Bulletin of the *Transilvania* University of Braşov
Series IX: Sciences of Human Kinetics • Vol. 18(67) No. 1 – 2025
https://doi.org/10.31926/but.shk.2025.18.67.1.1

THE ROLE OF BODY MOVEMENT IN PHASE I OF SKI JUMP IN ACHIEVING PERFORMANCE

Wilhelm Robert GROSZ[1]

Abstract: *The ski jumping specific complexity is under the influence of factors that can determine, in various positive or negative ways, the athletes' motor skills, such as the action of external or internal forces and mental peculiarities. Most specialists consider the second phase of the jump (take-off) as the most important one. Recent studies show the special importance of the first phase (start and inrun) in obtaining the accuracy of the other jump phases and, therefore, in sports performance. It is known that physical development induces changes in proprioception as well as in the other motor abilities. Permanent control of the body mass index, with a direct influence on the correct distribution of centre of mass in the first phase, is essential for the other three phases of the jump. Consequently, monitoring and identification of possible negative influences induced by physical development on technique are of particular importance. The research subjects were six athletes aged 13-14. The research activity took place during June-September 2022, on the HS 71m Râșnov hill. The results highlight the importance of body movement in phase I of the jump related to the subjects' individual characteristics, aiming to a correct distribution of CoM on the track.*

Key words: *centre of mass (CoM), BMI, ski jumping, performance, physical development.*

1. Introduction

The research approach was aimed at highlighting the importance of the actions-body movements in phase I of ski jumping in relation to the individual characteristics of the subjects, with the defined objective of ensuring the correct distribution of CoM on the inrun.

Ski jumping is marked by a particular complexity in the four phases – inrun, take-off, flight, landing, any one of them being of particular importance during the entire execution [6]. Komi and Virmavirta believe that the take-off (the second phase of ski jumping) is probably the most important [8].

In phase I of the jump, the external forces that act on the ski jumper,

[1] Department of Physical Education and Special Motricity, *Transilvania* University of Braşov.

namely the ascent speed on the inrun, resistances and air force, the frictional resistance of the skis with the inrun, but also the centrifugal, centripetal and gravitational forces influence to a very large extent the preservation during the movement of the efficient distribution of CoM on the inrun [1]. Also, the different constructive types of jump hills, with start gates located at different heights, the inrun angle, the length and degree of the inrun radius, and the angle of the jump hill table require quick adaptation from the practitioners of this sport in actions resulting from the adoption and maintaining the inrun position.

Of course, maintaining the inrun position on the inrun track where the previously mentioned forces are manifested must be achieved by tensing the joints at the level of the ankles, knees and coxo-femoral [1]. As a result, the speed achieved on the inrun track depends entirely on the actions of the athlete and the correct distribution of the CoM [5].

In the current context, both theoretical calculations and experimental observations have highlighted the fact that maintaining the jump position with the correct distribution of CoM at the end of phase I and at the initiation of phase II is of substantial importance in increasing the length of the jump [4].

The mechanical importance of improved afferent gains in neuromuscular control seems to reflect abilities to modify the neuromuscular system in the direction of muscle activation and the effective increase in force development at the moment of take-off [3].

In addition, it is found that the ski jumper must adopt a position on the inrun track that gives him the best possible execution of the technical component now of take-off [9]. The same aspect is found when an efficient inrun position reduces friction and increases the execution speed of the jumper now of take-off [7].

2. Research Purpose

The aim was to create an automatic model of the specific actions of phase I in ski jumping in an individualized way to obtain a movement stereotype in settling and maintaining the inrun position.

3. Objectives

The proposed objectives were:

- obtaining the automaticity of actions specific to phase I,
- the application of sports training methods in the direction of improving the proprioceptive sense.

4. Hypothesis

We hypothesized that the automation of the body movements, of the technical components in phase I of ski jumping, in an individualized way, will create a movement stereotype with positive effects in increasing the length of jumps on the hill.

5. Material and Methods

Experimental approach to the problem

The study was designed to improve the technical content of phase I ski jumping.

Subjects

The research was carried out on six male ski jumper subjects, aged between 13-14 years.

The content of the research

The research was carried out between June and September 2022, at the jump hill with HS71m (K64m), in the town of Râșnov, Brașov county, on synthetic material. To get a clear picture of the effectiveness of introducing the proposed imitative exercises, the experimental method based on the pre-test = TI – post-test = TF model was chosen [2].

