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ORIGINAL ARTICLE

The effects of a 40-week periodized military training program on physical fitness and body composition in male army cadets

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ABSTRACT

Physical fitness underpins military readiness, but whether gains from an initial training block persist across a multi-phase macrocycle is unclear, because most studies assess only entry and exit. This study characterized physical fitness and body composition across four phases of a 40-week periodized military training program in male army cadets. In a single-group, repeated-measures observational design, 206 male cadets were assessed at the end of each phase (approximately weeks 2, 12, 32, and 40), with 204 completing all four assessments. The first assessment followed a two-week adaptation phase and is not a pre-training baseline. Primary outcomes were estimated VO_{2max} (2.4 km run), 2-min push-ups, and 2-min sit-ups; secondary outcomes were bioimpedance-derived body composition. Linear mixed models with phase as a fixed factor and a random intercept per cadet yielded estimated marginal means, Bonferroni-adjusted contrasts, and within-participant effect sizes (d_z). All fitness outcomes peaked at the end of the development phase and declined thereafter. Estimated VO_{2max} rose from 50.5 to 56.1 ml·kg^{-1}·min^{-1} (d_z = 2.63) before falling to 53.5, retaining 53% of the peak gain; sit-ups retained 72% and push-ups 48%. The decline was outcome-specific in timing. The entire sit-up loss and 56% of the aerobic loss occurred during the combat-specific phase, whereas push-up performance fell only during maintenance. Fat mass increased by 1.17 kg and fat-free mass decreased by 1.14 kg, while BMI changed by no more than 0.21 kg·m^{-2}. Endpoint-only evaluation would have reported a successful program while concealing both the mid-program peak and the subsequent regression.

Keywords: performance analysis; military training; periodization; cardiorespiratory fitness; muscular endurance; body composition.

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INTRODUCTION

The burden of musculoskeletal injury and limited physical capacity remain among the main reasons for lost duty days and non-deployability in armed forces, and both are strongly modifiable by physical fitness (Molloy et al., 2020; Nindl et al., 2017). In military populations, lower aerobic capacity and reduced muscular endurance independently predict injury and impair occupational task performance. Higher fitness supports load carriage, sustained field training, and recovery from repeated physical stress (Bunn et al., 2021; De La Motte et al., 2017; Jones et al., 2017; Rhon et al., 2022; Tomes et al., 2020). This association is consistent across services and study designs: slower running times and lower muscular endurance have been consistently linked to increased injury risk at the start of training (Müller-Schilling et al., 2019; Robinson et al., 2016; Tomes et al., 2020). For officer cadets in particular, training represents the most opportune period for establishing physical capability, and the structure of the program will dictate the degree to which this capability is achieved. Many academies have therefore adopted periodized cadet training, defined as the systematic fluctuation of training load parameters (frequency, intensity, time, and type — the FITT principle) across training cycles, aiming for progressive fitness gains while mitigating the injury risk associated with high training loads (Heilbronn et al., 2020; Kyröläinen et al., 2018).

Military training reliably develops physical fitness within a single training block. Across different participant groups and training durations, basic and specialist training improve cardiorespiratory endurance and muscular strength, with the magnitude of improvement strongly dependent on entry fitness: less-fit individuals show the greatest improvement, while fitter individuals may show little change or even a decline in fitness under identical training programs (Burley et al., 2018; Maroni et al., 2024; Pihlainen et al., 2020; Rue et al., 2024). Most military programs combine substantial aerobic conditioning with strength and calisthenic training, a concurrent-training model that typically produces greater strength and endurance gains for occupational tasks than endurance training alone (Helén et al., 2023; Kraemer et al., 2004; Vaara et al., 2022). At higher endurance volumes, however, concurrent training can blunt strength and hypertrophic adaptations. This interference effect is generally small in humans, is most pronounced in already-fit individuals, and its underlying molecular mechanisms remain incompletely characterized (Coffey & Hawley, 2017; Fyfe et al., 2014; Huiberts et al., 2024; Murlasits et al., 2018). Body-composition responses are similarly variable; meaningful fat loss and lean-mass gains are typically observed only during longer interventions that incorporate resistance training and dietary control (Coge et al., 2024; Gobbo et al., 2022).

Less well understood is the trajectory of fitness across an entire multi-phase periodized macrocycle, including whether gains achieved during the earlier development phases are maintained through the later specialization phases. Most military training studies employ a two-timepoint pre–post design within a single block and therefore provide only net change information without revealing the shape of the change (Maroni et al., 2024; Pihlainen et al., 2020). The evidence that does extend further is instructive: endurance performance has been shown to deteriorate during extended operational deployments and advanced training phases, and reductions in overall training load, particularly endurance load, have been linked to performance and body-composition declines, especially in those who started fitter (Pihlainen et al., 2023). Meta-analytic and longitudinal data also indicate that muscular power and endurance can deteriorate following demanding operational or advanced training as a result of fatigue and inadequate recovery (Murray et al., 2025; Ojanen et al., 2023). Whether fitness continues to improve, plateaus, or declines as the program shifts from development to combat-specific work, and then to a reduced-load maintenance phase, cannot be determined from a single pre-post comparison. This distinction matters because the reduced-load period could act in either direction. A taper that reduces volume while maintaining intensity may preserve previous improvements, whereas a reduction in intensity more closely resembles detraining (Bosquet et al., 2007;

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Mujika & Padilla, 2000b). If cadets train at a lower intensity during the later phases than during the mid-program peak, fitness levels may deteriorate. It remains uncertain, however, whether the fitness improvements from the development phase of a multi-phase periodized program are maintained during the subsequent combat-specific and maintenance phases.

The aim of the present study was therefore to characterize the trajectory of physical fitness and body composition across the four phases of a 40-week periodized military training program in male army cadets, with particular attention to whether the gains attained during the early development phase were sustained through the later combat-specific and maintenance phases. The specific objectives were: (i) to describe phase-by-phase changes in field aerobic performance, muscular endurance, and body composition; (ii) to identify the phase at which each fitness outcome peaked and to quantify the magnitude of any subsequent change; and (iii) to determine the extent to which the gains achieved during the development phase were retained at program completion.

METHODS

Study design

This study used a single-group, repeated-measures observational design to characterize changes in physical fitness and body composition across the four phases of a 40-week periodized military training program. A single-cohort design without a control group was adopted because randomization or withholding of training was not feasible within the operational structure of cadet training, where the program was mandatory and delivered to the entire intake simultaneously. Reporting follows the STROBE guidance for observational studies (von Elm et al., 2007). The study was reviewed and approved by the Sultan Idris Education University Ethical Research Committee Board and conducted in accordance with the Declaration of Helsinki; written informed consent was obtained from all participants after the protocol, risks, and discomforts had been explained. Participation in the research was voluntary, and declining carried no consequence for training or assessment.

