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THE ANALYSIS OF ALPINE SKIING TECHNIQUES ADOPTION BASED ON ANTHROPOMETRIC PERFORMANCES

ABSTRACT: This research analyzes the techniques involved in basic winding in relation to anthropometric characteristics of subjects. The first aim of this study was to determine whether there is a statistically significant difference between the subjects in the technique of performing basic curvature in relation to their anthropometric characteristics. The second aim of this study was to determine the difference in the technique of primary windings in relation to anthropometric characteristics of subjects. In a sample of 30 students, average age 22 years, male, measuring by 12 anthropometric measures and a situational-motor test was carried out. Alpine skiing technique was assessed through primary windings, the technical element of skiing which is present in the basic form of skiing. Based on the performance of the basic curvature and the obtained results, three subsamples of respondents were defined as "weak", "moderate" and "good". Between the treated subsamples, differences in anthropometric characteristics were established and clearly defined limits in the degree of adoption of the basic winding technique. The subsample defined as "weak" has less pronounced measures of longitudinal and transverse dimensionality, volume and body weight and moderately has pronounced skin folds of the upper arm and back, more pronounced length of the lower leg. The subsample defined as "moderate" has less pronounced skin folds and moderately expressed the length of the lower leg, the circumference of the upper leg and the diameter of the knee. Body height, shoulder width, skin fold of the abdomen, body weight, arm length, medium chest circumference and pelvic width are more pronounced. The subsample defined as "good" has a less pronounced knee length and medium chest circumference and has a moderately pronounced body height, shoulder width, skin fold of the abdomen, body weight, arm length and pelvic width. It has more pronounced skin folds of the upper arm and back, as well as the circumference of the upper leg and the diameter of the knee. Based on these results, we can conclude that, the differences are established and boundaries are clearly defined in the level of adoption of the basic winding techniques between subsamples in relation to anthropometric characteristics.

KEY WORDS: Alpine skiing – Basic winding – Anthropometric characteristics

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INTRODUCTION

Development and improvement of ski equipment, ski primarily, entailed the emergence and production of the first carving skis that allow development of new, carving skiing technique Hirano and Tada (2005), Hörterer (2005). Alpine skiing is the specific and complex sport activity that takes place on a different configuration of the terrain and that requires the skiers to have skiing technique of high quality that can be applied in given circumstances (Hadžić *et al.* 2012). Carving skiing technique enables all the time driving on the curb turn and turn without skidding performance Hörterer (2005). Also, the appearance of carving ski caused an innovation in the learning process of carving ski technique. In the process of learning of ski technique as a transitional phase between the elements of the plow and parallel ski technique often used today is the so-called wedge (V) position of skis, in which the last parts of the skis are less widespread compared to the pulmonary position (Lesnik *et al.* 2002). Using the V-position ski in the learning process, either as a methodological exercise or as an element of ski technique allows gradual buildup to the turnaround performance in its entirety by the parallel ski technique (Cigrovski *et al.* 2010). This learning approach completely omits elements of the plow ski technique Murovec (2006). Therefore, it is important to identify factors that play a significant role in the adoption of skiing technique, and that each skier, beginner, through the alpine ski schools adopt the elements of alpine skiing at a high level (Joksimović *et al.* 2009). It can be said that the success in alpine skiing depends primarily on the level of the adopted specific motor skills (Kuna *et al.* 2008). Meandering ski technique represents the basic element in which a skier continuously connects multiple turns that are a combination of wedge turns and parallel skiing technique Hadžić (2008). It is because of the new learning approach to alpine skiing, the goal of this work is to determine the difference in the technique of primary meandering in relation to anthropometric characteristics of the subjects, and to determine which anthropometric characteristics are contributing to the adoption of the basic techniques of meandering at the ski beginners. Research focused on the valorization and evaluation of skiing techniques (Andersen *et al.* 1990, Dopsaj 2004, Cigrovski 2007, Blakeslee 2009, Mladenović 2016) indicate a different approach in defining the way in which the degree of adoption of ski knowledge is assessed, i.e. determined. By determining and analyzing various parameters of the adoption of alpine skiing techniques, it is possible to systematically monitor the relevant performance variables of rational technique and discover reserves for better sports results at each level and degree of training in skiing technique. From recreational aspect, alpine skiing is one of the most popular winter sports with millions of people participating world-wide (Senner *et al.* 2009, Thiel *et al.* 2009). Alpine skiing, although enjoyed by millions of people worldwide, is perceived as a "high-risk" sport (Castanier 2010), demanding for both learning and teaching (Makowski 2014).

