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Lower-body Muscular Power Predicts Performance on Urban Combat Simulation

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ABSTRACT

BACKGROUND: Military operations in urban environments requires faster movements and therefore may place greater demands on soldier strength and anaerobic ability. **OBJECTIVE:** The aim was to study how physical fitness and body composition are associated with occupational test for urban combat soldiers before and after a 5-day military field exercise (MFE). **METHODS:** Twenty-six conscripts (age=20±1 yrs.) volunteered, of which thirteen completed the study. Occupational performance was determined by using the newly developed Urban Combat Simulation test (UCS); which included 50-m sprinting, moving a truck tire (56 kg) 2 meters with a sledgehammer, a 12-m kettlebell carry (2x20 kg) up the stairs with a 3-m ascent, 4-time sandbag lifts (20 kg) with obstacle crossing, and a 20-m mannequin (85 kg) drag. Aerobic and muscle fitness, as well as anaerobic capacity were measured, and, body composition was assessed with multifrequency bioimpedance analysis. **RESULTS:** The UCS performance correlated significantly with standing long jump performance, as well as lower and upper body maximal strength before (r=-0.56 to -0.66) and after (r=-0.59 to -0.68) MFE, and, with body mass and FFM before (r=-0.81 to -0.83) and after (r=-0.86 to -0.91) MFE. In the regression analyses, fat free mass (R2=0.50, p=0.01) and counter movement jump in combat load (R2=0.46, p=0.009) most strongly explained the UCS performance. **CONCLUSION:** This study demonstrated that muscle mass and lower body explosive force production together with maximal strength are key fitness components related to typical urban combat soldiers` military tasks. Physical training developing these components are recommended.

Keywords: Soldier, Military, Readiness, Fitness, Task performance, Physical training

1. INTRODUCTION

Armed forces need soldiers who are physically and mentally capable of performing their tasks, many of which are physically very demanding [1]. The tasks require different types of physiological capabilities like aerobic and anaerobic endurance and muscular strength [2]. In the latest decade´s conflicts the combat load has been reported to be about 50 kilograms depending on the task and situation [3]. Nowadays, military operations have centered more to urban areas, which has also brought new physical demands for the soldiers [4]. Although urban combat operations include similar maneuvers and tasks to symmetrical and traditional operations, they also have differences in physiological demands. Urban operations include faster average movement pace [5] and therefore, anaerobic energy production together with rapid force production are emphasized. Previously, it has been reported that mean heart rate is higher during urban operations compared to traditional operations [5]. In addition, operating in an urban area includes different types of physical demands when the tasks, like breaching the doors and windows, using of stairs, and crossing different types of obstacles are performed inside the buildings [6]. To ensure that the soldiers can meet the demands of these tasks and the operating environment, physical performance tests are utilized for measuring soldiers' combat readiness [7].

During the last few years several studies have questioned the relevance of common fitness assessments to test combat readiness [8, 9, 10]. Instead, assessment of combat readiness with more specific simulations, including maneuvers and tasks of the battlefield, could increase content validity of fitness testing. Also, tests using body mass as only resistance favor lighter personnel, whereas regular combat duties are typically performed in combat load which increases the relative load of lighter soldiers [10]. In addition, the effectiveness of physical training program can be evaluated with more specific occupational relevance when the physical fitness test consists of soldier specific tasks [9].

It has been reported that several ground-combat tasks, including heavy load carriage, casualty evacuation, short rushes to cover and manual material handling, require high levels of maximum and explosive force production of the lower limbs [1, 2, 11, 12] and anaerobic capacity [6, 7]. In addition, it has been shown that body composition, especially muscle mass, predicts combat readiness, which has been tested with simulation tests [1, 13, 14]. Although, several new job specific and occupational simulation tests have been developed within the last few years [6, 7, 13, 15], only a few of them have focused especially on urban combat fitness performance. On the other hand, these studies [6, 7, 13] have not reported the possible effects of operative stressors, such as sustained physical activity and sleep deprivation, to military specific performance.