Participants

Participants were male army cadets enrolled in the army graduate-officer course at the Malaysian Army Academy Camp. Of the 232 cadets enrolled, 26 were excluded due to non-completion of the training and assessment schedule, leaving a final sample of 206 cadets. Participants had to be injury-free and able to complete all physical assessments (2-min push-up test, 2-min sit-up test, 2.4 km run) and body-composition measurements. Cadets with orthopaedic or clinical conditions that posed a risk or could affect assessment were excluded. The sample was not statistically representative but constituted a complete operational intake; no a priori sample-size calculation was performed because the program intake was fixed.

Training program

Cadets completed a periodized program delivered in four progressive phases spanning approximately 40 weeks, structured around the FITT principle and targeting aerobic capacity, muscular endurance, core stability, flexibility, and mobility. Two ~60-minute sessions were completed per working day, supervised by appointed military trainers, with daily energy intake provided through standard military rations (~2800 kcal for males). Warm-up and cool-down were incorporated at the beginning and end of all sessions. Session content, distances, and loads across the four phases are outlined in Table 1. The combat-specific content for Phase III is described in general terms only, owing to operational sensitivity. The program is described as periodized in the sense of a planned sequence of phases with intended shifts in volume, intensity, and specificity.

Because internal and external training load were not quantified, the term denotes planned structure rather than verified load manipulation.

Table 1. Phase-by-phase structure of the 40-week periodized military training program.

Phase (weeks)	Morning session	Evening session	Run	Load / intensity
I (1–2) Introduction & adaptation	Warm-up; running drills (high knee, ankling, high-knee extension, back kick, heel kick); core-strength (raise static squat, raise squat, standing superman, bridge); cool-down	Warm-up; easy run; strength (L-shape push-up, crunches); cool-down	<3 km	Drills 3×30 m; core 2×30 s; strength 10×10; lowest intensity
II (3–12) Development	As Phase I, with graded interval and circuit work added; agility and military movement patterns	Warm-up; easy run; strength (L-shape push-up, crunches); cool-down	<3 km	Progressive increase in volume and load; self-recovery introduced
III (13–32) Combat-specific	TABATA and combat-training circuits; core-strength with added elbow plank / shoulder tap; flexibility drills	Hill run (50 m) and forest run (3 km); strength (L-shape push-up, crunches); recovery emphasised	<7 km	Highest intensity of the program; injury-recovery maximised
IV (33–40) Maintenance	Warm-up; running drills and core-strength (withhold push-up / shoulder tap); cool-down	Warm-up; easy run; strength (L-shape push-up, crunches); cool-down	<10 km	Intensity deliberately reduced to low–moderate; active recovery to prevent detraining

Procedures and assessment schedule

To preserve anonymity, cadets were identified by military identification number. Fitness and body-composition testing occurred at the end of each training phase (approximately weeks 2, 12, 32, and 40). The first assessment therefore followed the two-week introduction and adaptation phase. It represents the first available measurement rather than a pre-training baseline, and adaptations occurring during those initial two weeks were not captured. All Phase 1 to Phase 2 changes accordingly understate the complete early response to the program. To minimize circadian variation, each assessment round was conducted on separate days, with the same test progression and time of day (±1–2 h). The day before the test, cadets were given written instructions to ensure adequate sleep (≥8 hours) and to refrain from heavy physical activity. Nutritional intake followed standard military rations (approximately 2800 kcal·day^{-1} for males) but was neither monitored nor standardized at the individual level, and no verification of dietary intake or fluid status was performed.

Body composition

Stature was measured with a calibrated stadiometer (SECA GmbH & Co. KG, Hamburg, Germany; Model 213). Body composition was assessed with a bioelectrical impedance analyser (BIA; TANITA Corporation, Tokyo, Japan; Model BC-418MA), following the manufacturer's instructions, by the same technician across all measurements, in a controlled ambient temperature (21–24 °C). Body-composition outcomes were body-fat percentage, muscle percentage, fat mass, and fat-free mass. Fat mass was calculated as body mass multiplied by body-fat percentage, and fat-free mass as body mass minus fat mass. Body-fat and muscle percentages derive from the same device algorithm and are not independent, their sum remaining constant at 95.5% to 95.6% across all four phases. The two percentages therefore carry one body-composition signal and are reported together for completeness rather than as separate outcomes.

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Muscular endurance

Muscular endurance in both the upper body and trunk was measured using standardized measures for 2-min of push-ups and 2-min sit-ups. For the push up, cadets began prone with hands under the shoulders and straightened their arms into the straight body position, pushing down until the elbows were about 90° with their arms parallel to the ground; time on the push-up was 2 minutes, and it was discontinued if cadets lost correct form. As for the sit-up, cadets started supine with knees flexed at 90°, feet flat and arms crossed over the chest, lifted the trunk to approximately 30° of flexion relative to the floor, then returned the scapulae to the mat, repetitions were counted for 2 minutes, and the routine was stopped if the form was compromised or the feet moved. Both protocols followed the field-test procedures of the Malaysian Armed Forces cadet fitness assessment, with test duration set at 2 minutes per item to align with the cadet officer fitness standard. Positioning and execution criteria correspond to those described for military field testing of muscular endurance (Santtila et al., 2019). Repetitions were counted by trained military instructors, with one assessor assigned to each cadet for the duration of the test. Repetitions not meeting the stated criteria were not counted and were announced to the cadet at the time. Inter-rater reliability was not formally quantified.

Cardiorespiratory fitness

Field aerobic performance was assessed via a 2.4 km run on a standard synthetic 400 m track under similar morning environmental conditions. The 2.4 km run is the established field measure of cardiorespiratory endurance in Malaysian cadet officer assessment (Kassim & Mokhtar, 2016). Before the run, cadets were instructed on the course (six laps), pacing, and safety, then completed a standardized 10-minute warm-up. Times were recorded by trainers using dual synchronized stopwatches at the start and finish lines, entered independently into spreadsheets, then read aloud, verified, and cross-checked between manual and digital records. Times were captured at 0.01 s resolution but are reported and interpreted to the nearest 1 s, because manual stopwatch operation introduces reaction error larger than the recorded resolution. Maximal oxygen uptake (VO_{2max}, $ml \cdot kg^{-1} \cdot min^{-1}$) was estimated from run time using the 2.4 km run equation of Burger et al. (1990) equation: $VO_{2max} = 85.95 - (3.079 \times \text{run time in minutes})$ (Burger et al., 1990). Because estimated VO_{2max} is an indirect, field-based measure influenced by pacing, motivation, environment, and running economy (standard error of the estimate 2.24–2.91 $ml \cdot kg^{-1} \cdot min^{-1}$), it is treated as a measure of field aerobic performance rather than a direct measure of aerobic capacity.

