

Correlations between control exercises of combat fitness test and control exercises of physical conditioning

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Abstract

As the military environment is characterized by high levels of physical activity, physical activity is an important component of military action. A soldier with good overall fitness is one of the guarantees that in combat and peace conditions he or she will be able to perform his/her duties and help others. It is important to determine the best control exercises, which optimally reflect a soldier's physical conditioning. Every army has tests developed according to the policy of the country where these tests are applied. However, as the physical conditioning of residents decreases, so does the physical conditioning of potential soldiers, and physical conditioning tests are to be periodically updated and compared to the tests current in other countries. The aim of this study is to analyse the correlation of physical conditioning control exercises with combat fitness test control exercises. The methods include three different physical conditioning tests, the National Armed Forces physical conditioning test, the test put together by the study authors, the Great Britain Armed Forces physical conditioning test and the combat fitness test developed by the British Armed Forces. The accumulated data was processed to gain mutual correlations. Results and conclusions: medium close correlations were discovered, particularly between the Great Britain Army Force evaluation test and the cumulative physical conditioning test developed by the study authors, which confirms the initial hypothesis that the soldiers of each country differ in physical conditioning, and, in order to determine a soldier's preparedness, a separate physical conditioning test is to be designed for each group of soldiers following their specification.

Key words: military, testing, physical conditioning, combat readiness.

Introduction

In military service, a high level of physical conditioning is an important criteria not only of health, but also of the ability to perform military tasks, of injury prophylaxis and of the sustainability of military service (Hauret et al., 2016; De la Motte et al., 2019).

In order to determine the level of a person's physical conditioning, it is necessary to perform control exercises or tests. Control exercises help to assess physical characteristics and their level. The results of the tests and especially the dynamics of results indicate the efficiency of the training or point to imperfections and mistakes in the training process. Without tests, it is impossible to assess the strong and weak points and their balance. Gathering the results of standardized and unified tests provides an opportunity for regularly collecting the newest data on the level of physical fitness, work capacity, and development tendencies, which is one of the most important indicators (Kīsis et al., 2015).

For a test battery to effectively measure physical fitness, it needs to be valid, reliable, and feasible (Miller, 2012). Validity means that a particular test measures what it is supposed to measure. Reliability means that the test is repeatable and free from individual preconception. Feasibility means that the test is easily administered and does not require a great deal of skill or equipment (Peterson, 2015).

In addition to being valid, reliable, and feasible, a test battery should also be operationally relevant. Operational relevance (also known as face validity) refers to the extent that a particular test mimics actual occupational and/or battlefield requirements. Current research suggests that traditional military physical fitness tests have poor operational relevance (Peterson, 2015).

Regular testing of soldiers to determine the soldiers' special physical conditioning and ability to perform military tasks using a combat fitness test is time-consuming and complicated to administrate, requiring additional investment of human resources and materials; therefore, compiling sets of physical conditioning control exercises, which would make it possible to forecast soldier input and combat fitness test results would facilitate the daily work of the unit commanders as well as save time and resources for determining soldiers' combat fitness by using an easier to administrate and less time consuming set of physical conditioning control exercises.

It is possible to ascertain if the soldier has an all-round physical conditioning by performing various combat and physical conditioning control test, and, the wider the range of the control tests, the more objective the results gained in assessing the soldiers' physical conditioning (Foulis et al., 2017; Robson et al., 2017). Numerous studies by groups of authors (Oderov et al., 2017; Kyröläinen et al., 2018; Vaara et al., 2021) confirm that a higher level of physical conditioning facilitate the performance of military tasks, such as relocating heavy loads, repeated lifting of heavy loads, going through an obstacle course, transporting a wounded person, and other military tasks.

A combat fitness tests is standardized in the state armies of numerous countries, including such control exercises as bending and straightening the arm, raising the upper part of the body and a sprint of 3-3.2 km, which would test only aerobic endurance and strength endurance (Heinrich et al., 2012) without objective indicators to determine the soldiers' ability to perform combat tasks (Worden & White, 2012; Foulis et al., 2015; Huang et al., 2018). The leading NATO member states, as well as other states, have changed the physical conditioning system of the army, thus also altering the physical conditioning control exercises (Kirknes & Aandstad, 2016; Canadian Forces, 2017; Foulis et al., 2017; British army, 2018). Control exercises are set so as to imitate characteristic activities during combat, and the results achieved would facilitate the unit commanders' task of assessing the combat fitness of the unit (Harman et al., 2008; Worden & White, 2012).

Soldiers' physical conditioning is considered to be an important factor for the successful performance of combat operations (Burley et al., 2018; Klymovych et al., 2020). Still, the significance of such physical characteristics as aerobic endurance, anaerobic endurance, and strength endurance in military performance has received contradictory assessment. Individual studies emphasise the importance of aerobic endurance in performing military tasks (Friedl et al., 2015; Hauschild et al., 2017; Robson et al., 2021), without stating whether a high level of aerobic endurance facilitate a more successful performance of combat tasks; at the same time, other studies indicate that the optimal preparedness of military personnel is not largely predicated on the maximum strength or endurance indicators. The performance of numerous tasks requires a combination of strength and endurance, e.g., moving loads, repeatedly lifting weights (equipment, arms, provisions, etc.) (Kraemer et al., 2004). Some studies state that a high level of aerobic endurance has no essential link to the successful performance of combat exercises, while the strength of the upper body and anaerobic endurance determine the successful performance of combat tasks (Solomonson et al., 2016). Accordingly, a group of Australian scholars (Silk & Billing, 2013) in developing the standards of physical conditioning based on the combat tasks performance defined the most important combat tasks as breaking the contact with the adversary and movement with fire, thus determining the soldier's ability to perform repeated, short-term, high intensity loads in combination with movement reaction. On the other hand, other groups of authors stated in their studies that the role of aerobic endurance in the military sphere is undeniable (Friedl et al., 2015; Hauschild et al., 2017; Robson et al., 2021).

The aim of the study is to analyse the correlation of the control exercises in the physical conditioning test with the control exercises of the combat fitness test.

