DE GRUYTER OPEN

Physiotherapy and Health Activity

www.ptha.eu pha@awf.katowice.pl

2015;23:16-21 ISSN: 2392-2664

DOI: 10.1515/pha-2015-0010

The effectiveness of stability training of the lumbo-pelvic-hip complex in ballroom dancers with low back pain

Received: 10-08-2015

Accepted: 11-10-2015

Published: 30-11-2015

Jacek Małecki[1], Mirosław Kokosz[2], Edward Saulicz[2], Izabela Świat-Borowczyk[1]

[1]PhD Studies, The Jerzy Kukuczka Academy of Physical Education in Katowice
[2]Department of Physiotherapy, The Jerzy Kukuczka Academy of Physical Education in Katowice
.

Abstract

Background: Low back pain is a common problem in ballroom dancers. In the United States of America about 23% of all injuries in dancers is low back pain. Low back pain in dancers can be related to the extended position of the spine during dancing. The activity of the abdominal muscles, such as transverse abdominis and multifidus muscles can play significant role in the pathomechanics of the problem. These muscles are important for stability of the pelvis and the lumbar spine. The purpose of the study was to estimate the effectiveness of stability exercises of the lumbo-pelvic-hip complex in reducing low back pain among ballroom dancers.

Material/Methods: 30 professional dancers (mean age of 19 years) both males and females participated in the research. Subjects were randomised into two groups. Dancers from the first group continued normal dance training with extra stability training (the experimental group). Participants from the second group continued normal dance training only, without any modifications (the control group). The pain rate was measured by the Numerical Pain Rating Scale. The stability muscles activity was estimated with the biofeedback pressure unit in supine and prone position.

Results: After 6 weeks of stability trainings in dancers from experimental group low back pain significantly decreased and the stability muscles activity improved ($p < 0.05$).

Conclusions: Results of the study show that stability exercises can be effective in reducing low back pain in ballroom dancers. However, prolonged observations and research comparing different training regimens (e.g. general exercises or Pilates) are needed.

Keywords: spinal disorders; competitive dancing; core stability

Word count: 2399

Tables: 6

Figures: 0

References: 30

Corresponding author

Jacek Małecki
MEDICO Rehabilitation Centre,
43-300 Bielsko-Biała, ul. Komorowicka 23, Poland
phone number: (33) 816 40 25
jmm.malecki@gmail.com

INTRODUCTION

Low back pain (LBP) is a common problem in ballroom dancers (Garrick and Requa, 1993; Solomon et al., 1999). About 23% of all injuries in dancers in the United States, is a low back pain (Smith, 2009; Beckmann-Kline et al., 2013). Due to specific body position, overload of the lower spine is more common in standard dancers than in latin dancers. Often repeated and long-lasting extension and rotation of the lower spine during trainings and competitions can produce overload of muscles, ligaments, articular capsules and spinal conjunctions (Opila et al., 1988; Panjabi, 2006; Bolin, 2001). Altered activation pattern of the deep abdominal muscles such as transversus abdominis or multifidus can enhance the problem (Holm et al., 2002; Hodges and Richardson, 1996, Roussel et al., 2013). These muscles are responsible for maintenance of the neutral zone of spinal joints, providing segmental stability of the lumbar vertebrae (Panjabi, 2003).

Low back pain in dancers can occur as a consequence of frequent and sustained asymmetrical body positions (Smith, 2009). Moreover, permanent extension and lateral bend of the spine to the left side is associated with reduction of intervertebral spaces around the spinal nerves. Appearance of pain or just fear of pain can lead to the segmental control disturbances and decreases stability of the lumbo-pelvic-hip complex (Hodges and Richardson, 1996).

Experimental research addressing low back pain in dancers is not very common (Roussel et al., 2013; Hagins, 2011). Nevertheless, findings related to the LBP in the general population may be applied to the dancer population (Hagins, 2011). One of the most effective management in nonradicular low back pain is the stabilising exercises (Fritz et al., 2007). This approach promote low-load recruitment of the deep abdominal muscles such as the transversus abdominis and the lumbar multifidus muscles (Phillips, 2005).

There is a lack of research considered the usefulness of the stability regimen among ballroom dancers with LBP. Therefore, the purpose of the study was to evaluate the effectiveness of stability exercises for the lumbo-pelvic-hip complex in reducing low back pain in ballroom dancers.

MATERIAL AND METHODS

The studies were carried out in accordance with the Declaration of Helsinki. Participants and their parents obtained written information about the research. They were also verbally instructed about the goal and procedure of the investigation. Each participant (or their parents) signed informed consent form.