Therefore, the primary purpose of this study was to assess which physical fitness characteristics may be associated with Urban combat simulation (UCS) performance in recovered state. In addition, secondary purpose was to study how the abovementioned associations may change when the UCS is performed in a fatigued state immediately after a 5-day military field exercise.

2. METHODS

The new Urban Combat Simulation (UCS) consisted of typical Urban Combat soldier maneuvers and tasks. The test was developed according to the NATO PES-development procedure [16]. The development process started with a task analysis by using earlier studies and a survey where Urban

Jaeger drill instructors and operators (n = 14) responded to a series of questions regarding type, importance, frequency, duration, and intensity of the most common physically demanding urban combat tasks. The test was thereafter developed based on analysis of the survey responses. According to the survey, the most common tasks in the urban area included a variety of maneuvers such as walking, running, crawling, inside and outside the buildings. Different maneuvering types were mentioned in answers 28 times. Soldiers are required to breach and trespass openings (e.g., doors, windows, holes in walls) inside the buildings, which were mentioned 19 times. In addition, to carrying an individual combat load, Urban combat soldiers need specific tools, like sledgehammer (10−15kg) and other equipment for breaching (8−12kg), for operating inside buildings, which increases the total carried load. The respondents of the survey evaluated with the scale of 1 (not important) to 4 (important) that strength endurance (importance 3.71) and aerobic endurance (importance 3.50) are the two most important physiological characteristics for an urban combat operator. Also, the respondents evaluate that anaerobic endurance (importance 3.14) is quite important for urban combat operator.

2.1 Subjects

Twenty-six (n = 26) voluntary male conscripts were recruited with mean (±SD) age, body mass, and height of 20 ± 0 years (range 19–29), 73.6 ± 6.3 kg, 181 ± 6 cm, respectively. Before the baseline measurements, 12 subjects withdrew from the study because of COVID-19 infections and its precautions. One of the subjects withdrew after the baseline measurements because of COVID-19. Thus, thirteen subjects completed all measurement phases of the study. Study participants had been in duty 8 months before the study began. The present study was granted an ethical approval from the National Defence University (AR8050) and the study was approved by the Finnish Defence

Forces (AR12455). The conscripts were informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study.

2.2 Procedures

The baseline physical fitness and UCS performance assessments of the present study were performed during 6 different days during 6-week period. Between the test days, subjects had a minimum of 48-hour recovery period from the previous experiment, although they proceeded with their regular military service during their recovery. During the first two weeks of the study, conscripts performed the baseline measurements in the following order: 12–minute running test (assessment day 1), standing long jump, 1-minute sit-up and 1-minute push-up (assessment day 2), body composition and 30 seconds repetitive jump test (assessment day 3), maximal isometric strength both the lower and upper extremities and countermovement jump (assessment day 4). Maximal isometric strength and countermovement jump were measured just before the UCS1 and again after the MFE just before the UCS2 performance. (Figure 1)

FIGURE 1 about here, please

Endurance performance was evaluated by using the 12–minutes running test. The test was performed on a standardized 400 meter running track. The soldiers were instructed to complete the test with their maximal effort and run as long distance as possible within 12 minutes. The results were recorded as running distance, with an accuracy of 5 meters [17].

Explosive force production and dynamic endurance of the musculoskeletal system were tested using a standing long jump (SLJ), 60-s sit-ups and 60-s push-ups in mentioned order [18]. The test battery was performed with a break of at least 5 minutes between each assessment. Before each test, a supervisor showed the correct technique for each performance and incorrect repetitions were excluded from the results.

Standing long jump (SLJ) was used to assess explosive force production of the lower extremities [19]. The jumps were performed from a standing position, feet about at the pelvis width. Strain position was taken by bending knees and moving hands backward. Bilateral take off was assisted by extension of the hip and swinging of the arms. The landing was performed bilaterally. The best result of three jumps, expressed as centimeters of the shortest distance from the starting line to the landing point, was selected for further analyses.

