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Recruit fitness and police academy performance: a prospective validation study

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Background	Police academies need fit recruits to successfully engage in training activities. In a previous retrospective study, we documented that recruits with poor fitness at entry to the academy had significantly lower graduation rates, and we also suggested evidence-based entry-level fitness recommendations.
Aims	To validate our findings in a prospective cohort of police recruits.
Methods	Recruits entering Massachusetts municipal police academies during 2015–16 were followed prospectively until they dropped out, failed or successfully graduated their academy classes. Entry-level fitness was quantified at the start of each training class using: body composition, push-ups, sit-ups, sit-and-reach and 1.5-mile run time. The primary outcome of interest was the odds of failure (not successfully graduating from an academy). We used logistic regression to assess the probability of not graduating, based on entry-level fitness.
Results	On average, successful graduates were leaner and possessed better overall entry-level fitness. After adjusting for age, gender and body mass index, several fitness measures were strongly associated with academy failure: fewer sit-ups completed (OR 9.6 (95% CI 3.5–26.3) (≤15 versus 41–60)); fewer push-ups completed (OR 6.7 (95% CI 2.5–17.5) (≤20 versus 41–60)); and slower run times (OR 18.4 (95% CI 6.8–50.2) (1.5 miles in > 15 min 20 s versus 10 min 37 s to 12 min 33 s)). The prospective study results supported previously suggested minimum entry-level fitness (95% graduation rate) and target (98% graduation rate) recommendations.
Conclusions	Push-ups completed and 1.5-mile run time at police academy entry were successfully validated as predictors of successful academy graduation, while sit-ups were also a strong independent predictor in the prospective study.
Key words	Aerobic capacity; fitness; occupational health; police academy; push-up; recruits.

Introduction

Law enforcement has many physical and psychological hazards [1–6]. These include high job demands, frequent confrontational interactions, overtime and other duties that require high levels of physical exertion [7–9]. Traditional cardiovascular risk factors such as obesity, hypertension, high cholesterol and smoking in concert with job-related stressors probably explain the increased prevalence of cardiovascular disease among law enforcement officers [6,7]. In the USA, sudden cardiac death accounts for up to 10% of on-duty police fatalities and it is much more likely to occur during more stressful duties, especially physical altercations and suspect pursuits [8]. On the other hand, the risks of incident cardiovascular disease, in general, and sudden cardiac death, in particular, are mitigated by high levels of physical fitness [10,11]. Therefore, physically fit police officers have a number of advantages.

Likewise, high levels of fitness among police recruits are also beneficial. Firstly, successful recruits will enter a physically demanding profession as elaborated above.

Key learning points

What is already known about this subject:

- Policing is a hazardous occupation.
- Physical fitness conveys several advantages for safely working as a police officer, and fitter recruits tend to do better in training academies.

What this study adds:

- The results validated push-ups completed and 1.5-mile run time at police academy entry as predictors of successful academy graduation.
- The results support and validate our previously determined entry-level fitness recommendations.
- These fitness recommendations should provide future recruits with actionable information to better prepare for police academy training and to achieve those levels of physical fitness most associated with successful graduation from a police academy.

What impact this may have on practice or policy:

- A considerable proportion of recruits who are able to pass a job-based physical abilities test lack the physical fitness required to endure the rigours of police academy training.
- Our findings confirm that entry fitness characteristics are strongly associated with the likelihood of graduation from Massachusetts police academies.
- Informing future candidates of suggested entry-level fitness recommendations and encouraging them to achieve them prior to academy entry may improve graduation rates and thus the return on public investments made for officer training.

Secondly, fit recruits are expected to better tolerate the rigours of police academy training. Thirdly, municipal sponsorship of recruit officers to attend police academy training represents a significant financial investment and, therefore, it makes sense to send and train those recruits most likely to succeed in a police academy and in their subsequent careers.

