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Structural validity of the physical fitness test battery

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Abstract

Purpose: of the study was to examine the validity of the Army Combat Fitness Test tests on a sample of air defense personnel in the Ukrainian Ground Forces.
Material and methods. The respondents to this study were 271 air defense servicemen of the ground forces aged 18 to 40 years (73 cadets of the Ivan Kozhedub Kharkiv National Air Force University and 198 military personnel). The structural validity was evaluated using a confirmatory factor analysis.
Results. Compliance was achieved with the two-factor model obtained in the course of exploratory factor analysis, as evidenced by the following indixes: $\chi 2$ (8, Critical N = 465.29) = 10.43; $\chi 2$ / df = 1.303; Non-Normed Fit Index = 0.98; Normed Fit Index = 0.97; Root Mean Square Error of Approximation = 0.035 (90 Percent Confidence Interval for Root Mean Square Error of Approximation = (0.0; 0.088), Comparative Fit Index = 0.99. In addition, all factor loadings were statistically significant at the $p < 0.01$ level, that indicates that these two factors were well designed at every stage. Correlation between factors was weak, which confirms the discriminant validity of the test. The significant correlation found between the items and the overall test score confirmed the validity of the test.
Conclusions. It was found that Army Combat Fitness Test is a suitable tool for evaluating the physical fitness condition of air defense personnel into the Ground Forces. The dilemmas about the possible use of Army Combat Fitness Test for all age groups of military personnel regardless of gender require further study.
Key words: validity, physical fitness, confirmatory factor analysis, military personnel

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Анотація

Палевич С., Кирпенко В., Піддубний А., Божко С., Цимбалюк Ж., Майкл Ентоні Мартінес Велес, Федеріко Анібал Мартінес Велес, Хорхе Армандо Морета Вінуеса, Федеріко Антоніо Мартінес Леон. Структурна валідність батареї тестів для перевірки фізичної підготовленості

Мета: перевірити обґрунтованість тестів на бойову працездатність армії на вибірці особового складу протиповітряної оборони Сухопутних військ України.

Матеріал і методи. Респондентом у цьому дослідженні був 271 військовослужбовець протиповітряної оборони сухопутних військ віком від 18 до 40 років (73 курсанти Харківського національного університету повітряних сил імені Івана Кожедуба та 198 військовослужбовців). Структурну валідність оцінювали за допомогою підтверджувального факторного аналізу.

Результати. Відповідність досягнуто двофакторної моделі, отриманої в ході дослідницького факторного аналізу, про що свідчать такі індекси: χ2 (8, Критичний N = 465,29) = 10,43; χ2 / df = 1,303; Ненормований індекс придатності = 0,98; Нормований індекс підгонки = 0,97; Середньоквадратична похибка апроксимації = 0,035 (90-відсотковий довірчий інтервал для середньої квадратичної похибки апроксимації = (0,0; 0,088), індекс порівняльної відповідності = 0,99. Крім того, усі факторні навантаження були статистично значущими на рівні p < 0,01). вказує, що ці два фактори були добре розроблені на кожному етапі. Кореляція між факторами була слабкою, що підтверджує дискримінантну валідність тесту. Значна кореляція, виявлена між пунктами та загальним результатом тесту, підтвердила валідність тесту.

Висновки. Виявлено, що тест на бойову працездатність армії є підходящим інструментом для оцінки фізичної підготовленості особового складу протиповітряної оборони Сухопутних військ. Дилеми щодо можливого використання армійського тесту на бойову придатність для всіх вікових груп військовослужбовців незалежно від статі потребують подальшого вивчення.

Ключові слова: валідність, фізична підготовленість, підтверджувальний факторний аналіз, військовослужбовці

Аннатоция

Палевич С., Кирпенко В., Поддубный А., Божко С., Цымбалюк Ж., Майкл Антони Мартинес Велес, Федерико Анибал Мартинес Велес, Хорхе Армандо Морета Винуэза, Федерико Антонио Мартинес Леон. Структурная валидность батареи тестов для проверки физической подготовленности

Цель: проверка достоверности тестов армейской боевой пригодности на выборке личного состава противовоздушной обороны в Сухопутных войсках Украины.

Материал и методы. В исследовании приняли участие 271 военнослужащий ПВО сухопутных войск в возрасте от 18 до 40 лет (73 курсанта Харьковского национального университета ВВС имени Ивана Кожедуба и 198 военнослужащих). Структурная валидность оценивалась с помощью подтверждающего факторного анализа.

