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Longitudinal dimensionality affects repetitive strength in skiers

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Abstract

Skiing belongs to a group of activities that take place in special conditions of the external environment, and success in skiing primarily depends on morphological characteristics, motor and functional abilities. Accordingly, the aim of the research is to identify the structure of longitudinal dimensionality and repetitive power of skiers, and then examine the potential influence of longitudinal dimensionality on repetitive power of skiers. The sample of respondents consisted of 21 skiers with chronological age 16.04±2.51. The sample of measuring instruments consisted of nine variables, five variables for the assessment of morphological characteristics: body height (BH), leg length (LL), upper leg length (LUL), lower leg length (LLL) and arm length (LA), and four variables for repetitive strength testing: push-ups until failure (PUF), sit ups until failure (SUF), chin ups until failure (CUF) and squats until failure (SQUF). The influence of longitudinal dimensionality on the repetitive strength of skiers was determined using linear regression analysis. All statistical analyzes were performed with the statistical package IBM SPSS Statistics (Version 20). The results showed that the area of longitudinal dimensionality is dominantly defined by body height (BH), while the area of repetitive strength is defined by the squat until failure test (SQUF). Using linear regression, it is confirmed that there is a statistically significant influence of longitudinal dimensionality on the repetitive strength of skiers.

Keywords: *skiing, longitudinal dimensionality, repetitive strength, influence*

Introduction

Skiing is a motorically and energetically complex and demanding individual sports activity (Cigrovski & Matković, 2019). According to the criterion of structural complexity, this sport belongs to the group of monostructural activities in which there is one or more closed acyclic type movement structures that are successively repeated (Andersen & Montgomery, 1988; Cigrovski & Matković, 2019). Skiing is not only about going down the slope, but also involves turning, climbing, walking, very frequent change of direction movements, jumps and different landings that require specific morphological characteristics from the skier, as well as motor and functional abilities (Neumayr et al., 2003; Krsmanović & Lukman, 1993; Željaskov, 2004). Without a doubt, it can be suggested that skiing requires synthesis of conative characteristics, physical and cognitive abilities (Cigrovski & Matković, 2019). Numerous studies were carried out to determine the areas with greatest projections on success in skiing. All these studies focused on the influence of morphological charcteristics, motor and functional abilities (Ryabov et al., 2023; Scherge et al., 2021; Turković et al., 2020). Previous research has confirmed that certain morphological characteristics and motor skills have a very significant influence on success in skiing (Hadžić & Nikšić, 2022). Morphological characteristics and motor abilities are closely related to each other and influence the realization of motor tasks in skiing (Roczniak et al., 2020). Morphological characteristics of a person exclusively mean a certain system of basic anthropometric latent dimensions (Simić et al., 2022; Željaskov, 2004; Kurelić et al., 1975). Morphological characteristics are of particular importance for orientation and selection both in other sports and in skiing (Milanović, 1980; Kurelić, 1975). Of the morphological characteristics, longitudinal dimensionality has the greatest genetic predisposition, voluminousness is somewhat lower, while subcutaneous fat tissue is the least affected (Sergienko, 1999; Malacko & Popović, 2001; Đurašković, 2001). The longitudinal dimensions of the body as the best indicator of the growth of the human organism, are the result of a complex process of ontogenetic development and the action of biotic and abiotic factors in a certain environment. In

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addition to the longitudinal characteristics that affect success in skiing, motor abilities are also highlighted, which to a certain extent represent an indicator of success in this sport (Delas et al., 2008). A motor ability that stands out in addition to explosive strength is repetitive strength (Turković et al., 2020). Repetitive strength can be defined as the ability of a muscle to exert force in a long-term work mode when it is necessary to overcome an appropriate external load up to 75% of the maximum (Zatsiorsky & Kraemer, 2009; Kukolj, 2006; Željaskov, 2004; Kurelić, 1975; Malacko & Rađo, 2004). The positive influence of morphological characteristics on the strength of skiers has been confirmed in a large number of studies (Joksimović et al., 2011; Mujanović & Krsmanović, 2008).

The aim of the research is to identify the structure of longitudinal dimensionality and repetitive power of skiers, and then determine the potential influence of longitudinal dimensionality on repetitive power of skiers.

Methods

A sample of respondents

The research was conducted on a sample of 21 skiers, whose age was defined on the basis of chronological age, so that the research included respondents from 16.04±2.51 years. Respondents who participated in this research had to meet several conditions: they were male, they were permanent members of their ski clubs, they were healthy (not injured) and they were registered members of the ski association. For each participant in this study, their parents gave written consent prior to participation.

