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METHODOLOGICAL APPROACHES IN EDUCATING THE RAPID FORCE MOBILISATION CAPACITY OF SKI JUMPERS

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Abstract: *This study was conceived to bring a new orientation in the ski jumping training process addressing psychomotor quality, especially to its component - rapid force. The fast force education requires a new approach of the training process according to the technical components specificity and related to the individual particularities. The rapid force manifestation in symbiosis with de second phases in ski jumping and the takeoff movement ensures a fast entry into the flight phase with an optimal trajectory under a right timing. The research was conducted on young athletes - three components of the national ski jumping team aged 13-14 years - and targeted the rapid force as physical component. After applying the bi-cycle planned of rapid force development methodology, the results obtained provide more confidence in the effectiveness of the training and a positive prognosis regarding the results to be obtained in this field.*

Key words: *ski jumping, rapid force, timing, the takeoff.*

1. Introduction

Rapid force "represents the motor quality of the neuromuscular system of moving at maximum speed either parts of the body or the whole body, or objects" [11]. Scientific research and practice in the field have named the takeoff as the essential phase in executing a ski jump, becoming a key element in ski jumping technique. [6]

A successful takeoff greatly depends on the athlete's timing. Takeoff timing succeeds perfectly when the jumper reaches maximum rapid force at the hill edge. Thus, the good timing at the takeoff moment (which means that the explosive force is effectively used) will help the jumper to accelerate the horizontal speed of the jump-ski assembly, in a parallel direction to the hill table". [3]

Other studies on the force plate have confirmed that too much credit is given to vertical acceleration at the takeoff. For Tveit and Pedersen it is more important to determine how to move faster from the aerodynamic position before takeoff, to the aerodynamic position after takeoff, with minimal air resistance [9].

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In Troxler and Ruegg's opinion, impulse force and time parameters are important indicators for a good jump [8].

Studies by Janura, Vaverka and others on a group of subjects point out that the in-run execution differs from one subject to another in terms of body position and body segments [5]. The takeoff model is not unique, in practice it has a strong individualized focus, and the coach must act respectively [10].

Starting from these conclusions, during the present research tests, a special emphasis was placed on the correct distribution of each subject's CM.

Educating the rapid force of the ski jumpers needed at the takeoff moment requires the use of the individualization principle at children and juniors' level. It is known that the process of physical development negatively influences the degree of manifestation of motor qualities. Permanent testing of rapid force manifestation indices creates the premises of a factual record, which allows effective programming of sports training.

For data collection, hardware (MLD-Station Evo2, Evo3 and Evo5) and software (MLD - Muskel-Leistungs-Diagnose) from SPSport (SPSport diagnosegeräte GmbH, Austria) [12] were used. This platform is also known as MPD (Muscle Performance Diagnosis).

Vertical ground reaction forces were measured on two separate force plates. Each plate is made of solid aluminum, and the outer surface is provided with sensors (anodes). Each plate measures 400 x 600 x 80 mm and contains 4 four-dimensional force conductors and each can measure a maximum force of 7.5 kN. The sampling / sample rate is 1,000 Hz. The conductor / transducer signal is directly amplified in the platforms to reduce interference. The measurement accuracy is 0.1% of the final result [7].

2. Research Purpose

The purpose is to verify the importance of rapid force development in order to optimize the second phase - takeoff from the hill edge in ski jumping.

3. Objectives

The proposed objectives were:

- Study on the ability to rapidly mobilize the force and its importance in the technical contents of ski jumpers training;
- Identification of the methodological succession when developing the capacity for rapid mobilization of the force and verification of the positive transfer in the technical component - takeoff;
- Application and verification of the bi-cycle force development plan for each phase (anatomical adaptation, maximum force phase, explosive force phase, transformation phase, maintenance phase, final phase, compensation phase), in order to improve the rapid force.

4. Hypothesis

We suppose that, through a judicious programming and implementation of the means and methods for force education in relation to the individual particularities of the subjects, we will be able to obtain increased parameters of rapid force in ski jumping training.

