the Journal of Strength and Conditioning Research™

Characterization of the Physical Fitness of Police Officers: A Systematic Review

Eduardo F. Marins,[1,2] Gabriela B. David,[2] and Fabrício B. Del Vecchio[2]

[1]Federal Highway Police Department, Brasília, Brazil; and [2]College of Physical Education, Federal University of Pelotas, Pelotas, Brazil

Abstract

Marins, EF, David, GB, and Del Vecchio, FB. Characterization of the physical fitness of police officers: a systematic review. *J Strength Cond Res* 33(10): 2860–2874, 2019—Physical fitness tests (e.g., aerobic power, muscular endurance, and flexibility tests) are commonly used to assess the ability of police officers to perform work-related tasks. The purpose of this study was to describe, from a systematic literature review, data related to police physical fitness. The research was conducted in 5 electronic databases to search for original studies that measured physical fitness (aerobic and anaerobic capacity, strength, endurance, power, flexibility, agility, and speed) of police officers, as well as the article references. Original studies assessing objective measures of physical fitness in police officers were included, with no date restriction. Fifty-nine articles were included in the review. The studies mostly measured cardiorespiratory fitness indirectly, strength, and muscular endurance, as well as other performance components (body composition, power, flexibility, speed, agility, and anaerobic profile), with police officers generally presenting values similar or above the average of the general population. It can be concluded that intervention studies are needed to promote and incorporate programs related to improvement or maintenance of physical fitness in police officers, which would result in health benefits and specifically improvement in performance of specific tasks of police work. This review provides summary information to assist in the selection of physical fitness tests for police populations. Still, these findings have practical applications for public security agencies and its personnel responsible for the development and implementation of physical programs in policemen population.

Key Words: tactical, law enforcement, cardiorespiratory fitness, muscular strength, muscular endurance

Introduction

The demands related to public security worldwide have increased over recent years (33), especially regarding crime and violence, creating, therefore, a sense of insecurity. Thus, public safety officers (police officers, firefighters, and correctional officers), also termed "tactical personal," need to be constantly able—physically, mentally, and technically—to deal with these situations and, thus, ensure or restore the social order (46). In this sense, international studies have been conducted to measure and evaluate the level of physical fitness in police officers (16,47,48) because knowing the police officers' level of physical fitness can help to identify strengths and weaknesses, as well as reorientate the corporal practices of this professional group (1).

Police activity is considered of great risk because it is marked by hazardous situations that are stressful and physically demanding (45). Such risks to officers include population riots, physical violence, accidents, robberies, and armed clashes (63). Thus, professionals need effectiveness and accuracy in the execution of tasks and different physical abilities (such as muscle strength and endurance, cardiorespiratory fitness, power, speed, and agility). These components must be linked to complete such tasks with quality (5), even under high physical and mental demands (68,74). It also highlights the importance of police officers being in a good physical condition to perform their competencies because poor motor fitness limits performance, endangering individual and collective safety (15,17,65). However, there is growing evidence that the physical condition of police officers is below the recommended standards for general health (24,47). In this context, when comparing the maximal aerobic power ($\dot{V}O_2max$) of police officers on a cycle ergometer in the 1980s with values of the current decade, a reduction in cardiorespiratory fitness can be observed (average values from 41.8 $ml\cdot kg^{-1}\cdot min^{-1}$ to in the 1980s to 34.1 $ml\cdot kg^{-1}\cdot min^{-1}$ in 2015) (40,70).

Another factor influencing the performance of police activities is the load carriage of personal protective equipment worn by professionals throughout their working period, such as ballistic vest, short and long weapon possession, and even fireproof uniforms (46). Previous studies have shown an increased physiological demand with the use of this mandatory equipment by public security agents (6,20). Thus, one can stress that a high fitness level is required to undertake and perform complex tactical operations, such as dragging victims, carrying heavy loads, control of aggressive suspects, and other tasks (4). In addition, the importance of having high levels of physical fitness for health benefits is evidenced in the literature (18,19,43). In this context, individuals with greater cardiorespiratory fitness and strength have a 57 and 45% lower risk of all-cause mortality, respectively (38,54), with existing evidences that poor performance in a push-up and sit-up tests is associated with musculoskeletal injury risk (18).

Hence, published data about police forces' physical fitness and exercise prescription are becoming increasingly useful for exercise prescription; however, these results have not been systematically reviewed in the literature. For these reasons, the preparation of police officers requires frequent training specific to the activity, in

Address correspondence to Eduardo F. Marins, dudufrio@gmail.com.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (http://journals.lww.com/nsca-jscr).

Journal of Strength and Conditioning Research 33(10)/2860–2874

Table 1
Exclusion criteria.

Exclusion code (EX)	Notes	Title	Abstract	Full
EX1. Not original research in humans	Exclude reviews, meta-analyses, and other secondary research (i.e., outcome of conference proceedings, but retain systematic reviews for subsequent reference checking). Exclude animal studies.	86	5	1
EX2. Not relationship of topic	Exclude studies that not available physical fitness or the not study police officers.	2,405	16	4
EX3. Not police officer population	Exclude studies that evaluated only other populations (firefighters and military), not police officers.	17	6	2
EX4. Provided exclusively results of operations or specific tests	Exclude studies that report exclusively the results of occupational tests. No data on physical fitness tests.	0	1	8
EX5. Not have at least 1 result of physical fitness measured objectively	Exclude studies that measure physical fitness subjectively (i.e., surveys).	4	72	8
EX6. Presented missing or incomplete data	Exclude studies that not report mean and *SD* data, as well as can not identify such measures from the graphs.	0	2	2
EX7. Provided exclusively measured of body composition	Exclude studies that not measure others physical fitness (i.e., incremental test).	0	3	1
EX8. Other language	Exclude studies that were language that was not English, Spanish, or Portuguese.	2	0	1
EX9. Repeated results	Exclude studies that use the same sample and present the results of physical fitness as secondary data.	0	0	2
Total		2,514	105	29

both the technical-operational side (1) and the related physical fitness (13). Thus, given the significant impact that physical fitness has toward the quality of police activities, the aim of this study was to describe the existing data related to the physical fitness of police officers with a systematic literature review.

Methods

Experimental Approach to the Problem

A systematic review was performed to identify the physical fitness tests applied to police personnel and to describe the fitness levels of this population. The present systematic review followed the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) model (52) (see checklist Table, Supplemental Digital Content 1, http://links.lww.com/JSCR/A131). This study is exempt from ethical approval, as the authors collected and synthesized data from previous studies in which informed consent was already obtained by study researchers. Thus, this study was not approved by an institutional review board.

Procedures

Information retrieval was conducted from September to October in 2018. Searches were performed in the following primary electronic databases: MEDLINE (PubMed), LILACS (Latin American and Caribbean Health Sciences), SciELO (Scientific Electronic Library Online), Web of Science (Thomson Reuters), and COCHRANE. Furthermore, to account for the gray literature, other relevant studies were inserted from references found in articles included in the searches or reviews that addressed the topic.

In this study, the combination of the following descriptors were used in English to capture all relevant studies: "police," "law enforcement," "physical fitness," "physical exercise," "maximal oxygen consumption," "aerobic fitness," "aerobic power," "aerobic capacity," "flexibility," "muscular strength," "muscular endurance," "muscular resistance," "muscular power," "body composition," and "agility" (see the search strategy Table, Supplemental Digital Content 2, http://links.lww.com/JSCR/A132). To reduce the chances of publication bias in the studies, the guidelines of the journals were consulted to confirm that they were peer reviewed. The research was conducted independently by 2 researchers, and when they did not reach a consensus about the inclusion or exclusion of an article, a third researcher was consulted. The researchers evaluated the titles and abstracts of the articles found in the search independently, and the articles in which abstracts did not provide enough information to identify the pre-established criteria were read in full. Finally, for the full texts not available, the authors of the studies were contacted (email or through ResearchGate site) to obtain such documents.

Study Inclusion and Exclusion Criteria. Only publications that met the following criteria were included: original research; measured the components of physical fitness; police officer population; observational or experimental study design; and study outcomes included acute or chronic (after physical training). All studies were screened based on the exclusion criteria presented in Table 1.

Data Extraction. The following data were extracted from the methods and results sessions of included article and were presented in text and table form in this review. The data presented in the articles as figures were extracted when clearly identified. Finally, the following data of the selected articles for review were presented in the tables (Tables 2 and 3) in ascending order of year of publication: author and year of publication; sample characteristics/country; fitness components and measurement tests; and main results.

