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Relationships between Isometric Strength and the 74.84-kg (165-lb) Body Drag Test in Law Enforcement Recruits

by

Robert G. Lockie¹, Matthew R. Moreno¹, Megan B. McGuire¹, Tomas J. Ruvalcaba¹,
Ashley M. Bloodgood¹, Joseph M. Dulla^{2,3}, Robin M. Orr³, J. Jay Dawes⁴

*This study investigated whether: law enforcement recruits could complete a 74.84-kg (165-lb) body drag without specific training; relationships between the body drag and absolute and relative isometric grip and leg/back strength could be established to assist with training recommendations; a strength baseline needed to complete the 74.84-kg body drag could be established. Retrospective analysis on a recruit class (72 males, 21 females) from one agency was conducted. Recruits completed the body drag, and had strength assessed by hand grip and leg/back dynamometers in the week before academy. The body drag required the recruit to lift the dummy to standing and drag it 9.75 m as quickly as possible. Independent samples *t*-tests calculated between-sex differences in the drag and strength measures. Recruits were ranked according to drag time to describe the strength of recruits that could not perform the task. Pearson's correlations and a stepwise linear regression calculated relationships between the body drag and isometric strength. Male recruits completed the drag faster and were stronger than females ($p < 0.001$). Only two females could not complete the drag, and they had leg/back strength below 100 kg. Greater absolute ($r = -0.599$ and -0.677) and relative ($r = -0.261$ and -0.322) grip (combined score) and leg/back strength, respectively, related to a faster drag. Absolute leg/back strength predicted the body drag ($r^2 = 0.444$). Improving absolute isometric grip and leg/back strength could enhance dragging ability. A minimum isometric leg/back strength score of 100 kg may be needed to perform a 74.84-kg body drag.*

Key words: absolute strength; casualty drag; grip strength; leg/back dynamometer; police; tactical; victim drag.

Introduction

An essential job task for law enforcement officers is a body drag, which requires an officer to drag an incapacitated civilian or fellow officer to safety from a hazardous environment. Many law enforcement recruits will need to effectively complete a body drag as part of occupational physical ability testing (Lockie et al., 2018a; Lockie et al., 2019d; Moreno et al., 2019). As an example, in California in the USA, recruits must complete a drag with a 74.84-kg (165-lb) dummy as part of an exit examination called the Work Sample Test

Battery (WSTB) (Lockie et al., 2018a; Peace Officer Standards and Training, 2012). Recruits have to drag the dummy 9.75 m within 28 s to attain WSBT points (Peace Officer Standards and Training, 2012). Successful completion of the WSTB contributes to whether a recruit can graduate from academy and become a law enforcement officer.

However, the dummy mass may not be representative of the current USA population, or even law enforcement officers. The average adult

¹ - Department of Kinesiology, California State University, Fullerton, Fullerton, CA, USA.

² - Recruit Training Unit, Training Bureau, Los Angeles County Sheriff's Department, Los Angeles, CA, USA.

³ - Tactical Research Unit, Bond University, Robina, Qld, Australia.

⁴ - Department of Health and Human Performance, Oklahoma State University, Stillwater, OK, USA.

male in the USA weighs almost 90 kg, while an adult female weighs approximately 76-77 kg (Fryar et al., 2016). When considering incumbent law enforcement officers, male officers have been found to have an average body mass of 92-96 kg; female officers had an average mass of 74-77 kg (Dawes et al., 2017; Lockie et al., 2019c). These masses do not take into account any additional load that may be carried by a law enforcement officer, who can wear an extra 8-22 kg of equipment depending on their job responsibilities (Baran et al., 2018; Joseph et al., 2018). Regardless of the mass, it could be theorized that the potential to perform a body drag could relate to an individual's strength. Indeed, Lockie et al. (2019b) found that greater absolute ($r = -0.666$) and relative ($r = -0.619$) strength measured by a one-repetition maximum hexagonal bar deadlift related to a faster 74.84-kg body drag in male and female civilians. Although this study was not conducted on law enforcement personnel, several other studies have used this approach of using civilian males and females to analyze tactical tasks (Post et al., in press; Stevenson et al., 2017; Williams-Bell et al., 2009). This is because the important physical or physiological qualities for a law enforcement-specific task should be the same whether they are completed by tactical personnel or civilians (Lockie et al., 2019b; Post et al., in press; Stevenson et al., 2017).

