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Anthropometrical and Physical Performance Profiles of Military Cadets from Angola

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Abstract

Military efforts must include different evaluations to prepare for battles around the world. This study aimed to characterize the body composition and physical performance levels of military cadets from Angola. Ninety military academy participants (males: n=48, females: n=42) aged 18-24 years old performed a battery of physical fitness tests to evaluate upper and lower limbs muscle strength, cardiorespiratory fitness, and body composition. Significant differences between sexes were observed in all variables ($p<0.05$). Males and females, respectively, showed normal-range values in the body mass index (BMI) (23.32±3.95; 24.75±4.01 Kg/m2), body fat (9.09±6.17; 14.59±8.86 kg), push-ups (36.88±9.81; 20.67±6.62 repetitions), sit-ups (71.04±17.14; 61.95±19.05 repetitions) and medicine ball throwing (5.06±0.89; 4.00±0.84 m). However, countermovement jump (36.14±6.54; 23.53±7.62 cm), 80-meter sprint (13.08±1.90; 14.96±2.01 s), cardiorespiratory fitness (maximal oxygen uptake: 38.02±6.3; 33.18±6.49 ml/kg/min), and fat-free mass values (54.17 ± 8.06; 46.18 ± 6.9 kg) were considered low, specifically in females. Military cadets from Angola, especially females, presented low values of fat-free mass, cardiorespiratory fitness, and neuromuscular maximal performances (countermovement jump and sprint). This highlights a need for body composition and physical condition improvement to perform physical tasks with high military relevance.

Keywords: *cadets, military, profile, body composition, physical fitness*

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Introduction

Recent wars have highlighted the need to maintain military performance capabilities in demanding operations. These soldiers are expected to engage in regular vigorous physical activity to maintain the highest possible level of physical fitness (Okhrimenko et al., 2023). This is the only way they can maintain their physical standards to perform their duties at all times (Friedl, 2012). It has been shown that soldiers who are physically active on a daily basis perform better in combat and are more resilient in stressful situations (Flanagan et al., 2012). In addition, previous findings have shown that performance on military-specific tasks is improved by higher levels of physical fitness and scores on tests throughout the service (Harty et al., 2022; Romanchuk et al., 2021). Furthermore, these soldiers

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are less likely to develop diseases and musculoskeletal injuries due to the protective effects of physical activity on the entire body structure and better long-term health (Jones et al., 2017; Havenetidis et al., 2013). Physical fitness also has an impact on mental health, with several studies showing the benefits of physical fitness on mental health (Okhrimenko et al., 2023).

Some have argued that the physical fitness level of a military member should be higher than that of the general population because their missions are performed in a large variety of environments and require different physical abilities (Santtila et al., 2009; Maupin et al., 2018). Among the most commonly assessed and monitored components of physical fitness in the military are body composition, muscular strength, endurance, speed, and cardiorespiratory fitness (Maupin et al., 2018). Good levels of strength and endurance are essential to support the physical skills that are required for successful military combat activities (Santtila et al., 2009; Santtila et al., 2008). For example, a high level of physical fitness can increase the ability to generate strength and power, delay fatigue, and speed up recovery (Bulmer et al., 2022; Booth, 2006). In addition, the development of specific physical characteristics affects the overall ability to perform simple and complex motor activities. As a result, it is widely accepted that this is the foundation of military forces readiness (Knapik et al., 2012).

In addition to physical ability, the importance of body composition to overall performance cannot be ignored. Previous research has shown that body composition is associated with aerobic capacity and muscular endurance (Moreno et al., 2019). In fact, soldiers with more fat mass tend to have more difficulty performing lower and upper body strength tests, jumping and sprinting tasks, and cardiorespiratory fitness tests (Santtila et al., 2009; Campos et al., 2018, Hollerbach et al., 2022). In addition, health is known to be influenced by body composition, body weight, and body mass index (BMI), which are commonly associated with an increased risk of cardiovascular disease, type 2 diabetes, musculoskeletal disorders, and certain types of cancers (Santtila et al., 2008; Santtila et al., 2019).