Materials and Methods

4 different tests were performed as part of the study: 3 physical conditioning tests and 1 combat test. During the case study, 34 soldiers were tested ($N=34$, age 26.6 ± 1.7 years, height 180.6 ± 7.6 , weight 80.8 ± 12.6), 4 of whom were women. The first was the GB Army Force evaluation test (GBAFET). It consists of 6 control exercises, which are to be performed in combat outfit – the uniform, the boots, the web gear, the helmet, the arms, the magazine pouch, the patrol bag, and the backpack. The timespan for the entire test, including the rest time is 160 min. (the total exercise time is 90 min, and the rest between the 1st and 2nd and the 3rd and 4th exercises is 15 min., and between the 2nd and the 3rd, the 4th and the 5th, and the 5th and the 6th is 5 min.).

1st exercise. 4 km march with 40 kg load + 2 km march with 25 kg load (there is a 15-min. pause and backpack change between the exercises, with the performance standard being 4 km – 50 min. + 2 km – 15 min.); the exercise is performed in the following outfit: the uniform, the boots, the web gear, the magazine pouch and the arm – G36, the backpack and the patrol bag (for the 2 km march). The soldiers are allowed to take along a water bottle, which is not included in the total weight. During the march, there is a pacer going along, a soldier travelling with the average speed required to achieve the performance standard. During the exercise, a soldier is allowed to drop behind the pacer for up to 20 m, but at the instructor's warning is to join the group; if the soldier is unable to join the group and receives a third warning, the soldier is disqualified from continuing the exercise. Before the exercise, the soldiers are instructed that they can overcome the pacer.

2nd exercise. Tactical movement 20 x 7.5 m, a zigzag run with taking a shooting position, followed by a 15-m crawl on the belly with elbows and a 15-m run at maximum speed (the performance standard for the 7.5 m run with taking a shooting position is 8 sec., holding the shooting position for 8 sec., and crawling for 15 m followed by a 15-m sprint for 55 sec. each). The run with taking the shooting position is controlled by the instructor, who commands the beginning of the next exercise. The outfit for the exercise is the uniform, the boots, the web gear, the magazine pouch, and the arm – G36. If during the exercise the soldier is unable to

perform the 7.5 m run with taking a shooting position in 8 sec., the soldier is disqualified from continuing the exercise.

3rd exercise. Evacuating the wounded involves dragging a 110 kg sandbag over the distance of 20 m (performance standard 35 sec.). The outfit for the exercise is the uniform, the boots, the web gear, the magazine pouch, and the arm – G36. A soldier is allowed to change the grip during the exercise.

4th exercise. Carrying a 2 x 22 kg load (water container) over the distance of 240 m, imitating the evacuation of a wounded person on a stretcher (performance standard 4 min.). The outfit for the exercise is the uniform, the boots, the web gear, the magazine pouch, and the arm – G36. During the exercise, the soldier is prohibited from putting the container on the ground, pulling, or pushing it along the ground. If a soldier puts the container on the ground during the exercise, the soldier is disqualified from continuing the exercise.

5th exercise. Standing on a platform in a half-sit-up position, with the legs bent at 90°, a soldier holds a rope with a load with both hands and must raise the 70-kg load by straightening the legs and hold the load with straight legs and a straight back, imitating the evacuation of a wounded person from a vehicle (performance standard 3 sec.). The outfit for the exercise the uniform, the boots, the web gear, the magazine pouch, and the arm – G36. If during the performance of the exercise the soldier drops the load on the ground before 3 sec., the soldier is disqualified from continuing the exercise. Each soldier performs the exercise once.

6th exercise. 20 x 30 (2 x 15 m) repeated raising and carrying of a 20 kg load (sandbag) (performance standard 14 min.). During the exercise, a soldier lowers the 20-kg load with both hands from a platform raised at 1.5 m and puts it on the ground, then with both hands puts it on the shoulder and walks with it for 30 m. Returning to the platform, the soldier puts the load on the platform with both hands, etc. The outfit for the exercise the uniform, the boots, the web gear, and the magazine pouch. During the exercise, the soldier is warned when 7 min. have passed, with the following warnings after each successive minute.

Physical conditioning test Nr. 1 – a physical conditioning test of the National Armed Forces, to be performed by every soldier once a year. The test consists of 3 control exercises, which are performed in sports clothing and footwear. The time criterion for all the tests including the rest time is 60 min. (the total time of the control exercises is up to 20 min., with undetermined rest and transition times, preferably under 15 min., between the exercises).

1st exercise. *Push-ups*. The initial position (IP) is prone plank, with palms of the hands parallel. Moving the elbows back, with the upper arms and the body constituting a line, bend the arms and exhale. Straighten the arms and inhale. Performance time is 2 minutes. The soldier must try to make as many repetitions as possible. Methodological notes: the arms must be bent in the elbows up to 90°. The arms must be straightened after the exercise is performed. Rest is taken in the plank position, by transferring the weight to the legs without changing the arm position.

2nd exercise. *Sit-ups*. IP lying on the back, with legs bent at least 90°, the foot placed flat on the ground, the arms bent and crossed in front and the hands resting against the shoulders. Raise the upper body to the sitting position and exhale. Return to the IP and inhale.

3rd exercise. *Running on terrain*. The distance is 3000 m. Performance time is unlimited. Methodological notes: following the NAF physical conditioning test, women must run the distance of 1500 m, but in order to assess all the tests participants equally, it was decided that women also run 3000 m.

Physical conditioning test Nr. 2 (the set of control exercises developed by the study author) consists of 7 control exercises performed in sport clothing and footwear. Physical conditioning pilot test was performed in a gym. The time criterion for all the tests including the rest time is 60 min (the total time for the control exercises is 30 min., with a 5-min. rest and transition to the next exercise).

1st exercise. *Burpee* (power endurance exercise). IP – standing, arms down. 1 – squat with hands on the ground; 2 – plank position after a jump, arms straight; 3 – bend the arms; 4 – straighten the arms; 5 – with a jump, take the squatting position with hands on the ground; 6 – jumping up, straighten, arms above; land to the IP. Methodological notes: during the exercise, the soldiers determine the pace and the rest, if necessary. Rest is possible only in the IP.

2nd exercise. – *Plank* (static strength endurance exercise). IP – prone with support on the hands, the hands parallel to each other, and the palms turned to the floor. The soldiers must hold the IP statically. Methodological notes: the SP must be held for the maximum length of time, with no time limit. During the exercise, a soldier can receive 1 warning on inappropriate body position. After the second warning, the soldier is disqualified from further performing the exercise, and time is stopped.

