DOI: http://doi.org/10.25728/cs.2021.3.6

STUDYING THE INDICATORS OF REGIONAL SPORTS DEVELOPMENT IN RUSSIAN FEDERATION

V.N. Prokofiev[1], K.V. Akimova[1], and A.L. Myachin[1,2]

[1]National Research University Higher School of Economics, Moscow, Russia
[2]Trapeznikov Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia

[1]✉ vprokofiev@hse.ru, [2]✉ Aksenia1998@yandex.ru, [3]✉ amyachin@hse.ru

Abstract. The indicators of regional sports development in the Russian Federation are analyzed to find regions with a similar sports development strategy (according to the chosen methodology and measures of closeness) and identify dynamic groups in a four-year period. Some clustering and pattern analysis methods are described, and their use in the study is validated. The results obtained by classical clustering and ordinal-invariant pattern clustering methods are compared. The main state programs in the field of sports in the Russian Federation are highlighted and analyzed. The key aspects and problems of the state regulation of sports activities in the Russian Federation are indicated. Some ways for improving the existing regulatory and legal acts based on the dynamic analysis of regional patterns are proposed.

Keywords*:* sports, sport life, physical education, state regulation, cluster analysis, pattern analysis, ordinal-invariant pattern clustering.

INTRODUCTION

Over the past 15 years, reforms have been carried out in the Russian Federation to improve the sports infrastructure and increase the generalized indicators characterizing the health level of the citizens. As has long been known, sports improve well-being and increase the quality and duration of life.

When studying this topic, a problem consists in the operationalization of the very concept of "sports": "sports" and "physical culture" are often mixed. Several factors contribute to this ambiguity. As noted in the monograph [1], misunderstanding arises due to the similarity of these terms. In 2007, Federal Law no. 329 "On Physical Culture and Sports in the Russian Federation" was adopted in Russia to eliminate confusion and give precise definitions. This law contains sports concepts and their explanations and the rights and obligations of sports entities, forming a system of sports federations at all public authority levels. For example, the concept of "sports" is defined as "the sphere of social and cultural activities as a set of particular sports in the form of competitions and special practice of training a person for them" [2]. Hence, we conclude the following: although sports are part of physical culture, it differs significantly by content. This paper uses a basic system of indicators for a comprehensive study of sports development efficiency. To the best of authors' knowledge, only single indicators were estimated previously: infrastructure development [3], personnel policy [4], and the efficiency of state programs and regulatory legal acts [5].

Nowadays, sports, physical culture, and health care are socially popular and "in a growth trend" [6]: compared to 19% in 2011, the share of Russians involved in sports increased to 39.4% in 2018. This result is due to the state socio-economic policy considering the population's needs in sports and physical education in Russia. The government approves state programs encouraging people to participate in sports and improving the sports infrastructure in the country. An example is the Federal Target Program "Development of Physical Culture and Sports in the Russian Federation for 2006–2015," aimed at involving all segments of the population in sports by creating necessary conditions (developing sports infrastructure).

Table 1

Predicted and factual results of FTP "Development of Physical Culture and Sports in the Russian Federation in 2006-2015"

Indicator	Predicted results [7]	Factual results[1]
Share of citizens of the Russian Federation systematically involved in sports (%)	Increase to 30% of the total population of the Russian Federation	Before: 15.9 After: 31.7
Provision of population of the Russian Federation with sports objects (%)	Increase to 30 objects per 100 000 people (one object per 3 000 people)	Before: 22.7 After: 30.1
Number of qualified trainers occupied in sports and health work (in 1000 people)	Increase to 300 000 people (approximately 1 active trainer per 420 people)	Before: 295.6 After: 361.3
Share of sports events (%)	Increase from 3% in 2012 to 6% in 2020	Within the Unified Schedule of interregional, all-Russian, and international sports events, the number of such events increased by almost 6% compared to 2014. (More than 11 600 in total.)

