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Research on evaluation standard of civil aviation flying cadet' physical fitness

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ABSTRACT

This paper uses the methods of physical fitness test, document literature, expert argumentation method, questionnaire method and mathematical statistics method, takes the civil aviation flight trainees' physical fitness as the study object, formulates the evaluation standard of the civil aviation flight trainees' physical fitness by means of empirical study; this standard includes evaluation form of single index and comprehensive evaluation criteria. Development of evaluation criteria laid the scientific foundation for the physical health management of our flying cadets and the young pilots. © 2014 Trade Science Inc. - INDIA

KEYWORDS

Flight trainees;
Physical fitness;
Evaluation standard.

INTRODUCTION

National Fitness Program in China has implemented for nearly 20 years, and the national body measurements have been carried out more than 10 years. The physical fitness evaluation and research in all industries and regions have been widely carried out, and obtains more widely identification in the whole society; but the research and promoted application on the physical fitness of specific groups in civil aviation fall behind the overall national level; the field of civil aviation in particular, the pilot jobs have its uniqueness and importance demands of their physical fitness; the study of pilots' physical fitness, especially the study on the evaluation standards of the civil aviator's physical fitness is still in a space state. This paper is the first step in a systematic study of the pilot's physical fitness, through the development of physical fitness evaluation criteria on flying cadet of Civil Aviation University of China, it initially builds a more scientific test indicator framework for the scientific assessment of the pilots' comprehensive physical level; and provides a scientific basis and the method system for the ultimate defination and evaluatation of pilot's physical condition.

STUDY OBJECTS AND METHODS

Study objects

This paper uses cluster sampling method, extracts the 192 male pilot students of grade 2010, 2011, 2012 in International Flight Institute of Civil Aviation University of China as study object, among them there are 70 freshman, 64 sophomores and 58 juniors with an average age of 19.7 years.

Study methods

Document literature

Through querying literature, collecting progress of physical fitness research at home and abroad and analyzing, it provides a theoretical method and directional guidance for this study; by inquirying and collecting the physical fitness test related data and health records data of our various industries, it provides reference for this study.

Expert interview method

This paper conducts interviews on eight flight experts in civil aviation system and constitution experts of some sports college (such as: Do you think which requirement do the flying environment have on the pilots? what aspects do the pilots' physical fitness indicators? what indicators do the pilot's body function include? What are You? how to treat pilots' mental quality? what kind of psychological quality should pilots have, etc.), by combining with document literature, designs a "questionnaire survey on the evaluation index study of civil aviation cadet's physical fitness".

Questionnaire method

This papre issues "questionnaire survey of civil aviation flying cadet's physical evaluation index study" in twice to 15 flight experts in civil aviation system and physical Experts of some college sports, a total of 30 parts, recycle a total of 30 parts and the recovery is 100%. The main contents of the first questionnaire are the indicator screening of the flying cadet's physical fitness, the main contents of the second questionnaire are the determination of each index's weight.

Physical fitness test

In order to ensure the accuracy and reliability of the test results, before test the testers are strictly trained to fully understand the test details of each indicator; Test methods use the National Physique Monitoring System developed by the State Sports General Administration, and according to the special circumstances of the flight, conduct indicator tests on the flight trainees' flexibility, strength, endurance, and objective mental quality, organize and implement the whole testing work in accordance with standardized and normalized procedures for organizing.

Physical fitness test indicators

Morphological index: height, weight

Physiological index: vital capacity, step test

Physical fitness index: 1000 meters, grip strength, push-ups, standing long jump, sit and reach, standing on one foot with eyes closed.

Phychological quality index: choice reaction time, focused on the attention time, pay attention to assigning the correct number of times, spatial memory 1, spatial memory 2, perceptual differences of the speed.

Test site and personnel

Test site: Civil Aviation University of China;

Test personnel: test personnel after vocational training;

Test procedure: fixed testers test in accordance with standardized test procedures at a fixed location.

