

## **ANALYSIS OF KINETIC PARAMETERS OF UPPER LIMBS IN SPECIAL EXERCISES AND HURDLING**

### **Summary**

Hurdling is a spectacular and unique competition. Four aspects are required to obtain high results (speed-resistance-strength-technique), which are combined to form a specific in this competition hurdling “rhythm”. High level development of sport technique in hurdling is a key element to obtain high-class results. Technique analysis of overcoming a hurdle is one of the crucial control elements of the training process and it is an indispensable piece in the development of basic motor skills.

It is worth noting that hurdling is a part of physical education program at primary schools and high schools. It is therefore important to master complex technical skills in hurdle run and exercise, which simultaneously engage all motor skills. Additionally observed improvement in hurdling world records prompts to analyze the training methods in order to improve efficacy of overcoming a hurdle (Geux 2012).

Delving further into scientific literature widely illustrated section dedicated to hurdling technique can be noticed. Subject matter from scientific publications involves a broad spectrum of issues: the “model” of hurdling technique, somatic build, body position at particular moments of overcoming a hurdle, lateralization, the essence of hurdling “rhythm” as well as the aspects associated with the biomechanical evaluation of hurdle step. In studies concerning hurdling scientists focus on the part of overcoming a hurdle, emphasizing the kinematic parameters of lower limbs and almost completely overpassing the upper limbs.

The aim of this paper was the evaluation of upper limb movement during the hurdle clearance in hurdle race and during special exercises taking into consideration the technique of overcoming a hurdle with both lower limbs. To achieve the paper objectives the hypotheses involving issues from the borderline of scientific theories and sport training practice were verified. Issues presented in the paper involve defining the technique structure of the upper limbs while running through hurdle and during special exercises, which are the basis of the hurdling training. Problems defined in the paper refer to qualitative and quantitative evaluation of the upper limbs movement technique.

Studies conducted in 2018-2019 involved three study groups. First group involved the students of the State Higher Vocational School in Raciborz (n=45, age: 20-23 years), second group involved hurdlers, under 23 category (n=35, age: 19-23 years) and third group involved

the competitors from the national team and Polish representatives with minimum first sport class, (n=13; age: 20-29). The studies were conducted under the research project: “Biomechanical and training aspects of special exercises in hurdling” which was approved by the Ethics Committee of AWF in Katowice.

The studies involved: qualitative analysis of the upper limbs movement technique in 60 meters hurdles (I and II study group) and quantitative analysis of the upper limbs spatial parameters. The movement structure of the upper limbs in hurdle marching implicated linear speed of each limb segment and trajectory characteristics (graphs). The analysis of overcoming the third hurdle in running on the curve used 3D model, which allows to establish the human body configuration, i.e. position and spatial reasoning as well as angles between each segment of biomechanical parameters (for example: center of gravity distance from respective segments of the upper limb and rotations for individual joints). On the grounds of the information obtained this way it was possible to discover the upper limbs movement technique upon overcoming a hurdle. Gathered measurement material was established with basic statistics measurements. The compliance with normality of each variable was checked with Shapiro–Wilk test. Lack of Gaussian characteristics in the variables made all the test applied to be non-parametric tests. Comparative analysis of the technique of overcoming a hurdle among groups with different technical levels used Chi-Square test of independence. Wilcoxon test for paired data (dependent data) was used to analyze the differences between the samples. MANOVA test was used to compare march parameters in one sample at three moments (nonparametric equivalent to variance analysis). Comparative analysis of linear speed in reference to dominant and opposite leg was performed with Mann–Whitney U test.

Upper limb movement technique evaluations in physical education students group and hurdling competitors were correctly defined.

Based on the results obtained, it was found that:

1. There are differences in the change of the upper limbs movement technique during sprint hurdling, between the group of physical education students and the group of high-performance athletes. Movement technique of both limbs diversifies both study groups at landing. Changes in elbow joint flexion for trail and attacking upper limb differentiate the study groups at all three moments of overcoming a hurdle.
2. During specialized exercises performed while marching the selection of lower limb impacts the kinematic parameters of upper limbs. In most cases of hurdle marching the trial with dominant lower limb was characterized by greater speed in all analyzed moments.

3. X axis rotation is the parameter with the most important change in the upper limb movement during overcoming a hurdle in two runs trial with homonymous lower limb. Hurdlers gain lower angle change in the shoulder for both upper limbs while they choose left lower limb as attacking one (dominant limb).

Studies have shown that the problem of upper limb movement technique is complex and intriguing from the scientific and adaptation point of view. Upper limbs movement structure is individualized and it is hard to define it explicitly. The analysis results may be used in sport training as well as in hurdle training and methodology.