

Original Article

The factor structure of the physical condition of the 13 year-old young men going in orienteering

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Abstract

The article presents the results of the study that lasted during the 2017-2018 academic year. The study involved 132 young men aged 13 years (n=132) from the city of Chernivtsi. The purpose of the research was to identify the leading factors of the physical condition of 13-year-old young men who are orienteering at the initial preparation stage. To achieve this goal, the following research methods were used in this work: theoretical analysis and synthesis of scientific literature data; anthropometric research methods; physiological methods; psychological methods; methods for assessing physical performance; pedagogical methods; statistical data processing methods. The article presents the factor structure of the physical condition of 13-year-old youths going in orienteering. The percentage contribution of each factor was determined, and it was found that the overall physical condition is determined by a group of four factors: the cardio-respiratory system - the largest contribution - 28.4 %, cognitive functions - 25.3 %, physical fitness and performance, and coordination abilities have a contribution of 22.1 %, physical development has a contribution of 8.6 %, which together make up 84.4 % of the variance explained. We found that the most factor loadings have indicators that characterize: endurance, running 1,000 m race ($r = -0.868$ with $p < 0.01$); cognitive functions, information processing speed ($r = -0.850$ with $p < 0.01$), short-term memory capacity ($r = 0.848$ with $p < 0.01$), volume of the processed information ($r = 0.834$ with $p < 0.01$); total body size, body weight ($r = -0.845$ with $p < 0.01$), as well as indicators characterizing the fat component: the amount of skin fat folds ($r = 0.829$ with $p < 0.01$).

The results of the research have prognostic significance for the individualization and differentiation of the training process, as well as assessing the impact of the main means and methods at the initial preparation stage of 13-year-old young men in orienteering.

Key words: factor structure, physical condition, young men, orienteering.

Introduction

A wide range of opportunities of orienteering in meeting the various needs of people, provides great advantages of this type of motor activity, since it has no restrictions on the number of participants and age range. Orienteering, unlike many other types, offers great opportunities for students. The absence of the need to build special facilities, high emotional attractiveness, conducting outdoor activities, ordinary sportswear and footwear make it possible to successfully use this sport in different parts of Ukraine (Korol, 2013; Kirihiyanen, 2014; Berezovsky, 2016; Khimenes, 2016; Andrieieva, 2017; Blagii, 2018; Paliichuk, 2018; Sirakov, 2018; Leonenko, 2019). Orienteering as a type of motor activity, combines cross-country running with mental activity, has several advantages, since it is a means of developing not only physical but also intellectual abilities of schoolchildren.

Carried out sporadic scientific studies show that orienteering contributes to physical development, education of volitional and moral qualities (Shugaev, 2002); development of intellectual abilities, improving mental performance (Fedorov, 2004; Sukhanov, 2011; Rattray, 2012; Galan, 2015; Selcuk, 2018), it is an effective means of combined development of the basic physical qualities and motor skills (Slonov, 2003; Berezovsky, 2016).

Orienteering is one of the few sports in which an athlete must combine individual factors related to the orienteering process during a competitive activity: movement around the terrain, the orientation technique and the tactical actions inherent in the given sport (Creagh, 1997; Celestino, 2015;).

The range of development of various physical qualities and functional systems is determined, on the one hand, by the age and individual characteristics of an athlete, and on the other hand, by the rational construction of the years-long training activity and the choice of the optimal direction of training programs. The program of training in orienteering for adolescents should provide for the most effective ratio of training loads. Effective

management of the training process is impossible without the exact knowledge of the main factors determining the specific performance capability of young athletes. This problem is particularly acute in orienteering, since the result depends on a set of qualities related, on the one hand, to physical indicators, and, on the other hand, to an individual's intellectual abilities (Kashuba, 2017; Denysova, 2018; Imas, 2018).

The individual and psychological characteristics of schoolchildren aged 13 years during orienteering lessons are analysed. Attention is focused on the tasks of didactically innovative content that contribute to the development of mental cognitive processes (Galan, 2017).