Outcome measures

Primary outcomes were the field fitness tests (estimated VO_{2max}, 2-min push-ups, 2-min sit-ups). Body-fat percentage, muscle percentage, fat mass, and fat-free mass, derived from bioimpedance, served as secondary exploratory outcomes. BMI was evaluated as a stability check. Estimated VO_{2max} was calculated directly from 2.4 km run time; because run time and VO_{2max} represent essentially the same aerobic construct, only VO_{2max} is reported as the aerobic outcome.

Statistical analysis

Analyses were performed in IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Continuous outcomes were summarized by phase as mean and SD. Each fitness and body-composition outcome was winsorized at the 1st and 99th percentile values to limit the influence of extreme values likely reflecting variation in pacing or motivation rather than genuine physiological differences, particularly for the 2.4 km run. This conservative procedure adjusted approximately the top and bottom 1% of observations per outcome. The winsorizing limits were 8.54–13.42 min for the 2.4 km run, 24–75 repetitions for sit-ups, 19–80 repetitions for push-ups, 5.4–23.4% for body-fat percentage, and 72.62–89.68% for muscle percentage. Since the estimated VO_{2max} is a linear and monotonic function of run time, winsorizing run time at these percentiles is

the same operation as winsorizing estimated VO_{2max}, for which the corresponding limits are 44.63 to 59.66 $ml \cdot kg^{-1} \cdot min^{-1}$.

Changes across the four phases were modelled using separate linear mixed models for each outcome, with phase as a four-level fixed factor and a random intercept for each cadet, accounting for the repeated measurements taken on the same cadets over time. Denominator degrees of freedom were estimated using Satterthwaite's approximation, which yields non-integer values. This approach uses all available observations, including those from the two cadets with incomplete follow-up, assumes data are missing at random, and does not require listwise deletion. Marginal means were estimated for each model and pairwise comparisons between phases were made with Bonferroni adjustment. Five contrasts of interest (Phase 1 to 2, Phase 2 to 3, Phase 3 to 4, Phase 2 to 4, and Phase 1 to 4) were each expressed as a standardized within-participant effect size, calculated as the mean paired difference divided by the standard deviation of the paired differences, with 95% confidence intervals derived from the noncentral t distribution. Primary analyses used winsorized data. All models were additionally refitted on unmodified data as a sensitivity analysis. Given the high statistical significance reached by nearly all comparisons in this large sample, interpretation focused on effect sizes and absolute magnitudes alongside statistical significance. The significance level was $p < .05$ (two-tailed).

RESULTS

Demographic characteristics

Table 2. Characteristics of male army cadets at the first assessment, conducted at the end of Phase I, approximately week 2 (N = 206).

Characteristic	Mean ± SD	Range
Age (years)	24.9 ± 1.3	22–27
Height (cm)	169.8 ± 5.1	158–186
Weight (kg)	65.3 ± 8.6	44.9–99.5
Body mass index (kg/m^2)	22.6 ± 2.4	17.1–31.1

A total of 206 male cadets entered the program and completed the Phase 1 assessment, of whom 204 (99.0%) completed all four phase assessments. Two cadets were absent from the Phase 4 assessment, leaving 822 cadet-phase observations. Because linear mixed models accommodate incomplete cases without listwise deletion, all 206 cadets contributed to every model. Cohort characteristics at the first assessment are presented in Table 2. The two cadets with incomplete follow-up were 25 and 25 years of age, with body mass indices of 24.7 and 25.5 $kg \cdot m^{-2}$, placing both within the range of the completers. No inferential comparison was undertaken, given that only two cases were incomplete.

Trajectory of physical fitness and body composition

Table 3. Physical fitness and body-composition outcomes across the four phases of a 40-week periodized military training program (N = 206).

Outcome	Phase 1	Phase 2	Phase 3	Phase 4	Retention (%)
Estimated VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)	50.54 (3.12)	56.14 (1.90)	54.66 (2.06)	53.52 (2.16)	53
Sit-ups (reps/2 min)	43.17 (10.00)	59.14 (7.88)	54.60 (6.32)	54.65 (6.26)	72
Push-ups (reps/2 min)	44.48 (12.52)	57.70 (10.15)	56.90 (8.12)	50.83 (7.33)	48
Body fat (%)	13.98 (4.55)	14.32 (3.61)	15.53 (3.60)	15.81 (3.68)	—
Muscle (%)	81.51 (4.35)	81.23 (3.45)	80.08 (3.41)	79.84 (3.50)	—
BMI ($kg \cdot m^{-2}$)	22.59 (2.41)	22.38 (2.03)	22.57 (2.15)	22.49 (2.22)	—

Note. Values are descriptive means (SD) of winsorized data (1st and 99th percentile). Retention is a descriptive index, calculated as [(Phase 4 − Phase 1) / (Phase 2 − Phase 1)] × 100, and is not reported for outcomes without a significant Phase 1 to Phase 2 change.

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Table 3 presents phase means for all outcomes. Every fitness outcome improved between the first and second assessments and then regressed. Estimated VO_{2max} peaked at Phase 2 and fell across both later phases. Sit-up performance peaked at Phase 2, fell by Phase 3, and was then stable. Push-up performance held its Phase 2 value through Phase 3 before falling at Phase 4. Body-fat percentage rose and muscle percentage fell, with both changes concentrated after Phase 2. BMI varied by no more than 0.21 $kg \cdot m^{-2}$ across the entire program. Retention of the Phase 1 to Phase 2 gain at program completion was 53% for estimated VO_{2max}, 72% for sit-ups, and 48% for push-ups. Phase trajectories for all outcomes are shown in Figure 1.

Phase contrasts

Table 4. Phase contrasts from linear mixed models, with standardized within-participant effect sizes (N = 206).