Sit-up test assessed the performance of abdominal and hip flexor muscles [20]. In the starting position the soldier laid on his back and legs were supported by an assistant. The knees were at an angle of 90° and fingers were crossed behind the back of the head. One repetition was performed when the upper body was lifted from the starting position and elbows were brought to the same level with knees. Result of the test was the number of consecutive successful repetitions for 60 seconds.

The push-up test assessed performance of arm and shoulder extensor muscles [21]. In the starting position the soldiers placed feet parallel at pelvis width and hand positioned so that thumbs could reach the shoulders. The test started from the upright position with extended arms. The soldiers were instructed to keep the shoulders, trunk, and feet in the same line throughout the test. One successful repetition was performed when the soldier lowered his torso by flexing arms to an elbow angle of 90° and returned to the starting position. Result of the test was the number of consecutive successful repetitions for 60 seconds.

Body mass (BM), fat free mass (FFM), fat mass (FM) and fat percentage (FAT%) were determined by using the segmental multi-frequency bioimpedance analysis assessment (InBody 770, Biospace, Seoul, South Korea) in accordance with the manufacturer's guidelines. Measurements were performed in the morning after an overnight fast in the second week of the study.

Anaerobic capacity and power were assessed by 30-seconds continuous jump test (CJ30). The CJ30 consisted of maximal continuous vertical jumps performed for 30 seconds according to Dal Pupo et al. [22]. Participants were required to keep the trunk as vertical as possible, and hands were placed on hips. Jump heights were measured by OptoJump Next -optical sensor (Microgate, Bolzano, Italy). The mean height of the first four jumps (anaerobic power) and the mean height of all jumps (anaerobic capacity) were determined for further analyses. CJ30 has shown to correlate well with maximal and average power assessed using the Wingate 30-second anaerobic capacity test [22].

Maximal strength of the lower (MSlower) and upper (MSupper) extremities extensor muscles were measured by isometric leg press and bench press [23] by using an electromechanical dynamometer (University of Jyväskylä, Jyväskylä, Finland). In the lower extremity measurement, the seat was adjusted to maintain a knee angle of 107°. In the upper extremity measurement, the handlebar was adjusted to the height of shoulders and seat to maintain an elbow angle of 90°. In both tests, the soldiers were instructed to exert their maximal force in all three trials. The best performances regarding maximal force output in both tests were selected for further analysis.

Preceding the UCS, explosive force production was assessed with and without combat load. The participants performed two countermovement jumps with optical sensor (OptoJump Next, Microgate, Bolzano, Italy) both without the combat load (CMJ) and in the combat load (uniform, boots, helmet, body armor, replica rifle; CMJload). The soldiers were allowed 30 s for recovery between the jumps in both loading protocols. Theoretical maximal power was calculated from the height of the jump by using the Amonette et al. [24] equation (63.6 x jump height (cm) + 42.7 x body mass – 1846.5), which has shown a strong correlation with the maximal power measured with contact platform. Maximal strength of the lower and upper extremities and countermovement jumps in both loading protocols were assessed just before both UCS performances (UCS1 before MFE and UCS2 after MFE).

The UCS was performed inside an actual Urban Combat Operations training facility consisting of several rooms and thus, providing sensation of reality for the test. The UCS started outside with a 50-meter sprint to the entrance of the building. After the sprint, the soldiers relocated a truck tire without rim (56 kg) for a total of 2 meters by hitting it with a sledgehammer (10 kg). Thereafter, the soldiers carried two 20-kilogram kettlebells for 12 meters up the staircase with 3 meters total ascent. After the kettlebell carry the soldiers ran 5 meters and lifted a sandbag (20 kg) through a window and climbed through the window to repeat this for four times (window height from the ground: 1.4 meters from the front and 1.2 meters on the way back). Finally, the soldiers ran 8 meters and dragged an 85-kilogram mannequin (formed of three sandbags, attached to each other with cable ties) for 20 meters. The total length of the UCS track was 104 meters and it was performed without breaks in a shortest possible time (Figure 2). In addition, different components of UCS mentioned above were timed.