In this connection, in our opinion, it is relevant to objectively determine the basic physical and mental qualities that determine the success of competitive activities, as well as to identify the significant contribution of these qualities in 13-year-old young men at the initial training stage.

Materials and Methods

To achieve this goal, traditional research methods, which were tested in the course of research in the field of sports training theory and methodology, were used. When dealing with issues of the theoretical nature, analysis, synthesis and generalization were used. For empirical data, the following groups of research methods were used: analysis of special scientific and methodological literature, pedagogical observation of training and competitive activities, pedagogical testing; anatomical and physiological methods, namely: anthropometry (body weight, body length, chest girth), dynamometry (right and left hand dynamometry), pulsometry (heart rate at rest (HR)), tonometry (systolic blood pressure and diastolic blood pressure), spirometry (vital capacity of the lungs), as well as functional test of Ruffier and breathing-hold tests of Shtange and Genchi; psychological methods: methods for determining short-term memory capacity, attention span, speed of information processing. We studied the reaction rate data by application of Makarenko's technique "Diagnost 1". The technique included measurements of four types of reactions: simple motor reaction to light and sound, complex motor reaction of choice to various light signals, combined reaction to sound and light stimuli. For studies of physical fitness of young men, we used motor tasks that are most often used in practice (running, jumping, strength exercises). The mathematical statistics methods provided for the determination of basic statistical characteristics, used factor and correlation analysis; statistical processing of the data obtained was carried out using the package "Statystyka 6.0" (Stat Soft, USA).

The study was conducted on the basis of general educational institutions No. 6, 27, 30, 33 of the city of Chernivtsi. The pedagogical experiment involved 132 young men aged 13 years.

Results

The determination of the factor structure of the physical condition of the young men aged 13 years old during orienteering training practice is important for assessing the degree of influence of physical exertion on the body, making appropriate corrective measures in the case when its functionality is not enough for an adequate response to various physical exercises. All this generally contributes to the fulfil the primary objective of the training process – improvement of the health. Thanks to research, data on physical condition, technical and tactical readiness and quantitative achievements of those involved are accumulated. These data allow to plan more accurately and adjust the training process, thereby contributing to the improvement of its quality and efficiency. It is known that one of the effective methods for determining informative data obtained as a result of researches is factor analysis.

The study presents the results of the factor structure of the physical condition of the 13-year-old young men going in orienteering during extracurricular time. From literary sources it is known that (Voronov, 2012; Tomenko, 2017; Galan, 2017) the physical condition is characterized by a set of indicators reflecting gender and age characteristics, anthropometric profile, physical fitness, functional state of the muscular and cardio-respiratory systems of a person. Analysing the factor structure of the physical condition of the 13-year-old young men, performed to assess the contribution of every factor, gave an opportunity to ascertain that the group of four factors determines the general physical condition. This fact should be considered when developing the programme at the opening phase of the orienteering training. The base material for the analysis was the results of a comprehensive pedagogical study of the group of 132 young men of 13 years old, who were going in orienteering for two years. A total of 29 indicators of physical condition were determined, and 3828 measurements were performed. Table 1 presents the results of the factor analysis of indicators characterizing physical development, functional status, cognitive functions, as well as physical fitness and performance of 13-year-old young men.

So, the factor structure of the physical condition of the 13-year-old young men is determined by a group of 4 factors, whose contribution to the total variance of the sample is 84.4 %.

The greatest contribution to the total variance is 28.4 % of factor 1, which characterizes the cardio-respiratory system. High factor loadings have the following indicators: diastolic blood pressure ($r = 0.812$ at $p < 0.01$); vital capacity of the lungs ($r = 0.811$ at $p < 0.01$); systolic blood pressure ($r = 0.803$ at $p < 0.01$); Robinson index ($r = -0.775$ at $p < 0.01$); heart rate at rest (HR) ($r = -0.743$ at $p < 0.01$); the Genchi test ($r = 0.708$ at $p < 0.01$).