The initial testing in June 2022 began with the recording of anthropometric measurements and the calculation of BMI, preceded by jumps on the K 64m hill with the start bar fixed at gate number 6 for increased speed and at gate number 2, ensuring a slow speed and recorded the lengths of the jumps and calculated the points for each jump (2.4 points for HS 71).

The final testing was carried out in September 2022, repeating exactly the measurements and tests applied initially.

Between tests procedures:

In the June-September period, during the sports training period between tests, imitative exercises were implemented in each training session that focused especially on the actions – body movements related to phase I of ski jumping with a great emphasis on the correct distribution of the CoM.

Imitative exercises for phase I description:

1. Adopting an inrun position in a static plane with eyes open/closed.
2. Sitting on balance equipment.
3. Sitting on hedgehog balance pods.
4. Adopting a static inrun position, on a plane inclined at 15° with eyes open/closed.
5. From the start bar located at a different height from the ground (30, 40, 50cm) - adopting the inrun position and moving on the cart.
6. From the start bar located at a different height from the ground (30, 40, 50cm) with an inclination of 20° - adopting and moving in an inrun position on linear rollers.
7. Adopting and moving in the inrun position on roller skis.

The statistical analysis of the data was performed using SPSS 30.0 and MedCalc 23.0.6. To test the significance between pre- and post-programmes the significance level, or P-value, was calculated using the t-test, to assess whether the intervention produced any modifications. The level of statistical significance was $p<0.05$.

6. Results

TI and TF results in the BMI measurement and calculation Table 1

No. crt.	Subject	Date: June 2022 - TI			Date: September 2022 - TF		
		Weight [kg]	Height [cm]	BMI	Weight [kg]	Height [cm]	BMI
1.	S 1	59	171	20,18	59	171	20,18
2.	S 2	56	169	19,61	58	170	20,07
3.	S 3	58	172	19,61	57	172	19,27
4.	S 4	56	165	20,57	56	166	20,32
5.	S 5	56	167	20,08	55	167	19,72
6.	S 6	58	166	21,05	57	167	20,44

TI results in the jump lengths and points calculation Table 2

No. crt.	Subject	Jump Length Gate number 6 [m]	Points Gate number 6	Jump Length Gate number 2 [m]	Points Gate number 2	Total
1.	S 1	57	43,2	50	26,4	69,6
2.	S 2	59	48	51	28,8	76,8
3.	S 3	60	50,4	53	33,6	84
4.	S 4	56	40,8	49	24	64,8
5.	S 5	62	55,2	55	38,4	93,6
6.	S 6	57	43,2	51	28,8	72
TOTAL points			280,8	180		

TF results in the jump lengths and points calculation Table 3

No. crt.	Subject	Jump Length Gate number 6 [m]	Points	Jump Length Gate number 2 [m]	Points	Total
1.	S 1	63	57,6	55	38,4	96
2.	S 2	61	52,8	56	40,8	93,6
3.	S 3	66	64,8	57	43,2	108
4.	S 4	62	55,2	53	33,6	88,8
5.	S 5	64	60	58	45,6	105,6
6.	S 6	59	48	54	36	84
TOTAL			338,4	237,6		

TF and TI in total points calculation Table 4

No. crt.	Subject	Total TF	Total TI	*Difference*
1.	S 1	96	69,6	26,4
2.	S 2	93,6	76,8	16,8
3.	S 3	108	84	24
4.	S 4	88,8	64,8	24
5.	S 5	105,6	93,6	12
6.	S 6	84	72	12

7. Research Data Interpretation

Table 5

Descriptive statistics for the TI and TF BMI measurements

Statistics

		BMITI	BMITF
N	Valid	6	6
	Missing	0	0
Mean		20.1833	20.0000
Median		20.1300	20.1250
Std. Deviation		.56013	.43465
Range		1.44	1.17
Minimum		19.61	19.27
Maximum		21.05	20.44

Results

Difference	-0.183
Standard error	0.289
95% CI	-0.8282 to 0.4616
t-statistic	-0.633
DF	10
Significance level	P = 0.5408