5. Material and Methods

Subjects

Three athletes, members of the national ski jumping team B, aged 13 and 14 at the start of the study, were tested. For the sake of personal data confidentiality, they are named subject 1, subject 2 and subject 3.

Body indices of subjects 1, 2 and 3 during summer-autumn period Table 1

Crt. No.	Subject	Date: April		Date: July		Date: September	
		Weight [kg]	Height [cm]	Weight [kg]	Height [cm]	Weight [kg]	Height [cm]
1.	Subject 1	34.40	149	35.10	150	36.50	151
2.	Subject 2	40.90	148	41.20	149	41.60	151
3.	Subject 3	40.50	149	42.60	150	43.80	152

Body indices of subjects 1, 2 and 3 during winter period Table 2

Crt. No.	Subject	Date: November	
		Weight [kg]	Height [cm]
1.	Subject 1	39.10	152
2.	Subject 2	43.60	152
3.	Subject 3	44.70	154

The content of the research

At the end of the winter competition season, after the transition period, the bicycle sports training [2], was programmed as follows: a period of anatomical adaptation, a period of development of maximum strength, a period of explosive force development, a period of transformation (rapid force) and a period of maintenance, with the objective of reaching the 75-80% limit for approaching autumn competitions, followed by a compensation period and approaching sports preparation for the winter competitive season, through repeating the same periodization (with shorter periods aiming to reach the 100% limit) in the training of rapid force.

The initial testing was applied in April and the final one in November. Following the results of the initial testing, methods of force education were implemented, with emphasis on the muscle groups involved in the takeoff technical component, in relation to the level of training and age of the subjects, for a period of 7 months and a half, consisting of three weekly workouts, in the direction of rapid force training.

Research methods and techniques

The test with the highest degree of objectivity, applied to the components of the national ski jumping team consisted of using the MLD force plate to determine the force parameters.

In the MLD test, the measuring procedure involves the maximum isometric force as well as the explosive force (detention) of the lower limbs, the two tests being valid only when the average of the measured values are interpreted and classified according to the isometric capacities allowed by lower extremities [4].

In the study on the MLD force plate, two stages were distinguished:

I. STATODYNAMIC test without a load and with 20% of the body weight load.

II. ELASTODYNAMIC test without load and with load.

The tests consisted of performing five vertical jumps both in statodynamic and elastodynamic conditions by the subjects.

The best value of the 2 determined parameters was registered and the maximum force - Fmax and maximum speed - Vmax were recorded for the research.

6. Results

Values of Fmax and Vmax obtained by S 1 at TI and TF Table 3

MLD Test	Parameter	T initial	T final	Difference
Statodynamic	Fmax	699,80N	742,01N	**42,21N**
	Vmax	2,30 m/s	2,55 m/s	**0,25m/s**
Elastodynamic	Fmax	879,81N	1046,76N	**166,95N**
	Vmax	2,61 m/s	2,62 m/s	**0,01m/s**

Values of Fmax and Vmax obtained by S 2 at TI and TF Table 4

MLD Test	Parameter	T initial	T final	Difference
Statodynamic	Fmax	892,37N	917,44N	**25,07N**
	Vmax	2,55 m/s	2,72 m/s	**0,17m/s**
Elastodynamic	Fmax	1069,91N	1121,62N	**51,71N**
	Vmax	2,71 m/s	2,80 m/s	**0,09m/s**

Values of Vmax and Fmax obtained by S 3 at TI and TF Table 5

MLD Test	Parameter	T initial	T final	Difference
Statodynamic	Fmax	935,27N	1057,21N	**121,94N**
	Vmax	2,52 m/s	2,67 m/s	**0,15m/s**
Elastodynamic	Fmax	1063,11N	1209,82N	**146,71N**
	Vmax	2,63 m/s	2,76 m/s	**0,13m/s**