Results

Search Results

A total of 3,149 articles published in scientific journals were found, and after removing duplicates (n = 439), the titles and abstracts of remaining articles (n = 2,710) were reviewed for inclusion or exclusion. Articles were discarded according to exclusion criteria (n = 2,619), and after reviewing the full text

Table 2

Main results of observational studies.*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Smolander et al., (67)	*n* = 103 M; 27–46 y/Finland	N/A	$\dot{V}O_2$max (CE) = 41.2 ± 10.0 ml·kg^{-1}·min^{-1}	Pull-up = 4.8 ± 3.4 rep	Vertical jump = 55.7 ± 7.0 cm	Sit-up = 20.9 ± 3.4 rep/30 s	N/A	N/A	N/A	N/A
Spitler et al., (70)	*n* = 12 (9 M and 3 W); 32.4 ± 4.7 y/United States	%BF skinfold thickness = 15.9 ± 4.9 (M) and 19.1 ± 5.8 (W)	$\dot{V}O_2$max (TM) = 42.1 ± 8.9 ml·kg^{-1}·min^{-1} (M) and 41.5 ± 8.7 ml·kg^{-1}·min^{-1} (W)	Hand grip = 24.1 ± 6.1 kg; pull-up = 5.0 ± 4.1 rep; 1RM BP = 64.3 ± 28.9 kg	Vertical jump = 42.4 ± 9.7 cm	Push-up = 27.2 ± 13.5 rep; sit-up = 31.8 ± 7.2 rep/60 s	Sit and reach = 45.0 ± 6.1 cm	Dodging run = 8.1 ± 0.6 s	50 yard = 7.3 ± 0.5 s	N/A
Boyce et al., (8)	*n* = 514 (436 M and 78 W); 35.6 ± 8.3 (M) and 30.3 ± 5.7 (W) y/United States	%BF skinfold thickness = 18.9 ± 6.3 (M) and 26.8 ± 7.4 (W)	$\dot{V}O_2$max (CE) = 33.8 ± 9.1 ml·kg^{-1}·min^{-1} (M) and 32.4 ± 11.0 ml·kg^{-1}·min^{-1} (W)	1RM BP/BM = 0.9 ± 0.3 (M) and 0.6 ± 0.1 (W)	N/A	Sit-up = 45.5 ± 13.4 rep/60 s (M) and 42.5 ± 11.5 rep/60 s (W)	Sit and reach = 17.4 ± 3.3 cm (M) and 19.5 ± 2.5 cm (W)	N/A	N/A	N/A
Arvey et al., (3)	*n* = 115 (96 M and 19 W); 35.4 ± 8.8 y/United States	N/A	1-mile run = 663.6 ± 149.8 s; $\dot{V}O_2$max (TM) = 41.4 ± 7.1 ml·kg^{-1}·min^{-1}	Hand grip = 59.3 ± 11.7 kgf	N/A	Sit-up = 34.0 ± 10.7 rep/60 s	N/A	N/A	N/A	N/A
Young and Steinhardt, (78)	*n* = 412 M; 35.9 ± 6.7 y/United States	%BF skinfold thickness = 23.5 ± 8.5	$\dot{V}O_2$max estimated (TM) = 43.5 ± 6.9 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stanish et al., (72)	*n* = 48 (28 university students and 20 Royal Canadian Mounted Police applicants; 21 M and 27 W)/Canada	N/A	1.5-mile run = 11 min 24 s ± 2 min 08 s (M) and 13 min 20 s ± 2 min 59 s (W)	1RM BP = 81.5 ± 21.1 kg (M) and 43.9 ± 8.0 kg (W); 1RM LP = 257.7 ± 58.4 kg (M) and 172.8 ± 44.5 kg (W)	Vertical jump = 44.9 ± 10.2 cm (M) and 34.9 ± 4.7 cm (W); horizontal jump = 230.0 ± 20.0 cm (M) and 180.0 ± 20.0 cm (W)	70-Lb BP = 31.4 ± 8.6 rep/30 s (M) and 5.3 ± 7.9 rep/30 s (W); sit-up = 47.0 ± 10.0 rep/60 s (M) and 43.0 ± 13.0 rep/60 s (W); push-up = 39.0 ± 14.0 rep (M) and 21.0 ± 11.0 rep (W)	N/A	Barrow zigzag = (M) 21.2 ± 1.5 s and (W) 23.4 ± 2.9 s	40 m sprint = (M) 5.9 ± 0.4 s and (W) 7.1 ± 0.6 s	N/A
Volpino et al., (75)	*n* = 130 M; 36–58 y (traffic policemen—TG = 46.3 ± 5.7 y; control group—CG = 40.8 ± 5.4 y)/Italy	N/A	$\dot{V}O_2$max (CE): TG: 26.4 ± 8.9 and CG = 27 ± 4 ml·kg^{-1}·min^{-1}; $\dot{V}O_2$ at anaerobic threshold: TG = 13.9 ± 6.2 and CG = 16.2 ± 5.2 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boyce et al., (10)	*n* = 514 (436 M and 78 W); 30.3 ± 5.4 to 38.7 ± 8.2 y/United States	N/A	$\dot{V}O_2$max (CE) = 35.2 ml·kg^{-1}·min^{-1} (nonsmoker M) and 33.4 ml·kg^{-1}·min^{-1} (nonsmoker W), 30.3 ml·kg^{-1}·min^{-1} (smoker M) and 29.1 ml·kg^{-1}·min^{-1} (smoker W)	N/A	N/A	Sit-up = 47.2 rep/60 s (nonsmoker M) and 44 rep/60 s (nonsmoker W), 39 rep/60 s (smoker M) and 38 rep/60 s (smoker W)	N/A	N/A	N/A	N/A

Table 2
Main results of observational studies.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Santos and Filho, (63)	*n* = 70; 30.8 ± 3.1 y/Brazil	N/A	$\dot{V}O_2$max estimated (Cooper) = 55.1 ± 3.8 ml·kg^{-1}·min^{-1}	N/A	N/A	Sit-up = 60.3 ± 8.5 rep/60 s	N/A	Shuttle run = 11.3 ± 0.7 s	N/A	N/A
de Amaral Júnior et al., (34)	*n* = 28 M; radio patrol (RP) *n* = 14 (31.0 ± 6.3 y) and penitentiary guard (PG) *n* = 14 (28.7 ± 4.7 y)/Brazil	N/A	$\dot{V}O_2$max estimated (20-m MSFT) = 43.0 ± 5.2 ml·kg^{-1}·min^{-1} (RP) and 44.1 ± 3.3 ml·kg^{-1}·min^{-1} (PG)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sassen et al., (64)	*n* = 1,298 (874 M and 424 W), 44.8 y/Netherlands	N/A	$\dot{V}O_2$peak (CE) = 0–1 risk factor: 37.5 ± 7.6 ml·kg^{-1}·min^{-1}; 2 risk factors: 34.4 ± 8.1 ml·kg^{-1}·min^{-1}; ≥ risk factors: 31.0 ± 7.5 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Takken et al., (73)	*n* = 20; 16 M (32.0 ± 8 y) and 4 W (25.0 ± 5.0 y)/Netherlands	N/A	$\dot{V}O_2$max (CE) = 44.6 ± 6.0 ml·kg^{-1}·min^{-1} (M) and 35.1 ± 8.2 ml·kg^{-1}·min^{-1} (W)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Berria et al., (5)	*n* = 42 M; 34.7 ± 6.6 y/Brazil	%BF skinfold thickness = 20.5 ± 4.4	12-min run (Cooper) = 2,298.5 ± 352.2 m	N/A	Vertical jump = 45 ± 6 cm; horizontal jump = 194 ± 20 cm	Push-up = 24 ± 9 rep; sit-up = 33 ± 6 rep/60 s	Sit and reach = 22.7 ± 7 cm	Come and go = 10.8 ± 0.7 s	50-m sprint = 8.07 ± 0.6 s	N/A
Sperlich et al., (69)	*n* = 120 M; 28.9 ± 5.2 y/Germany	N/A	$\dot{V}O_2$peak (TM) = 57.4 ± 4.2 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Filho et al., (26)	*n* = 49 M; 25.6 ± 3.1 y/Brazil	N/A	$\dot{V}O_2$max estimated (1,600 m) = 43.6 ± 3.2 ml·kg^{-1}·min^{-1}; $\dot{V}O_2$max estimated (Cooper) = 39.4 ± 4.2 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heneweer et al., (30)	*n* = 1723 (1,169 M and 554 W); 39.8 ± 10.4 y/Netherlands	N/A	$\dot{V}O_2$max (CE) = 35 ml·kg^{-1}·min^{-1} (median)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pryor et al., (61)	*n* = 11 M; 36.5 ± 6.3 y/United States	%BF skinfold thickness = 18 ± 3	$\dot{V}O_2$max (TM) = 45.3 ± 6.1 ml·kg^{-1}·min^{-1}	1RM BP = 105.6 ± 16.2 kg; 1RM SP = 68.2 ± 11.6 kg; 1RM LP = 243.4 ± 32.7 kg	Vertical jump = 41.8 ± 5.3 cm	N/A	Sit and reach = 75.0 ± 23.9 cm	N/A	N/A	N/A

