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Comparing Levels of Fitness of Police Officers between Two United States Law Enforcement Agencies

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Abstract

BACKGROUND: The general physical task demands of law enforcement may suggest that police Officers are of similar fitness levels across cities, states and countries.

OBJECTIVE: To investigate whether fitness levels of police Officers from two different United States (U.S.) Law Enforcement Agencies (LEA) are similar.

METHODS: Retrospective data were analysed from two LEAs (LEA1 n=79 and LEA2 n=319). The data for Officers included: age, mass, 1-minute push-up repetitions, 1-minute sit-up repetitions, vertical jump height, 2.4-km run time (LEA 1) and 20-meter Multi-Stage Fitness Test results (LEA 2). Independent samples t-tests were used to compare anthropometric and fitness data between LEA with significance set at 0.05.

RESULTS: Officers from LEA1 weighed significantly less and performed significantly better than Officers from LEA2 on all fitness measures. When comparing male Officers alone, there was no statistical difference in age and mass; nonetheless, Officers from LEA1 significantly outperformed Officers from LEA2 on all fitness measures.

CONCLUSION: While similarities / differences in job tasks performed between these two LEA are not known, the results from this study suggest differences in fitness between these two different U.S. LEA. Fitness standards and training protocols need to be developed and contextualized to each LEA's specific population and needs.

Key words: Fitness standards, Physical fitness, Muscular strength, Muscular endurance, Aerobic fitness

1. Introduction

Police Officers are required to perform tasks that are highly varied in terms of type and duration [1]. Some of these tasks may include checking the identity of individuals, responding to a domestic incidents, and effecting an arrest [1]. To perform these duties safely and effectively, it is important for an Officer to have sufficient muscular power, strength and endurance, and cardiovascular endurance [2-5]. It is, therefore, not surprising that research has documented the importance and association of physical fitness with performance of routine policing tasks [2, 3, 6].

Research suggests that the nature of their occupation (e.g. shift work, stress, etc.) may lead Officers to lose fitness as service duration increases [7]. Four studies have investigated physical fitness among general duties Police Officers. One study compared the fitness levels between Officers and Cadets [7], one study compared the fitness levels of male and female Officers [8], a third study observed changes in Officers' strength over the duration of their employment career [3], and the final study reported on fitness levels over a 15-year period [6]. Orr et al. [7] showed that employment status, rather than age, may largely account for observed lower levels of fitness in Officers compared to cadets. Dawes et al. [8] profiled the levels of fitness of male and female

Officers, documenting that male Officers tended to be heavier, taller and displayed greater lower limb power, dominant hand grip strength, upper limb muscular endurance and aerobic fitness, than female Officers. Boyce et al. [3] showed that Officers increased their strength over the duration of their employment despite expected strength trends that follow an annual decline. Sorensen et al. [6] illustrated that Officers maintained aerobic capacity but showed a decrease in muscular performance and an increase in weight over a 15-year period.

Of the studies described above, three [3, 7, 8] used data from different United States (U.S.) Law Enforcement Agencies (LEA) while one described Officers from Finland [6]. With only three studies reporting results from U.S. agencies, the transferability of findings to other U.S. law enforcement Officers may be erroneously assumed. This is based on the assumption that each LEA is similar in terms of the fitness of their Officers, despite no known research specifically investigating differences in fitness, or even typical job tasks between LEAs.

Identification of any physical fitness differences between LEA is of importance given that agencies may adopt physical fitness standards from other agencies, be they for identifying injury risk, measures of cardiovascular health or work task performance, without contextualizing the physical requirements of the Officers roles to their specific city, county, or state. The aim of this study was to investigate whether the fitness levels of police Officers from two different U.S. LEAs were similar.

2. Methods

Retrospective data were collected from two different U.S. State LEAs (LEA1 and LEA2). Ethics approval for this retrospective cohort study was obtained through the University of Colorado – Colorado Springs Institutional Review Board (15-074) and Bond University Human Research Ethics Committee (RO1927).

