Bulletin of the *Transilvania* University of Braşov
Series IX: Sciences of Human Kinetics • Vol. 10 (59) No. 2 - 2017

CONSIDERATIONS ON THE IMPLEMENTATION OF SPECIFIC TRAINING METHODS FOR THE ADJUSTMENT OF PHASE III - FLIGHT IN SKI JUMPING

Wilhelm-Robert GROSZ [1]

Abstract: *In ski jumping, previous studies have revealed that adopting an optimal position on the inrun, in conjunction with a proper distribution of the center of mass (CM), allows the athlete to achieve a perfect timing, which enables him to obtain a maximum strength in his legs at the edge of the hill table. This contributes significantly to the increase of the horizontal speed of the jumper-ski system in a parallel direction with the hill table. Consequently, the adoption with great skill and a great sense of proprioception of the specific tasks during phases I and II of the jump enables a successful transition to phase III of the jump – the flight. Through raising and maintaining the center of mass as high as possible and the dorsal flexion of the feet - lifting the ski tips and fasten them and a gently controlled body stretching, the athlete will maintain his balance with arms slightly away from his body. In the last section of the flight, through the hyperextension of his body and by placing his arms stretched forward and slightly to the side, the athlete takes advantage of the so-called ground effect, increasing the length of the jump. Various training methods focused on specific physical and technical training under changing conditions were implemented in order to improve the technical execution during phase III of the jump. The study was conducted from August to October 2016 at the ski jumping hills in Râşnov and the sports centre in Săcele. The subjects were three components of the University Braşov Sporting Club. The tests that focused on technical training were performed on the HS 71m - synthetic grass hill in Râşnov.*

Key words: *ski jumping, timing, phase II – the takeoff, phase III – the flight, imitative exercises, specific training methods, ground effect, training adjusted to changing conditions.*

1. Introduction

The specific complexity of ski jumping requires great precision in the execution of technical components from athletes. The tasks related to jumping phases executed by athletes represent the ski jumping technique, which is defined as "the best biomechanical solution for the time being that consists of the sum of tasks that leads

[1] *Transilvania* University of Braşov, Faculty of Physical Education and Mountain Sports.

to the manifestation of an optimal, economical and efficient motor behavior in order to obtain constant high performances" [1, p. 35].

The acyclic characteristic of ski jumping is divided into four phases: the inrun, the takeoff, the flight and landing. Each stage of the jump requires extremely high skill in order to achieve high performance. Researchers have always been concerned about increasing sport performance for each jumping phase.

Taking into consideration the technical execution automatism on phases I and II of the jump, the third phase is of paramount importance due to factors such as: the weight of the athlete, the angle of attack, the air ascending component, the pressure on the jumper front surface, maintaining joints tensions, air sense, weather conditions (wind, thermal) etc. To extend the flight as much as possible, skiers use the ascension values by resorting to the following tasks: forward, lateral, extended arms, body hyperextension, head and eyes lifting up, actions that lead to increased lifting and gliding surface, using the ground effect. The ground effect is the phenomenon that occurs when the air flowing between a moving object and the ground creates gravitational force [6]. Increasing air density due to high pressure between the landing surface and the skier can increase the length of the jump.

2. Considerations on the Third Phase in Ski Jumping

The third phase of the jump represents the continuation of the second phase - the takeoff, when the last extension of the lower limb is completed in the air, followed by the dorsal flexion of the foot and its blocking, resulting in the lifting and maintaining of the skis above the horizontal. As a result of the angular momentum during the takeoff, the body reaches an aerodynamic position favorable to the flight. The adopted position shall meet as little resistance from the air as possible, the air stream facilitating the execution of some long jumps. The author Balint mentions that "the athlete moves in the absolute and strictly limited field of dynamic balance between float and fall" [1, p. 54].

Research conducted by Hubbard and others reveals that the use of specially designed models to be studied in the wind simulation tunnel provides a better understanding of how the aerodynamics of the jumper-ski system are affected by changing the body positions in flight and how the jumper can exert his muscular joint torques in order to obtain an optimal flight trajectory, which will lead to the longest jump distance [2, p. 272].

Other aeronautical studies highlight the fact that behind the wing of a glider the air flow is deflected downwards, and in the immediate vicinity of the ground, the airways are approximately horizontal and the current has no descent possibility. The larger the glider's size, the more of the ground effect will be felt. The ground effect is more pronounced in quiet times than when landings happen in strong wind conditions. It is proven that near the ground the wind speed drops suddenly [5, pp. 32-33].