The Massachusetts Municipal Police Training Committee (MMPTC) runs all municipal police training academies in Massachusetts. Prior to entry into an academy, the state of Massachusetts assesses all police recruits' ability to safely perform essential police duties through a state-regulated and -required medical/psychological examination followed by a mandatory 'Physical Ability Test' (PAT) [12]. The medical examination does not have an obesity or body composition (BC) standard, and we previously documented that as many as a third of public safety candidates in Massachusetts are obese at the time of this examination [13]. Additionally, because it is designed to assess minimum capabilities, the PAT requires only modest levels of aerobic capacity and overall fitness. Thus, very few candidates are screened out from entering a training academy on the basis of low fitness. The MMPTC leadership's anecdotal experience has been that because of the 'low bar' set by the above entry standards, many recruits enter academies ill-prepared for the physical and mental challenges of police training, and their performance during the academy suffers as a result. Therefore, an initial study testing the hypothesis that lower measured physical fitness increased the odds of failing or not completing the police academy training was commissioned at the request of the MMPTC [14].

That study reviewed the entry-level fitness (assessed during the first week of the academy) of >2900 police recruit officers during the years 2006–12, and analysed the odds of successful graduation as a function of entry-level fitness. Based on the retrospective analyses, the number of push-ups completed and the time to run a distance of 1.5 miles were found to be highly predictive of subsequent academy performance. Specifically, after adjusting for covariates, completing fewer push-ups and slower running times were associated with four to five times the odds of not graduating from the academy, as compared to other recruits with better performance. In addition, suggested minimum entry fitness recommendations (expected to be associated with a >95% likelihood of graduating from the academy) and target entry fitness recommendations (expected to be associated an ~98% likelihood of graduating from the academy) were derived [14].

This present study was also commissioned by the MMPTC and sought to validate our previous findings and fitness recommendations using data from a new prospective cohort of Massachusetts police recruits.

Methods

The prospective cohort included all recruit officers who entered municipal police academies throughout Massachusetts during the period 2015–16. All participants were 18 years of age or older. Because no interventions or experimental procedures were performed, and all information from these recruits' training records were abstracted on MMPTC premises into an electronic database without personal identifiers, the study protocol was

Table 1. Baseline characteristics by graduation status including only participants with complete data (i.e. with all sex, push-ups and run times available)

