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Fitness and movement quality of emergency task force police officers: An age-grouped database with comparison to populations of emergency services personnel, athletes and the general public

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ABSTRACT

The purpose of this study was to compare fitness, hip range of motion (ROM) and movement quality of an Emergency Task Force (ETF) police unit across age groups and with other populations. ETF had poorer hip ROM and back torso endurance compared to other cohorts which are variables linked with back disorders.

Relevance to Industry: Understanding functional capacity assists Ergonomists in designing standards for occupations and worker groups. The fitness and movement competency variables documented here for an elite police tactical squad assist in designing training programs to meet job demands and avoid injury.

Foreword

Ergonomics has been influenced by many notable personalities and great minds. In the area of physical ergonomics and psychophysical determination of functional capacity, Dr. Vincent Ciriello has been an influential scientist. Psychophysical approaches have been used to predict functional capacity which is affected by fitness and movement quality variables. The work described here reports these variables which may be helpful to assess the relationships and mechanisms of those physical capabilities predicted psychophysically. Dr. Ciriello's work produced a number of large databases on acceptable and non-acceptable loads for a wide range of the working population. The data base here may provide some mechanistic context.

1. Introduction

Police work, in particular the work of Emergency Task Force (ETF) units, is a highly physically demanding occupation, such that officers in these elite units and potential recruits train for a considerable amount of time to prepare themselves for challenges they may face while on duty. Efforts are made to improve the specific skills necessary to meet job requirements but the emphasis is typically placed on overall "physical preparedness". The ability to perform physically demanding tasks devoid of injury has been linked to both fitness levels (Cady et al., 1979) and

Abbreviations: ETF, Emergency Task Force; SIT, Static sit-up posture test; FPLK, Front plank; SPLK, Side plank; BSE, Biering-Sorensen; GRP, Grip strength; PUP, Pull-ups; EFLX, Hip extension with knee flexed range of motion test; EEXT, Hip extension with knee extended range of motion test; FFLX, Hip flexion with knee flexed range of motion test; FEXT, Hip flexion with knee extended range of motion test; IROT, Internal rotation hip range of motion test; EROT, External rotation hip range of motion test; SQT, Deep squat movement test; HRD, Hurdle step movement test; LNG, In-line lunge movement test; SHDR, Shoulder mobility movement test; SLR, Active straight leg raise movement test; PUSH, Trunk stability push-up movement test; ROT, Rotary stability movement test; POS, Standing posture movement test; SPOS, Seated posture movement test; FLEX, Segmental flexion movement test; EXT, Segmental extension movement test; BEND, Segmental lateral bend movement test; TWST, Segmental twist movement test; GAIT, Gait movement test; BOX, Box lift movement test; TORS, Torsion control movement test; PEL, Pelvis rock movement test; COIN, Coin lift movement test; FMS, Functional movement screen™.

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movement competency (e.g. better movement reduces joint loads and injury occurrence in the knee (Hewett et al., 1999) and in the back (McGill et al., 2003)), suggesting that both factors should be considered when preparing or testing one's level of readiness for a physically demanding occupation such as policing (Nabeel et al., 2007; Smolander et al., 1984). Documenting the characteristics of successful job incumbents to form a database has also provided insight into the levels of fitness required to perform occupational duties which relates to the concept of job content and construct validity (Kuruganti and Rickards, 2004). Using a database to compare to other occupational groups with demanding jobs may also help to understand the "balance" or relationship between the many variables used to define physical capabilities. This study quantified several "fitness" variables from an elite police task force, considered "occupational athletes", to form a database to characterize their physical profile and which could be compared to other existing databases obtained from firefighter, police, athletic and healthy groups.

One variable that has been shown to affect both physical fitness and movement patterns is age. Muscle strength and power, important factors for police work (de Loës and Jansson, 2002), have been shown to decrease with age in certain populations (Samson et al., 2000; Tarpenning et al., 2004). Similarly, in a study by Findley et al. (1995), age was associated with lower abdominal endurance (measured by maximum sit up repetitions in 2 min) in a group of firefighters. In the same investigation, however, there were no differences in cardiorespiratory endurance (VO_2) or upper body muscular strength and endurance across different age groups. These findings suggest many possibilities: In order to meet work requirements in a physically demanding job such as firefighting, incumbents must train in order to maintain their fitness levels; perhaps age degradation occurs much later in years; or perhaps the healthy and able "survivors" stay on the job. The work related tasks carried out by the firefighters on a daily basis were able to maintain the necessary fitness levels over the span of their careers. Whichever the case, these individuals were able to continue to perform their job requirements and sustain a level of fitness that was adequate for a career in an industry with demands that are much like those found in ETF police work.

