

Pedagogical Measurement of Physical Condition as a Component of Professional Readiness of Tactical Aviation Pilots

By

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Abstract

In modern military aviation practice, the pilot's physical readiness to carry out professional activities is of significant importance. It is caused by excessive physical (along with intellectual, psychological and psychophysiological) exertion affecting the body of a military pilot in the conditions of piloting modern 4th generation aircraft. The multidisciplinary theory of aviation psychology and pedagogy, as well as the achievements of military pedagogy, give reasons to understand physical readiness as a specific physical state of a person, refined in the body's functional state, which ensures the successful performance of certain activities, characterized by increased requirements for health and physical fitness. Furthermore, there are good reasons to interpret a physical component of the professional readiness of future tactical aviation pilots as the level of the body's functional state sufficient to carry out the professional activities of a military pilot under conditions of increased physical exertion and G-stress. The problem of its objective measurement during professional training of the military pilot for further application in the optimization of the educational process has an urgent applied value. However, the normative practice of such assessment existing in Ukraine cannot be considered efficient. This article highlights the author's approach to solving the posed problem. Here we present the methodical basis developed by us, which consists of a complex physical test and a relative criterion apparatus, which takes into account the specifics of the modern physical stress on a military pilot in the process of piloting a combat aircraft and the peculiarities of the effects of combat flight factors. This measurement complex, based on modern test technologies, has not yet been applied in the Ukrainian practice of professional training of future tactical aviation pilots. As an indicator of its efficiency, the results of an empirical experiment conducted by us at the premises of the Ivan Kozhedub Kharkiv National University of the Air Force are given and analysed. The obtained data are more informative, differentiated, and allow tracking the dynamics of changes in the physical condition of the cadets before and after all stages and phases of ground and flight training. Such information is essential for both the optimization and correlation of the educational process, and for more accurate professional selection of the cadets by types of aviation in the subsequent years of training.

Keywords: Tactical Aviation, Military Pilot, Professional Readiness, Pedagogical Measurement

Introduction

For the last year, starting from 24 February 2022, Ukraine has been the object of full-scale military aggression by Russia. In this war, which is recognized as the largest military conflict in Europe since the Second World War (Pereira et al., 2022), all the main types of troops (forces) of the armed forces of both sides are involved: ground forces, naval forces and air forces. However, having numerically and technically much greater potential, the Aerospace Forces of the Armed Forces of the Russian Federation were still unable to achieve superiority in Ukrainian airspace, and suffered unprecedented losses, while the aviation of the Air Forces

of the Armed Forces of Ukraine significantly compensated for its potential with skill and professional readiness of the military pilots (Karadima, 2022). We consider the last factor to be among the key ones in the air war in Ukraine, since, as evidenced by the events of February-March 2022, Ukrainian military pilots, being in much more unfavourable conditions, were able to push enemy tactical aviation from most of their airspace beyond the front line.

For a further more systematic and professional understanding of the problem raised by us, a number of its basic concepts and provisions needs to be explained and clarified.

Tactical aviation is the main combat type of aviation capable of solving tactical (operational and tactical) combat tasks of varying complexity independently and in cooperation with other types of armed forces (destruction of enemy aircraft, destruction or suppression of enemy ground forces, its echelon defence, communications and infrastructure, tactical air reconnaissance, conducting joint raids of highly manoeuvrable forces, etc.), performing, essentially, a defensive and deterrent function. Tactical aviation includes fighter, bomber, attack and reconnaissance aircraft, and is the most highly manoeuvrable and combat-capable part of the air force (Vision of Aircrafts 2035, 2020). A mixed model of military pilot training is used in modern Ukraine. It provides for the simultaneous combination of obtaining a higher military education with the assignment of an officer rank with a specific military aviation profile. The future pilot of tactical aviation is a cadet of a higher military educational institution (HMEI) specializing in “flight operation and combat use of aircraft”, who upon graduation from the institution and successful mastery of the relevant educational program is assigned the rank of military officer and the “class III pilot” class qualification. Such an individual studies exclusively at the expense of the state budget within the framework of a state educational order, and after graduation is assigned to a military unit (aviation brigade) for further contractual military service.