Over the years, there seems to have been a trend toward a decline in physical fitness among military recruits (Hoerster et al., 2012; Meadows et al., 2018). For example, the physical fitness levels of 3.875 female recruits changed significantly between 2005 and 2015, with body mass and BMI increasing by 4.2% and 3.8%, respectively (Santtila et al., 2019). Moreover, the proportion of female recruits with poor endurance performance increased by approximately 8% during these 10 years. This reinforces the need to monitor and evaluate military performance to help design appropriate training programs for this population. A deeper understanding of the physical fitness profiles of the military forces is important for analyzing recruit selection and supporting the development of specific strength and conditioning programs, particularly in some countries where this knowledge is scarce. Specific physical fitness profiles would make it possible to assess specific performance measures that determine success, address areas of weakness within the individual's fitness profile, and thus design a customized training program for each unit or individual (Maupin et al., 2018; Hall et al., 2022). In addition, these profiles would allow reduce the risk of injury and provide information for the design of specific training programs (e.g., return to training after a period of inactivity) (Roy et al., 2012). Therefore, the present study aimed to analyze the body composition, upper and lower limb muscle strength, and cardiorespiratory fitness of military cadets from the Instituto Superior Técnico Militar of Angola.

Methods

Study Design

In this cross-sectional study, the participants were recruited from the Instituto Superior Técnico Militar from Angola by convenience sampling. Participants ranged in age from 18 to 24 years old and had no recent history (within 6 months) of medical disorders that limited participation in their physical training activities. Participants were informed about the study protocol, and once they agreed, they voluntarily signed the informed consent form. The evaluation tests have been selected for their relevance in assessing the physical condition and their common use by conditioning specialists and coaches in sports training. The procedures were performed according to the Declaration of Helsinki and were approved by the review board of the Research Center in Sports Sciences, Health Sciences and Human Development of the University of Beira Interior, Portugal.

Participants

Ninety military personnel (48 male and 42 female) from the Instituto Superior Técnico Militar in Angola volunteered to participate in the study. Subjects were asked to report any previous illnesses, injuries, or other physical problems, and were excluded if there was any evidence of an orthopedic or clinical problem or any other self-reported problem that would compromise their health. Inclusion criteria to participate in the study were to be cadets at the Instituto Superior Técnico Militar of Angola, to be free of injury, and able to complete all physical and anthropometric assessments. They were excluded if they had any medical condition (temporary or permanent) or injury preventing exercise participation, had an implanted electrical medical device, or were pregnant. Participants were carefully informed about the study design, with specific information about potential risks and discomforts that may occur.

Procedures

After two familiarization sessions, the evaluations were performed in different sessions (48 hours between) for two weeks. In the first session, height was determined by a stadiometer (Seca, Hamburg, Germany), and body mass, body fat, and fat-free mass were determined by bioelectrical impedance analysis (OMRON HBF 510, Omron Healthcare, Inc., Illinois, USA). The device that was used was shown to be both reliable and valid for predicting fat-free mass and appropriate to use for body composition assessment in the adult population (Vasold et al., 2019). Participants' age, height, and sex were entered into the device and then the participant stepped barefoot onto it with feet width apart. Participants were instructed to hold the display unit with both hands and extend their arms parallel to the floor. The body composition assessment was performed after waking up and the participants were instructed to avoid alcohol and vigorous exercise 24 hours before evaluation. Body mass index (BMI) was calculated afterward. For ethical reasons, there was no recording of menstrual cycle time in female participants.

The following sessions were used to assess physical fitness, randomly: push-ups, medicine ball throwing, sit-ups, countermovement jump (CMJ), 80-meter sprint, and shuttle run test. The push-ups assessment was performed with the subject lying prone on the floor with both hands under the shoulders and pushed up off the floor until the elbows were straight while keeping the entire body straight. The participant then lowered the body with the arms until the elbows were bent at a 90° angle. Participants were instructed to repeat the exercise for 1 minute as many times as possible, stopping if they could not perform the push-up correctly (Santilla et al., 2019).

For the sit-ups evaluation, participants started with their feet and shoulders flat on the floor and their knees at a 90º angle with their arms crossed over their chest. A second person held the lower legs or ankles. At the beginning of the exercise, they were asked to lift their torso, bringing their chest toward their knees. When the subjects reached an angle of about 30º between their torso and the floor, they could return to the starting position. They were instructed to repeat the exercise as many times as possible for 2 minutes, stopping if they could not perform the sit-up correctly (Lin et al., 2022).