Like firefighters, an officer or potential recruit must attain a certain level of fitness to be eligible for ETF police work. An important issue, however, surrounds the individual factors that affect one's readiness. The objective of this study was to report selected fitness (torso endurance, absolute and normalized strength and hip range of motion) and movement competency scores for members of an Emergency Task Force for a police department in a major city. These variables were chosen to represent some representative fitness and movement qualities and for their links to resilience from injury (for example variables such as torso endurance, (Biering-Sorensen, 1984); hip range of motion (ROM), (Ashmen et al., 1996); and movement competency). Grip strength, for example, is important for translating other body strengths into function such as when rappelling buildings or perhaps for restraining a suspect during an arrest. Reduced hip ROM has been suggested to increase back injury risk (Ashmen et al., 1996) since more motion is relegated to the spine during bending, sitting and lifting (McGill, 2007), particularly from the floor. It was hypothesized that the ETF members would perform similarly on all tests regardless of age and demonstrate similar levels of torso endurance and strength to those previously reported for athletic populations. Given their high physical work demands and regimented fitness training, it was also hypothesized that the ETF members would have greater torso endurance and strength scores than the general population, non-elite police officers and firefighters.

2. Material and methods

2.1. Subjects

All members of the Emergency Task Force of a major city Police Department were recruited ($N = 53$). All were male. The ETF members were chosen because they performed a physically demanding job and engage in mandatory regular physical training sessions focused on strength and endurance enhancement but not necessarily on movement quality. The subject's mean $\pm$ SD age, height, body mass, BMI, active duty and weight training experience were: 37.8 $\pm$ 5.0 years, 1.79 $\pm$ 0.09 m, 88.7 $\pm$ 12.1 kg, 27.63 $\pm$ 2.12 kg/m^2, 13.4 $\pm$ 5.2 years and 16.3 $\pm$ 6.0 years, respectively. Each participant read and signed an informed consent approved by the University Office for Research Ethics.

2.2. Data collection

Each testing session lasted approximately 2.5 h and was performed prior to team training sessions. Personal information was recorded and participants were randomly assigned to begin with the fitness, range of motion or movement screen portion of the evaluation. Specific tasks within each group of tests were also performed in a random order.

2.3. Fitness testing

The fitness test was structured to evaluate static muscular endurance (static sit-up posture, front and side planks and Biering-Sorensen extension) and absolute and body size normalized strength (grip strength and pull-ups to task failure, respectively) (Fig. 1). Each task was administered with the following guidelines: 1) Static sit-up posture (SIT) – participants adopted a sit-up posture with the knees and hips flexed and the arms folded across the chest. The back (neutral spine) was placed against a box angled 55° from the floor. The test began when the box was pulled away from the back and ended when a neutral spine posture could no longer be maintained. The feet were secured for the duration of the test (after McGill et al. (2010)); 2) Front plank (FPLK) – from a prone position, participants bridged themselves off the ground (elbows and toes) and maintained a neutral spine position (spinal curves associated with an upright standing posture) for as long as possible. The test was ended when the position could no longer be held; 3) Side plank (SPLK) – from a side lying position, participants raised themselves off the floor with their elbow and feet (top foot was placed in front of bottom). A straight-body position was maintained for as long as possible and the test was ended when the posture could no longer be held. Both sides were tested; 4) Beiring-Sorensen extension (BSE) – the upper-body was cantilevered out over the end of a bench and the pelvis, knees and hips were secured. The upper arms were crossed and held across the chest while a straight-body position was held as long as possible. The test was ended when the horizontal position could no longer be maintained (Biering-Sorensen, 1984); 5) Grip strength (GRP) – participants were seated on a chair of standard height without armrests. The shoulder was adducted, the elbow flexed to 90° and the wrist placed in a neutral position (after Harkonen et al. (1993)). A hand dynamometer (Takei Kiki Kogyo, Nigata, Japan) was used to record three maximal effort trials with each hand, in an alternating fashion. The highest value was used for analysis; 6) Pull-ups (PUP) – using an overhand grip and a normalized hand position of shoulder width, participants were asked to perform pull-ups until task failure. Cadence was not controlled; however, the chin was required to reach hand height for the repetition to be recorded. Approximately 5 min of rest was given

