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Research article

FITNESS PERCENTILE RANK DATA FOR FEMALE LAW ENFORCEMENT RECRUITS IN THE USA

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Abstract. *Female law enforcement personnel make up a small percentage of the population compared to males. However, female officers and recruits tend to be under-analyzed relative to their male counterparts. Female recruits also tend to be less physically fit when compared to their male peers, but the distinction of physical fitness levels within females as a specific population group has yet to be documented. This study aimed to create fitness percentile ranks for female recruits from several law enforcement agencies. Retrospective analysis on 200 females from 14 law enforcement recruit classes from agencies in three American states was conducted. Physical fitness tests were conducted prior to academy. The tests included: maximal push-ups and sit-ups in 60 s, and the 20-m multistage fitness test (assessed by number of completed shuttles and estimated maximal aerobic capacity). For all tests, if a female was below the 40th percentile specific to recruits, they were near the 50th percentile for general population norms. Female recruits should aim to be in the 50th percentile or higher of the presented percentile rankings to better their preparedness for academy. Training staff could also use the percentile rank data to profile their female recruits and highlight their strengths in muscular endurance and aerobic fitness, and areas for needed improvement. By doing so, and by also developing strength, power, and endurance, females will be more prepared to complete academy training, perform job-specific tasks, and raise the expectations and overall fitness for females as a sex group in the law enforcement community.*

Key words: *Multistage Fitness Test, Police, Push-Ups, Sit-Ups, Tactical*

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INTRODUCTION

Law enforcement officers undergo long, strenuous, and at times stressful work shifts. An officer's daily routine may consist of tasks ranging from lifting and dragging civilians or colleagues to safety, participating in a foot pursuit, or apprehending a suspect (Bissett, Bissett, & Snell, 2012; Dawes et al., 2018; Dawes et al., 2017a; Moreno et al., 2019; Orr et al., 2020a; Orr, Pope, Stierli, & Hinton, 2017; Orr et al., 2019). Due to the physically taxing responsibilities of this occupation, a great majority of law enforcement agencies throughout the USA (and the world) have a variety of fitness requirements which must typically be met before a recruit may join their respective training academy. Fitness requirements for agencies are commonly measured using a variety of tests, which may include: maximal push-ups performed in 60 seconds (s) to measure upper-body muscular endurance, maximal sit-ups performed in 60 s to measure trunk muscular endurance, and number of shuttle runs performed during the 20-meter (m) multi-stage fitness test (20MSFT) to measure aerobic fitness (Cesario et al., 2018; Dawes et al., 2019b; Dawes et al., 2017b; Lockie et al., 2019a; Lockie et al., 2020a; Lockie et al., in press; Lockie et al., 2020c; Lockie et al., 2020e; Orr et al., 2020b; Shusko et al., 2017). Furthermore, it is generally expected that law enforcement recruits obtain an adequate level of physical fitness before starting academy training (Dawes et al., 2019b; Lockie, Dawes, Orr, & Dulla, 2020b).

For most agencies, all recruits, regardless of age or sex, are expected to meet the same minimum physical fitness requirements determined by their respective agency (Bissett et al., 2012; Reaves, 2012). As there have been several discrimination lawsuits in the past, in order to ensure the largest pool of qualified candidates and avoid a disparate impact on female applicants, some police departments have developed sex-norming procedures in certain tests to control for the physiological differences between men and women (Bissett et al., 2012). Other agencies have removed initial fitness testing altogether with the express goals of recruiting more females (Silvester & Pearson, 2019). Despite sex-norming procedures in some agencies to expand the female applicant pool, it is important to clearly note that occupationally required physical tasks of female officers do not differ from those of a male. Any call for help of an ongoing crime or breach of peace is expected to be handled by whoever (male, female, younger, or older officer) is on-duty. Accordingly, it is important to review the current fitness levels of female recruits and provide some training guidelines to best prepare these individuals for success in academy and their future career (Dawes et al., 2019b).