3rd exercise. *Illinois Agility test* (anaerobic endurance and movement coordination exercise). IP – prone position with the head at the starting line, the arms bent at the sides, the hands at the shoulders and the elbow not touching the ground. After the “start” signal, a soldier stands up and runs 10 m forward, around a cone, then returns. This is followed by a *zigzag run* between four cones. The soldier runs further 10 m forward, around a cone, then back, crossing the finish line. Methodological notes: if necessary, soldiers can make 1 training run and 2 registered runs. The best time is registered.

4th exercise. Throwing a medicine ball over the head (explosive strength exercise). IP – standing with the back against the direction in which the ball is to be thrown, the feet shoulder width apart, the heels at the starting

line, and the stuffed ball raised in straight arms. Moving the stuffed ball forward and down between the legs, simultaneously bending the legs, the ball is to be thrown upwards and backwards over the head. Methodological notes: after the stuffed ball is thrown, the soldier is allowed to “fall” behind the line. If necessary, soldiers can make 1 training throw and 2 registered throws. The best throw is registered.

5th exercise (for men). *Pull-ups* from a vertical hanging position on a horizontal bar (power endurance exercise for the upper body). Methodological notes: the exercise is registered if during the pull-up the chin is raised over the bar. Each soldier performs the maximum number of repetitions according to his physical conditioning. During the exercise, the soldier cannot swing or perform additional body movements.

6th exercise (for women). *Hanging from the bar with bent arms* (static strength endurance exercise). IP is a vertical hanging position with the arms bent on a bar, the hands gripping the bar from above, and the chin above the bar without touching it. Every soldier holds for the maximum time according to her physical conditioning. During the exercise, the soldier is allowed to receive 1 warning on inappropriate body position. On the 2nd warning, the time is stopped, the soldier is disqualified from further performance of the exercise, and time is stopped.

7th exercise. *Beep test* (aerobic endurance exercise). This test involves uninterrupted running between two lines at 20-m distance from each other. The pace is determined by a sound signal, the beep. The participants stand behind the line, facing the second line, and start running on hearing the signal. After a minute, the pace increases. Methodological notes: while performing the exercise, the soldier can receive 2 warnings for not crossing the second line on time (the soldier is ~ 1 m from the line). On the 3rd warning, the soldier is disqualified from further performance of the exercise and the current level is registered. The soldier who has not received the warning performs the exercise until deciding to quit.

One week after physical conditioning test Nr. 2, physical conditioning test Nr. 3 was performed (GB Armed Forces). The test consists of 6 control exercises performed in sports clothing and footwear. The time for performing the test, including the rest, is 60 min. (the total time for the control exercises is 35 min., with a 5-min. pause or transition between the exercises).

1st exercise. *Standing long jump or broad jump* (explosive strength exercise). Soldiers are allowed to make 2 training jumps if needed and 2 registered jumps, with the farthest jump being registered.

2nd exercise. *Hex bar deadlift* (maximum strength exercise). Soldiers perform 2-3 training lifts before the exercise, deciding with which weight they would work during the control exercise. The soldiers can lift the weight 1-10 times during the control exercise (see Table 1).

Table 1.

Assessment scale of results for the exercise “deadlift”

Number of repetitions	Kgs lifted											
	40kg	50kg	60kg	70kg	80kg	90kg	100kg	110kg	120kg	130kg	140kg	150kg
1x												
2x	42	51	63	72	84	93	106	112	128	136	146	154
3x	44	54	65	74	88	95	108	116	130	140	150	160
4x	45	55	67	76	90	100	110	122	132	144	154	164
5x	47	57	69	80	92	102	116	126	138	148	160	170
6x	48	59	71	82	96	105	118	128	140	152	164	174
7x	49	60	72	84	98	108	120	132	144	156	170	182
8x	50	62	75	87	100	112	124	138	150	162	174	188
9x	51	64	78	90	104	116	130	142	154	170	180	196
10x	52	68	80	93	108	120	134	148	160	172	188	200

3rd exercise. *Seated medicine ball throw* (explosive strength exercise). IP – seated with straight legs, with the back supported against the wall, and the stuffed ball held with both hands against the chest. The soldiers are allowed to make 2 training throws if necessary and 2 registered throws, with the farthest one being considered.

4th exercise. *5 x 20 m shuttle run* (anaerobic endurance and movement coordination exercise). IP – lying prone facing in the direction of the run, hands raised and fingers at the starting line. Soldiers are allowed to make one training run and 2 registered runs, with the fastest run considered.

5th exercise. *Pull-ups on the horizontal bar (4 sec.)* (power endurance exercise). During the exercise, soldiers perform the maximum number of repetitions without a time limit, making each exercise on the instructor counting 1, 2 – bend the arms, and 3, 4 – straighten the arms.

6th exercise. *Squats* (lower body endurance exercise). During the exercise, soldiers perform the maximum number of repetitions without a time limit. IP – feet shoulder width apart, hands straight in front. The legs are bent in the knees to a 90° angle, followed by straightening the knees and returning to the IP, with as many repetitions as possible. During the exercise, it is allowed to take rest for 2 sec. in the IP. The exercise is included in the set of control exercises depending on the weather conditions: in deep snow, the exercise can be substituted for a 2-km run around the stadium. The exercise is taken from the Chinese AF set of PC control exercises.

Results

GBAFET results:

The average result of the 1st exercise ($\bar{x}$) was 1;02:56 h, the highest result – 59;27 min., and the lowest result 1;06:24 h (see Table 3). With the test minimum passing standard, having summed up the results of both parts of the 1st exercise, being 1;05:00 h, the test was failed by 4 soldiers of 11.8% of the total number of the test participants. 2 soldiers (both women) fell behind the group in the 1st part of the exercise while performing the 4-km march with 40-kg load and 2 soldiers in the 2nd part of the exercise while marching 2 km with 25-kg load. The soldiers who have not passed the test and fell behind the pacer in the first part indicated as the main reason excessive load and pain in the shoulders, while the soldiers who have not passed the 2nd part indicated as the main reason insufficient rest time – 15 min. between the parts of the exercise – and the subsequent excessively high pace. According to the GBAFET assessment criteria, the 1st exercise is to be performed as part of a group, following the speed of the pacer. In our case, when beginning the 1st exercise of the GB Force evaluation test, the march, the soldiers were warned that they have to march to the end even if one member of the group falls behind the pacer, so that the remaining participants could perform the other exercises; also the soldiers were allowed to run or move at their own pace if the pacer was too slow for them.