Table 2
Main results of observational studies.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Blacker et al., (6)	*n* = 17 (16 M and 1 W); (6 = firearms house entry—FE; 33 ± 4 y; 11 = unarmed house entry and crowd control—UECC; 34 ± 5 y/United Kingdom	%BF skinfold thickness: FE = 16.0 ± 3.0 and UECC = 20.3 ± 3.6	$\dot{V}O_2$max (TM): FE = 53.4 ± 4.6 ml·kg^{-1}·min^{-1} and UECC = 50.6 ± 5.0 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dempsey et al., (20)	*n* = 52 M; 37.0 ± 9.2 y/New Zealand	N/A	$\dot{V}O_2$max (TM) = 50.0 ± 8.5 ml·kg^{-1}·min^{-1}	Pull-up = 8.2 ± 4.8 rep	N/A	N/A	N/A	N/A	N/A	N/A
Kayihan et al., (35)	*n* = 237 M; 20.4 ± 0.8 y/Turkey	N/A	$\dot{V}O_2$max estimated (20-m MSFT) = 49.4 ± 2.4 ml·kg^{-1}·min^{-1}	Hand grip = 46.9 ± 4.0 kg	N/A	N/A	Sit and reach = 27.6 ± 5.8 cm	N/A	N/A	N/A
McGill et al., (49)	*n* = 53 M; 37.8 ± 5.0 y/Canada	N/A	N/A	Pull-up: <35 y = 11.7 ± 2.2 rep, 35–39 y = 12.1 ± 2.4 rep, 40–44 y = 10.2 ± 3.9 rep, >44 y = 6.8 ± 4.3 rep; right hand grip: <35 y = 58.6 ± 8.0 kg, 35–39 y = 51.6 ± 14.3 kg, 40–44 y = 56.9 ± 9.2 kg, >44 y = 46.9 ± 4.3 kg; left hand grip: <35 y = 55.3 ± 5.7 kg, 35–39 y = 51.3 ± 7.3 kg, 40–44 y = 53.4 ± 9.5 kg, >44 y = 49.9 ± 3.3 kg	N/A	Back extention: <35 y = 107.9 ± 21.6 s, 35–39 y = 105.2 ± 24.3 s, 40–44 y = 109.9 ± 35.7 s, >44 y = 108.8 ± 37.4 s	N/A	N/A	N/A	N/A
Santos et al., (62)	*n* = 51 (38 M and 13 W); 30 ± 4 y/Brazil	N/A	$\dot{V}O_2$max estimated (Cooper) = 42.1 ± 4.5 ml·kg^{-1}·min^{-1}	Pull-up = 10 ± 3.8 rep/60 s	N/A	Push-up = 47 ± 5.8 rep/60 s; sit-up = 49 ± 10.6 rep/60 s	N/A	N/A	N/A	N/A
Dempsey et al., (21)	*n* = 52 M; 37 ± 9.2 y/New Zealand	N/A	$\dot{V}O_2$max (TM) = 50.0 ± 8.5 ml·kg^{-1}·min^{-1}		Vertical jump = 46.9 ± 7.6 cm	N/A	N/A	N/A	N/A	N/A

Table 2
Main results of observational studies.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Dimitrijevic et al., (23)	*n* = 281 M (91 program 1—P1, 92 program 2—P2, 98 program 3 - P3)/ Serbia	N/A	$\dot{V}O_2$max estimated (Cooper): P1 = 51.5 ± 3.9 ml·kg^{-1}·min^{-1}, P2 = 49.9 ± 3.8 ml·kg^{-1}·min^{-1}, P3 = 48.0 ± 5.7 ml·kg^{-1}·min^{-1}	Back extension: P1 = 1748.2 ± 203.1 N, P2 = 1728.1 ± 223.4 N, P3 = 1716.9 ± 271.6 N; hand grip: P1 = 640.2 ± 83.2 N, P2 = 628.2 ± 85.7 N, P3 = 629.9 ± 108.4 N	Horizontal jump: P1 = 245 ± 14.2 cm, P2 = 235 ± 12.6 cm, P3 = 228 ± 15.7 cm	Sit-up with rotation: P1 = 29 ± 2.9 rep/30 s, P2 = 26 ± 3.0 rep/30 s, P3 = 27 ± 2.5 rep/30 s	N/A	N/A	N/A	N/A
Esteves et al., (24)	*n* = 52 M; 38.3 ± 6.3 y/Brazil	%BF skinfold thickness = 23.6 ± 4.3	$\dot{V}O_2$max estimated (TM) = 34.8 ± 1.1 ml·kg^{-1}·min^{-1}	N/A	N/A	Push-up = 21 ± 8 rep/60 s; sit-up = 28 ± 8 rep/60 s	N/A	N/A	N/A	N/A
Kayihan et al., (36)	*n* = 351 M; 21.5 ± 1.1 y/Turkey	N/A	1-mile run = 5.4 ± 0.4 min; $\dot{V}O_2$max estimated = 59.2 ± 2.6 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beck et al., (4)	*n* = 16 M; 33.1 ± 8.7 y/United States	%BF DEXA = 22.7 ± 4.2	$\dot{V}O_2$peak (TM) = 42.7 ± 5.9 ml·kg^{-1}·min^{-1}	1RM BP = 93.1 ± 19.8 kg; 1RM BP/BM = 1.1 ± 0.3; 1RM LP = 647 ± 116.4 kg; 1RM LP/BM = 7.6 ± 1.6; right hand grip = 55.9 ± 6.4 kg; left hand grip = 52.5 ± 5.9 kg;	Vertical jump = 51.4 ± 10.2 cm	Push-up = 34.8 ± 12.6 rep/60 s; sit-up = 55.6 ± 45.9 rep/60 s	Sit and reach = 32.1 ± 9.8 cm	Illinois = 18.2 ± 1.6 s	N/A	N/A
Fernandes et al., (25)	*n* = 87 M; 44.2 ± 6.5 y/Brazil	N/A	12-min run (Cooper) = 2,353.0 ± 371.7 m	N/A	Horizontal jump = 180 ± 20 cm; throwing medicine ball = 510 ± 70 cm	Sit-up = 32.9 ± 8.1 rep/60 s	Sit and reach = 26.4 ± 8 cm	Shuttle run = 12.4 ± 1.2 s	30-m sprint = 5.2 ± 0.4 s	N/A
Leischik et al., (40)	*n* = 198 M (97 firefighters, 55 police officers and 46 sedentary office workers); age NR/ Germany	%BF bioimpedance = 21.4 ± 5.6 (police officers)	Police officers: $\dot{V}O_2$max (CE) = 34.1 ± 8.0 ml·kg^{-1}·min^{-1}; $\dot{V}O_2$ at anaerobic threshold = 17.9 ± 5.8 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lewinski et al., (42)	*n* = 20 M; 21.3 ± 2.6 y/United States	%BF bioimpedance = 12.0 ± 5.9	N/A	N/A	Vertical jump = 54 ± 10 cm	N/A	N/A	N/A	N/A	N/A
Wittink et al., (76)	*n* = 1,529 (1,068 M and 461 W); 38.1 ± 9.9 y/Netherlands	N/A	$\dot{V}O_2$peak (CE) = 38.0 ± 7.5 (M) and 31.6 ± 6.8 (W) ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dawes et al., (17)	*n* = 76 M; 39.4 ± 8.4 y/United States	%BF skinfold thickness = 16.9 ± 4.6	1.5-mile run = 12.8 ± 2.3 min; $\dot{V}O_2$max estimated = 41.3 ± 6.5 ml·kg^{-1}·min^{-1}	1RM BP = 93.8 ± 25.9 kg; 1RM BP/BM = 1.1 ± 0.2	Vertical jump = 61.3 ± 8.0 cm	Push-up = 55.6 ± 17.3 rep/60 s; sit-up = 41.1 ± 7.0 rep/60 s	N/A	N/A	300-m run = 56.0 ± 10.7 s	N/A

Table 2
Main results of observational studies.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Leischik et al., 2016 (41)	*n* = 37 W; 31.2 ± 6.2 y/German	%BF bioimpedance = 28.2 ± 5.9	$\dot{V}O_2$max (CE) = 35.3 ± 6.5 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orr et al., (57)	*n* = 1,021; age NR/ Australia	N/A	N/A	N/A	Vertical jump = 42.0 ± 7.4 cm (injured), 44.0 ± 7.6 cm (noninjured), 41.9 ± 7.5 cm (illness), 44.4 ± 7.5 cm (no illness)	N/A	N/A	N/A	N/A	N/A
Dawes et al., (15)	*n* = 495 (476 M and 19 W); 39.6 ± 7.7 y/United States	N/A	Less fit: 20-m MSFT = 24.1 ± 8.6 shuttles; $\dot{V}O_2$max estimated = 25.1 ± 3.3 ml·kg^{-1}·min^{-1}; more fit: 20-m MSFT = 52.1 ± 15.8 shuttles; $\dot{V}O_2$max estimated = 34.6 ± 5.0 ml·kg^{-1}·min^{-1}	Less fit: leg/back chain = 168.7 ± 34.4 kg, hand grip = 54.1 ± 9.1 kg; more fit: leg/back chain = 172.7 ± 31.4 kg, hand grip = 54.8 ± 7.7 kg	Vertical jump = 45.7 ± 7.5 cm (less fit) and 48.2 ± 7.6 cm (more fit)	Less fit: push-up = 30.3 ± 11.7 rep/60 s; sit-up = 27.8 ± 8.0 rep/60 s; more fit: push-up = 47.2 ± 12.9 rep/60 s; sit-up = 41.0 ± 7.3 rep/60 s	N/A	N/A	N/A	N/A
Dawes et al., (16)	*n* = 631 (597 M and 34 W); 37.9 ± 8.3 y/United States	N/A	20-m MSFT = 38.0 ± 19.0 shuttles (M) and 26.2 ± 10.9 shuttles (W)	Leg/back chain = 170.7 ± 37.5 kg (M) and 116.5 ± 20.9 kg (W); hand grip—dominant = 55.0 ± 7.8 kg (M) and 37.9 ± 5.3 kg (W)	Vertical jump = 50.7 ± 8.9 cm (M) and 36.8 ± 5.7 cm (W)	Push-up = 39.1 ± 15.6 rep/60 s (M) and 24.2 ± 11.6 rep/60 s (W); sit-up = 34.5 ± 10.3 rep/60 s (M) and 31.1 ± 9.5 rep/60 s (W)	N/A	N/A	N/A	N/A
Marins and Del Vecchio, (47)	*n* = 41 M; 40.5 ± 6.3 y/Brazil	%BF bioimpedance = 25.1 ± 4.9	N/A	Right hand grip = 47.4 ± 6.2 kg; left hand grip = 44.6 ± 6.3 kg; leg/back chain = 127.1 ± 20.8 kg	N/A	N/A	Sit and reach = 21.2 ± 9.4 cm	N/A	N/A	N/A
Nascimento Neto do et al., 2017 (53)	*n* = 15 M; 34.1 ± 5.4 y/Brazil	N/A	$\dot{V}O_2$peak (TM) = 44.9 ± 4.0 ml·kg^{-1}·min^{-1}	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orr et al., (58)	*n* = 169; age NR/ Australia	N/A	N/A	Right hand grip = 42.2 ± 8.3 kg; left hand grip = 41.9 ± 8.3 kg	N/A	N/A	N/A	N/A	N/A	N/A
Shusko et al., (65)	*n* = 2,692 (2,442 M and 250 W); median 27 y/United States	%BF skinfold thickness = 19.1 ± 7.1	1.5-mile run = 12.7 ± 2.1 min; $\dot{V}O_2$max estimated = 42.7 ± 6.0 ml·kg^{-1}·min^{-1}	N/A	N/A	Push-up = 41.3 ± 16.1 rep/60 s; sit-up = 36.8 ± 10.2 rep/60 s	Sit and reach = 45.3 ± 8.9 cm	N/A	N/A	N/A