The second most important factor determining the structure of the physical condition of the 13-year-old young men has a factor loading of 25.3 % of the total variance, and its indicators characterize cognitive functions: information processing speed ($r = -0.850$ at $p < 0.01$); the short-term memory capacity ($r = 0.848$ at $p < 0.01$); the volume of processed information ($r = 0.834$ at $p < 0.01$); attention span ($r = 0.764$ at $p < 0.01$); the latent period of a simple visual-motor reaction ($r = -0.720$ at $p < 0.01$); the latent period of a complex visual-motor reaction ($r = -0.714$ at $p < 0.01$); the number of mistakes ($r = -0.712$ at $p < 0.01$).

The second factor has a high connection with a group of tests that reflect the intellectual abilities of young men. Based on the results obtained, the second factor can be considered as the ability of young men to maintain a high level of mental activity in the context of growing physical activity. The results obtained also indicate that during the training process, it is necessary to pay attention to the development of cognitive functions causing high results in competitive activities.

The third in order of importance factor has a factor loading of 22.1 % of the total variance, and its indicators characterize physical fitness and performance. Factor loadings have indicators as follows: running 1,000 m race ($r = -0.868$ at $p < 0.01$); standing long jump ($r = 0.805$ at $p < 0.01$); running 60 m ($r = -0.795$ at $p < 0.01$); bent suspension with over-grip hanging ($r = 0.780$ at $p < 0.01$); the Ruffier index ($r = -0.746$ at $p < 0.01$); shuttle running 4x9 m ($r = -0.722$ at $p < 0.01$); the sharpened Romberg's test ($r = 0.721$ at $p < 0.01$).

The indicators, which are included in the third factor, characterize the specific physical fitness in endurance and running speed, speed-strength and strength fitness, as well as agility and dexterity. This feature can be explained by the fact that high efficiency in overcoming the distance is determined not only by the speed and technique of running but also by the ability to maintain a vertical position when moving along the traverse, to drastically change the direction of movement and to overcome obstacles. Also, this factor has a high factor loading of the indicator of the Ruffier index, which characterizes the response of the cardiovascular system to the dynamic load and can display the level of physical performance. This feature can be explained by the fact that in the process of the competitive activity of orienteering athletes, many obstacles need to be overcome, therefore this factor reveals the physical talent in young men.

Table 1. The results of factor analysis of the physical condition of the young men aged 13 years.

	Factors			
	1	2	3	4
Body length, cm	0.126	0.095	0.129	-0.845
Body weight, kg	0.575	0.080	0.238	0.592
Sum of the skin and fat folds, mm	0.565	0.007	0.048	0.829
Chest girth, cm	0.466	0.179	0.151	0.724
Vital capacity of lungs (VC)	0.811	0.161	0.451	0.585
Heart rate at rest, beats /min ⁻¹	-0.743	0.061	-0.513	-0.067
Systolic blood pressure, mmhg	0.803	0.067	0.271	0.087
Diastolic blood pressure, mmhg	0.812	0.048	-0.077	0.110
Dynamometry right, kg	0.308	0.223	0.388	0.488
Dynamometry left, kg	0.222	0.415	0.231	0.369
Ruffier index, nominal units	-0.605	0.223	-0.746	0.291
Robinson index, nominal units	-0.775	0.243	-0.359	-0.601
Shtange test, sec	0.509	0.449	0.568	0.259
Genchi test, sec	0.708	0.006	0.475	0.193
The latency of the simple visual motor reaction time, ms	-0.163	-0.720	-0.068	0.252
The latency of the complex visual motor reaction time, ms	-0.140	-0.714	-0.233	-0.133
Number of mistakes	-0.026	-0.712	-0.159	-0.054
Short-term memory capacity (STMC), %	0.317	0.848	0.423	0.234
Information processing speed, IPS bit · sec ⁻¹	-0.554	-0.850	-0.106	-0.091
Volume of the processed information (VPI), bit	0.654	0.834	0.201	0.091
Attention span	0.537	0.764	0.266	0.245
Sharpened Romberg test, second	0.678	0.273	0.721	0.424
Running 60m, sec	-0.475	-0.073	-0.795	-0.395
Running 1,000 m race, min sec	-0.461	0.258	-0.868	-0.652
Standing long jump, cm	0.070	0.195	0.805	0.100
Sit-up from the back-lying position, times /1min	0.531	-0.278	0.003	-0.384
Bent suspension with over-grip hanging	-0.021	0.152	0.780	-0.255
Shuttle running 4 × 9 m. sec	-0.386	0.175	-0.722	-0.075
The proportion of a factor to total variance, %	28.4 %	25.3 %	22.1 %	8.6 %

