# Delineation And Classification Of Physical Conditioning In Greek Army Officer Cadets

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## Abstract

**Background:** Even though considerable research has been conducted on the military fitness of reserves (soldiers, low-rank officers), few studies exist where career officers form the sample group.

**Purpose:** We assessed the physical fitness profiles of Greek Army Officer Cadets (GAOCs) and these data were compared with norms from age and sex-matched peers.

**Material and Methods:** 68 GAOCs from the Hellenic Army Academy participated in a series of laboratory tests (multistage shuttle run, handgrip dynamometry, counter movement jump, repeated bench press, sit and reach and body fat determination) and field tests (mile run, push ups, sit ups, pull ups and body mass index).

**Results:** Scores across all tests (mean ± SD) were on the 60th±20, 43th±13, 62th±27, 50th ±22, and 53th±18 percentile (males) versus the 60th±16, 63th±18, 63th±17, 65th±18, and 33th±14 percentile (females) for cardiorespiratory endurance, muscular strength, muscular endurance, flexibility and body composition respectively. Additionally, a mean 9% percentile increase across all GAOCs was found in field tests compared to laboratory tests (75th±13 versus 45th±22, 64th±16 versus 60th±24 and 33th±18 versus 53th±9 for the respective fitness abilities of cardiorespiratory endurance, muscular endurance and body composition.

**Conclusion:** Percentile scores for all fitness components place GAOCs above the average level (with the exception of body composition values for females) when compared with health norms for similar sample groups. However, a better standardised and/or more occupationally relevant fitness tests are needed in order to improve the accuracy of the physicalfitnessassessment.

**Key words:** Army personnel, Physical fitness, Work Capacity Evaluation, Diagnostic Techniques and Procedures, norms.

**Conflict of Interest:** There were no financial or personal conflicts of interest for this study. The results of the present study do not constitute endorsement of any product by the author or the Journal.

## Introduction

The Hellenic Army Academy (HAA) is one of the oldest tertiary institutions in Greece. For all those who want to pursue a military career in Greece, the HAA is the only institution which qualifies them to be high ranking combat and non combat officers. Admission to military education depends on individual students' performance in national examinations at the end of their secondary education, in addition to their performance in the following physical fitness tests where they get a "pass" or a "fail" mark: a) 100m run b) long jump c) shot-put d) high jump and e) 1000m run. Candidates who fail to pass the physical conditioning tests are not admitted into the HAA but (not allowed to be admitted into the HAA) are replaced by others from a substitute list. Candidates who successfully complete these physical fitness tests,are considered to meet the HAA standards for entry into the Basic Combat Training.

Basic Combat Training is a mandatory standardised physical conditioning period that all potential Greek Army Officer Cadets (GAOCs) must attend according to the structure and missions of the HAA in Greece as described previously[1]. Additionally, passing a battery of physical fitness tests immediately following Basic Combat Training is also essential, as improving scores in these test items will improve the GAOCs' physical conditioning level, a prerequisite for performing future military occupational tasks.[2,3,4] These tests are part of a semestrial physical fitness examination and include the maximum number of push ups in one minute, the maximum number of sit ups in one minute, the maximum number of pull ups and (an) a one mile run.

During the first academic year at the HAA, the physical fitness conditioning programmes do not comprise skill-based military tasks such as passing military obstacle courses; therefore, the tests initially used in semestrial physical fitness examinations aim to keep GAOCs at a high general physical conditioning level. Despite the periodical (twice a year) character of the semestrial physical fitness examination, no comprehensive reports of GAOCs' fitness profile in relation to other populations (matched for age and sex) currently exist. Furthermore, no additional tests have been used in order to increase the low validity of field testing[5] and give more insight on GAOCs' specific exercise abilities. The semestrial physical fitness examination is considered a reliable model, where all GAOCs perform various tests under exactly the same conditions. It therefore provides an ideal opportunity to gather physical conditioning information about future Army officers. This data may also serve to validate GAOCs' physical conditioning evaluation practices within the HAA and eventually provide direction to design more efficient exercise programmes. The purpose of the present study was to delineate the fitness profile of GAOCs and classify them according to the health data norms which are derived from matched sex and age sample groups.