For the strength assessments, upper-body and lower-body muscular power were assessed by medicine ball throwing and CMJ, respectively. For lower-body assessment, sprint performance was also evaluated. In the medicine ball throwing assessment, each participant seated against a wall at a 90°angle with his legs straight out and his head against the wall and then threw a 3kg medicine ball horizontally with as much force as possible without moving his back or head. The distance was then measured with a tape measure. Each participant had three attempts (3 minutes rest) and the highest value was recorded (Borms et al., 2018). In the CMJ, each participant performed three maximal jumps (3 minutes of rest between trials), and the height was measured (Optojump photocell system, Microgate, Bolzano, Italy). All CMJs were performed with the hands on the hips throughout the test. While standing upright, participants were instructed to bend their knees to a squatting position (90º) and immediately rebound in a maximal vertical jump. The best height score was recorded for analysis (Claudino et al., 2017). Regarding sprint, two test trials of 80m linear sprint running were performed (10 minutes of rest between trials). The time taken to complete the 80 m distance was measured by two experienced coaches using a chronometer (Golfinho Sports MC 815, Aveiro, Portugal). The mean value was recorded for further analysis.

The cardiorespiratory fitness was evaluated by a shuttle run test. This test required running between two lines set 20 meters apart at a speed dictated by a stereo system that played sounds at predetermined intervals. The initial speed was set at 8.5km/h for the first minute and increased by 0.5 km/h each minute. The test score achieved by the subject was the number of 20-meter shuttles completed before the participant either gave up voluntarily or failed to be within 3 meters of the end lines on two consecutive tones (Paradisis et al., 2014). Maximal oxygen uptake (VO2max) was then determined using a validated equation (Flouris et al., 2005): Vo2max = (MAS x 6.65-35.8) x 0.95 + 0.182, where MAS is the maximal attained speed during shuttle run test (km/h) and Vo2max is the predicted maximal oxygen uptake (ml/kg/min).

Statistical analysis

Means and standard deviations (SDs) were calculated for all measures, and 95% confidence intervals were determined. The normality of all distributions was tested using the Kolmogorov–Smirnov test and non-parametric statistical analysis was applied. The Mann-Whitney U Test was used to compare means, and the level of statistical significance was set at p≤0.05. A specific effect size calculator was used to determine the effect size of the non-normally distributed variables (Hopkins et al., 2009). The effect size calculator for non-parametric tests was used to determine the eta square and then converted to Cohen's d values for standardization (Lenhard et al., 2016). Cohen's d values were 0.20, 0.60, 1.20, and 2.00, corresponding to small, moderate, large, and very large magnitudes, respectively (Hopkins et al., 2009). A percentile distribution was then generated for each of the variables analyzed in the study. Statistical analyses were performed in Microsoft Office Excel® (Microsoft Inc., Redmond, WA, USA) and SPSS v28 (IBM Corp., Armonk, NY, USA). Data were plotted using GraphPad Prism v7 (GraphPad Inc., San Diego, CA, USA).

Results

Physical performance and anthropometric characteristics are presented in Table 1 for males and Table 2 for females. Differences between men and women were found for height (p<0.001, d=1.50), BMI (p=0.019, d=0.51), body fat (percentage: p<0.001, d=0.96; kg: p<0.001, d=0.75), fat-

Table 1. Anthropometric characteristics and physical test results of the male militaries (n = 48)

	Mean ± SD	Range	Percentiles		
			25	50	75
Age (y)	20.92 ± 1.49	19 – 24	20	20	23
Height (m)	1.69 ± 0.07	1.52 – 1.84	1.64	1.70	1.75
Body mass (Kg)	66.34 ± 10.02	51.8 – 102.2	58.63	64.65	72.35
BMI (Kg/m^2)	23.32 ± 3.95	18.67 – 38.47	21.09	22.28	24.60
Body fat (Kg)	9.09 ± 6.17	2.68 – 33.69	5.27	7.19	11.53
Body fat (%)	13.12 ± 7.07	5.0 – 38.2	8.38	10.95	16.10
Fat-free mass (Kg)	54.17 ± 8.06	25.0 – 71.7	50.15	53.30	58.75
VO$_2$max (ml/kg/min)	38.02 ± 6.30	23.03 – 54.62	32.51	38.41	41.98
Push-ups (n)	36.88 ± 9.81	15 – 56	30.0	35.5	45.0
CMJ (cm)	36.14 ± 6.54	17.71 – 47.14	33.16	37.09	40.90
Sit-ups (n)	71.04 ± 17.14	26 - 98	60.25	70.00	84.50
80-meter sprint (s)	13.08 ± 1.90	10.45 – 18.21	11.47	12.51	14.45
Medicine ball throw (m)	5.06 ± 0.89	3.2 – 6.9	4.40	5.00	5.78

free mass (p<0.001, d=1.06), push-ups (p<0.001, d=2.08), CMJ (p<0.001, d=1.79), sit-ups (p=0.019, d=0.50), 80-meter sprint (p<0.001, d=1.03), VO2max (p<0.001, d=0.75), and medicine ball throwing (p<0.001, d=1.27). Despite higher body height, body mass, and fat-free mass, men had lower BMI and fat mass. In addition, physical fitness variables showed higher mean values in men, specifically the number of push-ups, sit-ups, VO2max, medicine ball throwing, and CMJ. Men were also faster than women in the 80-meter sprint.