Despite relatively high values achieved for all indicators (see Table 1), the following problems were identified in the report[2] of the Ministry of Sports following the results of this state program:

– no effective system for the development of children's and youth sports,

– a weak level of competition in elite sports,

– average statistical opportunities for improving physical development and health among citizens,

– lagging in innovative sports technologies.

As mentioned earlier, the values of the sports development indicators were nevertheless successfully increased. Thus, some problems have already been partially solved. For example, a technologically innovative sports base and infrastructure have been created (thanks to hosting the 2018 FIFA World Cup, which improved the investment climate and enhanced Russia's image in the world sports arena). However, there are some problems [8]:

– high market entry barriers for new manufacturers of sports goods,

– the lack of research and development projects in the field of sports,

– an insufficient demand for domestic sports goods and an insufficient share of Russian goods at the world level.

For solving them in 2019, the Government of the Russian Federation approved the Strategy for the Development of the Sports Industry until 2035 [9], with a focus on creating a new system of sports education for the population and elaborating and implementing active promotion measures for a healthy lifestyle, and providing efficient conditions for the development of physical education in educational institutions. The strategy is expected to increase to 55% the share of the population systematically involved in sports and to 67 years the average healthy life of the population. In addition, it is planned to renovate about 20 000 sports grounds, providing them with modern equipment, and increase the exports of Russian sports goods by 30% by 2024 (up to approximately $113 million).

1. METHODOLOGY FOR DETECTING HOMOGENEOUS GROUPS OF REGIONS BY SPORTS DEVELOPMENT STRUCTURE

Even under a fixed system of indicators, detecting structurally similar regions by the level of sports development is difficult. Various detection methods have certain features determining the difference in the final results. According to the problem statement, the following approaches can be used: linear convolution and threshold aggregation; formation of aggregate ratings (when applying the theory of individual and social choice); data classification, data clustering, and pattern analysis methods. Let us discuss each approach in detail.

A unified aggregate rating based on linear convolution and threshold aggregation allows identifying single groups of regions and has several positive aspects. First of all, it is simple and transparent calculations. Assigning each region a particular numerical

[1]https://www.minsport.gov.ru/activities/reports/9/28555/ (Accessed January 17, 2021).
[2]https://minsport.gov.ru/activities/reports/fiz-ra-i-sport-skryt/26361/ (Accessed January 17, 2021).

characteristic (linear convolution) or a particular rank (threshold aggregation) shows how much regions lag behind others. In addition, the time costs are minimized since these methods do not require intensive computing (given a basic system of indicators). However, the complexity of such an approach lies in determining the weight of each indicator (justifying their equal significance), which is often impossible. When compiling a unified aggregate characteristic, linear convolution allows compensating the small values of some indicators with the high values of others. Note that building a unified rating of regions by the level of sports development goes beyond the scope of this study.

Another approach involves aggregate ratings (if possible, within the theory of individual and social choice). Different quantitative indicators allow using different procedures (e.g., Borda's rule, Hare's rule, Nanson's procedure) to compile the unified aggregate rating. Thus, the closeness of the regions can be determined by their rank in the rating.

The practical application of data classification methods in this study is complicated by the uncertainty about the finite number of classes and their typical representatives. It is difficult to compile a learning sample, and using such methods is therefore complicated.

The main difference between the two remaining approaches (cluster analysis and pattern analysis) is that the latter methods are independent of the absolute values of indicators. Data clustering methods were considered in many surveys; for example, see [10, 11]. This study aims at dividing all regions into groups, each containing elements with a similar set of features. Hence, clustering methods seem to be one of the possible solutions. We adopt the concept of a "cluster" defined in the paper [11, p. 4]: "a piece of data…standing out from the rest of the data by some homogeneity of elements." Among the numerous methodologies, we employ two approaches with good interpretations of the final results: hierarchical clustering and *k*-means. All calculations were performed in Orange (Fig. 1) with the Manhattan distance L_1 and the Euclidean distance L_2 as the measures of closeness. For comparison, in the applied pattern analysis methods, the Hamming distance is used to estimate the proximity of objects.