18 female and 12 male dancers at the age of 13-27 ($\bar{x}$ = 19 ± 3,8) participated in the study. Dancers were recruited from the tournament group and must have at least 2 years experience in sport dancing ($\bar{x}$ = 8,5 ± 4,8). Participants had a different skills level in ballroom dancing, from basic up to advanced. Characteristic of the group is presented in table 1.

Table 1. Descriptive statistics of participants (N=30)

	$\bar{x}$	±	**min-max**
Age (y)	19	3.8	13-27
Weight (kg)	58.2	10.1	44-80
Height (m)	1.703	0.094	1.53-1.85
BMI (kg/m^2)	19.9	1.9	17.6-23.9
Experience (y)	8.5	4.8	2-19

$\bar{x}$ – mean; ± – standard deviation; min-max – minimal and maximal value; BMI – Body Mass Index.

Dancers were randomly assigned to an experimental or control group. Randomisation was performed with the use of a computer algorithm. Results of randomisation are rendered in Table 2 and 3. Individuals from the experimental group carried on the stability exercise programme besides the conventional dance training. Dancers from the control group continued only the standard dance training programme without any modification.

Table 2. Descriptive statistics of experimental group (n=15)

	$\bar{x}$	±	**min-max**
Age (y)	19	3.8	13-27
Weight (kg)	56.3	9.5	44-69
Height (m)	1.696	0.106	1.53-1.85
BMI (kg/m^2)	19.4	1.7	17.6-23.9
Experience (y)	6.2	2.3	2.5-12

$\bar{x}$ – mean; ± – standard deviation; min-max – minimal and maximal value; BMI – Body Mass Index

Table 3. Descriptive statistics of control group (n=15)

	$\bar{x}$	±	**min-max**
Age (y)	20	3.7	14-25
Weight (kg)	60.2	10.6	48-80
Height (m)	1.71	0.084	1.53-1.84
BMI (kg/m^2)	20.5	2.1	17.6-23.9
Experience (y)	10.7	5.6	2-19

$\bar{x}$ – mean; ± – standard deviation; min-max – minimal and maximal value; BMI – Body Mass Index

The experiment was preceded by strength measurements of the lumbar deep stabilisers, such as transversus abdominis and multifidus muscles. The data were collected in supine and in prone position. In supine position, the biofeedback pressure unit (PBU) was placed under the lumbar spine, 1-2cm above the posterior superior iliac spines. During the breathe-out phase of respiration, the subject was asked to draw in their abdomen (abdominal drawing-in manoeuvre – ADIM). Changes of the initial pressure value (40mm

Hg) were noticed. In prone position, the initial pressure in the PBU was equal 70mm Hg. Participants repeated the ADIM with the PBU under the lower part of the abdomen. Pressure differences between the relaxed posture and after the ADIM were registered. The measurement was repeated three times in both positions to allow extraction of the mean value for the following analysis. The results were recorded with 1mm Hg accuracy. Subjects were instructed to avoid additional movements of the thorax and pelvis while breathing normally during tests with PBU (Costa et al., 2006). Each participant had one trial test before collecting the data.

Stability exercise programme was eclectically based on the several training propositions reported by Richardson and Jull (1995), Hodges and Richardson (1996, 1998), Richardson and Hides (2004), O'Sullivan (2000), McGill (2001), and Hicks and al. (2005). Stability exercise sessions were carried on three times a week for 40 to 50 minutes. The training was conducted in three stages (Table 4), according to Fitts and Posner description of the motor learning process (Shumway-Cook and Woollacott, 1995). In the beginning, the practice included exercises in low load and static positions to achieve local stabilisers co-contraction without global muscles substitution. During following trainings, higher attitudes and more dynamic tasks were applied for re-education of the local muscles activity with maintenance of neutral lumbar spine. The third stage of stability trainings was directed to produce automatically co-contraction of transversus abdominis and multifidus muscles during functional challenges and dance (for details, see Table 4). Depending on the exercise, 20 to 30 repetitions of isometric contraction for 4-8 seconds were performed (excluding the third stage of training). There was a 5 second break between repetitions and 1 minute pause before proceeding to the next exercise. During the last week of training, analogous proportions was kept: 5 second pause interrupting following repetitions of the same exercise and 1 minute rest before the next challenge.

