the strength and extensibility of core muscles of dancers improves.

Examination sample and methods

Examination sample

We performed controlled, longitudinal, not randomized examination with convenience sampling, which was performed on the examined dancers again following a three-month therapy.

We examined 92 female dancers, and we were able to perform back tests on 62 persons after the three-month exercise programme. The complete sample included the representatives of 3 dance styles ($n=92$, average age: $14,15 \pm 2,95$ (9-18) years). It was characteristic of the complete sample that despite their young age, the examined dancers have been dancing for an average of $5,22 \pm 2,97$, with an average of $3,02 \pm 1,02$ training sessions per week, which last for an average of $100 \pm 28,08$ minutes. In addition to the regular weekly training, the dancers have an average number of $1,49 \pm 1,27$ (pcs) of $34,21 \pm 26,28$ minutes long performances.

Selection criteria:

Aged between 9-18 a background of minimum three years of regular dance at a given company or school.

Exclusion criteria:

A spine condition that requires treatment, spine surgery, sports injury in the last 3 months, participation in core prevention programme in the last six months.

Examination methodology

The examination of low back pain

The intensity and strength of low back pain was examined with visual analogue scales. The participants had to mark the intensity of low back pain in accordance with their own judgement, on a 100-grade scale from 0-100% in respect to the extent to which low back pain influences their performance during training and on stage (VAS1: to what extent does the low back pain influence performance during training, VAS4: to what extent does the low back pain influence performance on stage), and also in respect to the intensity of pain during training and during performance on stage (VAS2: the intensity of low back pain during training, VAS5: the intensity of low back pain during stage performance), and also after training and stage performances (VAS3: the intensity of pain after trainings, VAS6: the intensity of pain after stage performances). 0% meant that pain does not have any influence in these respects, 100% meant that it fully influenced them. (Ogona 1996) The visual analogue scales concerning pain are also frequently used among young dancers. (Nowacki 2013)

The functional condition of the spine

The functional condition of the spine was examined with the help of a Roland-Morris questionnaire. The questionnaire contains 24 statements concerning the relationship between

pain and the ability to perform everyday activities. The respondents only have to mark the square next to each statement if they deem the given sentence true for their state on the given day. Thus, the result of the questionnaire is a score received on a scale between 0-24, which is directly proportional with the extent of the decrease in functionality. (Stratford 1996, Davidson 2002)

The examination of posture (photogrammetry test)

The photogrammetric examination of posture is a frequent method for analysing the posture in case of every age group. Three photographs were taken of each examined subject, one front view, and two side-view pictures. Concerning the attire of the subjects when the photographs were taken, it was important that they were barefoot, possibly 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 2m, with NIKON COOLPIX L21 camera (focal length= 6,72mm, flash: Flash fired, sensitivity: ISO 200, normal exposure function, F-number: 3,1). The height of the symmetry grid surface was 2m, width was 1m, the grid size was: 6,5x6,5 cm. In the examination of the habitual posture, the dancers were asked to stand as they normally do. In case of the posture „deemed correct” the examined persons were asked to stand in a position that they considered appropriate. The parameters determining the posture were defined through scoring. If in the frontal plane the line of the shoulders and of the pelvis are parallel, 2 points, if they are not symmetrical, 1 point was given. If in the frontal plane the weight line intersects 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 weight line, if the weight line did not intersect these points – non-physiological weight line- 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 weight line 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 weight line did not intersect with either of the above lines, 1 point was given. (Smith 2009, Iunes 2016, Lehmann 2000)

Examination of lumbar motor control

Sitting Forward Lean Test:

In order to perform the test, the examined person sits on the treatment bed so that the popliteal space should touch the edge of the bed. The hips and knees are in a 90-degree flexion position, the lumbar section and the spine are in neutral position. We assist the participants to sit in the correct posture. 10cm is measured up along the median of the spine, from the upper endplate of vertebrae sacrum I, and mark the endpoint of the measured distance. After marking the distance, we ordered the participants to pull their right, then their left leg towards their chest, then pull their arms backward while stretching it straight above their heads, then bend forward three times with a straight back. After performing the exercises the participants were asked again to take exactly the same sitting position as before, then the distance between the two marks were measured with a tape-measure and the result was recorded in mm. After the evaluation, we took the difference between the two values into consideration and recorded

it in mm. With regard to the received values, they were considered normal, if the value after performing the exercises was also 10cm, 3mm deviation from that value in either direction (from 10,4cm and 9,6cm) already signifies inappropriate lumbar motor control ability. (Enoch 2011) The use of the test can also be observed among youth. (Khale 2009)