METHODS

The key issue, and the whole problem orientation of this research is related to the analysis of the performance of primary meandering in alpine skiing in relation to anthropometric characteristics of subjects. Measurement of anthropometric characteristics was carried out at the Faculty of Sports and Physical Education, before departure of students in compulsory practical teaching of skiing. Assessment of skiing technique was performed on the slopes of Kopaonik realized after a seven-day program. Ski teaching lasted for seven days, a total of 42 hours, and was performed by three teachers at the identical program. During the day the class is created with the total of 6 hours where the first three hours was applied learning elements of ski technique and the three-hour afternoon were for training purposes. Assessors were teachers who have vast experience in this business. Each subject was evaluated by all three assessors from different positions. Three independent assessors gave the ratings to each respondent for the demonstration of selected elements of ski technique – basic meandering as the final score takes the average of the three ratings. Evaluation of adoption levels of skiing skills in participants valued the score of 5 to 10 relating to the conduct of skis arc turns, speed control based on completion of shift, the appropriate attitude that ensures the center of gravity in the middle of the foot, lightness and softness demonstration. The processing of the data, based on the final (formed) in the performance evaluation of primary windings, sample is divided into three sub-samples, which were called "poor", "moderate" and "good" (Hadžić *et al.* 2013). During processing of the data, based on the final (formed) grades in the performance evaluation of basic meandering, sample is divided into three sub-samples, which were called "poor", "moderate" and "good" (Hadžić *et al.* 2013). The first sub-sample ("bad") included the subjects who received grades 5 and 6 to the techniques of basic meandering, the second ("moderate") included the subjects who received grades 7 and 8 of the techniques of primary windings and third sub-sample ("good") included the subjects who received grades 9 and 10 for the performed technique of basic meandering.

Subjects sample

In this study, the sample entered the 30 students of the Faculty of Sports and Physical Education, ski novice male, average age 22 years, divided into three sub-samples compared to the techniques involved in basic twists as follows: first sub-sample consists of 9 subjects classified as ("weak"), the second of 10 respondents classified as ("moderate") and the third sub-sample consists of 11 respondents classified as ("good").

A sample of measuring instruments

Anthropometric characteristics followed in this study were measured according to the instructions and regulations of the International Biological Program (IBP). The program consists of 39 measures Mišigoj-Duraković (2008), some of which were used in this study as follows: body weight, chest circumference, thigh circumference, body height, lower leg length, arm length, upper arm skinfold, abdominal skinfold, back skinfold, knee diameter, pelvic width, shoulder width. Criterion variable in this study was the basic meandering.

Methods of data processing

In line with the aim of research appropriate statistical methods of data was chosen. The first part shows the central and dispersion parameters, measures of skewness and kurtosis compared to the monitored parameters. The second part analyzes the differences between respondents in the technique of basic meandering in relation to anthropometric characteristics. Then the characteristics and homogeneity of each sub-sample are defined in relation to the basic techniques of performing twists and the distance between them is determined. Finally the results are presented graphically. To avoid losing information, finding the finest links and information on nonparametric sizes, data scaling was performed on contingency tables. Based on the above it is evident that the application of discriminant analysis (DISCKRA) on the scaled data is possible. By calculating the coefficient of discrimination features that determine the specificity and characteristics of the subsamples are standing out to be excluded from further processing, i.e. reduction of the observed space is applied. Also, the representation of the homogeneity of the subsamples, the distance between them and cluster analysis, is aimed to study

TABLE 1: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics of the sub-sample – "weak" (9). Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk (standardized coefficient of asymmetry, curvature), Ku (standardized coefficient of elongation or flatness).

	M	SD	Min	Max	CV	Range		Sk	Ku
AMAST	75.56	15.77	61.0	114.0	20.86	63.43	87.68	1.76	2.13
AOGK	96.67	9.42	88.0	117.0	9.75	89.42	103.91	1.21	.34
AONDK	53.33	5.96	44.0	64.0	11.17	48.75	57.91	.25	-.49
AVIST	176.78	7.93	167.0	191.0	4.49	170.68	182.88	.50	-.73
ADUPK	55.33	16.71	51.0	59.0	30.20	52.49	78.18	.64	-1.49
ADRUK	76.33	3.78	71.0	81.0	4.95	73.43	79.24	-.44	-1.36
AKNNL	10.86	6.01	5.0	22.0	55.38	6.23	15.48	.79	-.84
AKNTR	16.50	10.62	6.0	39.0	64.35	8.34	24.66	1.11	.23
AKNL	13.77	10.79	7.0	41.0	78.39	5.47	22.06	2.03	2.77
ADKL	8.99	1.18	7.5	10.9	13.10	8.08	9.89	-.02	-1.11
AŠIKA	29.72	2.28	27.0	33.0	7.67	27.97	31.48	.22	-1.60
AŠIRA	40.22	3.05	33.5	44.0	7.59	37.88	42.57	-1.10	.78

observed phenomena as best as possible. The purpose of the application of mathematical and statistical analysis aims to determine the characteristics of each sub-sample, the homogeneity and the distance between them in relation to the derived characteristics that could be used for reliably and accurately forecasting and prediction with a specified reliability.

RESULTS

In accordance with the defined purpose of research, the thematic unit anthropometric characteristics of the respondents will be analyzed in relation to the techniques involved in basic meandering in alpine skiing. The central and dispersion parameters, measures of skewness and kurtosis of the mentioned anthropometric characteristics represent the basic technique of meandering and direct us to the possibility of using parametric procedures.

