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Original Research

Shoulder Taps: Relationships Between a New Movement Screening Assessment with Body Composition and Physical Fitness in Law Enforcement Recruits

CAITLYN E. HEREDIA†1, J. JAY DAWES‡2,3, JOSEPH M. DULLA†4, ROBIN M. ORR‡4, and ROBERT G. LOCKIE‡5

[1]Huntsville City Football Club, Huntsville, AL, USA; [2]School of Kinesiology, Applied Health and Recreation, Oklahoma State University, Stillwater, OK, USA; [3]Tactical Fitness and Nutrition Lab, Oklahoma State University, Stillwater, OK, USA; [4]Tactical Research Unit, Bond University, Robina, Qld, AUSTRALIA; [5]Center for Sport Performance, Department of Kinesiology, California State University-Fullerton, Fullerton, CA, USA

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 17(4): 702-719, 2024. The overhead squat, as part of the Functional Movement Screen (FMS), can analyze total- and lower-body mechanics. Shoulder taps, which incorporates a push-up position and challenges shoulder, trunk, and hip stability, may identify movement deficiencies indicated by multiple FMS actions which could be useful for law enforcement recruits. This study determined overhead squat and shoulder taps relationships, associations between these screens with body composition and fitness, and differences in body composition and fitness according to overhead squat/shoulder taps scores in recruits by sex. Retrospective analysis was conducted on 202 recruit datasets (158 males, 44 females), which included: overhead squat and shoulder taps scores; age, height, and body mass; skeletal muscle (SMM%) and body fat mass (BFM%) percentage; waist-to-hip ratio; grip strength; 60-s push-ups and sit-ups; 75-yard pursuit run; vertical jump; medicine ball throw; and multistage fitness test (MSFT). Spearman's correlations ($p<0.05$) determined relationships between the overhead squat and shoulder taps, and between the screens and other variables. Kruskall-Wallis H tests compared the variables when recruits were split into groups based on overhead squat/shoulder taps scores. A significant correlation was found between the screens for male ($\rho=0.231$) but not female ($\rho=0.258$) recruits. Overhead squat score had a moderate relationship with BFM% in females ($\rho=-0.312$). Shoulder taps had a small relationship with SMM% in males ($\rho=0.163$). There were no differences in body composition and fitness when recruits were split based on screen scores ($p=0.086$-0.994). While morphology may influence movement screen performance, the screens had minimal capacity for associating movement deficiencies to fitness.

KEY WORDS: Functional Movement Screen, multistage fitness test, overhead squat, police, tactical

INTRODUCTION

Specific movements are often used to screen and identify certain deficiencies in individuals that could influence physical performance and injury risk. For example, knee abduction within certain actions can relate to injurious movement biomechanics (30). One of the more popular screening tools used by practitioners is the Functional Movement Screen (FMS). The FMS is comprised of seven actions: overhead squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability (10, 11, 28). Cook et al. (10) characterized these movements as challenging an individual's ability to facilitate movement in a proximal-to-distal manner. Each movement is scored from 0 (unable to perform due to pain) to 3 (no movement corrections needed to complete the action), for a final composite score out of 21.

Following a meta-analysis of the literature and when considering the composite score, Moran et al. (31) suggested that there were limitations in using the FMS as a screening tool for injuries. Previous research has suggested that the scoring system may not be sensitive enough to identify a specific muscle or joint restrictions (28). Nonetheless, many studies that have investigated the FMS have used athletic populations. The FMS could have application with tactical personnel (i.e., military, first responders/emergency personnel), as these professions draw from the general population, where fitness and movement capabilities may be lower (4). Indeed, numerous tactical populations have utilized the FMS is movement testing, including the military (12), firefighters (40), and law enforcement (5, 35). It would be of value to focus on law enforcement, as especially within the USA, many agencies are facing challenges with the recruitment and retention of personnel (18). Given that fitness and movement capabilities can vary greatly within populations such as law enforcement recruits (24), the use of effective screens that could inform movement training, allowing for greater retention of personnel during the academy training process. That is, following limited training (9), training staff could use the screening information to better teach recruits how to move to enhance aspects of job performance and reduce their risk of injury.

One such example could be screening with the overhead squat. Even though the FMS composite score may not significantly predict injury (31), policing occupational task performance (5), or fitness measures such as sprinting speed and jump performance (28, 36), individual screens could provide more useful information for the practitioner. Researchers have previously used the overhead squat to analyze total body mechanics, specifically the mechanics of the ankle, knee, hip, and trunk (15, 30, 37). Additionally, the overhead squat could be used to identify gross movement errors (6). In an analysis of recreational male team sport athletes, Lockie et al. (28) found that following the stratification of subjects into those that scored 1, 2, or 3 in the overhead squat, there was a tendency for the subjects who scored 3 to perform better in sprint speed and jump tests. Further, those who scored 3 in the overhead squat had a longer standing broad jump when compared to those that scored 1 (p = 0.067) or 2 (p = 0.041). Interestingly, Heredia et al. (15) found no significant differences in the knee and ankle biomechanics of apparently-healthy men and women who scored 1 or 2 in the overhead squat. However, neither of these studies analyzed law enforcement recruits. Due to the challenges numerous law enforcement organizations have with the hiring and retention of personnel (18), and the potential for movement screening to assist with recruit retention (5, 24, 35), this population should be specifically analyzed. The overhead squat could potentially be used to identify movement limitations (e.g., restricted hip movements) in law enforcement recruits (10), and these limitations could influence job-specific activities such as sprinting (13) and jumping (32). However, this requires further analysis.

