Popular physical education and sports in the volga federal district: progress analysis

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Abstract
Objective of the study was to analyze progress of popular physical education and sports in the Volga Federal District using cluster analysis.
Methods and structure of the study. We applied for the purposes of the study a group of statistical data processing methods commonly referred to as the "learning without teacher", with a special application of a non-hierarchical clustering method with separation around k-medoids. Medoid means herein a centroid whose coordinates are shifted to the nearest input data array. We mined data for the study from the 2017-2020 reports of the Ministry of Sports of the Russian Federation.
Results and conclusion. A comprehensive statistical data processing with cluster analysis made it possible to find the constituents of the Volga Federal District in need of special support in the popular physical education and sports encouragement initiatives. It should be mentioned that the Udmurt Republic has been ranked among the constituents still lagging behind in the physical education and sports committed population growth statistics for the last four years under study.

Keywords: *cluster analysis, development of physical education, mass sport, sports practices.*

Background. Health benefits of sports are considered indisputable nowadays, with sound scientific evidence that a habitual physical activity helps prevent cardiovascular diseases [3, 7], mental and cognitive disorders, and even exposure to risks of cancer [7]. In addition to the health benefits, physical education and sports are known to improve labor activity and, consequently, corporate progress standards in terms of at least HR management and labor facilitation physiology [1]. It should be emphasized, however, that modern sports have evolved into a large commercial sector, with the modern physical education and sports industry considered among the groundwork elements for the social and economic progress [4] and contributors to the gross domestic product. This is the reason why the national governments tend to support sports industries by facilitating sponsorships on the whole and sports event sponsorship in particular [6], plus multiple governmental initiatives and programs to encourage sports.

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Methods and structure of the study. We applied for the purposes of the study a group of statistical data processing methods commonly referred to as the "learning without teacher", with a special application of a non-hierarchical clustering method [5] with separation around k-medoids. Medoid means herein a centroid whose coordinates are shifted to the near-

est input data array. We mined data for the study from the 2017-2020 reports of the Ministry of Sports of the Russian Federation.

Results and discussion. We grouped the Volga Federal District constituents based on reports of the National Physical Education and Sports Development Program of the government of the Russian Federation for 2017-2020: see the Table 1.

Table 1. Statistical indices for the Volga Federal District constituents clustering analysis

Index
1. Population group reporting habitual physical education and sports, %
2. Supply of the local physical education and sports infrastructure rated by the full service capacity, %
3. Disabled population group reporting habitual physical education and sports versus the relevant health group total having no contraindications for physical education and sports, %
4. The 3-29 year-old population group reporting habitual physical education and sports versus the relevant group total, %
5. The 30-54 year-old women and 30-59 year-old men reporting habitual physical education and sports versus the relevant total, %
6. The 55-79 year-old women and 60-79 year-old men reporting habitual physical education and sports versus the relevant total, %

The non-hierarchical clustering method implies a simple effective algorithm; although, as reported by K.V. Shitikov and S.E. Mastitsky [2], it has two significant problems: (1) Its results are sensitive to a random selection of the initial group centers; and (2) It requires a number of clusters being preset for the clustering analysis. Problem 1 may be solved by multiple iterations. And Problem 2 may be solved by a few special methods to find an optimal number of groups, with the average elbow width method being one of them. We used this method to find the optimal number of clusters (two) for 2017-2020 data arrays.

Having analyzed the 2017 data, we formed the following two clusters with medoids (see Figure 1): (1) Udmurt Republic and (2) Republic of Tatarstan. It should be noted that Cluster 1 indices are below the Volga Federal District average; versus Cluster 2 indices that are significantly above the district average. This is the reason for us to assume that Cluster 1 represents the constituents with relatively low commit-

ment for physical education and sports – versus Cluster 2 with the high proportion of the habitually sporting population.
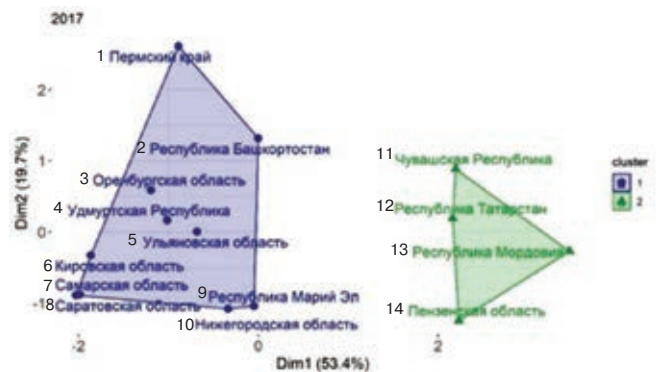
Figure 1. *Regional clusters of the constituents covered by the Physical Education and Sports Development Program of 2017*