FIGURE 2 about here, please

During the UCS, subjects wore a combat uniform, running shoes and combat gear including body armor, helmet, and assault rifle replica. The total weight of combat gear with rifle was 18.2 ± 2.5 kilograms. Heart rate (HR) was measured during the UCS performance with a chest-worn sensor (Polar H10, Polar Electro Oy, Kempele, Finland). Relative intensity (%HRpeak) was calculated by assessing HRpeak by using Tanaka et al. [25] formula (208-0.7*[age]). Subjective workload was estimated before and after the UCS performance by using the Borg 0-10 rating of perceived exertion (RPE) -scale [26]. Before the recovered UCS performance assessment (UCS1), conscripts were introduced to and familiarized the test.

The 5-day military field exercise (MFE) was conducted during week 6, followed by the repeated UCS measurement (UCS2) immediately after the MFE performed. MFE included combat training and live fire exercises, which were conducted about 7-9 hours per day. The rest of the time included normal service at the base, such as maintenance of personal and unit equipment and guarding. Combat training was also conducted during two nights of the field training. The average sleep time during the MFE was 5 hours/night according to the conscripts' own assessment. The conscripts described verbally the total load of field training as moderate. The total load of field training was assessed with Borg 0−10 RPE scale [26] and maximal strength and countermovement assessments before the UCS2 performance.

2.3 Statistical analysis

Commercial software (IBM SPSS 22.0.0.0, Chicago, Illinois, USA) was used for statistical analyses. Descriptive statistical methods were used for the calculation of means, ranges and standard deviations (SD). The associations between UCS performances and other measured baseline variables were tested with Spearman´s two-tailed correlation coefficients. Significance of the relative differences between RPE and neuromuscular variables measured before and after MFE were analyzed by using One-Sample Wilcoxon Signed Rank Test. Linear regression analyses were used to study the associations of UCS and baseline physical fitness as well as body composition. Furthermore, it was analyzed how much (R2) body composition and physical fitness explained the performance in UCS test performances. The alpha value (p) was set to < 0.05 was used to establish statistical significance. Regarding paired comparisons the sample size was 13 and also 13 in correlations and regressions

3. RESULTS

The descriptive results of the baseline body composition and physical fitness measurements are presented in Table 1.

TABLE 1 about here, please

The mean (±SD) UCS performance time remained similar before and after the 5-day MFE (UCS1: 89±19 seconds, UCS2: 91±18 seconds) and there was no statistical difference between performances (p=0.04). Neither were there significant differences in the HRpeak or RPE values between the UCS1 and UCS2 performances. The mean HRpeak during the UCS1 was 175±9 bpm (range 159–194 bpm) or 90±5 % of the estimated HRpeak (range 82–100 % HRpeak). After the 5-day MFE in UCS2, the mean HRpeak was 177±7 bpm or 92±4 % HRpeak. The RPE ratings were 9±1 after both, UCS1 and UCS2 performance, respectively. However, RPE assessed before the UCS1 test was lower as compared to UCS2 (UCS1 1.4±0.8, UCS2 4.0±1.7, $p=0.003$). In addition, maximal strength of the lower extremities before UCS1 (355±44 kg) was higher than the respective test result before UCS2 (255±39 kg, $p=0.001$).

The Spearman correlation analysis showed that the strongest relationships with the performance times of both UCS1 and UCS2, were found for baseline explosive force production of the lower extremities, especially CMJload (UCS1 $r = -0.70$, $p=0.011$, UCS2 $r = -0.78$, $p<0.001$). Thus, the greater the value in the CMJLoad the quicker the time to complete the UCS. Furthermore, all maximal strength variables of the lower extremities were among the strongest associations with UCS. Correlations between the baseline tests and UCS1, as well as UCS2 were rather similar (Table 2). However, neither the performance time of UCS1, nor UCS2correlated ($p>0.05$) with aerobic or anaerobic capacity. Nevertheless, within the UCS test, time of the casualty evacuation component (the last part of the UCS test) correlated with anaerobic power (UCS1 $r = -0.58$, $p=0.038$, UCS2 $r = -0.68$, $p=0.013$) and capacity (UCS1 $r = -0.63$, $p=0.021$, UCS2 $r = -0.74$, $p=0.011$).