Pattern analysis is less known in the Russian-language literature than cluster analysis. (On February 25, 2021, the Google Academy resource provided 76 000 search results for the user query "кластерный анализ" vs. 42 000 search results for the user query "анализ паттернов" and more than 4.5 million search

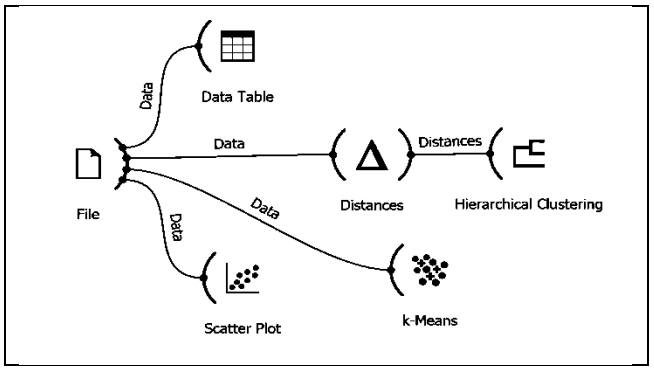

Fig. 1. Cluster methods realization in Orange.

is understood as "a combination of certain qualitatively similar features" [12, p. 139]. The methods should group objects with a similar structure of indicators under the endogenous composition and number of the groups. We select pattern analysis methods with the paired comparison of indicators (ordinal-fixed and ordinal-invariant pattern clustering). Their algorithmic implementation was presented in the papers [12–14]. Ordinal-fixed pattern clustering involves a predetermined sequence of the indicators and is often used to obtain preliminary ("rough") results. Ordinal-invariant pattern clustering assumes that the results are independent of the chosen initial sequence of indicators. A complete description of this methodology, including main properties, was given in the paper [12].

At present, pattern analysis is used in various fields: science, education, and innovations [15], macroeconomic analysis, political science, and regional innovative development assessment [16], and electoral behavior analysis [17]. In the paper [18], the behavior of commercial banks was analyzed, and the state capacity was estimated in [19].

This method prevails due to the possibility of analyzing both the current position of the objects (statics) and the dynamic trajectories of development (when studying regional pattern changes over time).

2. INDICATORS OF REGIONAL SPORTS DEVELOPMENT IN RUSSIAN FEDERATION

The efficiency of sports and physical culture development in the country depends on many factors. Among them, we mention, e.g., economic (wages, construction of the necessary infrastructure), demographic (the standard of living of the population), and political factors (state programs and funding, state support for sports life). The Ministry of Sports of the Russian Federation formed a system of indicators

characterizing all sport life areas. Regular reports on these indicators are published on the official website of the Ministry of Sports of the Russian Federation.

The initial variables are the indicators for the period 2014–2017 (see the annual reports of the Ministry of Sports of the Russian Federation). For clarity, each region r_i in year t is described by the vector $r_i^t = (r_{i1}^t, r_{i2}^t, r_{i3}^t, r_{i4}^t, r_{i5}^t, r_{i6}^t, r_{i7}^t)$ with the following notations:

r_{i1}^t is the factual share of citizens systematically involved in sports in year t;

r_{i2}^t is the factual share of schoolchildren and students systematically involved in sports in year t;

r_{i3}^t is the number of sports objects per 100 000 people in year t;

r_{i4}^t is the factual provision of population with sports objects, based on the capacity of sports objects in year t;

r_{i5}^t is the number of rated sportsmen trained in year t;

r_{i6}^t is the amount of sports funding per one resident in year t (RUB);

r_{i7}^t is the number of sports staff in year t.

The data for the period 2018–2020 were not considered due to some differences in their acquisition and the methodology for calculating some indicators. These data will be studied in future as one line of further research.