Characteristic	Overall (N = 724)		Graduated (n = 661)		Not graduated (n = 63)	
	n (%)		n (%)		n (%)	
Academy**						
Academy 1	41 (6)		37 (90)		4 (10)	
Academy 2	27 (4)		26 (96)		1 (4)	
Academy 3	46 (6)		40 (87)		6 (13)	
Academy 4	44 (6)		43 (98)		1 (2)	
Academy 5	34 (5)		32 (94)		2 (6)	
Academy 6	29 (4)		29 (100)		0 (0)	
Academy 7	82 (11)		67 (82)		15 (18)	
Academy 8	45 (6)		42 (93)		3 (7)	
Academy 9	37 (5)		37 (100)		0 (0)	
Academy 10	50 (7)		46 (92)		4 (8)	
Academy 11	43 (6)		41 (95)		2 (5)	
Academy 12	45 (6)		41 (91)		4 (9)	
Academy 13	40 (6)		37 (93)		3 (8)	
Academy 14	58 (8)		46 (79)		12 (21)	
Academy 15	103 (14)		97 (94)		6 (6)	
Sex*						
Males	649 (90)		598 (92)		51 (8)	
Females	75 (10)		63 (84)		12 (16)	
Age (years), median (Q1, Q3), NS	723 (99)	26 (24, 29)	661 (100)	26 (24, 29)	62 (98)	27 (24, 31)
Weight (pounds), mean ± SD*	724 (100)	192.2 ± 35.6	661 (100)	190.9 ± 34.5	63 (100)	206.0 ± 44.0
Body fat (%), mean ± SD***	723 (99)	20.99 ± 7.54	660 (99)	20.57 ± 7.46	63 (100)	25.39 ± 7.00
Body fat—men	648 (90)	20.40 ± 7.38	597 (90)	20.05 ± 7.35	51 (80)	24.49 ± 6.54
Body fat—women	75 (10)	26.02 ± 7.08	63 (10)	25.41 ± 6.82	12 (20)	29.21 ± 7.88
BMI, mean ± SD***	724 (100)	27.80 ± 4.24	661 (100)	27.58 ± 4.09	63 (100)	30.11 ± 5.05
Push-ups (number), mean ± SD***	724 (100)	39.47 ± 15.42	661 (100)	40.36 ± 15.04	63 (100)	30.13 ±16.32
Push-ups (number)***						
≤20	80 (11)		59 (74)		21 (26)	
21–40	312 (43)		283 (91)		29 (9)	
41–60	275 (38)		265 (96)		10 (3)	
≥61	57 (8)		54 (95)		3 (5)	
Sit-ups, mean ± SD***	723 (99)	34.60 ± 9.38	661 (100)	35.25 ± 8.93	62 (98)	27.63 ±11.20
Sit-ups (number)***						
≤15	26 (4)		14 (54)		12 (46)	
16–30	191 (26)		70 (89)		21 (11)	
31–45	425 (59)		398 (94)		27 (6)	
≥46	81 (11)		79 (98)		2 (3)	
Sit-and-reach (inches), mean ± SD, NS	652 (90)	17.46 ± 5.17	592 (90)	17.29 ± 3.49	60 (95)	19.13 ±13.03
Sit-and-reach (inches), NS						
<16	198 (30)		179 (90)		19 (10)	
16–18	143 (22)		129 (90)		14 (10)	
18–20	147 (23)		136 (93)		11 (8)	
≥20	164 (2)		148 (90)		16 (10)	
1.5 mile run (min), mean ± SD***	724 (100)	12.79 ± 1.94	661 (100)	12.59 ± 1.78	63 (100)	14.89 ± 2.36
1.5-mile run times***						
≥15 min 20 s	81 (11)		55 (68)		26 (32)	
15 min 20 s–12 min 33 s	274 (38)		247 (90)		27 (10)	
12 min 33 s–10 min 37 s	281 (39)		273 (97)		8 (3)	
<10′37″	88 (12)		86 (98)		2 (2)	
VO_2max (ml/kg/min), mean ± SD***	724 (100)	41.87 ± 6.56	661 (100)	42.52 ± 5.97	63 (100)	35.01 ± 8.37
VO_2 max***						
≤35	99 (14)		72 (73)		27 (27)	
35–42	239 (33)		217 (91)		22 (9)	
42–49	302 (42)		290 (96)		12 (4)	
>49	84 (12)		82 (98)		2 (2)	

Significance based on difference between recruits passing and failing. Percentages rounded to the nearest whole per cent. NS, not significant.
*P < 0.05; **P < 0.01; ***P < 0.001.

approved with a waiver of individual consent by the institutional review board of the Cambridge Health Alliance.

Recruit records were reviewed with the assistance of MMPTC staff, and the following academy entry data were extracted: academy location, gender, age, start date and results of the entry-level fitness assessment (see below). Fitness assessments were performed according to standardized procedures at the start of each training class [14–16]. Entry-level fitness was quantified from the following measures: BC (body mass index (BMI) and body fat percentage), push-ups, sit-ups, sit-and-reach and 1.5-mile run time, as documented by MMPTC training instructors. VO_2max was also estimated using each recruit's 1.5-mile run time and weight [17], but for simplicity and consistency, we analysed and report all results related to graduation probabilities using the directly measured run times.