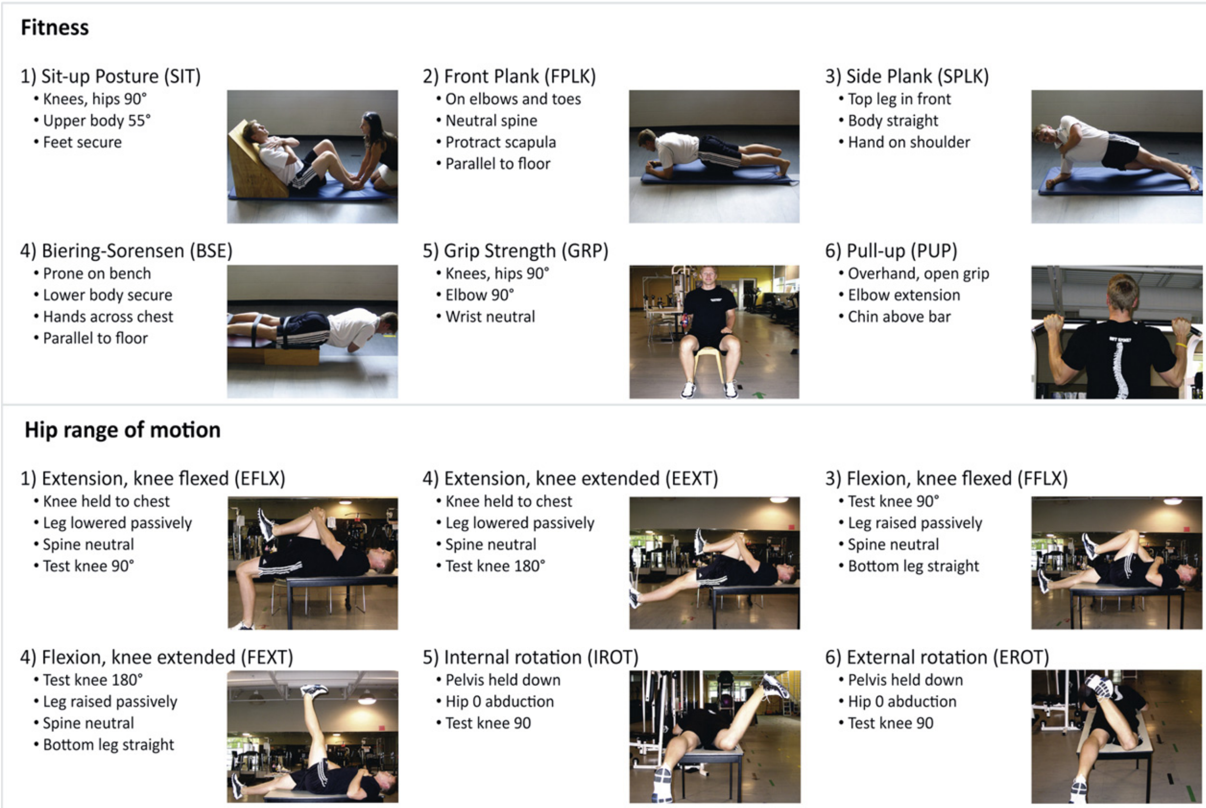

Fig. 1. Administration procedures for the fitness and hip range of motion tests.

between each task, which has shown to be sufficient (McGill et al., 1999).

2.4. Range of motion testing

Given suspected links of restricted hip motion to future injury (Ashmen et al., 1996), passive hip range of motion (flexion, extension and internal and external rotation) was assessed with six tests (Fig. 1): 1) Hip extension (knee flexed) (EFLX) – lying supine with the non-test leg's hip and knee flexed (i.e. Thomas test position), the research assistant ensured that the spine was in a neutral position. The test leg's knee was flexed to 90° and lowered passively. Hip extension was recorded as the angle between the horizontal and a line between the greater trochanter and the lateral epicondyle of the femur using an orthopaedic goniometer. The horizontal was taken as 0°, with hip extension greater than 0° resulting in a positive number (i.e. as the test leg lowered, the measurement of extension in degrees increased); 2) Hip extension (knee extended) (EEXT) – the test leg was extended (0° knee flexion) and a second hip extension measurement was taken. The horizontal was taken as 0°, with hip extension greater than 0° resulting in a positive number (i.e. as the test leg lowered, the measurement of ROM in degrees increased); 3) Hip flexion (knee flexed) (FFLX) – lying supine on a bench with a neutral spine and the non-test leg fully extended, the test leg was placed in 90° knee flexion and raised by the research assistant until spine motion was noted. Hip flexion was recorded as the angle between the horizontal and a line between the greater trochanter and the lateral epicondyle of the femur. The vertical was taken as 0°, with hip flexion greater than 0° resulting in a positive number (i.e. as the test leg moved closer to the chest with more hip flexion, the measurement of flexion in degrees increased); 4) Hip flexion (knee extended) (FEXT) – the test leg was extended (0° knee flexion) and a second hip flexion measurement was taken; 5) Hip internal rotation (IROT) – lying prone, the hips were placed at 0° abduction and the test knee was flexed to 90°. The research assistant passively guided the hip into internal rotation and a measurement was taken between the vertical and the shank; and 6) Hip external rotation (EROT) – lying prone, the hips were placed at 0° abduction and the test knee was flexed to 90°. The research assistant passively guided the hip into external rotation and a measurement was taken between the vertical and the shank.

2.5. Movement competency screening

Movement competency was assessed with 20 general tasks (Fig. 2). Seven comprised the Functional Movement Screen™ (FMS) (tasks 1–7) and were administered with specific instructions (Cook et al., 2006a, 2006b). The FMS was developed as a tool to quantify some aspects of movement competency. The remaining thirteen movements were chosen to reflect tasks often used by clinicians to evaluate injury risk (McGill, 2007) or return to work status. The twenty tasks were: 1) Deep squat (SQT) – a dowel was placed over head with the arms outstretched as the individual squatted as low as possible; 2) Hurdle step (HRD) – a dowel was placed across the shoulders and the individual stepped over a hurdle (tibial tuberosity height) placed directly in front of them; 3) In-line lunge (LNG) – with the feet aligned and a dowel contacting the head, upper back and sacrum the participant performed a split squat; 4) Shoulder mobility (SHDR) – the individual attempted to touch their fists together behind their back (internal and external shoulder rotation); 5) Active straight leg raise (SLR) – while lying supine on the ground the individual actively raised one leg as high as possible while the other

