

# CORRELATION BETWEEN GYMNASTICS ELEMENTS KNOWLEDGE AND PERFORMANCE SUCCESS IN YOUNGER CATEGORIES OF ALPINE SKIING

**Blaž Lešnik, Vanja Glinšek and Milan Žvan**

Faculty of Sport, University of Ljubljana, Slovenia

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## **Abstract**

*On a sample of 24 female competitors and 30 male competitors (ages 12 to 13 years) we wished to determine the correlation between knowledge of gymnastic elements and acrobatics, and performance success in Mercator Cup children's competitions in alpine skiing. The sample of variables at the measurements consisted of evaluations of eight (8) gymnastic and acrobatic skills (evaluated on scale 0-5), while performance success criterion was represented by competitors ranking in the official children's competitions in ski season 2013/14.*

*By means of calculating the Spearman coefficient of correlation ( $r_s$ ), we found that by female competitors two individual gymnastics variables, as well as average evaluations of all gymnastics variables are statistically significantly associated with the performance success criterion. Based on the processing of data by the method of using the "Mann Whitney U test," we both in girls (GIM; Sig. =0.012\*) as well as in boys (GIM; Sig.=0.033\*) confirmed a statistically significant correlation between the average values of gymnastics variables (GIM) and the performance success in competitions in the Mercator Cup. This means that both in boys as well as in girls higher rankings in competitions were achieved by those with better knowledge of acrobatics and gymnastics elements.*

*Keywords: alpine skiing, children, gymnastic and acrobatic elements, successfulness, training*

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## **INTRODUCTION**

Acrobatics is nowadays in terms of basic physical preparation a very important complementary part of the training process in alpine skiing (Mujanović, Atiković, & Nožinović Mujanović, 2014). With practicing acrobatics we enrich both the

energetic as well as informatic part of motor efficiency of an athlete in situations where the result can be decisively influenced on by the determination and ability of orienting in space. The diversity and complexity of motor tasks, which primarily involve controlling one's own body (Lešnik, 1996), according to the theory

of motor learning is an important factor in the adequate formation of motor schemes (Bolkovič & Kristan, 2002; Schmidt & Lee, 2005; Willingham, 1998). Mastery of gymnastic elements is a good base for faster and easier conquering of new motor programs from other kinds of sports, including alpine skiing. Acrobatics with its complexity has also in training of young alpine skiers a positive impact on the development of overall movement coordination, ability to move in space and body control in a non-supportive phase (Krističević, Živčić, Cigrovski, Simović, & Rački, 2010). In accordance with some scientific studies, acrobatics presents a helping hand also in the development of all forms of power (Bompa, 1999; Cigrovski & Matković, 2007; Žvan & Lešnik, 2000).

Alpine skiing ranks among the complex sports (Hébert-Losier, Supej, & Holmberg, 2014; Lešnik, 1999), so it is difficult to determine all the factors which influence on achieving good results. The training process is a case of developing motor abilities through a variety of methods and training contents (Bompa, 1999; Bosco, 1997; Kostelić, 2005; Ušaj, 1996). Therefore, the integration of training of gymnastics and acrobatics into special preparation of alpine skiers is very important (Glinšek, 2013; Petrović, Šmitek, & Žvan, 1984). The latter in alpine skiing is particularly important due to possible unpredictable situations, which the competitor must solve with the objective to race through the ski piste as fast as possible and without mistakes (Figure 1). Situations like slip on the icy surface, loss of balance and falls can be very frequent in alpine skiing, so it is important that competitors have good control over their body movement (Lešnik, Podovšovnik Axelsson, & Supej, 2013). Efficiency of movement in skiing requires coordinated action of the whole body of the skier, being almost equally important the work of legs, torso and arms (Mujanović, Atiković, & Nožinović Mujanović, 2014). The structures of movement in alpine skiing are becoming more and more sophisticated and complex due to increasing speed and more difficult

settings of ski pistes (Jentschura and Fahrbach, 2004; Lešnik, 1999; Vaverka, Vodičkova, & Elfmark, 2012). Therefore, it is important that trainings in alpine skiing enable competitors comprehensive development and simultaneous progression in all dimensions, which have a significant impact on performance success in competitions (Lešnik, 1996; Neumayr et al., 2014).



