Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/medici

Original Research Article

# Spinal posture in different DanceSport dance styles compared with track and field athletes

Helena Kruusamäe [a,*], Katre Maasalu [b], Matthew Wyon [c,d], Toivo Jürimäe [a], Jarek Mäestu [a], Martin Mooses [a], Jaak Jürimäe [a]

[a] Faculty of Exercise and Sport Sciences, University of Tartu, Tartu, Estonia
[b] Faculty of Medicine, University of Tartu, Tartu, Estonia
[c] Research Centre for Sport, Exercise and Performance, University of Wolverhampton, Walsall, United Kingdom
[d] National Institute of Dance Medicine and Science, The Old Finsbury, Town Hall, London, United Kingdom

ARTICLE INFO

*Article history:*
Received 27 November 2014
Accepted 31 August 2015
Available online 11 November 2015

*Keywords:*
Spine
Thoracic kyphosis
Lumbar lordosis
Ballroom dance
Sport

ABSTRACT

*Background and objective:* In DanceSport, athletes train for many years to develop a very specific posture. Presently there are few data as to whether these adaptations are habitual or cause permanent anatomical changes to the spine. The aim of the current study was to evaluate lumbar lordosis and thoracic kyphosis of the international level DanceSport dancers using track and field athletes as controls.

*Materials and methods:* Thirty competitive DanceSport couples (15 men aged 23.4 ± 6.6 years; 15 women aged 22.5 ± 6.4 years) and 29 track and field athletes (16 mean aged 27 ± 4.4 years and 13 women aged 22 ± 4.1 years) volunteered. Twelve couples were Standard, 7 Latin American and 11 were Ten Dance couples. Thoracic kyphosis and lumbar lordosis angle were assessed in lateral view using a Vertebral Fracture Assessment scan.

*Results:* DanceSport athletes had smaller S-shaped vertebral curvatures compared to track and field athletes. Male (5.7 ± 4.7°) and female dancers (8.7 ± 5.9°) had significantly smaller lumbar lordosis angle compared to their track and field counterparts (22.3 ± 9.9° for men; 20.3 ± 5.9° for women). Female dancers (25.3 ± 8.0°) also demonstrated significantly smaller thoracic kyphosis angle than female track and field (32.1 ± 8.9°) participants. It was further revealed that female Latin American dancers had significantly smaller lumbar lordosis values (3.7 ± 3.1°) compared with female Standard (10.7 ± 6.1°) and Ten Dance dancers (9.7 ± 5.5°).

*Conclusions:* The results of the present study suggest that smaller S-shaped vertebral curvatures of DanceSport athletes compared with track and field athletes are permanent changes rather than habitual.



* *Corresponding author at*: Faculty of Exercise and Sport Sciences, University of Tartu, Jakobi 5, 51014 Tartu, Estonia.
E-mail address: helena.kruusamae@ut.ee (H. Kruusamäe).

Peer review under the responsibility of the Lithuanian University of Health Sciences.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.medici.2015.08.003

## 1. Introduction

International DanceSport requires dancing in couples and competing in Standard, Latin American or Ten Dance disciplines [1]. The shape of the posture and partners' dance hold is very important in all three DanceSport disciplines. The physiological demands of Latin American competitive dances are greater than the Standard Dance equivalents, especially in female dancers [2]. The correct posture requires the neck and spine to be elongated, the abdominal muscles are pulled in, hips are rotated forward, shoulders are lowered, and the weight is held more forward on balls of the feet [3]. In Standard dances, the female is poised backwards from the waist so that spine is arched back away from the partner [3,4]. To be able to keep this posture during competitions dancers are training it many years.

DanceSport competition combines athletic performance and esthetic values [1]. This can be observed within their posture on and off the dance floor. As posture is such a fundamental aspect of DanceSport competition, dancers spend a considerable amount of training developing the appropriate posture and dance hold. This raises the issue as to whether these adaptations are habitual or cause permanent anatomical changes to the spine.

