

Kinematic analysis of sway motions of elite dance sport competitors

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Purpose: This study aimed to identify the potential relationship between scores given by judges and kinematic variables used to characterise the sway movement in the Viennese waltz as performed by dance sport athletes.

Methods: The study involved six world-class and six intermediate dance couples. The pairs were asked to perform three identical series of three natural spins of the figure in a Viennese waltz and were all recorded by camera as they danced to music. Six international adjudicators evaluated all trials of each couple from the viewpoint of the technical quality component based on the Absolute Judging System. A triaxial rotational angular velocity measurement device (gyroscope) was placed on the dorsal part of the pelvic girdle and on the posterior part of the thorax of every athlete.

Results: The analysis of covariance showed that maximum angular rotation velocities of the thoracic spine in forward sway movements (in the transverse plane) in male dancers were strongly associated with the judging score obtained ($F_{1,9} = 11.5$; $P < .05$; $\eta_p^2 = .05$) regardless of the assignment to the given group.

Conclusion: According to the study conducted and a comparison of elite and intermediate level athletes, the proposed method of assessing, presenting and reviewing the movement profile of the pelvic girdle and thoracic movement is likely to become useful for the overall assessment of movement technique, and also for carrying out quick and effective qualitative and quantitative biomechanical assessment of selected components of movement technique in dance sport.

Keywords: Standard style, technique, ballroom dancing, Viennese waltz, absolute judging system.

Introduction

The World DanceSport Federation is committed to continually improving its judging methods and systems in an effort to make them more transparent and clearer and seeks to eliminate any possible ambiguity in the process.^{1,2} Nevertheless, some authors have suggested that its definitions of dance and the components and subcomponents of the assessment, as well as their scale, need to be described in much more detail.³⁻⁵ Sway movement is one of the key components in an assessment of body movements, and experts consider it to be one of the primary actions that is specifically considered in the assessment process.^{6,7} A kinematic assessment of the individual movements performed during a dance by top-level competitors, using accelerometers, may prove to be very useful in teaching couples movement technique and also in quantitatively assessing their dance.⁸ Theoretically, a kinematic characterisation of top-level couples could help develop a movement model for a top level and, over a longer time horizon, may support the jurors in effectively and objectively assessing dance couples.^{9,10} Publications on movement technique in standard dance suggest that sway motions are considered as one of the most important motions that are executed while dancing.¹¹ A review of the literature suggests that no research has yet been performed by other authors on the relationship between the technical execution of individual dance elements and the assessment given by the judges. The purpose of this study was to identify a possible relationship between scores given by the

jurors and variables that describe the sway movement in the Viennese waltz as performed by dance sport athletes.

Material and methods

Participants

The present study involved a total of twelve dance sport couples. The purpose and method of the procedure, along with the opportunity to opt out without having to give reasons at any stage of the survey, were communicated to all respondents, and they provided their written consent to participate. The research was granted with ethical approval from the local ethical committee (number SKE 01-13/2022) and it was performed according to the principles outlined in the Declaration of Helsinki. Six pairs from the adult category of the championship group were tested to obtain a movement pattern. All the athletes from this group are of the highest sport class (international class) and are champions or vice-champions of their respective countries. The studied competitors represent the top world level in standard style. The other six couples participating in the study are Polish, of a sporting dance class competing at the national level, which is characterised by an average sporting level. Table 1 below specifies the basic characteristics of the top-level and intermediate groups.

Table 1. Mean (SD) values of age, body weight, training experience and BMI of top level and intermediate group athletes

	Top Level Group		Intermediate group	
	Males (n = 6)	Females (n = 6)	Males (n = 6)	Females (n = 6)
Age (years)	31±3.6*	28±3.9*	20±2.4	19.7±2.0
Body height (cm)	182±3.8	170±6.3	181.5±3.4	170.8±4.9
Body mass (kg)	71.3±3.0	52.7±4.0	72.7±4.1	52.8±5.7
BMI	21.6±1.0	18.2±0.4	22.1±1.3	18.1±1.3
Training experience (years)	22±2.6*	19±3.1	11.8±1.5	12.7±2.1

