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Recruit Fitness as a Predictor of Police Academy Graduation

M. Shusko[1]★, L. Benedetti[1]★, M. Korre[1,2], E. J. Eshleman[1,2], A. Farioli[1,4], C. A. Christophi[1,3] and S. N. Kales[1,2]

[1]Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA 02115, USA, [2]The Cambridge Health Alliance, Harvard Medical School, Cambridge, MA 02139, USA, [3]Cyprus International Institute for Environmental and Public Health, Cyprus University of Technology, Limassol 3041, Cyprus, [4]Department of Medical and Surgical Sciences, University of Bologna, Bologna 40126, Italy.

★Co-first authors and contributed equally.

Correspondence to: Stefanos N. Kales, The Cambridge Health Alliance—Employee & Industrial Medicine, Macht Building, Suite 427, 1493 Cambridge Street, Cambridge, MA 02139, USA. Tel: +617 665 1580; fax: +617 665 1672; e-mail: skales@hsph.harvard.edu

Background: Suboptimal recruit fitness may be a risk factor for poor performance, injury, illness, and lost time during police academy training.

Aims: To assess the probability of successful completion and graduation from a police academy as a function of recruits' baseline fitness levels at the time of academy entry.

Methods: Retrospective study where all available records from recruit training courses held (2006–2012) at all Massachusetts municipal police academies were reviewed and analysed. Entry fitness levels were quantified from the following measures, as recorded at the start of each training class: body composition, push-ups, sit-ups, sit-and-reach, and 1.5-mile run-time. The primary outcome of interest was the odds of not successfully graduating from an academy. We used generalized linear mixed models in order to fit logistic regression models with random intercepts for assessing the probability of not graduating, based on entry-level fitness. The primary analyses were restricted to recruits with complete entry-level fitness data.

Results: The fitness measures most strongly associated with academy failure were lesser number of push-ups completed (odds ratio [OR] = 5.2, 95% confidence interval [CI] 2.3–11.7, for 20 versus 41–60 push-ups) and slower run times (OR = 3.8, 95% CI 1.8–7.8, [1.5 mile run time of ≥15′20″] versus [12′33″ to 10′37″]).

Conclusions: Baseline pushups and 1.5-mile run-time showed the best ability to predict successful academy graduation, especially when considered together. Future research should include prospective validation of entry-level fitness as a predictor of subsequent police academy success.

Key words: Aerobic; Cooper Fitness; police; push-up; recruits; VO_2 max.

Introduction

Policing is a dangerous occupation that is both physically and psychologically demanding [1–6]. Stressors in law enforcement include shift work; frequent overtime; high job demands in the context of low decisional control; and frequent confrontational interactions [7,8]. Additionally, specific duties such as suspect pursuits and physical altercations with suspects or detainees may require sudden high levels of physical exertion [3,9,10]. We recently documented that sudden cardiac deaths (SCD) account for up to 10% of all on-duty deaths during police activities and that SCD events are much more likely to occur during stressful duties, especially physical altercations with and pursuits of suspects [8]. Therefore, there are many reasons that police officers and candidate recruits joining the law enforcement profession should be fit.

The state of Massachusetts mandates all recruit police officers pass a state-regulated medical examination and then a job-specific physical ability test (PAT), prior to potential entrance into one of the Commonwealth's police academies [11]. The PAT was designed to replicate certain

functions and capabilities of police work in an effort to test a participant's ability to safely perform essential police duties. However, based on concerns of inclusiveness and non-discrimination, the medical exam does not have an obesity or body composition standard. Likewise, the PAT requires only modest levels of fitness, because it is designed to assess minimum capabilities, rather than select the most competitive candidates. Within the current obesity epidemic, we previously found that as many as a third of public safety candidates in Massachusetts were obese [12].

The present study was initiated by the Massachusetts Municipal Police Training Committee (MMPTC). The MMPTC leadership's anecdotal experience is that many of their student recruits are ill-prepared for the rigours of 20 weeks of police academy training. Such recruits seem particularly likely to drop out of academies early on or otherwise fail to complete their training. There are strong financial incentives to minimize the number of unsuccessful candidates. Each recruit's training costs the Commonwealth of Massachusetts $5000 on average. In addition, the hiring jurisdiction loses tens of thousands of dollars invested during the hiring process. Therefore, if fitness predicted academy success, target physical fitness standards are desirable and may inform potential police recruits as to how to better prepare themselves for a training academy. Therefore, our study tested the hypothesis that lower measured physical fitness increased the odds of failing or not completing the police academy.

