Modern trends in development of elite and youth ski jumping take-off technique

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Abstract

Objective of the study was to reveal the dynamics of angular characteristics of take-off variations in the ski jumping of the leaders of international competitions versus the Russian elite and junior ski jumpers in the major events of 2015 through 2020.

Methods and structure of the stud. The take-off techniques were side-captured at 50 fps by video camera fixed perpendicular to the jumping line opposite the take-off table edge, with the take-off technique sequence processed by StatPlusPro 7 and analyzed by DartFish Pro 10.0 software tools.

Results and conclusion. The study found statistically significant ($p<0.05$) changes in the world bests' take-off techniques in 2015 to 2019, particularly in the trunk angle and take-off angle; whilst the Russian elite was tested with no statistically significant progress in any of the test rates. The Russian junior ski jumpers were found to make even statistically significant regresses in the take-off angle and knee angle ($p<0.05$). The national ski jumping training systems, therefore, are recommended to be revised to as required by the recent take-off technique progress trends.

Keywords: *ski jumping, take-off, angular characteristics, elite ski jumpers, junior ski jumpers.*

Background. Modern ski jumping sport is ranked among the technically challenging Winter Olympic sports disciplines. The growing competitiveness urges the sport communities to give a special priority to the technical excellence elements and the relevant training trends. Russian elite ski jumpers have been regretfully unsuccessful for the last few years in competitions with the world best "flying skiers", with only a few national competitors demonstrating occasional successes due to their special training systems.

Objective of the study was to profile and analyze variations in the ski jumping take-off angles and techniques of the world best jumpers versus the Russian elite and juniors in the major events of 2015 through 2020.

Methods and structure of the study. Side views (profiles) of the take-off techniques were video-captured in the following major men's and junior's events in the 2014-2015/ 2019-2020 winter seasons: Continental Cup finals of 15.03.15 in Nizhny Tagil (K120m ramp); All–Russian Youth Ski Jumping Competitions of the 15-16-year-olds (born in 2000-2001); Kavgolovsky Games of 16.02.15 (K65m ramp) in St. Petersburg; World Cup qualifiers of 08.12.19 in Nizhny Tagil (K120m ramp); All–Russian Youth Ski Jumping Competitions for the 15-17 year-olds (born in 2003-2005) at the X Winter Student Spartakiad on 03.03.2020 in Tchaikovsky (K95m ramp).

The take-off technique was side-captured at 50 fps by Sony HDR-CX650 E video camera fixed perpendicular to the jumping line opposite the take-off table edge, with the take-off technique sequence processed by DartFish Pro 10.0 software to track variations in the following test rates: shin angle, trunk angle, knee angle, and take-off angle (angle between the hip-to-ankle line and take-off table line. We captured the take-off technique of the top-10 world best, top-9 Russian leaders who qualified for the events under the

Table 1. *Group take-off technique in the 2019-2020 qualifiers*

Group		Trunk angle	Knee angle	Shin angle	Take-off angle
Model rates, 2019		**30-35**	**≥130**	**60-65**	**83-88**
Top-10 world best	Ẋ	▲39,86	140,20*	62,85	▲81,21*●
	δ	3,62	11,96	4,07	2,82
Top-9 Russian elite	Ẋ	36,57	132,94	62,09♦	84,43♦
	δ	5,26	9,26	4,67	2,54
Top-10 Russian juniors	Ẋ	35	122	65♦	93♦
	δ	8,91	▲9,71*	3,84	▲4,21*

*Note: statistically significant differences at ● p<0.05 for the world best versus Russian elite; * p<0.05 for the world best versus Russian juniors; ♦ p<0.05 for the Russian elite versus Russian juniors;* ▲ p<0.05 for variations in the related samples *(2005-2019*

national quota, and top-10 junior competitors of the All-Russian Youth Ski Jumping championships.

Results and discussion. The 2014-2015 take-off angle variation profiles of the Russian elite were found partially corresponding to the-then standards (model rates) [3]; although the world bests take-off techniques were tested more active, with the more acute shin angle, trunk angle and the resultant take-off angle. Such a take-off technique helps attain the key strategic goal upon the take-off – that is to secure the aerodynamically best position of the skier-ski system for the flight with a minimal air drag and maximal lifting forces. This take-off technique version with the fast transition to the flight phase may be viewed as the priority goal of every ski jumping technique excellence system. It is commonly understood that every minor detail in the take-off biomechanics, with all the other technical elements being equal, may be crucial for success in the highly competitive events.

Youth ski jumping training systems should make a special emphasis on compliance with the modern model rates due to the fast puberty-related changes in anthropometrics and functionality, when a plain copying of the adult leaders' techniques is still impossible. Table hereunder gives the test data of 2019-2020.

We found statistically significant differences ($p<0.05$) between the take-off angles of the world best versus the Russian juniors in the take-off angle and knee angle; plus the statistically significant ($p<0.05$) differences between the Russian elite and juniors in the shin angle and take-off angle.

As reported by German experts [4] the 2014-2018 Olympic cycle has seen further changes in the take-off technique of the world best jumpers, with the body mass center actively pushed forward to reduce the resultant take-off angle – at some sacrifice of the vertical take-off speed element. This finding clearly demonstrates the trend towards fast taking the best aerodynamic position for the flight upon the take-off phase.

Our test data confirmed the above findings of the German experts. The world best take-off angle average was tested to drop to 81.2°, with the knee joint extension angle growing to 140.2° versus the 2015 average. The Russian elite for the same period made no progress in these aspects – that may mean that their training systems still underestimate the recent take-off technique progress trends.

The Russian junior group was tested with the take-off angles falling within the valid standards (model ranges), with the take-off angle averaging above 90° - that means that their training systems are still insensitive to the modern take-off technique progress trends [1, 2]. A comparative analysis of two related samples found statistically significant ($p<0.05$) changes in the world best take-off technique elements in 2015 and 2019: trunk angle (Tem=3, Tkr=10) and take-off angle (Tem=6, Tkr=10) at.

The Russian elite take-off technique analysis found no significant changes for the same period; whilst the Russian juniors were tested with statistically significant ($p<0.05$) changes in the take-off angle (Tam=1, Tcr=10) and knee angle (Tem=0, Tcr=10). In view of the above reported take-off technique variation trend, we would classify it as a regress indicative of serious errors in the junior ski jumping training systems.

Conclusion. The ski jumping take-off technique profiling study demonstrate the need for revision of the standard national ski jumping training systems as required by the recent take-off technique progress trends.

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