Mathematical statistics

Conduct statistical processing on all data by using statistical software and determine the evaluation criteria by using percentile method; determine the weight of each index by using expert consultation results, statistical calculation results and methods combined sport measurement with evaluation theory.

RESEARCH RESULTS AND ANALYSIS

Index selection

Index primary selection

In order to better reflect the characteristics of flying cadet's body shape, we follow the principles of index's reliability, validity, objectivity, and operability in the actual test, based on the large number of documents and expert advice, by combing the special requirements for physical fitness of pilot position, it summarizes four first level indicators: body shape, body function, physical fitness and objective psychological quality; 13 secondary indicators: height, weight, body fat percentage, vital capacity, blood pressure, heart rate, step test, endurance quality, strength quality, flexibility quality, balancing ability, reaction sensitivity, brain cognitive processing quality; 17 third level indicators: 1000 m, 3000 m, 5000 m, grip strength, push-ups, pull-ups, standing long jump, vertical jump, sit-ups, sit and reach, standing on one foot with eyes closed, choice reaction time, focuse on the attention time, pay attention to assigning the correct number of times, spatial memory 1, spatial memory 2, perceptual differences of the speed.

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Expert screening and statistical optimization

This paper gives out the evaluation index creening questionnaire to 15 civil aviation flight experts and national physique experts, takes more than 75% of people choose "important" and above as inclusion criteria, and finally determines 4 first level indexes, 10 second level indexes and 12 third level indexes, the details are shown in TABLE 1.

The developed method and process of evaluation criteria for civil aviation flying cadet's physical fitness

In accordance with the measurement and evaluation theory, grade evaluation usually adopts five-grade evaluation. Five grade evaluation. can use deviation method, also use percentile method; in addition to the advantages of deviation method, compared to deviation method, since percentile method does not take the mean value as a reference value and takes the standard deviation as the discrete distance, but takes the median as the reference value and takes the other percentiles as discrete distance to divide the evaluation level, so a variety of data with normal and non-normal distribution can be applied. This method has been widely used abroad, speaking from the development trend, the percentile method is likely to replace the deviation method[1]. The physical fitness evaluation involves human body shape, function, quality, and psychology four categories; some test results of these indicator sample are normal distribution and some are non-normal distribution; by combining with expert advice and theoretical analysis, the development of physique evaluation criteria is main based on percentile method.

TABLE 1 : List of physique evaluation index for flying cadet of civil aviation

First level index	Second level index	Third level index
Body Shape	Height	
	Body weight	
Body function	Vital capacity	
	Step test	
Physical Fitness	Endurance Quality	1000 meters
	Strength quality	Grip strength
		Push-ups
		Standing long jump
	Flexility quality	Sit and Reach
	Balancing capacity	Standing on one foot with eyes closed
	Sensitivity of Response	Choice reaction time
Objective psychological quality	Brain cognitive processing quality	Focus on the attention time (3 minutes 3 speeds)
		Pay attention to assigning the correct number of times (1 minute)
		Spatial memory 1
		Spatial memory 2
		Perceptual differences of speed (2,4,6 times of speed)

Develop methodologies for height and standard weight

Due to the special restrictions in the special career whereabouts, enrollment number, height (165 cm ~ 185cm) and weight (≤ 80kg) of flying cadets, in the initial link of the selection of student pilots, airlines have conducted a rigorous screening; so the body shapes of this study object are more symmetrical from a visual point of view. Based on the internationally recognized body mass index (BMI) that reflects the relationship between adult weight and height, the BMI values are in 18.5~24[2], there is no phenomenon of slim and overweight. After consulting with the relevant expert's advice, on body shape index the study uses three aspects as airline's rigid requirements range of pilot trainees' height and weight and the generally accepted range of BMI values to conduct comprehensive evaluation. Namely for the test objects whose height and body weight meet the requirements of the airline and the BMI values between 18.5~24, and get full mark on this

index.