Figure 1. Skier during giant slalom.



Figure 2. Skier attempting handstand.

Krističević, Živčić, Cigrovski, Simović and Rački (2010) determined in their study the correlation of control of acrobatic elements with success in slalom and giant slalom in younger alpine skiers. The sample of measured participants consisted of 46 young alpine skiers (24 boys and 22 girls), aged 8-10 years. They found that the control of acrobatic elements is statistically

significantly associated with the success of competitors in alpine skiing.

One of the most important roles of gymnastics program is to develop basic motor abilities such as strength, movement coordination, flexibility, balance and speed and the main objectives of gymnastic education is the development of conscious control of the position and movement of the body (Bučar Pajek, Čuk, Kovač, & Turšič, 2010; Novak, Kovač, & Čuk, 2008; Živčič, 2007). Therefore, it is important that the contents of gymnastics and acrobatics are intertwined with the physical preparation programs in all age categories of alpine skiers through all the periods of training (Kostelič, 2005; Živčič & Krističević, 2008).

The main objective of the research is to determine the relation between control of gymnastic elements and performance success in competitions of young girls and boys in alpine skiing. Given the fact that the presented sample of measured participants is in a sensitive period of psycho-physical development (12-13 years), it is also interesting to compare the influence of covered variables according to the gender. Since, in practice, the contents of acrobatics are an important part of the training process in different categories of skiers (Krističević, Živčič, Cigrovski, Simović & Rački, 2010), we were interested in how mastering of gymnastic elements affects the performance success in the category of younger girls and boys in alpine skiing.

## METHODS

The study included 24 younger girls and 28 younger boys, aged 12 to 13 years. In the measurements performed on November 10th, 2012 (Faculty of Sport, University of Ljubljana), they had to fulfil the following requirements: that they were born between 1999 and 2000, were registered as competitors in Slovenian skiing clubs and had actively taken part in the regular training process in the previous year, and had no physical injuries or other problems.

The evaluation of body control has been done by assessing gymnastic skills (gymnastics variables). The sample of variables consists of:

- 8 gymnastics variables: straddle vault (STR), forward roll (RFOR), backward roll (RBAC), handstand to forward roll (HS-RFOR), cartwheel (FLIS), roundoff (FLIS90°), felge on lower bar on uneven bars (TRN), squat vault (SQU) and
- the average score of all gymnastics elements (GYM).

These gymnastics variables were used because they are in terms of the complexity of body movement and solving motoric problems related to movement in alpine skiing. By movement in alpine skiing it is considered both ski sliding, jumping over the turning points as well as any falls and loss of balance. The selected elements of gymnastics, the examinees performed after preliminary preparation (heating) and demonstration of each element. Exercises were performed in the same order, and all executions were recorded with the camera. Based on the recorded material each examinee received for the execution of each exercise (variable) an assessment from 1 to 5. The final assessment of each implemented element was represented by an average assessment of two independent and experienced gymnastics judges (Čuk, Fink, & Leskošek, 2012). The final assessment of the GYM variable was represented by an average value of assessments of all the other variables.

The criterion of success (PTS) is represented by performance success or the number of points scored by an individual in Mercator Cup in ski season 2012/13. In the season 2012/13 in Mercator Cup there were realized 10 competitions in total (5 x slalom and 5 x giant slalom competitions). Super giant slalom result could not be taken into account because it had not been performed due to bad weather conditions. Based on the calculation of points scored was calculated the performance success rankings of

younger boys and girls in the Mercator Cup. The Ski Association of Slovenia determines the performance success of participants in competitions after the agreed criteria, where a competitor is given 150 points for the 1st place, 135 points for the 2nd place, 120 points for the 3rd place, 108 points for the 4th place, 96 points for the 5th place... (Competition System in Alpine skiing, 2013).

Data processing was carried out using the program SPSS - statistical package for social sciences. For the results obtained, we first calculated the basic statistical parameters (M-mean, and SD-standard deviation). To determine the relation between body control variables (STR, RFOR, RBAC, HS-RFOR, FLIS, FLIS90°, TRN and SQU) and the average score of all gymnastics elements (GYM) with performance success (PTS), the Spearman correlation rho coefficient (rs) and statistical significance of Spearman correlation rho coefficient (Sig.rs) were used. The coefficient of statistical significance was calculated due to the reliability of the data of the correlation between individual variables and criterion variable. The risk level of statistical significance was between 1% and 5%.