Different than in intermediate level group: * – $p < 0.05$

Accelerometric measurement of kinematic characteristic features in dance

The angular velocity of the pelvic girdle (ω_{z1}) and thoracic spine (ω_{z2}) around the sagittal axis was measured. 90 seconds was the measurement time for every trial and 200 Hz was the sampling rate. To measure the angular velocities of the thoracic spine and pelvic girdle segments of the dancers participating in the study, four three-component accelerometers with gyroscope function were used (ZPP-3D/B, Zb. Staniak, Poland length x width x depth: 8x4x2 cm, mass: 70g with a frequency of 500 Hz)¹² and the data were downloaded wirelessly. Angular velocities were measured while the dance couples performed clockwise rotations, which are a basic figure from the Viennese waltz called the "natural turn".¹¹ Three identical series of three complete natural turns along a straight line were performed by all couples in the top-level and intermediate groups on the dance floor. The studied sport couples danced to music at a tempo of 60 bars per minute with each of the three iterations recorded by a camera in 4K quality, 30 fps. Six judges, holding an international World DanceSport Federation judges' licence, appraised all the dance pairs' rehearsals. In their evaluation, the judges took into account each of the three dance repetitions of the competitors using a technical quality criterion on a scale of 1 to 10 as defined by the Absolute Judging System (AJS). Considering that the first natural turn is accompanied by a preparatory movement and the last one by a stopping movement, it was decided that only each second natural turn of the tested couple should be considered in the analysis of the kinematic characteristics of the dance and the judges' evaluation.

Arrangement of recorders

Two triaxial acceleration and triaxial rotation angular velocity sensors were positioned in foam stabilisation pads and then arranged on the dorsal part of the pelvic girdle (sacroiliac joint) and the thoracic (Th5) spine of the tested dancers. Stability pads

with accelerometers were attached with a rubber band.

Statistical analysis

For needs of the analysis the following variables were established: average difference of the squares of the angular velocity waveforms ω_{z1} and ω_{z2} (C) in male and female dancers:

$$C = \frac{1}{T} \int_0^T [\omega_{z1}(t) - \omega_{z2}(t)]^2 dt,$$

where t is time, and T is time of execution of a sway movement, as well as minimum, mean, maximum and standard deviation values of angular velocities of rotation in relation to the sagittal axis of the pelvic girdle (ω_{z1}) and angular rotation velocities in relation to the sagittal axis of the thoracic spine (ω_{z2}). Sway is the lateral tilt or flexion of the body to the left or right of the sagittal axis. It can be used in any movement that involves rotation. Each rotation is initiated by a step with an opposite body movement and is immediately followed by a sway movement in subsequent steps. As the study group was quite small, it was decided that the non-parametric Mann-Whitney test should be used to compare the obtained values of relevant kinematic criteria to appraise the technique of dancers from the top-level and intermediate groups and, as an indicator of the effect size, Glass's biserial correlation coefficient. To examine the dependence of judges' scores on the quantitative predictor under study (accompanying variable) and group membership (top level, intermediate), an analysis of covariance (ANCOVA) was conducted. Specific variables were used as an accompanying variable to describe the kinematics of dance. The magnitude of the effect was assessed by applying the partial eta squared value (η_p^2). Spearman's rank correlation coefficient was used to compare the concordance of the mean courses of angular velocities of dancers from both studied groups. The level of significance was set at $\alpha = .05$. Statistica 13.0 was applied to carry out the statistical analysis.

Results

Scores awarded by adjudicators

Table 2. Average scores awarded by the judges for the technical quality component to couples in the top-level (champion) and intermediate groups are presented in Table 2 below.

	Top level group						Intermediate group					
mean scores of adjudicators	9.79	9.43	9.33	9.49	8.79	8.19	3.43	3.17	2.45	3.04	3.18	2.77

Sway motion of dancers in forward movement

Significant differences were noted among group of men with respect to the mean angular velocities of hip rotation (ω_{z1}) ($Z = -2.16$; $P < .05$; $R = .7$), in the maximum angular velocity of the thoracic spine rotation (ω_{z2}) ($Z = 2.00$; $P < .05$; $R = .7$) and in standard deviations in angular velocity of thoracic spine rotation (ω_{z2}) ($Z = 2.00$; $P < .05$; $R = .7$). The analysis of covariance also showed that maximum angular rotation velocities of the thoracic spine in forward sway movements in males were strongly associated with the score obtained from the jury ($F_{p9} = 11.5$; $P < .05$; $\eta_p^2 = 0.5$). The characteristics of mean changes in the angular velocity of pelvic rotation (ω_{z1}) of men from the top-level and intermediate groups point to the existence of considerable similarity (correlation $R = .6$).