Leg lowering Test:

The test was performed with the help of the Stabilizer Pressure Bio-Feedback (Chattanooga 92101DDJO) device. 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, and to place their feet to the ground, and hold their arms straight beside the body. After the correct posture was reached, we started to pump up the cushion until 40 Hgmm, and then we asked the participants to press down the cushion with the help of their abdominal muscles until 45 Hgmm, then they were instructed to bend and pull their right and then their left knees to their chest, while trying to keep the meter of the device at 45 Hg mm. With the help of the device the minimum and maximum value of the deviation from 45 Hgmm was recorded in in case of both legs. Based on the literature, 5 Hgmm difference from the 45Hgmm was considered to be appropriate lumbar motor skill, the higher difference means inappropriate lumbar motor skills. (Cynn 2006)

The Examination of the strength and extensibility of core muscles

Kempf test:

The test system created by Hans-Dieter Kempf is perfectly suitable for the examination of the strength and extensibility of the core muscles, and is regularly used in Europe for preventive, rehabilitation and occupational health care purpose among athletes, patients and ordinary persons. The literature is mainly in German language, but is available in the forms of translations in several European languages. (Kemf 2016, Kempf 2013, Kemf 2011, Kempf 2006)

The test, which consists of eight exercises, serves the purposes of measuring the strength and extensibility of core muscles. (Kempf 2008, Lonn 1999)

Exercises aimed at measuring muscle strength: Thigh extension muscle group (exercise 1), abdominal muscle (exercise 2) core and shoulder girdle muscles (exercise 3), muscles of the arms, shoulders and chest (exercise 4), gluteal muscles (exercise 8).

Exercises aimed at measuring the extensibility of muscles: thigh flexors (exercise 5), hip flexors (exercise 6), chest muscles (exercise 7). (table 1)

Kraus-Weber test:

The test consisted of six exercises, 0-10 points could be received for each exercise, each of which was marked separately, and was also evaluated on the basis of the total number of points (0-60). The maximum total was 60 points, in case of a value between 50-60 points the condition of the core muscles was considered good, in case of values between 0-40 points it was considered weak. (Ángyán 1995, Babalola 2008)

Core-test:

Participants 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. It was important to ensure that the shoulders were above the elbows, the head was straight as the elongation of the spines, and the hip is neither tilted, nor lifted too high, so that the lumbar lordosis was not increased. After fixing the exact position time – how long the participants could hold the position—was measured by a stopwatch (max120 s). The test was over when the subject gave it up, or the lumbar region control was lost. In every case the actual number of seconds was recorded. The received values were thereafter analysed with the help of an evaluation table. (Oliver 2010) The use of various plank tests with similar evaluation parameters is frequent in the case of youth as well. (Boyer 2013, Imai 2016)

The applied exercise programme:

We developed a three-month spine prevention programme, whose aim is the primary and secondary prevention of low back pain in case of dancers. The programme was created in accordance with international principles (stabilization therapy, progressive preliminary training) and with the special needs of the dancers. (Norris 1995, Norris 2000, Norris 2008). The material of the spine prevention exercise programme has been registered in the voluntary registration of works by the Hungarian Intellectual Property Office as „own scientific work”.

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.

3rd month: it contains dance-specific muscle balance and lumbar motor control exercises. (Kovácsné, Járomi 2015)

The method of statistical analysis:

The SPSS 20.0. programme was used for the statistical evaluation, and the average value and standard deviation was calculated, and Chi square test, normality test, paired-sample t-test, Kuskal-Wallis test, Mann-Whitney test and Wilcoxon test were also performed. Through the tests, we examined whether there is a significant difference prior to applying the exercise programme between the representatives of the examination groups of the three dance styles

concerning the parameters determining the core muscle conditions of the examined groups, and that whether significant improvement can be observed concerning the examined parameters following the three-month intervention. The value of significance was determined at the value of $p < 0,05$.