Результаты. Соответствие достигнуто с помощью двухфакторной модели, полученной в ходе исследовательского факторного анализа, о чем свидетельствуют следующие индексы: χ2 (8, Critical N = 465,29) = 10,43; χ2 / df = 1,303; Ненормированный индекс соответствия = 0,98; Нормированный индекс соответствия = 0,97; Среднеквадратичная ошибка аппроксимации = 0,035 (90-процентный доверительный интервал для среднеквадратичной ошибки аппроксимации = (0,0; 0,088), сравнительный индекс соответствия = 0,99. Кроме того, все факторные нагрузки были статистически значимыми на уровне p <0,01, что указывает на то, что эти два фактора были хорошо разработаны на каждом этапе. Корреляция между факторами была слабой, что подтверждает дискриминантную валидность теста. Существенная корреляция, обнаруженная между элементами и общей оценкой теста, подтвердила валидность теста.

Выводы. Было обнаружено, что армейский тест боевой пригодности является подходящим инструментом для оценки физического состояния личного состава ПВО в Сухопутных войсках. Дилеммы о возможности использования армейского теста боевой пригодности для всех возрастных групп военнослужащих, независимо от пола, требуют дальнейшего изучения.

Ключевые слова: валидность, физическая подготовленность, подтверждающий факторный анализ, военнослужащие.

Introduction

The lack of a process for evaluating the achievement of the necessary level of physical readines of the Armed Forces of Ukraine personnel may lead to a discrepancy between the level of physical readiness of the military personnel and the requirements for physical condition, training and coherence of units its necessary for the implementation of combat capabilities [1, 2].

Thereby, monitoring and evaluating motor skills development is an important goal for unit commanders. Controlling the process ensures the timely receipt of objective information about the state of physical fitness of military personnel. This task is solved by the system of verification and evaluation of physical fitness [3]. The model focuses on assessment technology, tests and regulatory requirements that determine the level (quality) of qualification [4, 5].

Nowadays, the armies of the leading nations of the world are considering a wide and varied range of research areas for the concept of «readiness». The existing tests have been criticized for lack of evidence to support their link to military fitness for every soldier. The fitness tests, Established in 1980, fitness tests proposed in 2002 and 2010 were not implemented because they were not validated [6, 7, 8] and have been revalued [8, 9, 10]. Since October 2020, the U.S. Army Physical Fitness School and the U.S. Army Center for Initial Military Training have been validating the Army Combat Fitness Test tests [11, 12].

The Army Combat Fitness Test test evaluates five components of physical fitness such as muscle and aerobic endurance, muscle strength, speed / agility and explosive strength [2, 13] The strongest argument for the new test is that it has a high correlation between Army Combat Fitness Test exercises and ground combat requirements [10]. It does not imply gender and age differences [11, 12, 14].

An objective evaluation of the readiness of military personnel, determines the need to validate the Army Combat Fitness Test tests for the Armed Forces of Ukraine. Ensuring the implementation of the acquired combat capabilities to perform into combat missions, achieving compatibility with the armed forces of NATO member states.

Matherials and methods

Participants

The participants in this study were 271 air defense military personnel of the ground forces between 18 to 40 years (73 cadets of the Ivan Kozhedub Kharkiv National Air Force University and 198 military personnel). The data, showing the sample subdivided into age groups, are presented in Table 1. All of the military personnel had been individually evaluated for the physical fitness verification procedure in accordance with the requirements of the Army Combat Fitness Test [11]. The evaluation was conducted during the period of the year 2020.

Table 1

Demographic characteristics of participants (n = 243)

Sex	Up to 25 years old	Up to 30 years old	Up to 35 years old	Up to 40 years old	Total
Male (number)	148	79	22	5	254
Female (number)	-	17	-	-	17
Total (number)	148	96	22	5	271

For various reasons, 28 soldiers did not pass the test. Only those subjects who completed all tests were included in the analysis of validity (n = 243).

Data collection measuring instrument

The participants completed the Army Combat Fitness Test training and testing program during the 4th and 5th courses at the Ivan Kozhedub Kharkiv National Air Force University and during the baseline period in the army. The participants performed the exercises in the following order:

1. 3 Repetition maximum deadlift;
2. Standing power throw;
3. Hand release push-up – arm extension;
4. Sprint-drag-carry;
5. Leg tuck;
6. Two-mile run.