Before analysis, the data were preprocessed. Correlation analysis with the Pearson correlation coefficient was carried out; see Table 2 presenting the results for the year 2017. Each indicator was normalized using linear scaling by the formula

$$r_{ij}^t = \frac{r_{ij}^t - r_{j\_\min}^t}{r_{j\_\max}^t - r_{j\_\min}^t},$$

where $r_{j\_\max}^t$ and $r_{j\_\min}^t$ denote the maximum and minimum values of indicator j in year t, respectively.

Correlation analysis for the four years showed a strong correlation (at the level of 0.83) between the factual share of citizens and the factual share of schoolchildren and students systematically involved in sports. Therefore, one of these indicators should be excluded from further analysis: a strong correlation may negatively affect the grouping of patterns. Also, note a positive correlation between the number of sports objects per 100 000 people and the factual provision of population with sports objects (0.73) and a weak correlation between the factual share of citizens systematically involved in sports and the factual provision of population with sports objects (0.28). This fact is partially explained by the relative efficiency of the government's policy to promote sports development and involve the population in sports. However, despite the increasing demand from the population for sports, the number of sports objects is not enough.

Table 2

Correlation analysis of indicators for year 2017

	r_{i1}^{2017}	r_{i2}^{2017}	r_{i3}^{2017}	r_{i4}^{2017}	r_{i5}^{2017}	r_{i6}^{2017}	r_{i7}^{2017}
r_{i1}^{2017}	1						
r_{i2}^{2017}	0.83	1					
r_{i3}^{2017}	0.31	0.37	1				
r_{i4}^{2017}	0.34	0.36	0.76	1			
r_{i5}^{2017}	0.26	0.21	–0.17	–0.23	1		
r_{i6}^{2017}	0.44	0.37	0.14	0.12	0.46	1	
r_{i7}^{2017}	–0.16	–0.20	–0.14	–0.17	0.02	–0.07	1

3. ANALYSIS RESULTS

We studied 340 objects: 85 Russian regions over four years. The results yielded by pattern analysis methods were compared with those of cluster analysis. Then groups of regions were identified and combined using different methodologies. Note that 1/3 of the studied objects were classified as "unique" (one pattern for one region). Let us describe some of the groups obtained.

Group 1. A distinctive feature of this regional group is a relatively great number of people involved in sports, although sports funding and staffing are relatively low. Possible explanations are as follows: similar to the availability of sports objects, the share of citizens involved in sports is high since the regional policy aims at increasing this share by actively promoting a healthy lifestyle and increasing the number of free and outdoor sports grounds. (For example, more than 800 sports events were organized in Omsk oblast.) The regional data are visualized below by piecewise linear functions in a parallel coordinate system for ease of comparison.

Figure 3 visualizes **Group 2**. In Vologda oblast, the share of citizens involved in sports is sufficient, but the number of sports staff has decreased compared to the year 2014. There was a massive downsizing due to small funding in the subsequent years. The regional authorities should support sportsmen who graduated from professional sports institutions and sports clubs and include the corresponding articles in the budget). In Kursk oblast, the provision of population with sports objects lags the normative values. Note that the municipal administration of this region and PJSC Gazprom concluded a cooperation agreement, increasing the number of sports objects in the region and improving the availability of sports for the population.

Group 3 includes only one region for two years: Krasnodarskii krai (Fig. 4). This region has medium and relatively high values of most indicators. Note that the 2014 Winter Olympic Games were held there, and the level of sports development sharply increased.

The second task of this study is to construct dynamic trajectories for the development of different regions of the Russian Federation in the period 2014–2017 based on the selected structure of sports indicators. The following question arises: Are there any changes in the sports development trajectory of these regions and their belonging to patterns? It can be answered using dynamic pattern analysis, the methods described in detail in [14, 15, 17]. In short, after partitioning the regions into groups, each region is assigned a vector $y_{ri} = (y_{2014}, y_{2015}, y_{2016}, y_{2017})$, where y_t is the number of the group to which region i belongs in year t. Thus, dynamic groups are identified according to the change in strategies:

– absolutely stable (the region stays in the same group during the period),

– stable (the region changes its group only once);

– unstable (the region changes its strategy annually).

