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Correlation analysis of the level of physical fitness, the physical condition of the students and the success of the summer internship

Abstract. ***Purpose:*** *to estimate the density of the correlation between the measures of the quality of students in summer training.* ***Material and Methods:*** *the monitoring of cadets at the stages of flight training, the method of correlation analysis.* ***Results:*** *It was found that for the assessment of the nature and extent of communication between all pairs of managerial and controlled process variables control the quality of training of pilots, should be, along with the correlation statistical analysis of grade distribution laws studied random variables and statistical hypothesis testing of their belonging to a particular type.* ***Conclusions:*** *with a high degree of reliability of the result obtained on the weak relationship between the level of physical fitness, the physical condition of the students and the successful passing of cadets flight experience.*
Keywords: *cadet, flight training, control, correlation analysis, physical fitness.*

Introduction. Preparation of an aircrew is a many-sided process of a study which includes theoretical, training, psychological, psycho-physiological, and physical and directly – flight training. Focusing of results of pedagogical influences of all six types of preparation also defines a professional preparedness.

Vocational training of pilots relates to a number of those components of the aviation system where a large number of dangerous factors are hidden which timely identification makes an essence of management of safety of flights through improvement of the process of a study [1; 5; 9; 15].

It is necessary to develop an adequate set of the operated variables to operate processes of the improvement of quality of training of military experts effectively. The set of these variables has to include the following subsets:

– variables that characterize conditions of an object of management;

– variables that characterize administrative actions to a subject of management or factors through which it is possible to influence a subject of management [2; 3; 5; 14].

Such difficult system as “training of pilots” is characterized by a large number of properties which need to be considered at the organization of management.

Therefore it is necessary to use sufficient efforts for such approach to a choice of a set of operated variables at which, on the one hand, they would be least of all, and on the other hand – quality of administrative processes has to be not lower than the set.

The correct solution of this task considerably depends on knowledge of a character and an extent of communication between all couples of administrative and controlled variables. The correlation and regression analyzes are applied for a communication assessment between sizes that generally are casual [4; 8; 13].

As our research showed, the problem of physical preparation of an aircrew at different stages of the professional formation and improvement in the military HEI isn’t new, but insufficiently studied (A. A. Gorelov, O. M. Kernitsky, M. S. Korolchuk, G. N. Makarov, M. J. Eyrand, R. Thorton, C. Brown, C. Higenbottam) [1; 3; 7; 9; 16; 17]. All not the smaller the reforming of education demands a consideration of this problem from a position of modern technologies of improvement of quality of a study according to new state educational standards.

The analysis of scientifically-pedagogical literature on the studied problem [7; 8; 13] specifies that the correlation analysis promotes ensuring of the effective management of processes of training of an expert. The closer available connection, the bigger reliability of the forecast of one factor for value of another is (the forecast by a regression). The correlation analysis opens durability of the communication between factors which characterize quality of an expert at stages of his preparation. To them belong:

a) X – the level of physical fitness;

b) Y – the average gain score during a flight study;

c) Z – the level of a physical state.

Communication of the research with scientific programs, plans, subjects. The research is executed according to the plan of the research works of Air Forces of Armed Forces of Ukraine, the subject of the RW “Theoretically-methodical principles of functioning of the system of physical training of the military personnel of Air Forces of Armed Forces of Ukraine”, the code “Management – PP” with the number of the state registration 0101U001112.

The objective of the research: to give an assessment to density of the correlation communication between measures of quality of cadets in the period of flight training.

Material and methods of the research. 9 cadets of the flight faculty of I. Kozhedub KUAF took part in the researches. The monitoring of a condition of an expert at stages of flight training was used for the solution of the put task:

- Z – estimates of quality of a cadet by results of the level of a functional state [12; 17];

- X – estimates of quality of a cadet on certain integrated indicators of the level of physical fitness (to an average point during a study or only by a set of the general physical qualities) [4; 11];

- Y – estimates of quality of an expert by the integrated indicator which is calculated on parametrical indicators of the progress of passing by cadets of flight practice [6; 15].

The correlation matrix is calculated for an assessment of density of the correlation communication which elements contain correlation coefficients which answer qualimetrics scales of indicators (X, Y, Z).

Two options of combination of scales of measurement of sizes of X and Y are considered.

Option 1. Size X is measured in a scale of intervals (relations). Size Y is measured in a scale of intervals (relations). Pearson's coefficient r_{xy} is applied to an assessment of a measure of the correlation communication:

$$r_{xy} = \frac{n\sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\cdot\left(\sum_{i=1}^{n} y_i\right)}{\sqrt{\left[n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2\right]\cdot\left[n\sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right]}}, (1)$$

where x_i and y_i – are selective values of the sizes X and Y; n – selection volume.

Option 2. Size X is measured in a dichotomizing scale which is based on a normal distribution, elective set [9]. Size Y is measured in a scale of intervals (relations).