Computer studies conducted in 1995 on the aerodynamic forces the athlete can use to his advantage by body actions during the flight reveal the way in which the forces manifested during the flight, namely the gravitational force, the lift force and the air resistance and the force resulting from the angular momentum, can be used to increase the jump distance [3, pp. 269-270].

Research conducted in 2001 by Seo and others also shows that ground effect is one of the key factors to ensure success. The research concludes that if the angle formed

by the skis during the V-flight is steadily increasing, the flight distance increases significantly, as a result of the experiments carried out in the aerodynamic tunnel on the ascending parameters both in the presence and absence of the ground platform. [4, pp. 128-130].

3. The Hypothesis

We consider that by maintaining a longer period of time the skis in the "V"-style with angles between 18 ° -50 ° during the flight and anticipating the right time for quick body extension in the pre-landing phase, the benefits of the ground effect on the jump distance will be emphasized.

4. Materials and Methods

Subjects

The study was conducted on three athletes, members of the ski jumping section of CSU Braşov. The survey was carried out between August and October 2016 at the base of ski jumping complex in Râşnov and the gym in Săcele.

Used materials

Ski jumping equipment, takeoff support, takeoff stroller, position keeping flight harnesses, fitness ball, digital camera and video camera.

Methods

In this research, we used the bibliographic method to deepen the theoretical knowledge and the studies conducted in the field on the ski jumping phases actions/tasks, especially for phase III - the flight, the case study method and the test method.

The research also involved the use of imitative exercises for the third phase of the jump, the achievement of the motion stereotype and of the automatism in the pre-landing phase.

The test method

Test I – jumps with short skis - 10 cm shorter than the FIS rules.

Test II jumps with regular skis - according to FIS rules.The set of tests consisted of:

The test conditions were the same and similar times were chosen from the weather point of view (temperature, wind), as well as the starting time.

Complete executions were performed on HS 71m jumping hills. The jump distances have been converted to points according to the FIS rules, the value of one meter on the HS 71m hills being 2.4 points.

Initial trials were conducted on August 2, 2016 and final tests on October 15, 2016 and consisted of six jumping sessions, three with shorter skis and three with regular skis.

Statistical processing

The data obtained from the research was processed and interpreted using Word and Excel.

The operational model implemented during the research activity

Exercises for Phase III – Flight

1. Lying face-up, with support on the arms - execution of the flight position (trunk parallel to the ground, maintaining an upward pelvis) - controlled extensions;
2. Push-ups in flight position with controlled backward stretch and upward pelvis;
3. Adoption of the flight position on the takeoff support (emphasis on keeping the trunk parallel with the ground and upward pelvis) - controlled extensions;
4. Partner having his trunk bent, arms extended with palms supported on the knee - adopting the flight position on his back - the partner performs different movements to create imbalance;
5. Adopting the flight position on the fitness ball, the partner supports the performer around the ankles, pushing

him slightly forward or gently pulling him backwards;
6. Flight position - energetic takeoff on the takeoff support and maintaining flight position helped by the partner (emphasis on the body extension in the perspective of the landing);
7. Flight position - energetic takeoff, maintaining flight position above the partener' head (emphasis on specific tasks to exploit the ground effect);
8. Adopting the flight position with arms on the takeoff stroller - successive stretches with the upper basin holding and trunk extension;
9. Flight positioning in harnesses with shoulder and foot support - controlled extensions.

5. Results

5.1. Initial test – Complete executions

- HS 71m, the start gate in position 14 – Râşnov (2,4 points/meter)

Table 1

The centralization of the subjects'results after the initial test (meters) on HS 71m

Date 02.08.2016	Test I - jumps with short skis [meters]			Test II - jumps with regular FIS skis [meters]		
Subjects/Jumps	I	II	III	I	II	III
Subject 1	58	57	57	62	61	62
Subject 2	58	58	59	63	63	62
Subject 3	60	59	57	63	63	61

Table 2

The centralization of the subjects'results after the initial test (points) on HS 71m