Significant differences in the minimum angular velocities of hip rotation were observed among women (ω_{z1}) ($Z = -2.00$; $P < .05$; $R = .7$), deviations of standard angular velocities in the pelvic girdle rotation (ω_{z1}) ($Z = 2.00$; $P < .05$; $R = .7$) and standard deviations of angular rotation velocities of the thoracic spine (ω_{z2}) ($Z = 2.16$; $P < .05$; $R = .7$). Characteristics of mean changes in velocity ω_{z1} between female dancers in the championship and intermediate groups indicate a significant correlation ($R = .5$). However, at the end of the first step, the rotation of the pelvic girdle of the top-level group dancers tends to slow down.

Sway motion of dancers in backward movement

Significant differences were observed in the mean angular velocities in rotation of the thoracic spine (ω_{z1}) ($Z = -2.80$; $P < .05$; $R = .9$), at maximum velocities of angular rotations of the thoracic spine (ω_{z2}) ($Z = -2.80$; $P < .05$; $R = .9$) and in standard deviations of angular rotation velocities of the thoracic spine (ω_{z2}) ($Z = -2.64$; $P < .05$; $R = .9$). A significant difference was also observed in the mean squares of signal differences between the angular rotation velocities of the pelvic girdle (ω_{z1}) and the angular velocities of the thoracic spine (ω_{z2}) ($Z = -2.64$; $P < .05$; $R = .9$). The mean courses of angular velocities of pelvic girdle rotation (ω_{z1}) of male dancers from the top-level and intermediate groups are characterised by similarity ($R = .5$). An increase in velocity was observed in the second and third step. The velocity of the sway movement of intermediate dancers increased only during the second step. A significant difference was observed between the women's groups in the minimum angular velocities of hip rotation ω_{z1} ($Z = 2.32$; $P < .05$; $R = .8$), in standard deviations of the angular velocity of hip rotation (ω_{z1}) ($Z = -2.00$; $P < .05$; $R = .7$) and in the standard deviation of the angular velocity of rotation of the thoracic spine (ω_{z2}) ($Z = -2.32$; $P < .05$; $R = .8$).

Consistency of the sway motion in forward movement

Significant correlations of the mean angular rotation velocities in the forward leaning movement were noted in the top-level group and the intermediate group. A stronger correlation in the angular rotation velocities of the pelvic girdle (ω_{z1}) were observed in the execution of the sway motion of women and men from the intermediate group ($R = .8$). For the top-level group dancers, $R = .5$. As regards the characteristic description of changes in angular rotation velocity of the thoracic spine (ω_{z2}) of women and men from the top-level group, a high correlation was observed ($R = .9$). Figure 1 below shows an example of the mean angular velocity waveforms ω_{z1} during the execution of the forward sway motion of the female dancer (F) and male dancer (M) from the top-level group.

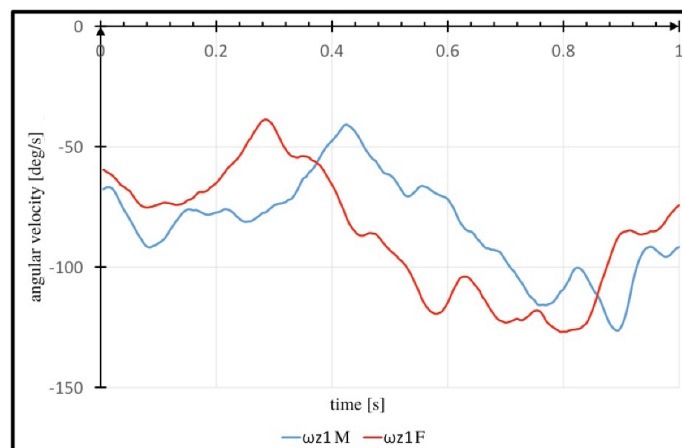


Figure 1. Average angular velocity waveforms ω_{z1} during the performance by a female (F) and a male (M) dancer from the top-level group of the forward sway movement

ω_{z1} – Angular velocity of rotation in relation to the sagittal axis of the pelvic girdle

Significant differences between female and male top-level dancers were found for the average speeds ω_{z2} ($Z = -2.48$; $P < .05$; $R = .9$) and minimum velocities in angular rotation of the thoracic spine (ω_{z2}) ($Z = -2.64$; $P < .05$; $R = .9$). Significant differences were also noted in the mean squares of signal differences between the measured angular velocities of rotation of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) ($Z = -2.32$; $P < .05$; $R = .8$). Significant differences were observed between men and women in the intermediate group in the execution of the sway movement in forward steps – in the mean angular velocities of rotation of the thoracic spine (ω_{z2}) ($Z = -2.64$; $P < .05$; $R = .9$), in the maximum angular rotation velocities of the thoracic spine (ω_{z2}) ($Z = -2.80$; $P < .05$; $R = 1$) and in the mean squares of the signal differences between the angular rotation velocities of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) ($Z = -2.80$; $P < .05$; $R = 1$).