Table 2
Main results of observational studies.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Lockie et al., (44)	n = 179 (142 M and 37 W); 27.7 ± 6.2 y/United States	N/A	N/A	N/A	Vertical jump = 54.4 ± 11.2 cm (M) and 38.2 ± 10.3 cm (W); throwing medicine ball = 620 ± 100 cm (M) and 400 ± 60 cm (W)	N/A	N/A	N/A	N/A	N/A
Thomas et al., (74)	n = 12 M; 33.7 ± 5.2 y/United States	N/A	$\dot{V}O_2$peak estimated (TM) = 44.8 ± 5.3 ml·kg^{-1}·min^{-1}	1RM BP = 117.6 ± 19.0 kg; 1RM BP/BM = 1.3 ± 0.2; 1RM LP = 430.5 ± 88.2 kg; 1RM LP/BM = 4.6 ± 0.8	Vertical jump = 57.4 ± 5.6 cm; vertical jump/BM = 0.6 ± 0.1 cm·kg^{-1}	Push-up = 50.3 ± 15.4 rep/60 s	Sit and reach = 29.6 ± 6.8 cm	Illinois = 16.9 ± 0.9 s	N/A	Wingate mean/BM = 7.5 ± 0.7 W·kg^{-1}; Wingate peak/BM = 10.7 ± 0.7 W·kg^{-1}

*1RM = 1 repetition maximum; BF = body fat; BM = body mass; BP = bench press; CE = cycle ergometer; DEXA = dual-energy x-ray absorptiometry; LP = leg press; M = men; MSFT = multistage fitness test; N/A = not available; NR = not reported; SP = shoulder press; TM = treadmill; $\dot{V}O_2$max = maximal oxygen uptake; $\dot{V}O_2$peak = peak oxygen uptake; W = women.

considering the eligibility criteria, 52 studies were included in this review. Moreover, 7 articles were incorporated from searches in the gray literature, resulting in a total of 59 publications (Figure 1).

Tables 2 and 3 present the main information from studies included, according to observational and experimental design, respectively.

Characteristics of Included Studies

Regarding study designs, 42 studies were observational, and 17 studies used an experimental design. The studies involved police officers from different continents, such as: America (United States, Canada, and Brazil), Europe (Germany, Italy, Holland, Finland, Serbia, England, and United Kingdom), Oceania (Australia and New Zealand), and Asia (Turkey) (Tables 2 and 3).

Thirty-two studies reported data from only male subjects, 22 studies reported results from both sex, 1 study reported data from female subjects only, while in the remaining 4 studies, subjects' sex was not specifically identified (Tables 2 and 3).

As for the components of physical fitness, different outcomes were measured in the studies. The most common measure taken was aerobic capacity, which was reported in 49 of 59 studies. The next most common tests performed were strength and muscular endurance measures, reported in 29 studies for each variable, followed by body composition, assessed in 20 studies, muscular power, in 19 studies, and flexibility, in 14 studies. The least common tests reported were speed parameters, measured in only 9 studies, agility, reported in 8 studies, and anaerobic capacity, in only 3 studies. However, the protocols through which these fitness assessment data were collected in the studies varied widely.

Body composition, as represented by body fat percentage (range of means = 12% (42)–28.2% (41)), was measured using skinfolds, bioimpedance, hydrostatic weighing, or double energy x-ray absorptiometry.

A range of measures of aerobic fitness were performed in treadmill or cycle ergometer using direct methods (21 studies), treadmill or field tests to estimate the $\dot{V}O_2$max (18 studies), and field tests with time or distance measures. The range of relative $\dot{V}O_2$max was 25.1–59.2 ml kg^{-1}·min^{-1} (average of mean values = 41.3 ml·kg^{-1}·min^{-1}), the Cooper test was 2,298–2,353 m (average of mean values = 2,326 m), 1.5-mile run was 678–800 seconds (average of mean values = 742 seconds), 1-mile run was 324–720 seconds (average of mean values = 619 seconds), and the 20-m multiple shuttle run test was 24.1–72.6 shuttles (average of mean values = 51.3 shuttles). The mean cardiorespiratory fitness of police officers was 38.7 ml·kg^{-1}·min^{-1}, measured through ergospirometry. As for the studies that assessed the same measurement indirectly, the mean $\dot{V}O_2$max was 44.8 ml·kg^{-1}·min^{-1}.

Muscle strength was measured using different procedures across all studies. The 1 repetition maximum (1RM) test was used in bench press, with a range of loads varying from 36.2 to 117.6 kg (average of mean values = 80.2 kg) and leg press, with a range of loads from 172.8 to 647.0 kg (average of mean values = 350.3 kg). The number of repetitions in the pull-up test was measured in various studies, with results ranging from 4.8 to 12.1 repetitions (average of mean values = 8.2 repetitions). Hand grip isometric strength was performed in most of the studies, with results varying from 24.1 to 65.3 kg (average of mean values = 52.6 kg). Moreover, leg and back chain isometric strength was assessed using dynamometers, with values from 116.5 to 172.7 kg (average of mean values = 157.2 kg).

Table 3

Main results of studies with experimental design.*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Stamford et al., 1978 (71)	*n* = 75 (69 M and 7 W); 24.7 ± 4.4 y/United States	%BF hydrostatic weighing = pre (M) 17.7 ± 4.5 (W) 25.1 ± 4.1 post (M) 15.8 ± 3.8 (W) 23.9 ± 3.2	$\dot{V}O_2$max CE (ml·kg^{-1}·min^{-1}) = pre 36.5 ± 5.8 (M) and 29.3 ± 4.2 (W), post 44.3 ± 5.8 (M) and 42.7 ± 3.0 (W);	Pull-up (rep) = pre 5.2 ± 3.3 (M) and 27.3 ± 3.6 (W), post 6.4 ± 3.8 (M) and 30.7 ± 1.9 (W)	N/A	N/A	N/A	N/A	N/A	N/A
Norris et al., 1990 (56)	*n* = 100 M; 20–50 years/ England	N/A	1-mile run (min): aerobic group = pre 11.3 ± 2.0, post 10.0 ± 1.5; anaerobic group = pre 12.0 ± 1.0, post 11.9 ± 1.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Harrell et al., 1993 (29)	*n* = 187 (152 M and 35 W); 26.4 and 26.8 y/United States	%BF skinfold thickness = pre (M) 17.0 ± 6.9 (W) 27.0 ± 6.9, post (M) 14.8 ± 6.0 (W) 25.0 ± 7.1	N/A	1RM BP (lbs) = pre 184.1 ± 51.6 (M) and 79.7 ± 15.9 (W), post 198.3 ± 52.1 (M) and 95.8 ± 16.6 (W)	N/A	Sit-up (rep/60 s) = pre 37.7 ± 8.8 (M) and 30.9 ± 7.1 (W), post 48.7 ± 9.6 (M) and 43.9 ± 6.7 (W)	Sit and reach (cm) = pre 18.8 ± 3.2 (M) and 20.8 ± 3.2 (W), post 19.8 ± 3.0 (M) and 21.4 ± 2.9 (W)	N/A	N/A	N/A
Copay and Charles, 1998 (12)	*n* = 556 (506 M and 50 W); 20–59 y/United States	%BF skinfold thickness = pre 19.5 ± 2.3, post 10 wk 18.5 ± 4.5.	N/A	Hand grip right (kg) = pre 54.6 ± 9.8 kg, post 10 wk 54.2 ± 9.3	N/A	N/A	N/A	N/A	N/A	N/A
Sorensen et al., 2000 (68)	*n* = 100 M; 49 (range 42–61) y/Finland	N/A	$\dot{V}O_2$max estimated CE (ml·kg^{-1}·min^{-1}) = pre 42.8 ± 10.1, post 38.4 ± 8.3	Pull-up (rep) = pre 5.0 ± 3.4, post 4.0 ± 4.0	N/A	Push-up (rep/30 s) = pre 25.5 ± 8.5, post 18.6 ± 9.9; sit-up (rep/30 s) = pre 20.9 ± 3.4, post 17.5 ± 5.6	N/A	N/A	N/A	N/A
Boyce et al., 2009 (9)	*n* = 327 (297 M and 30 W); 24.6 ± 3.4 y (initial recruitment) and 37.1 ± 3.7 y (in-service) post average 12.5 ± 2.0 y between tests/ United States	N/A	N/A	Pre: 1RM BP (kg) = (M) 85.6 ± 21.8 (W) 37.8 ± 5.7; 1RM/BM = (M) 1.0 ± 0.2 (W) 0.7 ± 0.1; follow-up 12.5 y: 1RM BP (kg) = (M) 99.1 ± 20.8 (W) 42.6 ± 7.8; 1RM/BM = (M) 1.1 ± 0.2 (W) 0.7 ± 0.10	N/A	N/A	N/A	N/A	N/A	N/A
		N/A	1.5-mile run (min) = pre 11.3 ± 1.0	Pull-up (rep) = pre 7.7 ± 4.4 (M) and	N/A	Push-up (rep) = pre 37.7 ± 9.4 (M) and	N/A	N/A	300-m sprint (*s*) = pre 46.3 ± 2.6 (M)	N/A