The dynamic groups were formed according to this approach. For example, consider three regions—Vladimir, Kostroma, and Orenburg oblasts—that changed their groups once (the stable type of dynamic groups, see Fig. 5).

The unstable group contains 32 regions. However, some regions returned to the original sports development strategy after changing it. Note that changes from "best" to "worst" strategies (and conversely) were not considered: ranking of regions goes beyond the scope of this study.

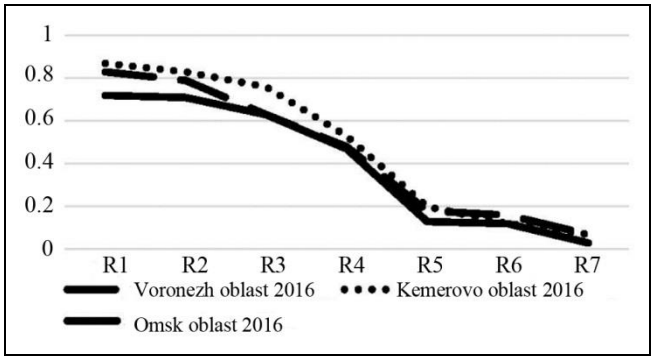

Fig. 2. Visualization of Group 1 in parallel coordinates.

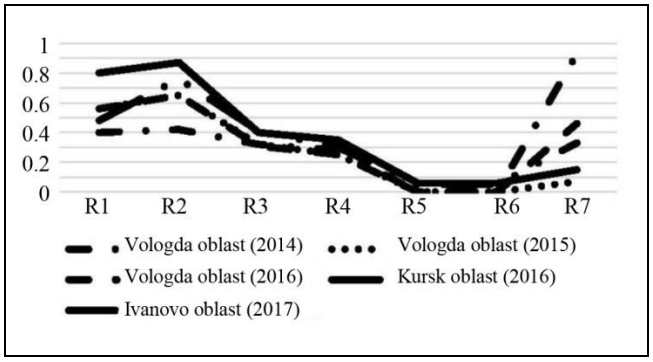

Fig. 3. Visualization of Group 2 in parallel coordinates.

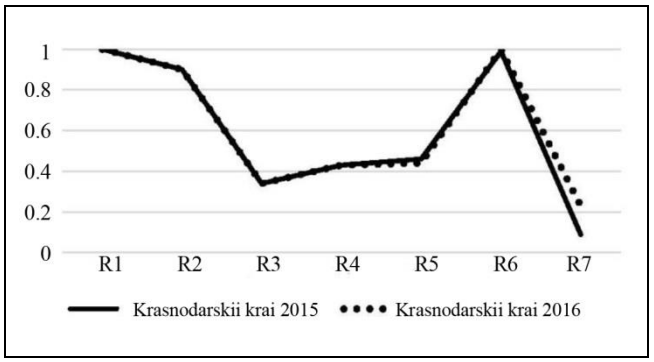

Fig. 4. Visualization of Group 3 in parallel coordinates.

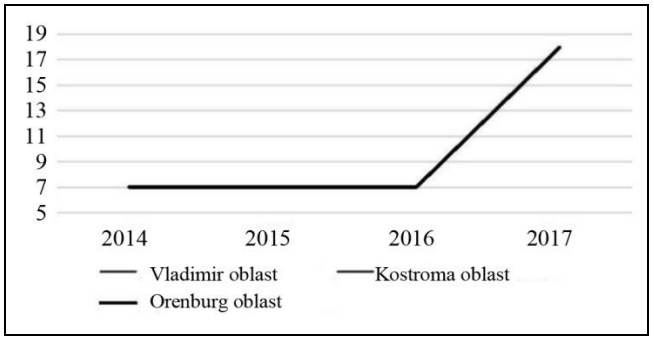

Fig. 5. Example of regions with strategy change by the system of indicators.