## Material and Methods

A total number of 68 GAOCs (50 males and 18 females; plebes) were recruited from the HAA and who volunteered to participate in the present study, after being informed of the nature and risks of the experiments and after signing subject consent forms. Their mean ± SD values for age, body mass and body height were 19.8±1.0 years, 71±10.3 kg and 171±8 8.2 cm respectively. All procedures were approved by the Research Committee of the Greek Ministry of Defence. Ethical approval was obtained by the HAA Ethics Committee. This research has been conducted in compliance with all applicable international regulations governing the protection of human subjects in research.

The present study was conducted after the completion of the 7-week period of Basic Combat Training. That period consisted of an average of 15 hours running (intense and low paced), 2 hours sprinting (combat manoeuvres and live fire exercises), 35 hours marching (hiking with pack and equipment), 37 hours strength training (callisthenic and partner assisted exercises) and 43 hours military activities (prolonged standing in formation-bayonet training). Following a 48 hour rest from Basic Combat Training period, subjects participated in two series of tests (laboratory and field tests) interspersed by a 48 hour recovery.

The military abilities tested (endurance, strength and mobility) were selected according to the U.S. Army Physical Fitness School.[6,7,8]. Endurance refers to cardiorespiratory endurance, whereas the strength concept incorporates muscular strength/power and muscular endurance.

Mobility includes balance, flexibility, coordination, speed, and agility. In the present study, throughout the first and second series of testing, most of these components have been evaluated. (The only exception was mobility testing, which does not permit assessment in a single test because it comprises various skills, therefore, only flexibility was selected for evaluation). The only exception was mobility testing, which did not permit assessment in a single test because it measures various skills. Only flexibility was therefore selected for evaluation. Body composition was also assessed since there is evidence that it may be related to performance in various military tasks.[9]

Cardiorespiratory endurance was evaluated via a multistage shuttle run test (MSRT); strength via the handgrip dynamometer test (HDT) and power via the counter movement jump test (CMJT); muscular endurance via repeated paced efforts on a bench press (BPET); flexibility via the sit and reach test (SRT); and body composition via body fat determination (BF). Although many factors influence the testing sequence, in this study the more fatiguing tests were performed last. Consequently, tests were performed in the following order: BF, HDT, SRT, CMJT, BPET and MSRT. The battery of laboratory tests used to evaluate these qualities were selected due to their simplicity, swiftness, validity and reliability. Additionally, these tests are associated with the largest database of normative data. Since most of the military data worldwide are considered classified, not widely published and with limited access, percentile scores for GAOCs were determined according to various norms for healthy subjects in the respective age category.[5,10,11]

First series of testing - laboratory tests – MSRT, HDT (Average of both dominant and non-dominant hand), CMJT, BPET, SRT and BF.

### Multistage shuttle run test

The test was conducted on a flat, clearly marked 20m stretch on an indoor running track. Subjects were required to run over and back on the 20m stretch, touching the line at either end with one foot, as a signal sounded from a pre-recorded tape (Multi-Stage Fitness Test, National Coaching Foundation, Leeds, UK). The signal from the tape was incremental and corresponded to a specific speed. The initial running speed of 8.0km/h was increased to 9.0km/h after 1 minute and was subsequently increased by 0.5km/h each minute thereafter. The test was terminated when a subject voluntarily dropped out or did not make the line on two consecutive laps. Both lines were monitored closely by two spotters at either end. The final successfully completed lap was recorded as the finishing point. Subjects were instructed to complete as many laps as possible. The final successfully completed lap was expressed in metres per second, which was recorded and then converted to a $VO^2max$ value.[12] Both the tape and tape recorder were calibrated before each test. Body mass and height were measured to the nearest 0.1kg and 0.5 cm respectively, using a balance beam scale (Seca 710, Hamburg, Germany) equipped with a stadiometer. During each measurement subjects were standing barefoot wearing minimal clothing. BMI was also calculated as body mass in kilograms divided by height in metres squared.

### Handgrip dynamometry test

From the standing position and with the upper arm in vertical position, subjects placed their forearm at any angle between 90$^o$ and 180$^o$ (right angle to straight) of the upper arm. Their wrist and forearm was at midprone position. Then they exerted maximally and quickly the dynamometer (Takei 5001, Nigata, Japan) in each hand with at least 30s recovery between trials for the same hand. Three trials were allowed for each hand and the examiners recorded as the maximum score the sum of the best right and left grip strength measurement.