The data for both male and female Officers included: age, mass, 1-minute push-up (1PU) and 1-minute sit-up (1SU) repetitions, vertical jump height (VJ), and 2.4-km run time or 20-meter Multi-Stage Fitness Test (20m-MSFT) results. LEA1 provided data for 80 incumbent Officers. Data for one individual were removed due to a missing 1SU result. LEA2 provided data for 566 incumbent Officers. Data for 247 individuals were removed for lack of mass data (n=3), 1PU data (n=7), 1SU data (n=7), VJ data (n=5), and 20-m MSFT data (n=39). A further 186 datasets from LEA 2 were removed due to exceptionally low scores on the 20m-MSFT, which could not accurately be converted to VO_2 max values given that the conversion matrix tables did not report VO_2max scores for shuttle run levels below Level 4. As such, while all Officers did provide their best effort, only 20m-MSFT scores above Level 4 were included.

2.1. Participants

LEA1 participant data comprised of 79 incumbent Officers including 72 male Officers (age = 39.43±8.28 years; mass = 87.46±11.59 kg) and seven female Officers (age = 38.14±3.84 years; mass = 62.72±4.49 kg). LEA2 participant data comprised of 319 incumbent Officers including 315 male Officers (age = 37.9±7.71 years; mass = 88.84±12.93 kg) and four female Officers (age = 32.0±7.07 years; mass = 73.14±18.36 kg).

2.2. Procedures

Both U.S. LEAs used indoor training facilities for testing, whereby LEA1 used a large warehouse space with rubber flooring on concrete, as well as an outdoor track for the run component, while LEA2 used a wood basketball court for all testing. Instructors responsible for conducting these assessments were certified by either the National Strength and Conditioning Association or the Cooper Institute. Participants from both agencies were allowed to wear self-selected training clothing. Participants from LEA1 were all volunteers, while participants from LEA2 were required to participate. Data were originally collected by pen and paper, before being entered into a Microsoft Excel spreadsheet. Statistical analysis between agencies (LEA1 vs. LEA2) and sex (LEA1 males vs. LEA2 males) were performed to measure the differences in anthropometrics and fitness levels of incumbent Officers.

2.3. Body mass

Law Enforcement Agency 1 (LEA1)

The Officer's body mass was measured using a doctor's beam scale (Cardinal; Detecto Scale Co, Webb City, MO), with the Officer dressed in physical training clothing and no footwear. The results were initially recorded in pounds and then converted to kilograms (kg) when entered into a Microsoft Excel spreadsheet.

Law Enforcement Agency 2 (LEA2)

Mass measurements were self-reported by the Officers at the commencement of the testing period. All imperial measures were subsequently converted to metric values for analysis.

2.4. 1-minute push-up test

Push-up assessments are commonly used by LEAs to measure the muscular endurance of the upper-body muscles, which are used in pushing, lifting, carrying, and use-of-force situations [9-11]. For both LEAs, the maximum number of push-up repetitions that could be performed in one minute was used as a fitness outcome measure. This protocol has been used and described in previous research [9, 11].

Participants began the 1-minute push-up (1PU) test in the ‘up’ position, which required the body to be held in a rigid and straight line, elbows in full extension, hands placed slightly wider than shoulder width and fingers pointing forward. To control for depth, partners placed a closed fist on the floor underneath the participant’s chest. When instructed to begin, each participant was required to lower themselves to touch their partner’s fist with their chest before returning to the ‘up’ position by extending their elbows. Each participant repeated this movement as many times as possible within the allotted time of 1-minute. Time was kept with a stopwatch by the tester and the number of repetitions performed were recorded by each participant’s partner. Rest was allowed in the ‘up’ position, but the participant was required to maintain a straight and rigid alignment with the legs and torso. The test was completed when the participant was unable to maintain the required movement form, once the 1-minute time period ended, or they elected to stop.

2.5. 1-minute sit-up test

A 1-minute sit-up (1SU) repetition max test was used by both LEAs to measure abdominal muscle endurance [9, 11]. Participants began in the supine position with knees bent to 90° and feet flat on the floor. Participants in LEA1 were required to place hands behind the neck with fingers linked while participants in LEA2 were required to place arms in front of the body wrapped across their chest with each hand on the opposite shoulder. Partners were used to secure the participant's feet to the ground. Once instructed to begin, each participant flexed their trunk and touched their elbows to their knees by lifting their shoulders off the ground. This movement was repeated as many times as the participant could achieve within the allotted time of 1-minute. Time was kept on a stopwatch by the tester while the partner counted and recorded each participant's number of repetitions.