Sample variables

The following variables were used to measure the longitudinal dimensionality of skiers: body height (BH), leg length (LL), upper leg length (LUL), lower leg length (LLL) and arm length (LA). The repetitive strength of the skiers in this study was tested with the following battery of tests: push-ups until failure (PUF), sit ups until failure (SUF), chin ups until failure (CUF) and squats until failure (SQUF).

A sample of measuring instruments

Measurements and testing of skiers were carried out in the premises of the clubs for which the skiers perform in the morning hours. Before repetitive strength testing, general and specific warm-up exercises that increase the range of motion of individual body parts were performed.

Statistical analysis

In order to adequately determine the structure of the observed spaces of repetitive strength and longitudinal dimensionality of the tested skiers, the method of principal components will be applied. The influence of longitudinal dimensionality on the repetitive strength of skiers will be examined using linear regression analysis. All statistical analyzes were implemented within the statistical package IBM SPSS Statistics (Version 20).

Results

The results of descriptive statistical analysis of studied population are presented in Table 1.

Table 1. Descriptive analysis studied population

	N	Min	Max	Mean	SD	S-W
CUF	21	11.00	17.00	13.90	1.51	0.634
PUF	21	13.00	22.00	17.85	2.26	0.929
SUF	21	40.00	47.00	43.47	1.80	0.833
SQUF	21	52.00	66.00	58.23	4.82	0.083
BH	21	156.00	185.00	170.38	6.62	0.898
LL	21	79.02	95.00	88.43	4.30	0.771
LUL	21	43.60	52.00	47.51	2.22	0.634
LLL	21	30.30	45.00	40.97	3.31	0.001
LR	21	43.00	53.50	48.59	2.99	0.534

Legend: CUF - chin ups until failure; PUF – push-ups until failure; SUF - sit ups until failure; SQUF - squats until failure; BH - body height; LL - leg length; LUL - upper leg length; LLL - lower leg length; LA - length arm

Parameters of the arithmetic mean and standard deviation show the expected values for this level of the group of respondents taking into account their chronological age. In order to determine the normality of the distribution of the investigated parameters, the Shapiro-Wilk was applied. The Shapiro-Wilk normality test indicates that the lower leg length variable (LLL) had a statistically significant

Table 2. Factor analysis of the longitudinal dimensionality studied population

Variable	Factor
	1
BH	0.954
LL	0.914
LUL	0.873
LR	0.938
Eigenvalue	3.389
% of Variance	84.716
Cumulative %	84.716
KMO	0.769

Legend: BH - body height; LL - leg length; LUL - upper leg length; LA - length arm

deviation from the normal distribution in one test. The lower leg length (LLL) variable will be removed from further tests as it does not meet the conditions of a normal distribution. After the statistical analysis and normality tests were applied, an exploratory analysis of the main components was performed below in order to isolate the number of specific factors that describe the space.

The result of the KMO (Kaiser-Meyer-Olkin) measure of sample adequacy indicates that the stated value of 0.769 is satisfactory. These parameters show the justification of applying the method of principal components to the selected set of variables. In Table 2, it is noted that one component extracted is a significant variable which explains 84.71% of the total variance. Looking at Table 2, it can be concluded that it is body height (BH) with an isolated factor of 0.954.

Table 3. Factor analysis of the repetitive strength studied population

Variable	Factor
	1
CUF	0.981
PUF	0.980
SUF	0.946
SQUF	0.984
Eigenvalue	3.786
% of Variance	94.642
Cumulative %	94.642
KMO	0.770

Legend: CUF - chin ups until failure; PUF – push-ups until failure; SUF - sit ups until failure; SQUF - squats until failure

The result of the KMO (Kaiser-Meyer-Olkin) measure of sample adequacy indicates that the stated value of 0.770 is satisfactory. These parameters show the justification of applying the method of principal components to the selected set of variables. In Table 3, it can be seen that one component extracted is a significant variable which implies 94.64% of the total variance. Analyzing the Table 3, we note that it is squats until failure (SQUF) with an isolated factor of 0.984.

Using factor analysis, latent dimensions were extracted and factorially calculated scores using regression methods. After these procedures, linear regression was applied to establish a potential statistically significant influence of longitudinal dimensionality (LD) on repetitive strength (RS) of skiers.

Table 4. Linear regression analyses

Variables	Repetitive strength						
	B	SE	β	t	p	95% CI	
						LL	UL
Longitudinal dimensionality	0.961	0.063	0.961	15.135	<0.0001	0.828	1.094

The results in Table 4 indicate a high correlation between the variables of repetitive strength and longitudinal dimensionality (R=0.961), while this observed high correlation is statistically significant (p<0.0001). Regression analysis was used to examine whether there is a statistically significant effect of longitudinal dimensionality on skiers' repetitive strength. The regression analysis indicates that longitudinal dimensionality explains 92.3% of the variance of skiers' repetitive strength. Based on this, it can be concluded that longitudinal dimensionality significantly affects the repetitive strength of skiers.