Methods

The retrospective cohort consisted of all recruits (all aged 18 years and older) who enrolled in a police recruit training course at any of the 10 municipal police academies throughout Massachusetts during the period of 2006–2012. All records from these recruit training courses were abstracted on MMPTC premises into an electronic database without personal identifiers. The study protocol was approved and individual consent was waived by the institutional review boards of the Cambridge Health Alliance and the Harvard T.H. Chan School of Public Health.

The Cooper assessment [13] is performed during the recruits' first week at the academy as a baseline set of standardized measures. It includes height, weight, body mass index (BMI), body fat per cent (caliper measurements), push-ups (number performed in one minute), sit-ups (number performed in 1 minute), sit and reach (measure of forward reach while sitting flat on the floor with the legs flat and outstretched) and a timed 1.5 mile run (recorded in minutes and seconds) [13]. In addition, VO_2 max can be estimated from the 1.5 mile run-time, using standardized conversion charts [13,14].

In Massachusetts, police recruit training academies for full-time, entry-level municipal, University of Massachusetts, and environmental police officers consist of a 20-plus week basic training course. The programme combines 'classroom instruction, practical exercises, and scenarios designed to provide the knowledge, skills, and abilities needed to excel in the police profession and be an asset to the community' [15].

Furthermore, each recruit is expected to participate in all physical fitness training sessions during the academy. 'Full' participation includes completing runs of increasing lengths (1.5–5 miles, maximum) during the academy, at a minimum pace of 11 minutes per mile. Recruits are subject to dismissal from the academy if they fail to participate fully in more than 30% of the fitness training sessions. However, the baseline Cooper fitness assessment is not graded; no 'pass' or 'fail' judgment is given, and no credit towards graduation (positive or negative) is given. Furthermore, it is not counted as a training session and therefore, its completion is not included in the 30% fitness participation rule [16]. Successful graduation is determined by overall academy performance, including attendance, any disciplinary actions, participation in fitness training, classroom activities and written test scores as well as other practical exercises and practical test scores. According to the MMPTC director's estimates, 70% of failures to graduate are due to recruits who drop out of the academies (usually because they are ill-prepared); another 20% do not meet the above-mentioned fitness participation criteria and roughly 5% fail due to poor academic performance and 5% for other reasons. However, individual reasons for academy failure were not maintained by the MMPTC and not available for the current study. Therefore, academy failure was the primary outcome of our study, and failure was defined as not successfully graduating from the police academy for any reason.

The following data were extracted for each recruit: academy location, training start date, age, gender, entry-level Cooper fitness characteristics (see above), and academy performance/outcome (graduation/failure). Independently, one researcher extracted demographic and fitness data blind to the outcome data, while another researcher collected outcome data blind to the recruit's fitness data. The blinded collection of the independent variables from the dependent outcome variable minimized potential information bias.

We restricted the primary analyses to candidates with complete baseline Cooper physical fitness data (push-ups, 1.5 mile run-time), gender, and graduation outcome (excluding missing data on a case-by-case basis). We also analysed all recruits in a model where we assumed those with a missing baseline fitness parameter were unable or unwilling to complete the baseline fitness assessment.

We used generalized linear mixed models in order to fit logistic regression models, with random intercepts for academy, assessing the probability of not graduating. The parameterization of continuous covariates was chosen by first applying fractional polynomials and then selecting the parameterization that minimized the deviance of the model. We did not find evidence supporting

a non-linear association between the outcome and the studied metrics of physical performance. Hence, all variables were treated as linear. We assessed the presence of interactions between gender and fitness parameters by including interaction terms in the model and evaluating their significance with the use of the likelihood ratio tests. We performed statistical analyses using Stata 12.1 SE (Stata Corp, College Station, TX) and SAS 9.4 (SAS Inc., Cary, NC). We defined as statistically significant a two-sided P value of <0.05.