Among the body composition variables, the UCS performance times showed the highest correlations with BM (UCS1 $r = -0.81$, $p=0.002$, UCS2 -0.86, $p < 0.001$) and FFM (UCS1 $r = -0.83$, $p=0.002$, UCS2 $r = -0.91$, $p<0.001$). Thus, individuals with greater body mass and fat free mass performed the UCS quicker. There were only small differences in the correlation values between the UCS1 and UCS 2 performances and body composition (Table 3).

TABLE 2 and 3 about here, please

In the regression analyses, FFM ($R2 = 0.50$, $p=0.01$) and CMJload ($R2 = 0.46$, $p=0.009$) moderately predicted the variance in the UCS1 performance. FFM also predicted the variance in the UCS2 performance ($R2 = 0.77$, $p < 0.001$) after the 5-day MFE. For physical fitness characteristics, CMJload and MSlower together explained 67% of the variance in UCS2 performance time ($R2 = 0.67$, $p=0.002$). Moreover, anaerobic power ($R2 = 0.38$, $p=0.019$) explained the UCS2 performance moderately. CMJ2, MSlower and anaerobic power together strongly explained the variance in the UCS2 performance ($R2 = 0.74$, $p=0.014$).

4. DISCUSSION

In the present study, baseline maximal strength and power of the lower extremities and fat free mass were the strongest predictors of the UCS performance time. Also, maximal strength of the upper extremities and body mass explained the variance in UCS performance. There were no significant differences between the UCS performance times before and after the 5-day military field training. The operational stress does not seem to affect significantly to the relationships between UCS and the measured body composition and physical performance variables. The relationships between the strongest variables and UCS1, namely countermovement jumps, only got slightly stronger after the operational stress in UCS2.

The findings of this study are in line with previous studies which have also reported the importance of neuromuscular performance of the lower extremities in various military tasks [7, 8, 12]. The strongest individual variable was the countermovement jump with combat load which had strong correlations for both the UCS1 and UCS2 performances. The contribution of lower body strength and power may be explained by high-intensity muscle contractions required during UCS performed with combat uniform carrying extra loads. Urban combat soldiers are trained for the combat in human-built areas, where individual operations can last several hours. Throughout that time soldiers are mainly required to operate in an upright position on their feet and wearing their combat load which varies from 20kg to 40kg, depending on the task. These requirements highlight the importance of strength and power of the lower extremities.

In this study, there were no significant associations between the UCS performance and aerobic or anaerobic endurance. As mentioned, urban combat soldiers may have to operate several hours clearing buildings in a repeated manner. Ojanen et al. [15] showed that the relationships between a military task simulation and physical performance variables change when tasks are repeated within short intervals. It is possible that the association of aerobic fitness would increase if UCS performance would be repeated several times as in the study of Ojanen et al. [15].

There was also significant correlation between the UCS performance and maximal strength of the upper body ($r = -0.66$, $p = 0.02$). Previous studies [27, 28, 29] support the present findings, reinforcing that also upper body´s maximal strength is associated with the tasks included in the UCS performance. UCS consisted of several manual material handling tasks, such as using a sledgehammer, lifting heavy objects, and climbing with equipment. Efficiency of these tasks at least partly depends on high-intensity neuromuscular output of the upper body, which likely explains the observed relationships with the UCS performance. Hauschild et al. [9] reported in their review that upper body strength was associated with tasks consisting of lifting and lowering materials, lift and carry and stretcher carry. UCS consisted of similar tasks and thus, it is logical that our findings confirm those of Hauschild et al. [9]