2.6. Vertical jump (VJ)

The vertical jump test is commonly used among law enforcement agencies to measure explosive power, which is important for pursuit tasks that require jumping and vaulting [9, 11, 12]. The test was conducted differently between the two LEAs.

Law Enforcement Agency 1 (LEA1)

VJ was measured using the Vertec™ apparatus (Vertec Scientific Ltd., Aldermaston, UK). Before beginning, all participants performed a 3-5-minute self-selected warm-up with no familiarization trials conducted for this assessment as all participants had conducted this test previously. Each participant's standing reach height was then measured. Each participant was then instructed to execute a countermovement jump with an arm-swing to reach the highest level they could on the device. All participants were allowed a minimum of 10 sec. and a maximum of 30 sec. rest between each jump. The participant's VJ height was determined by subtracting standing reach height from jump height. Participants were given three attempts and the greatest height achieved (rounded to the nearest 0.5 inch) was used as their final score. This result was then converted to cm.

Law Enforcement Agency 2 (LEA2)

VJ height was measured using a Just Jump (ProBotics Inc, Huntsville, Al) electrical contact operated system. The Just Jump Mat is a 27-inch x 27-inch mat that calculates vertical jump height by measuring vertical displacement time. VJ height for this device was calculated by measuring the amount of time the feet are not in contact with the mat. All participants were instructed to step on to the mat and when ready, perform a countermovement arm swing and jump as high as possible. This score was used to determine the vertical jump height of each participant. The best of three attempts were taken, and maximal jump heights were recorded to the nearest 0.5 inch.

2.7. Aerobic fitness tests

The two LEAs employed different measures to determine aerobic fitness. LEA1 used the 1.5-mile (2.4-km) run, while LEA2 used the 20m-MSFT. Both measures are commonly used by LEAs to assess aerobic fitness [9, 13].

Law Enforcement Agency 1 (LEA1)

Using a ¾ mile course measured around a local city block, Officers were instructed to complete two laps as fast as they could with their times being recorded to the nearest 0.10 sec using a stopwatch. Prior to beginning the test, a two-hour rest period was provided for the participants to allow for an appropriate recovery period following the previous tests.

Law Enforcement Agency 2 (LEA2)

Participants were required to run back and forth between two lines marked on the ground spaced exactly 20 meters apart [14]. The speed of running for this test is standardized by pre-recorded auditory cues (beeps). The initial speed for the test is set at 8.5 km/h and increases by 0.5 km/h with each additional stage. This test is scored according to the final stage and shuttle (e.g. Stage 5 Shuttle 5) the participant can achieve before being unable to run at the speed required. The test was terminated when the participant was unable to reach the next line twice in a row in accordance with the auditory cues.

The test-retest reliability for the 20m-MSFT has previously been determined to be 0.95 for adults, using a population of 81 men and women aged 20-45 years [15]. The validity of the 20m-MSFT has been reported several times [15-18], the most recent meta-analysis concluding that the 20m-MSFT has a moderate to high mean correlation coefficient for estimating VO_2 max [17]. Further conclusions on the validity of the 20m-MSFT have been reported, including the assumption that maximal work rate is achieved at the end of the test, which is supported by reports of similar VO_2 max scores between a treadmill test and 20m-MSFT [19].

2.8. Statistical Analysis

Participant's data for performance on the 20m-MSFT was provided in the form of stage and shuttle. Utilizing the table proposed by Ramsbottom, et al. [20], stage and shuttle numbers were converted to VO_2 max scores. Likewise, the 1.5-mile (2.4-km) run times were converted to VO_2 max [21] to allow for comparison between aerobic fitness measures.

The extracted data were entered into a Microsoft Excel spreadsheet (version 1712) [22] before being imported into the Statistical Package for the Social Sciences (SPSS) version 24 [23] for analysis. Descriptive analyses (mean and standard deviation) were performed on age, weight, 1PU, 1SU, VJ and VO_2 max, for each sex and agency. Independent samples t-tests were used to compare anthropometric and fitness data by whole cohorts (LEA1 vs. LEA2) and by sex (LEA1 males vs. LEA2 males). Significance was set at $p < 0.05$. Due to the low number of female Officers in LEA1 (n = 7) and LEA2 (n = 4) datasets, no inferential statistics were performed with the female Officer data.