Detailed instructions about the Army Combat Fitness Test test is available at Army

Combat Fitness Test 3.0: Exploring a more inclusive scoring assessment, planks stay [11]. Each participant voluntarily provided a written informed consent prior to participation.

Statistical analysis

Statistical analysis of the results was carried out using STATISTICA 10.0. The normal distribution was evaluated using the Shapiro-Wilk criterion (W). For the entire sample, the parameters of the descriptive statistics were calculated. Parametric indicators are presented as $\bar{x} \pm S$, where $\bar{x}$ (Mean) is the average, S is the standard deviation.

To compare the mean values of the results of the test items by representatives of different age groups and gender, the procedure of one-way analysis of variance (Anova) in SPSS Statistics 17.0 was carried out according to Fisher's exact test. The compared variances of distributions of values statistically do not differ significantly if the p-level of Levene's test is > 0.05. If $F_{obs.} \leq F_{cr}$ all measurement results belong to one general population. The F_{stat} will be close to 1 at a significance level of p> 0.05. If $F_{obs.} > F_{cr}$ an alternative hypothesis is accepted. F_{stat} will be much more than 1. Scheffe's method was performed when a significant difference was found by analysis of variance.

Correlation analysis was used to establish a quantitative measure of strength and direction of the probabilistic relationship between test items and the overall standard score [15]. When evaluating the strength of the relationship between correlation and coefficients, a scale was used that differentiates both positive and negative correlations into three levels. From 0.01 to 0.29 − weak positive correlation, from 0.30 to 0.69 − moderate positive correlation, from 0.70 to 1.00 − strong positive correlation. From -0.01 to -0.29 − weak negative correlation, from -0.30 to -0.69 − moderate negative correlation, from -0.70 to -1.00 trong negative correlation [16].

To evaluate the validity of the test, the primary data matrix containing the cadets' scores was subjected to exploratory principal component analysis followed by varimax rotation of the selected factors and Kaiser-Meyer-Olkin's test standards in SPSS Statistics 17.0 to evaluate the constructive validity of the test. To evaluate the quality of the model, the following indexes were used: the Kaiser-Meyer-Olkin's sample adequacy method and Bartlett's sphericity method. The Kaiser-Meyer-Olkin's sample adequacy method is a value that characterizes the degree of applicability of factor analysis to a given sample (≥ 0.9 − unconditional adequacy; (0.8; 0.9) − high; (0.7; 0.8) − acceptable; (0.6; 0.7) − satisfactory; (0.5; 0.6) − low; < 0.5 − factor analysis is not applicable to the sample). Bartlett's sphericity method is a multidimensional normality test for the distribution of variables. Significance level p < 0.05 indicates that the data are quite acceptable for factor analysis [2, 15].

Confirmatory factor analysis was performed in LISREL 8.8 to test the internal structure of the two-factor model [17]. The following indexes were used to evaluate the degree of conformity of the model: $\chi 2$ (chi-square), quotient $\chi 2$ and *df* does not exceed 2 ($\chi 2 / df < 2$), not normalized fit index (Non-Normed Fit Index ≥ 0.90), normalized fit index (Non Fit Index ≥ 0, 90) and root mean square error of approximation (Root Mean Square Error of Approximation ≤ 0.05). Since the value of $\chi 2$ depends on the sample size and, with large sample sizes, can be reliable even for insufficiently suitable models, an additional reliability indicator called the comparative fit index (0 < Comparative Fit Index <1) was calculated. The model is considered to be consistent with the data obtained if the Comparative Fit Index exceeds 0.95 (for the many authors, values of at least 0.85 are also acceptable).

Statistical significance was evaluated with 95% confi-dence intervals. Analyses were performed using SPSS version 17, and statistical significance was set at an alpha level of 0,05.

All parameters of validity were calculated using standard scores.

Results

The analysis of the hypothesis about the normality of the distribution of the results of the Army Combat Fitness Test test tasks is presented in Table 2. The statistics of the W test are insignificant. The hypothesis about the normal distribution of the values of the variable is accepted.

Baseline scores for individual Army Combat Fitness Test assignments are shown in Table 3. The results were directly compared between each age group to test for the perceived lack of gender and age differences for the test takers.

Once we analyzed the results. It should be noted that the lowest results for female military personnel are shown in the 3 Repetition maximum deadlift exercise. with 76 % not meeting the threshold level. 41 % performed below the threshold level in Standing power throw and Two-mile run exercises. The best result at the level of 81-82 points is shown in the Sprint-drag-carry. Hand release push-up – arm extension and Leg tuck tasks. Overall. more than one female soldier did not fully complete the Army Combat Fitness Test test as required.

