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PROPRIOCEPTIVE TRAINING STUDY FOR THE OPTIMIZATION OF THE 110 M. HURDLES TECHNIQUE

Ş. ALECU[1] D. IONESCU-BONDOC[1]
A. ONEA[1] F.B. WAER[2]

Abstract: *Proprioceptive training represents a contemporary dimension in athletic preparation, yielding significant performance enhancements for athletes around the globe. Our study aims to quantify the technical performance of the hurdle step via biomechanical analysis. This involves measuring kinematic parameters and their association with the enhancement of coordination abilities, derived from tailored proprioceptive training. By analyzing kinematic parameters and implementing a specialized motor program, we can enhance coordination abilities and rectify technical mistakes. This leads to improved grouping of the lower limbs, quicker transitions, as well as more stable and effective landings. Such improvements optimize the movement path of the body's center of gravity towards the hurdle plane and ensure optimal spatial-temporal alignment for subsequent strides between hurdles.*

Key words: *110 m hurdles, coordinating capacities, proprioceptive training, biomechanical analysis, kinematic records*

1. Introduction

The current research commenced with the notion that 110m hurdles training should culminate in the adoption of a highly precise and cost-effective method through analytical training. This method is informed by a quantified analysis of movement simulations conducted on computers [3], aligning with the tenets of contemporary research. This study seeks to underscore the profound link between

[1] Department of Physical Education and Special Motricity, *Transilvania* University of Braşov.
[2] High Institute of Sport and Physical Education of Sfax, *University of Sfax*, Tunisia.

kinesthetic awareness, the motor memory developed through tailored proprioceptive training, and the enhancement of coordination abilities, directly influencing the technique of hurdling [2]. To fully integrate the treadmill technique for hurdling [10], it is imperative to supplement the fundamental conditions of sports training with advanced techniques that contribute to the enrichment of an athlete's training regimen. This includes kinematic analyses using calibrated cameras. The scrutiny and continual assessment of technical performances [16] via high-definition video recordings and specialized software are instrumental in identifying and rectifying imperceptible execution errors, thereby refining technical precision. Proprioceptive training is essential in elevating athletic prowess [10] across a spectrum of sports, particularly in track and field events. In hurdling, a discipline that requires meticulous coordination, nimbleness, and velocity, the role of proprioceptive training is especially significant. The 110m hurdles, a notably arduous track event, demands that athletes traverse a sequence of ten hurdles while preserving flawless technique and momentum. Mastery in this discipline extends beyond mere physical training; it necessitates the sharpening of proprioceptive faculties to surmount hurdles with exactitude and adeptness. This paper explores the critical role of proprioceptive training in refining the technique of the 110m hurdles and offers insights derived from an extensive study to ascertain its impact [8].

2. Material and Methods

The foundational aim of our research is to quantify the technique of hurdling through biomechanical analysis, which involves recording kinematic parameters that are linked to the enhancement of coordination skills via personalized proprioceptive training [6]. The primary goal of this foundational study on the 110m hurdles, characterized by the objectives, direction, and identification of errors in technical execution, is directed towards a methodical and phased attainment of intermediate and operational goals [5]. It is postulated that through the examination of the recorded kinematic parameters, it is possible to detect execution errors and subsequently, the ideal performance of the technique can be quantified following a biomechanical evaluation. The premise is that the amelioration of coordination capabilities [11] and the amendment of execution errors through the analysis of kinematic parameters will result in improved grouping, a swifter and more balanced transition, and a more secure and effective landing. This includes the space-time positioning with the optimal trajectory [12] of the center of gravity relative to the hurdle. Research in performance sports is increasingly reliant on digital technologies through the introduction of methods and devices in sports, facilitating the emphasis and refinement necessary for achieving peak performance. The integration of biomechanical analysis or the recording of complex motor actions into a digital

format, quantifiable through human motor analysis software, allows for the detection of the biomechanical parameters of the subject's movement [9]. This approach enables the elimination of certain execution errors, leading to the documentation of significant advancements in the technical execution within the sample being studied. Furthermore, the data that is recorded and analyzed [14] can contribute to the rectification of errors, supporting an optimal performance of the sports technique, in this case, the 110m hurdles running. The study is grounded in a kinematic analysis of recorded spatial and temporal parameters. Various components of step biomechanics will be measured in relation to the hurdle:

- The magnitude of the attack angle
- The magnitude of the landing angle
- The horizontal distance from which the attack on the hurdle is initiated
- The horizontal distance of landing from the hurdle [9] The fundamental research included two participants, one a multiple national champion and member of the national team with Olympic prospects, the other a national champion in the junior category III with potential for national team selection [7].