4. PROPOSALS FOR IMPROVING THE EXISTING LEGISLATION

According to the study results, it seems reasonable to revise the sports law completely and develop a single codified act—the Sports Code of the Russian Federation (SC RF). The code will fill the existing gaps in law and regulate public relations in sports as widely as possible: in the absence of relevant legal norms, these relations cannot develop properly. (In particular, the matter concerns the mechanisms for replicating and deploying best regional practices among the "lagging" regions of the Russian Federation.) Positive expectations from this code are based on foreign experience: for example, a similar document was adopted in France. The French Sporting Code compiles all existing normative and legal acts regulating sports activities, and new laws are not adopted.

Social relations in sports and associated areas have substantial and unique specifics. In interaction and interconnection, they differ by completeness, and most importantly, by systemic integrity: they can be treated as an independent area of state-legal management and regulation. The SC RF is the most efficient way of regulating and systematizing sports norms into a single whole [20].

Today, sports undergo various changes: new kinds of sports appear in the "snowball" (e.g., extreme sports and "active" cybersport), which are not included in the state classification of physical culture. It is very difficult to register a sport or a sports federation at the state level. This procedure should be transparently regulated and simplified as much as possible.

CONCLUSIONS

The previous studies raised the issue of analyzing sports clusters only. The definition of this concept included the construction of a sports infrastructure [21]. Increasing the number of sports objects that meet all technical requirements is a priority task of the state program, but some adjustments are needed. In this paper, "sports clusters" have been therefore defined as groups of regions with a similar sports development strategy. They have been combined using cluster and pattern analysis. According to the obtained results, each group contains one region with the indicator values differing from those of all other regions in the group. The sports development strategy in such a region is most efficient; therefore, the authorities of all other regions in the group should pay attention to the lagging indicators, undertaking some measures to improve them based on the best regional practice.

To the best of authors' knowledge, this paper applied pattern analysis methods to study sports activities in the Russian Federation for the first time in the literature. Some features of this method have been highlighted. Although pattern analysis is a relatively young data analysis method, it has already demonstrated high effectiveness in many areas. Identifying regions with a similar structure of indicators allows modifying the state and regional policies according to the regional sport life characteristics. The recommendations have been supplemented with some proposals for improving the current legislation.

REFERENCES

1. Matveev, L.P., *Obshchaya teoriya sporta i ee prikladnye aspekty* (General Theory of Sports and Its Applied Aspects), St. Petersburg: Lan', 2005. (In Russian.)
2. Federal Law no. 329-FZ dated December 4, 2007, "On Physical Culture and Sports in the Russian Federation" (as amended on August 2, 2019). (In Russian.)
3. Bobrovskii, E.A., Improvement of Sports Infrastructure as a Tool of Sports Popularization in a Region, *Mezhdunarodnyi Zhurnal Prikladnykh i Fundamental'nykh Issledovanii*, 2017, no. 3-2, pp. 297–301. (In Russian.)
4. Bobrovskii, E.A., Staff Policy in the Sphere of Physical Culture and Sports in the Russian Federation, *Karelian Scientific Journal*, 2017, vol. 6, no. 4 (21), pp. 315–318. (In Russian.)
5. Kosova, Yu.A., Perspective Guidelines of Governmental Policy in the Field of Physical Training and Sports in Russia, *Transport Business in Russia*, 2011, no. 8, pp. 115–116. (In Russian.)
6. Russian Public Opinion Research Center (VCIOM) Named the Main Life Values of Russians. https://www.dp.ru/a/2017/06/07/VCIOM_nazval_glavnie_zhizn (In Russian.)
7. Resolution of the Government of the Russian Federation no. 7 dated January 11, 2006, "On the Federal Target Program "Development of Physical Culture and Sports in the Russian Federation for 2006–2015." (In Russian.)
8. Decree of the Government of the Russian Federation no. 1101-r dated August 7, 2009, "On Approval of the Strategy for the Development of Physical Culture and Sports in the Russian Federation for the period up to 2020." (In Russian.)
9. Decree of the Government of the Russian Federation no. 1188-r dated June 3, 2019, "On Approval of the Strategy for the Development of the Sports Industry until 2035 and a Set of Measures for the Formation of a Modern Branch of the Sports Industry for 2019–2020." (In Russian.)
10. Kim, D.O., *Faktornyi, diskriminantnyi i klasternyi analiz* (Factor, Discriminant and Cluster Analysis), Ripol Klassik, 1989. (In Russian.)
11. Mirkin, B.G., Review of Cluster Analysis Methods for Decision-making Support, Working paper no. WP7/2011/03, National Research University Higher School of Economics, Moscow, 2011. (In Russian.)
12. Myachin, A.L., Pattern Analysis in Parallel Coordinates Based on Pairwise Comparison of Parameters, *Autom. Remote Control*, 2019, vol. 80, pp. 112–123.