Discussion

The results in this research showed that the space of longitudinal dimensionality is dominantly defined by body height (BH), while the space of repetitive strength is defined by the squat until failure test (SQUF). Using linear regression, it is confirmed that there is a statistically significant influence of longitudinal dimensionality on the repetitive strength of skiers.

Morphological characteristics describe the structure of the body, that is, the somatotype characteristics of athletes (Milanović, 1980). Today we know that the overall constitution and structure of the body is a predisposition that, along with other external factors, will be an important component for success in sports, including skiing. However, the review papers of Jarić (2002) and (2003) show that the influence of morphological characteristics on the results of motor ability tests is often neglected, that is, that the normalization of measurement results is inadequate or even non-existent. Given that the aim of this research was to explore the latent structure of the longitudinal dimensionality and repetitive strength, as well as to determine the influence of longitudinal dimensionality on the repetitive strength of skiers, one factor was isolated in the space of longitudinal dimensionality, named body height (BH), and the space of repetitive strength of skiers was dominantly defined by one factor that describes that dimension named squats until failure (SQUF). The squat test is a valid and reliable test for the assessment of lower extremity performance considering its correlation with the isokinetic test, as well as its excellent relative and acceptable absolute reliability (Beato et al., 2021). Zoppirolli et al. (2020) in the conducted research reported that the success in skiing is more influenced by the strength of the lower extremities as opposed to the upper extremities. Especially with the constant change of direction during the movement. Using linear regression, a statistically significant influence of longitudinal dimensionality on the repetitive strength of skiers was established. The results obtained in this research are in accordance with previous research when it comes to the influence of body height (BH) on the manifestation of repetitive strength of the muscles of the lower extremities, i.e. test squats

until failure (SQUF) (Vuković & Srdić, 2015). Also, in the research conducted by Mujanović & Krsmanović (2008) on a large number of respondents, they came to the conclusion that morphological characteristics significantly affect success in skiing, and that the most dominant morphological characteristic is body height (BH). Branković et al. (2012) obtained a statistically significant influence of morphological characteristics on repetitive strength in elementary school students. Joksimović et al. (2011) conducted research with the aim of determining the degree of influence of morphological characteristics and motor skills on the efficiency of performing technical elements. They obtained a statistically significant influence of morphological characteristics and motor skills on the success of performing technical elements in skiing (Joksimović et al., 2011), again in line with our findings.

Conclusion

Morphological characteristics and motor skills are recognized as very important factors in the final success in skiing and in other sports, both in theory and in practice. The results showed that the space of longitudinal dimensionality is dominantly defined by the measure body height (BH), while the space of repetitive strength is defined by the variable squats until failure (SQUF). In addition, we observed a statistically significant influence of longitudinal dimensionality on the repetitive strength of skiers. Since the limitation of this research is the small number of participants which are males, it is very important to focus future research on a larger sample and inclusion of female participants as well.

Authors contributions

Durlević Slavka designed the study and wrote the first draft of the manuscript. Durlević Marija and Mijajlović Milica collected and analyzed the data. Durlević Slavka performed statistical analyses. Ilić Igor compressed the tables, contributed to the technical editing of the manuscript and critically reviewed the manuscript. All authors approved the final submission for publication.

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References

Andersen, R.E., & Montgomery, D.L. (1988). Pshysiology of Alpine skiing. *Sports Medicine*, *6*, 210-221.

Beato, M., Fleming, A., Coates, A., & Dello Iacono, A. (2021). Validity and reliability of a flywheel squat test in sport. *Journal of sports sciences*, *39*(5), 482-488.

Branković, N., Milanović, S., Pavlović, R., & Simonović, Z. (2012). Kanoničke relacije morfoloških dimenzija i repetitivne snage kod učenica srednjih škola. *Glasnik Antropološkog društva Srbije, 47*, 35-40.

Cigrovski, V., & Matković, B. (2019). *Sportovi na snijegu*. Zagreb: Sveučilište u Zagrebu, Kineziološki fakultet.

Delas, S., Miletic, A., & Miletic, Dj. (2008). The influence of motor factors on performing fundamental movement skills - the differences between boys and girls. *Physical Education and Sport*, *6*, 31-39.

Hadžić, R., & Nikšić, E. (2022). The analysis of alpine skiing techniques adoption based on anthropometric performances. *Anthropologie*, *60*(1), 161-172.