Table 3
Main results of studies with experimental design.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Knapik et al., 2011 (37)	*n* = 6,298 (pre and post tests: 2,580 M and 655 W)/United States		(M) and 12.7 ± 1.2, post 10.8 ± 0.9 (M) and 12.0 ± 0.9 (W)	0.9 ± 1.9 (W), post 8.4 ± 4.5 (M) and 1.1 ± 2.2 (W)		19.8 ± 8.9 (W), post 40.6 ± 8.9 (M) and 23.6 ± 7.3 (W); sit-up (rep/60 s) = pre 45.9 ± 5.4 (M) and 44.5 ± 6.9 (W), post 50.2 ± 4.2 (M) and 49.8 ± 4.2 (W)			and 56.6 ± 3.7 (W), post 45.3 ± 2.4 (M) and 54.9 ± 3.5 (W)	
Hage and Reis Filho, 2013 (28)	*n* = 82 M; 23.7 ± 2.1 y/Brazil	N/A	$\dot{V}O_2$max estimated Cooper (ml·kg^{-1}·min^{-1}) = pre 45.9 ± 5.8, post 12 wk 50.2 ± 4.3	Pull-up (rep) = pre 7.5 ± 2.3, post 12 wk 10.3 ± 3.0	N/A	Push-up (rep) = pre 34.4 ± 4.3, post 12 wk 39.7 ± 5.8; sit-up (rep) = pre 67.0 ± 14.1, post 12 wk 79.4 ± 20.9	N/A	N/A	N/A	N/A
Silveira et al., 2014† (66)	*n* = 32 M—placebo (P—*n* = 12), glutamine (G—*n* = 10), creatine (C—*n* = 10); 18–30 years/Brazil	N/A	$\dot{V}O_2$max estimated Cooper (ml·kg^{-1}·min^{-1}) = pre P = 46.9 ± 4.6, C = 48.3 ± 4.5, G = 48.4 ± 5.1	N/A	Horizontal jump (cm) = pre P = 227.4 ± 22.1, C = 223.1 ± 14.6, G = 218.3 ± 18.3	Push-up (rep) = pre P = 38.4 ± 7.2, C = 36.6 ± 5.4, *G* = 42.2 ± 10.4; sit-up (rep) = pre P = 38.9 ± 5.8, C = 41.6 ± 4.7, G = 40.8 ± 7.1	Sit and reach (cm) = P = 31.5 ± 6.4, C = 34.4 ± 6.7, G = 31.5 ± 9.7	N/A	N/A	Shuttle run (s) = pre P = 9.9 ± 0.5, C = 9.9 ± 0.3, G = 9.9 ± 0.3
Dias et al., 2015 (22)	*n* = 13 M; 25 ± 3 y/Brazil	N/A	$\dot{V}O_2$max TM (ml·kg^{-1}·min^{-1}) = pre 46.5 ± 4.5, post 18 wk 51.2 ± 3.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
McGill et al., 2015† (50)	*n* = 53 M; 37.9 ± 5.0 yrs/Canada	N/A	N/A	Pre: pull-up (rep) = 11.6 ± 4.6 (injured) and 10.6 ± 2.8 (noninjured); right hand grip (kg) = 56.0 ± 6.6 (injured) and 55.9 ± 9.2 (noninjured); left hand grip (kg) = 54.0 ± 4.0 (injured) and 52.6 ± 8.3 (noninjured)	N/A	Pre: sit-up static (s) = 162.4 ± 77.6 (injured) and 131.3 ± 46.0 (noninjured); back extention = 101.7 ± 27.4 (injured) and 108.0 ± 28.6 (noninjured)	N/A	N/A	N/A	N/A
Wu et al., 2015 (77)	*n* = 51 (41 M and 10 W); 26.6 ± 3.7 y/United States	%BF NR = pre 17.0 ± 6.3 post 16.5 ± 5.6.	1.5-mile run (s) = pre 710.6 ± 67.3, post 641.2 ± 84.2	N/A	N/A	Sit-up (rep/NR) = pre 36.1 ± 8.0, post 45.0 ± 6.0	Sit and reach (cm) = pre 17.3 ± 2.4, post 19.9 ± 2.1	N/A	N/A	N/A

Table 3
Main results of studies with experimental design.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
Cocke et al., 2016 (11)	*n* = 61 M; 27.5 ± 5.5 y/United States	%BF skinfold thickness = pre RTG = 17.8 ± 5.7; PTG = 16.7 ± 6.2; post 6-mo RTG = 14.5 ± 4.5, PTG = 13.5 ± 4.1	2.4-km run (min) = pre RTG = 12.5 ± 1.4, PTG = 11.5 ± 1.4; post 6-mo RTG = 11.1 ± 1.2, PTG = 10.9 ± 1.2	1RM BP (kg) = pre RTG = 88.5 ± 23.7, PTG = 106.2 ± 15.2, post 6-mo RTG = 101.1 ± 21.6, PTG = 113.0 ± 20.1	Vertical jump (cm) = pre RTG = 55.3 ± 10.7, PTG = 64.5 ± 8.6; post 6-mo RTG = 62.7 ± 8.6, PTG = 64.3 ± 9.2.	Push-up (rep/60 s) = pre RTG = 49.0 ± 15.2, PTG = 53.5 ± 14.4; post 6-mo RTG = 70.6 ± 12.0, PTG = 70.2 ± 13.7; sit-up (rep/60 s) = pre RTG = 34 ± 9, PTG = 42.3 ± 8.5, post 6-mo RTG = 46.4 ± 5.4, PTG = 51.8 ± 5.2	N/A	N/A	300-m run (s) = pre RTG = 53.4 ± 5.0, PTG = 51.8 ± 4.2; post 6-mo RTG = 48.2 ± 4.0, PTG = 49.8 ± 4.0	N/A
Crawley et al., 2016 (13)	*n* = 55 (49 M and 6 W); 23 ± 3 y/United States	%BF skinfold thickness = pre 13.6 ± 6.5, post 16 wk NR	0.5-mile shuttle run test (s) = pre 233 ± 19, post 16 wk 221 ± 17	1RM BP (kg) = pre 85 ± 28, post 16 wk NR; right hand grip (kg) = pre 53 ± 11, post 16 wk NR; left hand grip (kg) = pre 50 ± 12, post 16 wk NR	Vertical jump (cm) = pre 57.1 ± 12.1, post 16 wk 61.2 ± 10.2.	Push-up (rep/60 s) = pre 44 ± 15, post 16 wk 51 ± 15; sit-up (rep/60 s) = pre 43 ± 8, post 16 wk = 49 ± 7	Sit and reach (cm) = 28.4 ± 8.3, post 16 wk NR	T-test (s) = pre 11.5 ± 1.5, post 16 wk 11.0 ± 1.1	40-yard (s) = pre 5.6 ± 0.5, post 16 wk 5.4 ± 0.3	Arm crank peak power/BM ($W \cdot kg^{-1}$) = pre 2.2 ± 0.7, post 16 wk 2.4 ± 0.5; Wingate anaerobic test peak power/BM ($W \cdot kg^{-1}$) = pre 10.2 ± 1.9, post 16 wk 10.8 ± 1.6
Orr et al., 2016 (59)	*n* = 287; age NR/Australia	N/A	Session 1: 20-m MSFT (shuttles) = pre GC = 63.4 ± 17.3, GI = 60.9 ± 17.4; post GC = 65.4 ± 18.3, GI = 63.0 ± 19.2. Session 2: 20-m MSFT (shuttles) = pre GC = 63.3 ± 15.7, GI = 61.0 ± 16.5, post GC = 67.5 ± 16.0, GI = 70.1 ± 16.5.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Araujo et al., 2017 (2)	*n* = 86 M; 24.0 ± 3.0 y/Brazil	N/A	$\dot{V}O_2max$ estimated Cooper ($ml \cdot kg^{-1} \cdot min^{-1}$) = pre 44.9 ± 5.3, post 54 wk 53.1 ± 3.6	Pull-up (rep/60 s) = pre 6.3 ± 3.5, post 54 wk 8.6 ± 2.9	N/A	Sit-up (rep/60 s) = pre 39.6 ± 3.7, post 54 wk 47.5 ± 3.9	N/A	N/A	50-m sprint (s) = pre 7.2 ± 0.4, post 54 wk 6.8 ± 0.3	N/A
Maupin et al., 2018 (48)	*n* = 47 M; age NR/Australia	N/A	20-m MSFT (shuttles) = pre 72.6 ± 11.8, post	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3
Main results of studies with experimental design.* *(Continued)*

Author, year of publication	Sample and country	Body composition	Aerobic capacity	Strength	Power	Muscular endurance	Flexibility	Agility	Speed	Anaerobic capacity
			13 mo 77.5 ± 11.5; $\dot{V}O_2$max estimated (ml·kg^{-1}·min^{-1}) = pre 51.1 ± 3.6, post 13 mo 52.6 ± 3.5							

*1RM = 1 repetition maximum; BF = body fat; BM = body mass; BP = bench press; CE = cycle ergometer; DEXA = dual-energy x-ray absorptiometry; GC = group control; GI = group intervention; LP = leg press; M = men; MSFT = multistage fitness test; N/A = not available; NR = not reported; PTG = periodized training group; RTG = randomized training group; TM = treadmill; $\dot{V}O_2$max = maximal oxygen uptake; $\dot{V}O_2$peak = peak oxygen uptake; W = women; † = only pre test data.