The normal spine has curves that develop during growth periods and are influenced by stresses placed upon it during work and activities [5–7]. The function of these spinal curves is to increase the overall strength of the vertebral column and to help maintaining of the balance in the upright position [6]. They also facilitate to absorb stresses placed on our bodies through impact activities such as running and jumping [6]. The curves are described as convex (kyphosis) or concave (lordosis) to illustrate the direction of the arch in relation to the hollow or depressed side of the curve [8].

Physical activity influences developing of the spinal curvatures [7,9]. Sagittal spinal curvatures may adapt gradually following long and intensive training periods [9]. Training volume, specific and repetitive movements, type of sport and postures of each sport have been found to be associated with developing spinal curvatures [7,9]. During periods of stature growth, the sagittal configuration of the spine changes with an increase in thoracic kyphosis and lumbar lordosis [7]. Wojtys et al. [7] reported that athletes between 8 and 18 years of age demonstrated larger angles of thoracic kyphosis and lumbar lordosis and these angles were associated with cumulative training time. Lack of physical activity is associated with smaller curves [7]. Although the effects of hyperlordosis or hypolordosis are not yet well established, the loss of lumbar lordosis can have significant adverse effects [10,11]. Altered lumbar lordosis may cause disk degeneration and radicular pain [12], while increased lumbar lordosis and diminished abdominal muscle force can increase the risk of chronic low back pain [10].

The aim of the current study was to evaluate lumbar lordosis and thoracic kyphosis of the international level DanceSport dancers and compare it with track and field athletes. In this study track and field group was used as physically active control group. We decided to compare DanceSport with track and field athletes to exclude the influence of sedentary lifestyle. The reason for choosing precisely track and field athletes was that both sports are having continues and various movements. In track and field, the posture is also important and the body position is trained but posture on track and field athletes bases on natural body position while DanceSport specific posture demands permanent hips rotation and spine extension.

## 2. Materials and methods

### 2.1. Participants

The DanceSport and track field groups were matched for age and gender. Sixty competitive DanceSport athletes (30 couples) – amateur or qualified professionals – served as subjects for this study. Twelve couples were Standard, 7 Latin American and 11 were Ten Dance couples. Dancers belonged to the top 6% of the athletes listed in the world rankings [13]. All subjects were healthy, injury free and involved in full intensity training and competing at an international level during the testing period. The dancers averaged 15 ± 5.1 years of training and were presently training for 12 ± 6.3 h per week (Table 1).

**Table 1 – Mean (±SD) anthropometrical characteristics, spinal curvatures, training experience and training volume of male and female dancers in different dance styles.**

| | Standard | | Latin | | 10 dance | |
|---|---|---|---|---|---|---|
| | Male (*n* = 12) | Female (*n* = 12) | Male (*n* = 7) | Female (*n* = 7) | Male (*n* = 11) | Female (*n* = 11) |
| Age (years) | 26.7 ± 8.3 | 25.3 ± 8.4 | 21.5 ± 2.3 | 21.1 ± 3.1 | 19.4 ± 2.7[½] | 19.0 ± 3.3[½] |
| Height (m) | 183.4 ± 3.6 | 170.9 ± 4.3[*] | 175.4 ± 3.7[#] | 162.7 ± 4.6[*,#] | 180.4 ± 6.6 | 166.6 ± 4.5[*,½] |
| Body mass (kg) | 72.5 ± 4.6 | 57.3 ± 5.0[*] | 70.0 ± 5.1 | 53.4 ± 4.4[*] | 72.3 ± 8.2 | 55.5 ± 4.0[*] |
| Thoracic kyphosis (°) | 25.8 ± 10.8 | 24.8 ± 9.1 | 24.3 ± 4.9 | 24.9 ± 7.8 | 21.3 ± 10.3 | 26.2 ± 7.5 |
| Lumbar lordosis (°) | 5.9 ± 5.8 | 10.7 ± 6.1 | 6.1 ± 3.6 | 3.7 ± 3.1[#] | 5.2 ± 4.2 | 9.7 ± 5.5[¤,*] |
| Years of training | 16.8 ± 7.9 | 15.8 ± 5.5 | 13.5 ± 8.5 | 15.5 ± 8.1 | 12.8 ± 3.9 | 13.2 ± 3.5 |
| Training volume (h/w) | 11.7 ± 4.7 | 12.1 ± 5.7 | 13.4 ± 10.1 | 16.2 ± 9.4 | 10.3 ± 5.8 | 10.7 ± 5.7 |