Low back pain intensity was estimated individually by Numerical Pain Rating Scale (NPRS) from 0 (no pain) to 10 (the worst pain imaginable). The NPRS is valid, reliable, sensitive and responsive to change (Ferreira-Valente, 2011).

Table 4. Stabilisation exercises with criteria for progression of each exercise

Stage	Week	Position	Exercises	Criteria of progression
I	1-3	Supine crook-lying	ADIM	30 repetitions with 8s hold
			ADIM with heel slides	20 rep. per leg with 4s hold
			ADIM with leg lifts	20 rep. per leg with 4s hold
			ADIM with bridging (2 legs support)	30 rep. with 8s hold
			ADIM with bridging (1 leg support)	20 rep. per leg with 4s hold
		Four point kneeling	ADIM	30 rep. with 8s hold
			ADIM with single leg extension	20 rep. per leg with 4s hold
			ADIM with "bird-dog" exercise	20 rep. per side with 4s hold
II	2-5	Sitting	ADIM	30 rep. with 8s hold
			ADIM with leg lifts	20 rep. per leg with 4s hold
			ADIM with DF*	30 rep. with 8s hold
			ADIM with DF and leg lifts	20 rep. per side with 4s hold
		Standing	ADIM	30 rep. with 8s hold
			ADIM with single leg stance	20 rep. per leg with 4s hold
			ADIM with DF	30 rep. with 8s hold
			ADIM with DF and single leg stance	20 rep. per leg with 4s hold
III	6	Dancing	ADIM with DF and walking	20 rep. of 12 meters
			ADIM with DF and the upper body rotations	20 rep. per side with 4s hold
			ADIM with DF and basic waltz pattern (box step)	10 rep. of dancing for 10-30s
			ADIM with DF and basic tango pattern (2 walks/progressive side step)	10 rep. of dancing for 10-30s
			ADIM with DF and basic slow foxtrot pattern (feather step/three step)	10 rep. of dancing for 10-30s
			ADIM with DF and basic viennese waltz pattern (natural turn)	10 rep. of dancing for 10-30s
			ADIM with DF and basic quickstep pattern (quarter turn to right/progressive chasse)	10 rep. of dancing for 10-30s

ADIM – abdominal drawing-in manoeuvre; DF – dance frame
* Dance frame means the specific position of dancers' arms for ballroom dancing (Jarmolov and Selck, 2011)

After six weeks of regular trainings, deep muscles strength tests were repeated. Also pain level was quantified again in both, experimental and control group. The data were analysed using the STATISTICA, version 8.0. Minimal and maximal values, and standard deviations for every measure were established. The Mann-Whitney's U-test was used for intergroup differences and the Wilcoxon's test for intragroup differences. The level for statistical significance was set at 0.05 for each analysis.

RESULTS

Six weeks of regular trainings resulted in decreasing of low back pain complaints in both groups. Differences in pain intensity between baseline and the final measurements were significant only in the experimental group (p = 0.0014). Table 5 shows the NPRS results for experimental and control group. At the baseline, considered groups were homogeneous as to the severity of the symptoms.

Table 5. Numerical pain rating scale results for low back pain

	Initial testNPRS		Final testNPRS		Disparity	p-value*
	$\bar{x}$	±	$\bar{x}$	±		
Experimental group	4.13	1.96	1.6	1.4	-2.53	0.0014
Control group	3.27	1.67	2.6	2.59	-0.67	> 0.05

$\bar{x}$ – mean; ± – standard deviation
* p-value for differences between initial and final test

Significant increase in deep muscles strength measures was observed in both, prone and supine position. Table 6 shows the results of deep muscles strength test using the biofeedback pressure unit.

Table 6. Deep muscles strength measured with biofeedback pressure unit

		Initial		Final		Disparity	p-value*
		$\bar{x}$	±	$\bar{x}$	±		
Supine	Experimental	0.47	0.83	5.53	3.39	5.06	0.0014
Supine	Control	1	1	0.47	1.06	-0.53	> 0.05
Prone	Experimental	0.53	1.13	3.27	2.52	2.74	0.0054
Prone	Control	0.73	1.79	1	1.77	0.27	0.5

$\bar{x}$ – mean; ± – standard deviation
* p-value for differences between initial and final test

Analysed groups were homogeneous in the PBU examination during the initial tests. Intergroup differences were significant only for the final measurements of the strength of stabilisers both in prone (p=0.0052) and in supine (p=0.00061). The other intergroup differences were statistically insignificant (p > 0.05).