7. Research Data Interpretation

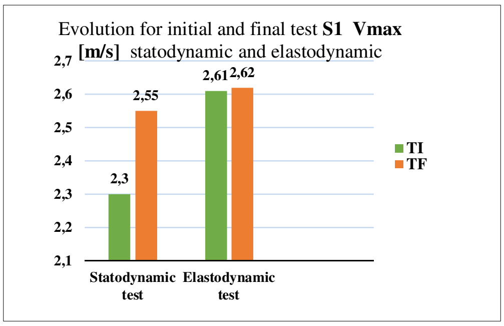

Chart 1. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Vmax for subject 1*

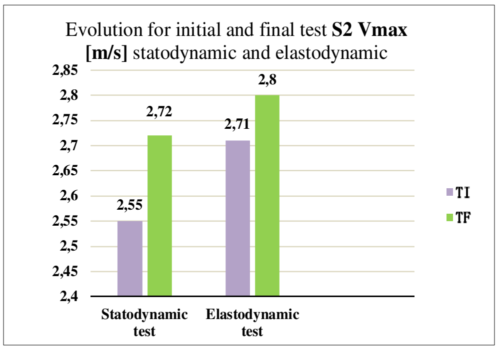

Chart 3. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Vmax for subject 2*

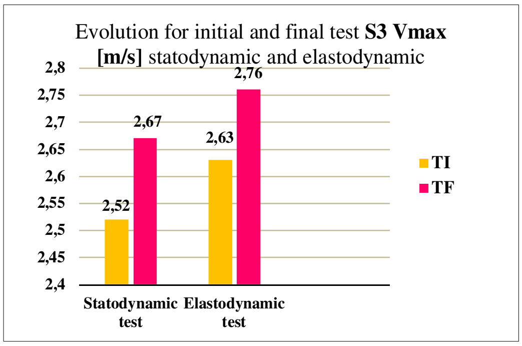

Chart 5. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Vmax for subject 3*

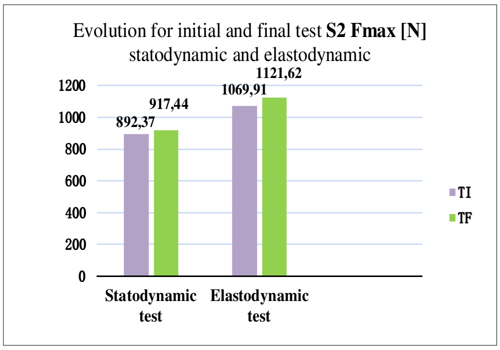

Chart 4. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Fmax for subject 2*

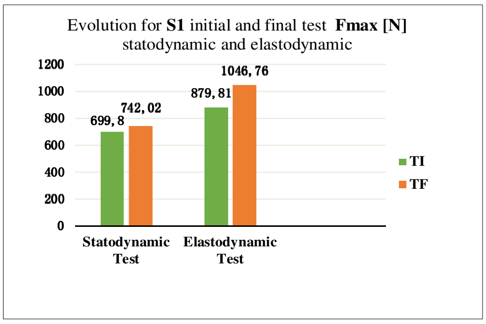

Chart 2. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Fmax for subject 1*

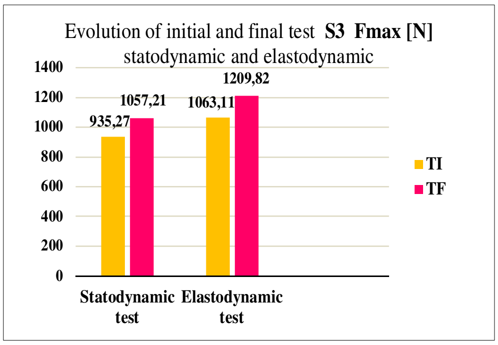

Chart 6. *Comparison of initial results vs. final results statodynamic and elastodynamic tests - Fmax for subject 3*