Outcome	Contrast	Mean difference (95% CI)	*p*	d_z (95% CI)
Estimated VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)	Phase 1 to 2	5.60 (5.22, 5.97)	< .001	2.63 (2.34, 2.92)
	Phase 2 to 3	−1.48 (−1.86, −1.10)	< .001	−0.96 (−1.13, −0.80)
	Phase 3 to 4	−1.15 (−1.53, −0.77)	< .001	−0.69 (−0.84, −0.54)
	Phase 2 to 4	−2.63 (−3.01, −2.25)	< .001	−1.62 (−1.83, −1.41)
	Phase 1 to 4	2.97 (2.59, 3.35)	< .001	1.14 (0.97, 1.32)
Sit-ups (reps/2 min)	Phase 1 to 2	15.97 (14.21, 17.73)	< .001	1.47 (1.27, 1.66)
	Phase 2 to 3	−4.54 (−6.30, −2.78)	< .001	−0.55 (−0.70, −0.41)
	Phase 3 to 4	0.06 (−1.71, 1.83)	1.000	0.00 (−0.14, 0.14)
	Phase 2 to 4	−4.48 (−6.25, −2.71)	< .001	−0.48 (−0.62, −0.33)
	Phase 1 to 4	11.49 (9.73, 13.26)	< .001	1.08 (0.90, 1.25)
Push-ups (reps/2 min)	Phase 1 to 2	13.22 (11.30, 15.14)	< .001	1.22 (1.04, 1.40)
	Phase 2 to 3	−0.81 (−2.72, 1.11)	1.000	−0.08 (−0.22, 0.05)
	Phase 3 to 4	−6.06 (−7.98, −4.14)	< .001	−0.71 (−0.86, −0.55)
	Phase 2 to 4	−6.86 (−8.79, −4.94)	< .001	−0.76 (−0.92, −0.61)
	Phase 1 to 4	6.36 (4.43, 8.28)	< .001	0.57 (0.42, 0.71)
Body fat (%)	Phase 1 to 2	0.34 (−0.05, 0.74)	.137	0.14 (0.00, 0.28)
	Phase 2 to 3	1.21 (0.81, 1.60)	< .001	0.77 (0.62, 0.93)
	Phase 3 to 4	0.32 (−0.08, 0.71)	.210	0.24 (0.10, 0.38)
	Phase 2 to 4	1.52 (1.13, 1.92)	< .001	0.87 (0.70, 1.03)
	Phase 1 to 4	1.86 (1.47, 2.26)	< .001	0.72 (0.56, 0.87)
Muscle (%)	Phase 1 to 2	−0.28 (−0.66, 0.11)	.335	−0.12 (−0.25, 0.02)
	Phase 2 to 3	−1.15 (−1.54, −0.77)	< .001	−0.76 (−0.91, −0.60)
	Phase 3 to 4	−0.28 (−0.67, 0.11)	.330	−0.21 (−0.35, −0.07)
	Phase 2 to 4	−1.43 (−1.82, −1.05)	< .001	−0.81 (−0.97, −0.65)
	Phase 1 to 4	−1.71 (−2.10, −1.33)	< .001	−0.69 (−0.84, −0.53)
BMI ($kg \cdot m^{-2}$)	Phase 1 to 2	−0.21 (−0.37, −0.05)	.004	−0.22 (−0.35, −0.08)
	Phase 2 to 3	0.19 (0.03, 0.35)	.013	0.31 (0.17, 0.45)
	Phase 3 to 4	−0.05 (−0.21, 0.11)	1.000	−0.10 (−0.24, 0.04)
	Phase 2 to 4	0.14 (−0.03, 0.30)	.166	0.18 (0.05, 0.32)
	Phase 1 to 4	−0.08 (−0.24, 0.09)	1.000	−0.07 (−0.21, 0.07)

Note. Mean differences and confidence intervals are estimated marginal mean contrasts from linear mixed models with phase as a four-level fixed factor, a random intercept per cadet, and Bonferroni adjustment across the six pairwise phase comparisons. d_z is the mean paired difference divided by the standard deviation of the paired differences, with confidence intervals from the noncentral *t* distribution.

Phase contrasts are presented in Table 4. All outcomes changed significantly across phases: estimated VO_{2max}, $F(3, 613.3) = 549.0$, $p < .001$; sit-ups, $F(3, 613.8) = 209.8$, $p < .001$; push-ups, $F(3, 613.4) = 143.9$, $p < .001$; body-fat percentage, $F(3, 613.0) = 73.1$, $p < .001$; muscle percentage, $F(3, 613.0) = 67.0$, $p < .001$; and BMI, $F(3, 613.0) = 4.79$, $p = .003$. Model standard errors were constant across phases within each outcome, ranging from 0.15 $kg \cdot m^{-2}$ for BMI to 0.68 repetitions for push-ups. The Phase 1 to Phase 2

improvement was large for all three fitness outcomes, and each then declined by a different magnitude, with the Phase 2 to Phase 4 loss largest for estimated VO_{2max} and smallest for sit-ups. Net change from Phase 1 to Phase 4 remained positive and significant for all three. Neither body-fat nor muscle percentage changed significantly between Phase 1 and Phase 2, though both changed significantly thereafter. Two BMI contrasts reached statistical significance, but no BMI difference exceeded 0.21 $kg \cdot m^{-2}$ and no BMI effect size exceeded 0.31. The timing of decline differed by outcome. The entire sit-up decline occurred between Phase 2 and Phase 3, with no change across the final two phases. Push-up performance did not change between Phase 2 and Phase 3, and 88% of its total decline occurred between Phase 3 and Phase 4. Estimated VO_{2max} fell across both intervals, with 56% of the total loss occurring between Phase 2 and Phase 3. For body-fat percentage, 79% of the Phase 2 to Phase 4 increase occurred between Phase 2 and Phase 3.

Absolute body composition

Table 5. Absolute body composition across the four phases of a 40-week periodized military training program (N = 206).