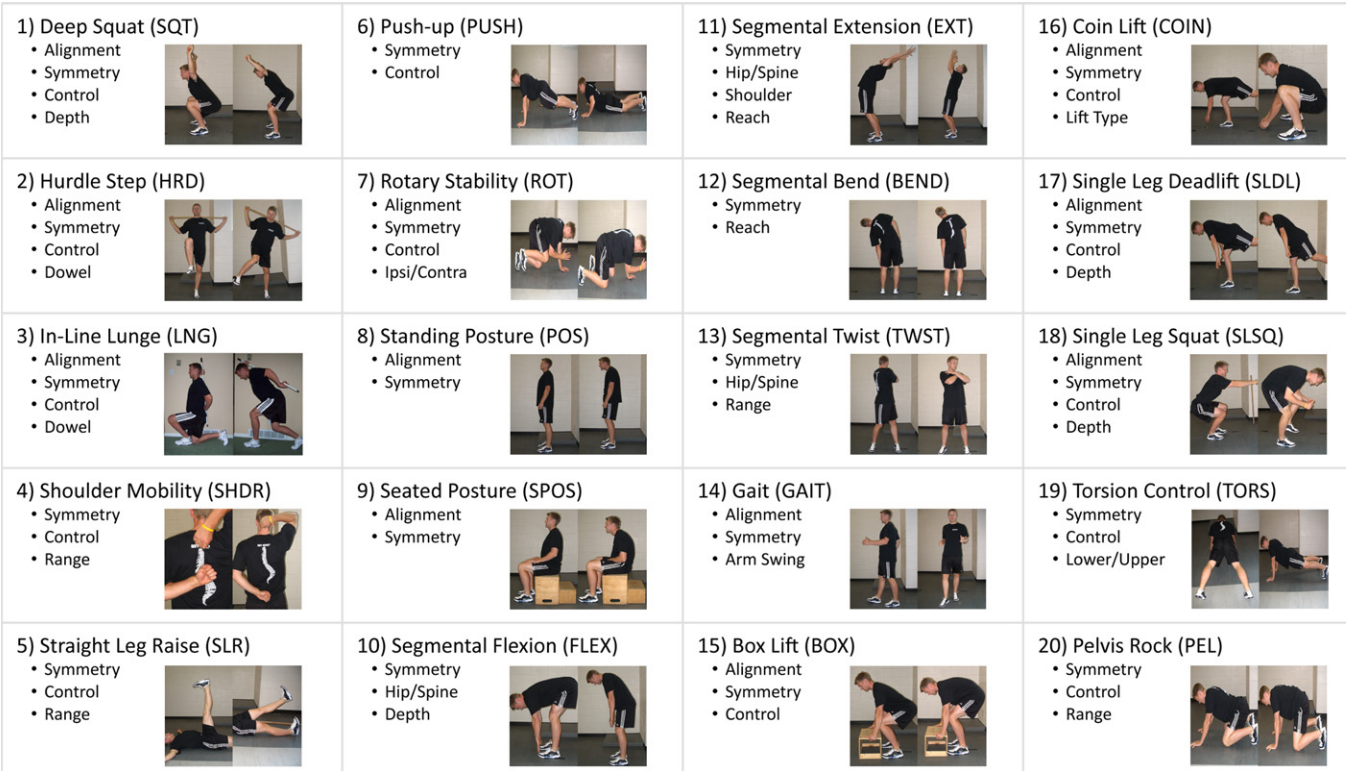

Fig. 2. Twenty movement tasks formed the movement competency score. Examples of 'good' (scored a 3) and 'bad' movement quality (scored a 1) are shown in the left and right panels, respectively.

leg remained in contact with the ground; 6) Trunk stability push-up (PUSH) – the participant performed a push-up with their hands shoulder width apart; 7) Rotary stability (ROT) – the individual assumed a quadruped position and attempted to touch his knee and elbow, first on the same side of the body and then on the opposite. "Clearing" tests were included with the SHDR, PUSH and ROT tasks to expose other potential sources of pain (Cook et al., 2006a, 2006b) (although these were not the focus of this study); 8) Standing posture (POS) – the participant stood in a relaxed position with his arms at the side; 9) Seated posture (SPOS) – the participant sat on a box (0.40 m in height) in a relaxed manner with his arms on his lap; 10) Segmental flexion (FLEX) – from standing, the individual bent forwards as far as was comfortable; 11) Segmental extension (EXT) – from standing, the individual bent backwards, reaching over head with their arms, as far as was comfortable; 12) Segmental lateral bend (BEND) – from standing, the individual bent laterally as far as was comfortable; 13) Segmental twist (TWST) – from standing, the individual twisted about the hips and spine as far as was comfortable; 14) Gait (GAIT) – the participant walked 10 paces; 15) Box lift (BOX) – from standing, a light-weight (approximately 2 kg) box (0.33 × 0.33 × 0.28 m) was lifted to waist height and returned to the ground; 16) Coin lift (COIN) – from standing, a coin was picked up off the floor; 17) Single leg deadlift (SLDL) – the individual balanced on one leg with a dowel in his hands and bent over as far as was comfortable; 18) Single leg squat (SLSQ) – the individual balanced on one leg and squatted down as low as was comfortable; 19) Torsion control (TORS) – while bridging off the floor (hands and toes) one arm was lifted off the ground. The task was also performed by lifting each leg off the ground; 20) Pelvis rock (PEL) – beginning in a quadruped position, the individual rocked his pelvis back towards his heels while keeping the hands on the ground.

