

## Using the methods of mathematical statistics in sports and educational research of masters in physical education and sport

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**Abstract:** Sport and pedagogical researches provide for statistical analysis of observation results. More stringent conditions are put forward to the training of future masters in physical education and sport, including the ability to quickly respond to challenges, systematically expand knowledge, and perform complex calculations. It envisages the availability of skills to use information technology to computerize the process of statistical calculations. Multifunctional criteria, in particular the  $\phi$  Fisher criterion, deserve special attention, since they can be used to solve various tasks. **The purpose of the article** is to justify the universality of the using Fisher's  $\phi$ -criterion in scientific research in physical culture and sports. **Material and methods.** Methods using at studying process are studying, analysis, systematization of scientific and special literature, generalization of scientific, educational and practical experience. **Results.** Scientists often have to deal with questionnaire data, represented at nominative scale, in sports and pedagogical scientific research. In other cases, researchers have to relate samples for particle size with certain features. Comparative analysis of sample data for feature, which is measured at nominative scale, for feature, which is measured in quantitative scale or for feature distribution in quantitative scale, can be done using Fisher's angle criterion. It is possible to simplify analysis process for researchers in the field of physical culture and sport due to programming product MS Excel. Article contains examples of use an F-test for analysis of sports and pedagogical data. **Conclusions.** Analysis of experimental results in the field of physical culture and sport have to computerize using MS Excel.

**Keywords:** analysis, sample, criterion, comparing, computerization, calculations

### Introduction.

The development of science is the determining factor for progressive social transformations (Dedelyuk, 2010). Scientific activities include the phased collection and analysis of data, the study of the parameters of the studied objects, the identification of correlation relationships between them, the establishment of patterns and trends between the objects of research and a pedagogical experiment in which a hypothesis is put forward that requires confirmation or refutation. At the same time, requirements for measurement accuracy and the level of validity of research results continue to grow (Glants, 1998; Novicov, 2004). Therefore, statistical processing of empirical data is an integral part of the scientist's activities (Byshevets, 2017-2018).

Until this moment, people have accumulated significant theoretical and practical analysis of data set. Experts developed methods of automation of statistical computations (Shelamova, 2010). Especially common methods for determining statistical hypothesis in the field of natural and political sciences are parametric methods. Researcher knows data about distributive law of statistical population, where the samples were taken of and parameters were found out (Edwards, 1948; Starychenko, 2004). However in some spheres of human

activity, such as in sports and pedagogical researches significant part of data can be received only on the basis of questionnaire poll, It means, studying subjects have non-numerical identity. In such cases, nonparametric tests of mathematical statistics are used to ensure level of confidence that the end results are objective (Yates, 1934; Mc Nemar Quinn, 1947; Kruskal, 1952).

In sports and educational research, a number of criteria are applied, each of which has its own conditions of application and limitations (Lakin, 1990; Denisova, 2011-2012; Denysova, Shynkaruk, Usychenko, 2018). Multifunctional criteria attract considerable attention; they can be used to solve several types of problems. Their universality is related to the fact that the source data can be measured on any scale, including nominative, the samples can be dependent or independent, the samples can be small in volume (Sysa, 2010).

One of these criteria is the  $\varphi$ -test. It is designed to compare two samples (independent or related) according to the frequency of the received effect and allows to evaluate the differences between the particles of both samples in which the effect was received. Hypothesis  $H_0$  is that the proportion of subjects who had the effect under investigation in sample 1 is no more than in sample 2. Then the alternative hypothesis  $H_1$  is the proportion of subjects who have an effect in sample 1 is larger (less) than in sample 2 (Parygina, 2016).

The analysis of literary sources showed that the specialists presented methods of applying nonparametric criteria (Arkhipova, 2009) and described application of an  $\varphi$ -test in psychological and pedagogical researches (Rudenko, 2012).

However, nowadays, methods of test of personal data, in particular an  $\varphi$ -test, are not widely used as basis of validity and effectiveness of results in sport and pedagogical researches. The question of automating its use in the field of physical education and sport is not sufficiently covered in literary sources.

**The purpose of the article** is to justify the universality of the using Fisher's  $\varphi$ -criterion in scientific research in physical culture and sports.

#### Material and methods.

Methods using at studying process are studying, analysis, systematization of scientific and special literature, generalization of scientific, educational and practical experience.

#### Results.

During the questionnaire poll, measurement is by assigning numbers to objects in accordance with existing rules. That is, the personal data is presented in the nominal scale, which allows to divide studying objects into classes. Using this scale, comparing different values among themselves, one can only say whether they are at a level or not. occurs

Numbers that describe amount of objects in certain class are used in quantitative processing of experimental data (Ashykhmina, 2009).