Minimum (min) and maximum (max) values of the anthropometric characteristics of subgroups "weak" indicates that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates the subsample "weak" by the following characteristics: length of the lower leg (ADUPK), forearm skin fold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL) and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), pelvic width (ASIKA) and shoulder width (ASIRA). Increased values of Skewness (Sk.) indicate that the distribution is highly asymmetric with negative pelvic width (ASIKA). Increased values of Skewness (Sk) indicates extremely positive asymmetric distribution with the following characteristics: body mass (AMAST), chest circumference (AOGK), abdominal skinfold (AKNTR) and skinfold (AKNL). Normal (tolerant) asymmetry values of Skewness (Sk) are determined by the following characteristics: the volume of the thigh (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), forearm skin fold (AKNNL), knee diameter (ADKL) and pelvic width (ASIKA). Higher values of Kurtosis (Ku) indicate the elongated curve, with the following characteristics: body mass (AMAST), chest circumference (AOGK), abdominal skinfold (AKNTR), skinfold (AKNL), shoulder width (ASIR). Negative values of Kurtosis (Ku) indicates the flattened curve, with the following characteristics: the volume of the thigh (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), forearm skin fold (AKNNL), knee diameter (ADKL), pelvic width (ASIKA).

Minimum (min) and maximum (max) values of the anthropometric characteristics of subgroups

TABLE 2: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics of the sub-sample – "moderate" (10). Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk (standardized coefficient of asymmetry, curvature), Ku (standardized coefficient of elongation or flatness).

	M	SD	Min	Max	CV	Range		Sk	Ku
AMAST	81.90	13.75	68.0	105.0	16.78	72.06	91.74	.83	-.90
AOGK	100.70	8.87	89.0	116.0	8.81	94.35	107.05	.39	-1.02
AONDK	55.60	4.79	50.0	64.0	8.61	52.17	59.03	.54	-.92
AVIST	180.50	6.93	170.0	190.0	3.84	175.54	185.46	-.10	-1.32
ADUPK	56.00	10.50	54.0	61.0	18.75	52.49	67.51	2.39	4.23
ADRUK	77.60	3.92	72.0	83.0	5.05	74.79	80.41	-.03	-1.50
AKNNL	10.18	3.85	5.6	17.0	37.83	7.42	12.94	.67	-.69
AKNTR	19.66	8.91	11.0	35.0	45.32	13.28	26.03	.64	-1.16
AKNL	13.15	5.05	8.0	25.0	38.43	9.53	16.77	1.39	1.07
ADKL	9.94	.89	8.0	11.4	8.99	9.30	10.58	-.56	.75
AŠIKA	30.05	1.34	28.0	32.0	4.47	29.09	31.01	.18	-1.06
AŠIRA	41.55	2.60	36.0	46.0	6.25	39.69	43.41	-.45	.75

"moderate" indicates that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates the subsample "moderate" by the following characteristics: forearm skin fold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL) and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), pelvic width (ASIKA) and shoulder width (ASIRA). Increased values of Skewness (Sk) indicate that the distribution is highly negatively asymmetric and it's not notified. Increased values of Skewness (Sk) indicates extremely positive asymmetric distribution with the following characteristics: length of the lower leg (ADUPK) and skinfold (AKNL). Normal (tolerant) asymmetry values of Skewness (Sk) are determined by the following characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), forearm skin fold (AKNNL), abdominal skinfold (AKNTR), knee diameter (ADKL), pelvic width (ASIKA)and shoulder width (ASIRA). Higher values of Kurtosis (Ku) indicate the elongated curve, with the following characteristics: length of the lower leg (ADUPK), skinfold (AKNL), knee diameter (ADKL), shoulder width (ASIRA).Negative values of Kurtosis (Ku) indicates the flattened curve, with the following characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), forearm skin fold (AKNNL), abdominal skinfold (AKNTR), pelvic width (ASIKA).

Minimum (min) and maximum (max) values of the anthropometric characteristics of subgroups "good" indicates that the values are in the expected range. Greater heterogeneity of the coefficient of variation (CV) indicates the subsample "good" by the following characteristics: forearm skin fold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL) and knee diameter (ADKL). The coefficient of variation (CV) indicates the homogeneity characteristics: body mass (AMAST), chest circumference (AOGK), thigh circumference (AONDK), body height (AVIST), length of the lower leg (ADUPK), arm length (ADRUK), pelvic width (ASIKA) and shoulder width (ASIRA). Increased values of Skewness (Sk) indicate that the distribution is highly negatively asymmetric at chest circumference (AOGK). Increased values of Skewness (Sk) indicates extremely positive asymmetric distribution with the following characteristics: length of the lower leg (ADUPK). Normal (tolerant) asymmetry values of Skewness (Sk) are determined by the following characteristics: body mass (AMAST), thigh circumference

TABLE 3: The central and dispersion parameters and measures of skewness and kurtosis of the anthropometric characteristics of the sub-sample – "good" (11). Legend: M (mean), SD (standard deviation), Min (minimum value), max (maximum value), CV (coefficient of variation), Range (Range), Sk (standardized coefficient of asymmetry, curvature), Ku (standardized coefficient of elongation or flatness).