2.6. Data analysis

Movement competency for the 7 FMS tasks was graded using the guidelines published by Cook et al. (2006a) and Cook et al. (2006b). The inter-rater reliability for the FMS has shown to be high (Minick et al., 2010); therefore, one clinician with 5 years of movement screening experience graded all tests. Scores of 0–3 were assigned to each task (based on explicit criteria) to differentiate between movements performed with or without compensatory motion and pain. Compensatory motion was defined by criteria described by Cook et al. (2006a), 2006b). A three, two, one and zero represented performed without compensation (according to relevant criteria), performed with compensation, could not perform (according to relevant criteria) or pain, respectively. All other movement tasks were scored with the same 0–3 system (extensive descriptions of the scoring system for the other movement tasks are provided for the interested reader in a comparison paper (Frost et al., 2012)). Tasks requiring performances of the left and right side of the body were given a grade equal to that of the lowest score. The cumulative sum of all tasks was defined as the total movement competency score.

2.7. Comparative groups

Fitness, hip ROM and movement quality scores of the members of the ETF were compared to populations of firefighters, police officers, athletes, students and healthy adults. Torso endurance scores from 82 male university students (age and mass not reported for the male subpopulation) and 660 male firefighters (mean age = 37.5 years, mean mass = 89.2 kg) were used (McGill et al., 2010). BSE and right SPLK means were also drawn from 44 intercollegiate basketball players and 18 intercollegiate cross-country runners (mean age = 19.1 ± 0.9 years, mean mass = 78.8 ± 13.3 kg, collectively) (Leetun et al., 2004). SIT scores from 32 varsity rowers were used as well (Tse et al., 2005). For measures of GRP, the ETF was compared to 805 Chinese police officers (mean age = 18.3 ± 1.0 years, mean height = 170.4 ± 5.3 cm, mean mass = 62.5 ± 8.8 kg) (Wang et al., 2003) and 95 normal male adults (ages 25–54, mass not reported for this subpopulation) (Massy-Westropp et al., 2004). For a comparison of hip mobility, EFLX values were taken from a total of 117 rowers, basketball players, runners and tennis players (Harvey, 1998) and IROT and EROT values from 100 healthy adults (mean age = 26 ± 5) (Ellison et al., 1990). Sixty-two professional football players (Kiesel et al., 2009) and 23 firefighters (mean age = 29.6, mean mass = 195.5 lbs) produced a database for comparing movement quality.

2.8. Statistical analyses

Means, standard deviations, minimums, maximums and ranges were calculated for all variables, except for the individual movement screening tasks where only means and standard deviations are reported for the 7 FMS tasks. This was done to compare movement scores from the ETF members to previous reported data that used the same tasks. A Pearson product moment correlation was done to investigate the relationships between all continuous variables (i.e. age, height, weight, years of active duty, years of training experience, measures of fitness and hip ROM testing and the sum of movement scores for all 20 tasks). Participants were also separated into age groups (<35, 35–39, 40–44, >44) for the reporting of fitness scores, hip ROM and movement within the ETF population. Analyses of variance and appropriate post hoc procedures were used to investigate differences between age groups with a level of significances of $\alpha = 0.05$. Participants were evenly distributed between the three younger groups ($N = 16$), leaving 5 participants in the oldest age category.

3. Results

3.1. Data base description

Personal information and FMS total score (sum of scores for the 7 movements that comprise the FMS), fitness and range of motion data are presented in Tables 1a, b and c respectively.

Table 1
The following tables show range, minimum and maximum values, mean and standard deviation (SD) of all variables for each age group. a: Personal information and movement screening total score. b: Fitness testing. c: Range of motion testing measured in degrees.

a	Age				Height (cm)				Mass (kg)				Total FMS score			
Age group	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44
Range	6	4	4	7	50.0	22.9	35.7	15.0	53.8	27.4	70.5	29.8	5	7	8	7
Minimum	28	35	40	45	143.0	165.1	165.0	170.0	53.0	72.6	59.0	70.0	12	13	11	13
Maximum	34	39	44	52	193.0	188.0	200.7	185.0	106.8	100.0	129.5	99.8	17	20	19	20
Mean	31.9	37.5	41.3	47.0	179.1	177.4	180.9	175.2	89.1	85.9	91.9	86.2	14.7	15.7	14.8	15.2
SD	1.7	1.5	1.4	2.9	11.4	6.5	8.3	6.4	12.9	8.1	14.7	12.9	1.8	2.1	2.3	2.9

b	SIT (seconds)				FPLK (seconds)				Right SPLK (seconds)				Left SPLK (seconds)			
Age group	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44
Range	234	126	319	152	201	156	248	124	81	125	114	52	76	69	73	38
Minimum	66	70	41	88	58	86	66	126	41	49	36	68	49	47	37	72
Maximum	300	196	360	240	259	242	314	250	122	174	150	120	125	116	110	110
Mean	155.0	129.6	132.2	145.4	144.0	154.4	161.2	177.4	73.1	85.4	78.0	88.8	77.1	78.8	78.9	85.8
SD	58.2	39.7	68.9	61.7	49.9	49.5	59.7	50.9	20.7	30.1	26.9	21.2	22.9	22.0	20.9	15.1