Results

During the study period, data were available for 2993 recruits, and the overall academy graduation rate was 90%. Gender information was missing for 25 recruits, and these were excluded from the main analysis. Of the remaining 2968 records, 13% of women (37 of 287) and 9% of males (239 of 2681) had incomplete information and were also excluded from the main analysis. Among recruits with complete exposure information (n = 2692), the academy failure rate (not graduating) was only 5% (versus 10% for the entire cohort (Table 1)) and compared with a 55% failure rate among recruits with incomplete baseline fitness data. Therefore, the 301 recruits with missing information accounted for a disproportionately large number of academy failures (166 of the total 286) (ST1). In other words, only 45% of the recruits with missing baseline fitness data graduated, and those with missing baseline data accounted for 58% of all those not graduating during the study period (ST2).

The baseline characteristics of Massachusetts police recruits during the study period are presented in Table 1 by graduation status. Table 1 is limited to recruits with complete information (gender, push-ups, 1.5 mile run-time and graduation status (n = 2692)). The first section of the table shows that graduation rates varied significantly across different individual academies; Academy 2 had the lowest graduation rate (84%) and Academy 7 had the highest (100%). Supplementary Digital Content Table 3 summarizes the gender distributions and entry-level fitness characteristics for each individual academy (ST3).

During the study period, the recruit population was 91% male. Graduation rates for all recruits, including those with missing baseline fitness data, were significantly higher for men (91%) when compared to women (87%) ($P < 0.05$). When only recruits with complete baseline fitness data were considered, the rates were not statistically different for men (96%) and women (95%). Among the smaller number of candidates with incomplete baseline fitness data, graduation rates were higher for men (47%) than women (35%) although the difference was not statistically significant.

Successful graduates had a slightly but significantly younger age distribution. Also, on average, at academy entry, successful graduates weighed less; had less body fat; performed more push-ups and sit-ups and had faster 1.5 mile run-times (all $P < 0.01$, except body weight ($P < 0.05$)). The distributions of selected study variables in the entire population are presented in Supplementary Digital Content (women) and Supplementary Digital Content Figure 2 (men) by graduation status (SF1, SF2)

The results of the generalized linear mixed models for the probability of academy failure (not graduating) and using Cooper fitness components as categorical variables are presented in Table 2. The reference categories for the fitness variables are generally those that represented the largest proportion of successful male recruits (SF2). Push-ups and VO_2 max (derived from run-time) were significant predictors of successful graduation in all models, including the logistic regression models using Cooper fitness components as continuous variables (data not shown).

In Table 3, we summarize the probability of academy failure (not graduating) expressed as a per cent chance of failure stratified by gender and the other statistically significant variables: number of push-ups and VO_2 max from the previous regression models. For both genders, as push-up capacity and VO2 max increased, the probability of successful graduation increased.

In Table 4, we present results for the same matrices using the entire population of recruits and assuming that those with missing push-up or run data were unwilling or unable to complete the assessment and therefore are placed in the lowest performance category for that respective fitness component. In this model, we see the same pattern of results but with much higher failure rates for those in the lowest fitness categories: 29% of women and over 50% of men.

Discussion

This retrospective study of police academy graduation outcomes as a function of recruits' entry-level (baseline) fitness demonstrated that push-ups and 1.5 mile run-time were the Cooper fitness assessment parameters most strongly associated with academy graduation. Both measures are inexpensive and do not require any special training or equipment to assess. Furthermore, pairing the results for push-ups and run-time by gender provided a simple visual matrix for the predicting the probability of successful graduation from a police academy.