Consistency of the sway motion in backward movement

Substantial correlations were observed among male and female dancers of the intermediate as well as top-level groups. A higher correlation in the angular velocity of pelvic girdle rotation (ω_{z1}) was observed in dancers from the intermediate group ($R = .5$) as compared to dancers from the master group, where $R = .5$. A significant correlation of $R = .7$ was detected in the angular rotation velocities of the thoracic spine (ω_{z2}) of female and male dancers in the top-level group. No significant correlation in the angular rotation velocities of the thoracic spine (ω_{z2}) was detected in competitors of the intermediate group. When comparing the execution of the sway motion by female and male dancers in backward steps, significant differences were noted in the top-level and intermediate groups. In the mean, minimum and maximum angular velocities of the thoracic spine (ω_{z2}), ($Z = -2.80$; $P < .05$; $R = 1$). A significant difference was also found in the mean squares of the differences in the angular velocity signal of rotation of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) ($Z = -2.80$; $P < .05$; $R = 1$). Angular velocities of rotation of the thoracic spine in women are higher than in men in both groups.

Comparison of simultaneous execution of the sway movement between men and women

Significant differences were observed between men and women in both groups in mean values ($Z = -2.80$; $P < .05$; $R = 1$), minimal ($Z = -2.80$; $P < .05$; $R = 1$) and maximal values ($Z = -2.80$; $P < .05$;

$R = 1$) of angular rotation velocities of the thoracic spine (ω_{z2}) and in the mean squares of the differences in the rotation angular velocity signal of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) ($Z = -2.80$; $P < .05$; $R = 1$). In average ($Z = -2.16$; $P < .05$; $R = .8$) and maximum ($Z = -2.16$; $P < .05$; $R = .8$) angular rotation velocities of the pelvic girdle (ω_{z1}), differences were observed only in the master group. In the intermediate group, no significant differences in angular velocities of rotation of the pelvic girdle were found (ω_{z1}). The Mann-Whitney test revealed significant differences in the tested kinematic variables between men and women only in the championship group (M) – in the average angular velocity of pelvic girdle rotation (ω_{z1}) ($Z = 2.00$; $P < .05$; $R = .7$), in the thoracic spine (ω_{z2}) ($Z = 2.80$; $P < .05$; $R = .7$), in minimum angular velocities of rotation of the pelvic girdle (ω_{z1}) ($Z = 2.00$; $P < .05$; $R = .7$), in standard deviations of angular rotation velocities of the pelvic girdle (ω_{z1}) ($Z = 2.00$; $P < .05$; $R = .7$) and in the mean squares of the differences in angular velocity signals of the pelvic girdle rotation (ω_{z1}) and the thoracic spine (ω_{z2}) ($Z = 2.32$; $P < .05$; $R = .8$).

Discussion

Understanding the characteristics of variable kinematic sway movements can contribute to developing a correct movement technique in many sports disciplines, including sports dance.^{13,14} The authors point out the need for understanding the biomechanics of movement in sports-artistic disciplines in order to improve the training process, but also to prevent potential injuries.¹⁵ Our research showed that the sway movement of dancers performed during the forward dance in both groups of men (master and intermediate) differs significantly in terms of the achieved mean angular velocities of rotation of the pelvic girdle (ω_{z1}), maximum angular velocities of rotation of the thoracic spine (ω_{z2}) and in terms of standard deviations of the courses of angular velocities of rotation of the thoracic segment of the spine (ω_{z2}). The results of our research demonstrate that the maximum angular rotation velocity of the thoracic spine in forward sway motions in males has a determinant impact on the judging score. The study confirmed the similarity of the motion performed by both groups of male dancers. This was corroborated by the positive correlation of angular velocity changes with respect to the sagittal axis of the pelvic girdle ($R = .6$) of the studied male dancers. It is interesting to note that the characteristics of changes taking place in signal components of the thoracic spine (ω_{z2}) of male dancers in the top-level group are visibly different from those of the intermediate group in the second and third steps of the right rotation. Based on the results of our research and a video analysis, it was concluded that the thoracic spine of the top-level athletes increases its angular velocity of rotation to the left at the end of the first step and in the main part of the second step. The change in sway from left to right occurs at the end of the second step and continues in the third step of the natural turn. Such performance, while commonly recommended by coaches, has so far not been described in any scientific paper in the literature. An interesting phenomenon was also observed in the final part of the third step, where the velocity of the thoracic spine (ω_{z2}) in the incline movement of male dancers in the top-level group is significantly higher than that of the dancers in the intermediate group. This points to more efficient preparation of the sway, which is to be made in the second part of the figure. The results of our study are consistent with the theory described by Shioya¹³ and confirm that the sway motion in the Viennese waltz should be started in the second step of the natural turn. Taking note of this fact may be particularly helpful when novice