Outcome	Phase 1	Phase 2	Phase 3	Phase 4	Phase 2 to 3 (95% CI)	Phase 1 to 4 (95% CI)
Fat mass (kg)	9.40 (0.25)	9.45 (0.25)	10.38 (0.25)	10.57 (0.25)	0.92 (0.60, 1.24)*	1.17 (0.85, 1.49)*
Fat-free mass (kg)	55.85 (0.36)	55.30 (0.36)	55.07 (0.36)	54.71 (0.36)	−0.23 (−0.52, 0.06)	−1.14 (−1.43, −0.85)*
Body mass (kg)	65.26 (0.56)	64.75 (0.56)	65.45 (0.56)	65.29 (0.56)	0.69 (0.23, 1.15)*	0.03 (−0.43, 0.49)

*Note. Values are estimated marginal means (SE) from linear mixed models with phase as a four-level fixed factor and a random intercept per cadet, based on all 822 cadet-phase observations with no exclusions. Fat mass was calculated as body mass × body-fat percentage, and fat-free mass as body mass minus fat mass. * p < .05 after Bonferroni adjustment.*

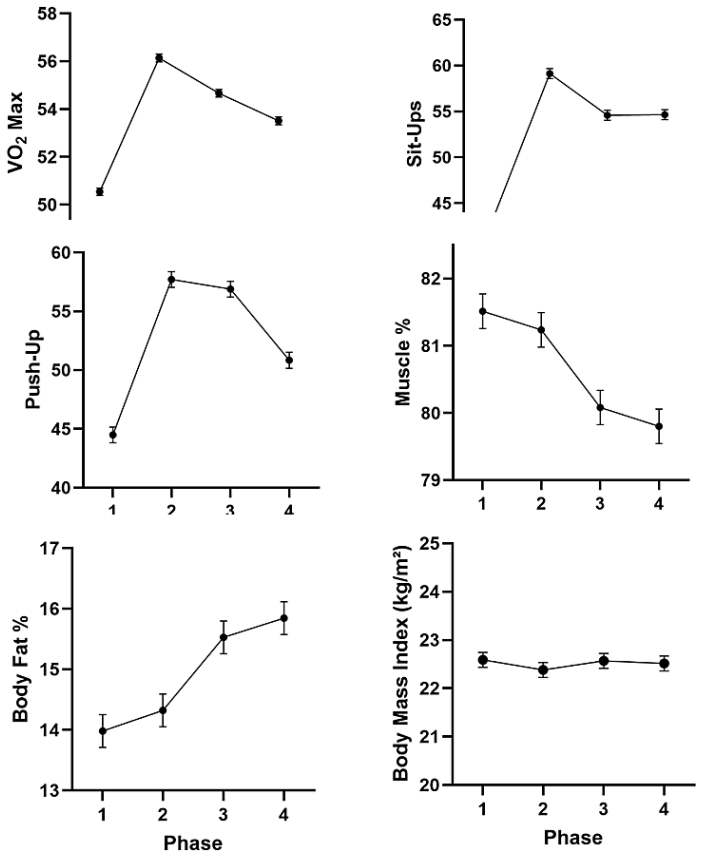

Figure 1. Estimated marginal means (± SE) for each outcome across the four phases of the 40-week periodized military training program (N = 206).

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Absolute body-composition outcomes are presented in Table 5. Absolute fat mass increased by 1.17 kg from Phase 1 to Phase 4, and fat-free mass decreased by 1.14 kg. Body mass at Phase 4 was within 0.03 kg of its Phase 1 value. The two components followed different time courses. Fat mass was unchanged from Phase 1 to Phase 2 (p = 1.000) and then rose by 0.92 kg between Phase 2 and Phase 3, accounting for 79% of the total increase. Fat-free mass declined progressively instead, with significant reductions between Phase 1 and Phase 2 and between Phase 3 and Phase 4, but no significant change across the intervening interval (p = .199).

Sensitivity analysis

All models were repeated on unmodified data. Winsorization altered no phase mean by more than 0.31 units, with the largest shifts occurring at Phase 1 and all later phases differing by no more than 0.14 units. No conclusion changed: every contrast retained its direction, and every significance decision under Bonferroni adjustment was identical on both datasets. Omnibus F values were lower on unmodified data for all outcomes except BMI, most notably for muscle percentage (31.8 compared with 67.0), which is attributable to a single record in which the analyser returned a muscle mass incompatible with the recorded body mass and fat percentage. Because winsorization drew in a lower tail composed disproportionately of Phase 1 observations, every Phase 1 to Phase 2 change was smaller after adjustment, so the reported early improvement is conservative. The one effect size that moved materially was the Phase 1 to Phase 2 dz for estimated $VO_{2}max$, which was 1.79 on unmodified data and 2.63 after winsorization; all other effect sizes differed by no more than 0.08.

DISCUSSION

The purpose of this study was to describe changes in physical fitness and body composition across a 40-week periodized military training program. The key finding was that fitness did not increase linearly. Field aerobic performance and muscular endurance improved sharply to a peak at the end of the development phase, approximately week 12, and then regressed. Fat mass increased by 1.17 kg and fat-free mass decreased by 1.14 kg, while body mass and BMI remained stable. A comparison of the first and final assessments alone would have underestimated the mid-program peak and masked the subsequent regression entirely.

The early, large gains are consistent with the responsiveness of fitness to the initial phase of military training, when previously sub-maximally trained individuals encounter a structured stimulus (Burley et al., 2018; Pierce et al., 2024; Pihlainen et al., 2020). Between-cadet variability narrowed across the program, consistent with reports that the least fit recruits gain most while the fittest gain least or regress (Burley et al., 2018). Gains have been reported to plateau by approximately the eighth week, well before the end of longer courses (McCleary et al., 2026). The subsequent decline is the more informative feature, and it aligns with evidence that fitness does not persist through later phases when the training focus shifts away from the qualities assessed (Murray et al., 2025; Ojanen et al., 2023; Pihlainen et al., 2023).

The timing of the decline constrains the explanations available. Most of the regression preceded the reduced-intensity maintenance phase. The entire sit-up decline, 56% of the aerobic decline, and 79% of the increase in body-fat percentage occurred between Phase 2 and Phase 3. That interval corresponds to the 20-week combat-specific block, which the program designated as its highest-intensity phase. Only push-up performance declined across the maintenance phase. The pattern is outcome-specific, and no single mechanism accounts for all outcomes. For push-ups, the decline coincided with removal of the pressing stimulus, because the Phase IV morning session withheld push-up work. This is consistent with training

specificity, under which the capacities that decay first are those no longer trained (Pihlainen et al., 2023). Tapering evidence indicates that performance is maintained when volume is reduced by 41% to 60% while intensity and frequency are preserved (Bosquet et al., 2007). Reductions in intensity more closely resemble the conditions under which adaptations are lost (Mujika & Padilla, 2000a, 2000b). The magnitude of loss here exceeds what intensity-preserving tapers typically produce, which is suggestive but not conclusive. The comparison warrants caution, because that evidence derives from two-week tapers in competitive athletes rather than an eight-week phase in cadets (Bosquet et al., 2007).