Table 2

Normality analysis of the distribution of the results of the Army Combat Fitness Test tasks

Army Combat Fitness Test tasks	Mean	Median	Skewness	Std.Err. Skewness	Kurtosis	Std.Err. Kurtosis	Shapiro-Wslk W	p
3Repetition maximum deadlift (conventional units)	76.28	76	10.385	0.148	0.148	-0.395	0.990	0.070
Standing power throw (conventional units)	77.26	77	7.838	0.109	0.148	0.536	0.989	0.055
Hand release push-up – arm extension (conventional units)	67.60	67	11.637	0.427	0.148	-0.211	0.991	0.120
Sprint-drag-carry (conventional units)	74.66	74	9.700	0.212	0.148	-0.109	0.990	0.070
Leg tuck (conventional units)	82.59	83	10.320	-0.353	0.148	-0.213	0.992	0.120
Two-mile run (conventional units)	70.88	71	10.333	0.112	0.148	0.385	0.995	0.159

Table 3

Evaluation of the results of the Army Combat Fitness Test tasks

Army Combat Fitness Test Task	$\bar{x}$ (S)				
	Male				Female
	Up to 25 years old (n = 148)	Up to 30 years old (n = 79)	Up to 35 years old (n = 22)	Up to 40 years old (n = 5)	Up to 30 years old (n =17)
3 Repetition maximum deadlift (conventional units)	67.81 (10.99)	70 (12.83)	66.14 (11.14)	69 (7.71)	56.11 (4.58)
Standing power throw (conventional units)	77.44 (10.30)	76.81 (9.77)	76.27 (9.63)	76.8 (8.35)	63.59 (7.6)
Hand release push-up–arm extension (conventional units)	83.22 (9.79)	83.82 (9.58)	83.55 (10.68)	88 (8.03)	68.64 (8.68)
Sprint-drag-carry (conventional units)	77.89 (7.61)	77.84 (7.80)	78.18 (7.28)	73.6 (3.71)	68.94 (7.18)

Leg tuck (conventional units)	75.04 (8.99)	75.73 (10.88)	73.68(7.66)	78.4 (13.30)	66.41 (7.75)
Two-mile run (conventional units)	70.99 (10.21)	71.13 (11.03)	74.18(7.45)	78 (6.36)	62.47 (7.89)
Total Army Combat Fitness Test	452.12 (31.42)	455 (33.61)	452 (28.6)	463.8 (31.22)	386.18 (15.40)

In men under 40. none of the participants reached the maximum result of (100 points) in any task. Most of the maximum results were shown by men under 30 years old in Hand release push-up – arm extension (6.3 %), Leg tuck (2.5 %), Two-mile run (2.5 %), 3 Repetition maximum deadlift (1.2 %) tasks. The Hand release push-up – arm extension task was completed most successfully in all groups (4.7 %; $\bar{x}$ = 83.53. S = 9.74). 22.51 % of the personnel did not fulfill the threshold level in one or more assignments.

The results of the Anova analysis (Table 4) confirm significant statistically differences in the average group results of the Army Combat Fitness Test test tasks performed by women and representatives of different age groups of men ((Sig. = 0.000) − the variances for the groups of men and women do not statistically significantly differ (< 0.05). Analysis of variance is correct)).

Table 4

ANOVA Analysis Results Analysis of variance of the results of the Army Combat Fitness Test test tasks performed by female and representatives of different age groups of male

Army Combat Fitness Test tasks	ANOVA	
	F	Significance (Sig.)
3 Repetition maximum deadlift	5.429	0.000
Standing power throw	7.527	0.000
Hand release push-up – arm extension	9.667	0.000
Sprint-drag-carry	5.879	0.000
Leg tuck	3.767	0.005
Two-mile run	4.172	0.003
Total Army Combat Fitness Test	18.721	0.000

Multiple comparisons of the average performance of female and male military personnel during the test and Total Army Combat Fitness Test are presented in Table 5.