Female recruits on average could do less push-ups and ran slower, yet their graduation rates were nearly identical, if they had completed the fitness assessment. Higher physical fitness may be a marker for greater motivation and preparation for the academy, which may explain in large part the observed associations. As a group, the female recruits are likely to be in better physical condition than the general female population of the same age, whereas the male recruits' average physical fitness is probably similar to that of the age-matched general male

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 = 2692)		Graduated (passed academy) (n = 2572)		Not graduated (failed academy) (n = 120)		P value*
	N (%)		N		N		
Academy							
Academy 1	196 (7)		195 (99)		1 (<1)		
Academy 2	276 (10)		232 (84)		44 (16)		
Academy 3	392 (15)		371 (95)		21 (5)		
Academy 4	198 (7)		195 (98)		3 (1)		
Academy 5	416 (15)		406 (98)		10 (2)		
Academy 6	215 (8)		212 (99)		3 (1)		
Academy 7	97 (4)		97 (100)		0 (0)		
Academy 8	553 (20)		538 (97)		15 (3)		
Academy 9	273 (10)		253 (93)		20 (7)		
Academy 10	76 (3)		73 (96)		3 (4)		
Sex, n (%)							NS
Males	2442 (91)		2335 (96)		107 (4)		
Females	250 (9)		237 (95)		13 (5)		
Age (years), median (Q1, Q3)	2667	27 (24, 30)	2550	27 (24, 30)	117	28 (25, 33)	**<0.01**
Weight (pounds), mean ± SD	2692	190.6 ± 34.6	2572	190.3 ± 34.4	120	197.6 ± 39.1	**<0.05**
Body fat (%), mean ± SD	2222	19.05 ± 7.07	2114	18.94 ± 7.07	108	21.29 ± 7.70	**<0.001**
Push-ups (number), mean ± SD	2692	41.30 ± 16.11	2572	41.72 ± 15.96	120	32.28 ± 16.64	**<0.001**
Push-ups (number), n (%)							**<0.001**
≤20	268 (10)		239 (89)		29 (11)		
21–40	1054 (39)		995 (94)		59 (6)		
41–60	1062 (39)		1036 (98)		26 (2)		
≥61	308 (11)		302 (98)		6 (2)		
Sit-ups, mean ± SD	2690	36.77 ± 10.19	2571	36.99 ± 10.13	119	32.10 ± 10.31	**<0.001**
Sit-ups (number), n (%)							**<0.001**
≤15	71 (3)		64 (90)		7 (10)		
16–30	575 (21)		534 (93)		41 (7)		
31–45	1583 (59)		1524 (96)		59 (4)		
≥46	461 (17)		449 (97)		12 (3)		
Sit-and-reach (inches), mean ± SD	2329	17.82 ± 3.52	2235	17.83 ± 3.48	94	17.67 ± 4.34	NS
Sit-and-reach (inches), n (%)							NS
<16	531 (23)		508 (96)		23 (4)		
16–18	557 (24)		531 (95)		26 (5)		
18–20	569 (24)		550 (97)		19 (3)		
≥20	672 (29)		646 (96)		26 (4)		
1.5 mile run (min), mean ± SD	2692	12.67 ± 2.09	2572	12.59 ± 1.99	120	14.19 ± 3.28	**<0.001**
VO2 max (ml*kg^{-1}*min^{-1}), mean ± SD	2692	42.73 ± 5.97	2572	42.90 ± 5.88	120	39.06 ± 6.58	**<0.001**
1.5 mile run times, n (%)							**<0.001**
≥15′20″	269 (10)		239 (89)		30 (11)		
15′20″-12′33″	910 (34)		866 (95)		44 (5)		
12′33″-10′37″	1103 (41)		1061 (96)		42 (4)		
<10′37″	410 (15)		406 (99)		4 (1)		

*Difference between recruits passing and failing.

population. For example, we observed that over 60% of the women candidates had a normal or healthy body mass index, while the majority of the male police recruits were overweight or obese, consistent with our earlier study of fire and ambulance recruits in Massachusetts [12].

While the statistically significant relationships between entry fitness and graduation success were clearly evident among the majority of recruits with full information regarding fitness, the most striking finding related to recruits whose entry physical fitness assessment data were missing. The 301 recruits (10% of the study population) with missing baseline fitness information accounted for 58% (166 of 286) of those who failed to successfully graduate during the study period. Only 45% of the recruits with missing fitness data graduated compared to 95% of the recruits with complete fitness data. Based on discussions with academy leadership, most often, recruit candidates fail to

Table 2. 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 VO2 max are used as categorical variables