Results:

Two measurements were performed among the dancers during the examination. The first measurement (week 1) was a survey of the condition of core muscles, with the aim of examining the differences between the representatives of the different dance styles. Following the survey of the condition of core muscles, the three-month dance-specific exercise programme was applied at the hip-hop group. After the intervention, the measurements were performed again (week 12) with the aim of observing whether any improvements occurred in the examined parameters compared to the values measured before the exercise programme. The ballet ($n=30$) and the hip-hop ($n=32$) group participated in the spine prevention exercise programme, the ballroom dance group did not wish to participate due to lack of time.

Low back pain:

The results received before the exercise programme indicated that out of the representatives of the three dance styles, low back pain during training, being significant for their performance, occurred significantly more frequently ($p < 0,019$) in the case of ballroom dancers (week 1 VAS1) than in the case of the two other groups (7,67% of ballet dancers, 5,89% of hip-hop dancers, and 19,06% of ballroom dancers reported existing low back pain). With regard to low back pain occurring during training (week 1 VAS2) there was no significant difference ($p = 0,206$) between the examined groups, but the highest percentage (12,81%) of the ballroom dancers reported low back pain occurring during trainings. Meanwhile, only 9% of the ballet dancers and 8,04% of the hip-hop group reported existing complaints. There was no significant ($p = 0,079$) difference between the three groups concerning low back pain occurring after trainings either (week 1 VAS3), however, among them the hip-hop dancers reported the existence of low back pain after training in the highest proportion (16,25%), while it occurred in the case of only 10,17% of the ballet dancers and 10,63% of the ballroom dancers.

No significant difference was observed in the case of low back pain influencing performance on stage either (week 1 VAS4), but the members of the hip-hop group reported existing pain in the highest proportion (10,54%). They were followed by the ballroom dancers with 10%, and 3% of ballet dancers reported an intensity of pain that had a negative effect on their performance on stage. Concerning low back pain occurring during performances on stage (week 1 VAS5), a significantly ($p = 0,045$) higher percentage (7,5%) of the members of the hip-hop group gave a positive reply compared to the other two examined groups. As regards to low back pain occurring after stage shows (week 1 VAS6), no significant ($p = 0,312$) difference was experienced, but again, the hip-hop group reported the existence of pain in the highest proportion (11,25%).

After completing the 3-month spine prevention programme, the performance during trainings (week 12 VAS1) significantly improved concerning both the ballet dancer ($p=0,004$) and hip-hop ($p=0,002$) groups. However, from the two groups the hip-hop group reported a larger scale of decrease in performance due to the pain, and the scale thereof decreased by 6,5% in the hip hop group, and by 7,7% in the ballet group after the exercise programme. Also, a significant improvement was observed concerning the pain occurring during trainings (week 12 VAS2) both in the ballet dancer ($p=0,011$), and hip-hop group ($p<0,001$). The extent of pain was higher in case of the hip-hop group for this parameter as well, however, a decrease in its intensity could be observed, which meant an improvement of 5,21% in case of ballet dancers and 3,09% in case of hip-hop dancers. As for pain occurring after training (week 12 VAS3), also significant improvement occurred both among ballet dancers ($p=0,005$) and hip-hop dancers ($p<0,001$). The extent of improvement was the highest concerning the hip-hop group in case of this parameter, as among the values measured before the exercise programme they reported the existence of pain in highest percentage in this examined aspect, which, compared to the value measure after the exercise programme, showed an improvement by 9,58%. The extent of the improvement in the case of the ballet dancers was 0,83%.

Regarding performance on stage (week 12 VAS4) again, significant improvement could be observed compared to the results measured before the programme in the case of both examined groups, which, in numbers, was $p=0,016$ in case of ballet dancers (2,35%) and $p=0,003$ in case of hip-hop dancers (8,94%). With regards to pain occurring on stage (week 12 VAS5), no significant improvement was observed in the case of the ballet dancer group ($p=0,059$), while again, significant improvement was experienced in the hip-hop group ($p=0,003$). The scale of the improvement was also higher in the case of the hip-hop group again, being 4,7%, while it meant an improvement of 1,46% in the case of the ballet group. In the case of low back pain present after stage performances (week 12 VAS6) again, significant improvement was observed both in the ballet ($p=0,018$), and the hip-hop group ($p<0,001$). With regard to the scale of improvement, in this case again the hip-hop dancers showed a higher scale improvement of 7,25%, but the results of the ballet dancer group also improved by 6,35% compared to the results measured before the intervention.