Nonetheless, it would be beneficial to measure the strength of law enforcement personnel and analyze whether it relates to performance of specific tasks such as the body drag. One of the reasons why Lockie et al. (2019b) used civilians is that law enforcement agencies (LEAs) may be reluctant to have their recruits complete maximal dynamic strength testing. This is because recruits demonstrate a wide range of physical capabilities before academy (Lockie et al., 2020a; Lockie et al., 2018c; Lockie et al., 2018d), and it is likely that some recruits have limited resistance training experience. Conducting a maximal dynamic strength test may not be the best approach to find a physical indicator as to whether a recruit could perform a body drag. Isometric strength tests may be more applicable as they are easier to perform, and grip (Dawes et al., 2017; Lockie et al., 2020b) and leg/back (Dawes et al., 2019; Dawes et al., 2017) dynamometers have been used to measure strength in law enforcement

populations. Furthermore, any strength testing data that can be collected specifically from law enforcement populations is essential to assist with developing the qualities that could keep an officer safe in the field of duty.

There is anecdotal resistance to using heavier masses for the body drag during training or testing because of the demands associated with the task, and the potential risk of injury for recruits. A contributing factor to this thought process is that many agencies are attempting to increase the diversity of their workforce, which can often focus on recruiting and retaining women (Felkenes et al., 1993; Zhao et al., 2006). Females generally have less muscle mass (Janssen et al., 2000), and achieve lower results in strength-based tasks (Danneskiold-Samsoe et al., 2009). Nevertheless, a stronger female should still be able to effectively perform a task such as a body drag (Lockie et al., 2019b). There could be less resistance to any suggested change if: 1) incoming male and female recruits can complete the 74.84-kg body drag without specific training; 2) relationships between the body drag and practical strength measures can be established to assist with training recommendations; and 3) a strength baseline needed to complete the 74.84-kg body drag can be established.

The purpose of this study was to investigate the relationships between isometric strength measured by grip and leg/back dynamometers with the 74.84-kg body drag in law enforcement recruits. A retrospective analysis of data from one academy class was conducted. This analysis ascertained whether male and female recruits could perform the body drag to state standards before specific training, and the degree to which isometric strength contributed to this task. It was hypothesized that male recruits would perform the 74.84-kg body drag faster than their female counterparts, and that absolute and relative grip and leg/back strength would correlate with, and predict, body drag performance.

Methods

Participants

Data from one academy class were released with consent from a LEA for this study. This sample of convenience consisted of 93 recruits, including 72 males and 21 females.

Descriptive data for the recruits is shown in Table 1. The characteristics of the subjects in this study, in addition to the ratio between males and females, was typical of law enforcement populations (Cesario et al., 2018; Lockie et al., 2018a; Lockie et al., 2020a; Lockie et al., 2018b; Lockie et al., 2020b). No control was placed on strength and conditioning practices or dietary interventions of individual recruits during the period prior to academy (Lockie et al., 2019a; Lockie et al., 2020a; Lockie et al., 2018b; Lockie et al., 2020b). Based on the archival nature of this analysis, the institutional ethics committee approved the use of pre-existing data (HSR-17-18-370). Recruits were required to complete the fitness assessments as part of their physical training within academy for this agency. Nevertheless, the study still conformed to the recommendations of the Declaration of Helsinki (World Medical Association, 1997).

Procedures

Data were collected by staff working for one LEA who were all trained by a certified Tactical Strength and Conditioning Facilitator. Prior to testing, each recruit's age, height, and body mass were recorded. Body height was measured barefoot using a portable stadiometer (seca, Hamburg, Germany), while mass was recorded by electronic digital scales (Omron Healthcare, Kyoto, Japan). Recruits hand grip strength was tested before they completed a dynamic warm-up. They then completed the body drag, followed by the leg/back dynamometer. Testing was conducted outdoors on a flat asphalt surface at the LEA's training facility between 0900-1400 during the Fall in southern California. Recruits cycled through testing in groups of 14-16. Although conducting outdoor testing is not ideal, there was no indoor facility available and these procedures were typical of staff from the LEA (i.e. during the hiring process, for recruits during academy, and for incumbents during skill refresher programs) (Lockie et al., 2020a; Lockie et al., 2020b).