Developed methods of individual indicators

Inferior	Lower	Medium	Higher	superior

Concrete steps to develop the evaluation criteria of single index: 1) identify the 10th percentile, 25th percentile, 75th percentile and 90th percentile of each individual indicator as the segmentation criteria; 2) according to the above theory, percentile divide the different sections of each individual index; 3) define different levels depending on the different sections, namely more than 90% is, 75% -90% is defined as higher grade, 25% -75% is defined as medium grade, 10% -25% is defined as lower grade, less than 10% is defined as inferior grade, which are assigned to 5 points, 4 points, 3 points, 2 points and 1 point respectively. It determines the score list of each individual index for flying cadet of civil aviation (TABLE 2). Students can use the standard to fully understand their constitution location and level in all the flying cadets' physical fitness, and provide reference and basis for the development of individual exercise prescription.

Formulation of overall rating standards

Determining the weight of each individual indicator

Since the significance and importance of physical fitness reflected by each individual indicator are different, therefore, each indicator should be given different weights in comprehensive rating. This paper uses expert questionnaire survey method to determine the weight of each index. Specific steps are as follows: we grant questionnaire survey to the civil aviation flight experts and the domestic physical fitness specialists, ask the experts to divide the importance degree of the indicators into very important, important, more important, general and unimportant 5 levels by combining the physical characteristics of pilots and the requirements of flying job, use five grade scoring methods to conduct assignment on the importance degree of each index at all levels, the assignment is 5,4,3,2 and 1.

Using the equation:

$$w_i = \frac{\sum_{j=1}^{15} pij}{\sum_{i=1}^{4}\sum_{j=1}^{15} pij} \qquad (i = 1,2,3,4)$$

Where: Wi means the weight of index i of flying cadet's physique level; Pij means the assignment of index i by expert j; after the above steps, the paper gets the weights of four first level indexes; according to the statistical calculation results and the expert questionnaire, it determines the weights of 10 second level indicators and 12 third level indicators (TABLE 3).

Formulation of overall rating standards

Overall rating criteria can more fully reflect the physical level of flight trainees. Therefore, it is neces-

TABLE 2 : The score list of each individual index for flying cadet of civil aviation

Test index	1 point	2 points	3 points	4 points	5 points
Vital capacity(ml)	≤3346	3347-3987	3988-4352	4353-4859	≥4860
Cardiac function index	≤44	45-49	50-58	59-69	≥70
1000 meters	≥4′21"	4′20"-4′14"	4′13"-3′51"	3′50" -3′30	≤3′29"
Grip strength(kg)	≤38.8	38.9-42.1	42.2-47.0	47.1-50.6	≥50.7
Push-ups(times)	≤16	17-21	22-25	26-30	≥31
Standing long jump(m)	≤2.19	2.20-2.29	2.30-2.44	2.45-2.58	≥2.59
Sit and Reach (cm)	≤4.0	4.1-7.9	8.0-13.6	13.7-18.6	≥18.7
Standing on one foot with eyes closed (s)	≤14	15-27	28-49	50-65	≥65
Choice reaction time (ms)	≥0.60	0.59-0.52	0.51 -0.49	0.48-0.41	≤0.40
Focus on the attention time (s)	≤177.8	177.9-178.5	178.6-179.3	179.4-179.8	≥179.9
Pay attention to assign the correct number of times (times)	≤ 64	65-70	71-82	83-90	≥91
Spatial memory 1 (calculation)	≤5.99	6.00-6.22	6.23-6.32	6.33-6.56	≥6.57
Spatial memory 2 (calculation)	≤8.99	9.00-9.32	9.33-9.65	9.66-9.99	≥10.00
Perceptual differences of speed (s)	≥2.34	2.33-1.99	1.98-1.49	1.48-0.70	≤0.69

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TABLE 3 : The list of each index weight for the flying cadet of civil aviation