Date 02.08.2016	Test I - jumps with short skis [points]			Test II - jumps with regular FIS skis [points]		
Subjects/Jumps	I	II	III	I	II	III
Subject 1	45,6	43,2	43,2	55,2	52,8	55,2
Subject 2	45,6	45,6	48	57,6	57,6	55,2
Subject 3	50,4	48	43,2	57,6	57,6	52,8

5.2. Final test – Complete executions

- HS 71m, the start gate in position 14 – Râşnov (2,4 points/meter)

Table 3

The centralization of the subjects' results after the final test (meters) on HS 71m

Date 15.10.2016	Test I - jumps with short skis [meters]			Test II - jumps with regular FIS skis [meters]		
Subjects/Jumps	I	II	III	I	II	III
Subject 1	40,8	43,2	43,2	55,2	55,2	60
Subject 2	45,6	45,6	50,4	60	55,2	60
Subject 3	38,4	36	38,4	48	48	45,6

Table 4

The centralization of the subjects' results after the final test (points) on HS 71m

Date 15.10.2016	Test I - jumps with short skis [points]			Test II - jumps with regular FIS skis [points]		
Subjects/Jumps	I	II	III	I	II	III
Subject 1	46	42	48	58	56	58
Subject 2	38	48	50	56	56	64
Subject 3	16	24	18	28	26	30

6. Interpretation of Research Data

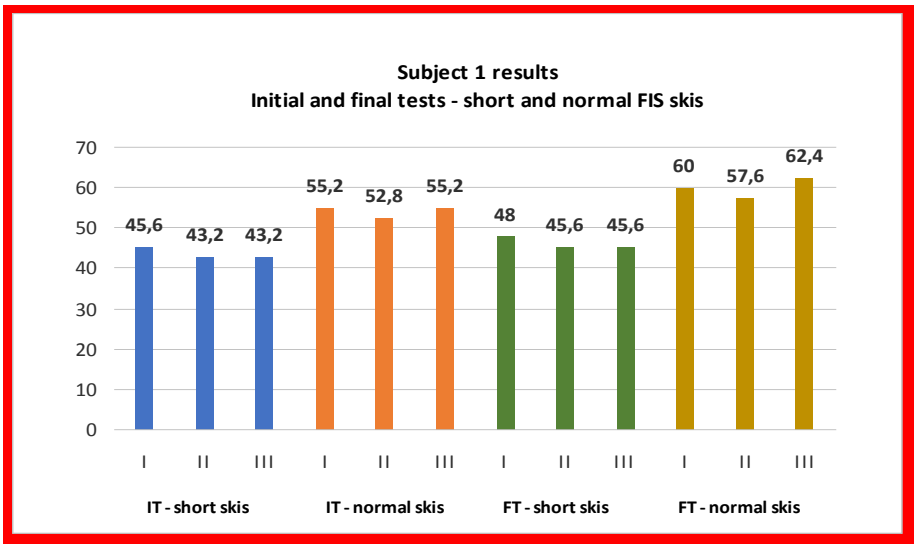

Fig.1. *The representation of the points obtained by subject 1 in the initial and final tests*

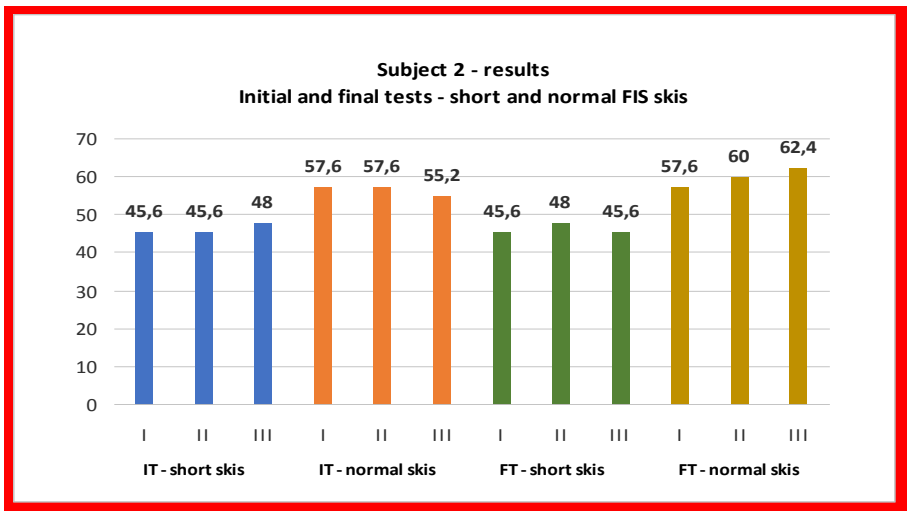

Fig.2. *The representation of the points obtained by subject 2 in the initial and final tests*

