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SUMMARY OF THE DOCTORAL THESIS

Training model for the optimisation of high-jump performance capacity in junior 2 and 1 female athletes

Scientific advisor: Prof. GLORIA RAŢĂ, PhD
Doctoral student: Feniuc (Balaban) Aura Petronela

The high jump event was revolutionised by Dick Fosbury when he cleared the bar headfirst and backwards for an Olympic gold medal at the 1968 Mexico City Summer Games. With the introduction of the deep foam mat that allows landing on the back with no risk of injury, the high jump technique has changed forever. Since its successful use at the 1968 Olympics, the "Fosbury flight" has dominated the high jump scene for many reasons: it allows the jumper to use the speed generated by the approach (run-up); the rotations occurring on take-off are used to the advantage of the jumper, who can clear the bar more efficiently and easily; the techniques can be refined relatively easily for immediate success.

In the Fosbury Flop, exercise capacity should be considered as a particular synthesis of the factors that underpin it and determine exercise capacity in general. Depending on the exercise duration and intensity for a single jump, the event can fall into the anaerobic alactic effort zone, with the predominant engagement of the neuromuscular system.

If the approach, take-off, flight/bar clearance and landing are taken into account, it is found that the effort lasts about 1.5-2 seconds, and the exercise intensity or muscle contraction with the production of explosive power is maximum. The total number of attempts and the total duration of the effort, as well as the number and duration of recovery breaks between jumps are variable and depend on the level and number of competitions.

The purpose of this thesis is to develop a training model for the optimisation of high-jump performance capacity in junior 2 and 1 female athletes.

From a structural point of view, the thesis was organised into three parts, with each one presenting information and data correlated with the research purpose.

The first part highlights general and specific aspects regarding the developments in the high jump technique and performance, the technique and biomechanics of jumping, as well general aspects related to the preparation of this event. Theoretical information and meaningful arguments extracted from national and international literature referring to high jump training are also provided.

The high jump is one of the most technical and complex events in athletics, which encompasses a cyclic and an acyclic part due to the precise beginning and end of the movement, which is delimited in time and space. Jumps can be called 'specialised motor behaviours' whose purpose is to achieve, through the interaction between internal and external forces, an aerial trajectory of the body's general centre of gravity as high or as long as possible.

Although the high jump is a complex event, few studies address the biomechanics of movement by jumping phase, namely: run-up, take-off, flight and landing.

The topic of our thesis debates the teenage period. During adolescence, the training process will be mainly focused on observing the puberty phase, especially for young people who have already experienced several years of training. Adolescence represents a new period that is particularly favourable for learning, which is why it should be exploited as efficiently and carefully as possible (Rost, 1995), given that the execution technique needs to be adapted to a new development level of psychomotor skills. Valuable athletic performance is achieved through the optimal action of the training means on the athlete's body systems and psyche, which is differently exercised during one or more training cycles.

Training and performance are closely related and strictly individualised. The development of a training model focuses on the notions of training specificity and individualisation of training programmes. Designing a training model is a long and continuous process, considering that the model changes in direct relation with athlete development (Bompa & Haff, 2009). To design a training model, the coach needs to have some knowledge about general and individual physiological, morphological, anatomical, biomotor and psychological characteristics. After a thorough assessment, the coach interprets all the collected information and determines the athlete's potential in order to improve their performance level. For this purpose, the main training factors are established. These factors include load progression, training intensity, training volume, training frequency and the number of repetitions needed to stimulate proper physiological and psychological adaptations.

The French Contrast training method is increasingly used by athletes and is defined as a combination of heavier and lighter loads within a series. Using this method assumes that complex training has a positive outcome

and generates good development of explosive power. The main objective of assessment in the field of sport is the athlete's performance, which requires the constant improvement of the sports training content as a tool for goal achievement, especially power development. By applying this method, we found that the effects of complex strength training were positive.

Complex and contrast training uses the phenomenon of post-activation potentiation (PAP). Post-activation potentiation is a less common concept in Romanian literature. There are close functional relationships between the principles of plyometric training and post-activation potentiation. (Neagu, 2018) The PAP phenomenon can be very useful in sprinting, jumping and throwing workouts, and even more so in the high jump, which is a highly explosive event.