	BSE (seconds)				Right GRP (kg)				Left GRP (kg)				PUP (repetitions)			
Age group	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44
Range	81	100	138	97	35	61	39	12	23	28	37	8	7	9	17	12
Minimum	67	39	50	60	48	6	28	42	46	36	28	46	7	6	2	0
Maximum	148	139	188	157	83	68	67	54	69	64	65	54	14	15	19	12
Mean	107.9	105.2	109.9	108.8	58.6	51.6	56.9	46.9	55.3	51.3	53.4	49.9	11.7	12.1	10.2	6.8
SD	21.6	24.3	35.7	37.4	8.0	14.3	9.2	4.3	5.7	7.3	9.5	3.3	2.2	2.4	3.9	4.3

c	Right EFLX				Left EFLX				Right EEXT				Left EEXT			
Age group	<35	35-39	40-44	>44	<35	35-39	40-44	>44	<35	35-39	40-44	>44	<35	35-39	40-44	>44
Range	34	31	32	33	32	30	31	30	30	35	34	35	40	28	36	26
Minimum	−15	−15	−11	−11	−15	−8	−11	−7	−15	−17	−15	−14	−22	−10	−14	−9
Maximum	19	16	21	22	17	22	20	23	15	18	19	21	18	18	22	17
Mean	1.4	5.1	3.8	9.6	0.7	5.4	4.1	8.8	−0.4	3.9	2.6	6.4	−1.7	6.1	3.3	7.4
SD	9.8	9.6	9.5	12.4	10.6	7.7	10.2	11.2	10.8	9.8	10.6	13.3	12.8	9.4	10.5	9.9

	Right FFLX				Left FFLX				Right FEXT				Left FEXT			
Age group	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44
Range	54	62	34	40	125	51	39	32	57	78	76	40	60	70	63	28
Minimum	−50	−51	−45	−50	−45	−42	−39	−47	−21	−38	−38	−35	−15	−31	−29	−28
Maximum	4	11	−11	−10	80	9	0	−15	36	40	38	5	45	39	34	0
Mean	−21.8	−16.6	−25.4	−28.6	−18.9	−17.4	−21.5	−25.4	−2.5	−1.6	−10.1	−14.0	2.5	−0.7	−5.9	−11.2
SD	13.3	16.6	11.0	14.3	27.4	13.7	10.5	12.9	18.5	21.2	18.9	16.4	18.4	22.3	14.6	13.3

	Right IROT				Left IROT				Right EROT				Left EROT			
Age group	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44	<35	35–39	40–44	>44
Range	45	41	40	38	56	23	40	11	28	28	35	15	39	42	41	26
Minimum	5	4	5	10	6	0	0	10	17	12	15	30	17	6	14	24
Maximum	50	45	45	48	62	23	40	21	45	40	50	45	56	48	55	50
Mean	23.3	15.0	21.2	21.6	22.5	13.5	16.3	14.8	33.3	27.1	28.3	33.8	35.5	25.8	31.6	36.4
SD	13.7	9.5	9.8	16.3	13.3	7.3	9.8	5.4	7.8	9.0	10.5	6.4	9.3	11.7	12.5	9.3

Age had a significant negative influence on PUP scores ($F = 4.36$, $p < 0.01$). A Tukey HSD post hoc analysis revealed that PUP scores declined from 11.7 in the <35 and 12.1 in the 35–39 age groups to 6.8 in the >45 age group ($p = 0.016$ and $p = 0.008$, respectively) (Fig. 3). A Pearson correlation of $R = -0.44$ ($p < 0.001$) between age and PUP scores, but not between age and any other variable, suggests that only PUP scores could be predicted by age. Torso endurance (SIT, FPLK, SPLK, BSE) and GRP scores, however, did not change significantly with age ($p > 0.48$ and $p > 0.08$ for torso endurance and GRP, respectively). There were also no significant differences between age groups for total FMS scores ($p > 0.691$). The ETF showed right/left symmetry in hip mobility across all measurements of hip ROM. There were also no differences found between age groups ($p > 0.075$). Years of active duty was negatively correlated with total movement score ($R = -0.30$, $p = 0.031$), yet years of resistance training experience was positively related to total movement score ($R = 0.34$, $p = 0.022$). This may indicate that resistance training improves performance on the movement tasks selected in the current study. Similar to age, years of active duty was also negatively correlated with PUP scores ($R = -0.30$, $p = 0.031$). This may suggest that those individuals who are generally “fit”, based on these fitness variables, perform well across all fitness tests.

