

CORRELATION BETWEEN THE POTENTIAL MORPHOLOGIC-MOTOR INDEX OF SKI-JUMPERS AND THEIR COMPETITIVE SUCCESS

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The purpose of the study was to find the correlation between the morphologic-motor potential index of ski-jumpers and their competitive success. A sample of twenty-two top Slovene ski-jumpers, among which was also the two-time winner of the World Cup in the seasons 1996/97 and 1997/98, gave a statistically significant correlation ($r=.48$; $p<.05$) between the potential index and competitive performance. An analysis of the inter-correlation coefficients between the potential index and the variables that define it, showed a medium correlation with body mass ($r=-.48$; $p<.05$) and a high correlation with duration of takeoff ($r=-.83$; $p<.01$) and acceleration (explosiveness) of the ski-jumpers' takeoff ($r=.94$; $p<.01$).

KEY WORDS: ski-jumping, morphologic and motor potential index, competitive performance

INTRODUCTION: The profile of the morphologic-motor model of a ski-jumper has to be optimised from the viewpoint of a maximal jump-length, according to the general characteristics of the ski-jumping technique, acting in the individual phases of the jump (approach, takeoff, flight and landing). Hubbard, Hibbard, Yeadon & Romor (1989) presented a multi-segment model of ski-jumping. The model relied on aerodynamic data from previous wind tunnel tests that incorporated the effects of varying body configuration and orientation on lift, drag and pitching moments. Praxis poses the problem of identifying those characteristics of a ski-jumper that significantly influence the geometry, kinematics and dynamics of ski-jumping technique. To this purpose we attempted to define a potential morphologic-motor index of success of ski-jumpers (GISS). A ski-jumper with optimal technique should have the lowest possible mass, relative to the body surface. At the same time he should execute the jump in the shortest possible time, with the greatest possible acceleration (Virmavirta & Komi, 1989). The relation between body height and leg length of the jumper is also important, since it defines the moments of aerodynamic forces (Jost, Pustovrh & Dolenc, 1998), presuming a positive influence of relatively shorter lower extremities in comparison with body height. The above-stated tendencies of the individual parameters were the constructive elements of the potential morphologic-motor index of performance in ski-jumping, having the following mathematical form:

$GISS = \{(asr + asm) * atv / 2 * at * adn\} * (eksplo1 / tod_r)$ where the codes mean the following:

GISS – potential morphologic-motor index of performance

asr – shoulder width (cm)

asm – pelvic width (cm)

atv – body height (cm)

adn – leg length (cm)

at – body mass (kg)

eksplo1 – acceleration of take-off, defined in the first part of the takeoff performed in laboratory conditions ($m \cdot s^{-2}$)

todr – duration of takeoff in laboratory conditions (ms)

METHOD: We conducted our research on a sample of twenty-two top Slovene ski-jumpers in the period 1994 -1998, headed by the two-time winner of the World Cup in ski-jumping in the seasons 1996/97 and 1997/98. The morphologic variables were measured in accord with the International Biologic Programme. The acceleration and time of takeoff were measured and computed on the basis of force data from a force-plate (KISTLER, model 9287, Winterthur CH), with a sampling frequency of 1000 Hz. Competitive success (in points) was assessed

and computed on the basis of the placements of the jumpers in the 1997/198 season. The best season placement of each jumper was used.

RESULTS: The analysis, using t-test for small independent samples (table 1), showed that the group of top six jumpers significantly differed in the GISS index from the group of low six jumpers ($t = 5.22$, sig. $t = .00$).

Table 1: Analysis of t-test for small independent samples, GISS - morphologic-motor index of ski-jumpers, season 1997/198

Group	N	Mean	Std. Deviation	t	Sig. (2-tailed)
Best	6	18.45	1.93	5.22	.000
Low	6	12.33	2.11		

To make the presentation even more precise, we also performed an analysis of the development of the GISS index (graph 1) for the best Slovene ski-jumper, the two-time winner of the World Cup in ski-jumping in the seasons 1996/197 and 1997/198. We compared this with the average value of the index for the remaining seven top Slovene ski-jumpers in the 1994-1998 period.