### Counter movement jump test

Subjects performed three maximal vertical jumps on a portable Bosco force plate with dimensions 170x73cm (Musclelab, Ergotest Innovation, Italy) from an upright standing position with a preliminary counter movement of legs and arms. The flight time values obtained from the force-time curves were used to calculate the height of rise of the centre of gravity for the best trial.

### Bench press endurance test

Subjects lay supine on a wide bench with the knees bent and the soles of the feet on the bench. The spotters handed the 36.3kg (males) or the 15.9kg (females) barbell into the subjects' hands (thumbs medial) spaced about shoulder width apart and at chest level. Upon the signal of the metronome (60 beats/min) the subjects raised the weight to a straightened-arms position directly above the chest and then returned the barbell to the preparatory position. The test was terminated when the subjects were unable to follow the pace of the metronome (30 lifts/min) or to reach full extension of the elbows. The score recorded was the maximum number of successful repetitions.

### Sit and reach test (modified)

After a standardised 5 min warm up, shoeless subjects sat on the floor with their back, hips and head against a wall. Then they placed soles and heels against the sit and reach box (Acuflex I, Power Systems, USA) and fully extended their legs about shoulder width (20-30cm) apart. The starting (zero) position was determined when subjects reached forward as far as possible along the measuring device and slid the indicator without having their head and back leave the wall. After the recording was made, subjects reached again three times along the device, with each trial being held for at least 2 seconds. The best score across the three trials was recorded.

### Body fat percentage determination

Body fat percentage (BF) was assessed using a hand-held bioelectrical impedance device (Omron BF300, Kyoto, Japan). Prior to testing all subjects were instructed to adhere to the following bioelectrical impedance guidelines[13]: i) empty bladder within 30 min of the start of the test, ii) no diuretic medications within 7 days before the test, iii) no exercise within 12 hours before the test, iv) no food or drink within 4 hours before the test and v) no alcohol within 48 hours of the start of the test. Measurements were made at a specific time period (06:00-09:00 am) in a comfortable and standard ambient temperature (22$^o$C).

Second series of testing - field tests - push ups, sit ups, pull ups (only males) and a (an) one mile run. For these tests (except for the one mile run) the maximum number of repetitions during a one minute period was recorded for each individual separately. The one mile run took place on an outdoor synthetic track (tartan) 400m long and it was performed by 12 subjects each time. Three experienced track coaches recorded the time using handheld digital stopwatches (Accusplit 625, Linemore, USA). Push ups, sit ups and pull ups were performed using standardised procedures.[10] Subjects were allowed 30 minutes to recover between each series of test trials. They also followed the same eating, sleeping and activity schedules throughout the study. The reliability of all laboratory measurements was assessed by making repeated trials on successive days on a random subsample (n=10) of subjects (average intra-class correlation coefficient ranged from 0.90 to 0.97; $p<0.01$). Means and standard deviations (SD) of variables and fitness scores were computed. A paired t-test was used to detect differences in percentile scores between laboratory and field tests. Probability values from level 0.001 to level 0.05 were taken to indicate statistical significance. All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS, Chicago, Illinois, USA) version 13.0.

## Results

Mean ± SD values for the first and second series of testing as well as fitness assessment based on health norms are presented in Table 1.

The statistical analysis showed that there were significant differences in percentile scores (p<0.001 and p<0.01) between laboratory and field tests both in males and females.

**Table 1. Mean ± SD values across all fitness tests with percentile scores in parentheses**

| Laboratory tests | | | Field tests | | |
|---|---|---|---|---|---|
| Test | Females | Males | Test | Females | Males |
| MSRT VO2max (ml/kg/min) | 42.2±6.1 (40%)*** | 49.6±5.3 (50%)††† | One mile run (min) | 473±36 (80%) | 371±33 (70%) |
| HDT (kg) | 50.5±10.0 (55%)*** | 95.6±9.0 (40%) | Pull ups (reps) | -- | 12.0±7.0 (60%) |
| CMJT (cm) | 28.4±4.36 (70%)*** | 35.0±5.1 (45%)†† | Sit ups (reps) | 40.0±3.0 (45%) | 45.0±3.0 (50%) |
| BPET (reps) | 25±8.0 (60%)*** | 25.0±10.0 (60%)††† | Push ups (reps) | 40.0±2.0 (85%) | 45.0±4.0 (75%) |
| BF (%) | 23.0±3.7 (45%)*** | 13.8±5.3 (60%)††† | BMI (kg/m2) | 24.3±2.5 (20%) | 23.9±2.7 (45%) |
| SRT (cm) | 43.6±7.8 (65%) | 35.0±9.1 (50%) | | | |
| ***p<0.001 significantly different from field test (males)<br>†††p<0.001 and ††p<0.01 significantly different from field test (females) | | | | | |

As shown in Table 1 during the first series of testing both female and male subjects were above the average category (50th-65th percentile) in four out of six laboratory tests respectively.