Table 6

Descriptive statistics for TI and TF Jump Points from Gate 6

Statistics

		POINTSGATE6 TI	POINTSGATE6 TF
N	Valid	6	6
	Missing	0	0
Mean		46.8000	56.4000
Median		45.6000	56.4000
Std. Deviation		5.41996	5.82958
Range		14.40	16.80
Minimum		40.80	48.00
Maximum		55.20	64.80

Results

Difference	9.600
Standard error	3.250
95% CI	2.3594 to 16.8406
t-statistic	2.954
DF	10
Significance level	P = 0.0144

Table 7

Descriptive statistics for TI and TF Jump Points from Gate 2

Statistics

		POINTSGATE 2TI	POINTSGATE 2TF
N	Valid	6	6
	Missing	0	0
Mean		30.0000	39.6000
Median		28.8000	39.6000
Std. Deviation		5.20308	4.48999
Range		14.40	12.00
Minimum		24.00	33.60
Maximum		38.40	45.60

Results

Difference	9.600
Standard error	2.806
95% CI	3.3485 to 15.8515
t-statistic	3.422
DF	10
Significance level	P = 0.0065

When the P-value is less than 0.05 ($P<0.05$), the conclusion is that the two means are significantly different. The results showed that there are statistically significant differences in the final test TF compared to the initial test TI in each of the two tests on the jump hill.

8. Conclusions

1. The consolidation and improvement of phase I in ski jumping can be achieved by using carefully selected imitative exercises. The training model adopted in the training of these six ski jumpers was verified as well in the process.
2. Following the statistical-mathematical analysis, it follows that the average of the body mass index improved slightly at the final testing, without significant implications on the technical performances.
3. In the high-speed integral ski jumps tests, the number of the obtained points registered an increase of 9.6 points in the final test.
4. In the low-speed integral ski jumps tests, the mean of the obtained points registered an increase of 9.6 points in the final test as well.
5. The drive systems used to improve the proprioceptive senses in the adoption of the inrun position and the correct distribution of CoM, the clear sequence of actions produced significant increases in technical performance and flight distance, a fact that highlights the particularly important role that must be given to phase I of ski jumping.
6. The findings emphasize the importance of considering individual features of ski jumpers when designing imitative exercises to improve the body movements in phase I in ski jumping.

References

1. Balint, L., Grosz, W.R., Gaspar, P.: *ABC-ul în schi sărituri - teoria şi metodica instruirii de bază (ABC in ski jumping - the theory and methodology of basic training).* Braşov, Edit. Universităţii Transilvania, 2009.
2. Epuran, M.: *Metodologia cercetării activităților corporale (Research Methodology of Body Activity*), Bucureşti, Edit. FEST, 2005
3. Gollhofer, A., Alt, W., Lohrer, H., Gruber, M.: *Functional adaptation following proprioceptive training for ankle and knee joint stabilization*. In: Science and Skiing II. Verlag Dr. Kovac, Hamburg, 2001.
4. Hoff, J., Berdahl, G.O., Braten, S.: *Jumping Height Development and Body Weight Considerations in Ski Jumping*, In: Science and Skiing II. Verlag Dr. Kovac, Hamburg, 2001.
5. Kagawa, H., Yoneyama T.: *Effective action of skier's center of mass in skiing,* In: Science and Skiing II. Verlag Dr. Kovac, Hamburg, 2001.
6. Komi, P.V., Virmavirta, M.: *Ski-Jumping Take-Off Performance: Determining Factors and Methodological Advances*. In: Science and Skiing. Taylor&Francis e-Library, 2004.
7. Pauli, C.A., Keller, M., Ammann, F., Hübner, K., Lindorfer, J., Taylor, W.R., Lorenzetti, S.: *Kinematics and Kinetics of Squats, Drop Jumps and Imitation Jumps of Ski Jumpers*. In: Journal of Strength and Conditioning Research 30(3), p 643-652, March 2016. | DOI: 10.1519/JSC.0000000000001166
8. Virmavirta, M., Komi, P.V.: *Factors Influencing the" Explosiveness" of Ski Jumping Take off.* In: Science and Skiing II. Verlag Dr. Kovac, Hamburg, 2001.
9. Vodicar, J., Jost, B.: *Reliability and Validity of the Ski Jumping Technique Factors*. Verlag Dr. Kovac, 2017.
10. MedCalc Software Ltd. *Comparison of means calculator.* https://www.medcalc.org/calc/comparison_of_means.php (Version 23.0.6; accessed October 22, 2024).