Table 2. Anthropometric characteristics and physical test results of the female militaries (n=42)

	Mean ± SD	Range	Percentiles		
			25	50	75
Age (y)	20.31 ± 1.49	18 – 24	19	20	21
Height (m)	1.60 ± 0.06	1.46 – 1.71	1.56	1.60	1.64
Body mass (Kg)	63.10 ± 11.03	45.3 – 89.5	53.83	64.10	69.20
BMI (Kg/m^2)	24.75 ± 4.01	16.82 – 35.33	22.55	24.50	27.13
Body fat (Kg)	14.59 ± 8.86	2.42 – 37.77	7.33	12.33	19.29
Body fat (%)	22.13 ± 10.19	6.0 – 42.4	12.13	23.55	28.98
Fat-free mass (Kg)	46.18 ± 6.90	34.9 – 62.7	40.25	46.00	51.13
VO_2max (ml/kg/min)	33.18 ± 6.49	23.03 – 48.30	29.35	32.51	38.82
Push-ups (n)	20.67 ± 6.62	10 – 40	16.75	20.00	25.00
CMJ (cm)	23.53 ± 7.62	9.61 – 42.69	17.71	22.69	28.25
Sit-ups (n)	61.95 ± 19.05	30 – 95	48	64	75
80-meter sprint (s)	14.96 ± 2.01	11.41 – 20.55	13.44	14.63	16.41
Medicine ball throw(m)	4.00 ± 0.84	2.9 – 6.1	3.48	3.80	4.50

The individual plots presented in Figure 1 and Figure 2 allow an understanding of the distribution of results by percentiles, in each variable analyzed. In Figure 1, the anthropometric variables confirm the higher values for height, weight, and fat-free mass, and the lower values for body mass index and body fat in men. Figure 2 shows the fitness variables and confirms the higher performance of the males.

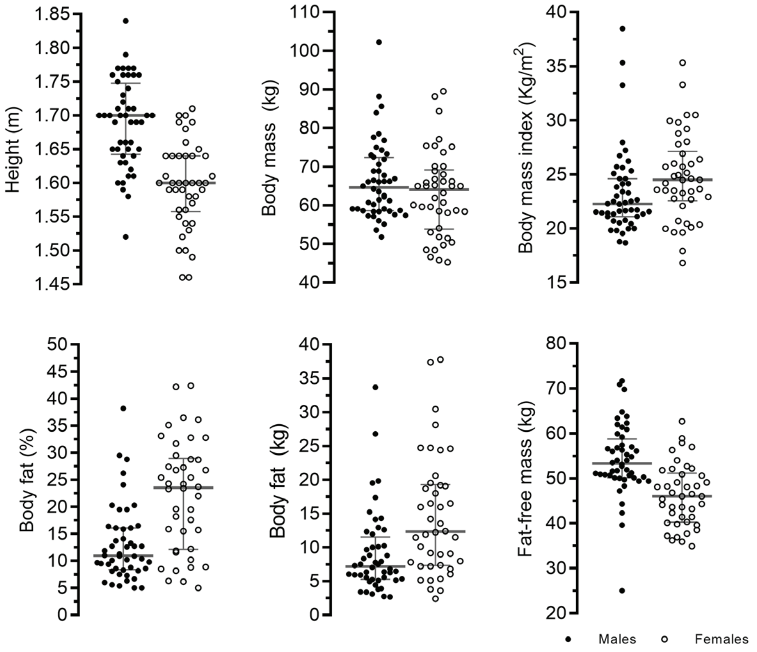

Figure 1. Individual value plot of anthropometrical variables observed in males and females. Median with interquartile range are also presented (gray lines).