dancers are learning this motion. An interesting phenomenon is the timing of the maximum velocities reached by the women's pelvic girdle relative to the sagittal axis. Female dancers in the top-level group reach their maximum velocities earlier than women in the intermediate group, and in the case of the thoracic spine segment (ω_{z2}) much later, at the end of the sixth step of the natural turn. As regards female dancers in the intermediate group, the angular rotational velocity is characterised by retaining the velocity of the maximum values of the thoracic spine for the first two steps of the forward movement (steps 4-5). The decline in velocity was observed in the last, sixth step. As regards female dancers of the top-level group, changes in the velocity of the angular rotation of the thoracic spine (ω_{z2}) can be seen in each step taken forward. In the final phase of the fourth and sixth steps, the velocity of the sway movement of the upper part to the left increased, similarly to the male dancers in the top-level group in the same movement. The characteristics of changes to angular velocity of rotation in the sway motion of the pelvic girdle in female dancers from both groups (ω_{z2}) in forward steps appear to be highly similar. This is corroborated by the Spearman correlation ($R = .6$). It is interesting to note the decline in the angular velocity of the tilting movement of the pelvic girdle (ω_{z2}) in top-level dancers in the final phase of the fourth step, and its subsequent increase to a maximum velocity already in the fifth step. Arguably, this may be an effect of emphasis on the number two beat in the music and the impetus given to the dance couple by the person moving forward.¹⁶ Given the changes in velocity of the sway movement of female dancers in the intermediate group, a smaller amplitude of change in the velocity can be observed in relation to the dancers of the top-level group. It seems that the movement of dancers in the intermediate group is smooth and is characterised by a slight increase in velocity from the beginning of step four to the last one. In the sway movement with respect to the sagittal axis of the thoracic spine (ω_{z2}), no significant correlation was observed between the female dancers' groups, although it can be noted that in both groups the women maintained a leftward sway in all forward steps. Certainly, the tilting movement of elite dancers is characterised by a more dynamic change in angular velocity relative to the sagittal axis. It is puzzling that the results of our study did not indicate a correlation of the achieved maximum angular rotation velocity of the thoracic segment (ω_{z2}) with the adjudication as in male dancers.

The results of our research and data obtained from cited literature supported the conclusion that the factor differentiating to the greatest extent the top-level group from the intermediate group is the way in which the upper body sway motions are performed. Significant differences were observed between groups of male dancers in mean and maximum velocities and in standard deviations of angular velocities of rotation of the thoracic spine (ω_{z2}). As a result of the significant differences mentioned above, there is no correlation between the components of the angular rotation signal with respect to the sagittal axis of the thoracic spine (ω_{z2}). In the available literature, the authors seem to be unanimous in stating that top-level pairs have made the most progress in upper body work over the last few years.¹⁷

The results of our study were found to support this observation. The characteristics of signal increments of the mean angular velocity changes in the rotation of the pelvic girdle (ω_{z1}) relative to the sagittal axis in men from both groups are similar. This may be proven by the positive correlation of $R = .5$. An increase in the components of the pelvic girdle signal (ω_{z1}) of male dancers in the intermediate group was only observed during the fifth step