The functional condition of the spine

On the basis of the Roland-Morris questionnaire, there was a significant difference ($p=0,011$) among the three groups concerning the functional condition of the spine. The received results show that in the case of 56,7% of the ballet dancers the low back pain is an influencing factor concerning everyday activities. They were followed by hip-hop dancers with 32,1%, while the occurrence of low back pain meant an obstacle in everyday life to the lowest extent in case of ballroom dancers, in 18,8%. With regard to the complete sample, the received results showed that in case of 35,6% of the 92 dancers the low back pain meant an obstacle in everyday life.

Following the three-month exercise programme, on the basis of the Roland-Morris questionnaire, significant improvement could be experienced in the case of both examined groups after the three-month intervention, which, expressed in numbers is the following: $p=0,002$ in the case of the ballet dancers (28,1%), and $p=0,011$ in case of the hip-hop dancers

(15,4%). Comparing the two examined groups, while the scores of the hip-hop dancers were higher concerning the occurrence of low back pain when performing everyday activities than those of ballet dancers, the frequency of the occurrence of low back pain significantly decreased in case of both groups after completing the spine prevention programme.

Examination of posture:

In the course of the photogrammetry test (week 1) when examining the habitual posture in front view, no significant differences ($p=0,275$) were found among the groups. Among the examined groups, 50% of the hip-hop group, 68,8% of the ballroom dance group, and 66,7% of the ballet group showed an asymmetric posture. Also, no significant difference was found in case of the lateral habitual posture ($p=0,476$). Concerning lumbar lordosis, only 35,7% of the hip-hop group, 43,3% of the ballet dancers and 56,3% of the ballroom dancers exhibited a physiological bend. A case of increased lumbar lordosis was observed in 32,1% of the hip-hop dancers, 33,3% of the ballet dancers and 28,1% of the ballroom dancers. The posture deemed correct (week 1) in frontal view was correct, symmetric in case of 46,4% of the hip-hop group, 73,3% of the ballet group and 75% of the ballroom dance group. The posture deemed correct in frontal view was significantly worse ($p=0,038$) in case of the hip-hop group than the other two groups. It is important to mention that this value is 4,6% lower in the case of the hip-hop group than the value measured concerning the habitual posture, which means that the posture deemed correct is worse (less physiological) than the habitual one, while the same value improved by 6,2% in the case of the ballroom dancers and 6,6% in the case of the ballet dancers. The posture deemed correct in lateral view changed in a non-physiological direction in the case of the ballet dancers and ballroom dancers, while it remained unchanged in the case of the hip-hop dancers. There was no significant difference between the groups. ($p=0,224$).

Following the 3-month exercise programme (week 12) in case of the front-view examination of the habitual posture improvement was experienced in the case of 34,78% of the ballet dancers, and 29,17% of the hip-hop dancers, as a result of which the posture could be considered symmetrical in front view. With regards to the habitual lateral posture, improvement in the physiological posture could be observed in the case of 52,17% of the ballet dancers, and 47,50% of the hip-hop dancers. Concerning the frontal-view examination of the posture deemed correct (week 12) improvement was experienced in the symmetry of the posture in the case of 26,09% of the ballet dancers and 33,33% of the hip-hop dancers.

Lumbar motor control ability

Sitting forward lean test:

No significant difference ($p=0,298$) was detected between the examined groups on the basis of the received results. The smallest deviation from the 10cm was detected in the case of the ballroom dancers among the three groups, and in their case the average value of the group was $10,281\pm0,934$ cm. They were followed by the ballet dancers with $10,321\pm0,647$ cm. The largest deviation could be observed in the case of the hip-hop dancers, where the average value of the group was $10,45\pm0,586$ cm after performing the exercises. This result, however,

exceeds the upper limit of the acceptable deviation, thus in the view of the received results it can be said that the lumbar motor control ability of this group needs improving.

After the 12-week exercise programme no significant improvement was experienced either in the case of the ballet dancer group ($p=0,849$), or in the case of the hip-hop group ($p=0,197$). The smallest deviation from the 10cm was detected in the case of the ballroom dancers among the three groups, and in their case the average value of the group was $10,309\pm0,292\text{cm}$, which was the same as the values measure before the intervention. They were followed by the hip-hop dancers with $10,400\pm0,469\text{cm}$. Although this value corresponds to the upper limit value (10,4cm), it can be qualified as „good”.