Discussion

The current study aimed to characterize the fitness levels and body profiles of military cadets from the Military Higher Technical Institute of Angola. The results showed gender differences in body anthropometrics and physical performance, with males having higher body mass, fat-free mass, and lower body fat, as well as greater strength (push-ups, sit-ups, CMJ, and medicine ball throwing), speed (80m

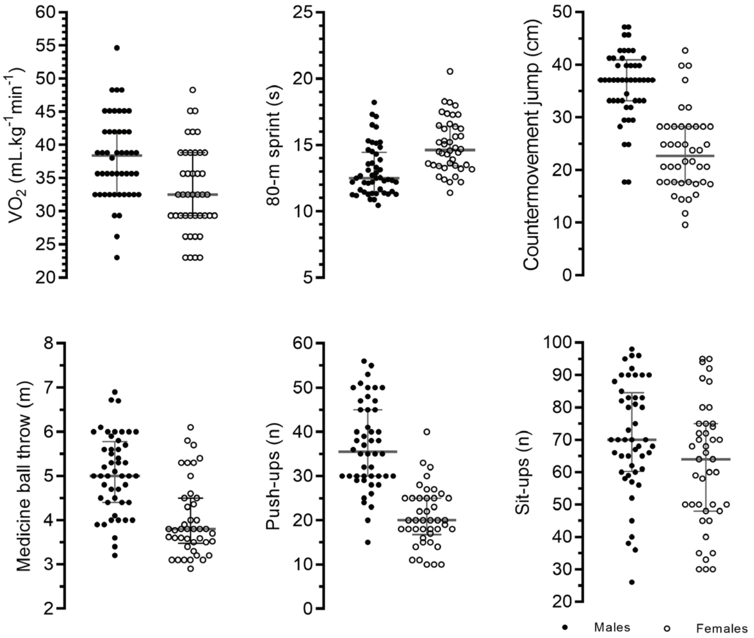

Figure 2. Individual value plot of physical performance variables observed in males and females. Median with interquartile range are also presented (gray lines).

sprint), and cardiorespiratory fitness. In addition, although anthropometric variables showed normal ranges, physical fitness tests showed low performance values, especially in women. It was also possible to determine data percentiles, which allowed the researchers to understand the spread within a distribution of values to provide a reference interval estimate. This is an important step in understanding the anthropometric and physical performance characteristics of military forces in Angola.

With respect to anthropometric measures, body fat mass and BMI recorded in other military forces were consistent with those in this study (Hall et al., 2022). For example, female and male recruits in Army Basic Training in New Zealand had mean BMI values of 26.0±3.1 kg/m2, and 24.3±3.0 kg/m2, respectively. Overall, these values are within a healthy range, although they are close to the upper limit. Thus, the potential for a higher BMI to have a protective effect against injury may hypothetically be due in part to the greater absolute muscle mass in the military. However, it is known that BMI can significantly affect physical performance and all its components (Friedl, 2022). Increases in BMI and body fat percentage may be associated with some decline in physical fitness (e.g., cardiorespiratory fitness) and reduced ability to bear external loads (Knapik et al., 2012; Romanchuk et al., 2021). Additionally, in some athletic movements, such as running or jumping, high body fat harms performance (Moreno et al., 2017; Santtila et al., 2019; Aandstad, 2020). Studies suggested that the elite military units generally have a lower body fat percentage (~15%) than the general population (~20%) and the general military (~17%) (Maupin et al., 2018). Nevertheless, recent data showed higher obesity rates among USA military officers than previous studies, especially for women (Hollerbach et al., 2022).

Despite normal BMI and body fat levels, the previously reported fat-free mass values were higher than those presented in the current study (Avila et al., 2013). Given the detrimental effects of high body fat and BMI and the need for high levels of lean body mass, exercise programs specifically designed for military newly recruits are important. For example, a 12-week training program with a total of 32 sessions of both aerobic and neuromuscular training in a sample of 130 male soldiers aged 18-19 years showed higher values at baseline (57.50±6.00kg) that increased after training (58.80±6.00kg) (Campos et al., 2017). With this in mind, it would be interesting to perform a similar exercise training program in this study to see if fat-free mass increases in the same proportion. In reference studies, exercise training programs of between 3 and 12 months, depending on the characteristics of the study, intensity, and volume of training, contribute to increases in fat-free mass (Oliver et al., 2017).

Interestingly, the physical performance assessment showed some low results for the Angolan military forces. For instance, previous studies have reported mean VO2max values slightly higher than ours in different military forces (e.g., Santtila et al., 2008; Campos et al., 2018; Figueiredo et al., 2022). The current results were relatively low and may be representative of the low cardiorespiratory fitness of this sample for males and females. The participants in the current study were at the beginning of their military service, and therefore their physical fitness is expected to change significantly with the implementation of an exercise training program. For example, aerobic exercise training has been associated with significant increases in VO2max (Santtila et al., 2008). In addition, VO2max is an important determinant of physical fitness, so higher levels may translate into better military performance (Santtila et al., 2008; Knapik et al., 2017).