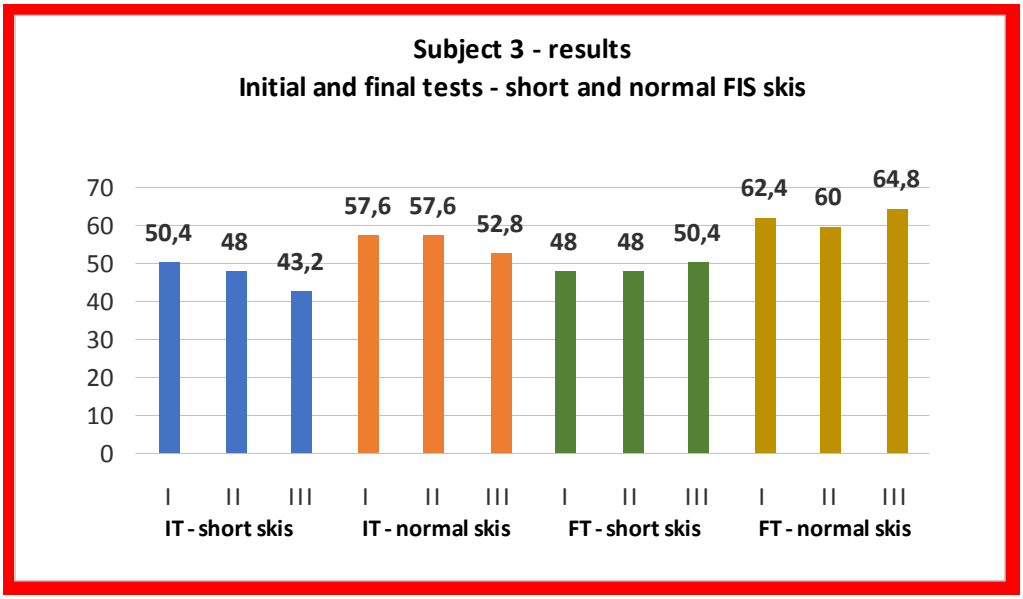

Fig.3. *The representation of the points obtained by subject 3 in the initial and final tests*

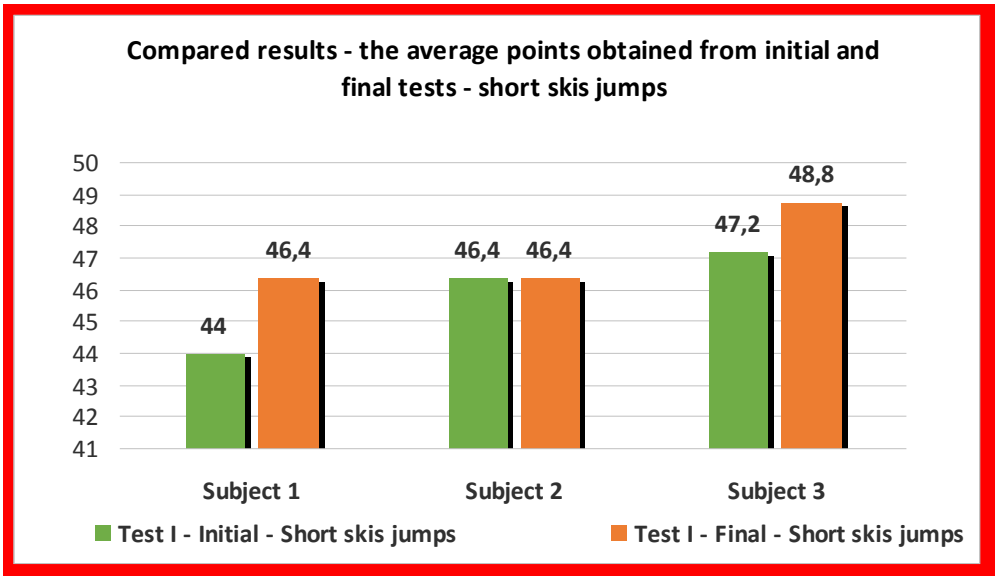

Fig.4. *The representation of the average points obtained in the initial and final Test I- short skis – comparative approach for the three subjects*