For sit-ups and field aerobic performance, a reduced-load explanation cannot apply, because the loss was complete or substantially advanced before maintenance began. Two alternatives remain. The first is a change in training content, since Phase III emphasised interval sessions, combat-conditioning circuits, hill running, and forest running, none of which reproduce a paced 2.4 km run or a timed sit-up. Operational military training produces small declines in upper-body and core endurance and larger declines in lower-body power (Murray et al., 2025). The second is accumulated fatigue or reduced energy availability across a 20-week block, both documented in prolonged military training (O'Leary et al., 2024; Ojanen et al., 2023). Late-course plateaus have been attributed to exactly these two possibilities (McCleary et al., 2026). The present design cannot separate them, because no measurement was taken between weeks 12 and 32.

The reductions were asymmetric in magnitude and timing. Retention was 48% for push-ups compared with 72% for sit-ups. Sit-up performance fell entirely within the combat-specific phase and was then stable, whereas push-up performance was preserved through that phase and fell only during maintenance. Both tests used the same measurement format but loaded different muscle groups, indicating a stimulus-specific rather than global mechanism. The later phases were dominated by sustained aerobic and combat-conditioning activities, which loaded the lower body and trunk while providing minimal upper-body pressing stimulus. Differential interference from high endurance volume may have compounded this specificity effect (Coffey & Hawley, 2017; Fyfe et al., 2014; Huiberts et al., 2024; Murlasits et al., 2018). This remains a working hypothesis, since the design did not quantify load per modality nor measure the signalling required to establish interference (Fyfe et al., 2014). Generalized military conditioning may preserve trunk endurance more effectively than upper-body pressing endurance.

The body-composition results warrant caution. Fat percentage and muscle percentage are algebraic complements within the device algorithm, their sum remaining constant at 95.5% to 95.6% across phases, so the two describe one signal rather than two. The absolute measures are more informative. Fat mass increased by 1.17 kg and fat-free mass decreased by 1.14 kg, with most of the fat gain occurring between Phase 2 and Phase 3. Fat mass increases across a 44-week military course have been reported previously, although lean mass was preserved in that cohort (O'Leary et al., 2024). This pattern differs from programs including dedicated resistance blocks or nutritional control, which report favourable body-composition change (Coge et al., 2024; Gobbo et al., 2022). Nutrition was neither standardized nor monitored here, and bioelectrical impedance is influenced by hydration and measurement conditions, so this trajectory is exploratory (Cialdella-Kam et al., 2023; Varanoske et al., 2023). BMI did not track these changes, which makes it inadequate as a stand-alone monitoring measure where occupational capacity depends on lean mass and fitness rather than total mass (Chapman et al., 2025; Harty et al., 2021; Jones et al., 2017).

A key strength was the design, comprising four repeated assessments across a full 40-week macrocycle in a large intact cohort, analysed with linear mixed models that captured the shape of change rather than only its endpoints. Several caveats temper interpretation. The study lacks a pre-training baseline, because the initial assessment followed the two-week introduction phase. No objective measure of training load was

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recorded, so the study documents change coincident with each phase but cannot attribute it to any programming variable. Assessments were taken only at phase endpoints, and the 20-week duration of Phase III prevents localising when the regression occurred. Acute fatigue, recent field exercise, and recovery status could not be controlled. The single-group design precludes causal attribution, and repeated exposure to identical tests may have produced familiarisation effects. Aerobic performance was estimated from a field run, and the standard error of the prediction equation exceeds several between-phase mean differences (Burger et al., 1990). Bioimpedance was conducted under unstandardized hydration conditions, so those outcomes are exploratory (Cialdella-Kam et al., 2023; Varanoske et al., 2023). The cohort included only male cadets from a single academy, restricting generalization.

Three implications follow from these data. Cadet programs should assess fitness at intermediate points rather than at entry and exit alone, because endpoint-only evaluation conceals both peak capability and subsequent regression. Gains achieved during a development phase should not be assumed to persist across an extended specialization block. Upper-body pressing endurance requires a preserved stimulus in the final phase. A practical monitoring schedule follows, comprising assessment at the end of the development phase, at the midpoint of the specialization phase, and before graduation. The mid-specialization assessment is the addition that matters, because the sit-up and aerobic losses occurred within a 20-week window containing no measurement. Predetermined thresholds could trigger reinstatement of the affected modality. Reducing volume while preserving intensity may maintain performance better than reducing intensity, and reduced frequency has also been proposed as a maintenance strategy (Bosquet et al., 2007; Mpampoulis et al., 2025; Mujika & Padilla, 2000b). Neither was tested here, and both warrant prospective comparison.

Direct body-composition assessment, with appropriate awareness of measurement limitations, is preferred (Chapman et al., 2025; Harty et al., 2021). Future research should confirm these inferences through controlled comparison: a prospective study contrasting an intensity-preserving maintenance phase with the present reduced-intensity protocol, with training load quantified by modality and body composition assessed by a reference method, to determine whether program design can prevent later-phase regression.

CONCLUSION

The main contribution of this study was to resolve the phase-by-phase trajectory of physical fitness and body composition across a complete 40-week macrocycle, rather than the net change reported by most prior work. Fitness rose to a peak at the end of the development phase and then regressed, but the regression was outcome-specific in its timing. Sit-up and aerobic losses occurred during the combat-specific phase, whereas push-up performance fell only when pressing work was withdrawn during maintenance. The practical implication is that intermediate assessment is necessary, because an entry-to-exit design would have reported a successful program while missing both the mid-program peak and the subsequent loss. Whether preserving intensity while reducing volume would sustain peak fitness was not tested and requires prospective comparison.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows:

Conceptualisation: E.W.M.C., H.M. Methodology: H.M., E.W.M.C., S.M.M.-R. Formal analysis: H.M. Investigation: M.F.A., S.H.H., R.S., E.W.M.C. Data curation: H.M., M.F.A., S.H.H., R.S. Writing – original

draft: H.M. Writing – review & editing: H.M., E.W.M.C., S.M.M.-R., M.F.A., S.H.H., R.S. Supervision: E.W.M.C., S.M.M.-R.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

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REFERENCES

Bosquet, L., Montpetit, J., Arvisais, D., & Mujika, I. (2007). Effects of tapering on performance: A meta-analysis. *Medicine & Science in Sports & Exercise, 39*(8), 1358–1365. https://doi.org/10.1249/MSS.0b013e31806010e0

Bunn, P. D. S., Meireles, F. O. A., Sodré, R. S., Rodrigues, A. I., & Silva, E. B. (2021). Risk factors for musculoskeletal injuries in military personnel: A systematic review with meta-analysis. *International Archives of Occupational and Environmental Health, 94*(6), 1173–1189. https://doi.org/10.1007/s00420-021-01700-3

Burger, S. C., Bertram, S. R., & Stewart, R. I. (1990). Assessment of the 2.4 km run as a predictor of aerobic capacity. *South African Medical Journal, 78*(6), 327–329.