The level of fitness for new candidates attending law enforcement academy training when considering both sexes combined tends to be similar between cohorts (Lockie et al., 2020b; Lockie et al., 2018c). However, as a majority of law enforcement recruits are male (Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., 2020b), this may not accurately depict the actual level of fitness of females. Indeed, when investigating the influence of sex on physical fitness, female recruits generally display lower strength, muscular endurance, and aerobic fitness when compared to male recruits (Cesario et al., 2018; Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., 2020b; Lockie et al., 2018b; Lockie et al., 2020c). Specifically, male recruits tend to demonstrate greater performance in both lower- and upper-body tests such as in the seated medicine ball throw, vertical jump, push-ups, and isometric grip strength when compared to female recruits (Cesario et al., 2018; Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., 2020b; Lockie et al., 2018b). Females also tend to perform significantly less 20MSFT shuttles and have lower maximal aerobic capacity ($\dot{V}O_{2max}$) values than males (Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., in press; Lockie et al., 2020c). Given that higher lean body mass has been associated with physical fitness in law enforcement populations (Dawes et al., 2016b; Lockie et al., 2020e), it is safe to assume females may be at a physical disadvantage in

most assessments as males tend to have more total skeletal muscle mass (Janssen, Heymsfield, Wang, & Ross, 2000).

Nonetheless, the differences in physical fitness levels amongst female recruits is less known, with law enforcement research tending to feature low female sample sizes (Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., 2020b). The low female sample sizes that feature in research studies reflect fewer females (compared to males) serving in law enforcement careers. As of September 2019, there were 98,738 women in law enforcement compared to 645,936 men, accounting for about 15% of the entire law enforcement population (Neely, 2019). More detailed analyses of female recruits are required to characterize this group.

Therefore, this study detailed percentile ranks of female recruits' fitness test performance in the number of push-ups, sit-ups, 20MSFT shuttles completed, and estimated $\dot{V}O_{2max}$. This was done to better distinguish fitness levels for female law enforcement recruits. Retrospective analysis was conducted on pre-existing de-identified data provided by three law enforcement agencies. The data in this study was also categorized relative to general population norms (Riebe, Ehrman, Liguori, & Magal, 2018), and previous law enforcement recruit data (Dawes et al., 2019b; Lockie et al., 2019a; Shusko et al., 2017). This was done to highlight the challenges for females who may report to academy with low fitness levels. The percentile rank data composed in this research could be used to drive training practices for female candidates for a law enforcement agency, or recruits in the lead-up to academy.

METHODS

Participants

Retrospective analysis of data for female recruits from 14 law enforcement academy classes across three states in the USA was conducted. The data presented in this paper were released with consent from the law enforcement organizations in question for the purpose of conducting this research. A convenience sample of a total of 200 female law enforcement recruits (age: 27.4 ± 6.3 years; height: 1.62 ± 0.07 m; body mass: 65.6 ± 10.8 kg) were analyzed in this study. As this was a convenience sample of data provided by the agencies, the researchers had no control of the final sample size. Inclusion criteria for the participants included complete data sets. Even though previous research has shown fitness can vary between different agencies (Myers et al., 2019), this study provided a larger data sample drawn solely from female recruits. Based on the archival nature of this analysis, institutional ethics committees approved the use of pre-existing data (HSR-17-18-370, ED-19-146-STW). The study still conformed to the recommendations of the Declaration of Helsinki (World Medical Association, 1997).

Procedures

The data in this study were collected by staff working for three different law enforcement agencies. The tests that were selected for analysis in this study were consistent across the agencies and performed with the same methodology. All recruits were tested prior to their respective training academy (as an initial academy assessment) as part of normal practice. Recruits were required to complete the fitness assessments within their academy physical training for each agency, often part of larger testing batteries (Lockie et al., 2020e). The staff from each agency were all trained to conduct the tests analyzed in this study.