DISCUSSION

Our research shows significant decrease in low back pain among dancers participating in the stability exercise programme compared to the controls. Moreover, pronounced improvement of deep muscles strength in the experimental group was observed. The study confirms usefulness of stability exercises for low back pain management and prevention in ballroom dancers.

Collected results correspond to investigations on low back pain in people who are not dancers and who are not involved in sports at all. According to Panjabi (1992), Cholewicki and McGill (1996), and Gardner-Morse (1995), insufficient coordination of muscles surrounding the spine and deep muscles weakness can lead to low back disorders.

Smith (2009) emphasises that the fully extended position of the lumbar spine is a component of dance aesthetics. Unfortunately, sustained or repetitive activity at the end range of extension can produce structural instability of the spine such as spondylolysis and following spondylolisthesis as a consequence of the excessive extension loading and fractures through the pars interarticularis of the vertebrae. Smith (2009) notes that in an extended position, especially with lumbar rotation, the risk of facet joints injuries increases due to large compression of the articular surfaces and transduction of forces from the intervertebral disc to the facet joints in their closed-packed position.

Kokosz et al. (2012) states there is a strong correlation between low back pain appearance and the impairment of kinaesthetic differentiation, and strength of deep stabilising muscles. This outcome corresponds with the reports of the effect of nociceptive stimulation, especially chronic, on motor abilities of muscles in the painful area (Nijs et al., 2012). Malfunction of active control of the neutral zone and overload of the passive spinal structures, i.e. articular cartilage, capsule and capsular ligaments, can occur as a result of mentioned mechanisms (Panjabi, 2003).

The efficacy of stability training in low back pain among dancers was considered by Beckman-Kline et al. (2013). However, in this research authors used different exercises, based on concentric and eccentric isotonic activities rather than isometric muscles contraction. Ballet dancers with current or previous lumbar pain or radiculopathy in the lower extremity were observed. Measurements and test were conducted at the beginning of the study, after three weeks and after six weeks of stability training implementation. The authors found improvement in strength, function, pain, sciatic nerve irritation and ballet performance in all the participants. This inquiry supports usefulness of stability exercises, using unstable equipment and plank positions in decreasing low back pain complaints and suggests that described type of muscle training can be widely applied, not only as an analgesic management but also for enhancing motor performance.

Furthermore, stability exercises in dance should not be interpreted as a simple muscles strengthening. Phillips (2005) emphasises the complexity and long-term efficiency of stability training as a result of motor programmes learning for achieving better overall performance and long-term benefits due to strong skill acquisition.

Limitations and Future Research

The study concerned only subjects with relatively low intensity of lumbar pain, in early stage of overload symptoms.

Short time of this study allowed the researcher to see trends in process of providing effective lumbar stability in connection to its analgesic influence (Beckmann-Kline et al., 2013). Although prolonged observations are needed to analyse long-term neuromuscular efficacy, six weeks seemed to be sufficient for estimating current dance performance.

Future research comparing different trainings used to improve low back pain in ballroom dancers, e.g. Pilates system or general exercises in opposite to the stability exercises are needed.

Stability exercises for lumbo-pelvic-hip complex are effective for reducing low back pain in ballroom dancers. Training of lumbar stabilisers improves the strength of local muscles such as transversus abdominis and multifidus. Stability training can be used as analgesic management of low back pain among ballroom dancers.

CONCLUSION

Stability exercises for lumbo-pelvic-hip complex are effective for reducing low back pain in ballroom dancers. Training of lumbar stabilisers improves the strength of local muscles such as transversus abdominis and multifidus. Stability training can be used as analgesic management of low back pain among ballroom dancers.

Acknowledgements

The authors would like to thank Mrs Anna Ermich-Dadas for her kind aiding the manuscript, incentive conversations and sagacious advices.