Burley, S. D., Drain, J. R., Sampson, J. A., & Groeller, H. (2018). Positive, limited and negative responders: The variability in physical fitness adaptation to basic military training. *Journal of Science and Medicine in Sport, 21*(11), 1168–1172. https://doi.org/10.1016/j.jsams.2018.06.018

Chapman, C. L., Giersch, G. E. W., Gwin, J. A., Goldenstein, S. C., Schafer, E. A., Roberts, B. M., Looney, D. P., Kenefick, R. W., Karl, J. P., Pasiakos, S. M., Cheuvront, S. N., & Margolis, L. M. (2025). Body

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composition and physical readiness in military servicemembers: Cross-disciplinary advances and current challenges. *Exercise, Sport, and Movement, 3*(1), e00050. https://doi.org/10.1249/ESM.0000000000000050

Cialdella-Kam, L., Bloedon, T. K., & Stone, M. S. (2023). Body composition as a marker of performance and health in military personnel. *Frontiers in Sports and Active Living, 5*, 1223254. https://doi.org/10.3389/fspor.2023.1223254

Coffey, V. G., & Hawley, J. A. (2017). Concurrent exercise training: Do opposites distract? *The Journal of Physiology, 595*(9), 2883–2896. https://doi.org/10.1113/JP272270

Coge, M., Neiva, H. P., Pereira, A., Faíl, L., Ribeiro, B., & Esteves, D. (2024). Effects of 34 weeks of military service on body composition and physical fitness in military cadets of Angola. *Journal of Functional Morphology and Kinesiology, 9*(3), 111. https://doi.org/10.3390/jfmk9030111

De La Motte, S. J., Gribbin, T. C., Lisman, P., Murphy, K., & Deuster, P. A. (2017). Systematic review of the association between physical fitness and musculoskeletal injury risk: Part 2: Muscular endurance and muscular strength. *Journal of Strength and Conditioning Research, 31*(11), 3218–3234. https://doi.org/10.1519/JSC.0000000000002174

Fyfe, J. J., Bishop, D. J., & Stepto, N. K. (2014). Interference between concurrent resistance and endurance exercise: Molecular bases and the role of individual training variables. *Sports Medicine, 44*(6), 743–762. https://doi.org/10.1007/s40279-014-0162-1

Gobbo, L. A., Langer, R. D., Marini, E., Buffa, R., Borges, J. H., Pascoa, M. A., Cirolini, V. X., Guerra-Júnior, G., & Gonçalves, E. M. (2022). Effect of physical training on body composition in Brazilian military. *International Journal of Environmental Research and Public Health, 19*(3), 1732. https://doi.org/10.3390/ijerph19031732

Harty, P. S., Friedl, K. E., Nindl, B. C., Harry, J. R., Vellers, H. L., & Tinsley, G. M. (2021). Military body composition standards and physical performance: Historical perspectives and future directions. *Journal of Strength and Conditioning Research, 35*(12), 3551–3561. https://doi.org/10.1519/JSC.0000000000004142

Heilbronn, B. E., Doma, K., Gormann, D., Schumann, M., & Sinclair, W. H. (2020). Effects of periodized vs. nonperiodized resistance training on army-specific fitness and skills performance. *Journal of Strength and Conditioning Research, 34*(3), 738–753. https://doi.org/10.1519/JSC.0000000000003029

Helén, J., Kyröläinen, H., Ojanen, T., Pihlainen, K., Santtila, M., Heikkinen, R., & Vaara, J. P. (2023). High-intensity functional training induces superior training adaptations compared with traditional military physical training. *Journal of Strength and Conditioning Research, 37*(12), 2477–2483. https://doi.org/10.1519/JSC.0000000000004559

Huiberts, R. O., Wüst, R. C. I., & van der Zwaard, S. (2024). Concurrent strength and endurance training: A systematic review and meta-analysis on the impact of sex and training status. *Sports Medicine, 54*(2), 485–503. https://doi.org/10.1007/s40279-023-01943-9

Jones, B. H., Hauret, K. G., Dye, S. K., Hauschild, V. D., Rossi, S. P., Richardson, M. D., & Friedl, K. E. (2017). Impact of physical fitness and body composition on injury risk among active young adults: A study of Army trainees. *Journal of Science and Medicine in Sport, 20*(Suppl. 4), S17–S22. https://doi.org/10.1016/j.jsams.2017.09.015

Kassim, M., & Mokhtar, R. (2016). The evaluation of cardiovascular endurance test for male cadet officers. *Modern Applied Science, 10*(2), 11–16. https://doi.org/10.5539/mas.v10n2p11

Kraemer, W. J., Vescovi, J. D., Volek, J. S., Nindl, B. C., Newton, R. U., Patton, J. F., Dziados, J. E., French, D. N., & Häkkinen, K. (2004). Effects of concurrent resistance and aerobic training on load-bearing performance and the Army physical fitness test. *Military Medicine, 169*(12), 994–999. https://doi.org/10.7205/MILMED.169.12.994

Kyröläinen, H., Pihlainen, K., Vaara, J. P., Ojanen, T., & Santtila, M. (2018). Optimising training adaptations and performance in military environment. *Journal of Science and Medicine in Sport, 21*(11), 1131–1138. https://doi.org/10.1016/j.jsams.2017.11.019

Maroni, T. D., Siddall, A. G., Rue, C. A., Needham-Beck, S. C., Walker, F. S., Greeves, J. P., Blacker, S. D., & Myers, S. D. (2024). Beyond change scores: Employing an improved statistical approach to analyze the impact of entry fitness on physical performance during British Army basic training in men and women. *Scandinavian Journal of Medicine & Science in Sports, 34*(4), e14610. https://doi.org/10.1111/sms.14610

McCleary, S. C., Uthoff, A., & Cross, M. R. (2026). What are the acute and chronic effects of initial military training on physiological and neuromuscular performance in military populations? A narrative review. *Sports Medicine, 56*, 1881–1898. https://doi.org/10.1007/s40279-026-02431-6

Molloy, J. M., Pendergrass, T. L., Lee, I. E., Chervak, M. C., Hauret, K. G., & Rhon, D. I. (2020). Musculoskeletal injuries and United States Army readiness part I: Overview of injuries and their strategic impact. *Military Medicine, 185*(9–10), e1461–e1471. https://doi.org/10.1093/milmed/usaa027