We also calculated the U-test (Mann-Whitney U-test) and statistical significance (Sig.) of correlation between used variables and criterion, separately for younger girls and younger boys. The categories of measured participants were divided into two ranks. With younger girls the first rank consisted of those who in the final standings reached places from 1-12 and the second of

those who reached places from 13-24. With younger boys the first group consisted of those who reached places from 1-15, and the other for places from 16-30. Using this method, we would like to identify in which gymnastics variables are more successful the competitors from the first rank, and in which the competitors from the second rank.

## RESULTS

Based on the calculation of basic statistical parameters and the use of methods of calculating the correlation (Spearman correlation coefficients and the Mann-Whitney U-test) between gymnastics variables and criterion variable, we have in the category of young girls and boys in alpine skiing come to the following conclusions.

The Table 1 shows that the average score range of gymnastic elements in a sample of younger girls is 3 to 4.12 (FLIS 90°; M=3.0, RFOR; M=4.12). The scores of other gymnastic elements are within the mentioned interval, with contestants achieving higher scores in elements carthwheel, squat vault, straddle vault (FLIS; M=3.96, SQU; M=3.96, STR; M=3.75), while the scores of other gymnastic elements were slightly lower (HS-RFOR; M=3.29, TRN; M=3.21, RBAC; M=3.12). The highest correlation with the points is noticeable by the roundoff (FLIS90°/PTS; rs=0.58\*\*), high correlation with the Cup points is present also by the forward roll variable (RFOR/PTS; rs = 0.42\*).

Table 1

Results of the arithmetic mean (M) and Spearman's rho correlaton (rs) of individual gymnastics variables and total score of gymnastic elements (GYM) with points (PTS) scored in Mercator Cup in younger girls (N=24).

	VARIABLES									
	STR	RFOR	RBAC	HS-RFOR	FLIS	FLIS90°	TRN	SQU	PTS	GYM
M	3.75	4.12	3.12	3.29	3.96	3.00	3.21	3,96	312.00	3.55
(SD)	(1.11)	(0.74)	(1.29)	(0.80)	(0.99)	(1.47)	(1.28)	(0.85)	(223.58)	
PTS (rs)	0.29	<b>0.42*</b>	0.36	0.33	0.35	<b>0.58**</b>	0.26	0,26	1.00	<b>0.51*</b>

Legend: N – number of competitors; STR – straddle vault; RFOR – forward roll; RBAC – backward roll; HS-RFOR – handstand to forward roll; FLIS – carthwheel; FLIS90° - roundoff; TRN – felge; SQU – squat vault; PTS – points scored in Mercator Cup; rs - Spearman's rho correlaton, GYM – total score of gymnastic elements; M – arithmetic mean, SD –standard deviation, \* Statistically significant correlation on a 5 % risk level, \*\* Statistically significant correlation on a 1 % risk level.

Table 2

Results of Mann-Whitney U test of points scored in Mercator Cup, gymnastic element variables and total score of gymnastic elements in younger girls (N=24).

Rank 1= 1- 12 Rank 2= 13-24 N= 24	M-W U-TEST	SIG. (1-TAIL)	RANK	M-RANK	SUM OF RANKS
PTS	0	<b>0</b>	1	18.50	<b>222</b>
			2	6.50	<b>78</b>
STR	44	0.55	1	14.83	178
			2	10.17	122
RFOR	43.50	0.52	1	14.88	178.5
			2	10.12	121.5
RBAC	58	0.19	1	13.67	164
			2	11.33	136
HS-RFOR	64	0.32	1	13.17	158
			2	11.83	142
FLIS	55	0.18	1	13.92	167
			2	11.08	133
FLIS 90°	37	<b>0.02*</b>	1	15.42	<b>185</b>
			2	9.58	<b>115</b>
TRN	44.50	0.06	1	14.79	177.5
			2	10.21	122.5
SQU	52.50	0.15	1	14.12	169.5
			2	10.88	130.5
GYM	<b>33.50</b>	<b>0.01*</b>	1	15.71	<b>188.5</b>
			2	9.29	<b>111.5</b>