The average result of the 2nd exercise ($\bar{x}$) was 49.9 sec., the highest result – 44 sec., and the lowest result – 55 sec. (see Table 3). As the minimum standard for passing the test is 55 sec., it was failed by 4 soldiers or 11.8% of the total number of participants. The main reason indicated by the soldiers who have failed the test was insufficient break of 15 min. between the 1st and the 2nd exercise and the out-of-order equipment hindering in the test performance, e.g., the helmet falling on the eyes and the magazine pouches fastened so that they hindered crawling. The average result of the 3rd exercise ($\bar{x}$) was 30.9 sec., the highest result – 26 sec., and the lowest result – 36 sec. (see Table 3). As the minimum performance standard for the test is 35 sec., it was failed by 2 soldiers or 5.9% of the total number of participants. The main reason for failing the exercise indicated by the soldiers was insufficient hand grip power, which made them change the grip several times while performing the exercise, resulting in lost time.

The average result of the 4th exercise ($\bar{x}$) was 3;39 min., the highest result – 3;21 min., and the lowest result – 3;55 min. (see Table 3). As the minimum performance standard is 4 min., the test was failed by 1 soldier or 2.9% of the total number of participants. The principal reason for failing the exercise indicated by the soldier was an accident, because the water container slid out of the soldier's hands due to inattention. Overall, the soldiers stated that, as in the 3rd exercise, the main thing for this exercise was hand grip, yet this exercise was easy and presented no problems.

The minimum performance standard set for the 5th exercise (to hold 70 kg for 3 sec.) was passed by all the 34 participants (see Table 3). After the exercise, all the soldiers stated that lifting 70 kg was not a problem and that the exercise weight must be reconsidered.

The average result of the 6th exercise ($\bar{x}$) was 13;31 min., the highest result – 12;20 min., and the lowest result – 13;55 min. (see Table 2). As the minimum performance standard is 14 min., the test was passed by all the soldiers. After completing the exercise, the soldiers indicated that in the last exercise of the test it was relatively easy to attain the minimum result, because everyone knew they did not have to save power for the next exercises and could work to their full.

Table 2.

Results of Great Britain Army Force evaluation test (GBAFET)

Respondents (n=34)	GBAFET					
	Loaded march 4+2 km (sec.)	Fire & Movement + 15 m crawling and 15 m sprinting (sec.)	Casualty Drag – 110 kg, 20 m (sec.)	240 m Water Can carry 2x22 kg (sec.)	70 kg Vehicle Casevac (sec.)	20 kg Repeated lift & carry 20x30 m (sec.)
$\bar{x}$ (sec)	3776.1	49.92	30.93	219	3	811.2
max	3884	55	34	235	3	835
min	3567	44	26	201	3	740

Results of Physical Fitness Test Nr. 1:

1st exercise – *bending and straightening the arms in the plank position* (push-up) had the average result ($\bar{x}$) of 62.5x, the highest result – 90x, and the lowest result – 32x.

2nd exercise – *raising the upper body (sit up)* had the average result ($\bar{x}$) of 69.3x, the highest result – 93x, and the lowest result – 39x.

3rd exercise – *3000 m run on the terrain* had the average result ($\bar{x}$) of 13;06 min., the best result – 10;20 min., and the longest time – 19;40 min. (see Table 3).

Table 3.

Results of Physical Fitness Test Nr. 1

Respondents (n=34)	Physical Fitness Test Nr. 1		
	Push up for 2 min. (n)	Sit up for 2 min. (n)	3000 m (sec.)
$\bar{x}$	62.5	69.3	786
max	90	93	1140
min	32	39	620

Results of Physical Fitness Test Nr. 2 (the test design by the study authors):

1st exercise – *Burpee* had the average result ($\bar{x}$) of 34,9x, the highest result – 46x, and the lowest result – 17x (see Table 4).

2nd exercise – *Plank* had the average result ($\bar{x}$) of 161 sec., the highest result – 300 sec., and the lowest result – 40 sec. (see Table 4).

3rd exercise – *Illinois Agility test* had the average result ($\bar{x}$) of 17.55 sec., the highest result – 20.16 sec., and the lowest result – 15,08 sec. (see Table 4).

4th exercise. – *throwing a medicine ball over the head backwards* had the average result ($\bar{x}$) of 11.98 m, the highest result – 15.45 m, and the lowest result – 7.45 m (see Table 4).

5th exercise – *bar pull ups* had the average result ($\bar{x}$) of 12,9x, the highest result – 24x, and the lowest result – 5x. The exercise was performed by men only (see Table 4).

6th exercise – *hanging at the bar with bent arms* had the average result ($\bar{x}$) of 9 sec., the highest result – 31 sec., and the lowest result – 1 sec. (see Table 4). The exercise was performed by women only.

7th exercise – *Beep test* had the average result ($\bar{x}$) of level 7.7, the highest result – level 14, and the lowest result – level 3 (see Table 4).

Table 4.

Results of Physical Fitness Test Nr. 2

Respondents (n=34)	Physical Fitness Test Nr. 2						
	Burpee (n)	Plank (sec.)	Illinois agility test (sec.)	Medicine ball throw (m)	Pull up – for men (n)	Power in bent arms – for women (sec.)	Beep test (level)
$\bar{x}$	34.9	161	17.55	11.98	12.9	9	7.77
max	46	300	20.16	15.45	24	31	14
min	17	40	15.08	7.45	5	1	3

Results of Physical Fitness Test Nr.3:

1st exercise – *standing long jump (broad jump)* had the average result ($\bar{x}$) of 2.36 m, the highest result – 2.83 m, and the lowest result – 1.72 m.

2nd exercise – *hex bar deadlift* had the average result ($\bar{x}$) of 122 kg, the highest result – 170 kg, and the lowest result – 68 kg.

3rd exercise – *seated medicine ball throw* had the average result ($\bar{x}$) of 4.62 m, the highest result – 5.96 m, and the lowest result – 2.64 m.

4th exercise – *5x20 m shuttle sprint* had the average result ($\bar{x}$) of 21.47 sec., the highest result – 19.22 sec., and the lowest result – 25.10 sec.

5th exercise – *pull up at the count (4 sec.)* had the average result ($\bar{x}$) of 7.3x, the highest result – 13x, and the lowest result – 0x.

