A LONGITUDINAL STUDY OF INTRA-INDIVIDUAL VARIABILITY IN THE EXECUTION OF THE IN-RUN POSITION IN SKI JUMPING

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INTRODUCTION: Ski jumping is an attractive sports discipline which brings together the necessary technical and physical preconditions along with risk factors. The effort to achieve the best results without being affected by the greater risks is accomplished by changing the ski jumping technique. The most significant of these changes is the transition from the parallel position of the ski in flight to the so called V-style. The jumper must respond to these factors already in the take-off phase. When considering this fact, it is necessary to determine whether the same applies to the in-run phase of ski jumping. For the solution of this problem it is necessary to think about the anthropometric parameters, somatotype of the competitors and the quality of the movement skills and abilities. We suppose that the influence of these factors is brought about by the individual solution of the in-run position for selected ski jumpers.

PROBLEM: The in-run is one of the basic phases in ski jumping (Baumann, 1979; Fayett, 1993; Virmavirta, 1989). The quality of the surface and the transition between the straight part and the curved part of the approach increases the demands on the development of the ski jumpers' movement. The magnitude and direction of the external forces, as well as their momentum are changed. The ski jumper must respond to these changes with muscle activity, which retrospectively influences the shape of the in-run position.

The competitor must master three basic tasks in this phase of ski jumping (Vaverka, 1987): maintenance of equilibrium, acquisition of maximum approach velocity, preparation for the take-off.

The transition to the V-style caused changes in the development of the take-off phase (Janura, 1996; Vaverka, 1994). At the beginning of the take-off the center of gravity is shifted more to the rear. The angle which determines the position of the center of gravity during this phase of ski jumping increases. The accomplishment of this phase is very individual with large differences in the group of competitors with similar performance (Vaverka, 1996).

In this paper we tried to answer two questions:

1. How changes in the technique of ski jumping influence the realization of the in-run phase?
2. Does a set of various models of the in-run position exist for selected competitors (inter-individual and intra-individual variability)?

METHOD: Data for this study were collected from the Intersport Tournee Innsbruck between 1992 and 1998. A camcorder (GRUNDIG S-VS 180) was placed at a distance 18 m before the edge of the jumping hill. The recordings were analyzed by a system of 2D kinematic analysis of ski jumping, which was developed at the

Laboratory of Human Movement Studies, Palacky University, Olomouc. A total number of about 500 sequences was analyzed. The in-run position was evaluated using eight angle parameters (Fig. 1). The parameters of the jumping hill in Innsbruck are very extreme. It could be supposed that even small changes in the in-run position can greatly influence the length of the jump. On the basis of the size of the angle parameters a longitudinal comparison was accomplished.
In all events three groups (n=13-15) were selected according to the length of jump: B-best, M-middle, L-low.

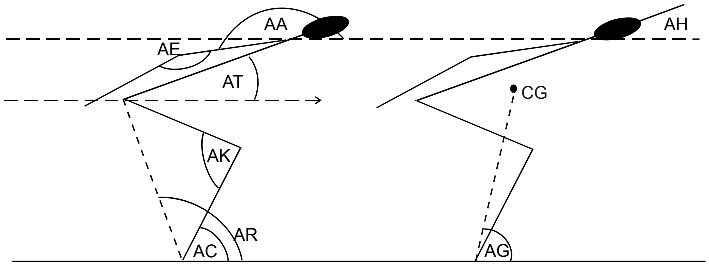

Fig. 1 Evaluated angle parameters

For the assessment of inter-individual and intra-individual variability 10 jumpers who participated at least five times in this event (1992-1998) were chosen from among all the competitors. The basic observed areas were: the position of the lower and upper extremities, the position of the trunk and the location of the center of gravity. For the assessment of the relationships the adjacent angles in the observed kinematic chain were used.
For analysis of the results, the statistical package ‘Statgraphics’ (one-way analysis of variance, Kruskal-Wallis one-way analysis by ranks, cluster analysis) was used.