In addition to any limitations with the lower-body, having some type of trunk stability assessment for law enforcement recruits would be beneficial. Poor trunk stability has been associated with low back pain (20), which is a common injury concern with law enforcement personnel (2). Further, inefficient movement of the trunk or hips can alter gait patterns during walking or running (21), which poses more problems with the load carriage required for law enforcement officers (19). Within the FMS, Balfany et al. (1) suggested that trunk stability was either directly or indirectly measured in the trunk stability push-up, active straight-leg raise, and rotary stability. However, performing all these screens could be potentially redundant and time-consuming, which is a concern considering the time restraints placed on law enforcement personnel (5). Balfany et al. (1) has described the shoulder taps test that provides an assessment of trunk stability, along with hip and shoulder stability. Lack of trunk stability may result in more movement at the hip, which could be observed within shoulder taps. Additionally, the shoulder taps potentially evaluates disparate movement characteristics when compared to the overhead squat. However, there is currently no research that has investigated the shoulder taps relative to the overhead squat, or fitness test performance, in law enforcement recruits. If the shoulder taps screening assessment does relate to the performance of recruits, it could be more advantageous for practitioners to use a screen that is broad with regards to identifying movement limitations, as well as being relatively time efficient (1).

Therefore, the purpose of this study was to determine whether the overhead squat correlated with the shoulder taps screen, and relationships between these screens with body composition and physical fitness in law enforcement recruits when analyzed by sex. Additionally, any differences in body composition and fitness between recruits who scored 1, 2, or 3 in the overhead squat and shoulders taps was also derived (28). The body composition and fitness tests analyzed in this study have been adopted previously in law enforcement recruit research (8, 16, 22, 23, 27). It was hypothesized that the overhead squat and shoulder taps would not significantly relate, to show that they may measure different movement qualities. It was further hypothesized that there would be significant relationships between the overhead squat and shoulder taps with body composition and fitness test performance. Lastly, it was hypothesized that recruits scoring 3 in the overhead squat or shoulder taps would have superior body composition (i.e., higher skeletal muscle mass, lower body fat) and fitness (i.e., better performance on the fitness test) compared to recruits who scored 1 or 2 in these tests.

METHODS

Participants

Archival data from two recruit classes were released with consent from representatives at the law enforcement agency. The convenience sample comprised 202 recruits (age: 26.74 ± 5.75 years, height: 1.71 ± 0.10 meters [m], body mass: 79.69 ± 14.66 kilograms [kg]), including 158 males (26.79 ± 5.91 years; height: 1.74 ± 0.08 m; body mass: 83.77 ± 13.45 kg) and 44 females (26.55 ± 5.20 years; height: 1.60 ± 0.06 m; body mass: 65.01 ± 7.92 kg). An individual recruit was included in this study if their data was complete and correct (i.e., they had data entries for all tests analyzed in this study). All available datasets were used. Ethnicity of the recruits was not provided within these datasets. However, the demographics would likely have been representative of the agency (Hispanic: 49%; White: 26%; Asian: 15%; Black: 8%; Other: 2%) (29). The two training cohorts completed their academy within a calendar year in 2018 in southern California. Participant consent was waived due to the use of de-identified, preexisting datasets provided by the law enforcement agency. The institutional ethics committee approved the analysis of pre-existing data (HSR-17-18-370). The study followed the ethical guidelines set forth by the editorial board for the International Journal of Exercise Science (33).

Protocol

The data in this study were collected by staff working on behalf of one law enforcement agency, using procedures described in the literature (8, 16, 22, 23, 27). All staff were trained by a certified tactical strength and conditioning facilitator who verified the proficiency of the staff members. Body composition and screening tests were performed indoors on a basketball court at the agency's training facility. Fitness tests were conducted outdoors on concrete or asphalt surfaces. Testing typically occurred between 9:00am-2:00pm depending on class availability. The recruits did not eat in the 2-3 hours prior to testing as they completed employee-specific paperwork and completed the tests in self-chosen physical training clothing and shoes. The recruits rotated through the body composition and screening tests as individuals, before completing the fitness tests in groups of 3-4. The only exception was the 20-m multistage fitness test (MSFT), which was completed in groups of 14-16. Recruits were permitted to drink water as required during testing.

Firstly, each recruit's age, height, and body mass were recorded. Recruits removed their shoes to have their height measured using a portable stadiometer (seca, Hamburg, Germany). Body mass, skeletal muscle mass percentage (SMM%), and body fat mass percentage (BFM%) were recorded by electronic digital scales, which included bioelectrical impedance analysis to estimate body composition (Model HBF-510, Omron Healthcare, Kyoto, Japan). Manufacturer guidelines were followed to record body composition (22). The recruit's age, height in cm, and biological sex were entered into the device. The recruit then stepped onto the scale with their feet positioned on the forefoot and heel electrodes and held the display unit with both hands positioned on top of the electrodes on the handles until their body mass was displayed on the screen. Once the recruit's feet and hands were positioned on the eight electrodes (two each for the hands and feet), they stood upright and extended their arms so they were parallel to the ground. Analysis was completed when the recruit's body mass was displayed again. Proprietary equations from the device provided the body mass, SMM%, and BFM% measurements.