Power was also measured considered measured with various methods, including vertical jump height performance (average of mean values = 48.3 cm; range from 34.9 to 64.5 cm) and horizontal jump performance (average of mean values = 216.1 cm; range from 180 to 245 cm).

Regarding muscular endurance, the trunk and upper limbs were most predominantly measured. The sit-up performed during 60 seconds was used to evaluate the trunk muscular endurance, with the number of repetitions completed varying from 28.0 to 60.3 repetitions (average of mean values = 40.5 repetitions). Also, the maximal number of repetitions of the push-up performed in 60 seconds was reported in a number of studies (range from 19.8 to 55.6 repetitions; average of mean values = 37.3 repetitions).

Flexibility was measured in 14 studies by the sit and reach test (average of mean values = 30.8 cm; range from 17.3 to 75.0 cm).

Agility and speed were measured with various methods in the studies, and anaerobic capacity was measured in 3 studies, with different methods.

Discussion

This review aims to investigate and describe the studies measuring the physical fitness of police officers. The major findings are that most of the publications measured on aerobic capacity, strength, and muscular endurance, and to a lesser extent, flexibility, power, speed, agility, and body composition. Overall, the mean values found are within the normality of the general population, but there is a heterogeneity among the protocols used to measure the components of the physical fitness of police populations.

Among the components of physical fitness, cardiorespiratory fitness is an important parameter of health and has implications for exercise prescription among police officers (26,43,47). Within the police service, this variable is relevant because it contributes to the performance their duties, such as pursuits on foot, fighting against offenders, and removal of victims in accidents (4,74). Despite that, the information regarding the cardiorespiratory fitness is useful for trainers and police officers who desire to reduce cardiovascular risk factors and improve the ability to perform specific tasks with no excessive fatigue (4,74).

Twenty-one studies measured oxygen consumption ($\dot{V}O_2$max) directly, which is considered the gold standard for this type of assessment. However, not all studies used this method of measurement because it is associated with high cost and requires sophisticating equipment (treadmill and gas analyzer). By contrast, in other studies (n = 18), the indirect method was used to assess aerobic power, which is widely used because of its application and low cost, although it is not considered to provide the most exact measures of aerobic capacity. It has been previously found that a strong correlation between the $\dot{V}O_2$max obtained directly and indirectly exists (39). The reliability of the indirect measure, however, is questionable, and values derived from indirect measurements may be underestimations or overestimations depending on the test used (60). Nonetheless, field tests measuring aerobic capacity were used with different parameters (i.e., distance, time, and shuttles).

According to reference values for the general population, the $\dot{V}O_2$max (41.3 ml·kg^{-1}·min^{-1}) of the most officers evaluated in these articles used in this review would be classified as having "good" aerobic power (32). In the context of police work, a low cardiorespiratory fitness may impair the effectiveness of the security service provided and can also endanger the life of the professional (1). In this context, police agencies should design strength

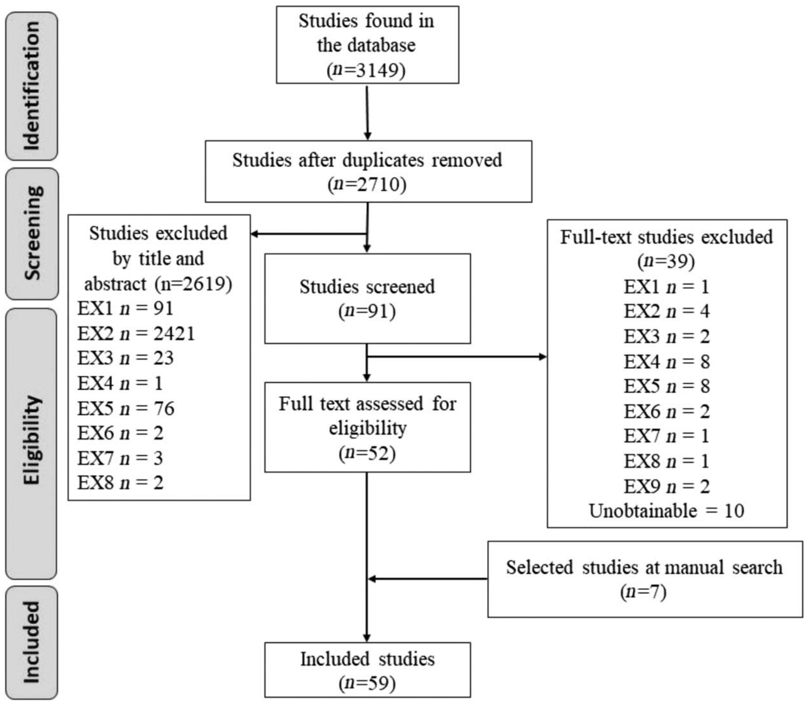

Figure 1. PRISMA study selection flowchart. EX1 = not original research in humans, EX2 = not police officer population, EX3 = provided exclusively, results of operations or specific tests, EX4 = not physical fitness measured objectively, EX5 = presented missing or incomplete data, EX6 = other language, EX7 = not relationship of topic, EX8 = exclusively measure of body composition, EX9 = repeated results.

and conditioning programs aimed at developing and maintaining cardiorespiratory fitness of their agents. Previously, studies performing interventions with this population reported an improvement in cardiorespiratory fitness after a training period (2,13,28).

A high musculoskeletal capacity is positively associated with health and presents benefits against chronic diseases (18,38) as well as being related to operational tasks (4). Most studies included in this review evaluated muscular endurance by the number of sit-ups and push-ups performed. However, the comparison of results between studies is difficult because of the different evaluation methods used. Some studies assessed the muscular endurance by the maximum number of repetitions performed in 1 minute, while others assessed a period of 30 seconds.

Nevertheless, more information regarding muscular endurance is important because police officers often need this component to transport external load (body armor, weapons, and other equipment) for long periods in their shift (1,6).

Some studies have evaluated subjects' strength based on 1RM, and others used isometric strength measurement for hand grip. It is known that muscle strength plays a key role in health and in prevention of disease and exercises focusing on this component are recommended in training programs for tactical personal (27). In addition, the isometric handgrip strength also is important and is considered a predictor of mortality (55). Therefore, it is an important to measure the muscular strength as part of physical fitness batteries because it is a required component of activities of the police profession (e.g., rescues and confrontations) (4).

The mean among studies for isometric handgrip strength was 52.6 kg, which is within the reference parameters for such a measure (7). Regarding the values of 1RM tests, the mean for the bench press exercise was 80.2 kg, which is within the 50 and 70 percentiles depending on age (32). In this sense, the strength training presents improvement in the health of the policemen (12,13,77) and the performance of specific tasks (1,4), e.g., during bodily combat or restraint of a suspect who resists an arrest.

Flexibility is an important measure related to physical fitness as joint mobility is directly linked to the individual's ability to safely perform their daily activities (51). Among police officers, flexibility is necessary because it can assist in running tasks reliably and specific tasks related to their professional requirements, such as squatting to go through physical barriers (19,47,74).

According to the reference values for the general population, the flexibility of the studied police officers found (30.8 cm) is classified as "regular" for men and as "good" for women (32). However, these values may not represent the population studied because flexibility was evaluated in only a few articles, making it difficult to determine an exact reference values for the police. Because flexibility decreases with aging (51), it is essential to implement interventions aiming to improve or maintain such capacity for the members of public safety because of the importance of the mobility for the execution of daily tasks (25). Thus, the inclusion of flexibility in training programs for this population is important because, specifically for police work, it can increase the capacity of law enforcement officers to meet their occupational demands, which may reduce functional limitations (1,77).

One of the strengths of this study relates to the pioneering results of this review. Other reviews only reported anthropometric indicators of obesity in police officers (14) or were limited to cite tests used without reporting the results of the evaluation of physical fitness in military and agent safety officers (31). Therefore, this is the first systematic review that provides objective figures of physical fitness components of police officers.