Push-ups

Each agency's training staff measured upper-body muscular endurance via a push-up test where recruits completed as many repetitions as possible in 60 s. Established procedures were used by all agencies (Lockie et al., 2018a; Lockie et al., 2020b). A tester placed a fist on the floor directly under the recruit's chest to ensure they descended to an appropriate depth. Although there may be some limitations with this approach, this ensured recruits descended to the required depth. All the 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 tester's fist before they extended their elbows to return to the initial position. Recruits correctly performed as many correct push-ups as possible using this technique within the allocated time.

Sit-ups

Abdominal muscular endurance was assessed via the sit-up test where recruits completed as many repetitions as possible in 60 s. This test also used standard procedures (Lockie et al., 2018a; Lockie et al., 2020b). 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 also counted the repetitions as they were positioned so they could view the technique and could communicate with the recruit. 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 correct repetitions as possible using this technique within the allocated time.

20-m Multistage Fitness Test (20MSFT)

The 20MSFT was proctored using a previously established methodology (Dawes et al., 2019b; Lockie et al., 2019a; Lockie et al., in press; Lockie et al., 2020c; Lockie et al., 2019d; Lockie et al., 2020e; Moreno et al., 2018; Orr, Ford, & Stierli, 2016). Recruits ran back and forth between two marked lines which were spaced 20 m apart. The speed of running for this test was standardized by pre-recorded auditory cues (i.e., beeps) played from an audio device. The recruits needed to reach the line on their opposite side before the auditory cues were given. Initial speed was set at 8.5 km/h and increased by 0.5 km/h after every minute. The test was terminated when the recruit was unable to reach the opposing lines twice in a row in accordance with the auditory cues. This test was scored according to the total number of shuttles completed. Using the total number of completed 20MSFT shuttles as a metric for aerobic fitness is a common approach in law enforcement research (Dawes et al., 2019b; Dawes et al., 2017b; Lockie et al., 2019a; Lockie et al., in press; Lockie et al., 2020c; Lockie et al., 2019d; Lockie et al., 2020e; Moreno et al., 2018; Orr et al., 2016). In addition to shuttle number, $\dot{V}O_{2max}$ (measured in milliliters per kg body mass per minute; ml/kg/min) was estimated for each recruit based on the table from Ramsbottom, Brewer, & Williams (1988). Estimating $\dot{V}O_{2max}$ in this manner has been done in previous law enforcement research (Lockie et al., in press; Lockie et al., 2020c).

Statistical Analysis

Data were collated for the female recruits between the different academy classes across the agencies. Microsoft Excel (Microsoft Corporation™, Redmond, Washington, USA) was used

to calculate the percentile ranks (Lockie & Hernandez, 2020; Lockie et al., 2020b). The "Rank and Percentile" tool within the Data Analysis ToolPak was used to calculate the percentile rankings for each fitness assessment in bands of 10 ranks (e.g. 90-100, 80-89, 70-79, etc.). Comparisons were also made to general population normative data (Riebe et al., 2018), and to studies that have measured the physical fitness performance of recruits who graduated or separated academy (Dawes et al., 2019b; Lockie et al., 2019a; Shusko et al., 2017).

RESULTS

The percentile rankings are shown in Table 1. When compared to normative data from Riebe et al. (2018), female recruits tended to score superior or similar to the general population norms for females in push-ups and sit-ups, but tended to perform poorer in aerobic capacity. Firstly, the number of push-ups ranged from 2 to 56 repetitions, with the mean number of push-ups performed by these female recruits (27 repetitions) falling in the good-to-excellent range relative to the general population (Riebe et al., 2018). Further, the mean push-up repetition value in this study was less than the mean number performed by recruits who did not successfully graduate from academy (~32-40 repetitions), which was documented in previous research (Dawes et al., 2019b; Lockie et al., 2019a; Shusko et al., 2017). Relative to the female recruits presented in this analysis, the mean number of push-ups performed by recruits who failed academy fell anywhere within the 70th to 87th percentile rank.