[*] Significant difference at $P < 0.05$ between males and females in the same dance style.
[#] Significant difference at $P < 0.05$ between Standard and Latin dancers of the same gender.
[½] Significant difference at $P < 0.05$ between Standard and 10 dance dancers of the same gender.
[¤] Significant difference at $P < 0.05$ between Latin and 10 dance dancers of the same gender. h/w: hours per week.

The track and field group consisted of 16 male and 13 female participants (men aged 27 ± 4.4 years; women aged 22 ± 4.1 years). All track and field athletes were involved in running events. Male participants were training regularly during the last 3 years with a minimum of 5 sessions per week and a mean distance of 60 km per week. The mean age of the female participants when starting regular dance training was 9 ± 2.5 years with a mean training volume of 10 ± 6.7 h per week. This study was approved by the Medical Ethics Committee and the signed informed consent was obtained from all the participants prior to testing.

### 2.2. *Anthropometry and spinal curvatures*

The height and body mass (A&D Instruments, UK) of the participants were measured to the nearest 0.1 cm and 0.05 kg, respectively. Thoracic kyphosis and lumbar lordosis angle were measured in lateral view with a Vertebral Fracture Assessment (VFA) scan using a Lunar DPX-IQ densitometer (Lunar Corporation, Madison, WI, USA). All measurements were performed by the same investigator. In order to measure thoracic kyphosis and lumbar lordosis, the upper and lower vertebral bodies defining the curve were selected and lines drawn extending along as the inferior border of the lower-end vertebra. From these two lines perpendiculars were drawn and the angle was measured at the intersection (Figs. 1 and 2).

### 2.3. *Statistical analysis*

Data analysis was performed using SPSS 20.0 for Windows (Chicago, IL, USA). Means and standard deviations (SD) were calculated. Data were assessed for normality and the paired t-test was used to test for the differences between the male and female dancers and same gender track and field athletes. Pearson product correlations were used to test ascertain relationships between specific variables. The level of significance was set at $P < 0.05$.

## 3. Results

The present study has revealed that DanceSport athletes have smaller S-shaped vertebral curvatures compared with track and field athletes (Figs. 1 and 2). Spinal curvatures and physical characteristics of the dancers and track and field athletes are shown in Table 2. Male (5.7 ± 4.7°) and female dancers (8.7 ± 5.9°) had significantly smaller lumbar lordosis angle compared with same gender track and field participants (22.3 ± 9.9° for men; 20.3 ± 5.9° for women). Female dancers (25.3 ± 8.0°) had also significantly smaller thoracic kyphosis angle compared with female track and field (32.1 ± 8.9°) participants.

Within DanceSport comparisons indicated that female Latin American dancers had significantly smaller lumbar lordosis values (3.7 ± 3.1°) compared with female Standard (10.7 ± 6.1°) and Ten Dance dancers (9.7 ± 5.5°) ($P < 0.05$).

The mean age at starting practicing DanceSport was 6.8 ± 1.8 years (range, 5–13 years). There was no correlation between years of training and both thoracic kyphosis (23.8 ± 9.5° for men; 25.3 ± 8.0° for women) and lumbar lordosis