The municipal police officer training course consists of a 20+ week basic programme which combines 'classroom instruction, practical exercises, and scenarios designed to provide knowledge, skills and abilities to excel in the police profession and be an asset to the community' [15]. In addition, it is also expected that each recruit participates fully in all fitness training sessions available during the course of the academy. Full participation is defined as completing at least 70% of runs of increasing lengths (1.5–5 miles, maximum) during the course, at a minimum pace of 11 min per mile. If the recruits fail to complete >30% of these fitness training sessions, they are subject to dismissal from the academy. The baseline fitness assessment is not considered a training session and, because of that, its completion is not graded or included in the 30% rule [18].

Successful graduation is determined also by overall attendance, disciplinary actions, classroom activities, written test scores and other practical exercise and test scores.

Final academy performance (graduation or failure) was extracted at the end of academies with the assistance of MMPTC staff. This extraction was blinded to the results of the initial fitness assessment. After completing the collection of the outcome data, the data on graduation status were merged with the fitness assessment data. The primary outcome of interest was the odds of not successfully graduating from an academy.

Our previous retrospective study suggested minimum entry fitness recommendations of >10 push-ups for women, >20 push-ups for men and a 1.5-mile run time <15 min and 20 s for both, which would be expected to be associated with a 95% likelihood of successful graduation [12]. The prior study also recommended target entry fitness criteria of >20 push-ups and a 1.5-mile run time of <14 min for women; and >40 push-ups and a 1.5-mile run time of <12 min and 30 s for men, which would be expected to be associated with a 98% likelihood of successful graduation. In the current prospective study, we used each candidate's entry-level data for push-ups and the 1.5-mile run and then, their subsequent graduation status to test the validity of these predictors using graduation rates and 95% confidence intervals (CIs).

Normally distributed continuous characteristics are presented as mean ± SD, whereas characteristics with non-normal distributions are presented as median (Q1, Q3). Categorical variables are presented as frequency (%). We compared the group that graduated from the academy with those not graduating using the *t*-test or the non-parametric Wilcoxon test, as appropriate, for quantitative characteristics and the chi-square test of independence for qualitative characteristics. Logistic regression models modelling the probability of not graduating were fit with the use of generalized linear mixed models with random intercepts for academy. Reference categories for each fitness component were set *a priori* based on our previous retrospective study [14]. Statistical analysis was

Table 2. Reasons for not graduating from the academy

Reasons for not graduating	Total, *N* (%)	Men NS, *N* (%)	Push-ups**, mean ± SD	Sit-ups*, mean ± SD	1.5-mile run NS, mean ± SD
Personal resignation	29 (46)	23 (79)	24.2 ± 13.7	24.9 ± 9.9	14.7 ± 2.4
Dismissal/separation (academic)	9 (14)	8 (89)	48.3 ± 20.5	40.4 ± 9.4	13.9 ± 2.2
Resignation due to any medical reason: injury, illness, etc.	7 (11)	6 (86)	28.6 ± 13.8	22.0 ± 9.6	15.8 ± 2.0
Withdrawal (by employing department or due to withdrawal of sponsorship)	6 (10)	5 (83)	31.5 ± 10.8	29.5 ± 6.1	15.5 ± 2.1
Dismissal/separation (disciplinary)	5 (8)	3 (60)	38.2 ± 14.7	27.8 ± 13.0	13.5 ± 1.0
Dismissal/separation (did not complete physical training participation standard)	5 (8)	4 (80)	23.6 ± 13.1	26.0 ± 14.0	17.4 ± 2.7
Dismissal/separation (driving/firearms)	2 (3)	2 (100)	31.5 ± 4.9	25.5 ± 13.4	14.0 ± 0.5
Total	63 (100%)				

Percentages rounded to the nearest whole per cent. NS, not significant.
*$P < 0.05$; **$P < 0.01$.

performed with the use of SAS 9.3 (SAS Inc., Cary, NC, USA) and all tests performed were two-sided, with $P < 0.05$ indicating statistical significance.