Table 5

Multiple comparisons of the average results of the test items and Total Army Combat Fitness Test of female and male of different age groups (according to Scheffe's method)

Army Combat Fitness Test tasks	Age	Average difference	Standard error	Significance (Sig.)	95% confidence interval	
					Bottom line	Upper bound
Standing power throw	Up to 25 years old	-13.85*	2.54	0.000	-21.73	-5.97
	Up to 30 years old	-13.22*	2.65	0.000	-21.45	-4.99
	Up to 35 years old	-12.68*	3.20	0.004	-22.62	-2.75
	Up to 40 years old	-13.21	5.05	0.147	-28.86	2.44
Sprint-drag-carry	Up to 25 years old	-8.95*	1.94	0.000	-14.96	-2.94
	Up to 30 years old	-8.89*	2.02	0.001	-15.17	-2.62
	Up to 35 years old	-9.24*	2.44	0.007	-16.82	-1.66
	Up to 40 years old	-4.66	3.85	0.833	-16.60	7.29
3 Repetition maximum deadlift	Up to 25 years old	-11.69*	2.89	0.003	-20.65	-2.74
	Up to 30 years old	-13.88*	3.01	0.000	-23.23	-4.53
	Up to 35 years old	-10.02	3.64	0.112	-21.31	1.27
	Up to 40 years old	-12.88	5.74	0.286	-30.67	4.91
Leg tuck	Up to 25 years old	-8.64*	2.43	0.015	-16.19	-1.09
	Up to 30 years old	-9.32*	2.54	0.010	-17.20	-1.44
	Up to 35 years old	-7.27	3.07	0.234	-16.79	2.25
	Up to 40 years old	-11.99	4.84	0.192	-26.99	3.01
Hand release push-up – arm extension	Up to 25 years old	-14.57*	2.49	0.000	-22.29	-6.85
	Up to 30 years old	-15.18*	2.60	0.000	-23.23	-7.12
	Up to 35 years old	-14.90*	3.14	0.000	-24.63	-5.17
	Up to 40 years old	-19.35*	4.94	0.005	-34.68	-4.02
Two-mile run	Up to 25 years old	-8.52*	2.59	0.031	-16.54	-0.49

	Up to 30 years old	-8.66*	2.70	0.038	-17.03	-0.28
	Up to 35 years old	-11.71*	3.26	0.013	-21.83	-1.59
	Up to 40 years old	-15.53	5.14	0.061	-31.47	0.41
Total Army Combat Fitness Test	Up to 25 years old	-65.95*	7.97	0.000	-90.69	-41.19
	Up to 30 years old	-68.81*	8.33	0.000	-94.65	-42.98
	Up to 35 years old	-65.82*	10.06	0.000	-97.03	-34.62
	Up to 40 years old	-77.62*	15.85	0.000	-126.78	-28.46

Note: * The average difference is significant at the level 0.05

The data in Table 4 do not reveal significant differences between the average difference in the results shown by male and female military personnel under 40 years old in performing Standing power throw, Sprint-drag-carry, 3 Repetition maximum deadlift. Leg tuck and Two-mile run test items. since the significance for all pairs of groups is greater than 0.05. There was no statistically significant difference with men under 35 years old in the 3 Repetition maximum deadlift and Leg tuck tasks. All other results in women differ significantly from those for men.

Anova's analysis. which is presented in Table 6. does not confirm statistically significant differences in the results of performing test items by representatives of different age groups in men. Levene's method for testing the hypothesis of equality of variances shows that the sample means are obtained from populations with the same general means. The calculated value of F does not exceed the critical value of F with a significance value of $p > 0.05$.

Table 6

ANOVA Analysis Results for men Analysis of variance of results of perfoming test items by representatives of different age groups of male

Army Combat Fitness Test tasks	Dispersion uniformity criterion		ANOVA	
	Levene's Statistics	Significance (Sig.)	F	Significance (Sig.)
3 Repetition maximum deadlift	1.184	0.317	0.916	0.434
Standing power throw	0.316	0.814	0.129	0.943
Hand release push-up – arm extension	0.174	0.914	0.423	0.737
Sprint-drag-carry	0.680	0.565	0.536	0.658
Leg tuck	1.894	0.131	0.461	0.710
Two-mile run	1.857	0.137	1.335	0.263
Total Army Combat Fitness Test	0.191	0.902	0.333	0.801

The exploratory factor analysis procedure showed:

1) as a result of using the Kaiser-Meyer-Olkin's sample adequacy method. an acceptable adequacy of the factor analysis applicability to the values of this sample was established (criterion value = 0.763);

2) as a result of using the Bartlett's sphericity method. it was found that the data are acceptable for carrying out the factor analysis procedure with them ($\chi 2$-square = 179.91. p value $\leq$ 0.001);

3) after using the Kaiser's method. we found that the first two factors are greater than one (1 - 3.099; 2 - 1.338). This means that it is optimal to single out two factors;

4) using R. Cattell's method for screening. we found that on the graph of normalized simple stress. the inflection point is at the value 3. This confirms the conclusion formulated as a result of using the Kaiser's method that two factors were distinguished in the structure;

5) the correlation matrix of 6 variables was subjected to a principal component analysis procedure. 2 factors were extracted with own value greater than one. These factors were rotated according to the varimax method.