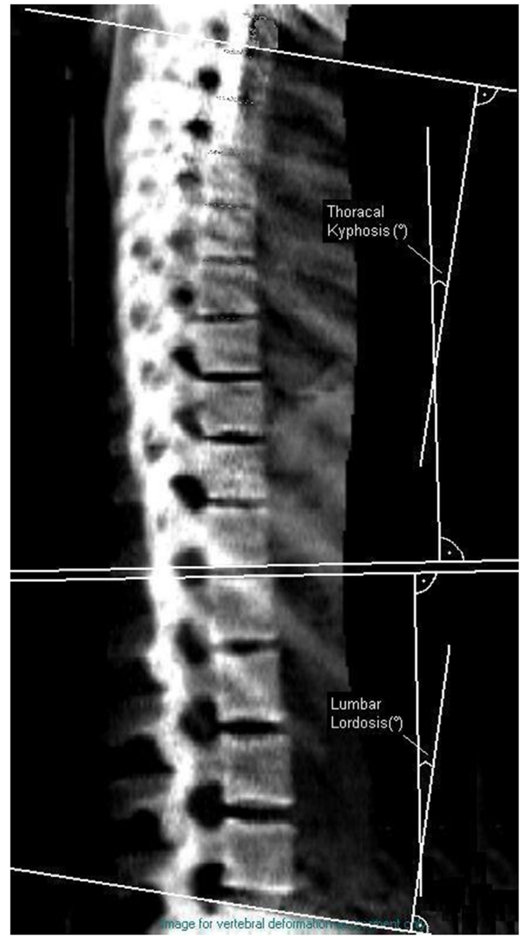


**Fig. 1 – Lateral view of the spine on DanceSport participant.**

**Table 2 – Mean (±SD) anthropometrical characteristics and spinal curvatures of DanceSport group and track and field group participants.**

| | DanceSport group | | Track and field group | |
|---|---|---|---|---|
| | Male ($n$ = 30) | Female ($n$ = 30) | Male ($n$ = 16) | Female ($n$ = 13) |
| Age (years) | 22.8 ± 6.6 | 22.0 ± 6.4 | 26.8 ± 4.4 | 21.5 ± 4.1 |
| Height (m) | 180.4 ± 5.7 | 167.4 ± 5.4 | 182.5 ± 5.7 | 169.7 ± 5.0 |
| Body mass (kg) | 71.9 ± 6.1 | 55.7 ± 4.6 | 73.3 ± 7.1 | 59.6 ± 6.7 |
| Thoracic kyphosis (°) | 23.8 ± 9.5 | 25.3 ± 8.0 | 38.8 ± 10.6 | 32.1 ± 8.9 |
| Lumbar Lordosis (°) | 5.7 ± 4.7 | 8.7 ± 5.9 | 22.3 ± 9.9# | 20.3 ± 5.9 |

# Significant difference at $P < 0.05$ between DanceSport and track and field group participants of the same gender.

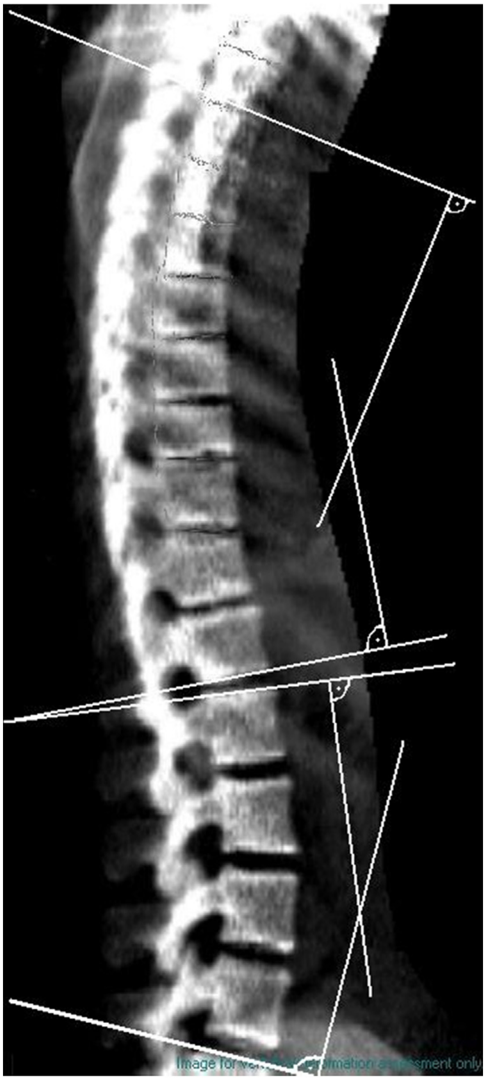


**Fig. 2 – Lateral view of the spine on track and field athlete participant.**

($5.7 \pm 4.7^{\circ}$ for men; $8.7 \pm 5.9^{\circ}$ for women) angle values. There was also no correlation between the age of starting regular trainings and both thoracic kyphosis and lumbar lordosis angle values.