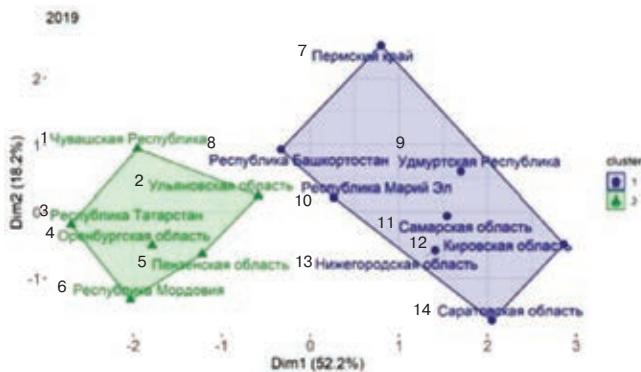|	
1. Perm Area	8. Mari El Republic
2. Bashkortostan Republic	9. Saratov Oblast
3. Orenburg Oblast	10. Nizhny Novgorod Oblast
4. Udmurt Republic	11. Chuvash Republic
5. Ulyanovsk Oblast	12. Tatarstan Republic
6. Kirov Oblast	13. Mordovia Republic
7. Samara Oblast	14. Penza Oblast

Cluster analysis of the 2018 data (Figure 2) shows the Udmurt Republic as one of the cluster centers, and Penza Oblast as the other cluster center. Note that the statistical indices of Cluster 1 (with Penza center) constituents are above the district average; and Cluster 2 (with the Udmurt Republic center) statistics are below the average. A comparison of the 2017 and 2018 data shows that the share of habitually sporting population has expanded to cover the Orenburg Oblast, Mari El Republic and Bashkortostan Republic.

Figure 2. *Regional clusters of the constituents covered by the Physical Education and Sports Development Program of 2018*

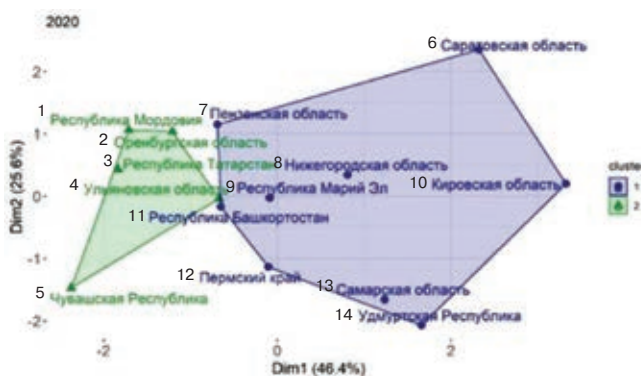|	
1. Mordovia Republic	8. Saratov Oblast
2. Penza Oblast	9. Nizhny Novgorod Oblast
3. Tatarstan Republic	10. Kirov Oblast
4. Orenburg Oblast	11. Samara Oblast
5. Mari El Republic	12. Ulyanovsk Oblast
6. Chuvash Republic	13. Udmurt Republic
7. Bashkortostan Republic	14. Perm Area

Cluster analysis of the 2019 data (Figure 3) shows the cluster centers shifted to the Nizhny Novgorod Oblast for Cluster 1 (with low share of habitually sporting population) and the Orenburg Oblast in center of Cluster 2 (with a high sporting share), whilst the group compositions keep virtually the same.

Figure 3. *Regional clusters of the constituents covered by the Physical Education and Sports Development Program of 2019*

1. Chuvash Republic
2. Ulyanovsk Oblast
3. Tatarstan Republic
4. Orenburg Oblast
5. Penza Oblast
6. Mordovia Republic
7. Perm Area
8. Bashkortostan Republic
9. Udmurt Republic
10. Mari El Republic
11. Samara Oblast
12. Kirov Oblast
13. Nizhny Novgorod Oblast
14. Saratov Oblast

Cluster analysis of the 2020 data (Figure 4) shows the picture close to the prior periods: with the Tatarstan Republic being in center of the highly sporting cluster and Mari El Republic central in the low sporting cluster. Note that the physical education and sports statistics of the both groups come closer to the district average in this period. This fact, however, is unlikely due to progress of the constituents in the physical education and sports encouragement efforts, rather to the pandemic-related restrictions for popular physical education and sports including public physical education and sports events, gym trainings, swimming in pools, etc.

Figure 4. Regional clusters of the constituents covered by the Physical Education and Sports Development Program of 2020

1. Mordovia Republic
2. Orenburg Oblast
3. Tatarstan Republic
4. Ulyanovsk Oblast
5. Chuvash Republic
6. Saratov Oblast
7. Penza Oblast
8. Nizhny Novgorod Oblast
9. Mari El Republic
10. Kirov Oblast
11. Bashkortostan Republic
12. Perm Area
13. Samara Oblast
14. Udmurt Republic

Conclusion. A comprehensive statistical data processing with cluster analysis made it possible to find the constituents of the Volga Federal District in need of special support in the popular physical education and sports encouragement initiatives. It should be mentioned that the Udmurt Republic has been ranked among the constituents still lagging behind in the physical education and sports committed population growth statistics for the last four years under study.

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