	M	SD	Min	Max	CV	Range		Sk	Ku
AMAST	77.46	8.12	65.0	87.0	10.48	72.00	82.91	-.63	-1.18
AOGK	96.46	13.07	61.0	110.0	13.55	87.67	105.24	-1.91	3.13
AONDK	55.91	3.78	48.0	61.0	6.76	53.37	58.45	-.64	-.18
AVIST	179.18	4.92	172.0	187.0	2.74	175.88	182.49	.01	-1.22
ADUPK	54.64	9.10	51.0	59.0	16.65	52.52	64.75	2.44	4.82
ADRUK	76.73	3.35	72.0	82.0	4.36	74.48	78.98	-.12	-1.08
AKNNL	12.30	3.90	7.0	21.0	31.68	9.68	14.92	.93	.31
AKNTR	18.18	6.25	9.0	27.6	34.36	13.98	22.38	.02	-1.26
AKNL	13.78	3.11	9.0	17.9	22.55	11.69	15.87	-.16	-1.40
ADKL	10.13	.77	9.0	11.6	7.56	9.61	10.64	.37	-.56
AŠIKA	29.73	1.38	26.5	32.0	4.66	28.80	30.66	-.79	1.15
AŠIRA	41.32	3.04	37.0	48.0	7.37	39.27	43.36	.76	.21

(AONDK), body height (AVIST), arm length (ADRUK), forearm skin fold (AKNNL), abdominal skinfold (AKNTR), skinfold (AKNL), knee diameter (ADKL), pelvic width (ASIKA) and shoulder width (ASIRA). Higher values of Kurtosis (Ku) indicate the elongated curve, with the following characteristics: chest circumference (AOGK), length of the lower leg (ADUPK), forearm skin fold (AKNNL), pelvic width (ASIKA) and shoulder width (ASIRA). Negative values of Kurtosis (Ku) indicates the flattened curve, with the following characteristics: body mass (AMAST), thigh circumference (AONDK), body height (AVIST), arm length (ADRUK), abdominal skinfold (AKNTR), skinfold (AKNL) and knee diameter (ADKL).

This subsection will prove or reject the claim that there is a significant difference in the technique of basic meandering in relation to anthropometric characteristics of subjects.

Table 4 presents the results of discriminant analysis (DISKRA) to determine the significance of differences in the technique of primary windings in relation to anthropometric characteristics of subjects. When looking at the anthropometric characteristics as a system using discriminant analysis (DISKRA), it clearly shows, based on the value of p=.000, that there is a difference and clearly defined boundary in the technique of basic meandering between respondents, which is manifested latently. This fact suggests that there are probably latent characteristics that in conjunction with other features (synthesized) contribute to discrimination against respondents in the technique of basic meandering.

A review of Table 5, when considering the anthropometric characteristics of the subjects individually using discriminant analysis (DISKRA), is giving us discrimination coefficient (k.dsk) that indicates to the claim that there is a difference in the technique of basic meandering between respondents and that the greatest contribution to discrimination, that is the biggest difference, is with the following variables: body height (.189), shoulder width (.183), abdominal skinfold (.152), forearm skin fold (.147), body mass (.130), skinfold (.98), lower leg length (.093), length of hand (.090), the volume of the thigh (.080), knee diameter (.077), chest circumference (.051), pelvic width (.031).

TABLE 4: The significance of differences in the technique of basic meandering in relation to anthropometric characteristics of subjects.

Analysis	**n**	**F**	**p**
DISKRA	12	39.211	.000

TABLE 5: The significance of differences in the technique of basic meandering in relation to anthropometric characteristics of subjects. Legend: k.dsk is the coefficient of discrimination.

	F	**k.dsk**
AMAST	.637	.130
AOGK	.497	.051
AONDK	.803	.080
AVIST	.768	.189
ADUPK	.800	.093
ADRUK	.301	.090
AKNNL	.581	.147
AKNTR	.318	.152
AKNL	.028	.098
ADKL	3.982	.077
AŠIKA	.124	.031
AŠIRA	.560	.183

DISCUSSION

Based on the previous discussion and analysis of samples from 30 subjects, in accordance with the methodology applied, the logical sequence of study was to determine the characteristics and homogeneity of each subsample based on the performance technique of basic meandering and distance between them. The fact that p=.000, discriminant analysis (DISKARA) means that there are no clearly defined boundaries between subsamples on the basis of a technique of primary windings, that it is possible to determine the feature of each sub-sample of the primary windings of a technique in relation to anthropometric characteristics. The fact that p =.000 of discriminant analysis (DISKARA) means that there is no clearly defined boundary between subsamples on the basis of a technique of basic meandering, that it is possible to determine the feature of each sub-sample based on the performance technique of the basic meandering in relation to anthropometric characteristics.

