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Lumbar and Pelvis Posture Changes Due to the Degree of Turnout in Ballet Dancers

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Background

Dancers are highly trained athletes who are at significant risk of injury due the repetitive nature of movement patterns with the majority of dance injuries being a result of overuse [1-3] with the lower back accounting for between 9.4% and 23% of injuries sustained [4]. The causes of dance injuries are multi factorial and result from a combination of intrinsic and extrinsic risk factors [5]. Low back pain can be due to many factors including overload due to repetition of sustained postures and repeated movements which can stress soft tissues of the lumbo-pelvic region.

Within ballet there are 5 basic foot positions which are referred to as the first, second, third, fourth and fifth position. In all 5 positions, the knees are straight and the legs are externally rotated (ER) from the hips. All ballet moves pass through one of the 5 positions making turnout an essential element of dance. Dancers ideally achieve 180° of turnout by externally rotating the hips 70°, the lower leg 5° and the feet 15° unilaterally [6]. Dancers with hip ER of less than 70° can still achieve 180° turnout through compensation through the kinematic chain [7,8]. Dancers can force turnout by increasing their lumbar lordosis and anteriorly tilting the pelvis. This anterior tilt of the pelvis allows increased external rotation at the hip because the acetabular shelf is much deeper postero-superiorly than postero-inferiorly [6]. Repeated and prolonged hyperextension of the lumbar spine may well result in damage of the zygapophyseal complex. Damage to these structures from excessive loading through compression and tension has been shown to be closely related to back pain [5].

This observational study aimed to quantify the changes that occur at the lumbar spine (lumbar lordosis) and pelvis (pelvic angle) when adopting standardized degrees of turnout. We hypothesized that there would be changes in the lumbar and pelvic angle when different foot positions were adopted. Reliability analysis of the data collected was also under taken.

Method

Twenty five pre-professional dancers (10 males, 15 females, age (years) 19.54 (1.41), height (centimeters) 168.53 (6.48), weight (kilograms) 63.12 (8.16)), were recruited according to specific inclusion and exclusion criteria. Markers were placed by the same researcher on the anterior and posterior superior iliac spines and the spinous processes of the cervical spine level 7, thoracic level 12 and lumbar level 4. Two dimensional video data (sagittal view) was captured for each subject. Data was obtained from each subject for four foot positions in a randomized order. Foot positions in parallel standing, 90°, 150° and 180° of turnout in the first position were standardized by floor markers. A bespoke programme (R.W Deursen, Cardiff University) using Silicon COACH™ and MATLAB (The Math Works, USA) analyzed pelvic and lumbar angles at different foot turnout positions. Repeated measures ANOVA and Bonferroni correction analyzed difference between foot position and lumbar and pelvic angle. All subjects gave informed consent. Institutional Ethical approval was obtained.

Results

Intra-class correlations demonstrated that measurements taken using Silicon COACH™ and MATLAB demonstrated high reliability with all scores being reported as >0.90 for both the lumbar and the pelvis angle. The descriptive data of the lumbar and pelvic angles recorded at each foot position are shown in Table 1.

Analysis revealed significant increases in anterior pelvic tilt and lumbar lordosis as the degrees of turnout increased ($P<0.05$), except for lumbar lordosis when comparing parallel position to 90°.

Discussion

Overuse injuries are very common in dancers and arise from repetitive micro trauma to bone

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Table 1: Degrees (Mean and Standard deviation) of lumbar and pelvic angle at different degrees of turn out.

Foot turnout position	Lumbar Angle (Degrees)	Pelvic Angle (Degrees)
Parallel	32.07(5.14)	10.44 (4.30)
90°	32.84 (5.45)	11.88(4.46)
150°	34.85(5.53)	14.89 (4.76)
180°	37.40 (5.78)	17.94 (4.67)

or soft tissue structures. Due to the intensive nature of training and competition, recovery may be delayed as the injury cycle persists if causative factors are not eliminated [3]. Dance technique is characterized by the use of extreme positions such as turnout, which can place undue stress on muscles, joints and tendons particularly in the lower limbs and spine [3], and when this is combined with high training volumes injury risk is increased [1].

These findings support the hypotheses that there is compensation in the kinetic chain when during different positions of the turnout position. These changes in the lumbar lordosis and pelvic angle could have implications for loading of the tissues in the region due to overloading due to repetitive training [9]. At 180° we observed the highest degrees of anterior tilt and lumbar lordosis. This hyperextension of the lumbar spine could lead to impact of the posterior elements of the spine including the zygoapophyseal joints, as well as lengthening of the anterior structures of the trunk including the abdominal wall musculature such the internal oblique's, transversus abdominus and rectus abdominus. These findings have implications for rehabilitation in relation to strategies adopted for strength and conditioning training of the pelvis and trunk in dancers, as optimal functioning of the lumbo-pelvic musculature is a key component in order to reduce the occurrence and persistence of low back and pelvic pain.

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