The fourth most important factor has a factor load of 8.6 % of the total variance, and its indicators characterize the physical development of young men. The following factors have the greatest contribution: body weight ($r = -0.845$ at $p < 0.01$); sum of skin and fat folds ($r = 0.829$ at $p < 0.01$); chest girth ($r = 0.724$ at $p < 0.01$). The results indicate that physical development plays an important role in the period of formation of sportsmanship of the young men of 13 years.

Thus, the program on training in orienteering at the opening phase of training of the 13-year-old young men, should pay attention to groups of indicators reflecting the state of the main functional systems (cardiovascular, respiratory, central nervous), physical performance and fitness, as well as indicators of physical development.

Discussion

Orienteering as a variable module is included in the curriculum on the subject "Physical Education" for students of grades 5-11 of Ukrainian schools. Schoolchildren can learn the basics of orienteering, at the extracurricular time, in circles, sections, and in youth sports schools. Orienteering is a sport where physical and mental loads are combined against the background of significant volitional and emotional tensions aimed at independent solutions of a number of practical tasks. It is known that three basic types of training are used in orienteering: physical, mental and technical-tactical. Important mental qualities are: memory, attention, speed of information processing. In physical fitness, the main thing is the ability to quickly cover long distances over rough terrain. To do this, you need to develop endurance, strength and speed-strength abilities, to work out the technique of running.

For the development of professional qualities in orienteering, a rather wide range of various means is applied. The complexity of their application primarily lies in the fact that every means or method separately does not ensure the balance of the entire training system and, accordingly, does not make it possible to achieve the necessary training cumulative effect. With this in mind, the most acute problem of physical training methods in orienteering was and remains to clarify the rational dynamics of loads and the combination of both multidirectional and unidirectional training impacts at various phases of the long-term preparation (Voronov, 2012).

The results of researches give evidence that orienteering helps to improve the functional state of the cardiovascular and respiratory systems, to strengthen the musculoskeletal system, contribute to the speed of thinking processes, the effective development of physical qualities, especially of endurance. It has been established that under the action of regular orienteering trainings, memory, attention span and switch are significantly improved, which contributes to the harmonious development of a person.

The results of our research complement the data that the structure of the physical condition of 13-year-old young men training in orienteering is determined by the factors that characterize the functional state of the cardiovascular and respiratory systems (Kolomiets, 2009; Yarmak, 2018), the level of physical performance and fitness (Voronov, 1998; Glinskaya, 2001; Slonov, 2003; Shirinyan, 2005; Himenes, 2012), dexterity (Himenes, 2012), and the physical development indicators (Kolomiets, 2008). The indicators that have the highest factor loadings reflect the ability to preserve a high level of intellectual abilities under conditions of increasing physical load. (Ryzhenkov, 2006; Himenes, 2012)

The results of our research confirm the data (Voronova, 2012; Fedorova, 2014; Korol, 2015; Khimenes, 2016; Blagii, 2018; Rosen, 2018; Vaskan, 2019) on high factor loadings of indicators characterizing the dominant components of intellectual and physical fitness.

Conclusions

The obtained materials of the research indicate that in the 13-year-old young men, the structure of physical condition is determined by four factors, with a total factor loading of 84.4% of the total variance. High factor loadings have indicators characterizing endurance ($r = -0.868$ at $p < 0.01$) and cognitive functions (from $r = -0.850$ to $r = 0.834$ at $p < 0.01$). Therefore, when planning the training process for this age group, special attention should be paid to the development of specific endurance, memory, information processing speed and attention span.

Competing Interests

The authors declare that they have no competing interests.

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