The subjects involved in the research took part in training and competitions at the national level for juniors and youth. These athletes were selected for the following reasons:

Both athletes have won medals at national junior championships

The athletes recognized the benefits of enhancing their hurdle technique [13], cooperated with the experimental research requirements, and consented to participate in the experiment. Details on the experimental study, including anthropometric data and individual performance, are presented in the subsequent table:

The foundational research spanned from 6 March 2018 (initial test) to 23 June 2018 (final test). This timeframe was dedicated to the study, research, analysis, technical instruction, and evaluation of the space-time parameters recorded and verified in the preliminary experiment.

3. Results and Discussions

Based on the data gathered from initial experiments, the foundational research was carried out on each participant, maintaining their anonymity as Subject 1 and Subject 2. Each subject's performance was documented separately under the labels of initial and final tests [4]. The participants engaged in a training regimen designed for national-level competition. The training program, which spanned from the Initial Testing to the Final Testing, was tailored to the specific techniques of hurdling for the 110m event, building upon the groundwork laid during the Preliminary Testing. The motor program [1] implemented from the start to the end of the testing period was predicated on a system that fine-tunes training to optimize balance and re-evaluate kinetic feedback from the start of the jump to the landing. This system

accounted for various adjustments made throughout the testing phases, enabling athletes to consciously address and improve upon technical errors. Using Dartfish software, the longitudinal basic experimental research captured data at four critical junctures of the technical execution as outlined in the preliminary research, aiding in the refinement of the hurdling technique. During the initial phase, which includes the approach, takeoff, and hurdle attack, the takeoff distance was measured at 2.21 m, and the takeoff angle between the foot and the ground was 118°. This deviates from the reference model's 130°, resulting in a higher center of gravity elevation over the hurdle and a clearance height of 0.38 m. At the landing phase, the angle was recorded at 81.3°, leading to a horizontal landing distance beyond the hurdle of 1.54 m. The flight duration was also 0.02 sec longer than the reference model's, influenced by the center of gravity's peak height at 1.43 m above the ground, whereas the ideal is 1.29 m. In F4, the takeoff for the subsequent hurdle was executed at an angle of 120.2°, which will be discussed later as relatively high and unbalanced. In F1, the takeoff occurred at a distance of 2.28 m and an angle of 120°, facilitating better body positioning during the flight phase. During the third phase, the landing post-hurdle was at a mere 1.20 m and an angle of 82.4°, suggesting a lower attack height post-hurdle and an angle closer to the ideal 90° of the reference model, allowing for an improved launch angle of 130.4° for the next hurdle. A notable improvement in the landing angle was achieved through the proprioceptive training program [15], reaching angles of 88.4° and even the ideal 90° for a stable and balanced landing. The enhancement of coordination skills, crucial for the dynamics of hurdling, was realized through proprioceptive exercises that stimulate kinetic awareness, balance, mobility, and the automation of rapid movements.

Table 1

Centralization of kinematic parameters results for the 6 subjects – initial testing and final testing

	Raising the C.G.M. ground level (m.)		Maximum elevation of C.G.M. over the hurdle (m.)		Size of angle of attack (degrees)		Size of landing angle (degrees)		Flight time (sec.)		The horizontal distance from which the attack starts from the hurdle (m.)		Horizontal distance of the landing from the hurdle (m.)	
	T.i.	T.f.	T.i.	T.f.	T.i.	T.f.	T.i.	T.f.	T.i.	T.f.	T.i.	T.f.	T.i.	T.f.
S1	1,43	1,34	0,38	0,28	118	120	81,3	82,4	0,36	0,34	2,21	2,28	1,54	1,20
S2	1,44	1,36	0,45	0,37	120,2	121	78,5	81,9	0,43	0,39	1,99	2,06	1,76	1,64