Characteristic	Crude analysis		Multivariable analysis*		Multivariable analysis**	
	OR	95% CI	OR	95% CI	OR	95% CI
Gender						
Reference (Male)	1.00				1.00	
Female vs. Male	0.95	(0.52, 1.76)			0.32	(0.12, 0.81)
Age	1.04	(1.01, 1.08)			1.02	(0.98, 1.06)
Weight	1.01	(1.00, 1.01)			1.00	(0.99, 1.00)
Push-ups						
≤20 vs. 41–60	3.76	(2.13, 6.63)	4.72	(2.46, 9.06)	5.18	(2.30, 11.71)
21–40 vs. 41–60	2.22	(1.38, 3.57)	2.29	(1.38, 3.79)	2.19	(1.18, 4.07)
(41–60)	1.00	Reference	1.00	Reference	1.00	Reference
≥61 vs. 41–60	0.72	(0.29, 1.78)	0.80	(0.32, 2.00)	0.86	(0.28, 2.68)
Sit-ups						
≤15 vs. 31–45	2.37	(1.01, 5.59)	1.81	(0.73, 4.50)	0.67	(0.23, 1.92)
16–30 vs. 31–45	2.00	(1.31, 3.04)	1.83	(1.18, 2.85)	0.84	(0.48, 1.45)
Reference (31–45)	1.00	Reference	1.00	Reference	1.00	Reference
≥46 vs. 31–45	0.70	(0.37, 1.33)	0.77	(0.40, 1.48)	1.30	(0.59, 2.85)
Sit and reach						
<16 vs. 18–20	2.07	(1.09, 3.96)	1.82	(0.93, 3.54)	1.52	(0.77, 3.03)
16–18 vs. 18–20	1.61	(0.87, 2.98)	1.64	(0.88, 3.05)	1.50	(0.78, 2.88)
Reference (18–20)	1.00	Reference	1.00	Reference	1.00	Reference
≥20 vs. 18–20	1.13	(0.61, 2.08)	1.09	(0.58, 2.04)	1.20	(0.63, 2.28)
1.5 mile run times						
≥15′20″	3.68	(2.19, 6.21)	3.55	(1.94, 6.50)	3.78	(1.83, 7.83)
15′20″–12′33″	1.69	(1.07, 2.66)	1.60	(0.99, 2.59)	1.34	(0.75, 2.39)
12′33″–10′37″	1.00	Reference	1.00	Reference	1.00	Reference
<10′37″	0.23	(0.08, 0.64)	0.22	(0.08, 0.63)	0.36	(0.12, 1.07)

*Each model adjusted for gender, age, and weight.
**Full model.

Table 3. Percentage (%) of candidates not graduating according to gender, number of push-ups and 1.5 mile run time on the GLIMMIX model with sex, push-ups categories and VO2 max categories included (Run times expressed in minutes' and seconds")

	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′20″	1.9	2.0	3.5	5.7	4.3	4.7	7.9	12.6
15′20″–12′33″	1.0	1.1	1.9	3.1	2.3	2.5	4.3	7.1
12′33″–10′37″	0.7	0.7	1.3	2.2	1.6	1.7	3.0	5.0
<10′37″	0.2	0.2	0.3	0.6	0.4	0.5	0.8	1.3

graduate because they drop out or because they do not meet the minimum fitness training participation criteria. 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. Furthermore, although we cannot quantify an estimate, we learned that some academies had discarded the entire records of such candidates who dropped out early. Therefore, the present results are likely conservative estimates.

To the best of our knowledge, this is the first study of its kind to examine the relationship between police recruit physical fitness and successful academy graduation. Nonetheless, our findings are indirectly supported by previous research. A positive correlation between VO_2 max and push-ups has been observed among police recruits [17]. In addition, decreased functional movement capability was found to correlate with a higher risk of injury and illness among police academy trainees [18]. Another study found that individual differences among

Table 4. Percentage (%) of candidates not graduating according to gender, number of push-ups and 1.5 mile run time on the GLIMMIX model with sex, push-ups categories and VO2 max categories included (run times expressed in minutes(′) and seconds(″)) (with gender set to male if missing and push-ups and VO2 categories set to the lowest categories if missing)

	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′20″	2.8	3.4	6.4	28.7	7.6	9.2	16.2	53.4
15′20″–12′33″	0.6	0.7	1.3	7.4	1.6	2.0	3.7	18.6
12′33″–10′37″	0.5	0.6	1.2	6.8	1.5	1.8	3.4	17.2
<10′37″	0.2	0.2	0.4	2.6	0.5	0.7	1.3	7.0

police recruits, especially in dispositional resilience and preference and tolerance of highly intensive exercises, affected their level of endurance, muscular strength and overall fitness [19]. Law enforcement officers are commonly exposed to high levels of occupational stress, so dispositional resilience may be an important factor in determining long-term health of police officers [6,20].