REFERENCES

1. Beckmann-Kline J, Krauss JR, Maher SF, Qu X. Core strength training using a combination of home exercises and a dynamic sling system for the management of low back pain in pre-professional ballet dancers. *J Dance Med Sci*, 2013; 17(1): 24-33
2. Bolin D. Evaluation and management of stress fractures in dancers. *J Dance Med Sci*, 2001; 5(2): 37-42
3. Cholewicki J, McGill SM. Mechanical stability of the in vivo lumbar spine: implications for injury and chronic low back pain. *Clin Biomech*, (Bristol, Avon). 1996; 11(1): 1-15
4. Costa LOP, Costa LdaCM, Cançado RL, Oliveira WdeM, Ferreira PH. Short report: Intra-tester reliability of two clinical tests of transversus abdominis muscle recruitment. *Physiother Res Int*, 2006; 11(1): 48-50
5. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. *Pain*, 2011; 152(10): 2399-404
6. Fritz JM, Cleland JA, Childs JD. Subgrouping patients with low back pain: Evolution of a classification approach to physical therapy. *J Orthop Sports Phys Ther*, 2007; 37(6): 290-302
7. Gardner-Morse M, Stokes I, Liable J. Role of muscles in lumbar spine stability in maximum extensor efforts. *J Orthop Res*, 1995; 13(5): 802-8
8. Garrick J, Requa R. Ballet injuries: an analysis of epidemiology and financial outcome. *Am J Sports Med*, 1993; 21(4): 586-90
9. Hagins M. The use of stabilization exercises and movement reeducation to manage pain and improve function in a dancer with focal degenerative joint disease of the spine. *J Dance Med Sci*, 2011; 15: 136-42
10. Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil*, 2005; 86: 1753-62
11. Hodges PW, Richardson CA. Inefficient muscular stailization of the lumbar spine associated with low back pain: a motor control evaluation of transverse abdominis. *Spine*, 1996, 15; 21 (22): 2640-50
12. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. *J Spinal Disord*, 1998; 11(1): 46-56
13. Holm S, Indahl A, Solomonow M. Sensorimotor control of the spine. *J Electromyogr Kinesiol*, 2002; 12 (3): 219-34
14. Jarmolov D, Selck B. Teach like a pro: The ultimate guide for ballroom dance instructors. *Oakland: Ballroom Dance Teachers College*; 2011: 96

15. Kokosz M, Saulicz E, Wolny T, Saulicz M, Myśliwiec A, Gębala Ł, Mokrus O, Linek P. Strength and kinesthetic differentiation of deep muscles stabilizing lumbar spine in low back pain complaints. *Pol J Physiother*. 2012; 2(4), vol. 12: 101-11
16. McGill SM. Low back stability: From formal description to issues for performance and rehabilitation. *Exerc Sports Sci Rev*, 2001; 29: 26-31
17. Nijs J, Daenen L, Cras P, Struyf F, Roussel N, Oostendorp RAB. Nociception affects motor output. A review on sensory-motor interaction with focus on clinical implications. *Clin J Pain*, 28(2); 2012: 175-81
18. Opila K, Wagner S, Schiowitz S, Chen J. Postural alignment in bare-foot and high heeled stance. *Spine*. 1988; 13(5): 542-7
19. O'Sullivan PB. Lumbar segmental 'instability': clinical presentation and specific stabilizing exercise management. *Manual Ther*, 2000; 5(1): 2-12
20. Panjabi M. The stabilizing system of the spine. Part I. Function, dysfunction, adaptation and enhancement. *J Spinal Disord*, 1992; 5(4): 383-9; discussion 397
21. Panjabi M. Clinical instability and low back pain. *J Electromyogr Kinesiol*, 2003; 13: 371-9
22. Panjabi M. A hypothesis of chronic back pain: ligament subfailure injuries lead to muscle control dysfunction. *Eur Spine J*, 2006; 15: 668-76
23. Phillips C. Stability in Dance Training. *J Dance Med Sci*, 2005; 9(1): 24-8
24. Richardson CA, Hides JA. Closed chain segmental control. In: Richardson CA, Hodges PW, Hides JA, eds. Therapeutic exercise for lumbopelvic stabilization: a motor control approach for the treatment and prevention of low back pain. *New York: Churchill Livingstone*, 2004: 221-32
25. Richardson CA, Jull GA. Muscle control – pain control. What exercises would you prescribe? *Manual Ther,* 1995; 1: 2-10
26. Roussel N, De Kooning M, Schutt A, Mottram S, Truijen S, Nijs J, Daenen L. Motor control and low back pain in dancers. *Int J Sports Med*, 2013; 34: 138-43
27. Shumway-Cook A, Woollacott M. Motor control – Theory and practical applications. Baltimore: *Williams & Wilkins*; 1995
28. Smith J. Moving beyond the neutral spine. Stabilizing the dancer with lumbar extension dysfunction. *J Dance Med Sc*,. 2009; 13(3): 73-82
29. Solomon R, Solomon J, Micheli L, McGray E. The 'cost' of injuries in a professional ballet company: a five-year study. *Med Probl Perform Art*, 1999; 164-70
30. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. *Acad Emer Med*, 2002; 8: 1153-7