Results

During the study period, data were available for 724 recruits from 15 participating police academies. The overall graduation rate was 91%, with 63 recruits not graduating. Baseline characteristics of Massachusetts' police recruits during the study period are presented in Table 1. Table 1 includes recruits with complete data for each of the following parameters: body fat percentage, age, sex, weight and graduation status. Graduation rates varied significantly ($P < 0.01$) among academies from 79 to 100% (Table 1). Almost 90% of recruits were male, and 92% of male candidates successfully graduated compared to 84% of female candidates ($P < 0.05$). Successful graduates and unsuccessful recruits were of similar age, but unsuccessful candidates were on average heavier and had higher BMI and adiposity (all $P < 0.001$). Average performance on all entry-level fitness measures was significantly superior for successful graduates (all $P < 0.001$), with the exception of sit-and-reach.

Reasons for not graduating and associated average entry-level fitness are summarized in Table 2. The most frequent reason ($n = 29$, 46%) for failing to graduate was 'personal resignation', which includes cases where the recruits realized they were not prepared for the academy training or the police profession as well as any other 'voluntary' separations from an academy. Lower fitness was most prevalent among those not graduating because of personal resignations, medical resignations and failure to meet the physical training participation standard.

Table 3 summarizes graduation rates for male and female candidates meeting the suggested 'minimum' and 'target' recommendations for entry-level fitness. For both men and women, the 95% CIs for graduation included the expected values of 95% and 98% for recruits achieving the 'minimum' and 'target' criteria, respectively.

Logistic regression models for the probability of academy failure based on entry-level fitness are summarized in Table 4. In crude (unadjusted models), fewer sit-ups completed, fewer push-ups completed and slower run times were associated with significantly higher odds of academy failure. These three measures all remained significant predictors after adjusting for age, gender and BMI. In the fully adjusted model, fewer sit-ups completed and slower run times were significant independent predictors of failure to graduate.

Table 5 presents the probability of failure by gender for various combinations of entry-level push-ups and run times. Recruits of both genders who completed ≤20 push-ups and had running times in excess of 15 min 20 s have very high failure rates (38–45%). On the other hand, candidates of either gender who completed >20 push-ups and had run times <12 min and 33 s had graduation rates of ≥98%. When we included recruits without entry-level fitness data and imputed their push-ups and run times into the lowest categories, the failure rates increased to 40% for women and 49% for men.

Discussion

The current prospective study supports our previous findings that higher levels of physical fitness at the time of entry to a police academy convey higher probabilities of successful graduation despite the fact that all candidates had already passed a state-mandated physical abilities test designed to assess the ability to physically perform all essential policing duties safely [12]. Baseline push-ups and 1.5-mile run times were validated as predictors of successful academy graduation, and previously derived 'minimum' and 'target' fitness recommendations were also confirmed as predicting 95 and 98% graduation rates, respectively, within 95% CIs. Therefore, the current study reaffirms that better entry-level physical fitness among police recruits increases the likelihood of successfully completing police academy training. Because state and town sponsorship of recruit officers are major financial investments, high graduation rates are in the interest of multiple stakeholders, including the sponsors, police recruits and the tax-paying public.

Our results are consistent with previous studies of police and military recruits [19–23]. Attrition in the military also represents significant financial losses, and studies of military recruits have found that recruits with lower

Table 3. Graduation rate for male and female candidates meeting suggested 'minimum' and 'target' entry fitness recommendations

	Female ($N = 75$)		Male ($N = 649$)	
	Criteria	Graduation rate (95% CI)	Criteria	Graduation rate (95% CI)
Minimum fitness (95% expected to graduate)	>10 push-ups and 1.5-mile run time <15 min 20 s	$N = 41$ of 46 meeting criteria; 89% (76.4–96.4)	>20 push-ups and 1.5-mile run time <15 min 20 s	$N = 536$ of 565 meeting criteria; 95% (92.7–96.4)
Target fitness (98% expected to graduate)	>20 push-ups and 1.5-mile run time <14 min	$N = 24$ of 26 meeting criteria; 92% (74.9–99.1)	>40 push-ups and 1.5-mile run time <12 min 30 s	$N = 229$ of 233 meeting criteria; 98% (95.7–99.5)