State and town sponsorship of recruit officers represent major financial investments. Therefore, maximizing the likelihood of successful completion of police academy training is in the interest of multiple stakeholders, including the sponsors, police recruits, and the tax-paying public. Based on the current results and the distribution of baseline fitness attributes among the recruits studied, we have proposed two sets of recommended cut-off points to be validated in a separate, prospective study of Massachusetts police academy recruits. The first is a recommended 'Minimum' Entry Fitness Criteria of >10 push-ups and a 1.5 mile run of <15′20″ for women applicants, and >20 push-ups and a 1.5 mile run time of <15′20″ for male applicants. Based on the current study, otherwise qualified applicants meeting the minimum entry criteria should have more than a 95% likelihood of graduating from the academy. We further suggested 'Target' Entry Fitness Criteria of >20 push-ups and a 1.5 mile run time of <14′ for females and >40 push-ups and 1.5 mile run time of <12′30″ for males. Based on the current study, qualified applicants meeting the target entry criteria should have about a 98% likelihood of graduating from the academy.

Establishing and validating evidence-based fitness standards through additional prospective study should give future recruits actionable information to better prepare for police academy training and improve their likelihood of successful graduation. Rather than present a barrier for applicants who are below fitness standards, discrete minimum fitness goals could empower candidates to achieve a level of physical fitness most associated with police academy success.

The present study has several strengths. It is large and spans several thousand recruits in multiple academies over a 7-year period. Moreover, our results are most likely to be conservative estimates of the strength of the relationship between increasing fitness and an increasing likelihood of graduation. As elaborated above, recruits with missing data were likely to have been unable or unwilling to complete the fitness assessment, and some may have quit the academy at that point or shortly thereafter. This would explain the disproportionate failure rate of 55% or 10-fold that of recruits with complete baseline fitness data. Finally, another strength was that fitness and outcome data were extracted in a blinded fashion, which minimized the chances of information bias.

This study also has some limitations. First, the study cannot demonstrate causality between entry fitness levels and police academy graduation. The association between fitness and graduation outcomes may be determined by other associated factors such as attitude, motivation, and overall preparation. Furthermore, our study cannot reach any conclusions regarding recruit fitness and subsequent performance as a police officer. These limitations, however, do not alter the utility of using fitness as a predictor of academy success.

Second, our analyses were limited by the retrospective design and missing data regarding baseline fitness for some recruits. We also cannot quantify the number of police officer recruits who left the academy within the first several days because of negative experiences with fitness testing, as those records were not consistently maintained. However, this limitation does not change our results but leads us to conclude that our findings are likely to underestimate the true association between Cooper fitness variables and academy graduation. On the other hand, due to the lack of information on specific individual reasons for academy failure, we are unable to confirm the likely associations between poor baseline fitness and a greater risk of dropping out early from academies and with failure to meet the minimum physical fitness participation standards.

In conclusion, our findings strongly support that certain academy-entry fitness characteristics are strongly associated with the likelihood of recruits' subsequent graduation from Massachusetts police academies. Based on the present findings, the MPTC has commissioned a prospective cohort

study, which is currently underway. Such a prospective investigation would help further validate the present results and better quantify the observed associations.

Key points

- Our findings support an association between certain academy entry fitness characteristics and the likelihood of successfully graduating from a Massachusetts police academy.
- The 1.5 mile run time and push-ups were the fitness components most strongly associated with graduation and with each other.
- Pending prospective validation, these two components are simple, low-cost initial assessments that police academies could use before admitting recruits into the academy to predict a candidate's likelihood of successfully graduating.

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Conflict of interest

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

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