The concept known under the name of post-activation potentiation (PAP) has emerged as a way of rapidly increasing an athlete's power within a short period of time and is defined as a phenomenon by which the strength of a muscle is enhanced due to its previous contraction; thus, PAP improves excitability in the central nervous system and produces an increase in contractile function due to a high load stimulus. PAP is usually induced by maximal voluntary concentric and eccentric contractions, as well as submaximal isometric contractions. (Lagrange et al., 2020)

Complex and contrast training based on post-activation potentiation uses this phenomenon to improve the short-term contractile ability of a muscle to generate force. This improvement is due to the recruitment of high-intensity motor units, enhanced inter- and intra-muscular coordination and decreased presynaptic inhibition. Contrast training involves performing a maximal or near maximal lift (90-95% of an athlete's potential), followed by a short rest, and then another exercise with a lighter load (50-70% 1RM) but at increased velocity.

In other words, the contrast training subset includes a series of exercises performed in sequence within a single session as follows: a heavy compound exercise, a plyometric exercise, a light-to-moderate load compound exercise that maximises movement speed (i.e., power), and a plyometric exercise (Cormier et al., 2022).

This complex consists of 4 exercises performed one after another and includes: a heavy compound (80-90-95% 1RM) (half-squat/squat); a plyometric exercise; a drop set or weighted jump (30% 1RM); an accelerated plyometric exercise.

By applying this method, we found that the effects of complex strength training were positive.

Following the theoretical and methodological foundation of the topic addressed, in the second part of the thesis, entitled ***Preliminary research on coaches' opinions about the high jump training process and***

the dynamics of results in the period 2011-2020, we initiated two ascertaining studies that aimed at: knowing the opinions of novice and experienced coaches about the training methodology/strategy used in the high jump event; knowing the level of high jump performance in the last 10 years.

In the preliminary research, we established precise tasks to achieve the proposed purpose and objectives.

In the first part of the preliminary research, we tried to answer two predominant questions in the training process: *Are coaches' concepts of the high jump training process identical or different?; What was the trend in women's high jump results at the National Indoor and Outdoor Championships in the period 2011-2020?* Moreover, we aimed to verify the validity of the following hypothesis: *In the women's high jump event (junior 2), the average results obtained in the finals of the 2011-2020 National Outdoor Athletics Championships are better than those achieved in the finals of the National Indoor Athletics Championships during the same period*.

To know the opinions of novice and experienced coaches about the training methodology/strategy used in the high jump event, we designed an 18-item questionnaire with open-ended and closed-ended responses, and to know the dynamics of the high jump performance level in the last 10 years, we used as study material the results recorded at the National Indoor and Outdoor Athletics Championships for the high jump event.

In conclusion, coaches' responses to the question: *Are coaches' concepts of the high jump training process identical or different?* reveal the existence of different opinions and concepts. Most coaches responded that the shortage of material resources and height-dedicated sectors would be the main reason, along with the change in social dominance at the age of 18-19 years, forcing athletes from too early ages and the lack of coaches specialising in this event.

In the second study of the preliminary research, which aimed to reveal the dynamics of results for junior 2 high jumpers in the period 2011-2020, we performed an individual and group descriptive analysis as well as an inferential analysis, and finally we drew the following conclusions:

- at the 10 editions of the National Indoor Athletics Championships and 10 editions of the National Outdoor Athletics Championships that took place in the period 2011-2020, between 6 and 8 female competitors participated in the high jump event, an extremely small number for a National Championship final, and only six were included in this research;
- the average performance values per year did not have an increasing trend but were between 1.65 m in 2011 and 1.64 m in 2020 during the competitive indoor season and between 1.64 m in 2011 and 1.66 m in 2020 during the competitive outdoor season;

- according to these two findings, women's participation in the high jump event is not increasing in either performance or number, which should worry specialists, who should take certain measures;

- the dynamics of results for women's high jump event at the National Indoor and Outdoor Athletics Championships in the period 2011-2020 showed fluctuations, with a very small increase of 2 cm during the outdoor season.

These results entitle us to consider that the response to the question: *What was the trend in women's high jump results at the National Indoor and Outdoor Championships in the period 2011-2020?* is worrying for the leadership of Romanian athletics and requires approaching a new strategy.