of the natural turn, while in men in the top-level group it was observed in the fifth and sixth steps of the clockwise rotation in the backward motion. This indicates the correct execution of the sway movement in the latter group, which is continued until the end according to Zaletel et al.¹⁸ The phenomenon described in our research is also confirmed by the research of other authors.¹³ It is suggested that the sway motion should be observed to the same extent in the movement of the pelvic girdle (ω_{z1}) and the thoracic spine (ω_{z2}).¹⁹ However, the results of our research challenge this theory. Based on the studied kinematic variables of the top-level group, it can be concluded that the sway movement is evident in the lower and upper body. However, the thoracic segment of the spine (ω_{z2}) of the dancers is involved to a greater extent in the sway movement. An increase can be observed in the speed and achievement of the maximum angular velocity of rotation of the thoracic spine (ω_{z2}) of female dancers in the top-level group at the end of the first step and at the beginning of the second step. Significant correlations among dancers from the intermediate and top-level groups indicate a similarly executed sway movement of the pelvic girdle (ω_{z1}) in women and men. A lower amplitude of the sway movement of the pelvic girdle (ω_{z1}) in male and female dancers in the intermediate group contributed to a higher correlation ($R = .6$) as compared to pairs in the top-level group, where $R = .5$.

The effect of dancing in high-heeled shoes on the kinematic variables recorded was not addressed in this work. It would be useful to investigate this factor in prospective studies.

Other authors have analysed the relationship of a female dancer's initial position with greater deviation. It is argued that this could be a cause of greater stress on the spine, which may be the reason for frequent injuries and trauma among female dancers.²⁰ The somatic characteristics of sports dancers have already captured the interest of some researchers.²¹ However, the relationship of these characteristics to the dancers' movement technique has not yet been explored in the literature.

According to the literature, sway movements in dance partners tend to be antagonistic.²² When the male makes a sway motion in relation to the sagittal axis to the right, the female dancer should perform the same sway movement in relation to the sagittal axis to the left.²³ Accordingly, the mean squares of differences in the angular velocity signal of rotation and the significant differences in the angular velocities of rotation of the tested body points ω_{z1} and ω_{z2} of the women and men should indicate that the motion performed is consistent. In the first part of the natural turn figure (steps 1-3), when the male moves forward and the female moves backward, a significant difference was observed in mean squares of differences in the signal of the angular rotation velocities of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) in the top-level and intermediate groups. The sway movement of the pelvic girdle (ω_{z1}) differed considerably between men and women in the intermediate group in mean and maximum rotational angular velocities. This phenomenon was not observed in the intermediate group, indicating non-uniform performance of the pelvic girdle sway movement (ω_{z1}) of intermediate dancers. An analysis of the characteristics of changes in angular velocities of pelvic girdle rotation (ω_{z1}) in the master group revealed a clear exchange of activity. As the female dancer increases her angular velocities relative to the sagittal axis, a decrease in the angular velocities of the pelvic girdle is observed in the male dancer (ω_{z1}). The opposite occurs in the second part of the natural turn. No such clear exchange of sway motions was recorded in the intermediate group. Hearn²³ reported that the exchange of

motions and the difference in sway created in such a way result in more intense paired harmony and momentum. In the second part of the natural turn figure (steps 4-6) when men danced backwards and women danced forwards, significant differences were detected in the angular velocities of rotation of the pelvic girdle (ω_{z1}) and of the thoracic spine (ω_{z2}) between dancers in the top-level group only. The lack of significant differences between the measured velocities of selected points of the sway motion of dancers from the intermediate group indicates a weaker technical execution of the figure. In the second part of the natural turn, no significant differences were observed in the intermediate group. According to the literature, the person moving forward is always responsible for all activity in the couple.¹³

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Summary and conclusions

The results of the present research indicate that the scores awarded by judges for the quality of movement technique are to a large extent convergent. Top-category judges were unanimous in their judgement of dance couples from the top-level and intermediate groups. The group of top-level dancers differs from the group of intermediate dancers in terms of component criteria related to technical quality expressed quantitatively and qualitatively in terms of the courses of angular velocities performed during sway movements. It is worth noting that the exchange of movements during the dance between men and women observed in the top-level group does not result in an obvious simultaneous different sway of women to the left and men to the right and vice versa, as should happen according to the rules laid down in dance manuals. It should also be noted that the pelvic girdle is positioned in a rightward tilt most of the time and the thoracic spine is positioned in a leftward tilt. This is a very interesting phenomenon that indicates greater complexity of body sway changes between men and women in the top-level group than is described in the dance literature.

Ethical Committee approval

The research was granted with ethical approval from the local ethical committee (number SKE 01-13/2022).

Author-s contribution in according to ICMJE

Szymon Kuliś, design of the work; analysis and interpretation of data for the work, drafting the work reviewing it critically for important intellectual content, final approval of the version to be published

Matej Chren, analysis and interpretation of data for the work
Jan Gajewski, reviewing it critically for important intellectual content, final approval of the version to be published

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