The concept of “professional readiness” is rather ambiguous in the modern scientific and pedagogical discourse in general and within the subject of professional (aviation) and military branches of pedagogical theory in particular. Within the framework of the author's research, we reasonably suggest to interpret it as a structured and pedagogically designed set of professionally significant competences of individuals, required to efficiently carry out their professional activities in the acquired professional profile (Nevzorov, 2021a). Furthermore, with regard to the professional readiness of future tactical aviation pilots, we consider it as a complex of flight-theoretical, flight-practical, special psychological, physical, and psychophysiological qualities of the graduates of HMEI, which allow them to confidently and efficiently carry out direct professional activities (combat flights) immediately after acquiring the relevant professional profile (Nevzorov, 2021b). In other words, it is reasonable and necessary to consider the physical condition of military pilot cadets as a component of their complex professional readiness, as physical readiness for future professional activities.

The need to measure the physical condition as an indicator of the physical readiness of future military pilots is directly related to the specifics of their professional activities, which is especially relevant during a full-scale war. As is well known, the tactical aviation of Ukraine has the 4th generation Su-27 and MiG-29 fighters on combat alert, classified according to their tactical and technical characteristics as combat aviation complexes. When piloting the latter, especially in the conditions of a real combat situation (air combat, escort and cover of attack aircraft and bombers, interception and destruction of cruise missiles and unmanned aerial vehicles), the pilots are subject to significant, sometimes extremely heavy, physical exertion. Thus, according to the experts, the military pilots' bodies are negatively affected by physical dynamic factors (vibroacoustic, microclimatic, light environment, etc.) and extreme physical

exertion (increased heart rate up to 170 bpm, alternating G-stresses, bursts in muscle stress, etc.) on the cardiovascular, respiratory, visual, motor systems (Kalnysh et al., 2021; Kravchuk et al., 2020). It is natural that, under such conditions, it is necessary to measure the physical condition of future military pilots in a systematic way even during their training at the HMEI. However, the current practice is quite nominal, and is limited only to passing periodic formal regulations. Therefore, the development of a new criterion apparatus and tests of actual physical readiness (instead of the physical condition standards introduced back in the 1980s) and their experimental verification in the conditions of professional training of future tactical aviation pilots at the HMEI are urgent. This is the purpose of this article.

Literature Review

We should immediately note that to date, within the framework of the subject of pedagogical theory and/or within the framework of multidisciplinary research, this issue has not been studied thoroughly enough. The most relevant studies related to only tactical aviation are considered in this review.

A. Tomczak and M. Haponik (Tomczak, Haponik, 2016) studied the level of physical fitness and aerobic capacity of fighter pilots in Eastern Europe based on the measurement capabilities of the seven-skill physical fitness test and the Astrand-Ryhming test. They concluded that modern military pilots have an average level of physical performance that is lower than thirty years ago, which indicates existing miscalculations in their physical training.

M. Herrador-Colmenero, G. Fernández-Vicente, J. R. Ruiz (Herrador-Colmenero et al., 2014), A. Aandstad, F. Sandberg, R. Hageberg, E. Kolle (Aandstad et al., 2020), B. K. Bohnker, D. M. Sack, L. Wedierhold, M. Malakooti (Bohnker et al., 2005) studied the applied aspects of the efficiency of using special physical tests as a tool for diagnosing the actual physical readiness of military personnel of NATO and certain European countries outside the North Atlantic Treaty Organization, including military pilots. We believe that these works cannot be considered finished, since the results presented by the authors are only preliminary, obtained during individual measurements. However, they alone reveal the advantage and perspective of test technologies over the regulatory means existing in Ukrainian practice.