The number of sit-ups performed ranged from 5 to 58 repetitions, with the mean number of sit-ups performed by these female recruits (32 repetitions) being similar to the mean number performed by recruits who failed to graduate from academy (~32-33 repetitions) (Lockie et al., 2019a; Shusko et al., 2017). The mean number of sit-ups performed by recruits who failed academy fell anywhere into the 40th to 89th percentile rank. General population data for the sit-up was not available in Riebe et al. (2018).

Table 1 Percentile rankings for push-ups (n = 196), sit-ups (n = 197), 20MSFT shuttles (n = 200), and $\dot{V}O_{2max}$ (n = 200) from female recruit data. 'Recruit No.' refers to the number of recruits in each percentile rank.

Percentile Rank	Push-up Range	Recruit No.	Sit-up Range	Recruit No.	Shuttle Range	Recruit No.	$\dot{V}O_{2max}$ Range	Recruit No.
90-100	43-56	18	44-58	18	68-100	20	41.1-50.2	19
80-89	36-42	21	39-43	21	60-67	20	37.7-41	21
70-79	32-35	20	37-38	13	54-59	17	35.5-37.8	20
60-69	30-31	16	35-36	22	47-53	22	34-35.4	16
50-59	27-29	23	33-34	22	43-46	20	32.8-34.1	24
40-49	25-26	19	31-32	20	39-42	21	31.2-32.7	17
30-39	22-24	19	29-30	14	38	10	30.6-31.1	14
20-29	18-21	21	27-28	23	35-37	24	29.1-30.5	23
10-19	16-17	17	24-26	22	30-34	22	27.5-29	22
<10	2-14	22	5-23	22	8-28	24	26.8-27.4	27

The number of 20MSFT shuttles completed by these female recruits ranged from 8 to 100, with the mean number shuttles completed equaling 46 shuttles. When compared to other recruits who did not complete their academy training, these female recruits performed better than separated recruits from California (40 shuttles) (Lockie et al., 2019a), but worse than other separated recruits from Colorado (49 shuttles) (Dawes et al., 2019b). The recruits from previous studies who did not successfully graduate from academy fell in the 40th to 65th percentile rank.

Lastly, the recruit's $\dot{V}O_{2max}$ ranged from 26.8 ml/kg/min to 50.2 ml/kg/min, with a mean score of 33.3 ml/kg/min. Depending on the age of the recruit, this mean $\dot{V}O_{2max}$ value was in the poor-to-good range relative to the general population (i.e., if a 20-29 year old younger recruit had this $\dot{V}O_{2max}$, they would be classified as poor; a 30-49 year old would be classified as good) (Riebe et al., 2018). This mean $\dot{V}O_{2max}$ was below the mean $\dot{V}O_{2max}$ reported from recruits who did not graduate from academy in Massachusetts (39.06 ml/kg/min) (Shusko et al., 2017). The mean for the separated recruits from Shusko et al. (2017) would have positioned them near the 85th percentile rank of the female recruits in this analysis.

DISCUSSION

This study presented percentile ranks for upper-body (push-ups) and abdominal (sit-ups) muscular endurance, and aerobic fitness (20MSFT shuttles and estimated $\dot{V}O_{2max}$) specific to female recruits. Females were the focus of this research as they tend to comprise a much percentage of staff within a law enforcement agency (Neely, 2019), and also have low sample sizes in the research (Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., 2020b). Although this study analyzed general fitness tests and not job-specific tasks, these assessments are used to track fitness in law enforcement academies (Cocke, Dawes, & Orr, 2016), ensure sufficient fitness to minimize the risk of injury when undergoing academy training (Lockie et al., 2019a; Tomes, Schram, Pope, & Orr, 2020), and also underpin the physical qualities needed for job-specific tasks (Beck et al., 2015; Dawes et al., 2017a; Lockie et al., 2018a). Indeed, the push-up, sit-up, and 20MSFT are commonly used to determine initial hiring, gauge progress, and provide scoring for performance in physical training (Cesario et al., 2018; Dawes et al., 2019b; Lockie et al., 2019a; Lockie et al., 2018a; Lockie et al., in press; Lockie et al., 2020b; Lockie et al., 2020c; Shusko et al., 2017). As will be discussed, the results from this study further highlighted the importance of specific physical fitness characteristics needed in female recruits.