6th exercise – *squats* with the maximum number of repetitions had the average result ($\bar{x}$) of 176.4x, the highest result – 360x, and the lowest result – 45x (see Table 5).

Table 5.

Results of Physical Fitness Test Nr. 3

Respondents (n=34)	Physical Fitness Test Nr. 3					
	Broad Jump (m)	Hex Bar Deadlift (kg)	Seated Medicine Ball Throw (m)	5x20 m Shuttle Sprint (sec.)	Pull Up every 4 sec.-2 sec. for the upward phase, 2 sec. for the down phase (n)	Squats (n)
$\bar{x}$	2.36	122	4.62	21.47	7.3	176.4
max	2.83	170	5.96	19.22	13	360
min	1.72	68	2.64	25.10	0	45

Analysing correlations between GBAFET and 3 physical conditioning tests, we can see that there are several medium close correlations between combat fitness test results and Physical Conditioning Test Nr. 2 exercises (prepared by the study authors) (Table 6), but there are no close correlations with any physical conditioning control exercises.

The highest medium close correlations of the Physical Fitness Test Nr. 2 scores with scores on the GBAFET can be found in control exercises in *Loaded march* and *Fire & Movement* (Table 6). Control exercise *Loaded march* has medium close correlations with 2 control exercises of Physical Fitness Test Nr. 2 - *Beep test*

($r=0.47$) and *2-minute burpee* ($r=0.4$). Likewise control exercise *Fire & Movement* has medium close correlations with 2 control exercises of Fitness Test Nr. 2 – *2-minute burpee* ($r=0.51$) and *Pull-ups* ($r=0.47$). In turn, control exercises *Casualty Drag*, *Water Can carry* and *Repeated lift & carry* show very weak or weak correlations with all exercises of Physical Fitness Test Nr. 2.

Table 6.

Correlations of the Physical Fitness Test Nr. 2 scores with scores on the GBAFET

	Loaded march	Fire & Movement	Casualty Drag	Water Can carry	Repeated lift & carry
2-minute burpee	0.40	0.51	-0.04	-0.04	-0.22
Plank	0.38	0.23	-0.01	0.16	-0.04
Illinois Agility test	-0.22	-0.28	0.17	0.16	0.06
Standing power throw	0.18	0.28	-0.15	-0.08	-0.11
Pull-ups	0.36	0.47	-0.06	0.06	-0.21
Hanging at the bar*	0.54	0.50	-0.4	-0.47	0.35
Beep test	0.47	0.37	0.02	0.08	-0.35

* $p<0.05$ the exercise was performed by women only (4-pax)

Comparing the correlations of the Physical Fitness Test Nr. 3 scores with scores on the GBAFET, medium close correlations were observed only with control exercises *Loaded march* and *Fire & Movement* (Table 7). Control exercise *Loaded march* has medium close correlations with 2 control exercises of Physical Fitness Test Nr. 3 – *Pull Up to 4 sec.* ($r=0.46$) and *Squats for max reps* ($r=0.40$). Likewise control exercise *Fire & Movement* has medium close correlations with 2 control exercises of Physical Fitness Test Nr. 3 – *Pull Up to 4 sec.* ($r=0.55$) and *Horizontal jump (long jump)* ($r=0.40$). In turn, GBAFET control exercises *Casualty Drag*, *Water Can carry* and *Repeated lift & carry* show very weak or weak correlations with all exercises of Physical Fitness Test Nr. 3.

Table 7.

Correlations of the Physical Fitness Test Nr. 3 scores with scores on the GBAFET

	Loaded march	Fire & Movement	Casualty Drag	Water Can carry	Repeated lift & carry
Horizontal jump	0.34	0.40	-0.06	-0.16	-0.24
Deadlift	0.1	0.24	-0.16	-0.07	0.01
Seated Medicine Ball Throw	0.09	0.22	-0.05	-0.04	-0.17
5x20 m Shuttle Sprint	-0.36	-0.39	0.1	-0.1	0.1
Pull Up to 4 sec.	0.46	0.55	0.05	0.07	-0.07
Squats for max reps	0.40	0.25	-0.02	0.09	0.03

* $p<0.05$

A similar situation appears when comparing correlations of the Physical Fitness Test Nr. 1 scores with scores on the GBAFET, with medium close correlations observed only with control exercises *Loaded march* and *Fire & Movement* (Table 8). Control exercise *Loaded march* has medium close correlations with 3 control exercises of Physical Fitness Test Nr. 1 – *2-minute sit-ups* ($r=0.53$), *2-minute push-ups* ($r=0.46$) and 3 km run ($r=-0.45$), while control exercise *Fire & Movement* has medium close correlations with 2 control exercises of Physical Fitness Test Nr. 1 – *2-minute sit-ups* ($r=0.51$) and 3 km run ($r=-0.41$).

Table 8.

Correlations of the Physical Fitness Test Nr. 1 score with scores on the GBAFET

	Loaded march	Fire & Movement	Casualty Drag	Water Can carry	Repeated lift & carry
2-minute push-ups	0.46	0.39	-0.04	0.06	0.01
2-minute sit-ups	0.53	0.51	-0.00	-0.04	-0.07
3 km run	-0.45	-0.41	-0.08	-0.15	0.18

* $p<0.05$

In turn, GBAFET control exercises *Casualty Drag*, *Water Can carry* and *Repeated lift & carry* show very weak or weak correlations with all control exercises of Physical Fitness Test Nr. 1 (Table 8).

Discussion

The task of this study was to determine correlations between control exercises of combat fitness test and field control exercises, thus enabling commanders to use the control exercises that are easiest to arrange and register in field tests to determine genuine soldier combat power.

Soldiers' physical conditioning is considered to be an important factor in successful performance of combat operations (Burley et al., 2018; Klymowych et al., 2020). Still, the significance of certain physical qualities, such as aerobic endurance, anaerobic endurance, and power endurance, in a soldier's performance, is evaluated in various ways. Some studies highlight the importance of aerobic endurance in performing a soldier's tasks (Myles & Allen, 1979; Jones et al., 1992), without stating whether a high level of aerobic endurance would

facilitate a more successful performance of combat tasks, whereas other studies claim that in military personnel optimum preparedness does not necessarily depend on maximum power or endurance indicators. For performing numerous tasks, a combination of strength and endurance is necessary, e.g., for moving loads or for repeatedly lifting loads, such as equipment, arms, supplies, etc. (Kraemer et al., 2004). Similarly, the physical conditioning tests we proposed include both exercises on a combination of power and endurance and aerobic exercise.