Waist-to-hip ratio (WHR) was also used as a measure of body composition. WHR protocols followed that from the literature (27). A thin-line metric tape measure (Lufkin, Apex Tool Group, Maryland) was used to measure waist and hip circumference for all recruits. Waist circumference was measured in cm at the narrowest part of the waist just superior to the naval. Hip circumference was measured in cm at the greatest posterior extension of the hip. WHR was calculated by dividing waist by hip circumference.

Following body composition measurements, the recruits performed the overhead squat and shoulder taps in that order. Both screens were scored on a scale of 0-3; if recruits experienced pain when attempting either movement, they were assigned a score of 0 and did not complete the screen. To perform the overhead squat, the recruit placed a dowel on their head with their elbows flexed at 90º and then pressed the dowel up overhead (15). The recruit then squatted down as low as possible (Figure 1), before returning to the starting position. Three repetitions were completed, with the best repetition scored according to the criteria in Table 1.

Figure 1. Frontal (A) and sagittal (B) view of the overhead squat.

Table 1. Scoring criteria for the overhead squat screen (10).

0	1	2	3
• Pain was present at any point during movement.	• Thigh did not break parallel with tibia or ground when heels were elevated. • Knees and dowel were over feet when heels were elevated. • Torso was not upright or in line with the tibia when heels were elevated. • Forward trunk lean was present.	• Thigh was below parallel or parallel with tibia and ground when heels were elevated. • Knees and dowel were not over feet when heels were elevated. • Torso was upright or in line with tibia when heels were elevated. • Forward trunk lean was present.	• Thigh was below parallel with the tibia and ground. • Knees were not over feet. • Dowel was not over feet or knees. • Torso was upright or in line with tibia.

Shoulder taps procedures have been described by Balfany et al. (1). The recruit began in a position similar to a plank with their hands directly beneath their shoulders and with the feet shoulder-width apart, which is shown in Figure 2 (1). Once the recruit was in the proper position represented in Figure 2, the staff member placed a dowel along the individual's back (straight line from the head through the upper back and buttocks) (1). The recruit was then instructed to tap the left shoulder with the right hand and return to the plank position, and the right shoulder with the left hand and return to the plank position (Figure 2). These movements were performed in a controlled manner. If the recruit was unable to perform these movements in the initial plank position, they were instructed to spread their feet to a shoulder-width and a half stance and attempt the shoulder taps again. Recruits were scored according to the criteria in Table 2.

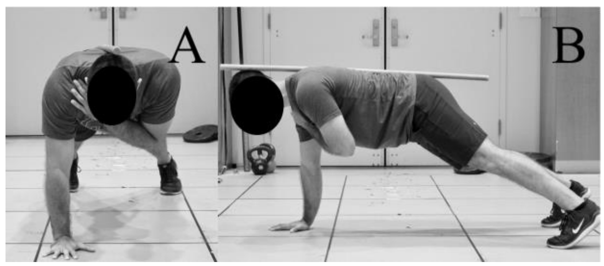

Figure 2. Frontal (A) and sagittal (B) view of the shoulder taps.

Table 2. Scoring criteria for the shoulder taps screen (1).

0	1	2	3
• Pain was present at any point during movement.	• Dowel did not maintain contact. • Hips rotated and dowel did not remain on back. • Unable to control shoulder motion. • Unable to complete taps with feet shoulder and a half width apart.	• Dowel remained in contact with spine (i.e. did not roll off). • Able to control motion of shoulder of moving arm. • Hips rotated and dowel remained on back. • Able to complete with feet shoulder and a half width apart.	• Dowel remained in contact with spine (i.e. did not roll off). • Able to control motion of shoulder of moving arm. • Hips did not rotate. • Able to complete with feet shoulder width apart.

The fitness tests were performed next. Grip strength for each hand was measured using a hand grip dynamometer (Takei Scientific Instruments, Japan) with previously described procedures (27). The dynamometer was adjusted so the base of the first metacarpal and the middle four fingers were in contact with the handle. Recruits kept their testing arm by their side throughout the assessment and squeezed the handle as hard as possible for approximately 2 seconds (s). Two attempts were completed for each hand and recorded to the nearest kg, with the left hand tested first. The best score for each hand was summed together to provide the combined grip strength score used for analysis.

The push-up test measured upper-body muscular endurance, where recruits completed as many repetitions as possible in 60 s. A staff member placed a fist on the floor directly under the recruit's chest to ensure they descended to an appropriate depth. Although there are some limitations with this approach, this ensured recruits descended to the required depth (23). All female recruits were partnered with a female tester. On the start command, the tester began the stopwatch and the recruit flexed their elbows and lowered themselves until their chests contacted the staff-member's fist before they extended their elbows to return to the starting position. Recruits performed as many repetitions as possible using this technique in the 60-s period.

The sit-up test measured abdominal muscular endurance, where the recruits completed as many repetitions as possible in 60 s. The recruits laid on their backs with their knees flexed to 90°, heels flat on the ground, and arms crossed over the chest. The feet were held to the ground by a tester who counted the repetitions. On the start command, recruits raised their shoulders from the ground while keeping their arms crossed over the chest and touched their elbows to their knees. The recruit then descended back down until their shoulder blades contacted the ground. Recruits completed as many repetitions as possible using this technique in 60 s.