3. Results

When comparing the raw scores of ages of both LEA, there were no significant differences ($t[397] = 1.505$, $p = 0.133$) between Officers from LEA1 and LEA2. However, there was a significant difference in mass, with Officers from LEA2 (mean= 88.6 ±13.09 kg) weighing significantly ($t[397]= -2.023$, $p= 0.044$) more than Officers from LEA1 (mean= 85.27 ±13.19 kg) (Table 1).

Insert Table 1 here

Data showed that Officers from LEA1 performed significantly ($t[103]= 6.55$, $p< 0.001$) more 1PU than Officers from LEA2. Significant ($t[397]= 3.752$, $p< 0.001$) differences were likewise found when comparing 1SU performance, where Officers from LEA1 performed better than Officers from LEA2. The data for VJ performance showed that Officers from LEA1 performed significantly ($t[397]= 8.782$, $p< 0.001$) better than Officers from LEA2. Lastly, regarding VO_2 max, the same trend was found with LEA1 performing significantly ($t[397]= 10.401$, $p< 0.001$) better than LEA2 (Table 1).

Insert Table 2 here

In male Officers, there were no significant differences in age and weight between the two cohorts ($t[386]= 1.479$, $p= 0.140$ and

$t[386]= -0.806$, $p= 0.421$ respectively) (Table 2). 1PU performance was significantly ($t[386]= 8.441$, $p< 0.001$) different, where LEA1 males performed better than LEA2 males, a trend repeated for 1SU performance ($t[386]= 3.085$, $p< 0.05$) and VJ performance ($t[386]= 9.694$, $p< 0.001$). Lastly, there was a significant ($t[386]= 9.734$, $p< 0.001$) difference in VO_2 max between LEA1 males and LEA2 males, with LEA 1 males reporting higher values (Table 2).

4. Discussion

The aim of this study was to investigate whether fitness levels between police Officers differed between two different United States LEAs. The results of this study demonstrated that Officers from LEA1 weighed less and outperformed Officers from LEA2 on all fitness measures. When viewed by sex, the results held true with male Officers from LEA1 outperforming male Officers from LEA2. These data are important as they demonstrated that different agencies could have Officers with markedly different levels of fitness. Thus, any physical training programing or fitness standard requirements may need to be contextualized to a specific LEA based on the physical requirements of their job.

The results indicate that Officers from LEA1 weighed significantly less than Officers from LEA2, with no significant differences in age. The mean ages (LEA1: 39.31 ±7.98 years, LEA2: 37.84 ±7.72 years) and weights (LEA1: 85.27 ±13.19 kg, LEA2: 88.6 ±13.09 kg) of the Officers in this study held some similarities to the findings of Orr et al. [7] who reported a mean age of 39.31 (±7.93) years and a mean weight of 87.47 (±11.59) kg (n= 80, ♂=73: ♀=7), Dawes et al. [8] who reported a mean age of 39.52 (±8.09) years (n= 631, ♂=597: ♀=34), and Baran et al. [24] who reported a mean weight of 85.69 (±15.08) kg (n= 246, ♂=203: ♀=43), for U.S. incumbent Officers. Differences in age and weight data from those reported in this study have also been found. Dawes et al. [8] reported a mean weight of 93.66 (±15.72) kg and Baran et al. [24] reported a mean age of 30.82 (±5.84) years for U.S. incumbent Officers. Orr et al. [25] reported a mean weight of 73.40 (±15.00) kg for Australian incumbent Officers (n= 10, ♂=4: ♀=6) and Lockie et al. [26] reported a mean age of 27.91 (±6.87) years and a mean weight of 75.95 (±15.73) kg for U.S. Custody Assistants (n= 108, ♂=69: ♀=39). Given the inconsistent findings in previous research and noting the findings of this research, it can be concluded that there may be significant differences between different LEAs in age and weight of the workforces and as such, similarities between LEA demographics should not be assumed when comparing physical capability.