An F-test is called angular, as its initial particle, normalized to one (P), is converted to the value of the angle, normalized to the value. In other words, the "there is an effect" part is assigned an angle in the range from 0 to 180.

There are restrictions on the  $\varphi$ -test:

1) none of the particles should be equal to 0;

2) there is not the upper limit of the sample, and the lower limits are defined in accordance with the following rules:

- $n_1 = 2, n_2 \geq 30$ ;
- $n_1 = 3, n_2 \geq 7$ ;
- $n_1 = 4, n_2 \geq 5$ ;

for  $n_1, n_2 \geq$  possible any comparisons

Consider the algorithm for analyzing personal data using MS Excel.

Let's enter the initial data in the MS Excel table.

Using a formula, we calculate the particles of the samples  $P_i$  where we can notice the effect.

We calculate the angles  $\varphi_1$  and  $\varphi_2$  by the formula:

$$\varphi_i = 2 \cdot \arcsin \sqrt{P_i} \quad (1)$$

Compute experimental value  $\varphi$ -criterion by the formula:

$$\varphi_{emp} = |\varphi_1 - \varphi_2| \cdot \sqrt{\frac{n_1 \cdot n_2}{n_1 + n_2}}, \quad (2)$$

where  $n_1, n_2$  – sample sizes.

Received value is compared with its critical value for targeted significance level  $\alpha$ . As a rule, it is equal 0,01 or 0,05.

If computed value of criterion is more than critical one, it means that hypothesis about absence of statistically significant differences between particles is deviated and differences are statistically significant at defined level of significance  $\alpha$ .

There are some examples of use of an F-test at sport and pedagogical researches.

*Example 1.*

During schooling year different methods of training were used at on the discipline "Information technology in scientific activities in physical culture and sports" in two groups of masters (with and without the use of cloud technologies). At the end of the research, students were interviewed if they like classes in this discipline. First group, consisting of 20 masters, gave 15 affirmative answers. Another group included 25 masters, 14 from those were completely satisfied by lessons. Can we state, the first methods is more appropriate for masters?

To get answer for this question we formulate and check hypotheses:

H0: the part of masters who are satisfied with the lessons on discipline in the first group is not less than the other.

H1 - shares of masters in both groups, satisfied with classes

Use an F-test

Calculate particles of students with sufficient and more development of speed quality and values of angles  $\varphi_1$  and  $\varphi_2$ , and defin the empiric value of angle  $\varphi$  (Fig. 1).

	N	Yes	$P_i$	$\varphi_i$	
Test 1	20	15	2,0944	$\varphi_r$	=ABS(M3-M4)*(J3*J4/(J3+J4))^0,5
Test 2	25	14	0,56	$\varphi_{kr}$	=2*ASIN(KOPEHЬ(L4))

Fig. 1. Example of calculation empiric value of angle  $\varphi$  using MS Excel

At the table we define critical value of angle  $\varphi$ , which is equal 1,64 and compare it with calculated value 1,344. As  $\varphi_p < \varphi_{kp}$ , we can state, particles of masters, satisfied by lessons in the discipline, are not statistically significant differences in both groups of students. So, these both training methods can be used in studying process.

*Example 2.* Test of the volume of memory and concentration of attention was held in group of 30 masters twice. Eight students gave high and sufficient level during the first test, and 17 – during the second one. Can we say that part of the masters with high results after first test is lower than it is after second test.

Formulate statistical hypotheses:

H0: part of masters with high and sufficient level of volume of memory and concentration of attention after the first test is not lower than it is after second test.

H1 – part of masters with high and sufficient level of volume of memory and concentration of attention after the first test is appreciably lower than it is after second test.

After reflection and calculation as at the previous example, we receive results, which are represented at picture (Fig. 2).

	N	Effekt	$P_i$	$\varphi_i$		
Test 1	30	8	0,2667	1,0853	$\varphi_r$	2,3983
Test 2	30	17	0,5667	1,7045	$\varphi_{kr}$	1,64

Fig. 2. Example of calculation empiric value of angle  $\varphi$  using MS Excel

As  $\varphi_r > \varphi_{kr}$  we can state, that comparing second test, statistically significant lower part of masters showed high results at the first test.