Billing et al. [8] studied the effects of extra loads on combat movements and showed that the duration of high-intensity movement increases in relation of the carried load. That may also partly explain, why FFM and BM correlated strongly with the UCS performance in the present study. The greater the additional load in relation to the soldier’s body mass, the more it negatively impacts the performance [8]. The strong correlation between the UCS and FFM, as well as BM, may be partly explained by same factors, because the relative load of the combat load during UCS is smaller for the more muscular and heavier soldiers. This is in line with the observations of Vanderburgh [10] who reported that soldiers have advantage of a larger body structure and a large FFM in load carriage tasks.

Another specific aim of this study was to observe how operational stress, which was induced by the 5-day military field exercise, affected the UCS performance. There were no significant differences in the UCS performance times, heart rates or after performance RPE values between UCS1 and UCS2. Thus, it can be concluded that the 5-days MFE did not induce acute fatigue negatively affecting the UCS performance even if there were significant difference between the PRE and POST measures of maximal isometric strength. Also, earlier studies [30, 31, 32] have noticed decrements in maximum strength of the lower extremities during field exercises. In 5-day MFE soldiers were on their feet several hours during the day with combat load, which induced neuromuscular fatigue. That may explain the difference in lower body maximal strength, even if there were not significant difference in other variables. Interestingly, the relationships between UCS and the measured body composition and physical performance variables that were the strongest at baseline only got slightly stronger after the operational stress. This highlights the importance of maintenance of physical performance during military occupational stress.

There are strengths and limitations in the present study. First, limited number of studies have been published regarding associations between the physical performance and urban combat tasks in the military field [5]. The UCS was created for this study and thus, the test method was novel for the participants. Even though the actual tasks of the test were mainly familiar from the previous military training and the UCS was trained before performances, the test performance may have been influenced by learning effect or different pacing strategy. Another limitation of this study is the low number of subjects who performed both UCS performances. Unfortunately, COVID-19 pandemic affected the normal life in garrison and thus, the study proceeding as some of volunteered conscripts had infection or were quarantined as a precaution.

In conclusion, the repeated nature of experiments of this study demonstrated that an efficient urban combat operator requires a significant amount of maximal strength and explosive force production. The relationships between UCS performance and physical performance as well as body composition variables, especially explosive force production of the lower extremities and fat-free mass, were strengthened to a small extent after the 5-day MFE, which may mean that the higher the maximum strength level, the less the occupational stress induced by military field exercise negatively affects the performance. Also, a combination of both lower and upper body maximal strength and anaerobic capacity are associated with the UCS test performance regardless of several days of field activity undertaken prior to the assessment.

5. CONCLUSION

5.1 Practical applications

The present results illustrate that high-intensity strength training focusing on strength and power of the lower extremities and increase in fat free mass may be effective method to improve occupational performance of the Urban Combat Soldiers. However, some part of the training for the Urban combat tasks should be occupational. The strongest correlations with UCS were countermovement jump with combat load, which supports the idea of incorporating physical training with combat load. In addition, military specific tasks, such as casualty drag, can be effective training method for Urban Combat Soldiers. Combat training must also be seen as an opportunity to develop Urban combat soldiers' physical capabilities, not only skills.

High level of muscle mass combined with explosive power and strength of both upper and lower extremities are essential performance variables for soldiers participating in short, high-intensity urban combat activities. These physical fitness attributes can be developed with optimized training programs during and outside military training. However, training intervention studies are required to confirm the dose-response between changes in physical performance and urban combat performance.

Ethical approval

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Informed consent

Informed consent was obtained from all individuals participating in the study.