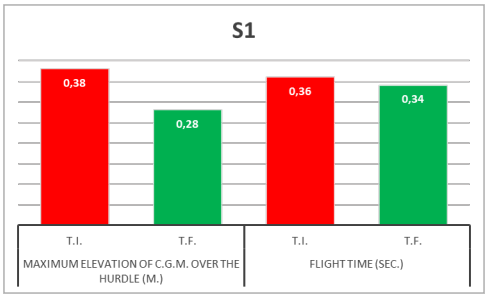

Fig. 1. *S1 Maximum elevation and flight time evolution Initial Test vs. Final Test*

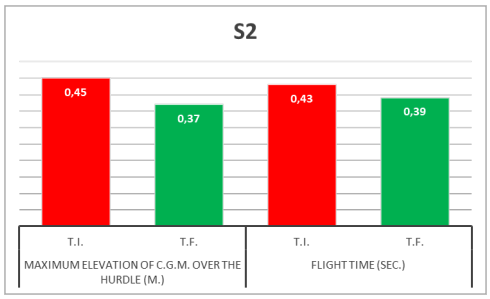

Fig. 2. *S2 Maximum elevation and flight time evolution Initial Test vs. Final Test*

To excel in hurdling, an athlete must integrate swiftness, flexibility, and precise technique. Proprioceptive training is aimed at enhancing the athlete's recognition of their body's positioning and movement, which is crucial for superior coordination and command. Engaging in exercises that test and improve balance, steadiness, and awareness of spatial positioning allows athletes to sharpen their motor functions and the feedback systems for proprioception, which are indispensable for hurdling expertise.

In our investigation, the athletes engaged in a systematic proprioceptive training schedule, which was specifically devised for the 110m hurdles' requirements. This schedule included a blend of proprioceptive routines, dynamic strength exercises, and drills tailored to hurdling, all intended to boost neuromuscular synchronization and proprioceptive sharpness. Throughout the training program, the participants exhibited marked enhancements in their hurdling technique, as shown by decreased times in clearing hurdles and more fluid transitions between them.

Additionally, proprioceptive training brought about supplementary benefits that went beyond the improvement of technique. The athletes experienced an increase in kinesthetic sensitivity, better equilibrium [17], and a reinforced sense of assurance in their hurdling performance. These outcomes highlight the comprehensive benefits of proprioceptive training, which not only augments performance but also contributes to the prevention of injuries and the holistic development of the athlete.

4. Conclusions

The study conducted through an analytical program focusing on key parameters during the hurdling phase has revealed that the main hypothesis stands validated through the rectification of technical flaws and the enhancement of hurdle navigation. The application of a proprioceptive training regimen has enabled two athletes to achieve notable progress and results, particularly in crucial metrics such as the flight duration over

the hurdle and the peak elevation of the Center of Gravity Mass (CGM) above the hurdle. It has been observed that for junior athletes, sports training in the 110m hurdles is significantly enriched by proprioceptive training. This training, informed by analysts' insights, employs selected methods that foster the growth and refinement of precise technical execution. This is achieved by developing combined, coupled, and segmental coordination abilities, as well as spatio-temporal orientation and dynamic kinetic and static capabilities. The experimental results have informed the following technical and methodological training approaches:

- Corrections to the values of the studied parameters (impulse angle, landing angle, attack initiation distance, and post-hurdle landing distance) were made based on the vectorial kinematic analysis.
- The research and analysis of the recorded parameters confirmed that the proprioceptive program enhances athletes' execution speed, balance, mobility, and coordination abilities.
- Monitoring of the areas during hurdle crossing revealed that correcting technical errors in the final test reduced flight time, which is anticipated to translate into improved competitive performance.
- The analytical employment of kinetic parameters via video recording scientifically substantiates the direct guidance provided by coaches through personalized technical training programs, aiming to optimize individual techniques and elements specific to the 110m hurdles. The outcomes of our research highlight the critical importance of proprioceptive training in refining the technique for the 110m hurdles. By integrating specific proprioceptive exercises into their training routines, athletes can bolster their neuromuscular coordination, fine-tune their motor skills, and ultimately elevate their track performance. Furthermore, the extensive benefits of proprioceptive training include injury prevention and the overall development of athletes, establishing it as an integral element of thorough hurdling training programs. As the pursuit of excellence in track and field persists, the incorporation of proprioceptive training into standard training practices offers significant potential for realizing untapped athletic capacities and advancing the standards of performance in the 110m hurdles and related disciplines.

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