**Discussion.**

Nowadays, statistical methods are widely used at scientific researches. Moreover, the requirements for accuracy of the test results of experimental activity are constantly growing. Therefore, in the training of specialists, considerable attention is paid to the formation of practical skills and abilities to process experimental data. However, in different areas of expertise a unequal role devoted to issue of grounding students of higher establishments for the implementation of statistical applied research. For example, there is sufficient amount proofs that students of pedagogical universities purposefully and thoroughly prepare for statistical data analysis (Arkhipova, 2009, Homuk, 2013). The researchers also emphasize the need to develop skills for statistical analysis of biomedical data, but critical appraisal of theses in the field of medicine give reason to doubt the correctness of the choice of methods for analyzing and interpreting the results, and therefore the correctness of the conclusions (Leonov, 2007). Despite the fact that special studies have not been carried out, our own

experience suggests that, unfortunately, specialists in the field of physical education and sports have certain difficulties in applying statistical methods for arguing the identified patterns and trends.

Specialists have special interest tonon-parametric criterion in the field of psychological and pedagogical researches. In many cases, when certain conditions are not fulfilled that allow the application of parametric criteria, the statistical analysis of sports pedagogical data provides for the application of non-parametric criteria for testing statistical hypotheses. Indeed, V.P. Leonov (2007) notes that the researchers usually use the Student's t-test without checking the normalcy of distribution of characters and not comparing their variances, which leads to erroneous conclusions. On the other hand, experts began to cover issues related to the application of non-parametric criteria in sports and educational research (Denisova 2011-2012, Bishevets 2018).

However, specialists do not often use application of non-parametric criterion in the field of sport and pedagogical researches. Analyzing the specifics of sports pedagogical data, we noticed that scientists often have to deal with data, in particular, measured in the scale of names, to compare the proportion of samples in which the effect was appeared. In such cases, special attention is given to multifunctional criteria, which can solve various problems. Therefore, O.A. Valchuk (2014) focuses on the fact that the Fisher  $\phi$ -test allows us to compare the levels of the character under study, evaluate bias in the values of the character under investigation and compare the distributions of the characters that are being studied. Fisher  $\phi$ -test arouses interest in researchers in the field of physical education and sports. Therefore, it becomes clear that the development of practical skills using the Fisher  $\phi$ -criterion for processing sports pedagogical data by students of higher establishments is an important step to improve the quality of training of future specialists in physical culture and sports

Multifunctional  $\phi$ -Fisher criterion can be used, when we compare samples by the feature, which is measured in the nominal scale; by the feature, which is measured in quantitative scale or distribution of a characteristic in data, which is measured in quantitative scale. In our opinion, illustration of conditions and methods of application  $\phi$ -Fisher criterion enable to improve level of sport and pedagogical researches. Besides, shown examples of calculation empiric value of angle  $\phi$  using MS Excel help to simplify analysis process to researchers in the field of physical training and sport.

### Conclusions and perspectives of further research.

1. Currently, there is an increase in the requirements for accuracy of the declared results of experimental activities in various fields of knowledge. Promulgation of results of scientific researches provide interpretation of empiric data based on using methods of mathematical statistics.

2. The processing of empirical data is the basis of medical and biological, sociological, psychological, sports and pedagogical researches. The quality of statistical data processing depends on the level of proficiency of specialists with the skills to process data using the tools of mathematical-statistical analysis

3. Extension the set of powerful statistical programs allows researcher to perform statistical analysis of data to a scientist of any field of study. Using MS Excel tools greatly simplifies the processing of personal data. At the same time, it should be noted that the qualitative statistical analysis of data remains the prerogative of particular specialists.

4. The problem of incorrect use of statistics in the field of physical education and sports must be solved at the stage of training future specialists due to the increase in the level of theoretical knowledge on these issues and the development of their practical skills in the implementation of statistical analysis.

5. Fisher's angle criterion is highly versatile. In particular, using Fisher's  $\phi$ -criterion, it is possible to analyze data obtained during sports-pedagogical research. Fisher's ratio test allows you to analyze the input data, which is measured on any scale, including nominative, small, dependent or independent samples.

6. Multifunctionality of the Fisher  $\phi$ -test is shown in the possibility of its application when researches compare samples by a character, which is measured on a nominal scale, by a character, which is measured on a quantitative scale or by a distribution of a character, measured on a scale.

7. In our opinion, the illustration of the conditions and methods of application of the Fisher's ratio test will allow to increase the level of sports and scientific research in a qualitative sense. In addition, examples given above of calculating the empirical value of the angle  $\phi$  using MS Excel will help simplify the process of analyzing data for researchers in the field of physical culture and sports.

### Conflict of interest

The author declares about absence of conflict of interest.

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