In this case the biserial coefficient of correlation is applied to an assessment of correlation:

$$r_{xy(bis)} = \frac{\overline{Y}_{(1)} - \overline{Y}_{(0)}}{S_y} \cdot \frac{n_1 n_0}{un\sqrt{n^2 - n}}, (2)$$

where $Y_{(1)}$ and $\overline{Y}_{(0)}$ – are average values of Y for objects which have according to unit and zero for X; S_y – an average square deviation of Y; n_1, n_2 – a number of units and zero for X ($n_1+n_2=n$); u – an ordinate of the normalized normal distribution in a point bywhich lies 100 (n_1/n) of a percent of the plane under a curve.

The received coefficients of correlation by formulas (1) or (2) are the realization of a random variable as the volume of selection of *n* is limited.

Therefore it is necessary:

- to check a statistical hypothesis of equality to zero coefficient of correlation (H_0:ρ = 0);
- to construct (to estimate) confidential borders for a correlation coefficient (in case if the zero hypothesis wasn't confirmed).

The technique of check of the statistical hypothesis of equality to zero coefficient of correlation H:ρ=0 against alternative H:ρ≠0. A case of a small selection:

- the assessment of coefficient of correlation r is calculated;
- the direct transformation of Fischer is applied:

$$Z = \frac{1}{2}\ln\frac{1+r}{1-r}; (3)$$

- the criterion statistics for set is estimated β, t_β and n:

$$S = \frac{t_\beta}{\sqrt{n-3}}; (4)$$

- the statistics of S and selective value Z are compared:

if $|Z| < S$ than hypothesis H_0:ρ = 0 – is accepted;

if $|Z| < S$ than hypothesis H_0:ρ = 0 - isn't accepted.

The technique of an assessment of a confidential interval $I_{r,\beta}$ at the set confidential probabilityβ for the small volume of selection (n<30):

$$Z = \frac{1}{2}\ln\frac{1+r}{1-r},\ (5)$$

with characteristics

$$M_Z = \frac{1}{2}\ln\frac{1+r}{1-r} + \frac{r}{2(n-1)};\ \sigma_Z = \frac{1}{\sqrt{n-3}}, (6)$$

where M_Z – a population mean of a random variable of Z;

σ_Z – an average square deviation of a random variable of Z.

A confidential interval for Z (at the fixed β):

$$I_{n,\beta}^{(2)} = \left[\underbrace{\frac{1}{2}\ln\frac{1+r}{1-r} + \frac{r}{2(n-1)} - \frac{t_\beta}{\sqrt{n-3}}}_{z'};\ \underbrace{\frac{1}{2}\ln\frac{1+r}{1-r} + \frac{r}{2(n-1)} + \frac{t_\beta}{\sqrt{n-3}}}_{z''}\right].$$

Applying the return transformation of Fischer of a form:

$$r = \frac{e^Z - e^{-Z}}{e^Z + e^{-Z}} = \frac{e^{2Z} - 1}{e^{2Z} + 1}, (7)$$

we receive confidential borders for ρ:

$$I_{\beta,n} = [r'; r''].$$

Results of the research and their discussion. The output data of the parameters X, Y, Z (integrated indicators) for a calculation of pair coefficients of correlation of r_{xy}, r_{xz}, r_{yz} are submitted to tab. 1.

Table 1

Indicators of the level of physical fitness (X), progress during a flight study (Y), a physical state (Z)

n	x_i	y_i	z_i
1	4	4,53	3,9
2	4	3,95	3,58
3	5	3,73	3,58
4	5	3,67	3,58
5	5	3,67	3,58
6	4	3,39	2,08
7	5	3,98	3,4
8	4	3,9	4,0
9	4	4,06	3,58

Values of coefficients of correlation are given to tab. 2 (for β=0,9 i t_β=1,65).

Table 2

Values of coefficients of correlation (n=9)

Type	Meaning of r	Z-transformation
r_{xy}	–0,335	–0,348
r_{xz}	–0,133	–0,133
r_{yz}	0,663	0,798

We count the statistics of criterion of acceptance of a hypothesis H_0:ρ=0 for β=0,95, t_β=1,96, by a formula (4). The statistics of criterion equals:

$$S = \frac{t_\beta}{\sqrt{n-3}} = \frac{1{,}96}{\sqrt{9-3}} = \frac{1{,}96}{2{,}45} = 0{,}8$$

We compare $|Z_{xy}|$=–0,348<0,8, $|Z_{xz}|$=–0,133<0,8, $|Z_{yz}|$=0,798<0,8.