Legend: N – number of competitors; Rank 1 – first rank of competitors; Rank 2 – second rank of competitors; M-W U-test – Mann-Withney U test; Sig. – significance of correlation; M-rank – Mean of rank; SUM OF RANKS – sum of ranks; PTS – points scored in the Cup; STR – straddle vault; RFOR – forward roll; RBAC – backward roll; HS-RFOR – handstand to forward roll; FLIS – carthwheel; FLIS90° - roundoff; TRN – felge; SQU – squat vault; GYM – total score of gymnastic elements; \* Statistically significant correlation on a 5 % risk level

Table 3

Results of the arithmetic mean (M) and Spearman's rho correlaton (rs) of individual gymnastics variables and total score of gymnastic elements (GYM) with points scored in Mercator Cup in younger boys (N=30).

N=30	VARIABLES									
	STR	RFOR	RBAC	HS-RFOR	FLIS	FLIS 90°	TRN	SQU	PTS	GYM
M	3.93	4.03	3.23	2.70	2.83	2.17	2.43	4.03	248.77	3.17
(SD)	(0.98)	(0.61)	(1.27)	(1.23)	(1.31)	(1.26)	(1.41)	(1.37)	(219.54)	
PTS	0.19	-0.06	0.06	0.30	0.05	-0.01	0.14	0.32	1	0.25

Legend: N – number of competitors; STR – straddle vault; RFOR – forward roll; RBAC – backward roll; HS-RFOR – handstand to forward roll; ; HS-RFOR – handstand to forward roll; FLIS – carthwheel; FLIS90° - roundoff; TRN – felge; SQU – squat vault; PTS – points scored in Mercator Cup; rs - Spearman's rho correlaton, GYM – total score of gymnastic elements; M – arithmetic mean, SD – standard deviation\* Statistically significant correlation on a 5 % risk level, \*\* Statistically significant correlation on a 1 % risk level

Table 4

Results of Mann-Whitney U test of points scored in Mercator Cup, gymnastic element variables and total score of gymnastic elements in younger boys (N=30)

Rank 1= 1- 15 Rank 2= 16- 30 N= 30	M-W U TEST	SIG. (1-TAIL)	RANK	M-RANK	SUM OF RANKS
PTS	0	<b>0</b>	1	23	<b>345</b>
			2	8	<b>120</b>
STR	83	0.11	1	17.47	262
			2	13.53	203
RFOR	106	0.36	1	15.93	239
			2	15.07	226
RBAC	109	0.45	1	15.73	236
			2	15.27	229
HS-RFOR	71	<b>0.04*</b>	1	18.27	<b>274</b>
			2	12.73	<b>191</b>
FLIS	111	0.467	1	15.60	234
			2	15.40	231
FLIS 90°	98.50	0.277	1	16.43	246.50
			2	14.57	218.50
TRN	73	<b>0.05*</b>	1	18.13	<b>272</b>
			2	12.87	<b>193</b>
SQU	68.50	<b>0.03*</b>	1	18.43	<b>276.50</b>
			2	12.57	<b>188.50</b>
GYM	68	<b>0.03*</b>	1	18.47	<b>277</b>
			2	12.53	<b>188</b>

Legend: N – nubmer of competitors; Rank 1 – first rank of competitors; Rank 2 – second rank of competitors; M-W U-test – Mann-Withney U test; Sig. – significance of correlation; M-rank – Mean of rank; SUM OF RANKS – sum of ranks; PTS – points scored in the Cup; STR – straddle vault; RFOR – forward roll; RBAC – backward roll; HS-RFOR – handstand to forward roll; ; HS-RFOR – handstand to forward roll; FLIS – carthwheel; FLIS90° - roundoff; TRN – felge; SQU – squat vault; GYM – total score of gymnastic elements; \* Statistically significant correlation on a 5 % risk level.