13. Myachin, A.L., Pattern Analysis: Diffusion-Invariant Pattern Clustering, *Control Sciences*, 2016, no. 4, pp. 2–9. (In Russian.)
14. Myachin, A.L., Pattern Analysis: Ordinal-Invariant Pattern Clustering, *Large-Scale Systems Control*, 2016, vol. 61, pp. 41–59. (In Russian.)
15. Aleskerov, F.T., Gokhberg, L.M., Myachin, A.L., et. al., Data Analysis of Science, Education and Innovative Activities Using Pattern Analysis Methods, Working paper no. WP7/2012/07, National Research University Higher School of Economics, Moscow, 2012. (In Russian.)
16. Aleskerov, F.T., Belousova, V.Yu., Mirkin, B.G., et al., Methods of Pattern Analysis in Statics and Dynamics, Part 1 : Literature Review and Clarification of the Term, *Business Informatics*, 2013, no. 3 (25), pp. 3–18. (In Russian.)
17. Aleskerov, F.T., Borodin, A.D., and Kaspe, S.I., Analysis of Electoral Preferences in Russia in 1993–2003: Polarization Index Dynamics, *HSE Economic Journal*, 2005, vol. 9, no. 2, pp. 173–184. (In Russian.)
18. Aleskerov, F.T., Solodkov, V.M., and Chelnokova, D.S., A Dynamic Analysis of Behavioral Patterns of Russian Commercial Banks, *HSE Economic Journal*, 2006, vol. 10, no. 1, pp. 48–62. (In Russian.)
19. Akhremenko, A.S. and Myachin, A.L., Pattern Analysis and Clustering in the Study of State Capacity: "Adaptive Optics" for Political Science, *Political Science* (*RU*), 2019, no. 3, pp. 112–139. (In Russian.)
20. Solov'ev, A.A., Concept of Sports Code of the Russian Federation, Sports Right Commission of Russian Lawyers Association, Moscow, 2009. (In Russian.)
21. Ananishnev, V.V. and Korepova, V.V., Problems of Formation of Sports Clusters in Russia, *Clusters. Research and Development*, Corporate Scientific Journal of the Moscow Cluster of Business Initiatives (Moscluster), 2016, vol. 2 (3), pp. 35–38. (In Russian.)

This paper was recommended for publication by P.Yu.Chebotarev, a member of the Editorial Board.

Received July 30, 2020, and revised March 16, 2021.
Accepted April 6, 2021.

Author information

Prokofiev, Vadim Nikolaevich. Dr. Sci. (Eng.), National Research University Higher School of Economics, Moscow, Russia, ✉ vprokofiev@hse.ru

Myachin, Aleksei Leonidovich. Dr. Sci. (Eng.), Trapeznikov Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia; National Research University Higher School of Economics, Moscow, Russia, ✉ amyachin@hse.ru,

Akimova, Kseniya Vital'evna. Student, National Research University Higher School of Economics, Moscow, Russia, ✉ Aksenia1998@yandex.ru.

Cite this article

Prokofiev V.N., Myachin A.L., Akimova K.V. Studying the Indicators of Regional Sports Development in Russian Federation. *Control Sciences* **3**, 44–50 (2021).
http://doi.org/10.25728/cs.2021.3.6