Therefore, the coefficients of correlation r_{xy}, r_{xz}, practically equal 0. Thus, zero hypothesis H_0:ρ=0 is confirmed. It is possible to consider significant only r_{yz}=0,663. The confidential interval equals for this purpose to coefficient of correlation (r_{yz}):

$$\mathrm{I}_{\beta,n}(z) = \frac{1}{2}\ln\frac{1+r}{1-r} + \frac{r}{2(n-1)} - \frac{t_\beta}{\sqrt{n-3}} < Z < \frac{1}{2}\ln\frac{1+r}{1-r} + \frac{r}{2(n-1)} + \frac{t_\beta}{\sqrt{n-3}} =$$

$$= [0{,}798 + 0{,}04 - 0{,}8 < Z < 0{,}798 + 0{,}041 + 0{,}8] = [z < z < z] = [0{,}039 < z < 1{,}639]$$

We apply the return transformation of Fischer and we receive for a confidential probabilityβ=0,95:

$$\mathrm{I}_{\beta,n}(\rho)=[0{,}038 < \rho < 0{,}93].$$

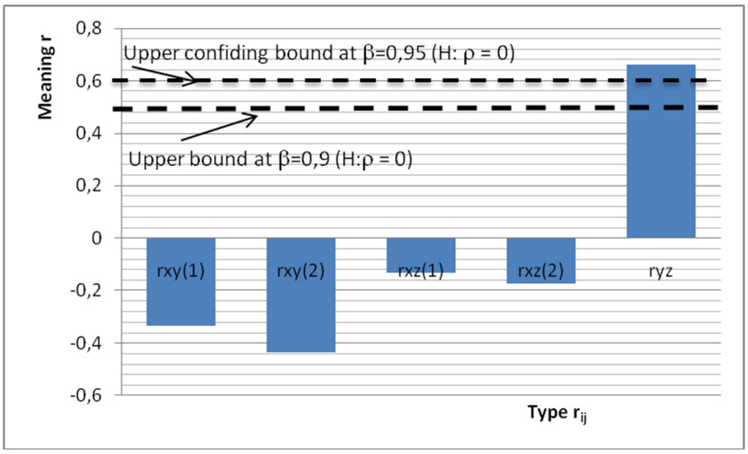
Results of the correlation analysis for r_{xy}, r_{xz}, r_{yz} are given in table 3 and graphically presented in pic. 1.

Table 3

The Built table for three variables (x, in, z) at β=0,95

Type of r_{ij}	Meaning of r	Options of calculations
r_{xy}	–0,335	1
r_{xy}	–0,434	2
r_{xz}	–0,133	1
r_{xz}	–0,172	2
r_{yz}	0,663	–

Notes. *1. The first option of calculations for conditions: x - a scale of intervals (I), y - a scale of intervals (I), z - a scale of intervals (I). 2. The second option of calculations: x - a dichotomizing normal scale (DN), y - a scale of intervals (I), z -a scale of intervals (I).*



Pic. 1. The diagram of results of the correlation analysis for r_{xy}, r_{xz}, r_{yz}

From the above it is possible to claim, what with a high degree of reliability (β>0,9) hypothesis of equality of the coefficient of correlation to zero (H_0:ρ=0) is confirmed, that is the correlation communication between certain factors (X, y), (X, z) (Y, z) is almost absent.

However features of the coefficient of correlation as communication stochastic measures between the studied random variables, for example (X, Y) don't allow drawing a conclusion on independence of these sizes from the following reasons.

The size of the coefficient of correlation of Pearson gives rather full information on narrowness of the communication between them. The closer value of the coefficient of correlation to unit is, the more the compact communication is. In a limit when the coefficient of correlation becomes equal to unit, the communication degenerates in functional [8; 10; 13].

If the coefficient of correlation equals to zero, it means only that fact that the sizes which aren't correlated that is between them there is no a linear communication.

These sizes are independent at equality to the correlation coefficient to zero, will be only in that case when the two-dimensional law of distribution of the system of the studied random variables (X, Y) is normal (the law of Gauss).

If the nonlinear communication takes place between the studied couples of random variables, the coefficient of correlation of Pearson comprises information both on narrowness of communication, and on a deviation of this communication from the linear. Therefore value of the coefficient of correlation can be close to zero as in case of a practical lack of communication between sizes, and in a case when communication is close to functional, but has obviously an expressed nonlinear character.

Such feature of the coefficient of correlation as measures of the stochastic communication between random variables adds additional difficulties on the interpretation of value of an assessment of the coefficient of the correlation received by a selection. There is a need for the analysis of statistical estimates of laws of the distribution of the studied random variables and check of statistical hypotheses of their accessory to this or that to type.

Conclusions. The result about a weak communication between the level of physical fitness, a functional condition of cadets and a progress of passing by cadets of flight practice is received with a high degree of reliability.

Receiving such result is connected with several circumstances:

– the lack of real system of monitoring of quality of the expert and the only information base doesn't allow to provide on these factors the sufficient volume of selection (N_{tr}≥200÷300). The real volume of selection by which it is necessary to define estimates of coefficients of the correlation for this time, fluctuates within np=8÷20. It is explained by the bad organization of collection of information and, as a result, impossibility of the formation of necessary number of the corresponding pairs of parameters (X, y), (X, z) (Y, z) which are investigated;

– the closer connection is observed between factors Y (an average point during flight study) and Z (level of a physical state), however it is also insignificant. It can be explained with a weak informational content of a technique of determination of the level of a physical state through the coefficient of a functional state.

The development of the automated subsystem of the statistical analysis of the operated and controlled variables is provided **in the long term of our research** by which quality of the process of training of an expert is estimated.

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