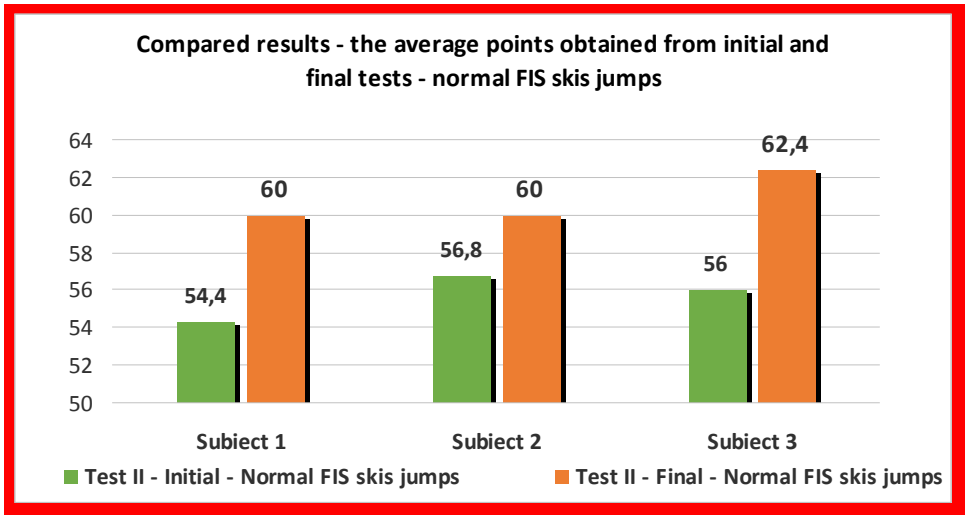

Fig.5. *The representation of the average points obtained in the initial and final Test II-regular FIS skis – comparative approach for the three subjects*

7. Discussions

Subject 1 – after the short skis tests, it was recorded an increase in average points by 2.4 points. In normal skis tests, it was noted an increase of 5.6 points.

Subject 2 – after the short skis tests, it has been noted stagnation, but the average points increased by 3.2 points on normal FIS skis tests.

Subject 3 - after short skis tests, it was recorded a 1.6 point increase in the average points obtained, and in the normal skis tests the average points increased by 6.4 points.

8. Conclusions

1. The variety of methods used in the training of ski-jumpers (alternating jumping hills size or sliding speed, under-sized skis, different types of suits) allows athletes to form and develop different senses, such as air sense, sliding sense so that their motor actions get more finesse and precision, with positive effects in achieving sports performance.
2. The understanding and using of the ground effect benefits in terms of well-developed techniques in phases I and II of the jump requires high-finesse/precision motor actions in flying speed of the performer resulting in increased jumping lengths.
3. If the use of short skis during the tests does not significantly increase the length of the jumps, in the case of normal skis tests, due to the increased lifting surface and to phase III technical operations, all subjects show significant increases in jumping lengths.
4. Clearly, we can not accurately quantify / determine the weight of the ground effect in increasing the length of the jumps, which is to some extent influenced by the improvement of the technical component in phases I, II and III of the ski jump.

References

1. Balint, L., Grosz, W.R. et al.: *ABC-ul*

în schi sărituri. Teoria şi metodica instruirii de bază (*ABC in ski jumping. The Theory and Methodology of Training*). Braşov. Editura Universităţii Transilvania, 2009.
2. Hubbard, M., Hibbard, L. et al.: *A multisegment dynamic model of ski jumping*. In: International Journal of Sport Biomechanics, No. 5, (1989), p. 258-274
3. Muller, W.: *The physics of ski jumping*. Eur. Sch. High-Energy 209–212 (2005). At https://scholar.google.com/scholar?q=The+physics+of+ski+jumping&btnG=&hl=en&as_sdt=0%2C5
4. Seo, K., Watanabe, I., et al.: *Aerodynamic study for the ground effect of ski jumping*. In: *Biomechanics Symposia* 2001, University of San Francisco, p. 128–130.
5. ***http://www.hailazbor.ro/manuale/performante_planificare.pdf. Accessed: 15.01.2017.
6. ***http://www.eval.ro/dictionar-evaluare/definitii-auto/efect-de-sol/. Accessed: 25.01.2017.