In military environment, aerobic endurance is studied most often, highlighting the essential nature of aerobic endurance for various military tasks, for instance, overcoming hurdle areas, marching, or evacuating casualties (Jette et al., 1990; Williams & Rayson, 2006). Most of the combat fitness tests include some aerobic endurance control exercises, for example, 3.2 km – 1.5 km sprint or *Beep* test or a laboratory test – *Treadmill run* or *Wingate cycle-ergometer test* (USAPHC, 2014). In our case study, we observed medium close correlations between each of the aerobic endurance test exercises and one GBAFET exercise – 6 km march, e.g., *Beep test* ($r=0.47$), 3 km run ($r=0.45$), *Squats for max reps* ($r=0.4$), as well as 2-minute *burpee* exercise ($r=0.4$). Also, our study shows medium close correlation between the GB Army Force evaluation test exercise march and power endurance control exercise for the upper body – *Pull Up to 4 sec.* ($r=0.46$), 2-minute *sit-ups* ($r=0.53$), and 2-minute *push-ups* ($r=0.46$).

In the study conducted by E. Harman et al. (Harman et al., 2008) it is indicated that battlefield performance can be best predicted by conducting explosive strength tests – high jump and standing broad jump – as well as aerobic endurance test – 3.2 km run. In our study, one of the tests (PC Nr. 3) includes an explosive strength control exercise – standing broad jump, which showed a medium close correlation ($r=0.4$) with only one of the GBAFET control exercises – *Fire & Movement*. In turn, the exercise included in the Physical Fitness Test Nr. 1, 3 km run, has medium close correlation with two of the GBAFET control exercises – *Loaded march* ($r=0.45$) and *Fire & Movement* ($r=0.41$), whereas another aerobic endurance control exercise – *Beep test* – included in the Physical Fitness Test Nr. 2, has medium close correlation with just 1 of GBAFET control exercises – *Loaded march* ($r=0.47$), and control exercise *Squats for max reps*, included in the Physical Fitness Test Nr. 3, as the 2 km run was not performed due to inappropriate weather conditions (deep snow), shows medium close correlation with 1 of the GBAFET control exercises – *Loaded march* ($r=0.4$).

As indicated in the studies conducted by Harman et al., power endurance exercise *sit-ups* has close correlation with 30 m sprint run (*30-m rush*), hurdle run, and 400 m run, whereas the USAPHC report of 2014 states that the control exercise *sit-ups* has weak correlation with the performance of combat tasks. In our study, the control exercise 2-minute *sit-ups* showed a medium close correlation with 2 of GBAFET control exercises – *Loaded march* ($r=0.53$) and *Fire & Movement* ($r=0.51$), whereas another power endurance control exercise, 2-minute *push-ups*, showed medium close correlation with 1 of GBAFET control exercises – *Loaded march* ($r=0.46$).

Individual studies show difference in stressing the importance of one or another exercise and the ability to predict battlefield performance; thus, USAPHC report states that the power endurance control exercise *push-up* is a good predictor of battlefield performance. On the other hand, G. Carstairs et al. (2016) in their study state that power endurance control exercises for the upper body *pull-ups* and *push-ups* “were poor predictors of performance in the majority of job tasks,” albeit the majority of combat fitness tests include one or another power endurance control exercise for the upper body, as it has been shown that upper body strength seems to have more impact on military tasks and routinely performed manual load handling tasks (Pandorf et al., 2003; Pori, Tušak & Pori, 2010). This statement is confirmed in our study only partially, as the Physical Fitness Test Nr. 1 includes a power endurance control exercise 2-minute *push-ups*, which showed medium close correlations with 1 GBAFET control exercise, *Loaded march* ($r=0.46$), and weak correlations with the other 4 GBAFET control exercises, whereas the control exercise included in the Physical Fitness Test Nr. 2, *Pull-ups*, has medium close correlations with 1 of GBAFET control exercises – *Fire & Movement* ($r=0.47$), and the control exercise included in the Physical Fitness Test Nr. 3 *Pull Up to 4 sec.* shows medium close correlation with 2 of GBAFET control exercises – *Loaded march* ($r=0.46$) and *Fire & Movement* ($r=0.55$). In turn, another power endurance exercise for the upper body, *Hanging at the bar*, included in the Physical Fitness Test Nr. 2, substituting control exercise *Pull Ups* for women, who often are unable to perform this exercise even once, showed medium close correlation with 4 of GBAFET control exercises – *Loaded march* ($r=0.54$), *Fire & Movement* ($r=0.50$), *Casualty Drag* ($r=0.4$) and *Water Can carry* ($r=0.47$), excepting control exercise *Repeated lift & carry* ($r=0.35$), where the correlation is low. Still, it must be noted that this control exercise was performed by 4 women only, so that the credibility of the test results is insignificant.

Individual studies highlight the importance of upper body strength in performing various combat tasks (Lester et al., 2010; Pori et al., 2010). The maximum lower body strength control exercise included in the Physical Fitness Test Nr. 3 *Deadlift* showed very weak or weak correlations with all the 5 GBAFET control exercises.

Numerous studies made in the recent years indicate the importance of a certain physical characteristic, movement coordination or agility and speed (frequency of movements) in performing combat tasks, such as reacting to the enemy fire, changing the shooting position or short and fast runs with direction changes (Silk & Billing, 2013). E. Doyle and L. McDaniel (2006); S. Jaenen (2009), as well as A. Solomonson et al. (2016) state

that nowadays short and swift runs rather than long endurance run predominate during combat. T. C. Roy, B. A. Springer, V. McNulty, and N. L. Butler (2010) indicate that regular sprint trainings improve results in jump height, jump power, jump length, squat strength, sprint speed, and agility. The maximum speed run control exercise is to be included in the sets of control exercises, because regular sprint trainings facilitate the performance not only of various combat tasks, but also 1.5-mile run. Accordingly, a group of Australian scholars (Silk & Billing, 2013) in developing physical conditioning standards based on battlefield performance defined as the most important tasks on the battlefield breaking contact with the enemy and movement with fire, thus determining the primary significance of the soldier's ability to perform repeated short-term high intensity load and movement reactions at speed. The movement and maximum speed control exercises included in our study, namely, *Illinois Agility test* and *5x20 m Shuttle Sprint* show very weak or weak correlations with all the 5 GBAFET control exercises. Likewise, explosive strength control exercises *Seated Medicine Ball Throw* and *Standing power throw* show very weak or weak correlations with all the 5 GBAFET control exercises.