First level index	weight	Second level index	weight	Third level index	weight
Body Shape	0.04	Height (165~185cm)	0.020		
		Body weight (≤80kg)	0.020		
Body function	0.20	vital capacity	0.100		
		Cardiac function index	0.100		
Physical Fitness	0.41	Endurance Quality	0.109	1000 meters	0.109
		Strength quality	0.115	Grip strength	0.0383
				Push-ups	0.0384
				Standing long jump	0.0383
		Flexility quality	0.038	Sit and Reach	0.038
		Balancing capacity	0.074	Standing on one foot with eyes closed	0.074
		Sensitivity of Response	0.074	Choice reaction time	0.074
Objective psychological quality	0.35	Brain cognitive processing quality	0.350	Focus on the attention time (3 minutes 3 speeds)	0.070
				Pay attention to assign the correct number of times (1 minute)	0.070
				Spatial memory 1	0.070
				Spatial memory 2	0.070
				Perceptual differences of speed (2,4,6 times of speed)	0.070

sary to establish the overall rating criteria of civil aviation flying cadet's physical fitness. The formulation steps of the standards are as follows: 1) based on the score sheet of single index calculate the grade scores of each flying cadet's individual indicator; 2) the scores of each individual indicator are multiplied by the their respective weights, the sum is then integrated score of flying cadet's physique; 3) use the percentile to formulate the grading standards of flying cadet's physical fitness comprehensive evaluation (TABLE 4).

TABLE 4 : Comprehensive evaluation grade standards of flying cadet's physical fitness

Grade	Inferior	Lower	Medium	Higher	superior
Corresponding percentile value	10%↓	10%-25%	25%-75%	75%-90%	90%↑
Composite score	≤1.80	1.81-2.34	2.35-3.04	3.05-3.64	≥3.65

Health Standard"— Editor's Note). We conduct rating on each individual pgysical index of the flying cadets, then sum the product of each individual index score and its weight, and obtain the total points of flying cadet's physical index. The results show that: scores above 3.05 account for 65.7%, indicating that this evaluation system has a certain reliability. Therefore, this evaluation criteria can be used as the basis for flying cadet's physical fitness evaluation.

Standard back-substitution test

According to the physical evaluation criteria of the flying cadets developed in this study, this paper conducts back-substitution test on the physical testing scores of the flying cadets in the Excellence classes of International flight School in Civil Aviation University develop a flight (outstanding trainees are the top 30 students in students with the same grades in the physical fitness scores and academic scores in entrance examination based on the universal "National Student Physical

Discussion

1 In this study, we first conduct interviews with relevant experts, and conduct questionnaire survey for 60 flying cadets, meanwhile simultaneously conduct a literature search; through comprehensive investigation and research, we have a basic understanding of the pilot's general physical needs and special physical needs. In this premise, we first conduct a general physical evaluation of the 192 flying cadets,

meanwhile conduct analysis and survey on the gruop differences of ordinary college students in other majors; whereby preliminarily understand the general physical condition of the flying cadets, the result shows that although the absolute value of flying cadets' indicators is superior to the general college students, but the relative value has no significant difference with the college students, suggesting that there is no significant difference in general physical fitness with flight trainees in other majors. On this basis, according to the survey results we redesign and organize the comprehensive physical fitness evaluation of the flying cadets, supplement some strength quality, sensitive quality, balancing ability quality and cognitive processing capacity, preliminarily understand the distribution situation of the flying cadets' special physical fitness. Through summary analysis on the flying cadet's general physical fitness evaluation and the special physical fitness evaluation results, we initially develop test indicators and evaluation criteria of flying cadet's physical fitness by combing with the special needs of airline on aviator's physical fitness.

