Firefighter trainee fitness, reasons for academy release, and predictive capabilities of fitness tests.

Lockie, Robert G.; Montes, Fernando; Orr, Rob Marc; Jay Dawes, J.

Firefighter Trainee Fitness, Reasons for Academy Release, and Predictive Capabilities of Fitness Tests

Robert G. Lockie[1] ◆ Fernando Montes[2] ◆ Robin M. Orr[3] ◆ J. Jay Dawes[4]

[1]Center for Sport Performance, Department of Kinesiology, California State University, Fullerton, Fullerton, CA, USA. [2]Los Angeles County Fire Department, Los Angeles, CA, USA. [3]Tactical Research Unit, Bond University, Robina, Qld, Australia. [4]Oklahoma State University, Tactical Fitness and Nutrition Lab, Oklahoma State University, Stillwater, OK, USA.

INTRODUCTION

- Firefighters complete many demanding job tasks, including carrying equipment, operating hose lines, climbing stairs, forcible entries, ladder raises, crawling and searching, and victim drags (3,7). These tasks are completed under load (personal protective equipment and self-contained breathing apparatus) and often in extreme environments (hot, smoky, wet, and toxic) (1,9).
- Prior to becoming a firefighter, trainees need a level of fitness to be admitted to and complete a training academy. Fitness could indicate a trainee's likelihood of graduation. Muscular strength, power, and endurance, and anaerobic and aerobic fitness, can assist with performing the skills necessary to become a firefighter (7), and fitter trainees are less likely to get injured during academy (4). In law enforcement recruits, Lockie et al. (5) has shown that fitness can influence reasons behind academy attrition. Recruits who left academy due to personal reasons or injury had lesser aerobic fitness as measured by the 20-m multistage fitness test (MSFT). Recruits who did not graduate due to injury were also slower in a change-of-direction speed test ~~called the~~ (75-yard pursuit run). Similar research has not been performed on firefighter trainees.
- The purpose of this study was to determine fitness differences between trainees who graduated (GRAD) or were released due to: a) injury (RELI), b) skills test performance failures (RELP), or c) resignation (RELR). A secondary purpose was to ascertain whether fitness predicted graduation or academy release.

METHODS

- De-identified archival data for 686 firefighter trainees were analyzed. The sex, age, height, and body mass of trainees were not provided. One reason these variables may not be collected is to avoid allegations of preferential hiring and retention based on age, body size and sex, based on the assumption that they are not job-related (2,8). Indeed, all trainees were required to attain the same standards within the training academy.
- Trainees completed an occupational physical ability test (OPAT) at the start of academy, which featured eight tests: Illinois agility test (IAT); push-ups; pull-ups; leg tucks; the MSFT, from which the shuttle number was used to estimate maximal aerobic capacity (VO_{2max}); backwards overhead 4.54-kg medicine ball throw (BOMBT); 10-repetition maximum (10RM) deadlift; and a farmer's carry over a 91.44-m course with 18-kg kettlebells (6). Data were recorded in raw and scaled scores. The scaled scores were based on internal department scoring; trainees could score 0-100 points on each test, for a potential total OPAT score of 800 points.
- Trainees were split into GRAD (n = 576), RELI (n = 33), RELP (n = 66), and RELR (n = 11) groups. A one-way ANOVA with Bonferroni post hoc ($p < 0.05$) calculated between-group differences. Stepwise linear regression ($p < 0.05$) determined whether raw and/or scaled fitness scores predicted group inclusion. Receiver operating curves (and area under the curve; AUC) derived test accuracy for predicting academy release (acceptable predictive accuracy: AUC ≥ 070) (10).