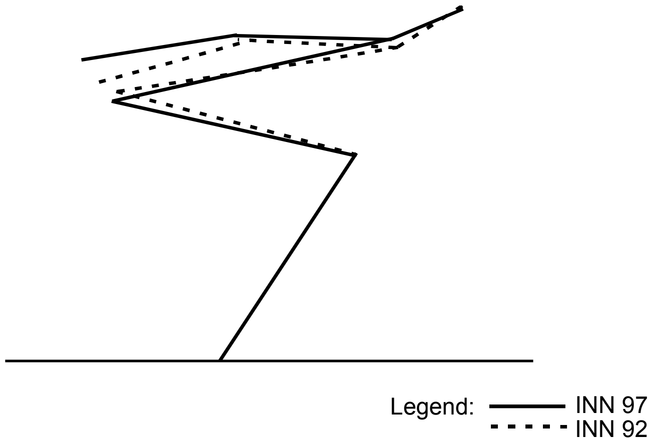

Fig. 2 Comparison of the in-run position - Innsbruck 1992, 1997

RESULTS: The graphic comparison of the in-run position in 1992 and 1997 is shown in Fig. 2. Significant differences in the trunk position (AT) and the location of

the center of gravity (AG) were found. The bigger opening of the trunk worsens the in-run position from the viewpoint of aerodynamics. These changes, with the displacement of the center of gravity towards the rear of the jumper, are necessary for the realization of the continuous rotation of the ski jumpers in the take-off and transition phase.
A large range for the analyzed angles was found for the groups of competitors with different jump lengths (B, M, L). The spans of the angles between these groups were very similar.
A similar situation was found for the group of 10 selected competitors. The changes occurring among the selected segments of the body varied with each individual athlete. The athletes under study could be divided into several qualitative groups:
- high stability of the lower extremities (subject 1 and 2),
- high stability of the upper extremities (subject 3),
- high stability of the lower extremities with regard to the trunk position (subject 4 and 5),
- in-run position with low stability (subject 6).

Subject 6 was the ski jumper with very uneven efficiency. The position of the center of gravity for subjects 1, 4, 7, 8, and 9 was often stable even with high variability of the other parameters. The range of the angle AG was under 3.5°. Subject 7 was the competitor with very good efficiency in these events. The position of the selected segments (with the exception of the trunk position) was unstable. But when the values for the two worst jumps were eliminated, the position of the lower extremities was very stable – differences of the angles dAC=0.8°; dAK= 0.5°.
The dependence between the angles among subjects on the lower extremities is shown in Fig. 3. Significant differences in the in-run position were discussed on the basis of this graphic comparison. Similar conclusions were found for the relationship between the trunk position and the location of the center of gravity (Fig. 4).

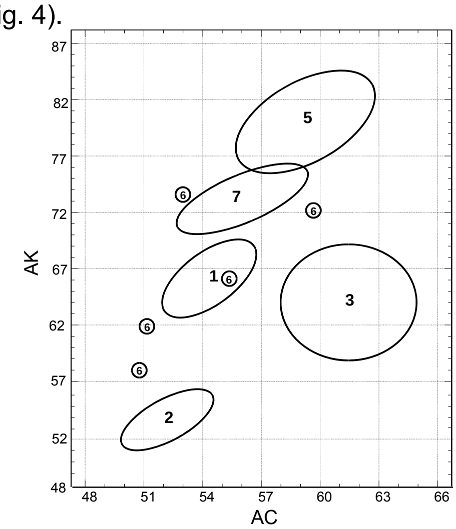

Fig. 3 Individual models of the lower extremities position

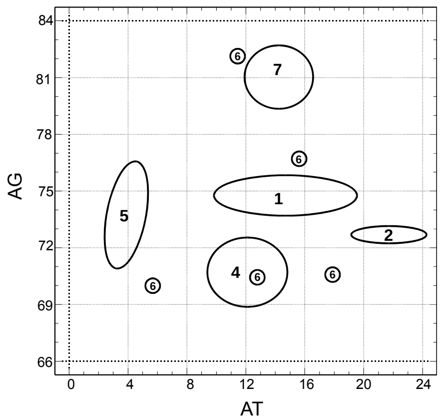

Fig. 4 The relationship between position of the trunk and location of the center of gravity

CONCLUSIONS:

1. Changes in the in-run position were found in all ski jumpers in the period between 1992 and 1998. Statistically significant differences existed among years of measurement – the bigger opening of the trunk and the displacement of the center of gravity in a rearward direction.

2. Changes among the selected groups of competitors with different efficiency (length of jump) were not found.

3. Within the group of 10 selected ski jumpers the execution of the in-run position varied for both body position and the position of the segments of the body. There was an individual solution for this movement situation for most ski jumpers – it can be called an individual model of the in-run position.

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