3.2. Comparison groups

Compared to other populations, ETF members were the lowest scoring in the BSE test (Fig. 4). Though the ETF members' scores were not much poorer than a group of firefighters, they had a much lower BSE score compared to a student population, larger than 1 standard deviation. The ETF also had a higher SIT score, resulting in a torso endurance flexion/extension ratio of 1.3. The average right GRP score of the ETF was 58.6 ± 8.0 kg. Compared to the average score of 38.0 ± 5.2 kg from members of the Chinese People's Armed Police Forces (CPAPF) (Wang et al., 2003), the ETF police officers' mean score was greater by 2.5 SD. Pull-up repetitions were compared between these two populations as well, where the ETF officers had a mean PUP score of more than 1.5 SD greater than the CPAPF (10.9 ± 3.4 reps and 4.8 ± 3.1 reps, respectively). GRP was also compared to a healthy male population across broader age groups than our analyses examined (Massy-Westropp et al., 2004). As shown in Table 2, the mean GRP scores of the ETF were consistently higher (by about 6 kg) than the middle of the ranges of the healthy male population for the younger groups.

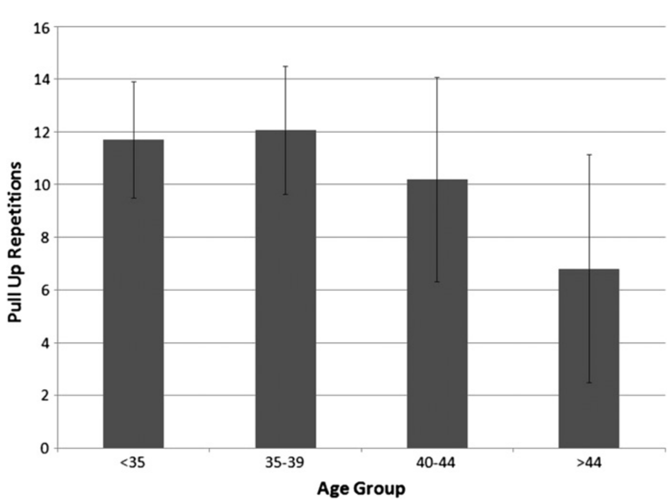

Fig. 3. Comparison of pull up repetitions between age groups.

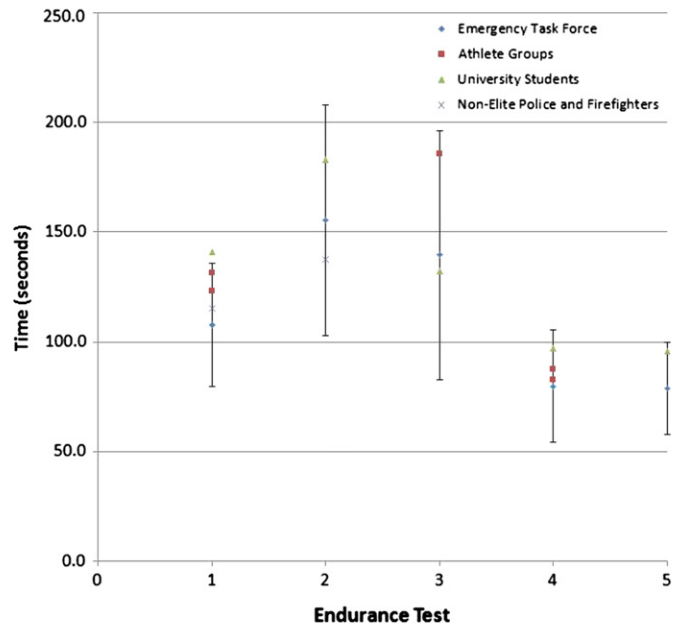

Fig. 4. Comparison of torso endurance times between Emergency task force members and athletic, male student and non-elite police and firefighter populations. Error bars represent standard deviation of Emergency task force data.

Comparison of hip mobility in the ETF members of this study to athletes and healthy males from the general population, specifically, EFLX (Harvey, 1998) and IROT and EROT (Ellison et al., 1990), respectively, revealed the ETF had poorer hip mobility than all comparative populations in all three measures (see Table 3a and b). As hip mobility is not emphasized in the training of this ETF, these findings were expected.

Movement quality as indicated by the FMS scores of the ETF was compared to those of football players (Kiesel et al., 2009) and firefighters. Both the football players and the firefighters had better movement quality on the SQT, HRD and SLR and lower movement quality on the LNG, SHDR, ROT and total scores than the ETF (Table 4).

4. Discussion

This study documented some selected fitness and movement competency scores for incumbent ETF police officers. The data may assist in the development of future standards or provide a resource to address issues related to job requirement content and construct validity. According to some research, age has a significant effect on fitness; however, as was hypothesized, this was not the case for this group of elite police officers who engage in regimented training (except for PUP scores). Note that few officers remain in the ETF after 45 years of age, implying that these observations and

Table 2
Comparison of grip strength (GRP) between healthy males and ETF measured in kilograms.