RESULTS

- The raw scores are shown in Table 1 and scaled scores in Table 2. The GRAD group were superior to the: RELI group in all tests ($p \leq 0.043$) except push-ups, pull-ups, and the raw farmer's carry score; RELP group in all tests except the farmer's carry; RELR group in $\dot{V}O_{2max}$, scaled deadlift, and total OPAT score. The RELR group also had a lower 10RM deadlift scaled score compared to the RELI and RELP groups ($p \leq 0.003$).
- The strongest predictive regression for the GRAD group included scaled scores for total OPAT, deadlift, BOMBT, and $\dot{V}O_{2max}$ ($R = 0.392$, adjusted $R^2 = 0.119$, $p < 0.001$) . For the RELI group, it was scaled $\dot{V}O_{2max}$., BOMBT, pull-up, and leg tuck scores ($R = 0.246$, adjusted $R^2 = 0.055$, $p < 0.001$), and scaled total OPAT and BOMBT scores for the RELP group ($R = 0.257$, adjusted $R^2 = 0.063$, $p < 0.001$). Scaled deadlift score was the strongest predictor for the RELR group ($R = 0.222$, adjusted $R^2 = 0.048$, $p < 0.001$).
- Raw $\dot{V}O_{2max}$ (Figure 1A) and total OPAT (Figure 1B) score had acceptable accuracy for predicting trainee release. Trainees who graduated were predicted to have a $\dot{V}O_{2max}$ of ≥43.05 ml/kg/min and a total OPAT ≥394.5 points (out of 800).

Table 1. Descriptive data (mean ± SD) for OPAT performance (IAT, push-ups, pull-ups, BOMBT, estimated VO2max, 10RM deadlift, and farmer's carry) for firefighter trainees who graduated (GRAD) or were released from academy training due to injury (RELI), performance (RELP), or resignation (RELR).

	Graduated (n = 576)	RELI (n = 33)	RELP (n = 66)	RELR (n = 11)
IAT (s)	18.07 ± 1.21	18.90 ± 1.01*	18.74 ± 1.09*	18.51 ± 0.86
Push-ups (no.)	67.40 ± 22.73	57.42 ± 20.43	54.71 ± 24.11*	60.64 ± 18.04
Pull-ups (no.)	12.39 ± 6.19	10.09 ± 6.21	8.45 ± 5.89*	8.64 ± 6.35
BOMBT (m)	9.62 ± 1.65	8.61 ± 1.76*	8.26 ± 2.00*	9.44 ± 1.67
Leg Tuck (no.)	13.57 ± 7.30	9.58 ± 7.98*	9.73 ± 6.31*	9.55 ± 6.56
VO_{2max} (ml·kg^{-1}·min^{-1})	47.10 ± 5.99	41.91 ± 4.63*	43.25 ± 5.65*	42.24 ± 3.03*
10RM Deadlift (kg)	145.88 ± 20.37	133.81 ± 24.82*	135.69 ± 25.56*	129.27 ± 14.14
Farmer's Carry (s)	27.34 ± 4.55	29.34 ± 4.17	28.52 ± 3.86	27.38 ± 2.76

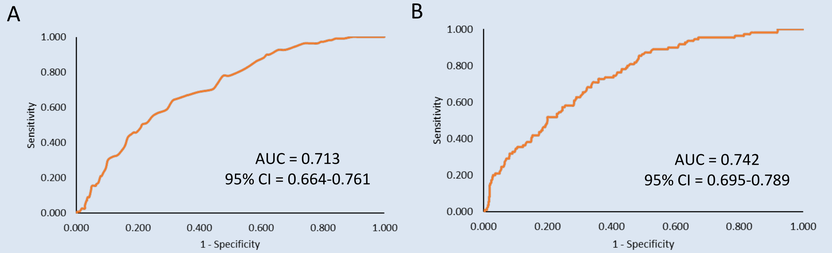
* Significantly ($p < 0.05$) different from the GRAD group.

Table 2. Descriptive data (mean ± SD) for OPAT points (IAT, push-ups, pull-ups, BOMBT, estimated VO2max, 10RM deadlift, farmer's carry, and total) for firefighter trainees who graduated (GRAD) or were released from academy training due to injury (RELI), performance (RELP), or resignation (RELR).

	Graduated (n = 576)	RELI (n = 33)	RELP (n = 66)	RELR (n = 11)
IAT	26.23 ± 36.59	8.64 ± 23.83*	8.64 ± 23.66*	0.00 ± 0.00
Push-ups	49.89 ± 41.88	37.70 ± 37.80	30.47 ± 40.57*	29.18 ± 41.20
Pull-ups	68.22 ± 29.96	59.18 ± 32.98	48.29 ± 36.92*	48.18 ± 39.19
BOMBT	77.15 ± 13.28	63.30 ± 28.31*	64.23 ± 25.70*	70.64 ± 24.86
Leg Tuck	72.55 ± 30.03	51.30 ± 40.69*	57.67 ± 35.81*	56.18 ± 37.91
VO_{2max}	50.86 ± 37.12	18.45 ± 39.69*	28.83 ± 35.26*	11.91 ± 26.51*
10RM Deadlift	90.56 ± 13.00	79.21 ± 23.13*	80.67 ± 21.15*	60.64 ± 39.59*§ϕ
Farmer's Carry	72.53 ± 23.10	61.18 ± 30.42*	67.09 ± 24.94	76.09 ± 8.08
Total	510.00 ± 143.97	379.21 ± 133.14*	387.30 ± 145.83*	338.27 ± 136.26*

* Significantly ($p < 0.05$) different from the GRAD group. § Significantly ($p < 0.05$) different from the RELI group. ϕ Significantly ($p < 0.05$) different from the RELP group.