Conflict of interest

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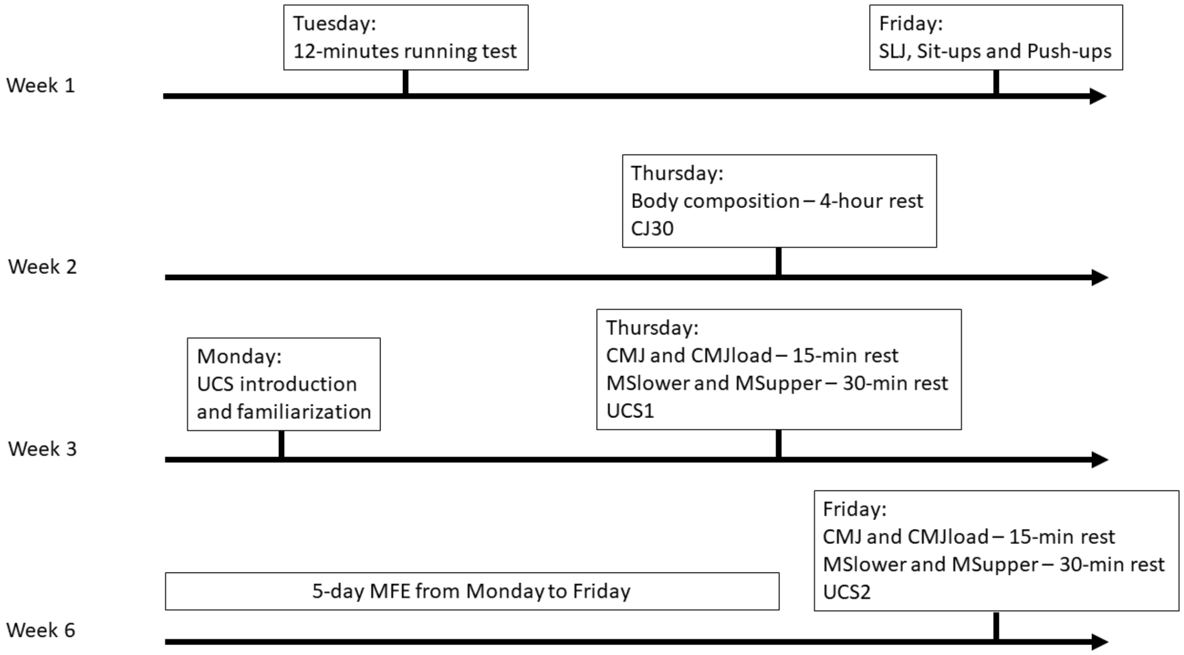
Figure 1. Figure showing the layout of the baseline physical fitness assessments and Urban Combat Simulation performances.



SLJ: standing long jump, CJ30: 30-seconds continuous jump test, UCS: Urban Combat Simulation, CMJ: Countermovement jump, CMJload: Countermovement jump with combat load, MSlower: Maximal isometric strength of lower extremities, MSupper Maximal isometric strength of upper extremities, MFE: Military field exercise.

Figure 2. Schematic illustration of the Urban Combat Simulation (UCS) test track.