Statistical analysis of fitness test results showed that as a cohort, Officers from LEA1 significantly outperformed Officers from LEA2. There is no other police cohort data (i.e. data of a cohort as a whole and inclusive of all sexes) available to compare these fitness measure results. Regardless, the results of this study indicate a significant difference between cohort fitness measures of performance. However, the influence of sex on fitness results is noted and considered below.

The results indicated that when comparing age and weight among male Officers from LEA1 and LEA2, there were no significant differences. Comparing these findings with those of cohort comparisons shows that although the female Officer population was relatively small (LEA1= 7 and LEA2= 4), female Officer results may have influenced the anthropometric profile of the cohort as a whole. The mean ages (LEA1: 39.43 ±8.28 years, LEA2: 37.92 ±7.71 years) and weights (LEA1: 87.46 ±11.59 kg, LEA2: 88.8 ±12.93 kg) of male Officers in this study were similar to those reported by Dawes et al.[27] who reported a mean age of 38.99 (±7.51) years (n= 518), Orr et al. [7] who reported a mean age of

39.43 (±8.28) years and a mean weight of 87.74 (±11.59) kg (n= 73), Baran et al. [24][16] who reported a mean weight of 89.27 (±13.31) kg (n= 203), and Boyce et al.[3] who reported a mean age of 37.1 (±3.8) years (n= 297), for U.S. incumbent Officers. Several studies of U.S. LEA reported different mean values for age and weight when compared to the results of this study. Baran et al. [24] reported different mean ages of 30.86 (±6.09) years, Dawes et al. [27] reported different mean weights of 91.45 (±13.9) kg, Boyce et al. [3] reported different mean weights of 94.6 (±15.9) kg, and Lockie et al. [26] reported different mean ages of 27.54 (±6.74) years and weights of 81.27 (±15.22) kg. In a population from a different nation, Sorensen et al. [6], who measured the fitness of 100 Finnish male Officers over a 15-year period, reported different mean ages of 33.6 (±4.1) years and weights of 83.1 (±9.7) kg. Taken together, even though no significant differences were found between some demographic characteristics of the two male populations reported in this study, the aforementioned premise may still bear true, whereby similarities between LEA male population demographics should not be assumed.

Comparing the performance differences between male Officers from LEA1 and LEA2 revealed that Officers from LEA1 significantly outperformed LEA2 on every test. The significant difference in male Officer performance is consistent with the data from male cohort comparisons. Dawes et al. [27] reported a 1PU mean value of 44.48 (±15.47) reps in a cohort of 518 male Officers, which while similar to that seen in LEA2 (42.16 ±13.59 reps), differs to that seen in LEA1 (57.76 ±16.42 reps). Similarly, Dawes et al. [8] also reported a VJ mean value of 50.74 (±8.89) cm being similar to LEA2 (53.06 ±7.77 cm), but again not LEA1 (62.63 ±6.53 cm). Conversely, Dawes et al. [8] reported a 1SU mean value of 34.46 (±10.29) reps, which is lower when compared to both LEA1 (40.16 ±8.0 reps) and LEA2 (36.96 ±6.53 reps). Regarding aerobic performance, the finding reported by Sorensen et al. [6] of 42.8 (±10.1) ml/kg/min (estimated by a submaximal incremental exercise test) is similar to LEA1 (41.44 ±6.81 ml/kg/min), but not LEA2 (34.1 ±5.51 ml/kg/min). It should also be noted, that these differences between other LEA and LEA 2 may be more pronounced given the removal of some LEA2 aerobic fitness data (20m MSFT) due to results being too low for use.

The differences in observed Officer fitness levels can be attributed to the findings of previous research which reinforces the supposition that Officers from different LEAs require different levels of fitness. Orr et al. [7] compared the fitness levels of Cadets with incumbent Officers and found that occupational status of a police population may be a key contributing factor to muscular endurance. Research by Anderson et al. [28] suggests there are core bona fide occupational requirements for incumbent Officers. Although the core tasks may be consistent between agencies (e.g., 80-90% of an Officer's job may be devoted to tasks requiring limited physical activity [29]), the frequency of tasks that have a physical component may vary considerably [1]. For example, a study by Orr et al., [1] found that even in one Australian State LEA, the frequency of job tasks between different regions (rural, urban and metro) varied considerably. As such, differences in age, occupational length of service, gender split and differing job requirements between LEA may be a contributing factor to differences in levels of fitness between LEA.