Grip Strength

Grip strength for each hand was measured by a hand grip dynamometer (Takei Scientific Instruments, Japan). Recruits kept their testing arm by their side, and squeezed the handle as hard as possible for approximately 2 s (Lockie et al., 2020b). Two attempts were completed for

each hand and recorded to the nearest kg, with the left hand tested first (Lockie et al., 2020b). The best score for each hand was summed together to provide the combined grip strength score. Grip strength was also scaled relative to body mass via the formula: $relative\ grip\ strength\ (kg \cdot kg^{-1}) = grip\ strength \cdot body\ mass^{-1}$.

Body Drag

The body drag was conducted according to standard procedures (Lockie et al., 2019b; Lockie et al., 2018a; Moreno et al., 2019; Peace Officer Standards and Training, 2012). Cones marked the start and finish lines for the 9.75-m dragging distance. The 74.84-kg dummy started face side up, with the head orientated towards the finish line. The feet were positioned 0.3 m behind the starting line. Timing was conducted via stopwatch by a trained staff member. Recruits picked up the dummy by wrapping their arms underneath the arms of the dummy and lifting it to a standing position by extending the hips and knees (Figure 1). Once the recruit was standing with the dummy, they informed the tester they were ready. Timing was initiated when the feet of the dummy passed the start line. The recruit dragged the dummy as quickly as possible by walking backwards over the required distance. Timing stopped when the dummy's feet crossed the finish line, and was recorded to the nearest 0.1 s. A single trial was completed by recruits if they completed the trial within 28 s (Peace Officer Standards and Training, 2012). If recruits failed the first trial by dropping the dummy, they were allowed a second attempt. If recruits could not pick up the dummy, their attempt was unsuccessful.

Leg/Back Isometric Strength

Leg/back isometric strength was measured using a dynamometer (Fabrication Enterprises, Inc., New York, USA). The recruit was positioned so their arms were extended and both hands were on the handle positioned at the mid-thigh (knee flexion angle of approximately 110°) (Dawes et al., 2019; Dawes et al., 2017). From here, and while maintaining proper spinal alignment and their feet flat on the base, recruits pulled the handle upward as hard as possible by attempting to extend the hips and knees. Two attempts were recorded to the nearest kg, with the best trial analyzed. Leg/back strength was also scaled relative to body mass.

Statistical Analysis

Statistical analyses were processed using the Statistics Package for Social Sciences Version 26.0 (IBM Corporation, New York, USA). Descriptive statistics (mean \pm standard deviation [SD]) were calculated for each variable. Independent samples t-tests ($p < 0.05$) compared male and female recruits in age, height, body mass, drag time, and the strength variables. Recruits were ranked according to drag time to describe the strength of recruits that could not complete the task. Pearson's correlations ($p < 0.05$) calculated relationships between grip and leg/back strength with the body drag. Males and females were combined as there are no corrections for sex in the WSTB (Peace Officer Standards and Training, 2012). This approach has also been used in other research on law enforcement-specific tasks (Post et al., in press). Correlation strength was defined as: r between 0 to 0.3, or 0 to -0.3, was considered small; 0.31 to 0.49, or -0.31 to -0.49, moderate; 0.5 to 0.69, or -0.5 to -0.69, large; 0.7 to 0.89, or -0.07 to -0.89, very large; and 0.9 to 1, or -0.9 to -1, near perfect for relationship prediction (Hopkins, 2013). Stepwise linear regression ($p < 0.05$) determined whether isometric strength predicted the body drag for those recruits who could complete the task. Scatter plots were

produced in Microsoft Excel (Microsoft Corporation™, Redmond, Washington, USA) for select variable pairs for further analysis.

Results

Generally, male recruits were taller, heavier, performed the body drag faster, and displayed greater strength than female recruits (Table 1). All males and 19 females (91% of the sample) completed the body drag to state standards prior to academy training. For the two females who could not complete the drag, they had a combined grip strength below 50 kg (41 kg and 47 kg) and leg/back strength below 100 kg (82 kg and 90 kg). One female had a combined grip strength of 40 kg, although her leg/back strength score was 100 kg and she could perform the drag. Absolute grip and leg/back isometric strength had large significant relationships with body drag time (Table 2). Relative grip strength had a small significant relationship with body drag time; relative leg/back strength had a moderate significant relationship. Absolute leg/back strength predicted the body drag ($r = 0.666$, $r^2 = 0.444$, $p < 0.001$), with 44% explained variance (Figure 2).