For the push-up performance test, the present results are consistent with the literature, which reported trend values of around 15 repetitions for females and around 35 repetitions for males (Jones et al., 2017, Knapik et al., 2017). In addition to push-ups, medicine ball throwing was also analyzed, as this was found to be the best of eight muscle fitness tests in predicting performance in both heavy lifting and carrying a task (Knapik et al., 2012; Harman et al., 2008). In addition, it was suggested that this assessment would make a significant contribution to defining the Army's mission performance (Aandstad et al., 2020). Some studies of military personnel at the beginning of their careers have shown an average of between 3 and 2m for men and women, respectively. These values are much lower than those presented in the current study for males and females. It should also be noted that the recruits who participated in the current study had no prior experience with military physical training. Perhaps the explanation for the higher upper body explosive strength could be due to the age and somatic characteristics of this sample, as previously reported (Aandstad et al., 2020).

Regarding the lower body neuromuscular performance, some authors have used similar tests, such as standing vertical and horizontal jumps, to simulate military tasks that could be added to field tests to expand the range of movement skills tested (e.g., Knapik et al., 2017). The values of both female and male cadets in this study were lower than some previous findings (e.g., Havenetidis et al., 2013), but similar to other results (e.g., Knapik et al., 2017; Pihlainen et al., 2018). These inconsistencies may arise due to differences in the study population, context, and testing equipment (Merrigan et al., 2020). Sprint times were also recorded to assess lower-body neuromuscular performance. The current sprint times were similar to those reported in recent studies (Romanchuk et al., 2021). However, the distance ran in the present study was lower (80 m vs. 100 m), which reveals the low sprint performance of the participants of the current study. Although no studies have reported 80-meter sprint running times in this context, the results presented suggest that the military personnel included in this study should train to improve their performance on this speed test. Contrary to most of the physical variables in the current study, the sit-up performance was consistent with previous findings in military forces (Oliver et al., 2017). This measure is used to determine the effect of physical fitness on the risk of musculoskeletal injury in Army training, but it should be interpreted carefully (Jones et al., 2017; Roy et al., 2021).

In summary, this research showed that body composition assessment and physical fitness can provide a characterization of military cadets, with a percentile distribution of military cadets from Angola. Low values of fat-free mass, cardiorespiratory fitness, and neuromuscular maximal performances highlight a need for specific training programs for body composition and physical condition improvement. Future studies should analyze innovative training protocols designed to stimulate strength and aerobic gains. Some limitations should be acknowledged, including the lack of circumference measurements and skinfolds for body composition assessment or other physical variables to complement evaluations. Also, despite the participants being instructed regarding diet and exercise, we should be aware that bioimpedance analysis for body composition assessment may be influenced by factors such as hydration status, skin temperature, or menstrual cycle. Interpreting and generalizing the findings of the present study must be done with caution and these data do not represent the whole population. Nevertheless, the representative sample used in the present study showed a significant contribution that can help design new strategies for the quality of future research and practical applications regarding military investigations.

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References

Aandstad, A. (2020). Association Between Performance in Muscle Fitness Field Tests and Skeletal Muscle Mass in Soldiers. *Military Medicine*, *185*(5-6), e839–e846. https://doi.org/10.1093/milmed/usz437

Avila, J. A., Lima Filho, P. D. B., Páscoa, M. A., & Tessutti, L. S. (2013). Efeito de 13 semanas de treinamento físico militar sobre a composição corporal e o desempenho físico dos alunos da escola preparatória de cadetes do exército. *Revista Brasileira De Medicina Do Esporte*, *19*(5), 363–366. https://doi.org/10.1590/S1517-86922013000500013

Booth, C. K., Probert, B., Forbes-Ewan, C., & Coad, R. A. (2006). Australian army recruits in training display symptoms of overtraining. *Military Medicine*, *171*(11), 1059–1064. https://doi.org/10.7205/milmed.171.11.1059

Borms, D., & Cools, A. (2018). Upper-Extremity Functional Performance Tests: Reference Values for Overhead Athletes. *International Journal of Sports Medicine*, *39*(6), 433–441. https://doi.org/10.1055/a-0573-1388

Bulmer, S., Aisbett, B., Drain, J. R., Roberts, S., Gastin, P. B., Tait, J., & Main, L. C. (2022). Sleep of recruits throughout basic military training and its relationships with stress, recovery, and fatigue. *International Archives of Occupational and Environmental Health*, *95*(6), 1331–1342. https://doi.org/10.1007/s00420-022-01845-9

Campos, L. C. B., Campos, F. A. D., Bezerra, T. A. R., & Pellegrinotti, Í. L. (2017). Effects of 12 Weeks of Physical Training on Body Composition and Physical Fitness in Military Recruits. *International Journal of Exercise Science*, *10*(4), 560–567.