T. C. Roy (2010) in his work emphasizes the importance of the core endurance in load movement, minimizing the risk of injuries and forming correct posture. Thus, core strength trainings must be the basis for any physical conditioning training programme. Studies show that repeated back exercises, such as abdominal muscle exercises and pull-ups, have no operative significance; instead, they can lead to lower back injuries (Peterson, 2013). Numerous scholars currently advise using isometric core strength exercises, such as the *Plank*, instead of repeated back exercises (Peterson, 2013). The control exercise included in the Physical Fitness Test Nr. 2 of our study, *Plank*, shows very weak or weak correlations with all the 5 GBAFET control exercises, which leads to questioning the importance of this control exercise in predicting battlefield performance.

J. L. Nuzzo (2020) stresses that flexibility has been previously excessively highlighted in performing specific professional tasks, emphasizing that flexibility has lower correlation with physical input than cardiovascular endurance indicators, muscular endurance and muscular strength indicators, and body conformation. It is indicated that flexibility has no direct impact on health indicators, with flexibility being important in reducing the risk of injury in individual sports, but not in military training. Despite the fact that all physical abilities are to be developed evenly during the training process, the importance of flexibility as a physical characteristic is not sufficiently appreciated (Garber et al., 2011) in considering the development of other physical characteristics and the performance of various specific combat tasks, such as combat in inhabited areas. Still, multiple previous studies have found no correlations between flexibility control exercises and battlefield performance (USAPHC, 2014). Similarly, we have not included flexibility control exercises in our sets of control exercises.

Conclusion

The aim of the study was to find correlations between the control exercises of the combat fitness test (GBAFET) and three different physical conditioning tests to prepare a set of physical conditioning control exercises that would be easier to administrate and perform in terms of time and resources involved as compared to a combat fitness test, while giving the unit commanders quickly accessible and sufficiently exact information on the physical conditioning, ability to perform combat tasks, and combat fitness of the military personnel.

Overall, it can be concluded that only 2 of GBAFET control exercises, *Loaded march* and *Fire & Movement*, have medium close correlations with multiple control exercises from physical conditioning tests, whereas the other 3 GBAFET control exercises – *Casualty Drag*, *Water Can carry*, and *Repeated lift & carry* – have weak or very weak correlations. The GBAFET control exercise *Loaded march* has close correlations with 6 control exercises of physical conditioning tests, the closest being with the control exercise *2-minute sit-ups* ($r=0.53$), while the GBAFET control exercise *Fire & Movement* has medium close correlations with 5 control exercises of physical conditioning tests, showing the closest correlation with the control exercise *Pull Up to 4 sec.* ($r=0.55$).

The study results can be used for preparing sets of physical conditioning control exercises to determine the ability to perform specific tasks by both soldiers and employees of other power structures.

Conflict of interest: The authors declare no conflict of interest.

References

- British army, 2018. Retrieved 2022-11-08 from <https://www.army.mod.uk/news-and-events/news/2018/09/new-physical-fitness-standards-for-combat-roles/>
- 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.
- Canadian Forces. (2017). Force Evaluation. Retrieved January 22, 2022, from <https://www.cafconnection.ca/National/Programs-Services/For-Military-Personnel/Military-Fitness/FORCE-Program/FORCE-Evaluation.aspx>.
- Carstairs, G. L., Ham, D. J., Savage, R. J., Best, S. A., Beck, B., & Doyle, T. L. (2016). A box lift and place