The 75-yard pursuit run (75PR) was used to simulate a foot pursuit and provided a measure of change-of-direction speed (8, 16, 22, 23, 27). The test structure is shown in Figure 3. The recruit completed five linear sprints about the square grid, while completing four, 45° direction changes across the grid. There were also three 2.44-m long and 0.15-m high barriers that simulated curbs that recruits had to run over. As per the agency procedures, time was recorded by stopwatch from the initiation of movement at the start until the recruit passed the finish line. Two trials were completed with at least 2 minutes rest between trials, with the fastest trial informing this research.

The countermovement vertical jump (VJ) provided an indirect metric for lower-body power, and was measured by a Vertec apparatus (Perform Better, Rhode Island, USA) using established protocols (8, 22, 23, 25, 27). The recruit stood side-on to the Vertec on their dominant side and while keeping their feet on the ground, reached upward as high as possible to displace as many vanes as possible. The last vane moved was the zero reference. The recruit then jumped as high as possible, with a countermovement but no preparatory step, with height recorded from highest vane moved. Jump height was calculated in inches by subtracting the standing reach height from the jump height, and was converted to cm. Each subject completed two trials, with a between-trial recovery time of approximately 60 s. The best trial was utilized in this study.

The 2-kg medicine ball throw (MBT) was used to indirectly measure upper-body power via conventional procedures (8, 22, 23, 25, 27). The recruit sat on the ground with their head, shoulders, and lower back against a concrete wall, and projected a 2-kg medicine ball (Champion Barbell, Texas, USA) as far as they could using a two-handed chest pass. The medicine ball was lightly dusted with chalk to assist with grip and mark the landing spot. Throw distance was the perpendicular distance from the wall to the chalk-marking closest to the wall, which was measured by a standard tape measure. Two trials were completed, with a between-trial recovery time of approximately 60 s, and the best trial was examined.

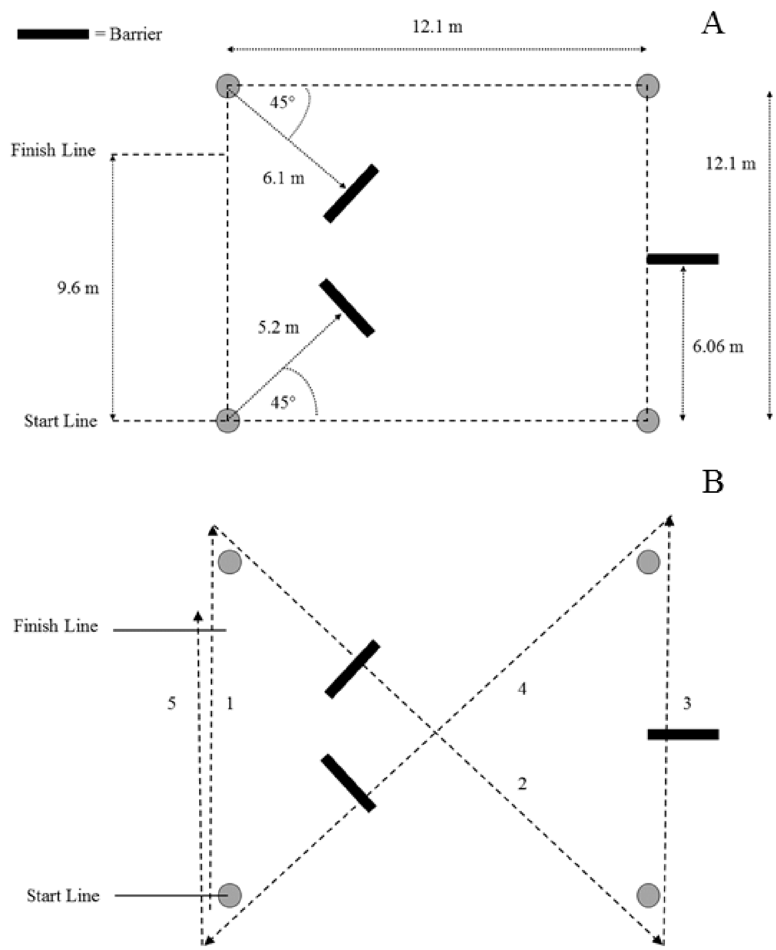

Figure 3. Dimensions for the 75-yard pursuit run in m (A) and the running direction (numbered in order; B).

The arm ergometer test measured upper-body muscular endurance, followed procedures defined by the agency training manual, and was performed on an arm ergometer (Monark 881E, Vansbro, Sweden) placed on a table (3, 7). The recruit completed 10 revolutions on the ergometer prior to the test to set the workload to 50 watts. Next, the recruit moved one handle to the start position marked on the ergometer so that one complete revolution took place and the counter registered '1'. A staff member then reset the counter to 0 and initiated the test. Recruits then completed as many revolutions as possible in 60 s. The final number of revolutions was recorded from the counter.

The MSFT measured maximal aerobic capacity in the recruits and was conducted outdoors on an asphalt surface (8, 16, 22, 23, 27). Recruits ran back and forth between two lines spaced 20 m apart, indicated by markers. Running speed was standardized by pre-recorded auditory cues, or beeps, played from an iPad handheld device (Apple Inc., Cupertino, California) connected by Bluetooth to a portable speaker (ION Block Rocker, Cumberland, Rhode Island), placed in the center of the running area. The test was terminated when the recruit was unable to reach the lines twice in a row in accordance with the auditory cues, or by voluntary exhaustion. This test was scored according to the final level and stage the recruit achieved, which were used to calculate the total number of completed shuttles.