From the Table 1 we can see that in younger girls the correlation between the overall gymnastics score and points scored in the Cup is statistically significant (GYM/PTS;  $r_s=0.51^*$ ). The calculated coefficient of statistical significance of the relation between the average score of all gymnastic elements (GYM) and points won in the Mercator Cup (PTS) in the measured sample is on a 5% risk level (GYM/PTS; Sig. $r_s=0.01^*$ ). Important statistically significant impact on the performance of the measured sample in the Mecator Cup (PTS) was calculated also with the roll forward variable (RFOR/PTS;  $r_s=0.42^*$ ). The level of correlation is statistically significant on a 5 % risk level (RFOR/PTS; Sig. $r_s=0.05^*$ ). It is also evident from the table that of the individual variables the variable roundoff has the strongest influence on the results achieved (FLIS90°/PTS;  $r_s=0.58^{**}$ ). Statistical correlation of the mentioned element with the performance success of measured sample is on a 1 % risk level (FLIS90°/PTS; Sig. $r_s=0.003^{**}$ ).

The Table 2 shows that in younger girls the influence of gymnastic elements scores on (GYM) performance success at competitions (PTS) is statistically significant on a 5% risk level (GYM; Sig. $=0.01^*$ ). The obtained calculation was largely contributed to by the results of the contestants in the first rank (Rank 1=1-12). Among individual variables (gymnastic elements) the greatest influence on achieving results in competitions was contributed by the variable roundoff (FLIS90°; Sig. $=0.02^*$ ). The calculated correlation is statistically significant on a 5% risk level, and close to a statistically significant influence on the success of the measured sample was also the calculation of the felge variable correlation (TRN; Sig. $=0.06$ ). The calculated results confirm that in girls, with the criterion variable there are largely related the gymnastics variables, which are among the more difficult to perform (FLIS90° and TRN). The highest level of correlation with the criterion variable is noticed in the variable of average score of all individual elements of

gymnastics (GYM). Since the latter is including the average score of all gymnastics variables, we can speak of a real relationship between mastery of gymnastic elements and performance success in competitions in alpine skiing.

The Table 3 shows that the average score range of gymnastic elements in a sample of younger boys is 2.17 to 4.03 (FLIS90°;  $M=2.17$ , RFOR and SQU;  $M=4.03$ ). The scores of other gymnastic elements are within the mentioned interval, with contestants achieving higher scores in elements straddle vault, backward roll and carthwheel (STR;  $M=3.93$ , RBAC;  $M=3.23$ , FLIS;  $M=2.83$ ), while the scores of other gymnastic elements were slightly lower (HS-RFOR;  $M=2.7$ , TRN;  $M=2.43$ ). The highest correlation with the points scored is noticeable by handstand to forward roll (HS-RFOR/PTS;  $r_s=0.30$ ) and squat vault (SQU/PTS;  $r_s=0.32$ ). With younger boys there is a correlation between performance success and body control, but not so strong that we could say that it is statistically significant. In a sample of younger boys also other gymnastic elements are not statistically significantly correlated with performance success. The same is true for the overall score of gymnastics and points scored (GYM/PTS;  $r_s=0.25$ ).

The Table 4 shows that in younger boys the influence of gymnastic elements scores (GYM) on performance success at competitions (PTS) is statistically significant on a 5% risk level (GIM; Sig. $=0.03^*$ ). The obtained calculation was mainly contributed to by the results of the contestants in the first rank (Rank 1=1-15). Among individual variables (gymnastic elements) the greatest influence on achieving results in competitions was contributed by the elements handstand to forward roll (HS-RFOR; Sig. $=0.04^*$ ), felge (TRN; Sig. $=0.05^*$ ) and squat vault (SQU; Sig. $=0.03^*$ ). The calculated correlations are statistically significant on a 5% risk level. The calculated results confirm that also in boys (like in girls) the gymnastics variables, which are among more difficult to perform (HS-RFOR, SQU and TRN), are correlated

with the criterion variable the most. Also in boys the variable of average score of all individual gymnastics elements (GYM) is highly and statistically significantly correlated to the criterion. As the latter (GYM) includes the average score of all gymnastics variables, we can also in the case of boys speak of a real relationship between mastery of gymnastic elements and performance success in competitions in alpine skiing.

## DISCUSSION

The aim of this study was to determine the level of correlation between controlling gymnastic elements and performance success of younger girls and boys in competitions in alpine skiing. The examined sample of participants was conducted in a sensitive period of their psycho-physical development (12-13 years), so we were interested also in possible differences in the influence of the variables sample according to gender (Pišot & Šimunič, 2006).