The mean percentile score for females and males were 56±18 and 44±22 respectively. During the second series of testing, female and male subjects were equal or above the average category (50th-65th percentile) in two out of four females and four out of five males. The field tests had mean percentile scores of 58±14 and 60±27 respectively . The mean percentile score for laboratory and field tests were 50±18 and 59±24 for females and males respectively. Percentile values for female and male subjects across laboratory and field tests for cardiorespiratory endurance, muscular strength, muscular endurance, flexibility and body composition are illustrated in Figure 1.

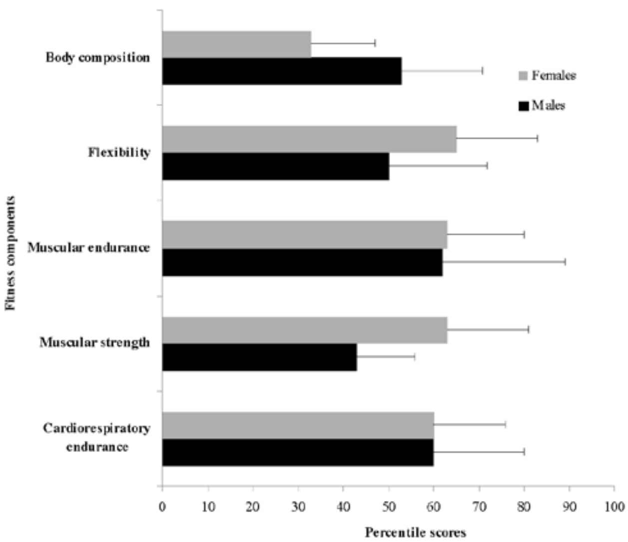


*Figure 1. Average percentile scores across all fitness tests for the major components of military fitness*

## Discussion

This is the first study published where the physical fitness profile of a Greek military population has been assessed according to physical fitness norms. The present data suggest that subjects were classified according to health norms in the "average" category and especially from the 50th percentile (cardiorespiratory endurance) up to the 65th percentile (muscular endurance) across the four major military fitness components. Differences in fitness tests, military populations and age ranges between the present study and previous studies[14,15,16] complicate the comparison of test figures. Nevertheless, the subjects presented similar fitness values compared to previous studies,[7,18] where sample groups consisted solely of Army Officer Cadets.

In a study conducted in the U.S.,[17] Army Officer Cadets presented exactly the same $VO^2max$ values as those in the present study (49.6 ml/kg/min), whereas females were characterized by slightly lower values (40.8 ml/kg/min). In another study (in the United Kingdom)[18] where the same testing methodology was used for aerobic capacity determination (time in the multistage shuttle run test), (subjects in the current study have considerably lower values compared to British Officer Cadets) subjects in the current study were found to have considerably lower values than those found for the British Officer Cadets [500 sec versus 720 sec (males) and 380 versus 515 sec (females)]. The British Officer Cadets however presented fewer pull up repetitions (8.3±4.3) when compared with their Greek counterparts (12.0±7.0).[14]

In terms of body composition, both male and female subjects were classified in the "below average" category (43rd percentile). In a study[18] where a similar testing instrument was used (bioelectrical impedance device), body fat values for males were considerably lower (11.7%) compared with those for the present sample group (13.8%). Despite that, both male sample groups were characterised by similar BMI values (23.90 versus 23.96) and the subjects possessed less fat-free muscle mass than their British counterparts. In contrast, (the opposite picture emerged with Greek female Cadets whaving higher BMI values than British officer Cadets) the Greek female Cadets had higher BMI values than the British officer Cadets (24.3 versus 23.0) but lower body fat values (24.3% versus 25.2%). Generally, the female subjects in our study seem to be characterised by higher BMI values compared with those in other Military Academies,[17,18,19,20] indicating the possibility that an increase of body mass may be due to decreased physical activity and/or an increased food/fat consumption over the years in the U.S.[21] but also in Greece.[22,23] Furthermore, body fat values such as those found in males in this study can be associated with an increased risk of injury.[24] Although this component of fitness (body composition) does not directly affect military performance,[18] these low percentile scores indicate that the potential for performance impairment still exists, considering these body composition values represent a status below that of an average healthy person.