Jaric, S. (2002). Muscle strength testing: use of normalisation for body size. *Sports medicine*, *32*, 615-631.

Jaric, S. (2003). Role of body size in the relation between muscle strength and movement performance. *Exercise and sport sciences reviews*, *31*(1), 8-12.

Joksimovic, A., Acimovic, D., & Hadzic, R. (2011). The methodology of shaping situational training in the case of alpine skiing. *Sport Mont*, *9*(28,29,30), 28-29.

Krsmanovic, R, & Lukman, L. (1993). *Technique and methodology of skiing* (Tehnika i metodika smucanja). Novi Sad: Fakultet fizicke kulture.

Kukolj, M. (2006). *Antropomotorika*. Beograd: Fakultet sporta i fizičkog vaspitanja.

Kurelic N., Momirovic, K., Stojanovic, M., Radojevic, Ž., & Viskic-Štalec, N. (1975). *The structure and development of morphological and motor dimensions of youth*, Belgrade: Institut for scientific reserches of Faculty of Physical Education.

Kurelić, N. (1975). *Struktura i razvoj morfoloških i motorikih dimenzija omladine*. Beograd: Fakultet za fizičku kulturu.

Malacko, J., & Rađo, I. (2004). *Tehnologija sporta i sportskog treninga*. Sarajevo: Fakultet sporta i tjelesnog odgoja.

Milanović, D. (1980). Kanonička povezanost morfoloških i motoričkih karakteristika i rezultata u nekimatletskim disciplinama. *Kinesiology*, *10*(1-2), 25-33.

Mujanović, E., & Krsmanović, R. (2008). Predictive value of motor abilities on the result in criteria variable ski short turns. *Sport–scientific and practical aspects, international scientific journal of kinesiology*, *5*(1&2), 61-65.

Neumayr, G., Hoertnagl, H., Pfister, R., Koller, A., Eibl, G., & Raas, E. (2003). Physical and physiological factors associated with success in professional alpine skiing. *International journal of sports medicine*, *24*(08), 571-575.

Roczniak, K., Babuśka–Roczniak, M., Wojtanowska–Kaczka, M., Racz, O., Roczniak, A., Lyubinets, O., ... & Roczniak, W. (2020). Morphological and motor skills condition among 10-11 year old children engaged in cross-country skiing attending Sports Primary School in Suprasl. *Journal of Education, Health and Sport*, *10*(6), 68-81.

Ryabov, A. A., Ryabova, E. K., Zebzeev, V. V., & Chumakov, V. N. (2023). Model characteristics of morphological indicators of the body composition of ski jumpers and nordic combined skiers. *Theory and Practice of Physical Culture, 2*, 40-42.

Savić, Z., Stojanović, T., Stojiljković, N., & Jorgić, B. (2013). Differences in the space of motor skills between younger male and female skiiers. *Facta Universitatis: Series Physical Education & Sport*, *11*(2).

Scherge, M., Stoll, M., & Moseler, M. (2021). On the influence of microtopography on the sliding performance of cross country skis. *Frontiers in Mechanical Engineering*, 7, 659995.

Simić, M., Ilić, I., Durlević, S., Zadražnik, M., & Popović-Ilić, T. (2022). Struktura i uticaj morfoloških karakteristika rukometaša na eksplozivnu snagu. U Stanković, V., Lilić, Lj., Stojanović, T., Cicović, B., & Ilić, I. (Urednici), *9. Međunarodna naučna konferencija „Antropološki i teoantropološki pogled na fizičke aktivnosti".* Zbornik radova, (pp. 223–230). Kopaonik.

Turković, B., Lakota, R., Hodžić, A., & Podrug-Arapović, M. (2020). The contribution of motor skills in predictiing the success of performing the basic elements of alpine skiing. *Homo Sporticus*, *1*, 33-37.

Vuković, S., & Srdić, V. Uticaj tjelesne mase na ispoljavanje sile ruku i ramenog pojasa. U M. Jovanović & Dj. Nićin, In *Peta međunarodna konferencija"Sportfiske nauke i zdravlje"*. (p. 82-90).

Zatsiorsky, V., & Kraemer, W. (2009*). Nauka i praksa u treningu snage (Science and practice in strength training)*. Belgrade: Data status.

Zoppirolli, C., Hébert-Losier, K., Holmberg, H. C., & Pellegrini, B. (2020). Biomechanical determinants of cross-country skiing performance: A systematic review. *Journal of sports sciences*, *38*(18), 2127-2148.

Željaskov, C. (2004). *Kondicioni trening sportista*. Beograd: Sportska akademija.