To verify the research hypothesis, we performed a descriptive analysis as well as an inferential analysis, and the results denied the hypothesis according to which *in the women's high jump event (junior 2), the average results obtained in the finals of the 2011-2020 National Outdoor Athletics Championships are better than those achieved in the finals of the National Indoor Athletics Championships during the same period*. This statement is also supported by the fact that the t-value is 3.09 and the p-value is less than 0.027, which highlights that the results do not have an upward trend, and the values of Cohen's coefficient (D = 0.15) show a small difference between the results achieved by the female athletes in indoor events and those achieved in outdoor events.

The third part of the thesis, entitled ***Preliminary research on the effectiveness of using a training model based on the development of explosive power through the French Contrast training method***, aimed to determine the effectiveness of the proposed training model for the optimisation of motor ability in junior 2 and 1 high jumpers using the French Contrast method.

To achieve this goal, we established three objectives, namely:

- knowing the level of motor ability in junior female high jumpers;

- developing and applying a personalised training model for performance improvement;

- highlighting the effectiveness of using the personalised training model.

In carrying out the experimental research, we aimed to verify three hypotheses, for which we used the following methods:

- the literature review related to the topic addressed;

- pedagogical observation of the training process for the high jump event;

- experimental method;

- mathematical statistics;

- graphical method.

For data analysis, we used the statistical processing performed by exploiting the options of a computerised application, *SPSS for Windows 20.00* (IBM, Chicago, IL).

Taking into account the small number of participants in the research, we chose to use the non-parametric $z_{Wilcoxon}$ in order to highlight the progress achieved by the female athletes, and we applied the Wilcoxon Signed-Rank Test to compare the median values for the non-normal distribution of a quantitative dependent variable (at least of ordinal level) whose values were collected twice for the same small-sized sample.

The study included female athletes aged 16-18 from sports clubs across the country, whose coaches accepted to collaborate in this experiment. The experiment was based on the study of 8 athletes from Bacău, Bucharest, Ploiești, Iași, Oradea and Deva. The assessments took place in Bucharest, Pitești and Bacău because the competitions attended by the research participants were held in these cities.

The assessment performed at this stage aimed to highlight the level of motor skills in high jumpers aged 16-18 years, for whom physical and technical motor tests were used.

To assess ***somatic development***, we measured the athletes' height, weight and body mass index.

To assess ***motor skills***, we chose 8 tests: 30 m run with a standing start, standing long jump, standing penta jump (5-hop test), vertical jump, half-squats with maximum load, Counter Movement Jump (CMJ), Plyometric Jump, Squat Jump (SJ).

To assess ***technical performance***, we chose 3 tests: standing backward high jump with a double-foot take-off; high jump with 3 running steps; high jump with 5 running steps.

To assess the ***physical parameters*** of movement, we used the Myotest PRO Accelerometer.

Analysis of the results for hypothesis 1 show statistically significant differences, which validates the hypothesis that *applying a training model structured on technical and physical training elements leads to the improvement of performance values for standing high jumps as well as high jumps with 3 and 5 running steps, but also the improvement of performance in competitions*.

Regarding hypothesis 2, the statistical results indicate significant differences between the means of the two measurements (initial and final ones), thus validating the hypothesis that *the use of a training model aimed at improving movement speed, length size, take-off height and squat strength leads to increased performance in assessment tests*.

The results measured with the electronic Myotest reveal statistically significant differences, which validates the hypothesis according to which *using the French Contrast method in a training model that aims to*

alternate between heavier and lighter loads leads to improved ground contact time, take-off height and take-off velocity.

The originality of the experimental research consisted in: designing, applying and interpreting a questionnaire regarding coaches' opinions about the high jump training process; conducting a study on the dynamics of results obtained in indoor and outdoor competitions by junior 2 high jumpers between 2011 and 2020; applying a training model for junior 2 and 1 high jumpers based on the French Contrast method structured on technical and general and specific physical training elements, which led to the improvement of performance in competitions and the achievement of a complex assessment with 19 tests.

The research results were disseminated by publishing three articles in national and international journals and by participating in international conferences held in Bucharest and Constanța.