	Age group	Healthy males		ETF		
		Range	Mid-range	Range	Mean	SD
Right GRP	25–34	32–73	52.5	48–83	58.6	8.0
	35–44	32–72	52	28–68	56.0	8.5
	45–54	39–63	51	42–54	46.9	4.3
Left GRP	25–34	30–69	49.5	46–69	55.3	5.7
	35–44	31–71	51	28–65	52.3	8.4
	45–54	36–63	49.5	46–54	49.9	3.3

Table 3
a: Right hip extension flexibility with knee flexed of ETF and athletes measured in degrees. b: Internal and external rotation of right and left hips of ETF and healthy males measured in degrees.

	Mean	SD
ETF	3.98	9.88
Rowers	−10.73	5.97
Basketball players	−11.82	4.89
Runners	−14.15	4.67
Tennis	−10.93	6.01

	IROT				EROT			
	Right hip		Left hip		Right hip		Left hip	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ETF	19.98	11.85	17.19	10.49	29.96	9.17	31.45	11.56
Healthy males	38.20	11.30	38.10	11.20	35.40	7.30	35.80	8.00

interpretations only pertain to members up to this age. Similar to the firefighters studied by Findley et al. (1995), members of the ETF were able to maintain a specific level of fitness throughout their career, suggesting that they were sufficiently fit to meet their work demands, irrespective of age. It is interesting to note that movement quality is not emphasized.

Were the ETF in fact more physically fit than other populations? To explore this question, metrics from the current study were compared to previously published data for students, athletes, firefighters, non-elite police officers and healthy adults. Interestingly, in general the ETF were not dissimilar to any of these groups, although there were specific tests on which they differed from the comparative groups. Low BSE time has been associated with both developing low back troubles (Biering-Sorensen, 1984) and with chronic reoccurrence of acute attacks (McGill et al., 2003). The ETF also had a higher SIT score, resulting in a torso endurance flexion/extension ratio of 1.3. A ratio higher than 1.0 (meaning the ability to hold the SIT longer than the BSE) has also been associated with low back troubles (McGill et al., 2003). Interestingly, the FMS score comparisons suggest that the ETF possesses movement qualities that may be specific to their work. For example, a greater SHDR score may be required for use of a variety of firearms or tactful training while lower SQT scores may not be reflective of their common movement patterns and need for competency.

Table 4
Comparison of FMS scores between ETF, firefighters and football players.

		Mean	SD
Deep squat (SQT)	ETF	1.5	0.8
	Firefighters	1.9	0.5
	Football players	2.0	NR
Hurdle step (HRD)	ETF	2.6	0.5
	Firefighters	2.3	0.7
	Football players	2.0	NR
In-line lunge (LNG)	ETF	2.3	0.7
	Firefighters	2.0	0.5
	Football players	2.0	NR
Shoulder mobility (SHDR)	ETF	1.4	0.8
	Firefighters	2.0	0.5
	Football players	1.0	NR
Active straight leg raise (SLR)	ETF	2.1	0.7
	Firefighters	2.2	0.7
	Football players	3.0	NR
Trunk stability push-up (PUSH)	ETF	2.5	0.5
	Firefighters	1.8	0.8
	Football players	3.0	NR
Rotary stability (ROT)	ETF	2.8	0.4
	Firefighters	2.0	0.4
	Football players	2.0	NR
FMS total score	ETF	15.1	2.1
	Firefighters	13.6	1.9
	Football players	13.3	1.9

NR. Data not reported.

Movement competency appears to be important for injury resilience (eg. Hewett et al., 1999) and performance. One finding here is that individuals who had greater hip mobility and more experience in weight training tended to be judged to have better competency of movement. For the ETF members, it is interesting, though, that their hip ROM was lower than the two cohorts they were compared to here.

Limitations of the current study incorporate the procedures used to assess movement. The FMS is an instrument intended to quantify movement competency through observation. Analysis of film records was not performed; however, the same rater scored the entire subject pool. Further, these protocols were adopted to best represent clinical practice and to mimic procedures that have been cited in previous research. Another limitation exists in the obvious inability to test inter-rater reliability of the many measurements made from all of the studies of comparative groups cited in this paper. Finally, any interpretation of age related effects do not pertain to men over 50 given that our subjects were less than 50 years of age.

5. Conclusion

The data of this study characterizes some fitness variables and movement competency of ETF members that facilitates comparisons to other groups. They are high level elite police officers who must complete exhaustive testing to be chosen for the task force. For purposes of job content and construct validity, there may be other aspects of fitness, such as aerobic and anaerobic capacity, or the ability to work while fatigued that might better highlight their unique skill-set. There are many unusual and unexpected demands associated with elite tactical police work. The acquisition of job-specific training and experience is likely also very important together with sufficient levels of fitness and movement competency for these individuals to become expert performers in their respective field. The general implications of these data and analyses are that members were able to retain their fitness regardless of age, at least until the late forties. However, the relatively low BSE and hip mobility scores suggest that the ETF members may benefit, however, from back torso endurance and hip ROM training. As these two factors have been suggested to relate to low back pain (Ashmen et al., 1996; Biering-Sorensen, 1984), improving these components of their fitness may help keep the ETF members prepared to meet job demands while avoiding injury. Further research is required to best determine the optimal tests or tasks to assess relevant fitness and movement for physical preparedness. The subjects of this study are also part of a longitudinal study to determine which variables, if any, are linked to future injury.

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