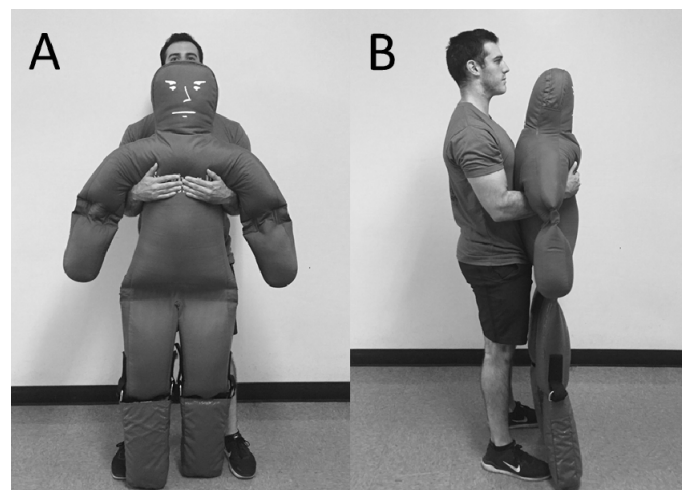


Figure 1

Anterior (A) and lateral (B) view of the starting position for the body drag.

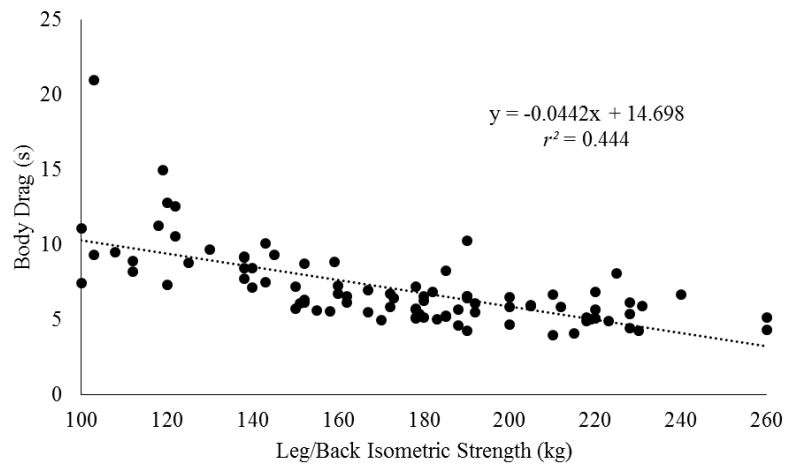


Figure 2
Scatter plot and regression equation for the relationships between absolute leg/back isometric strength relative to the 74.84-kg body drag in law enforcement recruits.

Table 1

Descriptive data (mean ± SD) for all, male, and female law enforcement recruits for the body drag, absolute and relative grip strength, and absolute and relative leg/back strength. * Significantly ($p < 0.05$) different from the male recruits..

	All Recruits (N = 93)	Males (n = 72)	Females (n = 21)
Age (years)	27.57 ± 6.14	27.78 ± 6.64	26.86 ± 3.99
Height (m)	1.71 ± 0.09	1.73 ± 0.08	1.61 ± 0.06*
Body Mass (kg)	80.01 ± 15.19	84.50 ± 13.55	64.63 ± 9.43*
Body Drag (s)	7.03 ± 2.57	6.16 ± 1.36	10.32 ± 3.33*
Grip Strength (kg)	99.33 ± 25.50	108.67 ± 20.00	67.33 ± 13.51*
Relative Grip Strength (kg·kg ⁻¹)	1.25 ± 0.27	1.31 ± 0.27	1.05 ± 0.19*
Leg/Back Strength (kg)	171.58 ± 40.25	186.53 ± 30.99	120.33 ± 21.96*
Relative Leg/Back Strength (kg·kg ⁻¹)	2.16 ± 0.41	2.24 ± 0.40	1.88 ± 0.32*

Table 2

Pearson's correlations between 74.84-kg body drag time with absolute and relative strength measured by grip and leg/back isometric strength in law enforcement recruits (N = 93). * Significant ($p < 0.05$) relationship between the two variables.