## 4. Discussion

The present investigation was aimed to evaluate differences in lumbar lordosis and thoracic kyphosis between international level DanceSport dancers and age- and gender-matched track and field athletes. The results of the study indicate that the DanceSport competitors had significantly smaller lumbar lordosis angle compared to the same gender track and field participants (Table 2). In addition, female dancers had smaller thoracic kyphosis angles compared with their equivalent track and field counterparts. This equates to the postural requirements of DanceSport that requires its participants to maintain an elongated back and forward rotated hips that have been reinforced over years of training. The cross-sectional design of the present study does not allow this conjecture and we cannot determine whether the observed curvature is due to training exposure or the selection of a specific body type for the activity but as previous study [20] on athletes spinal curvatures compared with control group concluded that differences in spinal curvatures might be due to regular engagement in intensive exercise we assume that small vertebral curvatures of DanceSport athletes may be related to the DanceSport specific training.

We did not study how changes in the spinal curvatures affect dancers' health and in particular injuries and pain complaints; in the literature it has been suggested that the loss of lordosis is associated with low back pain due to increased intradiscal pressure [14–19]. Moreover, loss of lumbar lordosis is related to anterior displacement of the C7 plumbline [12]. However, as these results are the first in the literature to report spine curvatures in DanceSport participants, further longitudinal research is needed to study spinal curvatures and back pain in DanceSport dancers.

This study observed significantly lower thoracic kyphosis angles in female dancers compared to their athletic counterparts; whilst there were no observed differences between the male subjects. Intra DanceSport comparisons revealed that female Latin American dancers had significantly smaller lumbar lordosis values compared to their Standard and Ten Dance equivalents. This may be due to the female dancers in Standard dance being required to maintain a particular posture. Female Standard dancers are bend slightly back between the 6th and 7th thoracic vertebrae. This involves the spine being hyperextended from the waist which limits the forward rotation of the hips that is observed in male and female Latin American dancers. This may be the reason why female dancers had significantly smaller thoracic kyphosis angles compared with female track and field participants while there was no significant difference between male participants. Female standard dancers' particular posture may be also the reason why female Latin American dancers had significantly smaller lumbar lordosis values compared with female Standard and Ten Dance dancers.

Wojtys et al. [7] reported that extended exposure to athletic pursuits during adolescent growth can affect the curvature of the spine. In this study, the average age for starting practicing DanceSport was $7 \pm 1.8$ years and the years of training was $15 \pm 5.1$. As the growing body is especially responsive for the external influence [21] this long term exposure to specific postural positions could influence the observed differences; however there were no significant differences between training experience and both thoracic kyphosis and lumbar lordosis angle values. Furthermore, there was no significant difference between the age of starting regular trainings and both thoracic kyphosis and lumbar lordosis angle values. The non-significant relationship might indicate that smaller thoracic kyphosis and lumbar lordosis angles were developed during the beginning of dancing carrier and then remained unchanged, but this finding can also be related to the fact that all the participated dancers started dancing trainings at the relatively similar age ($7 \pm 1.8$ years). However, longitudinal research is required to provide more than conjectural evidence.

## 5. Conclusions

DanceSport athletes had smaller S-shaped vertebral curvatures compared with track and field athletes. The observed differences between DanceSport and Track and field athletes may present adaptations due to training or selection procedures. DanceSport athletes were observed as having smaller lumbar lordosis angles compared to same gender track and field athletes. Female DanceSport dancers also had smaller thoracic kyphosis angle compared with female track and field participants. Moreover, there were differences between the different Dance Sport styles with female Latin American dancers having smaller lumbar lordosis than their Standard and Ten Dance counterparts. Longitudinal research is needed to study dancers spinal curvatures through their carrier.

## Conflict of interest

The authors state no conflict of interest.