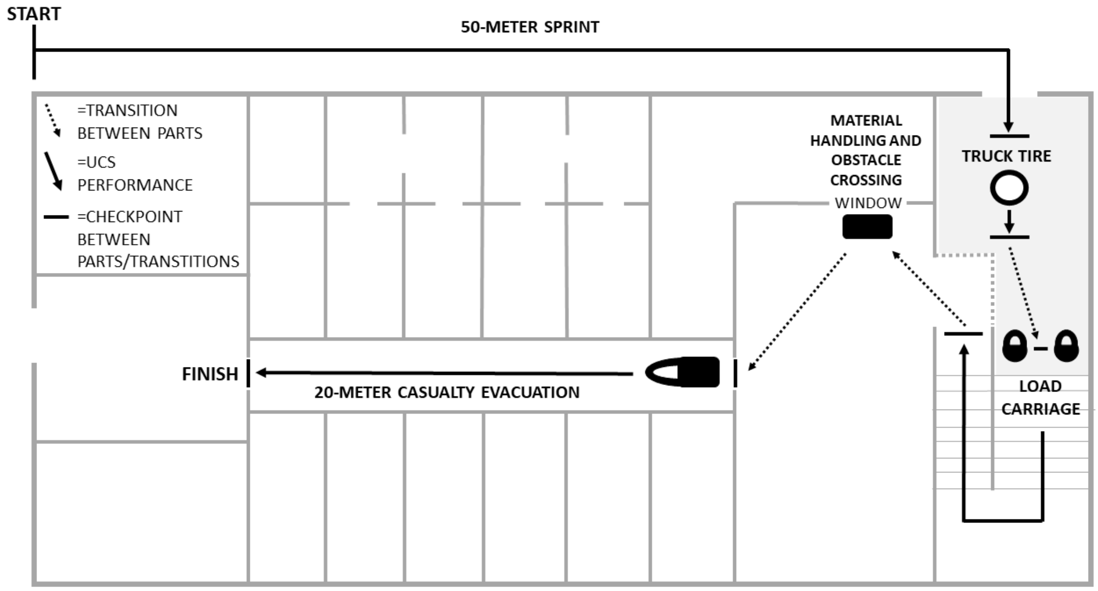


Table 1. The mean ±SD results of the baseline body composition and physical fitness measurements.

Variable	Mean	SD
Height (cm)	181.9	4.5
Body mass (kg)	75.4	8.7
Body mass index (kg/m^2)	22.8	2.2
Waist circumstance (cm)	83.0	5.6
Fat percent (%)	10.8	4.1
Fat mass (kg)	8.4	3.9
Fat free mass (kg)	67.1	6.3
12-minutes running test (m)	2790	300
SLJ (m)	2.38	0.27
Sit-ups (reps)	43	8
Push-ups (reps)	43	12
Anaerobic power (cm)	29.8	5.3
Anaerobic capacity (cm)	27.0	4.2
MSlower (kg)	346	53
MSupper (kg)	120	21
CMJ (W)	3578.9	610.6
CMJload (W)	3915.6	512.0

MSlower: Maximal isometric strength of lower extremities, MSupper: Maximal isometric strength of upper extremities, CMJ: Countermovement jump, CMJload: Countermovement jump with combat load.

Table 2. Associations between baseline physical fitness characteristics and Urban Combat Simulation performance.

Variable	UCS1 Time (s)		UCS2 Time (s)	
	r	p	r	p
12-minutes running (m)	-0.15	0.633	-0.06	0.851
SLJ (m)	-0.56	0.057	-0.65	0.016
Sit-ups (reps/min)	-0.34	0.285	-0.06	0.843
Push-ups (reps/min)	-0.28	0.372	0.10	0.736
MSlower (kg)	-0.62	0.033	-0.59	0.034
MSupper (kg)	-0.66	0.020	-0.68	0.010
Anaerobic capacity (cm)	-0.53	0.096	-0.53	0.075
Anaerobic power (cm)	-0.53	0.096	-0.49	0.103
CMJ (W)	-0.64	0.024	-0.70	0.001
CMJload (W)	-0.70	0.011	-0.78	0.001

UCS: Urban Combat Simulation, SLJ: standing long jump, MSlower: Maximal isometric strength of lower extremities, MSupper: Maximal isometric strength of upper extremities, CMJ: Countermovement jump, CMJload: Countermovement jump with combat load.

Table 3. Associations between baseline body composition and Urban Combat Simulation performance.

Variable	UCS1 Time (s)		UCS2 Time (s)	
	r	p	r	p
Height (cm)	-0.32	0.342	-0.33	0.303
BM (kg)	-0.81	0.002	-0.86	<0.001
BMI (kg/m^2)	-0.72	0.013	-0.69	0.012
Waist circumstance (cm)	-0.41	0.215	-0.46	0.134
FAT %	-0.14	0.689	-0.13	0.696
FM (kg)	-0.13	0.699	-0.14	0.667
FFM (kg)	-0.83	0.002	-0.91	<0.001

UCS: Urban Combat Simulation, BM: Body mass, BMI: Body mass index, FM: Fat mass, FFM: Fat free mass