		Body Drag Time
Grip Strength	r	-0.599*
	p	<0.001
Relative Grip Strength	r	-0.261*
	p	0.013
Leg/Back Strength	r	-0.666*
	p	<0.001
Relative Leg/Back Strength	r	-0.322*
	p	0.002

Discussion

This study investigated the relationships between isometric strength measured by grip and leg/back dynamometers with the 74.84-kg body drag in law enforcement recruits. Additionally, this research determined whether incoming male and female recruits could complete the 74.84-kg body drag without specific training, and whether there could be an isometric strength baseline for whether a recruit could complete the drag. The results indicated that isometric grip and leg/back strength did relate to body drag performance, with greater strength linked to faster drag times. Additionally, the majority of recruits in this study (100% of males, 91% of females) had sufficient strength and technical ability to drag a 74.84-kg dummy fast enough to achieve state standards prior to specific training, in an average time (7.03 ± 2.57 s) well under that required (28 s) (Peace Officer Standards and Training, 2012). This was also true for the female recruits (10.32 ± 3.33 s), although the only recruits that could not complete the body drag were the two females with the lowest strength scores. The data from these two female recruits suggested that a minimum leg/back isometric strength of 100 kg may be needed to perform a 74.84-kg body drag, although much more research is required in this regard. Nonetheless, the findings from this study have great application for LEA staff and practitioners that train law enforcement recruits.

Lockie et al. (2019b) linked the 74.84-kg body drag to lower-body strength in male and female civilians, which would suggest that improving this quality should positively influence drag performance. The current data supported these results, with greater grip and leg/back isometric strength relating to a faster drag time. Grip strength could contribute to the body drag as according to training standards, the dummy must be held throughout the drag (Peace Officer Standards and Training, 2012). Leg and back strength is important for lifting the dummy to a standing position, and maintaining this position during the drag (Lockie et al., 2019b). Although the lifting portion does not contribute to the drag time (Lockie et al., 2019b; Lockie et al., 2018a; Moreno et al., 2019; Peace Officer Standards and Training, 2012), a recruit who cannot lift the dummy cannot complete the drag. Absolute strength appeared especially important, as

demonstrated by the stronger correlations to drag time and predictive relationship of absolute leg/back isometric strength and the body drag. This is likely because the body drag involves moving a fixed load; a supposition supported by Orr et al. (in press) in specialist police officers. This, these data suggest that male and female law enforcement recruits would benefit from greater absolute grip and leg/back strength for completing dragging tasks.

This data also suggested that a minimum leg/back isometric strength of 100 kg may be needed to perform a 74.84-kg body drag. Given the resulting sample of only two recruits who could not complete the drag, these suppositions may be considered pilot data. Nevertheless, the two recruits in this sample who could not perform the body drag both had a leg/back strength score below 100 kg. More research is needed to provide a strong predictive relationship between leg/back isometric strength and the ability to perform a 74.84-kg body drag. Fitness testing is often performed as part of LEA hiring to determine whether candidates have the attributes to perform job-related tasks (Cesario et al., 2018), and complete academy training (Shusko et al., 2017). The current data indicates potential for use of the leg/back dynamometer in law enforcement fitness testing. The use of a leg/back dynamometer has other advantages other dynamic, repetition maximum strength testing in that it is relatively easy to perform, can be completed in a very short period of time, and has been used in strength testing for other law enforcement populations (Dawes et al., 2019; Dawes et al., 2017).

Anecdotally there is resistance to increasing the dummy mass in the body drag during testing or training because of increased task demands. There are concerns that a greater dummy mass could lead to higher failure rates for recruits (particularly females) unable to meet any change in standards, in addition to the risk of injury. Although these concerns are understandable given the wide variation in physical fitness that many recruits have prior to academy training (Lockie et al., 2020a; Lockie et al., 2018c; Lockie et al., 2018d), there is a high likelihood officers will have to drag masses in excess of 74.84 kg when on-duty (Dawes et al., 2017; Fryar et al., 2016; Lockie et al., 2019c). Given the relationships shown in this study, absolute

strength training should be a greater focus in the academy period. This is particularly important for women, and potentially smaller males, as they will generally be at a physiological disadvantage compared to larger males (Danneskiold-Samsøe et al., 2009; Janssen et al., 2000). Appropriate resistance training can lead to improvements in maximal strength for recruits during academy (Cocke et al., 2016), and this could translate to better performance in tasks such as a body drag for both males and females.