The status of each sub-sample performance of the techniques of basic meandering is mostly defined by body height because the contribution feature characteristics are 14.31% followed by: shoulder width (13.85%), abdominal skinfold (11.51%), upper arm skin fold (11.3%), body weight (9.84%), skinfold (7.42%), lower leg length (7.04%), arm length (6.81%), the volume of the thigh (6.06%), knee diameter (5.83%), chest circumference (3.86%) and pelvic width (2.35%). Homogeneity of the subsamples "weak" is 77.78%, for subsample of "moderate" is 60.00%, and for sub-samples "good" is 72.73%. Based on the above it can be said that the characteristics of the subsample of "weak" features has 7 of 9 subjects, which means that two subjects have other features rather than the characteristics of their group, homogeneity of subsamples is as great as 77.78%. Characteristics of subgroups "moderate" to 6 of the 10 subjects, homogeneity is 60.0% for 4 of the respondents have other features, also features sub-sample "goods" has 8 of the 11 subjects, homogeneity is high at 72.7% for 3 subjects had other characteristics. This means that one can expect that subjects whose characteristics are similar to that of sub-sample "weak", but they belonging based on basic meandering technique is unknown, have reliability of 77.8% of belonging just to the subsample of "weak", i.e., it is possible to forecast with certainty that a particular respondent with such features can be classified in the sub-sample "weak". Based on the anthropometric characteristics of the respondents, it can be said that the sub-samples have the following properties: Subsample of the "weak" have less pronounced following characteristics: body height, arm length, body mass, the volume of the thigh, shoulder width, pelvic width, knee diameter, abdominal skinfold. Moderately expressed are following properties: skinfold upper arm skinfold, circumference of chest. More pronounced are following properties: length of lower leg. Subsample of "moderate" has less pronounced following properties: skinfold, upper arm skinfold. Moderately are expressed the following properties:

TABLE 6: Characteristics and homogeneity of the subsamples based on the performance techniques of basic meandering in relation to anthropometric characteristics. Legend: hmg – homogeneity; dpr % – contributing feature characteristics.

	Weak	Moderate	Good	dpr %
AVIST	less	greater	moderate	14.307
AŠIRA	less	greater	moderate	13.853
AKNTR	less	greater	moderate	11.506
AKNNL	moderate	less	greater	11.128
AMAST	less	greater	moderate	9.841
AKNL	moderate	less	greater	7.419
ADUPK	greater	moderate	less	7.040
ADRUK	less	greater	moderate	6.813
AONDK	less	moderate	greater	6.056
ADKL	less	moderate* [1]	greater* [1]	5.829
AOGK	moderate	greater	less	3.861
AŠIKA	less	greater	moderate	2.347
n/m	**7/9**	**6/10**	**8/11**	
%	**77.78**	**60.00**	**72.73**	

TABLE 7: Distance (Mahalanobis) between the subsamples in the technique of basic meandering in relation to anthropometric characteristics of the respondents.

	Weak	Moderate	Good
Weak	.00	1.80	2.32
Moderate	1.80	.00	1.39
Good	2.32	1.39	.00

TABLE 8: Grouping of subsamples in the performance technique of basic meandering in relation to the anthropometric characteristics of the respondents. Legend: weak (poor) (1) moderate (2) good (3).

Level	Closeness
Moderate, Good	1.39
Weak, Moderate	2.16

length of lower leg, thigh girth, knee diameter. More pronounced are the following properties: body height, shoulder width, abdominal skinfold, body mass, arm length, circumference of chest and pelvic width. Subsample of "good" has less pronounced following properties: lower leg length and circumference of the chest. Moderately are expressed the following properties: body height, shoulder width, abdominal skinfold, body mass, arm length and width of the pelvis. More are expressed the following properties: skinfold upper arm skinfold, thigh girth and knee diameter.

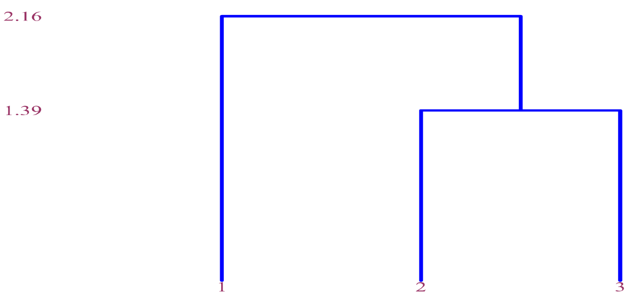
Similar conclusions were reached by applying anthropometric measures in the prediction of the achievement of the basic turn technique in alpine skiing (Hadžić *et al.* 2014).

By calculating, the Mahalanobis distance between the subsamples in the technique of basic meandering performance it can be obtained another indication of similarity or difference. Distances from Table (7) indicate that the least the distance is between subsamples of "good", "moderate" (1.39) and the outermost between sub-samples of "good" and "poor" (2.32).

Based on the displayed dendrogram it can be seen that the closest sub-samples are "moderate" and "good" with distance 1.39, and the biggest difference is between the subsamples "weak" and "moderate", distance 2.16.