8. Conclusions

1. The results of the research highlight an effective programming in approaching the education of force as a motor quality, particularly the rapid force mobilisation capacity.
2. The implementation of methods and means of action for educating and maintaining the parameters of rapid force during the competitive periods prove their efficiency even under the conditions imposed by the process of subjects' physical development.
3. All the subjects in the present research activity's indices increased for Vmax and Fmax (rapid force) at the final test compared to the initial test, which confirms the fairness of the sports training programming and correct selection of the action means and methods used in the rapid force training.
4. The correct distribution of the subjects'CM when executing the MLD tests on the force plate is essential in the objectification of the evaluation.
5. The precision of the executions during MLD test, in the light of the correct distribution of the subjects'CM, must be carefully monitored by the evaluator and at the same time implies a well-developed proprioceptive sense from the executor.

6. The results of the research show significantly higher values of the parameters Vmax and Fmax in the case of these three subjects in the statodynamic and elastodynamic tests at the final test compared to initial test.
7. The net higher values of the executions in the elastodynamic conditions compared to the ones in the statodynamic conditions lead to the idea of making the takeoff movement more efficient by using the double-stressed takeoff technique compared to the progressive takeoff one [1], which would lead to a good timing, with increased force and speed indices.

References

1. Balint, L., Grosz, W.R. et al.: *ABC-ul în schi sărituri Teoria şi Metodica Instruirii de Bază (ABC in ski jumping Theory and Methodology of Training Base*). Braşov, Editura Universităţii Transilvania, 2009.
2. Bompa, T.O.: *Periodizarea: Teoria și metodologia antrenamentului (Periodization: Training theory and methodology)*, ed. a2-a. București, Ed. Tana, 2006.
3. Ganzenhuber, P. [traducere Goiceanu, B.]: *Note de seminar pentru perfecţionarea antrenorilor români de schi-sărituri (Notes of seminar for improvement ski jumping of the Romanian coaches).* Villach (Aut), 2007.
4. Hubner, K.: *Veränderung der Explosivkraft der unteren Extremitäten in Abhängigkeit vom Widerstand - Studie bei Schweizer Spitzensportlern aus Sportarten mit hohem Explosivkraftanteil* - Dissertation, Magglingen – Leipzig, 2009, pp. 41-67.
5. Janura, M., Vaverka, F. et al.: A longitudinal study of intra-individual variability in the execution of the in-run position in ski jumping. In: *Proceedings of the 16th International Symposium on Biomechanics in Sports*, H.J. Riehle & M.M. Vieten (ed.), Konstanz: Universitatsverlag Konstanz, 1998, p. 124-127
6. Janura, M., Lehnert, M. et al: A comparison of the take-off and the transition phase of the ski-jumping between the group of the ski jumpers and the competitors in nordic combined. *Acta up Gymnica*, vol. 29, no.2, 1999, pp. 7-13. Retrieved from http://publib.upol.cz/~obd/ fulltext/gymn29_2/gymn29_2-1.pdf
7. Patterson, C., Raschner, C. et al.: Power variables and bilateral force differences during uploaded and loaded squat jumps in high performance alpine ski racers. *Journal of Strength and Conditioning Research,* Volume 23. Innsbruck, 2009, pp. 779-787.
8. Troxler, G., Rüegg, P.: *Kraftmes- sung auf dem Schanzentisch. [Force measurement on the takeoff table in ski jumping.]* Semesterarbeit in Elektrotechnik an der ETH, Zürich, 1979.
9. Tveit, P., Pedersen, P.O.: Forces in the take-off in ski jumping. In: Morecki E., K. Fidelus, *et al*. (ed.) *Biomechanics VII-B*, University Park Press, Baltimore, 1981, p. 472–477.
10. Vaverka, F., Janura, M. et al.: A General Versus Individual Model of the Ski Jumping Technique. In: Edicoes FMH, Abrantes J.M.C.S. (ed.), *Proceedings of the XIV ISBS Symposium*, Funchal-Madeira, 1996, p. 293–296.
11. Weineck, J.: *Optimales Training (Optimal Training)*. Spitta Verlag GmbH&Co. KG, 2004.
12. http://www.spsport.at Accessed: 06-04-2019.