Claudino, J. G., Cronin, J., Mezêncio, B., McMaster, D. T., McGuigan, M., Tricoli, V., Amadio, A. C., & Serrão, J. C. (2017). The countermovement jump to monitor neuromuscular status: A meta-analysis. *Journal of Science and Medicine in Sport*, *20*(4), 397–402. https://doi.org/10.1016/j.jsams.2016.08.011

Lin, Y. K., Tsai, K. Z., Han, C. L., Lee, J. T., & Lin, G. M. (2022). Athlete's heart assessed by sit-up strength exercises in military men and women: the CHIEF heart study. *Frontiers in Cardiovascular Medicine*, *8*, 737607. https://doi.org/10.3389/fcvm.2021.737607

Figueiredo, P. S., Looney, D. P., Pryor, J. L., Doughty, E. M., McClung, H. L., Vangala, S. V., Santee, W. R., Beidleman, B. A., & Potter, A. W. (2022). Verification of Maximal Oxygen Uptake in Active Military Personnel During Treadmill Running. *Journal of Strength and Conditioning Research*, *36*(4), 1053-1058. https://doi.org/10.1519/JSC.0000000000004019

Flanagan, S. C., Kotwal, R. S., & Forsten, R. D. (2012). Preparing soldiers for the stress of combat. *Journal of Special Operations Medicine: a peer reviewed journal for SOF medical professionals*, *12*(2), 33–41. https://doi.org/10.55460/RPAT-ESAK

Flouris, A. D., Metsios, G. S., & Koutedakis, Y. (2005). Enhancing the efficacy of the 20 m multistage shuttle run test. *British Journal of Sports Medicine*, *39*(3), 166–170. https://doi.org/10.1136/bjsm.2004.012500

Friedl K. E. (2012). Body composition and military performance--many things to many people. *Journal of Strength and Conditioning Research*, *26 Suppl 2*, S87–S100. https://doi.org/10.1519/JSC.0b013e31825ced6c.

Hall, N., Constantinou, M., Brown, M., Beck, B., Steele, M., Rousseau, J., & Kuys, S. (2022). Profiles of Recruits Entering Army Basic Training in New Zealand. *Military medicine*, usac090. Advance online publication. https://doi.org/10.1093/milmed/usac090

Harman, E. A., Gutekunst, D. J., Frykman, P. N., Nindl, B. C., Alemany, J. A., Mello, R. P., & Sharp, M. A. (2008). Effects of two different eight-week training programs on military physical performance. *Journal of Strength and Conditioning Research*, *22*(2), 524–534. https://doi.org/10.1519/JSC.0b013e31816347b6

Harty, P. S., Friedl, K. E., Nindl, B. C., Harry, J. R., Vellers, H. L., & Tinsley, G. M. (2022). Military Body Composition Standards and Physical Performance: Historical Perspectives and Future Directions. *Journal of Strength and Conditioning Research*, *36*(12), 3551–3561. https://doi.org/10.1519/JSC.0000000000004142

Havenetidis, K., & Paxinos, T. (2013). Delineation and classification of physical conditioning in Greek Army Officer cadets. *Journal Military Veterans Health, 21*, 19–25.

Hoerster, K. D., Lehavot, K., Simpson, T., McFall, M., Reiber, G., & Nelson, K. M. (2012). Health and health behavior differences: U.S. Military, veteran, and civilian men. *American journal of preventive medicine*, *43*(5), 483–489. https://doi.org/10.1016/j.amepre.2012.07.029

Hollerbach, B.S., Haddock, C.K., Kukić, F., Poston, W.S.C., Jitnarin, N., Jahnke, S.A., DeBlauw, J.A., Heinrich, K.M. (2022). Comparisons of Baseline Obesity Prevalence and Its Association with Perceived Health and Physical Performance in Military Officers. *Biology*, *11*, 1789. https://doi.org/10.3390/biology11121789

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*(1), 3–13. https://doi.org/10.1249/MSS.0b013e31818cb278

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

Knapik, J. J., Harman, E. A., Steelman, R. A., & Graham, B. S. (2012). A systematic review of the effects of physical training on load carriage performance. *Journal of Strength and Conditioning Research*, *26*(2), 585–597. https://doi.org/10.1519/JSC.0b013e3182429853

Knapik, J. J., Sharp, M. A., & Steelman, R. A. (2017). Secular trends in the physical fitness of United States Army recruits on entry to service, 1975–2013. *The Journal of Strength & Conditioning Research*, *31*(7), 2030-2052. https://doi.org/10.1519/JSC.0000000000001928

Lenhard, W., & Lenhard, A. (2016). Calculation of Effect Sizes. Retrieved from: https://www.psychometrica.de/effect_size.html. Dettelbach (Germany): Psychometrica.