The push-up is one of the most well-known exercises used in tactical populations. It is employed as a physical conditioning tool within tactical populations to help determine improvement in physical fitness after a new or modified physical conditioning program (Dawes et al., 2016a). Not only is the push-up test easy to administer due to its ability to be performed anywhere on a flat surface (e.g., grass, concrete, dirt), but evidence has also shown baseline push-ups when starting academy training as predictor of successful academy graduation (Dawes et al., 2019b; Shusko et al., 2017). Accordingly, the push-up test a very popular measure of physical fitness in both general and tactical population fitness assessments to measure and assess muscular endurance (Dawes et al., 2016a). Sit-ups have also been a staple exercise in tactical populations due to their commonality in being easy to administer and perform by the individuals being tested. Since research has shown push-ups and sit-ups measure different physical qualities (upper-body pushing vs. abdominal endurance) (Cesario et al., 2018), as well as also being related to multiple occupational tasks (Beck et al., 2015; Lockie et al., 2018a), these two exercises should be fundamental exercises included in a female recruit's strength and conditioning program to better optimize their overall physical fitness.

Aerobic fitness is also a crucial physical component for female recruits. Lesser performance in the 2.4-km (1.5-mile) run or 20MSFT has been associated with academy failure (Dawes et al., 2019b; Lockie et al., 2019a; Lockie et al., 2020a; Shusko et al., 2017; Tomes, Sawyer, Orr, & Schram, 2020), while higher aerobic capacities are significant predictors of occupational performance (Beck et al., 2015; Dawes et al., 2017a; Lockie et al., 2018a). Although academy

training focuses on the betterment of their recruits' aerobic capacity, females should still be implementing some aerobic endurance training prior to academy to maintain (or enhance) their aerobic capacity. This is especially notable given the importance of aerobic fitness in law enforcement job tasks (Beck et al., 2015; Dawes et al., 2017a; Lockie et al., 2018a), and how generally female recruits may have lower aerobic capacity compared to males (Dawes et al., 2019b; Lockie et al., 2020a; Lockie et al., in press; Lockie et al., 2020c).

For all these tests, if a female was below the 40th percentile in this sample of recruits, they were generally considered to be near the 50th percentile for general population norms (Riebe et al., 2018). However, it should be noted, this may not be an ideal ranking for female recruits because of the relationships between fitness and performance in academy (Dawes et al., 2019b; Lockie et al., 2019a; Lockie et al., 2020a; Shusko et al., 2017) and within job-specific tasks (Beck et al., 2015; Dawes et al., 2017a; Lockie et al., 2018a). Female recruits should ideally aim to be in the 50th percentile or higher of these presented percentile rankings in this recruit-specific population to better their preparedness for law enforcement academy training. Further to this, since the physical characteristics and performance of both sexes may decline with age in incumbent officers (Dawes et al., 2017b; Lockie, Dawes, Kornhauser, & Holmes, 2019c; Lockie et al., 2019e; Orr, Dawes, Pope, & Terry, 2018a), it is even more crucial for female recruits in the older age ranges (35 years of age or more) to arrive at academy at a higher level of physical preparedness relative to their respective general population norms. This is because they are already inclined to be at an initial physiological disadvantage compared to males their age (Dawes et al., 2017b; Lockie et al., 2019a; Lockie et al., 2020a; Lockie et al., 2019c).