H. Rintala, A. Häkkinen, S. Siitonen & H. Kyröläinen (Rintala et al., 2015) achieved the results significant for us when studying the impact of physical training on the functional capacity of military pilots. Among other things, they believe that the negative consequences of exposure to high G in the process of piloting a combat aircraft require more accurate measurements of physical fitness, and that moderate or even good physical performance, which is usually accepted in military aviation, is often not enough to maintain occupational health of a military pilot. These conclusions confirm our thesis about the need to develop and implement a more accurate system of monitoring the state of the physical component of the professional readiness of future military pilots at the HMEI.

Methodology

Research stages and design.

In order to comprehensively assess the physical condition of the cadets of the aviation HMEI (which is the only one in Ukraine: Ivan Kozhedub Kharkiv National University of the Air Forces (KhNUAF)), we have developed the appropriate methodical apparatus. It consists of the author's complex physical test and the relatively adapted criterion apparatus.

The first one takes into account the specifics of the physical exertion on a military pilot in the process of piloting a combat aircraft and the specifics of the effects of combat flight factors (Table 1).

Table 1. *Details of a complex physical test for measuring the physical component of professional readiness for combat flights of future tactical aviation pilots*

Indicator type	Task to measure the indicator	Measurement details
	General physical functional qualities	
Strength endurance	1. Simultaneous lifting of arms, head and legs lying face down (10/15/20 points)	High level – 140 points Sufficient level – 105 points Insufficient level – 70 points
	2. Squat jumps (20/30/40 points).	
	3. Push-ups (different variations) (20/30/40 points).	
	4. Pull-ups (different variations) (20/30/40 points).	
Speed	1. Complex running (different distances, different paces with rest intervals) (50/100/150 points).	High level – 150 points Sufficient level – 100 points Insufficient level – 50 points
	Special physical professionally oriented qualities	
G-tolerance	1. 400 m distance running in 60 s (10/20/30 points).	High level – 90 points Sufficient level – 60 points Insufficient level – 30 points
	2. Pointed angle support on the parallel bars (10/20/30 points).	
	3. Pull-over, 6 times (10/20/30 points).	
Swaying tolerance and spatial orientation	Three forward flips in a row from a squat position with closed eyes in 6-7 seconds; without pause – stand up, step to the left, turn to the right, right foot forward, left – to the side in 2-3 seconds; stand with eyes open 3 s (20/30/40 points).	High level – 40 points Sufficient level – 30 points Insufficient level – 20 points
Altitude tolerance	Swimming for a distance of 400 m with diving under water after every 50 m in 7 min. (20/40/60 points)	High level – 60 points Sufficient level – 40 points Insufficient level – 20 points
Condition of the cardiovascular system (“step test” according to the Ruffier index)	90 step-ups on a gymnastic bench (50 cm high) in 15 minutes.	High level – “athletic heart” Sufficient level – “average person heart” Insufficient level – heart failure
Overall result of passing the test		480 points + high/medium level of the cardiovascular

system (high) - **indicators of physical fitness and functional health are excellent and demonstrate full readiness for combat flights**

335 points + high/medium level of the cardiovascular system (sufficient) - **no health abnormalities (or minor abnormalities that do not interfere with further flight training), lags in physical training, allowed to flights**

190 points + heart failure (insufficient) - **problems with physical development and health that will not allow further flight training to improve functional state and physical fitness**

The developed criterion apparatus is aimed at establishing the objective physical readiness for such a body's functional state, when the pilot is able to efficiently carry out combat flights under conditions of rapidly changing physical exertion. Based on the peculiarities of the complex of physical exertion on the pilot's body during combat flights, which are described above, we attributed the indicators of this criterion as follows:

- 1) developed general physical functional indicators: endurance, speed, strength.
- 2) formed special physical professionally oriented indicators: G-tolerance, swaying tolerance, altitude tolerance, spatial orientation, stable condition of the cardiovascular system (before, during and immediately after the flight).