- assessment is related to performance of several military manual handling tasks. *Military medicine*, 181(3), 258-264.
- De la Motte, S. J., Lisman, P., Gribbin, T. C., Murphy, K., & Deuster, P. A. (2019). Systematic review of the association between physical fitness and musculoskeletal injury risk: part 3—flexibility, power, speed, balance, and agility. *The Journal of strength & conditioning research*, 33(6), 1723-1735.
- Doyle, E., & McDaniel, L. (2006). A concept for functional fitness. Marine Corps Combat Development Command special report, November 2006.
- Foulis, S.A., Redmond, J.E., Warr, B.J., Zambraski, E.J., Frykman, P.N., Gebhardt, D.L., Baker, T.A., & Sharp, M.A. (2015). Development of a Physical Employment Testing Battery for 12B Combat Engineers (Report #16-5) DTIC #:AD1000451. Natick, MA: US Army Research Institute of Environmental Medicine.17-41.
- Foulis, S. A., Sharp, M. A., Redmond, J. E., Frykman, P. N., Warr, B. J., Gebhardt, D. L., & Zambraski, E. J. (2017). US Army physical demands study: development of the occupational physical assessment test for combat arms soldiers. *Journal of Science and Medicine in Sport*, 20, S74-S78.
- Friedl, K.E., Knapik, J.J., Häkkinen, K., Baumgartner, N., Groeller, H., Taylor, N.A.S., Duarte, A.F.A., Kyröläinen, H., Jones, B.H., Kraemer, W.J., & Nindl, B.C. (2015). Perspectives on aerobic and strength influences on military physical readiness. *Journal of Strength and Conditioning Research* 29(11), 10-23. <https://doi.org/10.1519/JSC.0000000000001025>
- Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M., & Swain, D. P. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and science in sports and exercise*, 43(7), 1334-1359.
- Harman, E.A., Gutekunst, D.J., Frykman, P.N., Sharp, M.A., Nindl, B.C., Alemany, J.A., & Mello, R.P. (2008). Prediction of simulated battlefield physical performance from field-expedient tests. *Military Medicine*, 173(1), 36-41. doi: 10.7205/milmed.173.1.36.
- Hauret, K.G., Pacha, L., Taylor, B.J., Jones, B.H. (2016). Surveillance of disease and nonbattle injuries during US Army operations in Afghanistan and Iraq. *U.S. Army Medical Department Journal*, (2–16), 15–23.
- Hauschild, V.D., DeGroot, D.W., Hall, S.M., Grier, T.L., Deaver, K.D., Hauret, K.G., & Jones, B.H. (2017). Fitness tests and occupational tasks of military interest: a systematic review of correlations. *Journal of Occupational and Environmental Medicine*, 74(2), 144-153. doi: 10.1136/oemed-2016-103684.
- Heinrich, K.M., Spencer, V., Fehl, N., Poston, C.W. (2012). Mission Essential Fitness: Comparison of Functional Circuit Training to Traditional Army Physical Training for Active Duty Military. *Military Medicine*, 177(10), 1125–1130. doi: 10.7205/milmed-d-12-00143.
- Huang, H. C., Nagai, T., Lovalekar, M., Connaboy, C., & Nindl, B. C. (2018). Physical fitness predictors of a warrior task simulation test. *The Journal of Strength & Conditioning Research*, 32(9), 2562-2568. doi: 10.1519/JSC.0000000000002607.
- Jaenen, S. (2009). Identification of common military tasks. In: *Optimizing Operational Physical Fitness*. Technical Report TRHFM-080. Paris, France: NATO Research and Technology Organization.
- Jette, M., Kimick, A., & Sidney, K. (1990). Evaluation of an indoor standardized obstacle course for Canadian infantry personnel. *Canadian Journal of Sport Sciences = Journal Canadien Des Sciences Du Sport*, 15(1), 59-64.
- Kirknes, J., & Aandstad, A. (2016). New physical fitness tests and employment standards in the Norwegian Armed Forces.
- Klymovych, V., Oderov, A., Romanchuk, S., Korchagin, M., Zolochovskyi, V., Fedak, S., Gura, I., Nebozhuk, O., Lashta, V., Romanchuk, V., & Lesko, O. (2020). Correlation of physical fitness and professional military training of servicemen. *Sport Mont*, 18(2), 79-82.
- Kraemer, W. J., Vescovi, J. D., Volek, J. S., Nindl, B. C., Newton, R. U., Patton, J. F., & 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.
- 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. doi: 10.1016/j.jsams.2017.11.019.
- Ķīsis, I. (2015). Vispusīgās fiziskās sagatavotības trenera rokasgrāmata Rīga: Latvijas Treneru tālākizglītības centrs. 28.-29.
- Lester, M. E., Knapik, J. J., Catrambone, D., Antczak, A., Sharp, M. A., Burrell, L., & Darakjy, S. (2010). Effect of a 13-month deployment to Iraq on physical fitness and body composition. *Military medicine*, 175(6), 417-423.
- Miller, T., 2012. ed. NSCA's Guide to Tests and Assessments. Champaign, IL: Human Kinetics.
- Nuzzo, J. L. (2020). The case for retiring flexibility as a major component of physical fitness. *Sports Medicine*, 50(5), 853-870.
- Oderov, A., Romanchuk, S., Fedak, S., Kuznetsov, M., Petruk, A., Dunets-Lesko, A., Lesko, O., & Olkhovyi, O.

- (2017). Innovative approaches for evaluating physical fitness of servicemen in the system of professional training. *Journal of Physical Education and Sport*, 17(1), 23 – 27. doi:10.7752/jpes.2017.s1004
- Pandorf, C. E., Nindl, B. C., Montain, S. J., Castellani, J. W., Frykman, P. N., Leone, C. D., & Harman, E. A. (2003). Reliability assessment of two militarily relevant occupational physical performance tests. *Canadian journal of applied physiology*, 28(1), 27-37.
- Peterson, D. D. (2013). Proposed performance standards for the plank for inclusion consideration into the navy's physical readiness test. *Strength & Conditioning Journal*, 35(5), 22-26.
- Peterson, D., 2015. The Navy Physical Fitness Test. A Proposed Revision to the Navy Physical Readiness Test. *Strength and Conditioning Journal*. 37(4), 60-68. <https://doi.org/10.1519/SSC.0000000000000122>
- Pori, P., Tušak, M., & Pori, M. (2010). Which motor abilities have the highest impact on working performance of slovenian soldiers. *Biology of Sport*, 27(4), 301-305.
- Robson, S., Leamon, I., Lytell, M.C., Matthews, M., Chamberlin, M. (2021). A Review of the Air Force Fitness Assessment. RAND Corporation, Santa Monica, California.
- Robson, S., Lytell, M.C., Sims, C.S., Pezard, S., Manacapilli, T., Anderson, A., Bohusch, T., & Haddad, A. (2017). Fit for Duty? Evaluating the Physical Fitness Requirements of Battlefield Airmen. Retrieved August 18, 2021, from <https://bootcampmilitaryfitnessinstitute.com/elite-special-forces/us-elite-special-forces/afsoc-us-air-force-special-operations-command/us-air-force-battlefield-airmen-fitness-assessment-bafa/>
- Roy, T. C., Springer, B. A., McNulty, V., & Butler, N. L. (2010). Physical fitness. *Military medicine*, 175(suppl_8), 14-20.
- Silk, A. J., & Billing, D. C. (2013). Development of a valid simulation assessment for a military dismounted assault task. *Military medicine*, 178(3), 315-320.
- Solomonson, A. A., Dicks, N. D., Kerr, W. J., & Pettitt, R. W. (2016). Influence of load carriage on high-intensity running performance estimation. *The Journal of Strength & Conditioning Research*, 30(5), 1391-1396.
- US Army Public Health Command. Public Health Report No. 12-02-0614. Correlations Between Physical Fitness Tests and Performance of Military Tasks:A Systematic Review and Meta-Analyses. Prepared by Hauschild V.D., DeGroot D., Hall S., et al. Aberdeen Proving Ground (MD): USAPHC, 2014. Available from DTIC: <http://www.dtic.mil/docs/citations/ADA607688>.
- Vaara, J.P., Groeller, H., Drain, J., Kyröläinen, H., Pihlainen, K., Ojanen, T., Connaboj, C., Santtila, M., Agostinelli, P., Nindl, B.C. (2021). Physical training considerations for optimizing performance in essential military tasks. *European Journal of Sport Science*, 6(3), 142–167. doi: 10.1080/17461391.2021.1930193.
- Williams, A. G., & Rayson, M. P. (2006). Can simple anthropometric and physical performance tests track training-induced changes in maximal box-lifting ability? *Ergonomics*, 49(7), 661-670.
- Worden, T., & White, E.D. (2012). Modifying the U.S. Air Force Fitness Test to reflect physical combat fitness: one study's perspective. *Military Medicine*, 177(9), 1090-1094. doi: 10.7205/milmed-d-12-00066.