Figure 1. Receiver operating curves and area under the curve (AUC) values (with 95% confidence intervals [CI]) for the estimated maximal aerobic capacity from the 20-m multistage fitness test (A) and total points from the occupational physical ability test (OPAT; B).



CONCLUSIONS

- Physical fitness influenced academy graduation and reasons for release in trainees. The GRAD were superior in almost all fitness measures when compared to trainees who were released due to injuries or skills test performance failures. Superior fitness can decrease injury risk in trainees (4), and anaerobic and aerobic fitness are essential for completing firefighting job tasks (7).
- Although the group size was relatively small (n = 11), fitness appeared not to have as great an influence on trainees who voluntarily resigned from the training academy. Personal decisions made by the trainee factors into this type of academy release (5).
- Scaled scores could predict group inclusion in this department, with $\dot{V}O_{2max}$ and total OPAT score providing the most accurate predictors for release. Aerobic fitness is essential for firefighting job tasks, and the GRAD group had a mean $\dot{V}O_{2max}$ (~47.10 ml/kg/min) above that recommended for firefighter trainees (45 ml/kg/min) (3). The OPAT score provided a measure of physical capacity that incorporated multiple fitness domains (6). Given the diverse fitness needs of firefighters (7), OPAT performance could provide an indication of potential academy success for trainees.
- Identifying firefighter trainees to be at potential release risk due to poorer fitness early could reduce organizational costs (4). By targeting those trainees identified early to have poorer fitness, current attrition (~16% in this sample) could be reduced – either via targeted physical fitness interventions or more selective hiring practices.

References

1. Barros, B., Oliveira, M., & Morais, S. (2021). Firefighters' occupational exposure: Contribution from biomarkers of effect to assess health risks. *Environment International, 156*, 106704.
2. Cooper Institute. (2014). Frequently Asked Questions Regarding Fitness Standards in Law Enforcement. Retrieved from https://www.cooperinstitute.org/vault/2440/web/files/684.pdf.
3. Gledhill, N., & Jamnik, V.K. (1992). Characterization of the physical demands of firefighting. *Canadian Journal of Sport Sciences, 17*(3), 207-213.
4. Griffin, S. C., Regan, T. L., Harber, P., Lutz, E. A., Hu, C., Peate, W. F., & Burgess, J. L. (2016). Evaluation of a fitness intervention for new firefighters: Injury reduction and economic benefits. *Injury Prevention, 22*(3), 181-188.
5. Lockie, R.G., Balfany, K., Bloodgood, A.M., Moreno, M.R., Cesario, K.A., Dulla, J.M., Dawes, J.J., & Orr, R.M. (2019). The influence of physical fitness on reasons for academy separation in law enforcement recruits. *International Journal of Environmental Research and Public Health, 16*(3), 372.
6. Lockie, R. G., Orr, R. M., Montes, F., Ruvalcaba, T. J., & Dawes, J. J. (2022). Differences in fitness between firefighter trainee academy classes and normative percentile rankings. *Sustainability, 14*(11), 6548.
7. Rhea, M.R., Alvar, B.A., & Gray, R. (2004). Physical fitness and job performance of firefighters. *Journal of Strength and Conditioning Research, 18*(2), 348-352.
8. Roehling, M.V. (1999). Weight-based discrimination in employment: Psychological and legal aspects. *Personnel Psychology, 52*(4), 969-1016.
9. Smith, D.L., DeBlois, J.P., Kales, S.N., & Horn, G.P. (2016). Cardiovascular strain of firefighting and the risk of sudden cardiac events. *Exercise and Sport Science Reviews, 44*(3), 90-97.
10. Swets, J. A. (1988). Measuring the accuracy of diagnostic systems. *Science, 240*(4857), 1285-1293.