Table 4. Logistic regression modelling the probability of not graduating with random intercepts for academy, using Generalized Linear Mixed Models (GLIMMIX) analysis; push-ups, sit-ups, sit-and-reach and 1.5-mile run times are used as categorical variables

Characteristic	Crude analysis		Multivariable analysis[a]		Multivariable analysis[b]	
	OR	95% CI	OR	95% CI	OR	95% CI
Gender						
Reference (male)	1.00				1.00	
Female versus male	**2.25**	**(1.12–4.52)**			1.38	(0.51–3.79)
Age	1.03	(0.98–1.09)			1.00	(0.94–1.06)
BMI	**1.13**	**(1.07–1.19)**			1.07	(1.00–1.15)
Push-ups						
≤20 versus 41–60	**9.78**	**(4.28–22.38)**	**6.70**	**(2.56,17.54)**	2.29	(0.72–7.28)
21–40 versus 41–60	**2.73**	**(1.29–5.79)**	**2.24**	**(1.03–4.86)**	1.25	(0.52–3.03)
Reference (41–60)	1.00	Reference	1.00	Reference	1.00	Reference
≥61 versus 41–60	1.39	(0.36–5.34)	1.50	(0.39–5.80)	1.92	(0.45–8.26)
Sit-ups						
≤15 versus 31–45	**15.92**	**(6.26–40.48)**	**9.59**	**(3.50–26.27)**	**3.41**	**(1.13–10.33)**
16–30 versus 31–45	**2.02**	**(1.09–3.75)**	1.41	(0.73–2.73)	0.89	(0.43–1.87)
Reference (31–45)	1.00	Reference	1.00	Reference	1.00	Reference
≥46 versus 31–45	0.42	(0.10–1.85)	0.49	(0.11–2.16)	0.70	(0.14–3.43)
Sit-and-reach						
<16 versus 18–20	1.64	(0.73–3.69)	1.40	(0.60–3.28)	1.24	(0.51–3.02)
16–18 versus 18–20	1.35	(0.58–3.12)	1.43	(0.60–3.40)	1.33	(0.54–3.25)
Reference (18–20)	1.00	Reference	1.00	Reference	1.00	Reference
≥20 versus 18–20	1.20	(0.53–2.73)	1.36	(0.57–3.28)	1.30	(0.53–3.18)
1.5-mile run times						
≥15 min 20 s	**26.14**	**(10.43–65.50)**	**18.45**	**(6.79–50.15)**	**10.36**	**(3.52–30.54)**
15 min 20 s–12 min 33 s	**4.81**	**(2.08–11.16)**	**4.28**	**(1.82–10.08)**	**3.01**	**(1.26–7.21)**
Reference 12 min 33 s–10 min 37 s	1.00	Reference	1.00	Reference	1.00	Reference
<10′37″	0.74	(0.15–3.63)	0.84	(0.17–4.12)	0.84	(0.18–4.00)

Significant values are given in bold.
[a]Each model adjusted for gender, age and BMI.
[b]Full model adjusted for gender, age, BMI, push-ups categories, sit-ups categories, sit-and-reach categories and 1.5-mile run-time categories.

Table 5. Percentage (%) of candidates not graduating according to gender, number of push-ups and 1.5-mile run time

	Females				Males			
	Number of push-ups				Number of push-ups			
1.5-mile run times	≥61	41–60	21–40	≤20	≥61	41–60	21–40	≤20
>15 min 20 s	24.6	18.0	20.7	37.6	30.6	22.9	26.1	44.9
15 min 20 s–12 min 33 s	6.8	4.7	5.5	11.9	9.0	6.2	7.3	15.4
12 min 33 s–10 min 37 s	1.7	1.2	1.4	3.1	2.3	1.6	1.9	4.2
<10 min 37 s	1.3	0.9	1.0	2.4	1.8	1.2	1.4	3.2

baseline fitness levels have significantly higher levels of attrition [22–24]. These studies found that introducing a 'preconditioning' programme to recruits with low entry-level physical fitness prior to basic training camp resulted in lower injury and attrition rates [25]. Rather than present a barrier for applicants with low physical fitness, the evidence-based fitness standards validated through the current prospective study (Table 3) should provide future recruits with actionable information to better prepare for police academy training and to achieve

those levels of physical fitness most associated with successful graduation from a police academy.