Statistical Analysis

All statistical analyses were computed using the Statistics Package for Social Sciences (version 29.0; IBM Corporation, NY, USA) and Microsoft Excel (Microsoft Corporation, Redmond, Washington, USA). Descriptive data (mean ± standard deviation [SD]) was derived for all variables. Similar to other law enforcement research (3, 23, 25), the sexes were analyzed separately in this study. Normality of the data was evaluated by Shapiro-Wilk tests. As will be noted, the majority of the variables were not normally distributed, so non-parametric statistics were used in this study. To derive the relationships between the overhead squat and shoulder taps, Spearman's correlations and a regression were used. Spearman's correlations were also used to calculate relationships between the overhead squat and shoulder taps with the body composition and fitness metrics. Significance was set as $p < 0.05$. Correlation strength was defined per established guidelines (17). A rho (ρ) value between 0 to ±0.3 was small; ±0.31 to ±0.49, moderate; ±0.5 to ±0.69, large; ±0.7 to ±0.89, very large; and ±0.9 to ±1 near perfect for predicting relationships. Kruskal-Wallis H tests were utilized to compare recruits who scored 1, 2, or 3 in either the overhead squat or shoulder taps screens ($p < 0.05$).

RESULTS

The results of the Shapiro-Wilk test indicated that 9 of 16 variables were not normally distributed for the male recruits ($p \leq 0.009$). Seven out of 16 variables were not normally distributed for female recruits. Most notably for both sexes, the overhead squat and shoulder taps scores were not normally distributed ($p < 0.001$). Thus, non-parametric statistics were deemed appropriate for data analysis in this study. There was a significant, small relationship between the overhead squat and shoulder taps for male recruits ($\rho = 0.230$, $p = 0.004$), but this relationship was not significant for the female recruits ($\rho = 0.258$, $p = 0.091$). Further, the predictive ability of the overhead squat score to the shoulder taps score for both sexes was minimal (Figures 3 and 4). Two male recruits scored 0 for the overhead squat and were excluded from the regression. Correlation data for the overhead squat and shoulders taps with the body composition and fitness tests for male and female recruits is shown in Tables 3 and 4, respectively. There were only two significant relationships. For male recruits, the shoulder taps score had a small, positive relationship with SMM%. For female recruits, the overhead squat score had a moderate, negative relationship with BFM%.

The body composition and fitness recruit data relative to overhead squat score for the male and female recruits is shown in Tables 5 and 6, respectively. The two male recruits who scored 0 in the overhead squat were also excluded from the overhead squat between-group comparisons. There were no significant differences in age, body composition, or fitness regarding recruit scores for the overhead squat for either the male recruits (p = 0.115-0.842) or female recruits (p =

0.106-0.862). For the shoulder taps score, the male and female recruit data is shown in Tables 7 and 8, respectively. There were also no significant between-group differences in any variable with respect to shoulder taps scores for male (p = 0.086-0.874) or female (p = 0.169-0.994) recruits.

Table 3. Correlations (ρ) between the overhead squat and shoulder taps score with age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT) in male law enforcement recruits.

	Overhead Squat (n = 156)		Shoulder Taps (n = 158)	
Variables	ρ	p	ρ	p
Age	0.061	0.449	0.036	0.656
Height	-0.096	0.235	-0.143	0.073
Body Mass	-0.126	0.118	-0.127	0.111
SMM%	0.150	0.062	0.163*	0.041
BFM%	-0.126	0.118	-0.129	0.107
WHR	-0.068	0.405	-0.050	0.540
Grip Strength	0.052	0.516	0.043	0.592
Push-ups	0.097	0.228	0.133	0.096
Sit-ups	0.009	0.913	0.132	0.097
75PR	-0.135	0.092	0.005	0.947
Arm Ergometer	0.010	0.900	-0.023	0.776
VJ	0.092	0.252	0.068	0.398
MBT	-0.033	0.683	-0.065	0.418
MSFT	0.047	0.561	0.125	0.119

* Significant ($p < 0.05$) relationship between the two variables.

Table 4. Correlations (ρ) between the overhead squat and shoulder taps score with age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT) in female law enforcement recruits.

	Overhead Squat (n = 44)		Shoulder Taps (n = 44)	
Variables	ρ	p	ρ	p
Age	0.104	0.504	-0.283	0.062
Height	0.065	0.677	-0.013	0.934
Body Mass	-0.277	0.077	0.017	0.914
SMM%	0.240	0.116	-0.125	0.418
BFM%	-0.312*	0.039	0.088	0.570
WHR	-0.164	0.288	0.076	0.625
Grip Strength	-0.014	0.926	0.280	0.065
Push-ups	0.111	0.474	-0.042	0.787
Sit-ups	0.142	0.357	-0.150	0.332
75PR	-0.123	0.432	-0.206	0.185
Arm Ergometer	-0.208	0.176	-0.058	0.710
VJ	0.113	0.467	0.208	0.175
MBT	-0.155	0.315	-0.022	0.888
MSFT	0.173	0.261	0.200	0.193

* Significant ($p < 0.05$) relationship between the two variables.