The obtained results confirm our predictions and observations from practice and give us the answer in relation to the dilemma of whether the knowledge of acrobatics is important to achieve better results in competitions in alpine skiing. In younger girls (Table 1) the correlation between the overall gymnastics score and points scored in the Cup is statistically significant (GYM/PTS;  $r_s=0.51^*$ ), while in younger boys (Table 3) a statistically significant influence on a 5 % risk level could not be confirmed (GYM/PTS;  $r_s=0.25$ ). The reasons for the results obtained may also arise from the fact that in the pre-pubertal fase there is no significant difference in body structure and weight between boys and girls (Škof & Kalan, 2007). Later, sometime after 10 years of age, girls begin to overtake boys in development and growth. During the period of puberty, which begins in girls at around 10 years old and in boys a year or two later (Horvat & Magajna, 1989). It is going about a sensitive period with the major growth spurt and hormonal changes with the

development of the sexual organs and secondary sexual characters (Škof & Kalan, 2007). In accordance with the stated fact, boys enter into the puberty period slightly late, therefore, the accelerated growth comes with a delay of approximately two years. The consequences of accelerated growth are reflected in the altered relationship between muscle, bone and adipose tissue, which results in poorer movement coordination and consequently in poorer performing of more complex motor tasks (Pišot & Planinšec, 2005; Simons-Morton et al., 1988; Thomas & French, 1985). This may be the reason that a statistically significant correlation between controlling the elements of acrobatics and performance success in competitions in the Mercator Cup could not be proved with boys (GYM/PTS;  $r_s=0.25$ ). Despite the fact that the calculation of the Spearman correlation coefficients ( $r_s$ ) at the 5% risk level did not confirm statistically significant correlations between gymnastics variables and criterion, this does not mean that 12 and 13 year-old competitors in alpine skiing do not require acrobatics training. Acrobatics training is highly recommended and should, in particular to reduce the risk of injury, be an important part of training of alpine skiers.

In recent years in practice, particularly in measurements of children, we observe significant differences in body constitution (Lešnik, 2009). The reasons for this lie in genetic design of younger generations, as well as modern lifestyle (Maffetone, 2012). In the period after 12 years of age, children are subjected to accelerated development, which for some starts sooner, and for others later (Horvat & Magajna, 1989). With physical growth also the body weight is relatively increasing, which for competitors aged 11-14 years (categories of younger and older boys) may represent an inhibiting factor in the controlling of one's own body in space, but can greatly contribute to faster skiing between the gates (Müller & Schwameder, 2003). Technical knowledge of competitive ski turns in young competitors is not yet so sophisticated that

the outcome could be affected by the small details, as is the case in top-level athletes (Federolf et al., 2008; Maffiuleti et al., 2009; Supej, Kipp, & Holmberg, 2011). Therefore, the more body weight can be very helpful for a child in getting speed after braking (slipping from the ideal line) with changes in the direction of skiing down the slope (Bandalo & Lešnik, 2011; Lešnik & Žvan, 2013). According to the results of one other study the set of body measures variables is statistically significantly related to success in competitions (Lešnik & Žvan, 2014). Greater weight could therefore hypothetically represent an advantage in children's competitions. This, according to our results, does not apply for controlling gymnastic elements in boys.

Alpine skiers are on the piste constantly confronted with situations that need to be resolved quickly and efficiently. Like in gymnastics, also in skiing it is about the complex movement in accordance with the formed movement programs (Schmidt & Lee, 2005; Winter, 2009). In every moment they should be aware of orientation in space and body position (Glinšek, 2013; Luethi & Denoth, 1987; Supej & Cernigoj, 2006). Especially in girls the performance success in competitions is correlated strongly with gymnastic elements (Table 1), in which rotation in the forward or sideways direction is present (RFOR, FLIS90°). Mastering these elements allows the skier better preservation of the equilibrium position and effective rescue in the event of falls at higher speeds. Based on the findings of this study it can be said that in the Mercator Cup competitions higher ranks were achieved by female competitors with better knowledge of acrobatics and gymnastic elements. Girls who scored more points and were ranked higher in the final standings, received the highest scores especially by roundoff (FLIS90°). Similar results were obtained also by using the Mann Whitney U test, with which we confirmed that acrobatics and gymnastic elements are an important part of the training already at the lowest level competitive groups in alpine skiing (Table 2). The latter was confirmed with the

calculation of statistically significant correlations of variables FLIS90° (Sig.=0.019\*) and GYM (Sig.=0.012\*).

