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BIOMECHANICAL ANALYSIS OF HUNGARIAN FOLK DANCERS: THE EFFECT OF FATIGUE ON THE 'KALOCSAI MARS' DANCE

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1. Introduction

Biomechanics is widely used in sports for training, injury prevention, and device development purposes. However, the motion of Hungarian folk dancers was never analyzed previously from a biomechanical point of view [1] [2]. The staging of folk dance forms has a significant history in Hungary, dating back to the late 19th century. From children's ensembles to the most professionally organized groups, audiences in Hungary are treated to a wide variety of creatively reinterpreted Hungarian folk dance and folk music traditions [3].

The research contributes to long-term cooperation with the national folk dancers to improve the performance and help them to prevent injuries. The primary aim of the present work is to analyze the effect of fatigue on Hungarian folk dancers executing a set biomechanical measurement.

2. Materials and methodology

2.1 *Subjects and the investigated motion*

5 female and 6 male healthy adult dancers were involved in the study (age: 20.54 years, body height: 173.8 cm, body mass: 64.7 kg, BMI: 21.42), whom has at least 5 hours of practice in a week. None of the participants had suffered any injury which affects the locomotion and balancing system.

A relatively simple and repetitive folk movement was chosen as the investigated motion containing a series of short jumps and leg swings. This movement generally part of a dance called 'Kalocsai mars,' a detailed video of the motion can be watched via the following link: https://youtu.be/goCMP8qeEA8. Even though all the participants had prior experiences in this specific folk dance style, eligible practice time was provided to expertise the movement.

2.2 *Measurement setup and procedure*

An OptiTrack (NaturalPoint, Corvallis, Oregon, USA) based optical motion capture system was used to capture the dancers' motion. Flex 13 cameras were used with the resolution of 1.3 MP, the viewing angle of 56°, the maximum recording speed of 120 FPS, with accuracy of 0.5 mm [4]. This present study examined loads of lower extremities; thus, 16 markers were placed on the dancers' lower body (according to the Conventional Lower Body biomechanical model[1]). Simultaneously, a BTS P6000 (BTS Bioengineering, Italy) force plate was used to capture the ground reaction forces. with 600x800 mm total detection range. The maximum load capacity of a single force plate was 8000 N. The sampling frequency was 1000 Hz. The origin of the force plate and the motion tracking system were calibrated into one point.

During the fatiguing session, participants have to perform the examined motion of the 'Kalocsai mars' dance for 30 seconds. A 30 seconds resting period was allowed after each session. The dancing movement was repeated ten times.

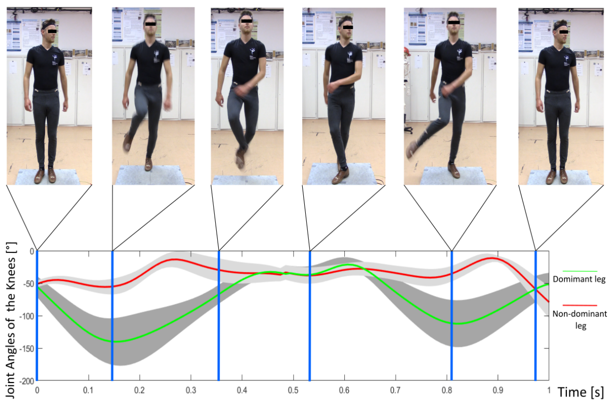

Fig. 1. ROM of knee flexion-extension angle during half a cycle

[1] https://v22.wiki.optitrack.com/index.php?title=Skeleton_Tracking#Biomechanics_Markersets

2.3 Data analysis

Applying the captured 3D positions of the anatomical landmarks, the angular parameters were calculated with the Inverse Kinematics toolbox of Opensim software (NIH Center for Biomedical Computation, Stanford University). The investigated parameters were the range of motion (ROM) of knee flexion-extension angle, hip flexion angle, and pelvic tilt angle. Prior to the experiment, dancers were asked to choose their dominant leg. Hence, in the pos-processing procedure, dominant and non-dominant leg would be distinguished. To qualitatively analyze the motion, the recorded fatiguing session had to split into cycles. One dance cycle lasted from a closed position to the next closed position. The average and the standard deviation of knee and hip joint angles for half cycle are shown in Fig 1. From the recorded ground reaction force (GRF) during the fatiguing session, the absolute maximum value was obtained and analysed in each cycle.

ANOVA tests were performed on the dataset. The parameters were the mean values of the biomechanical parameters. The factor was time in 30 seconds intervals. The null hypothesis was that the biomechanical parameters change with a confidence level of 0.05 due to fatigue.

3. Results

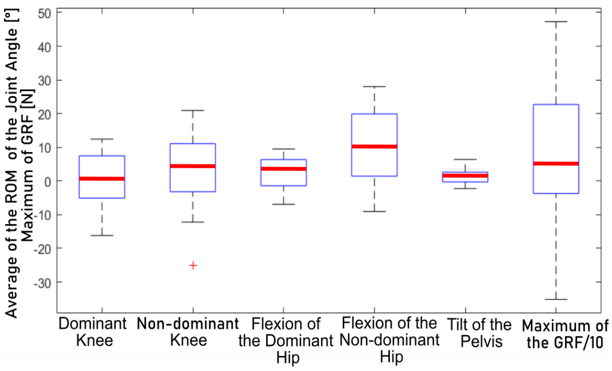

Fig. 2. The box plots of the differences between the first and last dance of the motion parameters.

Fig. 2. shows the mean differences between the first and last dancing sessions. Where parameters higher than zero suggest that the average of the ROMs of the last dance has escalated due to fatigue. This means that during the last dance session, most of the dancers executed the motion with a larger ROM in joint angles. The awaken forces of the last dance were greater than it was in the first dance. This means that the dancers paid less attention to the impact of the foot during last dance session. Furthermore, the results of the ANOVA test showed that there was a significant difference between the dominant and non-dominant knee joint angle, and non-dominant hip flexion angle (Table 1.).

Table 1. Results of the ANOVA tests.

Parameter name	p value [-]
Dominant knee flexion-extension angle	0.0443
Non-dominant knee flexion-extension angle	0.0033
Dominant hip flexion angle	0.0786
Non-dominant hip flexion angle	0.0052
Pelvic tilt angle	0.0665
Maxima of the ground reaction forces	0.6451

4. Conclusion

The present paper examined the effects of fatigue on joint angles in Hungarian folk dancers. As a result of the repetitive fatiguing session, the ROMs of joint angles increased by the end of the last session, suggesting that the dancers' movements are less bounded at the end of the session. Based on the statistical analysis, the motion of both knee angles changed significantly and affected by fatigue. Moreover, the ROM of hip flexion angle of the non-dominant leg also changed significantly, which may have caused by the fact that the dancers paid less attention to the non-dominant leg due to fatigue. The increased magnitude of ground reaction force and the changes in joint angles both could result higher loads in joints and muscles and may end as an injury.

Acknowledgements

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