The current study had several strengths. Firstly, the design was prospective. Secondly, outcome data were collected in a fashion that was blinded to the entry-level fitness assessments. Thirdly, it covered all municipal police training academies in the state of Massachusetts over a 2-year period. Finally, coordination with and training of instructors at the individual academies by the MMPTC improved record keeping and minimized the number of recruits with missing entry-level fitness assessments. Missing baseline fitness data were identified as an issue during the previous retrospective study and were often associated with subsequent academy failure [14]. In that investigation, we had suspected that recruits with missing fitness data were likely to represent candidates who were unable or unwilling to perform the initial Cooper fitness testing and thus prone to dropping out. The improved data collection in the current prospective study removes any doubts regarding the association of poor fitness at academy entry and higher odds of subsequently not successfully graduating from the academy. In the current prospective study, we were also able to document the specific primary reasons for failure to graduate for individual participants. While each failure is probably multifactorial, lower than average fitness was associated with the following specific reasons for failure: personal resignations, medical resignations, withdrawal (by employing department or due to withdrawal of sponsorship) and failure to meet the physical training participation standard. Those three issues accounted for 75% of the candidates who failed to successfully graduate.

The study does have some limitations. Because of the time and expense associated with creating and following prospective cohorts, the present study population was smaller than the previous retrospective population. Nonetheless, we had sufficient statistical power to find significant associations even after adjustment for covariates. Because of the male predominance in policing, the number of female recruits studied was smaller and CIs were wider around women's graduation rates based on our suggested minimum and target fitness criteria. Additionally, the present study does not prove a causal relationship between better fitness and graduation rates. For example, the observed associations between fitness and graduation outcomes may be determined in part by other factors such as better attitude, motivation, discipline and effort that may be more prevalent among fitter recruits. Finally, our study cannot comment directly on recruit fitness and subsequent performance as a police officer. These limitations, however, do not alter the fact that physical fitness measures are simple and powerful predictors of academy success.

In conclusion, our findings strongly support and confirm that academy-entry fitness characteristics are strongly associated with the likelihood of recruits' subsequent graduation from Massachusetts police academies. Moreover, meeting suggested minimum and target fitness recommendations predicted higher graduation rates. Informing future candidates of these criteria and encouraging them to achieve them prior to academy entry may improve graduation rates and thus the return on public investments made for officer training.

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Competing interests

S.N.K. reports serving as an expert in medico-legal cases involving police officers. The remaining authors declare no conflict of interest.

References

1. Cooper K, Prentice M, Beccaccio LA. Police physical fitness. *Police Chief* 1982;**49**:159–166.
2. Deschamps F, Paganon-Badinier I, Marchand AC, Merle C. Sources and assessment of occupational stress in the police. *J Occup Health* 2003;**45**:358–364.
3. Gershon RR, Lin S, Li X. Work stress in aging police officers. *J Occup Environ Med* 2002;**44**:160–167.
4. Reichard AA, Jackson LL. Occupational injuries among emergency responders. *Am J Ind Med* 2010;**53**:1–11.
5. Yoo H, Franke WD. Stress and cardiovascular disease risk in female law enforcement officers. *Int Arch Occup Environ Health* 2011;**84**:279–286.
6. Zimmerman FH. Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. *Cardiol Rev* 2012;**20**:159–166.
7. Kales SN, Tsismenakis AJ, Zhang C, Soteriades ES. Blood pressure in firefighters, police officers, and other emergency responders. *Am J Hypertens* 2009;**22**:11–20.
8. Varvarigou V, Farioli A, Korre M, Sato S, Dahabreh IJ, Kales SN. Law enforcement duties and sudden cardiac death among police officers in United States: case distribution study. *Br Med J* 2014;**349**:g6534.
9. Korre M, Farioli A, Varvarigou V, Sato S, Kales SN. A survey of stress levels and time spent across law enforcement duties: police chief and officer agreement. *Policing: J Policy Pract* 2014;**8**:109–122.