Maupin, D., Wills, T., Orr, R., & Schram, B. (2018). Fitness Profiles in Elite Tactical Units: A Critical Review. *International journal of exercise science*, *11*(3), 1041–1062.

Meadows, S. O., Engel, C. C., Collins, R. L., Beckman, R. L., Cefalu, M., Hawes-Dawson, J., Doyle, M., Kress, A. M., Sontag-Padilla, L., Ramchand, R., & Williams, K. M. (2018). 2015 Department of Defense Health Related Behaviors Survey (HRBS). *Rand health quarterly*, *8*(2), 5.

Merrigan, J. J., Stone, J. D., Thompson, A. G., Hornsby, W. G., & Hagen, J. A. (2020). Monitoring Neuromuscular Performance in Military Personnel. *International Journal of Environmental Research and Public Health*, *17*(23), 9147. https://doi.org/10.3390/ijerph17239147

Moreno, M.R., Dulla, J. M., Dawes, J., Orr, R. M., Cesario, K. A., & Lockie, R. G. (2019). Lower-body Power and its Relationship with Body Drag Velocity in Law Enforcement Recruits. *International Journal of Exercise Science, 12*(4), 847 - 858.

Okhrimenko, I. M., Chornous, V. D., Nikolaiev, O. T., Shtykh, V. A., Yuriev, S. O., Slivinskyi, Y. S., & Kotov, S. M. (2023). Formation of Psychophysical Readiness of Cadets During Applied Exercises. *Polski merkuriusz lekarski: organ Polskiego Towarzystwa Lekarskiego*, *51*(1), 48–53. https://doi.org/10.36740/Merkur202301107

Oliver, J. M., Stone, J. D., Holt, C., Jenke, S. C., Jagim, A. R., & Jones, M. T. (2017). The Effect of Physical Readiness Training on Reserve Officers' Training Corps Freshmen Cadets. *Military Medicine*, *182*(11), e1981–e1986. https://doi.org/10.7205/MILMED-D-17-00079

Paradisis, G. P., Zacharogiannis, E., Mandila, D., Smirtiotou, A., Argeitaki, P., & Cooke, C. B. (2014). Multi-Stage 20-m Shuttle Run Fitness Test, Maximal Oxygen Uptake and Velocity at Maximal Oxygen Uptake. *Journal of Human Kinetics*, *41*, 81–87. https://doi.org/10.2478/hukin-2014-0035

Pihlainen, K. A. I., Santtila, M., Häkkinen, K., & Kyröläinen, H. (2018). Associations of physical fitness and body composition characteristics with simulated military task performance. *The Journal of Strength & Conditioning Research*, *32*(4), 1089-1098. https://doi.org/10.1519/JSC.0000000000001921

Romanchuk, S., Oderov, A., Klymovych, V., Lototskiy, I., Iedynak, G., Mazur, V., ... & Ovcharuk, I. (2021). The effect of training in military pentathlon on the physiological characteristics of academy cadets. *Sport Mont*, *18*(1), 95-99.

Roy, T. C., Knapik, J. J., Ritland, B. M., Murphy, N., & Sharp, M. A. (2012). Risk factors for musculoskeletal injuries for soldiers deployed to Afghanistan. *Aviation, Space, and Environmental Medicine*, *83*(11), 1060–1066. https://doi.org/10.3357/asem.3341.2012

Santtila, M., Häkkinen, K., Karavirta, L., & Kyröläinen, H. (2008). Changes in cardiovascular performance during an 8-week military basic training period combined with added endurance or strength training. *Military Medicine*, *173*(12), 1173–1179. https://doi.org/10.7205/milmed.173.12.1173

Santtila, M., Kyröläinen, H., & Häkkinen, K. (2009). Changes in maximal and explosive strength, electromyography, and muscle thickness of lower and upper extremities induced by combined strength and endurance training in soldiers.

Journal of Strength and Conditioning Research, *23*(4), 1300–1308. https://doi.org/10.1519/JSC.0b013e3181a884bc

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

Vasold, K. L., Parks, A. C., Phelan, D. M., Pontifex, M. B., & Pivarnik, J. M. (2019). Reliability and validity of commercially available low-cost bioelectrical impedance analysis. *International journal of sport nutrition and exercise metabolism*, *29*(4), 406-410.