There are limitations in this study that should be acknowledged. This study only had access to data for one academy class from one LEA. Despite the encouraging results, much more data is required to ascertain the minimum isometric strength required as measured by grip strength or a leg/back dynamometer to perform a 74.84-kg body drag. The number of females ($n = 21$) analyzed relative to males ($n = 72$) was very different, although this is very typical in law enforcement research (Cesario et al., 2018; Lockie et al., 2018a; Lockie et al., 2020a; Lockie et al., 2018b; Lockie et al., 2020b). Future research investigating the isometric strength of law enforcement recruits should attempt to use a

greater sample size, and potentially recruits from different LEAs as well. This could determine whether isometric strength varies across agencies, and how this may influence job-specific performance. This study was cross-sectional in nature, and a longitudinal study is required to determine whether increased grip and leg/back isometric strength can also improve body drag performance.

In conclusion, improving grip and leg/back isometric strength could be important for enhancing the ability to perform a 74.84-kg body drag for law enforcement recruits. Absolute strength appeared to be more important than relative strength, and this could be because recruits had to drag a fixed 74.84-kg mass. Enhancing absolute isometric strength could be essential for female recruits, and possibly smaller males, especially considering the masses of people from the general population which will be encountered when on-duty. Although this requires further investigation, the leg/back dynamometer could be used to measure strength specific to the body drag during fitness testing for LEAs.

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References

- Baran, K, Dulla, J, Orr, R, Dawes, J, Pope, R. Duty loads carried by the Los Angeles Sheriff's Department deputies. *J Aust Strength Cond*, 2018, 26: 34-38
- Cesario, KA, Dulla, JM, Moreno, MR, Bloodgood, AM, Dawes, JJ, Lockie, RG. Relationships between assessments in a physical ability test for law enforcement: Is there redundancy in certain assessments? *Int J Exerc Sci*, 2018, 11: 1063-1073
- Cocke, C, Dawes, J, Orr, RM. The use of 2 conditioning programs and the fitness characteristics of police academy cadets. *J Athl Train*, 2016, 51: 887-896
- Danneskiold-Samsøe, B, Bartels, EM, Bulow, PM, Lund, H, Stockmarr, A, Holm, CC, Watjen, I, Appleyard, M, Bliddal, H. Isokinetic and isometric muscle strength in a healthy population with special reference to age and gender. *Acta Physiologica*, 2009, 197: 1-68
- Dawes, JJ, Lockie, RG, Kornhauser, CL, Holmes, RJ, Orr, RM. Relationships between absolute and relative strength and power in male police officers of varying strength levels. *J Sci Sport Exerc*, 2019, 1: 281-288
- Dawes, JJ, Orr, RM, Flores, RR, Lockie, RG, Kornhauser, C, Holmes, R. A physical fitness profile of state highway patrol officers by gender and age. *Ann Occup Environ Med*, 2017, 29: 16
- Felkenes, GT, Peretz, P, Schroedel, JR. An analysis of the mandatory hiring of females. *Women Crim Justice*, 1993, 4: 31-63
- Fryar, CD, Gu, Q, Ogden, CL, Flegal, KM. Anthropometric reference data for children and adults: United States, 2011-2014. *Vital Health Stat 3*, 2016, 1-46