Leg lowering test:

We did not find significant difference between the three groups neither in the case of the right ($p=0,639$), nor in the case of the left leg ($p=0,765$). In the case of the right leg only the values of the hip-hop group (4,03Hgmm) were inside the acceptable 5Hgmm deviation. However, the ballroom dancer and classic ballet dancer groups exceeded the acceptable value of deviation, and this value was 5,05Hgmm in the case of the ballroom dancers concerning the right leg, and 5,36Hgmm in the case of ballet dancers. The results received concerning the left leg indicated that the results of both the hip-hop and ballet dancer group remained within the acceptable limit values, as the deviation measured for the hip-hop group was 4,62Hgmm on average, and that of the ballet dancer group was 4,75Hgmm on average, thus the lumbar motor control ability of the two groups concerning the left leg can be considered good. However, the average values of the ballroom dance group also exceeded the acceptable 5Hgmm deviation in the case of the left leg, as their average deviation was 5,22Hgmm, as the lumbar motor control ability of the group needs improvement in the case of this leg as well.

After the completion of the exercise programme a significant improvement could be experienced both in case of the ballet dancer ($p<0,001$) and the hip-hop groups ($p<0,001$) concerning both legs. Concerning the right leg, both groups remained inside the acceptable 5Hgmm deviation, which meant $3,78\pm0,35\text{Hgmm}$ for ballet dancers, and $3,88\pm1,02\text{Hgmm}$ for hip-hop dancers. Concerning the left leg, the received results indicated that both the values of the hip-hop and ballet dancer groups remained within the acceptable limit value. The average deviation in the case of the ballet dancers was $4,26\pm0,28\text{Hgmm}$, and in the case of the hip-hop dancers it was $4,36\pm1,51\text{Hgmm}$. In the view of the above, it can be said that the lumbar motor control ability of both legs improved according to the leg lowering test.

The strength and extensibility of core muscles:

Kraus-Weber test:

According to the aggregated results of the Kraus-Weber test, the muscle balance of the dancers is appropriate, but among the core muscles, the abdominal muscle group completed the strength test in 75,7% and the dorsal muscle group completed them in 97,8%. In addition, in the case of the representatives of the different dance styles other differences could also be detected in the strength and extensibility of the muscle groups. On the basis of the aggregated

points no significant difference was experienced ($p=0,140$). However, in case of the individual exercises we received significant differences concerning the individual muscle groups. Following the completion of the preventive exercise programme, significant improvement was experienced in both examined groups, which meant a value of $p<0,001$ in the case of the ballet dancers, and $p<0,001$ for the hip-hop dancers. In terms of the individual exercises of the test, significant improvement was observed in both examined groups as well, in the case of the test exercises concerning the strength of abdominal muscles. No significant improvement was experienced concerning core muscle strength, due to the fact that the core muscle strength of the examined dancers already proved to be appropriate in the first survey. With regard to muscle extensibility, no significant improvement ($p=1,000$) was observed in the case of the ballet dancer group, while a significant improvement ($p=0,020$) occurred concerning the hip-hop group.

Kempf-test

In the course of the examination before the exercise programme, when comparing the three dance groups, significant differences occurred in muscle strength in the case of the strength of the thigh extension muscles (Kemp 2) ($p=0,003$), concerning the muscle strength of the core muscles and the shoulder girdle muscles (Kemp 3.) ($p=0,004$) and the muscles of the arms, shoulders and chest (Kemp 4) ($p=0,035$). In terms of muscle extensibility, the difference was significant in the extensibility of the thigh flexors (Kemp 5) both in the right ($p<0,001$) and left leg ($p=0,003$), and also in the case of the muscle extensibility of the hip flexors (Kemp 6) in the right limb ($p<0,001$).