The first factor can be interpreted as «Endurance (cardio-respiratory endurance. muscular endurance (upper body. lower body. whole body / trunk)», since the variables associated with this phenomenon have the highest loads on it: «Two- mile run = 0.892, Leg tuck = 0.889, Hand release push-up - arm extension = 0.873).

The second factor can be interpreted as «Strength (upper body, lower body, whole body / trunk) and mobility», since the variables associated with this phenomenon have the highest loads on it: «Sprint-drag-carry» = 0.841; «Standing power throw» = 0.768; «3 Repetition maximum deadlift» = 0.764.

The factors obtained as a result of the varimax rotation explain 73.95 % of the total variance:

a) the factor «Enduranc» explains 41.077 % of the total variance;

b) the «Strength and Mobility» factor explains 32.873 % of the total variance.

As a result. two unimodal factors were obtained. These factors describe 73.95 % of the total total variance.

To check the internal structure of the two-factor model. we used the procedure of the confidential (confirmatory) factor analysis. implemented in the LISREL 8.8 program. The set of relationships in the model is shown in the path diagram (Figure 1). To assess the agreement of the two-factor model. the maximum likelihood method was used. The evaluation of the original model showed that the model was consistent with the data, as evidenced by the following indixes: $\chi2$ (8. Critical N = 465.29) = 10.43; $\chi2$ / df = 1.303; Non-Normed Fit Index = 0.98; Normed Fit Index = 0.97; Root Mean Square Error of Approximation = 0.035 (90 Percent Confidence Interval for Root Mean Square Error of Approximation = (0.0; 0.088)). Comparative Fit Index = 0.99. In addition. all factor loadings were statistically significant at the $p < 0.01$ level. This suggests that these two factors were well designed.

As a result of the correlation analysis (Table 7). a strong positive relationship was established between the factors Sprint-drag-carry and Standing power throw (r = 0.842) and a weak positive relationship between Standing power throw and 3 Repetition maximum deadlift (r = 0.257), Standing power throw and Two-mile run (r = 0.267), Sprint-drag-carry and 3 Repetition maximum deadlift (r = 0.267), Sprint-drag-carry and Two-mile run (r = 0.245, 3 Repetition maximum deadlift and Two-mile run (r = 0.153, Hand release push-up – arm extension and Two-mile run (r = 0.296). While Standing power throw, Sprint-drag-carry, 3 Repetition maximum deadlift factors did not correlate with Leg tuck, Hand release push-up – arm extension. All test items were significantly correlated with the total standard score in the range from r = 0.425 to r = 0.674 at $p < 0.01$.

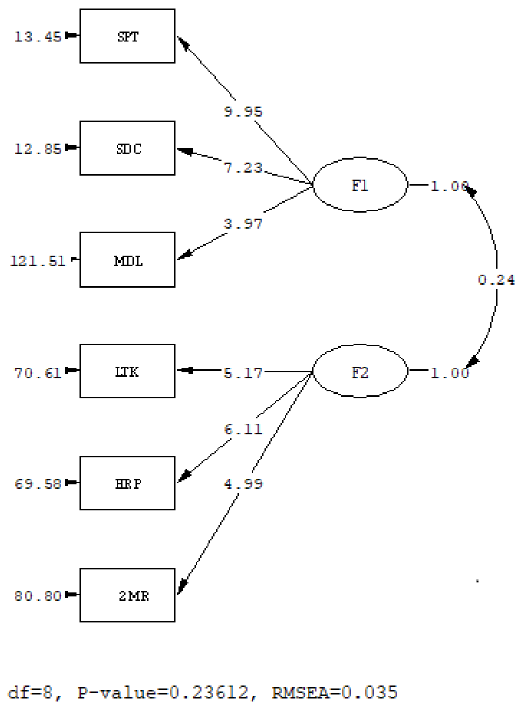

Fig. 1. Path diagram of Army Combat Fitness Test. Two-factor confirmatory factor analysis model. Satisfactory match statistics supporting a two-factor model