Based on the graphic display of ellipses (confidence interval) it may be possible to observe the relative positions and characteristics of each of the three sub-samples ("weak" 1, "moderate" 2, "goods" 3, on the basis of a technique of basic meandering in relation to the most discriminating 3 (features) anthropometric characteristics: body height (AVIST), shoulder width (ASIRA), abdominal skinfold (AKNTR).

The chart's (1) X-axis (horizontal axis) is the height of the body (an04) and the ordinate (vertical axis) is the width of the shoulders (an12). It is noted, that in relation to the size of the body, subsample "weak" (1) has the lowest value of anthropometric characteristics, and the highest value is the one of subsample "moderate" (2). In relation to the width of the shoulders subsample "weak" (1) has the lowest value



GRAPH 1: Graphic differences between the subsamples based on the performance technique of basic meandering in relation to the three most discriminating anthropometric characteristics.

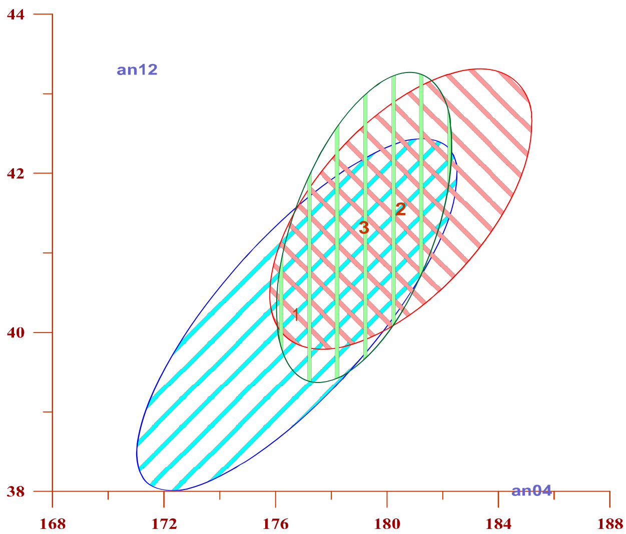


CHART 1: Ellipses (confidence interval), basic meandering of subjects by body height and shoulder width. Legend: "poor" (weak) (1), "moderate" (2) "goods" (3), body height (an04), shoulder width (an12).

of anthropometric characteristics, and the highest value has subsample "moderate" (2).

The chart's (2) x-axis (horizontal axis) is the height of the body (an04) and the ordinate (vertical axis) is the abdominal skinfold (an08). It is noted that in relation to the size of the body, subsample "weak" (1) has the lowest value of anthropometric characteristics, and the highest value is the one of subsample "moderate" (2). In relation to the abdominal skinfold, subsample "weak" (1) has the lowest value of anthropometric characteristics, and the highest value is for the sub-sample "moderate" (2).

The chart's (3) x-axis (horizontal axis) is the width of the shoulders (an12), and the ordinate (vertical axis) is the abdominal skinfold (an08). It is noted that in relation to the width of the shoulders subsample "weak" (1) has the lowest value of anthropometric characteristics, and the highest value is for the sub-sample "moderate" (2). In relation to the abdominal skinfold, subsample "weak" (1) has the lowest value of anthropometric characteristics, and the highest value is for the sub-sample "moderate" (2).

In the research conducted on a sample of 30 respondents, students of the Faculty of Sports and Physical Education, University of Montenegro, 12 anthropometric measures and one specific-motor test intended for the assessment of skiing technique (wedge winding) were applied. After analyzing the results, the respondents were classified into three groups ("weak", "moderate" and "good") according to the level of adoption of alpine skiing techniques. By applying mathematical-statistical analysis, the homogeneity of subsamples was determined and the boundary between them in relation to anthropometric characteristics was clearly defined. The results of the research provided an answer to how much anthropometric characteristics can contribute to the process of adopting the technique of alpine skiing. Based on the anthropometric characteristics of the respondents, it can be concluded that: the subsample defined as – "weak" has a less pronounced shoulder width, thigh circumference, skin fold of the abdomen and knee diameter. It has moderate body weight, body height, medium chest circumference, skin fold of the upper arm and skin fold of the back. The length of the lower leg, the length of the arm and the width of the pelvis are more pronounced, and the homogeneity of the "weak" subsample is 75.00%. The subsample defined as – "moderate" has a less pronounced body height, skin fold of the upper arm, arm length, pelvic width and skin fold of the back. It has a moderately pronounced shoulder width, thigh circumference, lower leg length, skin fold of the abdomen and knee diameter. The body weight and mean chest circumference are more