After completing the 12-week exercise programme, significant improvement was experienced in the strength of the thigh extension muscles (Kemp 2) both in the case of the muscle strength of the ballet dancers ($p=0,003$) and the hip-hop dancers ($p=0,005$), and concerning the strength of the muscles of the arms, shoulders and chest (Kemp 4), the strength also improved in the case of both groups (ballet: $p<0,001$, hip-hop: $p<0,001$), besides, the muscle strength of the gluteal muscles also improved in the case of the hip-hop group, in the right ($p=0,046$), and left limb ($p=0,046$) as well. In the course of the examination of muscle extensibility, significant improvement was detected in the extensibility of the thigh extension muscles in the hip-hop group in the case of both the right ($p=0,002$), and left leg ($p=0,002$), and concerning the same limb, the muscle extensibility also improved significantly in the case of the ballet dancer group ($p=0,014$). Further significant improvements were found when examining the muscle extensibility of the right hip flexors (Kemp 6) in the case of the hip-hop group ($p=0,002$). With respect to the left leg, significant improvement was measured in both examined groups, which was $p=0,014$ for ballet dancers, and $p=0,021$ for the hip-hop group. With respect to the extensibility of chest muscles (Kemp 7) significant improvement was measured in the case of both examined groups concerning both the right and left limb. With regard to the right limb the scale of improvement for the ballet dancers was $p<0,001$ and it was $p=0,004$ for hip-hop dancers. The left limb also showed significant improvement both in case of the ballet dancer group ($p<0,001$) and the hip-hop group ($p=0,002$).

Core-test:

When examining the core muscle strength, significant differences were detected among the three dancer groups ($p < 0,001$). The ballroom dance group had the best results, as they were able to hold the plank position for an average of 97,38s, they were followed by the hip-hop dancers with 77,56s, which can be considered „good” in accordance with the evaluation of the test. The ballet dancers were able to hold the requested position for an average of 58,8s, which, in accordance with the evaluation of the test, fell into the „average” category. After the 12-week exercise programme, significant improvement was experienced in the case of the ballet dancers ($p < 0,001$), while in the case of the hip-hop dancers, the scale improvement was not significant ($p = 0,155$). Following the three-month prevention programme the ballet dancers were able to hold the plank position for an average of 88,69s, which, in accordance with the evaluation table, falls into the „good” category. If the received values are compared to the values measure prior to the completion of the exercise programme, it can be observed that the performance of the ballet dancers increased by 29,83s, while the performance of the hip-hop dancers increased only by 6,2s.

Presentation of new results

With regard to the Hungarian literature, it can be said that no results have yet been published concerning examinations performed specifically among dancers, similar to our field of examination, aimed at the survey of the condition of core muscles. When examining international literature, however, several studies can be found which report results similar to our examination.

In our study, the examination of the condition of core muscles was performed concerning different dance styles, during which special emphasis was placed on the examination of the strength and extensibility of core muscles, that is, the examination of muscle balance.

In the international literature, several examinations can be found where the posture of dancers were examined with various methods. In Hungarian literature no similar research, carried out specifically among dancers, can be found

In our research, special emphasis was placed on the examination of habitual posture and the posture „deemed correct”, which are very different in the case of the representatives of different dance styles in terms of whether the stage posture in the given dance style determines the development of habitual posture and the one „deemed correct”.

The appropriate lumbar motor control ability is a highly determining factor in the development of low back pain and different spine conditions, which is of high importance both in the performance and career of amateur, and also of professional dancers. Several examinations are documented internationally where the relationship between lumbar motor control ability and low back pain, spine injuries is researched among dancers and athletes. No similar study could be found in Hungary.

In our study, we measured the lumbar motor control ability of dancers from various dance styles with several examination methods.

There are several preventive exercise programmes, applied among dancers in international practice, which, in addition to different skills development, play an important role in the prevention of spine injuries and low back pain. However, in Hungary we have not encountered no such dance-specific exercise programmes, used either with the aims of development or prevention, exist, neither among amateur nor among professional dancers.

We have developed a three-month core prevention exercise programme, which, in addition to raising awareness to and automatizing the correct posture and improving lumbar motor control ability, also contains dance-specific exercises, which enable the development of appropriate muscle balance, as a result of which, the low back pain and spine injuries resulting from the dance-specific moves can be prevented, and the already existing complaints can be cured. Thus, the developed exercise programme can be used in the area of prevention and rehabilitation, both in the case of amateur and professional dancers, in all dance styles.

Practical application

It would be important to apply preventive exercise programmes in the case of younger dancers preparing for a professional dance career, as these improve posture and lumbar motor control ability and increase the strength and extensibility of core muscles.

The preventive exercise programme can easily be integrated in the training material of dancers, and its regular application can help prevent the development of low back and spine complaints and injuries.

It would be practical to perform a regular survey, check-up of the core conditions of young dancers every six months.

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