Table 7

Correlation between tasks and total test score

Army Combat Fitness Test tasks	Standing power throw	Sprint-drag-carry	3 Repetition maximum deadlift	Leg tuck	Hand release push-up – arm extension	Two-mile run
Sprint-drag-carry	0.842**					
3 Repetition maximum deadlift	0.257**	0.267**				
Leg tuck	0.031	-0.006	-0.027			
Hand release push-up – arm extension	0.09	0.072	-0.027	0.211**		
Two-mile run	0.267**	0.245**	0.153*	0.278**	0.296**	
Total Army Combat Fitness Test	0.674**	0.643**	0.536**	0.425**	0.460**	0.568**

Notes: ** Correlation is significant at the 0.01 level (two-sided); * Correlation is significant at the 0.05 level (two-sided)

Discussion

The purpose of this study was to determine the structural validity of the Army Combat Fitness Test test battery for evaluating the physical condition on a sample of air defense personnel of the Air Force grounded forces of the Army of Ukraine. To date. a wealth of scientific experience has been accumulated in the development of tests for evaluating the individual level of physical fitness condition of military personnel of various categories [18, 19, 20] and age [21, 22]. However the problem is that the nature and conditions of combat activities of personnel change with the development of military affairs [1, 23].

At the same time, the workloads experienced by military personnel in modern combat are changing. The present study showed a significant difference in the average group performance of the Army Combat Fitness Test test items by women and representatives of different age groups in men. Excluding the results of male military personnel from 35 to 40 years old on Standing power throw , Sprint-drag-carry , 3 Repetition maximum deadlift, Leg tuck and Two-mile run . There was no statistically significant difference in the results of men under 35 and in the 3 Repetition maximum deadlift and Leg tuck tasks. 76 % of them did not meet the threshold level in the 3 Repetition maximum deadlift exercise. In Standing power throw and Two-mile run exercises. 41 % of them showed results below the threshold level. Overall. no female military personnel completed the Army Combat Fitness Test test as required. These results are in contrast to the U.S. Army's data. which shows that 54 percent of female soldiers failed the new Army's combat fitness test. up from 7 percent of men in the second quarter of 2020 [24].

The data raises concerns that the crossfit test is difficult for women. The performance imbalance is rooted primarily in one of the test's six events. the leg tuck. which requires troops to hang from a pullup bar with their arms extended before lifting themselves up using abdominal and arm muscles. Therefore, it must have an alternative to Leg tuck new task plank [14]. The plank is an alternate assessment that may be used. The plank helps build core strength that promotes back health and helps reduce injuries.

Failed to fulfill the threshold level in one or more tasks 22.51 % of the military personnel out of all tested. This situation can be explained by poor physical activity in their free time. Among the reasons that prevent military personnel from exercising in their free time are: family responsibilities. working hours, lack of equipment, unsafe environment, lack of company, housework and lack of financial resources. It is assumed that Army Combat Fitness Test is a way to standardize the military's physical conditioning. in which the technical aspects of physical conditioning that people have undergone can be noted [25, 26].

Anova's analysis does not confirm statistically significant differences in the results of the test items performed by representatives of different age groups of men. This confirms that the Army Combat Fitness Test was designed to more accurately predict the combat readiness of male military personnel regardless of the age. The performance requirements for each test item can be adjusted for military specialties and other factors. Some of these factors may or may not be used as variables for the final version of the new Army Fitness Standard, which will be known as the Army Combat Fitness Test for Army of Ukraine.

Matos et al [27] point out that fitness is essential to the readiness of the military provides the best conditions for their daily life. Improving physical fitness contributes to a significant increase in the combat readiness of military personnel. Physically healthy people are more resistant to disease and recover from injury faster than people who are not physically fit [1, 5, 28]. It is important to note that physically healthy people have high levels of self-confidence and motivation. In other words. well-trained military personnel are better able to withstand extreme combat situations [27, 28]. The results of this study show the problems in the organization of physical training classes with military personnel. The most difficult tasks for the military were the 3 Repetition maximum deadlift and Two-mile run tasks. So 18.45 % did not meet the threshold level in the 3 Repetition maximum deadlift task and 9.23 % in the Two-mile run.

Training of the Ukrainian Armed Forces in peacetime is organized according to training standards and is evaluated through pedagogical tests. Pedagogical tests are tests of achievement. They are designed to determine the extent to which military personnel have completed training objectives. The test should measure what has been taught and learned, nothing more. nothing less. According to military scientists for the test to be valid. the teacher must clearly understand the learning objectives. Our research has confirmed the opinion of military scientists [12, 24] that when testing activities of a certain level, the test tasks must correspond to just such a level of complexity so that they cannot be performed by means of activities of a lower level [29, 30].