Regarding the limitations of this review, we can mention the impossibility of major comparisons between studies because the tests used in the studies are not equivalent, limiting the information about the variables and their real importance for the police. Another limiting factor was the exclusion of studies that have evaluated physical fitness through specific tests to the sample concerned. However, the comparison would become even more unfeasible because of the diverse types of tests found in the literature (4,15,53,70).

Further research is suggested to assess the effects of excessive loads being carried by police (e.g., ballistic vest and weapons) on the components of physical fitness. Thus, security institutions will be aware of the consequences their equipment entail on the performance of police tasks and can readjust their programs of physical exercise to police's reality.

Another possible research area in the target population of this review relates to the use of the functional movement screening because it evaluates dynamic and functional movement patterns that are associated with task performance and the occurrence of musculoskeletal injuries (50).

Practical Applications

This is the first article that has systematically reviewed the existing published data regarding physical fitness of police officers. According to the studies included, the target population was assessed primarily in relation to their aerobic capacity and muscle resistance, which suggests the relevance of these components to police operational tasks. However, when these physical abilities are analyzed, it can conclude that the mean values of the police officers are classified as average or slightly above it when compared with the general population, which does not seem to be ideal, because police officers perform their tasks in different working conditions (e.g., dangerous and physically demanding) of other occupations. Finally, these findings have practical applications for public security agencies and its personnel responsible for the development and implementation of physical programs in policemen population. From this, it is recommended to educate about the importance of the physical fitness of police officers and how this may reflect on performance and their safety, as well the population's safety, in the current scenario.

References

1. Alvar B, Sell K, and Deuster P. Tactical Strength and Conditioning: An Overview. In: *NSCA'S Essentials of Tactical Strength and Conditioning*. Champaign, IL: Human Kinetics, 2017. pp. 1–8.
2. Araujo LGM, Sanches M, Turi BC, and Monteiro HL. Physical fitness and injuries: 54 weeks of physical training among military police officers. *Rev Bras Med Esporte* 23: 98–102, 2017.
3. Arvey RD, Landon TE, Nutting SM, and Maxwell SE. Development of physical ability tests for police officers: A construct validation approach. *J Appl Psychol* 77: 996–1009, 1992.
4. Beck AQ, Clasey JL, Yates JW, Koebke NC, Palmer TG, and Abel MG. Relationship of physical fitness measures vs. occupational physical ability in campus law enforcement officers. *J Strength Cond Res* 29: 2340–2350, 2015.
5. Berria J, Bevilacqua LA, and Daronco LSE. Motor fitness and ability for the work of military police of the special operations battalion. *Salusvita* 30: 89–104, 2011.
6. Blacker SD, Carter JM, Wilkinson DM, Richmond VL, Rayson MP, and Peattie M. Physiological responses of police officers during job simulations wearing chemical, biological, radiological and nuclear personal protective equipment. *Ergonomics* 56: 137–147, 2013.
7. Bohannon RW, Peolsson A, Massy-Westropp N, Desrosiers J, and Bear-Lehman J. Reference values for adult grip strength measured with a Jamar dynamometer: A descriptive meta-analysis. *Physiotherapy* 92: 11–15, 2006.
8. Boyce RW, Jones GR, and Hiatt AR. Physical-fitness capacity and absenteeism of police officers. *J Occup Environ Med* 33: 1137–1143, 1991.
9. Boyce RW, Jones GR, Schendt KE, Lloyd CL, and Boone EL. Longitudinal changes in strength of police officers with gender comparisons. *J Strength Cond Res* 23: 2411–2418, 2009.
10. Boyce RW, Perko MA, Jones GR, Hiatt AH, and Boone EL. Physical fitness, absenteeism and workers' compensation in smoking and non-smoking police officers. *Occup Med* 56: 353–356, 2006.
11. Cocke C, Dawes J, and Orr RM. The use of 2 conditioning programs and the fitness characteristics of police academy cadets. *J Athl Train* 51: 887–896, 2016.
12. Copay AG and Charles MT. Police academy fitness training at the police training institute, university of Illinois. *Polic Int J Police Strateg Manag* 21: 416–431, 1998.
13. Crawley AA, Sherman RA, Crawley WR, and Cosio-Lima LM. Physical fitness of police academy cadets: Baseline characteristics and changes during a 16-week academy. *J Strength Cond Res* 30: 1416–1424, 2016.
14. Da Silva FC, Hernandez SS, Gonçalves E, Arancibia BA, Da Silva Castro TL, and Da Silva R. Anthropometric indicators of obesity in policemen: A systematic review of observational studies. *Int J Occup Med Environ Health* 27: 891–901, 2014.
15. Dawes JJ, Lindsay K, Bero J, Elder C, Kornhauser C, and Holmes R. Physical fitness characteristics of high vs. low performers on an occupationally specific physical agility test for patrol officers. *J Strength Cond Res* 31: 2808–2815, 2017.
16. Dawes JJ, Orr RM, Flores RR, Lockie RG, Kornhauser C, and Holmes R. A physical fitness profile of state highway patrol officers by gender and age. *Ann Occup Environ Med* 29: 1–11, 2017.
17. Dawes JJ, Orr RM, Siekaniec CL, Vanderwoude AA, and Pope R. Associations between anthropometric characteristics and physical performance in male law enforcement officers: A retrospective cohort study. *Ann Occup Env Med* 28: 1–7, 2016.
18. de la Motte SJ, Gribbin TC, Lisman P, Murphy K, and Deuster PA. Systematic review of the association between physical fitness and musculoskeletal injury risk: Part 2—Muscular endurance and muscular strength. *J Strength Cond Res* 31: 3218–3234, 2017.
19. de la Motte SJ, Lisman P, Gribbin TC, Murphy K, and Deuster PA. A systematic review of the association between physical fitness and musculoskeletal injury risk: Part 3—flexibility, power, speed, balance, and agility. *J Strength Cond Res* 2017. Epub ahead of print.
20. Dempsey PC, Handcock PJ, and Rehrer NJ. Impact of police body armour and equipment on mobility. *Appl Ergon* 44: 957–961, 2013.
21. Dempsey PC, Handcock PJ, and Rehrer NJ. Body armour: The effect of load, exercise and distraction on landing forces. *J Sports Sci* 32: 301–306, 2014.
22. Dias RG, Silva MSM, Duarte NE, Bolani W, Alves CR, Junior JRL, et al. PBMCs express a transcriptome signature predictor of oxygen uptake responsiveness to endurance exercise training in men. *Physiol Genomics* 47: 13–23, 2015.
23. Dimitrijevic R, Koropanovski N, Dopsaj M, Vuckovic G, and Jankovic R. The influence of different physical education programs on police students' physical abilities. *Polic Int J Police Strateg Manag* 37: 794–808, 2014.
24. Esteves J, Andrade ML, Gealh L, Andreato LV, and de Moraes SF. Description of the physical condition and cardiovascular risk factors of police officers military vehicles. *Rev Andal Med Deporte* 7: 66–71, 2014.
25. Fernandes ACV, Furtado ABV, Dickel DC, Fantinel EM, and Daronco LSE. Motor skills of the military police of the course of the Training School and Improvement of Sergeants (ESFAS) of the Military Brigade of Santa Maria-RS. *Conexões* 13: 36–52, 2015.
26. Filho GR, Prada JA, Silva GCB, Neto G, Aguirre Neto A, dos Santos FN, et al. Evaluation of cardiorespiratory capacity (vo2max) in military police with indirect tests. *Rev Bras Cienc E Mov* 20: 5–13, 2012.
27. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Med Sci Sports Exerc* 43: 1334–1359, 2011.
28. Hage CCE and Reis Filho AD. Analysis of the physical performance and anthropometric profile of the students of the PM / MT-CEsp training course of soldiers through 12 weeks of physical training. *Rev Bras Presc Fisiol Exerc* 7: 498–505, 2013.
29. Harrell JS, Griggs TR, Roskin EW, Meibohm AR, and Williams OD. Impact of a 12-week aerobic exercise and weight program for law enforcement trainees. *Am J Health Promot* 7: 410–420, 1993.
30. Heneweer H, Picavet HSJ, Staes F, Kiers H, and Vanhees L. Physical fitness, rather than self-reported physical activities, is more strongly associated with low back pain: Evidence from a working population. *Eur Spine J* 21: 1265–1272, 2012.