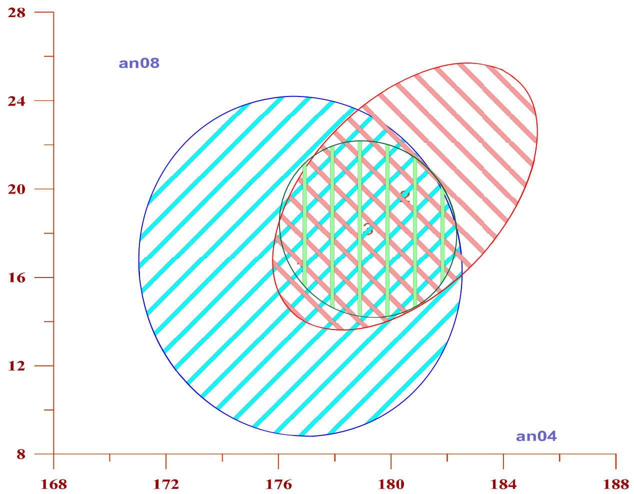


CHART 2: Ellipses (confidence interval) of basic meandering of subjects by body height and skinfold of the abdomen. Legend: "poor" (1), "moderate" (2) "goods" (3), body height (an04), abdominal skinfold (an08).

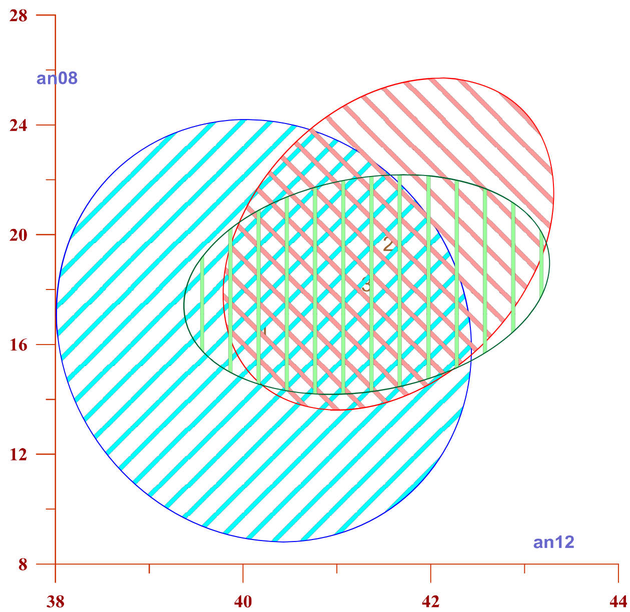


CHART 3: Ellipses (confidence interval) for basic meandering of subjects by shoulders width and abdomen skinfold. Legend: "poor" (1), "moderate" (2) "goods" (3), shoulder width (an12), abdominal skinfold (an08).

pronounced, the homogeneity of the "moderate" subsample is 81.82%. The subsample defined as – "good" has a more pronounced, shoulder width, body height, thigh circumference, skin fold of the abdomen, skin fold of the upper arm, skin fold of the back and knee diameter. He has a moderately pronounced arm length and pelvic width, and a less pronounced body weight, knee length and medium chest circumference. The homogeneity of the "good" subsample is 85.71%. Based on the characteristics of the examinees defined in this way, in case the affiliation of a examinee is not known on the basis of the technique of performing a wedge-shaped meandering, e.g. subsample "good", it is possible to predict with a certain reliability of 85.71% that the respondent with such characteristics will be classified as a subsample "good" (Hadžić *et al.* 2019).

Skiing is a highly demanding sport that requires a high level of skier's physical efficiency. However, as in other sports, one of the limiting factors in achieving the top-level results is also the athlete's body weight and the body height. The first aim of this research was to determine the differences in basic anthropometric characteristics of the elite female alpine skiers in relation to their classification on the most important international competitions in year 2006/2007. The second aim was to determine the differences in basic anthropometric characteristics of the elite female alpine skiers after one Olympic period (2006–2010). The sample for this research encompasses all female alpine skiers who classified in Olympic games 2006 in Turin, World championships in Äre 2007, World Cup 2006/07 as well as in Olympic games 2010 in Vancouver (56 SL, 56 GS, 47 DH, 56 SG, and 42 SC). Variables included in this analysis were body weight, body height and rank in each of five alpine disciplines. In order to calculate the differences between the basic anthropometric models for each discipline ANOVA was used. In slalom and super combination the best positioned are those skiers whose height is approximately 171 cm and body weight is approximately 68 kg. In the giant slalom better positioned are slightly lighter and shorter skiers, while in speed events heavier and taller individuals are better positioned. ANOVA analyses showed no statistically significant differences in any of the observed disciplines within the first 30 skiers classified. However, statistically significant difference in body height is observed between the skiers ranked 1–10 and 31 and more in Slalom, Downhill and Combined, as well as for the body weight in Slalom, Super G and Combined (Hraski and Hraski 2010). Balance is hypothesized to be important in alpine skiing, while it is known that balance depends on anthropometric indices. The aim of this investigation was to explore the association between balance, anthropometrics and skiing-results over two competitive seasons among youth alpine-skiers. Eighty-one skiers (40 females) participated in this study. The participants were tested twice over two competitive seasons: when they were 12–13 years old (U14) and when they were 14–15 years old (U16). The variables consisted of anthropometrics (body height and body mass) and three balance indexes (medio-lateral-, anterio-posterior- and overall-stability-index). Additionally, skiing results in U14 and U16 were evaluated. The balance status did not change significantly over the observed period of time regardless of the significant changes in body mass and height. The relationships between balance and skiing results were higher in the U14 (Pearson's $r = 0.45–0.54$) than in the U16 (Pearson's $r = 0.05–0.28$). The relationships between anthropometrics and competitive results were generally stronger in girls (Pearson's $r = 0.39–0.88$) than in boys (Pearson's $r = 0.26–0.58$). After clustering athletes into three achievement groups on a basis of their competitive performance, discriminant canonical analysis showed that relationships between balance and skiing results decreased, while the relationships between anthropometrics and skiing results increased over the two observed seasons (Lesnik *et al.* 2017).