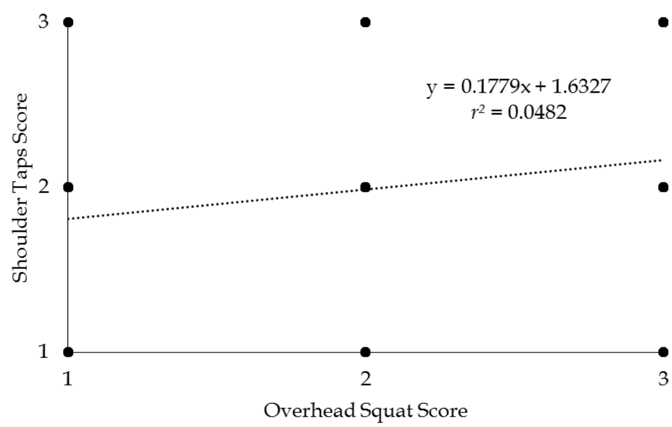

Figure 4. Regression between the overhead squat and shoulder taps score for male law enforcement recruits (N = 156).

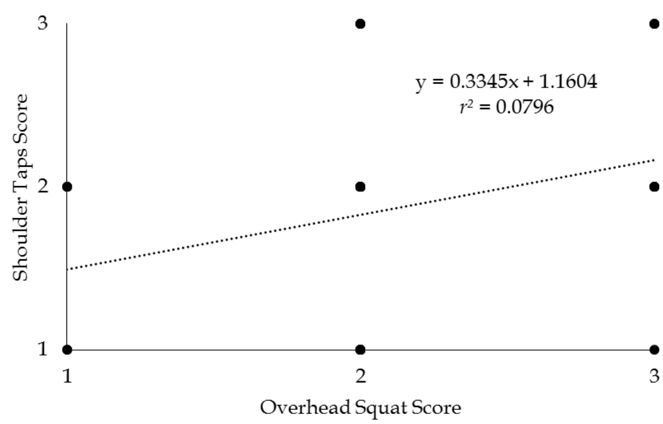

Figure 4. Regression between the overhead squat and shoulder taps score for female law enforcement recruits (N = 44).

Table 5. Descriptive data (mean ± SD) for male law enforcement recruits who scored 1, 2, or 3 in the overhead squat screen for age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT).

Variables	1 (*n* = 30)	2 (*n* = 92)	3 (*n* = 34)
Age (years)	27.37 ± 8.11	26.34 ± 4.69	27.62 ± 6.75
Height (m)	1.76 ± 0.09	1.73 ± 0.08	1.73 ± 0.08
Body Mass (kg)	85.41 ± 14.86	84.48 ± 11.89	80.15 ± 15.94
SMM%	37.13 ± 3.61	37.13 ± 3.55	38.41 ± 3.88
BFM%	24.43 ± 6.28	24.79 ± 5.42	22.10 ± 6.28
WHR	0.87 ± 0.05	0.87 ± 0.07	0.86 ± 0.07
Grip Strength (kg)	102.93 ± 19.26	105.97 ± 17.01	106.41 ± 20.38
Push-ups (repetitions)	45.23 ± 16.54	46.58 ± 13.40	49.35 ± 16.71
Sit-ups (repetitions)	37.33 ± 10.07	38.80 ± 8.67	38.24 ± 9.99
75PR (s)	17.25 ± 1.17	16.76 ± 0.99	16.75 ± 0.80
Arm Ergometer (revolutions)	135.53 ± 13.39	137.63 ± 16.88	134.94 ± 20.01
VJ (cm)	55.41 ± 10.97	58.24 ± 10.86	58.54 ± 10.83
MBT (m)	6.70 ± 1.10	6.71 ± 0.95	6.73 ± 1.33
MSFT (shuttles)	58.43 ± 19.09	60.40 ± 18.73	61.32 ± 20.33

Table 6. Descriptive data (mean ± SD) for female law enforcement recruits who scored 1, 2, or 3 in the overhead squat screen for age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT).

Variables	1 (*n* = 6)	2 (*n* = 29)	3 (*n* = 9)
Age (years)	25.67 ± 3.98	26.62 ± 5.70	26.89 ± 4.60
Height (m)	1.57 ± 0.07	1.61 ± 0.06	1.58 ± 0.06
Body Mass (kg)	67.60 ± 5.87	65.93 ± 8.28	60.33 ± 6.53
SMM%	26.23 ± 3.24	28.43 ± 3.39	29.69 ± 3.82
BFM%	39.67 ± 6.26	35.58 ± 4.97	32.14 ± 6.55
WHR	0.83 ± 0.04	0.79 ± 0.05	0.80 ± 0.05
Grip Strength (kg)	68.67 ± 11.59	67.83 ± 10.93	69.89 ± 11.86
Push-ups (repetitions)	20.67 ± 12.13	23.14 ± 10.57	25.67 ± 7.55
Sit-ups (repetitions)	27.00 ± 5.40	34.79 ± 20.21	30.89 ± 6.77
75PR (s)	18.95 ± 1.35	18.47 ± 1.57	18.43 ± 1.24
Arm Ergometer (revolutions)	116.17 ± 10.11	111.83 ± 18.44	104.67 ± 14.97
VJ (cm)	38.10 ± 7.99	40.03 ± 8.64	41.35 ± 6.16
MBT (m)	4.65 ± 0.61	4.36 ± 0.53	4.27 ± 0.43
MSFT (shuttles)	48.00 ± 14.81	50.34 ± 13.73	57.44 ± 18.63

Table 7. Descriptive data (mean ± SD) for male law enforcement recruits who scored 1, 2, or 3 in the shoulder taps screen for age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT).