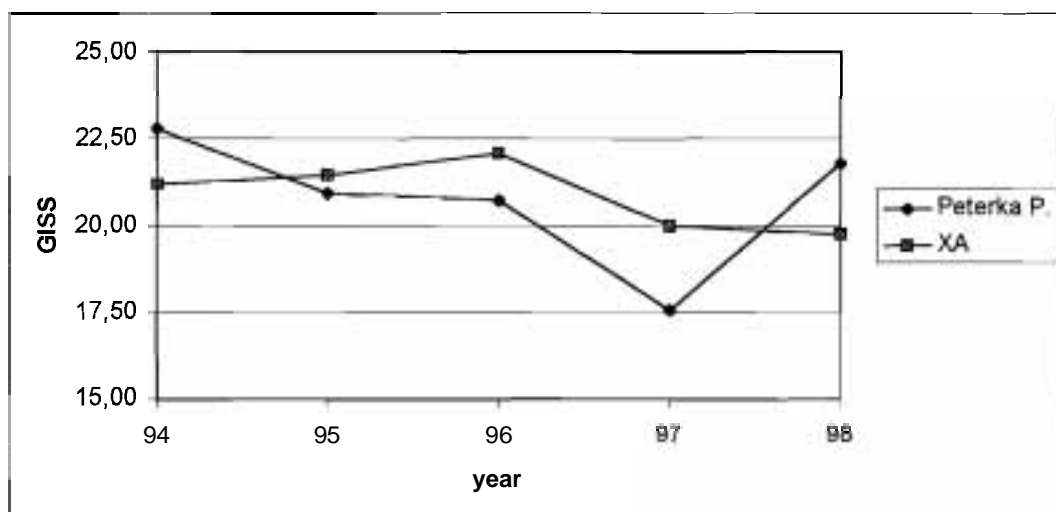


Figure 1: Change of the GISS index in the period 1994-1998 for 8 top Slovene ski-jumpers, comparison between the two-time winner of the World Cup in ski-jumping in the seasons 1996/197 and 1997/198 and average value of GISS of the remaining jumpers

The curves do not show a significant difference between the best Slovene ski-jumper and the mean of the remaining seven Slovene ski-jumpers who regularly took part in the World Cup competitions in the 1994-1998 period.

Correlation analysis was also conducted (table 2) on a sample of top twenty-two Slovene jumpers, showing a medium correlation ($r = .48$, $p < .05$) between the GISS index and the points of competitive success achieved in the 1997/198 season. Statistically significant correlations were obtained between the GISS index and: explosiveness of the ski-jumpers ($r = .84$, $p < .01$), takeoff time ($r = -.83$, $p < .01$), body mass ($r = .48$, $p < .05$) and pelvic width ($r = .46$, $p < .05$). The correlations between the potential morphologic-motor index (GISS) and the variables shoulder width ($r = -.34$, $p = .11$) and leg length ($r = -.26$, $p = .22$) were statistically non-significant at the 5% error level.

Table 2: Correlation between the morphologic-motor index of ski-jumpers GISS, members of Slovene national teams (**n=22**), and the chosen independent variables

Variable	r	SIG (2-TAILED)
Competitive success - points	0.48	0.02
Body height – cm	-0.39	0.06
Body weight – kg	-0.48	0.02
Shoulder width – cm	-0.34	0.11
Pelvic width – cm	-0.46	0.02
Leg length – cm	-0.26	0.22
Takeoff acceleration – m/s ²	0.94	0.00
Takeoff duration – ms	-0.83	0.00

On the basis of the correlation coefficients we can say that higher values of GISS will be achieved mainly by jumpers with greater explosiveness, shorter takeoff time, narrower pelvis and lower body mass. At the same time, jumpers with a higher GISS value will in general also be more successful in competitions.

DISCUSSION: The search for a geometric dynamic model of a ski-jumper has a double purpose from the viewpoint of an optimal use of aerodynamic forces and their moments:

1. To find a perfectly consistent theoretic physical geometric dynamic model, and
2. To test the theoretical model in praxis

The obtained results to some extent confirm the theoretical tendencies in the search for an optimal geometric model of a ski-jumper's body (Hubbard et al., 1989). The differences between the two groups (top six and low six ski-jumpers in our sample), defined on the basis of their GISS result, confirm the initial hypothesis on the importance of this index for competitive success of ski-jumpers. The group of top six jumpers had a mean GISS value of 18.45 and the group of low six 12.33. The difference between the groups is large and by itself shows the importance of this index for competitive success in ski-jumping. This was confirmed also by the correlation coefficients made on top twenty-two Slovene jumpers, who took part in the World Cup competitions in the 1994 -1998 period. The analysis of the trend of the GISS curve for the best Slovene jumper (figure 1) showed a high general level of the index, which varied from 22.50 (in 1994) to 17.50 (in 1997). The value of the index was lowest in 1997, then rose steeply in 1998. The recognition of the importance of the GISS index is very welcome for the coaches, since they will be able to choose those training means and methods that will increase its value.

It is important for ski-jumpers that they are as light as possible in regard to their body surface, have a high level of acceleration at takeoff and complete the takeoff in the shortest time possible. This enables them to assume the flight position sooner and at the same time raise the flight curve of the body centre of gravity (Virmavirta & Komi, 1994). A relatively low body mass in regard to body surface will give them, along with an ideal posture of the body and skis during flight, a more favourable flight angle and easier landing in the landing phase.

CONCLUSION: The results of the study confirmed the basic hypothesis that among the twenty-two top Slovene ski-jumpers in the competitive season 1997/98 those with a higher value of the potential morphologic-motor index GISS were more successful. The mentioned index therefore confirms the theoretical hypothesis about its importance for screening body types to better predict performance in ski-jumping. In this way the research introduces the need for a scientific study of the various extremes of morphologic-motor types of ski-jumpers, defined on the basis of the GISS index values. On the other hand, it warns of a greater need

for initial and later selection of talented young athletes, who would achieve a high level of this index already at the very start.

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