We recommend categorizing the specified indicators at the three levels as follows:

- high: indicators of physical training and functional health of the cadets are excellent and demonstrate full readiness to perform combat flights;
- sufficient: the cadets do not have health abnormalities or have minor abnormalities that do not interfere with further flight training, lags in physical, are allowed to flights;
- insufficient: indicates problems with physical development and health of the cadets, that will not allow further flight training to improve functional state and physical fitness.

The measurement of the physical readiness of the military pilot cadets was carried out as part of an empirical experiment to check the efficiency of introducing the pedagogical system developed by the author into the educational process of the KhNUAF to ensure the quality of professional training in combat flights of future tactical aviation pilots. The level of physical readiness was diagnosed at the beginning of the experiment (2019) and at its end (2021).

At the first stage, the measurement itself was carried out. At the second stage, the results of the initial and final control in the experimental group were compared with the establishment of the identified local quantitative regularities. At the third stage, the measurement results in the experimental and control groups were compared after the final control with the establishment of the identified local quantitative regularities. At the fourth stage, the obtained results were compared for reliability and validity.

Research participants. In the measurement of physical readiness, two groups were formed from the total number of the military pilot cadets in 2017 and 2018 (a total of 44 individuals): experimental group (EG) and control group (CG). The first group was directly subject to the experimental influence during the research; the second group did not participate in the experiment itself, but its results were compared with the results of the first one to establish the degree of the corresponding influence, validate the results and calculate the efficiency of the implemented measures.

The specified groups were formed in an indiscriminate manner: the experimental group (a total of 22 individuals) consisted of the cadets who independently expressed a desire to participate in the experiment, without knowing about its ultimate pedagogical purpose and projected result; the remaining part of the cadets entered the control group (a total of 22 individuals).

The experimental group included males aged 18-22 years old (at the beginning and at the end of the experiment, respectively).

Results

Table 1. Results of measuring the physical component in the EG and CG during the initial and final control assessment

Groups	Quantitative distribution based on the results of testing general physical functional qualities (GPFQ) by levels			Quantitative distribution based on the results of testing special physical professionally oriented qualities (SPPOQ) by levels		
	high	sufficient	insufficient	high	sufficient	insufficient
initial control assessment						
EG (22 individuals)	6	16	0	4	18	0
CG (22 individuals)	7	15	0	4	18	0
For the entire test (in %)	27.3	72.7	0	18.2	81.8	0
	31.8	68.2	0	18.2	81.8	0
final control assessment						
EG (22 individuals)	14	8	0	12	10	0
CG	7	15	0	5	17	0

(22 individuals)						
For the entire test (in %)	63.4	36.6	0	54.6	45.4	0
	31.8	68.2	0	22.7	77.3	0
	deviation					
	based on the results of the initial (“-”) and final (“+”) control assessments (in %)					
EG (22 individuals)	+36.1	-36.1	-	+36.4	-36.4	-
CG (22 individuals)	-	-	-	+4.5	-4.5	-

The calculation of the level of significance using the Student's t-criterion method based on the results of the initial control assessment was 5.29 – sample averages differ insignificantly; based on the results of the final control assessment, it was 28.01 – sample averages differ significantly.

The results of the initial and final control assessments of physical readiness in both groups provide evidence of the following:

- 1) the basic (initial) parameters of the formation of general physical functional qualities (GPFQ) and special physical professionally oriented qualities (SPPOQ) of the EG and CG cadets were statistically the same (with a slight advantage of the CG over the EG);
- 2) the initial (formed under the experimental influence in the EG and the influence of the “conventional” training system in the CG) parameters of the formation of GPFQ and SPPOQ demonstrated a significant gap:
 - in the absence of individuals with an insufficient level of formation of the relevant qualities, based on the results of the initial and final control assessments, the indicator of the dynamics of the number of individuals with a high level was taken into account (63.4% of the GPFQ significance and 54.6% of the SPPOQ significance for the EG and 31.8% of the GPFQ significance and 22.7% of the SPPOQ significance for the CG);
 - an increase in the number of the EG cadets with a high level between the two control assessments by 36.1% according to the GPFQ and by 36.4% according to the SPPOQ (in the CG, this indicator has not changed since the time of the initial control assessment according to the GPFQ and 4.5% according to the SPPOQ);
- 3) anticipation of the formation of the relevant qualities in the EG, compared to the CG, based on the results of the author's complex physical test, is thus 36.1% according to the GPFQ and 31.9% according to the SPPOQ.

Discussion

Enormous physical exertion, sometimes extreme for the body, associated with piloting modern military aircraft, as well as the possibility of unusual emergency situations (e.g., the need for operational ejection from a damaged aircraft) objectively determined the presence of special tactical aviation physical component (of their professional readiness) in the professional training of future pilots. According to aviation statistics and expert research, up to 90% of aviation events are caused by the human factor every year (Pamplona, Alves, 2020), and the spread of dynamic health problems among professional pilots leads to their early professional

“wear and tear” (Miranda, 2018). Such a situation, on the one hand, is related to the specifics of modern military aircraft control (super high speeds, complex manoeuvres, constant exposure to vibration, noise, hypodynamia, limited time to analyse the situation and make a decision, high accuracy of reactions), which objectively makes the professional activities of a military pilot physically exhausting and critically stressful, and on the other hand, the insufficient physical readiness of the graduates of the aviation HMEI for such excessive exertion. Under such conditions, the requirements for the physical fitness of military pilots have increased significantly, and determine the physical component of their professional readiness.

Thus, physical readiness should be considered in the context of the modern theory of professional (aviation) psychology and pedagogy as a whole as a specific physical state of a person (body's functional state, level of motor readiness), which ensures the successful performance of certain activities, characterized by increased requirements for the state of health and physical fitness, and the physical component of the professional readiness of future tactical aviation pilots – as a level of body's functional state, sufficient for the professional activities of a military pilot in conditions of increased physical exertion and G-stresses.

We believe that the measurement of physical readiness at the HMEI should be based on the calculation algorithms of modern test technologies. The latter are capable of comprehensively and sufficiently differentiated detection of the actual physical condition of the cadets who are future pilots of tactical aviation before and after all stages and phases of flight training. This is exactly what is needed to achieve the optimal level of their physical readiness at the finish line of professional training for professional activities.

Conclusions And Recommendations

Physical fitness as a component of the professional readiness of future tactical aviation pilots for professional activities should be considered as an indicator of the body's functional state, when the pilot is able to efficiently carry out combat flights in conditions of rapidly changing physical stresses. Like any indicator, it needs an apparatus and a measurement technique that allows it to be assessed as accurately and realistically as possible by criteria, indicators, and levels.

The proposed author's assessment complex (a special test and relevant assessment criteria), as demonstrated by the results of experimental measurement, is capable of differentially assessing the actual level of physical readiness of future tactical aviation pilots in the dynamics of its formation during training at the HMEI.

The obtained empirical results showed that in addition to the fact that the EG cadets do not have health abnormalities or have minor abnormalities that do not interfere with further flight training, lags in physical training and are allowed to flights, they also increased their level of physical readiness and functional health according to the results of experimental influence. This testifies to the efficiency of the monitoring system developed by us according to this component of their professional readiness.

Besides, the obtained results allow us to recommend the complex physical test developed by us for regular measurement of the physical component of professional readiness before and after each stage of ground and flight training at the specialized aviation HMEI. We believe that in order to improve the physical readiness and functional health of military pilot cadets, the existing approach towards specialized profile should be revised and enhanced differentiated monitoring of this component of professional readiness should be introduced.

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