Variables	1 (*n* = 25)	2 (*n* = 110)	3 (*n* = 23)
Age (years)	26.96 ± 8.29	26.65 ± 5.08	27.30 ± 6.75
Height (m)	1.76 ± 0.09	1.74 ± 0.08	1.72 ± 0.10
Body Mass (kg)	84.68 ± 9.57	84.70 ± 14.37	78.35 ± 11.52
SMM%	36.62 ± 3.94	37.37 ± 3.65	38.67 ± 3.02
BFM%	24.72 ± 6.51	24.25 ± 5.83	22.59 ± 5.14
WHR	0.87 ± 0.04	0.87 ± 0.05	0.87 ± 0.08
Grip Strength (kg)	103.52 ± 18.21	105.94 ± 18.33	105.87 ± 17.66
Push-ups (repetitions)	43.36 ± 11.91	47.06 ± 14.87	49.74 ± 16.29
Sit-ups (repetitions)	36.44 ± 8.54	38.23 ± 9.25	41.13 ± 9.04
75PR (s)	16.86 ± 1.14	16.87 ± 0.99	16.80 ± 0.93
Arm Ergometer (revolutions)	137.04 ± 18.83	135.89 ± 16.61	138.52 ± 17.05
VJ (cm)	57.81 ± 11.83	57.18 ± 10.81	60.02 ± 9.84
MBT (m)	6.87 ± 1.14	6.73 ± 1.11	6.53 ± 0.68
MSFT (shuttles)	57.64 ± 22.57	59.82 ± 18.18	65.74 ± 18.26

Table 8. Descriptive data (mean ± SD) for female law enforcement recruits who scored 1, 2, or 3 in the shoulder taps screen for age, height, body mass, skeletal muscle mass percentage (SMM%), body fat mass percentage (BFM%), waist-to-hip ratio (WHR), grip strength, push-ups, sit-ups, arm ergometer, vertical jump (VJ), 2-kg medicine ball throw (MBT), and 20-m multistage fitness test (MSFT).

Variables	1 (*n* = 13)	2 (*n* = 24)	3 (*n* = 7)
Age (years)	28.46 ± 5.65	26.04 ± 5.12	24.71 ± 4.07
Height (m)	1.60 ± 0.06	1.60 ± 0.06	1.59 ± 0.07
Body Mass (kg)	65.03 ± 7.78	64.93 ± 7.81	65.29 ± 9.72
SMM%	29.72 ± 5.00	27.80 ± 2.74	27.91 ± 2.21
BFM%	34.79 ± 5.70	35.73 ± 6.20	35.66 ± 5.09
WHR	0.80 ± 0.05	0.80 ± 0.04	0.80 ± 0.08
Grip Strength (kg)	63.92 ± 9.51	69.29 ± 11.23	73.43 ± 11.01
Push-ups (repetitions)	22.92 ± 9.35	24.17 ± 11.13	21.14 ± 8.78
Sit-ups (repetitions)	32.77 ± 7.65	33.92 ± 22.12	29.86 ± 6.49
75PR (s)	18.65 ± 0.89	18.65 ± 1.74	17.90 ± 1.08
Arm Ergometer (revolutions)	110.31 ± 17.70	114.58 ± 15.02	99.71 ± 19.18
VJ (cm)	38.88 ± 5.95	40.11 ± 9.02	41.91 ± 8.33
MBT (m)	4.38 ± 0.44	4.42 ± 0.54	4.29 ± 0.63
MSFT (shuttles)	45.38 ± 10.53	55.29 ± 17.13	49.71 ± 10.39

DISCUSSION

This study determined whether the overhead squat screen correlated with the shoulder taps screen in male and female law enforcement recruits, the relationships between these screens with body composition and physical fitness tests, and whether there were differences between these metrics when recruits were grouped by overhead squat or shoulder taps score. These two screens were investigated as the overhead squat has been isolated to analyze total-body mechanics (15, 30), while the shoulder taps has been suggested as a screen that could assess trunk and hip stability in a more efficient manner than via multiple movements (i.e., trunk stability push-up, active straight-leg raise, and rotary stability) from the FMS (1). Firstly, it was hypothesized that the overhead squat and shoulder taps would not significantly relate, to show that they may measure different movement qualities. While there was a significant relationship between the two screens for the male recruits, there was not for the female recruits. Further, the relationship strengths were small with weak predictive values. Thus, the data implied that both screening tests measured disparate movement characteristics. Second, it was hypothesized that there would be significant relationships between the overhead squat and shoulder taps with body composition and fitness test performance. This hypothesis was not supported, as there was only two significant relationships out of 56 correlations (overhead squat score and BFM% in female recruits, shoulder taps score and SMM% in male recruits). Lastly, it was hypothesized that recruits scoring 3 in the overhead squat or shoulder taps would display better body composition and fitness compared to recruits who scored 1 or 2 in these tests. This hypothesis was also not supported, as there were no significant between-group differences for either screen for male or female recruits. Practitioners who use either the overhead squat, or the more novel shoulder taps, will need to reckon with the study results and how they interpret the information they take from these screens.

As stated, although there was a significant relationship between the overhead squat and shoulder taps for the male recruits, there was not for the females. Moreover, for both sexes the strength of the relationships was small and there was a weak predictive relationship between the screens. The overhead squat is said to challenge total-body mechanics, symmetrical movement and mobility of the hips, knees, and ankles, symmetrical mobility of the shoulders, and mobility of the thoracic spine (10). Shoulder taps is suggested to assess core and trunk stability, in addition to shoulder and hip stability (1). The current data suggests the information a practitioner can take from each of these screens should be different, as both screening tests seem to measure disparate movement characteristics. However, what the practitioner needs to also concern themselves with is what this movement characteristic information means and how they could apply this to training law enforcement recruits.