It should be noted that in the present study the subjects' fitness level was evaluated on separate gender scales. This may be subject to criticism, as all military personnel are obliged to perform the same occupational tasks irrespective of gender. However, the current procedure was followed for the following reasons: Firstly, this is a common tactic in most military Academies; Secondly, the HAA policy requires that all cadets should always improve their physical conditioning status as part of their military preparedness. Based on this line of thinking, a constant and gradual improvement in fitness scores will eventually eliminate gender differences in military tasks, which predominantly require endurance capabilities, so trained females should reach comparable levels to males.[26] In contrast, if common scales were used, females in a short time would have reached a plateau in their physical conditioning or possibly deteriorate due to psychological reasons. Another reason for using separate gender norms was the policy of the HAA for improving general fitness abilities and not those derived from the actual mission demands. These latter will be specified after graduation, when cadets by that time will be officers and will follow careers in a specific corps (Special Forces, Artillery, Infantry, Logistics, Supply & Transportation, Army Aviation, Armoured Vehicles etc,). In these corps the "passing" criteria for the physical conditioning tests will no longer be age and/or gender adjusted.

It is also noteworthy that performance in the "commonly used" physical conditioning tests (push ups, sit ups, pull ups and one mile run) placed subjects to the upper end (59th percentile) of the "average" category (50th -65th percentile);. When more standardised tests were used (CMJT, BPET, HDT, MSRT), the average score dropped to the lower end (50th percentile) of the "average" category. This is possibly due to a more stringent control placed on laboratory tests as compared to those of field tests. However, these field tests are widely considered to be measures of health-related fitness,[25] they are conducive to mass testing and require little to no equipment, a key feature for military testing that often involves evaluation of hundreds of participants.

Nonetheless, simplified versions of CMJT and SRT, such as vertical/broad jump and fingertips to floor/sit-reach toe touching, could be supplementary to field tests in order to broaden the range of exercise abilities tested. Other researchers[26,27,28] (have utilized similar tests such as standing vertical and horizontal jump, in order to simulate occupational military tasks.) have utilised similar tests, including the standing vertical and horizontal jump, to simulate occupational military tasks. Additionally, since the scores in military field tests impose a systematic bias against larger cadets,[29,30,31] the use of more occupationally relevant and physically demanding tasks will eventually obliterate body mass bias. Through this procedure, subjects would not only be evaluated from a health-related and occupationally relevant fitness perspective, but also under fairer conditions.

It would be also interesting to compare the present fitness scores with those during physical fitness testing prior to Basic Combat Training and/or correlating them with Basic Combat Training completion-discard rates. However, the outcome of physical fitness testing was "pass or fail", therefore, no pre-training status data was registered owing to the nature of this process. Consequently, there was no opportunity to correlate the status of pre-training fitness with the completion of the Basic Combat Training course in order to determine whether or not a relationship exists. This lack of information can be considered a limitation of the present study.

In summary, these data show that GAOCs were aerobically fit, they presented strength levels within the "average" category, whereas their muscular endurance and flexibility scores were"above the average" for healthy individuals of the respective age group. Although their body-fat percentages were greater than expected for military personnel, the benefit of enhanced muscular endurance ability may overcome this drawback. The categorisation of subjects in the present study will also provide a reference value for other Military Academies within NATO and for the HAA the obligation to design more efficient physical conditioning programmes in the future. These results also have important implications for developing nutrition education programmes in the Greek Armed Forces. With the increasing childhood obesity in Greece, greater resources are required in order to minimise the negative effects on adolescents and so, potentially, Army Officers. Finally, the difference (9%) in the percentiles scores obtained by field tests compared to laboratory tests, emphasize the need to utilize more standardised and/or occupationally relevant fitness tests in the HAA semestrial physical fitness examination, in order to ensure its validity and specificity.

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