The findings of this study highlight differences in anthropometric and fitness performance profiles between different LEA. As such, each LEA requires dedicated consideration regarding the development of anthropometric (weight) and fitness (1PU, 1SU, VJ and VO_2 max) standards against the LEA's workplace requirements. An additional caution can be drawn from the study by Dawes et al. [8] which identified clear differences in Officer performance when compared against the normative data reported by the Cooper Institute. For example, in their study, Dawes et al. [8] noted that the push-up assessment results of the LEA that held a 15th percentile ranking was equivocal to that of the 50th percentile for the normative population cited by the Cooper Institute [30]. Hence, not only should the anthropometric and fitness performance profiles be considered cautiously when assuming to represent all LEA, but likewise should be considered cautiously when considered against a normative profile.

5. Limitations

There were certain limitations to this study that should be considered. The first limitation is regarding whether the differences in fitness testing protocols could skew results due to the variations in procedures. Noted in this study were the differences in data collection procedures between agencies for all fitness measures. Although the procedures for some tests did not vary to a great degree, it is important to stress the potential and need for consistency among all fitness tests. The second limitation of this study was the low number of female Officers in the dataset. Nonetheless, the low number of females is typical of law enforcement populations. Lastly, there were differences in the recruitment of participants for this study. Officers from LEA1 were volunteers while Officers from LEA2 were required to participate. Further studies are needed to i) explore the specific fitness requirements of individual LEAs and ii) develop larger data sets for both female and male Officers, all performing the same tests to the same level of effort..

6. Conclusion

Based on the significant differences in Officer anthropometrics and fitness test performance found in this study and when compared to the wider literature, it is important for each LEA to develop unique fitness standards applicable to their LEA. The development of job-related and health-related fitness standards, and associated health and conditioning strategies, will aid in the improvement of Officer health and fitness. This study also identified differences in fitness testing procedures, underlining the need for standardization of fitness testing procedures to ensure consistency and accuracy when comparing results. Future research should focus on profiling and comparing the fitness levels of different LEAs, both nationally and internationally, using similar fitness assessments. Additionally, there is a need for future research to also provide data on cohorts as a single entity (i.e., regardless of sex) as this is how a cohort presents for training and is how Officers are expected to perform in the workplace.

Conflict of Interest

None to report.

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Table 1. Anthropometric and fitness performance data (mean ± SD) of Officers from LEA1 and LEA2.

Table 2. Anthropometric and fitness performance data (mean ± SD) of male Officers from LEA1 and LEA2.

Table 1. Anthropometric and fitness performance data (mean ± SD) of Officers from LEA1 and LEA2.

	LEA1 (n= 79) ♂**=72:** ♀**=7**	**LEA2 (n= 319)** ♂**=315:** ♀**=4**
Age (years)	39.31 ± 7.98	37.84 ± 7.72
Weight (kg)	85.27 ± 13.19	88.6 ± 13.09*
Push-ups (repetitions)	55.69 ± 17.33	41.96 ± 13.77*
Sit-ups (repetitions)	40.64 ± 7.63	36.9 ± 8.0*
Vertical Jump (cm)	61.53 ± 7.30	52.81 ± 8.05*
VO_2 max (ml/kg/min)	41.52 ± 6.54	34.03 ± 5.51*

*Significantly different from LEA1 ($p < 0.001$).

Table 2. Anthropometric and fitness performance data (mean ± SD) of male Officers from LEA1 and LEA2.

	LEA1 **♂=72**	**LEA2** **♂=315**
Age (years)	39.43 ± 8.28	37.92 ± 7.71
Weight (kg)	87.46 ± 11.59	88.8 ± 12.93
Push-ups (repetitions)	57.76 ± 16.42	42.16 ± 13.59*
Sit-ups (repetitions)	40.16 ± 8.00	36.96 ± 6.53*
Vertical Jump (cm)	62.63 ± 6.53	53.06 ± 7.77*
VO_2 max (ml/kg/min)	41.44 ± 6.81	34.1 ± 5.51*

*Significantly different from LEA1 ($p< 0.001$).