## Acknowledgments

This study was supported by the Estonian Ministry of Education and Science target financed grant 0489; and by the Doctoral School of Behavioral, Social and Health Sciences project nr 1.2.0401.09-0072 created under the auspices of European Social Fund; and by Estonian Science Foundation (ESF) DoRa 6 and DoRa 8 program. We also gratefully acknowledge all the participants.

## REFERENCES

[1] World DanceSport Federation. WDSF DanceSport for all; 2012 [cited 16.02.15]. Available from http://www.worlddancesport.org/About/All.
[2] Liiv H, Jürimäe T, Mäestu J, Purge P, Hannus A, Jürimäe J. Physiological characteristics of elite dancers of different dance styles. Eur J Sport Sci 2014;14:S429–36.
[3] Howard G. Technique of ballroom dancing. UK: International Dance Teachers' Association Ltd.; 2007.
[4] Hearn GW. Technique of advanced standard ballroom figures. revised ed. UK: Geoffrey and Diana Hearn; 2004.
[5] Ballinger P, Frank E. Merrill's atlas of radiographic positions and radiographic procedures. 10th ed. USA: Mosby; 2003. p. 1840.
[6] Bontrager K, Lampignano J. Textbook of radiographic positioning and related anatomy. 6th ed. USA: Mosby; 2005. p. 336.
[7] Wojtys EM, Ashton-Miller JA, Huston LJ, Moga PJ. The association between athletic training time and the sagittal curvature of the immature spine. Am J Sports Med 2000;28:490–8.
[8] Anderson SM. Spinal curves and scoliosis. Radiol Technol 2007;79:44–65.
[9] López-Miñarro PA, Muyor JM, Alacid F. Influence of hamstring extensibility on sagittal spinal curvatures and pelvic tilt in highly trained young kayakers. Eur J Sport Sci 2012;12:1–6.
[10] Polly DW, Kilkelly FX, McHale KA, Asplund LM, Mulligan M, Chang AS. Measurement of lumbar lordosis. Spine 1996;21:1530–6.
[11] Walker ML, Rothstein JM, Finucane SD, Lamb RL. Relationship between lumbar lordosis, pelvic tilt, and abdominal muscle performance. Phys Ther 1987;4:512–6.
[12] Murata Y, Takahashi K, Yamagata M, Hanaoka E, Moriya H. The knee-spine syndrome. J Bone Joint Surg Br 2003;85:95–9.
[13] DancesportInfo Rating System, 2011. [cited 01.09.11]. Available from http://dancesportinfo.net/Desc_Rating.aspx.
[14] Itoi E. Roentgenographic analysis of posture in spinal osteoporotics. Spine 1991;16:750–6.
[15] Jackson RP, McManus AC. Radiographic analysis of sagittal plan alignment and balance in standing volunteers and patients with low back pain matched for age, sex and size: a prospective controlled clinical study. Spine 1994;19:1611–8.
[16] Jackson RP, Peterson MD, McManus AC, Hales C. Compensatory spinopelvic balance over the hip axis and better reliability in measuring lordosis to the pelvic radius on standing lateral radiographs of adult volunteers and patients. Spine 1998;23:1750–67.
[17] Lord MJ, Small JM, Dinsay JM, Watkins RG. Lumbar lordosis: effects of sitting and standing. Spine 1997;22:2571–4.
[18] Troyanovich SJ, Cailliet R, Janik TJ, Harrison DD, Harrison DE. Radiographic mensuration characteristics of the sagittal lumbar spine from a normal population with a method to synthesize prior studies of lordosis. J Spinal Disord 1997;10:380–6.
[19] Williams MM, Hawley JA, McKenzie RA, Wijmen PM. A comparison of the effects of two sitting postures on back and referred pain. Spine 1991;16:1185–91.
[20] Grabara M. Anteroposterior curvatures of the spine in adolescent athletes. J Back Musculoskelet Rehabil 2014;27 [Epub ahead of print].
[21] Widhe T. Spine: posture, mobility and pain. A longitudinal study from childhood to adolescence. Eur Spine J 2001;10:118–23.