PERFORMANCE SUCCESS IN SKI-JUMPING RELATED TO VERTICAL TAKE-OFF SPEED

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INTRODUCTION

Vertical take-off velocity in ski-jumping has already been dealt with in some studies (Jost and Strojnik, 1992; Vaverka, 1987). Lately the interest of researchers in the study of vertical velocity, particularly in field conditions, has increased even more owing to the development of adequate technological means. The intent and objective of this investigation was to study the problems concerning the vertical velocity of take-off in ski-jumping as one of the fundamental parameters of successful performance of a jumper. For this purpose we have tried to determine:

- the values of vertical velocity measured in the field and laboratory conditions;
- the difference between the values of vertical velocity, when measured in field conditions, in aggravated laboratory conditions and in normal laboratory conditions;
- the stability of vertical velocity, measured in the field and in laboratory conditions;
- the relation between the vertical velocity measured in the field and laboratory conditions and the length of the jump.

METHODOLOGY

This investigation was carried out on a sample of 26 Slovene ski jumpers, members of the state representative selections, who were between 16 and 30 years of age.

The following variables have been measured and calculated:

V1 - vertical take-off speed measured in field conditions on a jumping hill (m/s);
V2 - vertical take-off speed measured in aggravated laboratory conditions (the jumpers performed the take-off in ski-jumping shoes on a tensiometer board);
V3 - vertical take-off speed measured in normal laboratory conditions (m/s); the jumpers executed the take-off in gym shoes.

The length of a jump, DS, was taken as a criterion of success. All data were obtained in measurements carried out in Oberwiesenthal in the Federal Republic of Germany from 25th July to 27th July, 1990. The field part of the measurements was carried out on a 90 m jumping hill with the following characteristics: K = 90 m, P = 72 m, H/N = 0.496, plastic jumping track surface. In the platform area of the jumping hill, a tensiometer plate 12 m long was installed for the determination of dynamic parameters. This plate had an accuracy of up to 5% of error.

Each of the ski jumpers performed seven jumps in two days in the same order and in slightly windy conditions. On the second day the measurements of dynamic parameters were carried out in the laboratory wherein two jumps were performed in ski-jumping shoes and two jumps in conventional sport shoes. The data thus collected were evaluated at the Institute of Kinesiology at the Faculty of Sport in Ljubljana. The statistical program package employed was SPSS-X.

RESULTS

In Table 1, the basic statistical values and the stability of the vertical take-off speed, measured in field conditions on the jumping hill, are presented. The average vertical speed obtained on a sample of 182 take-offs of ski jumpers amounted to 2.3 m/s.

Table 1. Presentation of the values of vertical speed (VH) measured in different conditions.

VH	year	n	AS	RTT	%	r		Author
V3	1991	26	3.20	0.89	100			Jost
V2		26	3.00		93	V1	0.61	"
V1		26	2.30	0.92	71	V3	0.69	"
V3	1990	54	3.27	100		V1	0.27	Vaverka
V1	54	2.64	0.74	81				"

n - number of subjects subjected to measurement in the sample
AV - arithmetic mean of the vertical speed measured
RTT - reliability coefficient of vertical speed
% - percentages of individual types of vertical speed related to ordinary vertical speed, measured on vertical jumps in laboratory conditions, jumpers wearing gym shoes
r - correlation between individual types of vertical speed.

The vertical velocity attained in the take-off on the jumping hill (V1) is lower (7%) than that generally obtained when the take-off was performed in laboratory conditions in ski-jumping shoes (V2), and even lower (29%) than that attained when the take-off was performed in gym shoes (V3). The coefficients of correlation between individual types of the defined vertical velocity are moderate and confirm the hypothesis of a mild relationship between the field and the laboratory measure of the speed of the take-off in ski-jumping.

The correlation coefficients (Table 2) confirm the hypothesis of a moderate connection between the vertical take-off speed of ski jumpers and their success as regards the length of the jump. Vertical speed measured in laboratory conditions was statistically significantly related to the length of jump in only one coefficient.

DISCUSSION

The stability of vertical speed as expressed within individual rounded-off samples of measured jumps is high and shows that this parameter does not change from jump to jump, and that it well reflects the latent nature through which vertical speed expresses itself. The said finding has also been supported by the results of Vaverka (1990) (see Table 1) which simply confirms the fact that vertical speed manifests itself as a relatively stable motion property of a ski jumper.

The vertical velocity measured in field condition is considerably lower (Table 1) than the laboratory one. The reason lies in a more difficult take-off technique and personal outfit. The take-off on the jumping hill is performed in a more demanding inertial environment (influence of friction, aerodynamic forces, centrifugal pressure, rotational moments) than in the laboratory where no other external force acts with the exception of weight and friction. The whole force impulse in the laboratory is exclusively used to develop speed in the vertical direction, while on the jumping hill a part of the force impulse is also taken up to overcome the inertial environment.

Table 2. Correlation coefficients (rV, DS) between vertical take-off speed and jump length.

Year	Jump series	n	rV1,DS	rV2,DS	rV3,DS	
1991	1	26	0.43*		0.20	
	2	26	0.38*		0.37	
	3	26	0.42*	0.16		
	4	26	0.31	0.47*		
	5	26	0.36			
	6	26	0.45*			p = 0.38
	7	26	0.02			
1990	1	54	0.29*		0.16	Vaverka
	2	40	0.23		0.21	GP-Frenstat
1977-83	1-16		-0.15 to 0.58			Vaverka GP-Frenstat

n - number of subjects subjected to measurement.
p - coefficient of significance of correlation at 5% error.

Another factor accounting for lower speed lies in the jumper's outfit. The jumper on the jumping hill wears ski-jumping shoes that are not flexible in the ankle joint area and do not allow any plantar flexion. Thus generation of the complete impulse of muscle force in the ankle joint is difficult.

On the basis of the value of the coefficients of correlation (Table 2), it can be ascertained that for a sucessful jump, optimal take-off speed is necessary and that exceeding this optimum leads to a non-linear correlation destroying the performance success of the jump. This realization is very important for ski-jumping due to the fact that it clearly points out the specific nature of the requirements for vertical speed and power. These are closely associated with the laws of motion. Should the jumper want to increase the vertical take-off speed, he could achieve this, above all, by lifting the top part of his body and by stretching out the legs completely. This, however, would result in the destruction of the aerodynamic efficiency of the jump and thus in the destruction of its overall successfulness.

CONCLUSIONS

The basic intent of this investigation was to establish the size of the difference in vertical speed measured in the field and in laboratory conditions. The stability of vertical speed and the extent to which it is related to successful performance of 26 Slovenian ski jumpers, members of the state representative selections, was investigated. The results of the investigation showed that the variability of vertical take-off velocity measured in the field and in laboratory was relatively high. However, a high stability of this ability of the jumper and an average correlation to the jump length was established

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