The purpose of this study was to use a multiple regression analysis to identify the independent impact of morphological dimensions, physical fitness and technique in free and competitive Alpine skiing on competition performance in twenty categorized racers from various Slovenian ski clubs, girls aged 12 to 14. We used the reduced model variables of morphological dimensions – MD (the volume of the left knee, body mass index (BMI), % body fat), physical fitness – PHF (ten jumps on both legs, running eights, stability test), technique in free skiing – TEFSK (balance, movement coordination and derivation of the curve) and the technique in competitive skiing – TECSK (balance, derivation of the curve and the line of skiing). For the criterion variable, we used the total sum of the points in the Slovenian Cup in the 2013/14 season. The results showed that all four areas of measurement explain 82.6% of the variance of the points won ($R^2 = .826$), so the effect of these predictors on the competitive performance of the girls is very high (level set at $p<0.05$). This may show that the results of technique in competitive skiing ($p<.000$) in girls significantly explains the share of points won. The regression coefficients show that girls with better morphological dimensions and better technique in free skiing achieved higher scores. The study raises key areas of research in the field of technique in free and competitive skiing as the two are fundamental for achieving top results in competitive Alpine skiing (Puhalj, Lešnik 2017).

CONCLUSION

A sample of 30 subjects was analyzed and divided into three subgroups, based on the score obtained by the performance techniques of basic meandering in alpine skiing. In accordance with pre-determined objectives of the research, the methodological approach of this study analyzed the difference in the technique of basic meandering between the respondents in relation to anthropometric characteristics. Based on the results, their interpretation can give us the following conclusions: For anthropometric characteristics of respondents, by using discriminant analysis (DISKRA. 000), the results indicate that the technique of basic meandering shows no difference between the three subsamples with a coefficient of discrimination: body height (.189), shoulder width (.183), abdominal skinfold (.152), forearm skin fold (.147), body mass (.130), skinfold (.098), lower leg length (.093), arm length (.090), the volume of the thigh (.080), knee diameter (.077), chest circumference (.051), pelvic width (.031). As the differences are established and boundaries clearly defined the characteristics and homogeneity of each subsample are determined. Based on the anthropometric characteristics of the respondents it can be concluded that: Subsample defined as "poor" has a less pronounced body height, arm length, body weight, thigh circumference, shoulder width, pelvis, knee diameter, abdominal skinfold and moderately expressed a skin fold and upper arms back and chest circumference. More pronounced is length of the lower leg. Homogeneity of the subsample "weak" is 77.78%. Subsample defined as "moderate" has less pronounced skin folds of the upper arms and back while moderate pronounced length shin, thigh girth and knee diameter. More expressed is body height, shoulder width, abdominal skinfold, body mass, arm length, chest circumference and width of the pelvis. Homogeneity of the subsamples "moderate" is 60.00%. Subsample defined as "goods" has less pronounced shin length and circumference of the chest and has expressed a moderate body high, shoulder width, abdominal skinfold, body mass, arm length and width of the pelvis. More expressed are forearm skin fold and back as well as the volume of the thigh and knee diameter. Homogeneity of the subsamples "good" is 72.73%.

The significance of this research is manifold, both for theory and for practice. Observed from a theoretical point of view, it is undoubtedly that it has given new results that enable comparison with previous and future research in this field, and comparison of other skiers of the same age and gender. The contribution and practical significance of this paper is in a closer acquaintance with the causal relationships between anthropometric characteristics on the one hand and the success of the adoption of basic skiing techniques in the student population, on the other hand. The practical significance of the research is in monitoring the success of the adoption of basic skiing techniques by novice ski students, their anthropometric characteristics at the very beginning of the adoption of skiing techniques and in identifying important characteristics for success in the initial stages of alpine skiing training. Educating coaches in making selections, especially in working with younger categories, are a necessary step on the way to achieving top results. In that sense, based on the anthropometric characteristics of young skiers and comparison with the results obtained by this research, coaches can make an initial selection of young skiers who are directed to a competitive ski school. By determining and analyzing various parameters of technique adoption at the youngest age of skiers, trainees can systematically monitor the relevant variables of performance of rational technique, from the very beginning of training at each stage of improving ski technique. Based on this, it can be said that future research should be focused on further monitoring and identification of performance parameters and discovery of reserves for better sports results at each level and degree of training in skiing techniques.

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