The results are consistent with the findings of other researchers that the military is required not only for general enduranc, strength and speed. They require cardio-respiratory endurance, muscular endurance (upper body, lower body, whole body / trunk), muscular strength (upper body, lower body, whole body / trunk) and mobility [16, 31].

A factor-analytical study is carried out to classify fitness tests according to the ability to measure physical qualities. Factor analysis identified 3 [32] to 14 [33] physical ability or physical skill factors that can be measured using fitness tests. In our case, it is necessary to find out the structural components of the physical fitness of the air defense personnel of the Air force grounded forces of the Army of Ukraine.

To develop a theoretical model of physical fitness, a pilot study was carried out. The sample of which consisted of 73 cadets of the Ivan Kozhedub Kharkiv National Air Force University. The results of the study were subjected to quantitative and qualitative analysis. Model building began with determining the ability of individual test items to evaluate physical qualities. Each task was assigned to a specific category based on its usual interpretation in the literature (FM-21-20). In this case, the Two-mile run test was classified as an indicator of «aerobic capacity» or endurance. Leg tuck and Hand release push-up - arm extension were classified as indicators of muscular endurance (upper body, lower bod, whole body / trunk). 3 Repetition maximum deadlift and Standing power throw are muscular strength (upper body, lower body, whole body / trunk). Sprint-drag-carry is an indicator of muscular endurance and strength as well as mobility.

Factor analysis revealed two factors. One of these is determined mainly by variables related to cardio-respiratory and muscular endurance. Variables have the highest loads on it («Two-mile run» = 0.892; «Leg tuck» = 0.889; «Hand release push-up – arm extension» = 0.873). Another factor is determined by variables related to strength and mobility («Sprint-drag-carry» = 0.841; «Standing power throw» = 0.768; «3 Repetition maximum deadlift » = 0.764).

The next step in the analysis is confirmatory factor analysis. This analysis is necessary to confirm the structure of factors. which was revealed at the first stage in the course of the explanatory factor analysis. Standard classifications were used as the basis for confirmatory factor analysis models. The test items were acceptable indicators of cardio-respiratory and muscular endurance. strength and mobility. The estimation of the corresponding factor structure was carried out by the maximum likelihood method using the LISREL 8.8 program. A model with two factors that are weakly correlated with each other was obtained as a result of the analysis. In our case (see Fig. 1) the indicator $\chi^2 = 10.43$ ($p = 0.236$) is not statistically significant. This indicates good consistency of the model with the data. Indicators Goodness-of-fit statistic = 0.99 (> 0.95) and Root Mean Square Error of Approximation = 0.035 (< 0.07), Non Fit Index = 0.97 (> 0.95). Thereb, the proposed factor model provides good consistency with experimental data. All 6 test tasks were acceptable indicators of the indicated structure of the physical fitness of military personnel of the Air force grounded forces of the Army of Ukraine.

Causal models relate to physical ability and performance of physical tasks. Earlier work has shown that there may be bias in these models [34, 35].

The accuracy of the test battery can be improved by enabling multiple indicators for cardio-respiratory and muscular endurance. Strength, and mobility if possible. This model confirms these findings from Report No. 11-52 by the Office of Naval Research. Arlington.

Test items use the same factor because they are correlated. The sum of the standardized scores on two or more tests will allow a more accurate evaluation of true ability [27].

The correlation between the factors in the present study was weak. which confirmed the discriminant validity of the test. On the other hand. a significant correlation was found between the items and the overall test score. This correlation further confirmed the validity of the test.

The relationship between test items can be used to develop training programs. It can be used to prepare soldiers for tasks that require physical fitness endurance.

The limitation of the present study was not to use data from all military personnel. This is because 22.51 % of the military did not meet the threshold level on one or more missions or due to health restrictions.

Conclusion

We have found that Army Combat Fitness Test is a suitable tool for evaluating the physical fitness condition of the Air Force personnel in the ground forces. Army Combat Fitness Test missions are intuitive and easy to complete by all male military personnel. The dilemmas about the possible use of Army Combat Fitness Test for all age groups of military personnel regardless of gender. raised here. as well as in other studies. require further study.

Conflict of Interest

The authors declare that there is no conflict of interest.

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