2 Civil air transport is a high-tech, high-risk, high-intensity work; the pilots have to perform a variety of complex tasks, be ready to face a variety of complex situations and emergencies, and must have a better physique to be competent for work than the general social population. Through expert interviews, questionnaire survey and literature analysis, it summarizes the requirements for pilots' ideal physique by flying job: (1) physical health, good comprehensive physical fitness, slightly better than the general social population of the same age; (2) more sensitive action, the coordinated hand-eye-foot; (3) Since the pilot driving has a high degree of automation, general driving power devices are installed, there are no special requirements for strength quality, but grip strength and the upper body strength are slightly better than the social population with the same age; (4) Due to the rapid development of the domestic civil aviation operations, pilot has great workload intensity, more night flight and is prone to all kinds of fatigue, so it has a higher requirement on the pilot's cardio-pulmonary function and general endurance quality; (5) the stature is more moderate and symmetrical, it has certain specified range provision on the height and body weight, and the body flexibility is better than the general social groups; (6) the mind reaction is fast, decision-making judgment is fast, focus on good attention, good spatial memory and good perceptual speed[3]. In the course of the developing this standard, we first need to consider the general requirements and special requirements for pilots' physical fitness, and based on the actual needs of the airline, in line with the principles of practical feasibility and ease testing handleability, combined with expert advice and theoretical analysis, design and study the physical fitness testing indicators and evaluation criteria that is suitable for the characteristics of flight post.

3 Flight safety issue has been one of the major issues getting most concern in domestic and international civil aviation industry, and the most critical factor affecting flight safety is the human factor. Statistics show that flight accidents caused by human factors account for about 70%, among them the psychological factors constitute the major part of the human factor[4]; study on the pilot's psychological quality is imperative. On the basis of large number of document literature and expert advice, we use cognitive processing mental ability tests to reflect the psychological quality of pilots. Cognitive processing mental ability test is the effective means to evaluate, reflect the individual pivot's abillity on the information search, filter, selection, storage, judgment and decision-making ability, is widely used at home and abroad and receives unanimous approval in psychology worldwide, and is widely used in various fields. The related test has a more unified theoretical basis and methodological basis, and the test equipment and standardization degree of the process are very high. Flying job has unique requirements on the cognitive processing capacity of pilots, which is different from the general social industry; cognitive processing capacity involves the pilots' professional operating capacity and response capacity of crisis event, and is one of the core competencies of human factors in flight security. Cognitive processing capacity belongs to the physical ability of the brain, is also the mental ability in the usual sense; and in this section we try to incorporate the cognitive processing capacity into areas of

physical fitness tests, preliminarily explore and construct the pilots' physical fitness evaluation system including the central ability.

4 To reflect the contribution degree of the different indicators on the merits of cadet's physical fitness, and based on the expert survey and statistical calculation results, by combining with relevant document literature and theory analysis, we conduct weighting processing on different indexes, and carry through a more scientific and reasonable evaluation on flying cadet's comprehensive physical condition.

5 Although the study object is the flying cadet, established standards is also based on the test data of flying cadets; but considering the physical exercise behavior and habits, pilots with the same age are not better than flying cadets; their overall fitness level should have much difference with the flying cadets, and in the standards each grade value has a certain width, so this standard also applies to the physical evaluation of airline pilots under the age of 24. In addition, according to the body measurements group condition of each age group in various industries across the country organized by State Sports General Administration, 20 to 24 years are the same group; there is one evaluation criteria, the basis of the age group is to define based on a large number of previous studies, and has rigorous scientific basis. The basic age group of flying cadets are 19 to 22 years old, the age group of young pilot (flight age limit is 1-3 years) are 21 to 24 years old, these two groups are in the range of group 20 to 24, the body measurements can use the same standard.

CONCLUSIONS

1 The body measurement indicators of flying cadets include: height, weight, vital capacity, cardiac function index, 1000 meters, grip strength, push-ups, standing long jump, sit and reach, standing on one foot with eyes closed, choice reaction time, focus on attention, pay attention to span, spatial position memory and speed perception. The index system covers the body shape, cardio-pulmonary function, strength quality, flexibility and sensitivity, balancing ability and cognitive processing capacity.

2 It develops the individual physical evaluation criteria and comprehensive physical evaluation standard of civil aviation flying cadets (applicable to young pilots of 24 years old), and lays the scientific foundation for the physical health management of flying cadets and young pilots.

3 By back-substitution test, it proves that the evaluation system can simply, accuratly and effectively reflect the physical condition of flying cadets, demonstrats its scientificity and practicability, and can be applied in practice.

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