In younger boys the strongest correlation with performance success in competitions is visible by handstand to forward roll (HS-RFOR) and squat vault (SQU). None of these correlations in boys did not reach a statistical significance of a 5% level (Table 3). Poorer body control correlation can be explained by accelerated growth in puberty, when development among competitors is subjected to large individual differences. These are reflected in the weaker coordination and poorer control of the body in space and time, which can represent a big problem for a young competitor. Also during this period, in addition to body height also the body weight increases, while muscles develop more in boys than in girls (Horvat & Magajna, 1989; Pišot & Šimunič, 2006). U test results (Table 4) also confirmed that boys with better competitive results have more knowledge and better scores with four variables (HS-RFOR; Sig.=0.037\*, TRN; Sig.=0.048\*, SQU; Sig.=0.027\* and GYM; Sig.=0.033\*). Among these there are two more complex elements of movement (HS-RFOR and TRN), which require a high level of motor potential from examinees in terms of the structure of the movement. Proven statistically significant influence of the average of all gymnastics variables (GYM) both in girls and in boys confirms the fact that an all-round training of acrobatics significantly impacts on achieving good results in alpine skiing.

This study is from the perspective of the applied research methods similar to the study conducted by Krističević, Živčić, Cigrovski, Simović and Rački (2010), but otherwise the mentioned studies are quite different. The main difference between the two studies is in the age of the chosen sample of participants. The age difference of the chosen samples is 2-5 years. In the age period from 8-13 years there can be significant differences in the development level of the children (Pišot & Planinšek, 2005). Given the fact that the sample of

participants in our study is older (ages between 12 to 13 years) and physically and mentally more developed, we selected a sample of variables with slightly more complex gymnastic elements (for instance FLIS90° and TRN). Another difference is also the criterion variable, which in our case is defined as the total amount of points scored in the Mercator Cup (PTS) in accordance with the rules and the system of children's competitions of the Ski Association of Slovenia (Competition System in Alpine skiing, 2013). The results of those two studies have shown the importance of managing acrobatic elements to achieve success in competitions in alpine skiing. Consequently, it can be said that the acrobatics content in the alpine skiing training is important in different age categories of competitors.

Based on the obtained results it can be concluded that the correlation between control of gymnastic elements and performance success is statistically significant both in younger boys and girls. In the future it would therefore be necessary to include in the training process of young alpine skiers in all stages of training even more exercises with elements of acrobatics. Competitive alpine skiing will in the crowd of modern attractive ski disciplines (ski cross, new school, freeride ...) have to become even more dangerous and thus interesting and attractive for the people. The skiing speed that competitors are achieving in competitions is constantly growing (Lešnik & Žvan, 2010) and also presents more possibilities for falls and subsequent injuries (Cirovski & Matković, 2007; Veselko & Polajnar, 2008). Besides other important factors that influence on the success in alpine skiing (Cirovski, 2007; Dolenc & Žvan 2001), in the future the mastery of acrobatic elements will certainly become even more important. Such knowledge is in alpine skiing beneficial both in terms of better control of the skier's own body in solving complex motor tasks while skiing, as well as in the case of falls, when the movement of the skier can be controlled to a lesser extent (Kostelić, 2005;

Živčić & Krističević, 2008). In the future, it would be necessary for the acrobatics training to move even closer to the contemporary trends of ski movement. The training of "ski acrobatics" should be implemented in ski equipment and the training conditions should resemble the ski sliding conditions. Situational acrobatics training could also be approached with e.g. jumping on a large inflatable cushion ("air bag"). A growing number of ski centers has that kind of equipment. Training with these kind of contents would on the one hand allow a higher quality practice of body control and solving movement tasks with skis in the air, on the other hand, this type of training could represent an important enrichment of daily training for all age categories of competitors in alpine skiing.

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### Corresponding author:

Blaž Lešnik  
Faculty of Sport  
University of Ljubljana  
Gortanova 22  
1000 Ljubljana  
Tel: (+386) 1 5207700  
E-mail: [blaz.lesnik@fsp.uni-lj.si](mailto:blaz.lesnik@fsp.uni-lj.si)

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