- Hopkins WG. A scale of magnitude for effect statistics, 2002.
Available at: www.sportsci.org/resource/stats/index.html; accessed on 06.10.2011
- Janssen, I, Heymsfield, SB, Wang, Z, Ross, R. Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. *J Appl Physiol*, 2000, 89: 81-88
- Joseph, A, Wiley, A, Orr, R, Schram, B, Dawes, JJ. The impact of load carriage on measures of power and agility in tactical occupations: A critical review. *Int J Environ Res Public Health*, 2018, 15: 88
- Lockie, RG, Balfany, K, Bloodgood, AM, Moreno, MR, Cesario, KA, Dulla, JM, Dawes, JJ, Orr, RM. The influence of physical fitness on reasons for academy separation in law enforcement recruits. *Int J Environ Res Public Health*, 2019a, 16: 372
- Lockie, RG, Balfany, K, Denamur, JK, Moreno, MR. A preliminary analysis of relationships between a 1RM hexagonal bar load and peak power with the tactical task of a body drag. *J Hum Kinet*, 2019b, 68: 157-166
- Lockie, RG, Dawes, JJ, Balfany, K, Gonzales, CE, Beitzel, MM, Dulla, JM, Orr, RM. Physical fitness characteristics that relate to Work Sample Test Battery performance in law enforcement recruits. *Int J Environ Res Public Health*, 2018a, 15: 2477
- Lockie, RG, Dawes, JJ, Kornhauser, CL, Holmes, RJ. Cross-sectional and retrospective cohort analysis of the effects of age on flexibility, strength endurance, lower-body power, and aerobic fitness in law enforcement officers. *J Strength Cond Res*, 2019c, 33: 451-458
- Lockie, RG, Dawes, JJ, Orr, RM, Dulla, JM. Recruit fitness standards from a large law enforcement agency: Between-class comparisons, percentile rankings, and implications for physical training. *J Strength Cond Res*, 2020a, 34: 934-941
- Lockie, RG, Dawes, JJ, Orr, RM, Stierli, M, Dulla, JM, Orjalo, AJ. An analysis of the effects of sex and age on upper- and lower-body power for law enforcement agency recruits prior to academy training. *J Strength Cond Res*, 2018b, 32: 1968-1974
- Lockie, RG, Fazilat, B, Dulla, JM, Stierli, M, Orr, RM, Dawes, JJ, Pakdamanian, K. A retrospective and comparative analysis of the physical fitness of custody assistant classes prior to academy training. *Sport Exerc Med Open J*, 2018c, 4: 44-51
- Lockie, RG, Orr, RM, Moreno, MR, Dawes, JJ, Dulla, JM. Time spent working in custody influences Work Sample Test Battery performance of Deputy Sheriffs compared to recruits. *Int J Environ Res Public Health*, 2019d, 16: 1108
- Lockie, RG, Ruvalcaba, TR, Stierli, M, Dulla, JM, Dawes, JJ, Orr, RM. Waist circumference and waist-to-hip ratio in law enforcement agency recruits: Relationship to performance in physical fitness tests. *J Strength Cond Res*, 2020b, 34: 1666-1675
- Lockie, RG, Stierli, M, Dawes, JJ, Cesario, KA, Moreno, MR, Bloodgood, AM, Orr, RM, Dulla, JM. Are there similarities in physical fitness characteristics of successful candidates attending law enforcement training regardless of training cohort? *J Trainol*, 2018d, 7: 5-9
- Moreno, MR, Dulla, JM, Dawes, JJ, Orr, RM, Cesario, KA, Lockie, RG. Lower-body power and its relationship with body drag velocity in law enforcement recruits. *Int J Exerc Sci*, 2019, 12: 847-858
- Orr, R, Robinson, J, Hasanki, K, Talaber, K, Schram, B. The relationship between strength measures and task performance in specialist tactical police. *J Strength Cond Res*, in press,
- Peace Officer Standards and Training. Work Sample Test Battery Proctor Manual, 2012. Available at: https://post.ca.gov/post_docs/regulationnotices/2012-05/WrkSmplTestBattryProctrMan.pdf; accessed on 15.08.18
- Post, BK, Dawes, JJ, Lockie, RG. Relationships between tests of strength, power, and speed and the 75-yard pursuit run. *J Strength Cond Res*, in press, doi:10.1519/jsc.0000000000003398
- Shusko, M, Benedetti, L, Korre, M, Eshleman, EJ, Farioli, A, Christophi, CA, Kales, SN. Recruit fitness as a predictor of police academy graduation. *Occup Med*, 2017, 67: 555-561
- Stevenson, RD, Siddall, AG, Turner, PF, Bilzon, JL. Physical employment standards for UK firefighters: Minimum muscular strength and endurance requirements. *J Occup Environ Med*, 2017, 59: 74-79
- Williams-Bell, FM, Villar, R, Sharratt, MT, Hughson, RL. Physiological demands of the firefighter Candidate Physical Ability Test. *Med Sci Sports Exerc*, 2009, 41: 653-662

World Medical Association. World Medical Association declaration of Helsinki. Recommendations guiding physicians in biomedical research involving human subjects. *JAMA*, 1997, 277: 925-926
Zhao, JS, He, N, Lovrich, NP. Pursuing gender diversity in police organizations in the 1990s: A longitudinal analysis of factors associated with the hiring of female officers. *Police Q*, 2006, 9: 463-485

Corresponding author:

Dr. Robert Lockie

California State University, Fullerton
Department of Kinesiology
800 N State College Blvd
Fullerton, CA 92831
USA
Phone (international): 1 657-278-4971
Email: rlockie@fullerton.edu