31. Herrador-Colmenero M, Fernández-Vicente G, and Ruiz JR. Assessment of physical fitness in military and security forces: A systematic review. *Eur J Hum Mov* 32: 3–38, 2014.
32. Heyward VH. Assessment of cardiorespiratory fitness. In: *Physical Evaluation and Exercise Prescribing Advanced Techniques*. Porto Alegra, Brazil: ArtMed, 2004. pp. 85–121.
33. House PB. Amnesty International UK: Annual Report 2015.
34. de Amaral Júnior AT, Medeiros RJD, dos Santos Oliveira L, Ferreira LA, and de Sousa Mdo SC. Comparison of the maximum oxygen consumption (VO2max) of military personnel working on patrol and guarding. *Fit Perform J* 8: 90–95, 2009.
35. Kayihan G, Ersoz G, Ozkan A, and Koz M. Relationship between efficiency of pistol shooting and selected physical-physiological parameters of police. *Polic Int J Police Strateg Manag* 36: 819–832, 2013.
36. Kayihan G, Ozkan A, Koklu Y, Eyuboglu E, Akca F, Koz M, et al. Comparative analysis of the 1-mile run test evaluation formulae: Assessment of aerobic capacity in male law enforcement officers aged 20–23 years. *Int J Occup Med Environ Health* 27: 165–174, 2014.
37. Knapik JJ, Spiess A, Swedler D, Grier T, Hauret K, Yoder J, et al. Retrospective examination of injuries and physical fitness during Federal Bureau of Investigation new agent training. *J Occup Med Toxicol* 6: 1–11, 2011.
38. Kraschnewski JL, Sciamanna CN, Poger JM, Rovniak LS, Lehman EB, Cooper AB, et al. Is strength training associated with mortality benefits? A 15year cohort study of US older adults. *Prev Med* 87: 121–127, 2016.
39. Léger L and Gadoury C. Validity of the 20 m shuttle run test with 1 min stages to predict VO2max in adults. *Can J Sport Sci* 14: 21–26, 1989.
40. Leischik R, Foshag P, Strauss M, Littwitz H, Garg P, Dworrak B, et al. Aerobic capacity, physical activity and metabolic risk factors in firefighters compared with police officers and sedentary clerks. *PLos One* 10: e0133113, 2015.
41. Leischik R, Foshag P, Strauss M, and Spelsberg N. Left ventricular function and physiological performance in female ironman athletes and female police officers. *Percept Mot Skills* 122: 1002–1022, 2016.
42. Lewinski WJ, Dysterheft JL, Dicks ND, and Pettitt RW. The influence of officer equipment and protection on short sprinting performance. *Appl Ergon* 47: 65–71, 2015.
43. Lisman PJ, de la Motte SJ, Gribbin TC, Jaffin DP, Murphy K, and Deuster PA. A systematic review of the association between physical fitness and musculoskeletal injury risk: Part 1-cardiorespiratory endurance. *J Strength Cond Res* 31: 1744–1757, 2017.
44. Lockie RG, Dawes JJ, Orr RM, Stierli M, Dulla JM, and Orjalo AJ. Analysis of the effects of sex and age on upper- and lower-body power for law enforcement agency recruits before academy training. *J Strength Cond Res* 32: 1968–1974, 2018.
45. Marins E, Silva P, Rombaldi A, and Del Vecchio F. Occupational physical fitness tests for police officers—A narrative review. *TSAC Rep* 50: 26–34, 2018.
46. Marins EF, Cabistany L, Farias C, Dawes J, and Del Vecchio FB. Effects of personal protective equipment on metabolism and performance during an occupational physical ability test for federal highway police officers. *J Strength Cond Res*, 2018. Epub ahead of print.
47. Marins EF, and Del Vecchio FB. Health Patrol Program: Health Indicators in Federal Highway Patrol. *Sci Med* 27: ID25855, 2017.
48. Maupin D, Robinson J, Wills T, Irving S, Schram B, and Orr R. Profiling the metabolic fitness of a special operations police unit. *J Occup Health* 60: 356–360, 2018.
49. McGill S, Frost D, Lam T, Finlay T, Darby K, and Andersen J. Fitness and movement quality of emergency task force police officers: An age-grouped database with comparison to populations of emergency services personnel, athletes and the general public. *Int J Ind Ergon* 43: 146–153, 2013.
50. McGill S, Frost D, Lam T, Finlay T, Darby K, and Cannon J. Can fitness and movement quality prevent back injury in elite task force police officers? A 5-year longitudinal study. *Ergonomics* 58: 1682–1689, 2015.
51. Milanović Z, Pantelić S, Trajković N, Sporiš G, Kostić R, and James N. Age-related decrease in physical activity and functional fitness among elderly men and women. *Clin Interv Aging* 8: 549–556, 2013.
52. Moher D, Liberati A, Tetzlaff J, and Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med* 6: e1000097, 2009.
53. Nascimento Neto do LI, da Silva Machado DG, Agrícola PMD, de Junior Farias LF, et al. Effect of physical effort on police shooting performance military battalion. *Rev Bras Med Esporte* 23: 109–113, 2017.
54. Nocon M, Hiemann T, Müller-Riemenschneider F, Thalau F, Roll S, and Willich SN. Association of physical activity with all-cause and cardiovascular mortality: A systematic review and meta-analysis. *Eur J Cardiovasc Prev Rehabil* 15: 239–246, 2008.
55. Norman K, Stobäus N, Gonzalez MC, Schulzke JD, and Pirlich M. Hand grip strength: Outcome predictor and marker of nutritional status. *Clin Nutr Edinb Scotl* 30: 135–142, 2011.
56. Norris R, Carroll D, and Cochrane R. The effects of aerobic and anaerobic training on fitness, blood pressure, and psychological stress and well-being. *J Psychosom Res* 34: 367–375, 1990.
57. Orr R, Pope R, Peterson S, Hinton B, and Stierli M. Leg power as an indicator of risk of injury or illness in police recruits. *Int J Environ Res Public Health* 13: 237–246, 2016.
58. Orr R, Pope R, Stierli M, and Hinton B. Grip strength and its relationship to police recruit task performance and injury risk: A retrospective cohort study. *Int J Environ Res Public Health* 14: 941–951, 2017.
59. Orr RM, Ford K, and Stierli M. Implementation of an ability-based training program in police force recruits. *J Strength Cond Res* 30: 2781–2787, 2016.
60. Peserico CS, Mezzaroba PV, Nogueira GA, de Moraes SMF, and Machado FA. Comparison between direct and indirect methods of determining the maximum consumption of oxygen in female runners. *Rev Bras Med Esporte* 17: 270–273, 2011.
61. Pryor RR, Colburn D, Crill MT, Hostler DP, and Suyama J. Fitness characteristics of a suburban special weapons and tactics team. *J Strength Cond Res* 26: 752–757, 2012.
62. Santos JAB, da Silva RG, Browne RAV, Sales MM, Russo AF, and Segundo PR. Level of corporal adiposity and physical fitness of Military Police of Boa Vista-Roraima. *Rev Bras Presc Fisiol Exerc* 7: 21–28, 2013.
63. Santos MR and Filho JF. Study of the dermatological, somatostatic profile and physical qualities of police officers of the special operations battalion (PMERJ) of the year 2005. *Fit Perform J* 6: 98–104, 2007.
64. Sassen B, Cornelissen VA, Kiers H, Wittink H, Kok G, and Vanhees L. Physical fitness matters more than physical activity in controlling cardiovascular disease risk factors. *Eur J Cardiovasc Prev Rehabil* 16: 677–683, 2009.
65. Shusko M, Benedetti L, Korre M, Eshleman EJ, Farioli A, Christophi CA, et al. Recruit fitness as a predictor of police academy graduation. *Occup Med* 67: 555–561, 2017.
66. Silveira CL, Paiva de Souza TS, Batista GR, de Araujo AT, Gomes da Silva JC, Cirilo de Sousa MdoS, et al. Is long term creatine and glutamine supplementation effective in enhancing physical performance of Military Police Officers? *J Hum Kinet* 43: 131–138, 2014.
67. Smolander J, Louhevaara V, and Oja P. Policemen's physical fitness in relation to the frequency of leisure-time physical exercise. *Int Arch Occup Environ Health* 54: 295–302, 1984.
68. Sorensen L, Smolander J, Louhevaara V, Korhonen O, and Oja P. Physical activity, fitness and body composition of Finnish police officers: A 15-year follow-up study. *Occup Med Oxf* 50: 3–10, 2000.
69. Sperlich B, Krueger M, Zinner C, Achtzehn S, de Marees M, and Mester J. Oxygen uptake, velocity at lactate threshold, and running economy in elite special forces. *Mil Med* 176: 218–221, 2011.
70. Spitler DL, Jones G, Hawkins J, and Dudka L. Body composition and physiological characteristics of law enforcement officers. *Br J Sports Med* 21: 154–157, 1987.
71. Stamford BA, Weltman A, Moffatt RJ, and Fulco C. Status of police officers with regard to selected cardio-respiratory and body compositional fitness variables. *Med Sci Sports* 10: 294–297, 1978.
72. Stanish H, Wood T, and Campagna P. Prediction of performance on the RCMP physical ability requirement evaluation. *J Occup Environ Med* 41: 669–677, 1999.
73. Takken T, Ribbink A, Heneweer H, Moolenaar H, and Wittink H. Workload demand in police officers during mountain bike patrols. *Ergonomics* 52: 245–250, 2009.
74. Thomas M, Pohl MB, Shapiro R, Keeler J, and Abel MG. Effect of load carriage on tactical performance in special weapons and tactics operators. *J Strength Cond Res* 32: 554–564, 2018.
75. Volpino P, Tomei F, La Valle C, Tomao E, Rosati MV, Ciarrocca M, et al. Respiratory and cardiovascular function at rest and during exercise testing in a healthy working population: Effects of outdoor traffic air pollution. *Occup Med Oxf Engl* 54: 475–482, 2004.
76. Wittink H, Takken T, de Groot J, Reneman M, Peters R, and Vanhees L. Assessing peak aerobic capacity in Dutch law enforcement officers. *Int J Occup Med Environ Health* 28: 519–531, 2015.
77. Wu YN, Hallbourg KW, and Collins SM. Changes of general fitness and muscle properties following police cadet training. *J Phys Ther Sci* 27: 2783–2786, 2015.
78. Young DR and Steinhardt MA. The importance of physical fitness versus physical activity for coronary artery disease risk factors: A cross-sectional analysis. *Res Q Exerc Sport* 64: 377–384, 1993.