10. Kodama S, Saito K, Tanaka S *et al*. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. *J Am Med Assoc* 2009;**301**:2024–2035.
11. Clausen JSR, Marott JL, Holtermann A, Gyntelberg F, Jensen MT. Midlife cardiorespiratory fitness and the long-term risk of mortality: 46 years of follow-up. *J Am Coll Cardiol* 2018;**72**:987–995.
12. Service CoMC. *Medical and Physical Fitness Standards 2015*. 2015. http://www.mass.gov/anf/employment-equal-access-disability/civil-serv-info/med-and-physical-fitness-stnds/ (1 May 2015, date last accessed).
13. Tsismenakis AJ, Christophi CA, Burress JW, Kinney AM, Kim M, Kales SN. The obesity epidemic and future emergency responders. *Obesity (Silver Spring)* 2009;**17**:1648–1650.
14. Shusko M, Benedetti L, Korre M *et al*. Recruit fitness as a predictor of police academy graduation. *Occup Med (Lond)* 2017;**67**:555–561.
15. Committee CoMMPT. *Recruit Officer Course: An Overview of this Course 2015*. http://www.mass.gov/eopss/law-enforce-and-cj/law-enforce/mptc/training-and-academies/recruit-officer-courses/full-time-recruit-officer-courses/roc-overview.html. (1 November 2018, date last accessed).
16. Cooper Institute. *Physical Fitness Assessments and Norms for Adults and Law Enforcement*. Dallas, TX: Cooper Institute, 2007; 43–44.
17. Cooper KH. A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. *J Am Med Assoc* 1968;**203**:201–204.
18. MPTC. *Health and Wellness Guide 2010*. 30 April 2015. http://www.mass.gov/anf/employment-equal-access-disability/civil-serv-info/med-and-physical-fitness-stnds/. (1 November 2018, date last accessed).
19. Dawes JJ, Lindsay K, Bero J, Elder C, Kornhauser C, Holmes R. Physical fitness characteristics of high vs. low performers on an occupationally specific physical agility test for patrol officers. *J Strength Cond Res* 2017;**31**:2808–2815.
20. Dawes JJ, Orr RM, Siekaniec CL, Vanderwoude AA, Pope R. Associations between anthropometric characteristics and physical performance in male law enforcement officers: a retrospective cohort study. *Ann Occup Environ Med* 2016;**28**:26.
21. Beck AQ, Clasey JL, Yates JW, Koebke NC, Palmer TG, Abel MG. Relationship of physical fitness measures vs. occupational physical ability in campus law enforcement officers. *J Strength Cond Res* 2015;**29**:2340–2350.
22. Pope RP, Herbert R, Kirwan JD, Graham BJ. Predicting attrition in basic military training. *Mil Med* 1999;**164**:710–714.
23. Knapik JJ, Canham-Chervak M, Hoedebecke E *et al*. The fitness training unit in U.S. Army basic combat training: physical fitness, training outcomes, and injuries. *Mil Med* 2001;**166**:356–361.
24. Booth-Kewley S, Larson GE, Ryan MA. Predictors of Navy attrition. I. Analysis of 1-year attrition. *Mil Med* 2002;**167**:760–769.
25. Knapik JJ, Darakjy S, Hauret KG *et al*. Increasing the physical fitness of low-fit recruits before basic combat training: an evaluation of fitness, injuries, and training outcomes. *Mil Med* 2006;**171**:45–54.