Mpampoulis, T., Methenitis, S., Stasinaki, A. N., Zaras, N., Bogdanis, G. C., & Terzis, G. (2025). Effect of different reduced training frequencies after 12 weeks of concurrent ballistic and aerobic training on muscle power and triceps brachii muscle architecture. *Journal of Functional Morphology and Kinesiology, 10*(1), 37. https://doi.org/10.3390/jfmk10010037

Mujika, I., & Padilla, S. (2000a). Detraining: Loss of training-induced physiological and performance adaptations. Part I: Short-term insufficient training stimulus. *Sports Medicine, 30*(2), 79–87. https://doi.org/10.2165/00007256-200030020-00002

Mujika, I., & Padilla, S. (2000b). Detraining: Loss of training-induced physiological and performance adaptations. Part II: Long-term insufficient training stimulus. *Sports Medicine, 30*(3), 145–154. https://doi.org/10.2165/00007256-200030030-00001

Müller-Schilling, L., Gundlach, N., Böckelmann, I., & Sammito, S. (2019). Physical fitness as a risk factor for injuries and excessive stress symptoms during basic military training. *International Archives of Occupational and Environmental Health, 92*(6), 837–841. https://doi.org/10.1007/s00420-019-01423-6

Murlasits, Z., Kneffel, Z., & Thalib, L. (2018). The physiological effects of concurrent strength and endurance training sequence: A systematic review and meta-analysis. *Journal of Sports Sciences, 36*(11), 1212–1219. https://doi.org/10.1080/02640414.2017.1364405

Murray, A., Fraser, J. J., Bazett-Jones, D. M., & Norte, G. E. (2025). Changes in physical performance following operational military training: A meta-analysis. *Sports Medicine – Open, 11*, 18. https://doi.org/10.1186/s40798-025-00815-y

Nindl, B. C., Beals, K., Witchalls, J., & Friedl, K. E. (2017). Military human performance optimization and injury prevention: Strategies for the 21st century warfighter. *Journal of Science and Medicine in Sport, 20*(Suppl. 4), S1–S2. https://doi.org/10.1016/j.jsams.2017.10.029

O'Leary, T. J., Gifford, R. M., Knight, R. L., Wright, J., Handford, S., Venables, M. C., Reynolds, R. M., Woods, D., Wardle, S. L., & Greeves, J. P. (2024). Sex differences in energy balance, body composition, and metabolic and endocrine markers during prolonged arduous military training. *Journal of Applied Physiology, 136*(4), 938–948. https://doi.org/10.1152/japplphysiol.00864.2023

Ojanen, T., Pihlainen, K., Vaara, J. P., & Kyröläinen, H. (2023). Physiological and physical performance changes during a 20-day winter military training course and its subsequent 10-day recovery period. *International Journal of Circumpolar Health, 82*(1), 2207287. https://doi.org/10.1080/22423982.2023.2207287

 © 2027 ARD Asociación Española

Pierce, J. R., Cohen, B. S., Hauret, K. G., Sharp, M. A., Redmond, J. E., Foulis, S. A., & Hydren, J. R. (2024). Likelihood of fitness improvements during a standardised physical fitness programme in US Army trainees of different fitness levels. *BMJ Military Health*. Advance online publication. https://doi.org/10.1136/military-2024-002763

Pihlainen, K., Santtila, M., Nindl, B. C., Raitanen, J., Ojanen, T., Vaara, J. P., Vasankari, T., & Kyröläinen, H. (2023). Changes in physical performance, body composition and physical training during military operations: Systematic review and meta-analysis. *Scientific Reports, 13*, 21455. https://doi.org/10.1038/s41598-023-48712-2

Pihlainen, K., Vaara, J. P., Ojanen, T., Santtila, M., Vasankari, T., Tokola, K., & Kyröläinen, H. (2020). Effects of baseline fitness and BMI levels on changes in physical fitness during military service. *Journal of Science and Medicine in Sport, 23*(9), 841–845. https://doi.org/10.1016/j.jsams.2020.02.006

Rhon, D. I., Molloy, J. M., Monnier, A., Hando, B. R., & Newman, P. M. (2022). Much work remains to reach consensus on musculoskeletal injury risk in military service members: A systematic review with meta-analysis. *European Journal of Sport Science, 22*(1), 16–34. https://doi.org/10.1080/17461391.2021.1931464

Robinson, M., Siddall, A., Bilzon, J., Thompson, D., Greeves, J., Izard, R., & Stokes, K. (2016). Low fitness, low body mass and prior injury predict injury risk during military recruit training: A prospective cohort study in the British Army. *BMJ Open Sport & Exercise Medicine, 2*(1), e000100. https://doi.org/10.1136/bmjsem-2015-000100

Rue, C. A., Myers, S. D., Coakley, S. L., Ashdown, K., Lee, B. J., Hale, B. J., Saunders, S. C., Maroni, T. D., Walker, F. S., Greeves, J. P., Blacker, S. D., & Siddall, A. G. (2024). Changes in physical performance during British Army Junior Entry, British Army Standard Entry and Royal Air Force basic training. *BMJ Military Health, 170*(6), 484–490. https://doi.org/10.1136/military-2022-002285

Santtila, M., Pihlainen, K., Koski, H., Ojanen, T., & Kyröläinen, H. (2019). Physical fitness and body anthropometrics profiles of the female recruits entering to voluntary military service. *Military Medicine, 184*(1–2), e200–e205. https://doi.org/10.1093/milmed/usy145

Tomes, C. D., Sawyer, S., Orr, R., & Schram, B. (2020). Ability of fitness testing to predict injury risk during initial tactical training: A systematic review and meta-analysis. *Injury Prevention, 26*(1), 67–81. https://doi.org/10.1136/injuryprev-2019-043245

Vaara, J. P., Groeller, H., Drain, J., Kyröläinen, H., Pihlainen, K., Ojanen, T., Connaboy, C., Santtila, M., Agostinelli, P., & Nindl, B. C. (2022). Physical training considerations for optimizing performance in essential military tasks. *European Journal of Sport Science, 22*(1), 43–57. https://doi.org/10.1080/17461391.2021.1930193

Varanoske, A. N., Harris, M. N., Hebert, C., Johannsen, N. M., Heymsfield, S. B., Greenway, F. L., Beyl, R. A., Marcotte-Chénard, A., Margolis, L. M., & Pasiakos, S. M. (2023). Bioelectrical impedance phase angle is associated with physical performance before but not after simulated multi-stressor military operations. *Physiological Reports, 11*(6), e15649. https://doi.org/10.14814/phy2.15649

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *The Lancet, 370*(9596), 1453–1457. https://doi.org/10.1016/S0140-6736(07)61602-X



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