Similar to previous research (28, 36), there were very few significant relationships between the two movement screens from this study and the body composition and fitness tests. Specific to body composition, there was a significant, moderate relationship between the overhead squat with BFM% in the female recruits, which implied a higher overhead squat score related to a lower BFM% (i.e., less BFM). For the male recruits, there was a small relationship between the shoulder taps score and SMM%, which suggested a higher shoulder taps score related to a higher SMM% (i.e., more SMM). These data could be influenced by the fact that female recruits would likely have a higher BFM% compared to the male recruits (8, 22). Conversely, the male recruits would likely have a higher SMM% compared to the female recruits (8, 22). These data may provide some indication for the benefits of lesser BFM and more SMM in movements that challenge dynamic stability. However, neither body mass or WHR related to either screen for either sex. When split by sex, a law enforcement recruit's morphology may influence their potential results in screening tests. Nonetheless, any morphological bias may be relatively minimal given that there was only one significant relationship by sex for each screen.

With regards to the fitness tests, there were no significant relationships found between either screen and fitness test performance for male or female recruits. The requirements for more dynamic movements (e.g., push-ups, sit-ups, 75PR, VJ, MBT, and MSFT) may not relate to the relatively slow actions performed during the overhead squat and shoulder taps (28). The recruits were required to grip the dowel in the overhead squat, but the force output was not to the extent required in the grip strength test, which would highlight why there was no significant relationship with this fitness test for either sex. Indeed, grip strength may be more likely to relate to a task where high muscular force is required (e.g., a body or victim drag) (26). The current study cannot address whether the scoring system for the overhead squat or shoulder taps provides useful information about injury risk in law enforcement recruits. This would require a longitudinal study investigating injury rates that result from law enforcement training academies, and whether any movement limitations identified from either screen is predictive of, or a result of, these injuries. What the current data does suggest is that for the most part, neither the overhead squat nor shoulder taps relate to fitness test performance in male and female law enforcement recruits.

When recruits were grouped according to either their overhead squat or shoulder taps scores for each sex, there were no significant between-group differences in the body composition and fitness tests. When considering the mean data, there were some tests where relatively better performance could be observed as the screen scores increased from 1 to 3. For the overhead squat, this can be seen for push-ups, the 75PR, VJ, and the MSFT for male and female recruits. Regarding shoulder taps, the general better performance relative to scores can be observed for push-ups, sit-ups, the 75PR, and the MSFT for the male recruits. For females, this occurred for grip strength, the 75PR, and VJ. Some of this could relate to findings from Cesario et al. (7), who suggested that overall fitter recruits tend to perform better in a range of different fitness tests compared to less fit recruits. However, it should be reemphasized that none of these differences for either sex were significant. Specific to the biomechanics of the overhead squat, Heredia et al. (15) detailed no significant differences in hip and knee movements between adult men and women who scored 1 or 2, and noted limitations in test sensitivity. Although no such study has been conducted for the shoulder taps screen, it is plausible that the movement screens were not sensitive enough to identify specific muscle or joint restrictions (28). That is not to say there is no value in utilizing movement screens. Rather, the practitioner needs to be careful with how they interpret certain movement scores and how that could influence physical performance. Further, practitioners should have a specific strategy (i.e. specific exercise selections) if they do identify a movement limitation from a screen (14), and what this could mean for a recruit's training.

There are limitations for this study that should be acknowledged. Only two screens were analyzed in this study (i.e., overhead squat, shoulder taps). Given the suggestion that the shoulder taps could be use instead of multiple movements from the FMS (trunk stability push-up, active straight-leg raise, and rotary stability) (1), future studies should detail relationships between the shoulder taps and other FMS actions. Unfortunately, that was not possible in this study with law enforcement recruits due to the time restrictions associated with academy training. There is other technology that could provide more accurate body composition metrics (e.g., segmental body composition analyses) (8), and this could yield different results when correlated with the overhead squat and shoulder taps than the current study. All the fitness tests were not performed with the typical load carriage required of law enforcement personnel. Given that load carriage will negatively impact running performance (34) and FMS movement patterns (39), it is possible that any movement deficiencies indicated by the overhead squat or shoulder taps could be exacerbated when under load. Future research should document whether fitness test relationships with movement screens such as the overhead squat or should taps changes when the individual is carrying load. The fitness test battery did not feature any lower-body maximum strength tests, such as a leg/back dynamometer (26), back squat, or deadlift (38). It is possible that the overhead squat and shoulder taps could relate to these strength tests.

To conclude, the results from this study demonstrated a significant, small relationship between the overhead squat and shoulder taps in male but not female law enforcement recruits, which may suggest the two screens measure disparate movement characteristics. However, there were very few significant relationships between the overhead squat and shoulder taps scores with body composition and fitness. The overhead squat score did have a moderate, negative correlation with BFM% in female recruits. Shoulder taps score had a small, positive relationship with SMM% in male recruits. A recruit's morphology may have some influence in their ability to perform screening movements such as the overhead squat and shoulder taps. Nonetheless, there were no significant relationships between the screening tests and fitness test performance for either sex, nor were there significant differences between body composition and fitness when recruits were split in groups based on their overhead squat or shoulder taps score. Practitioners who use either the overhead squat or shoulder taps should be cautious with how they interpret the information they take from these screens and what impacts may (or may not) result for physical performance in law enforcement recruits.

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