There are study limitations that should be noted. This study incorporated female recruits from three different law enforcement agencies. As previously stated, fitness can vary across different agencies (Myers et al., 2019), so future investigations should incorporate more agencies to increase the sample size even further. The testing and environmental conditions may have varied across the different classes in each agency (Lockie et al., 2020b), although this limitation is almost unavoidable given the type of investigation conducted. Only three fitness assessments (push-ups, sit-ups, and the 20MSFT) were incorporated into this study. In addition to muscular endurance and aerobic capacity, some other important fitness qualities for law enforcement personnel include maximal strength, upper- and lower-body power, and anaerobic endurance (Beck et al., 2015; Dawes et al., 2017a; Lockie et al., 2018a; Lockie et al., 2020d; Lockie et al., 2021b; Orr, Caust, Hinton, & Pope, 2018b). Future research should categorize these qualities for female recruits. This could include tests such as grip strength, isometric leg/back dynamometer, and hexagonal bar deadlift to measure strength (Dawes et al., 2019a; Dawes et al., 2017b; Lockie, Balfany, Denamur, & Moreno, 2019b; Lockie et al., 2020d); the vertical jump, standing broad jump, and medicine ball throw to measure power (Dawes et al., 2019a; Dawes et al., 2019b; Lockie et al., 2019a; Lockie et al., 2021a; Lockie et al., 2020a; Lockie et al., 2018b; Lockie et al., 2021b; Lockie et al., 2020e; Moreno et al., 2019); and a 300-m run (or something similar) to assess anaerobic capacity (Cocke et al., 2016; Moreno et al., 2018; Orr et al., 2018a).

CONCLUSION

In conclusion, it should be strongly noted that an individual's sex should not be considered a limitation in the law enforcement profession. While required occupational tasks are the same for both sexes, limitations in fitness (which can also be applied to men) could be the

more challenging aspect. With the percentile ranks shown in this paper, law enforcement academy training staff can use this data to profile their female recruits and highlight their strengths in muscular endurance and aerobic fitness, and areas for needed improvement. For females considering law enforcement as a potential career, they should strive to better their aerobic capacity to potentially match normative $\dot{V}O_{2max}$ values in females from this recruit-specific population. By doing so, and by also further developing strength, power, and endurance, females will be more prepared to complete academy training, perform job-specific tasks, and raise the overall fitness for females in the law enforcement community.

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RANGIRANJE FIZIČKE SPREMNOSTI ŽENA REGRUTA U POLICIJSKIM SNAGAMA U SJEDINJENIM DRŽAVAMA

Žene u policijskim snagama čine mali procenat stanovništva u poređenju sa muškarcima. Međutim, žene policajke i regruti su nedovoljno analizirane u odnosu na svoje kolege muškog pola. Žene regruti takođe su često manje fizički sposobne u poređenju sa svojim vršnjacima, ali razlika u stepenu fizičke spremnosti žena kao posebne grupe stanovništva tek treba da se dokumentuje. Ova studija je imala za cilj stvaranje rangova fizičke spremnosti za žene regrute iz nekoliko agencija policijske službe. Sprovedena je retrospektivna analiza na uzorku 200 žena iz 14 regrutnih odeljenja iz agencija u tri američke države. Testovi fizičke spremnosti sprovedeni su pre neko štu su ispitanice pristupile policijskoj akademiji. Testovi su uključivali: maksimalan broj sklekova i trbušnjake za 60 sekundi, kao i višestepeni fitnes test na 20 metaraa (procenjen prema broju završenih shuttle run sprintova i procenjenim maksimalnim aerobnim kapacitetom). Za sve testove, ako je žena bila ispod 40. podeoka specifičnog za regrute, bila je blizu 50. podeoka za opšte populacione norme. Žene regruti trebalo bi da teže u najmanju ruku ka 50. podeoku kako bi poboljšale svoju pripremljenost za akademiju. Osoblje za obuku bi takođe moglo da koristi podatke o rangu za profilisanje svojih regruta, kako bi istakli njihove prednosti u pogledu mišićne izdržljivosti i aerobne kondicije, kao i oblasti na kojima bi trebalo dodatno poraditi. Na taj način, i razvijanjem snage, moći i izdržljivosti, žene će biti spremnije da završe akademsku obuku, obavljaju zadatke specifične za posao i povećaju očekivanja i ukupnu sposobnost žena kao rodne grupe u policijskim snagama.

Ključne reči: *višestepeni fitness test, policijske snage, sklekovi, vežbe za stomačne mišiće, taktički trening*