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Proposal of normative values for the physical evaluation of police officers

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ABSTRACT

Several studies have reported the application of inappropriate assessment protocols to assess physical fitness in police officers (PO) unvalidated cut-off points for this specific group were used. The aim is to propose specific normative values obtained from the application of a battery of physical tests. In addition, the contribution of age, body mass index, and waist perimeter on the results was also evaluated. We performed a descriptive-analytical study in male PO 20 to 39 years of age who participated in a promotion process. Physical fitness was evaluated with handgrip strength, agility test, the Abalakov vertical jump, and a 1000-meter run. The sample included 828 PO with a mean age of 29.90 ± 4.69 years. A percentile classification of the physical tests evaluated is presented as a proposal of normative values for this group. The mean of handgrip strength was 43.97 kg (SD = 5.64); the agility test was performed in 12.11 seconds (SD = 1.11); lower body power was 32.07 cm (SD = 4.74) and the maximum respiratory capacity estimated was 45.34 ml/kg/min (SD = 3.47). Age, body mass index and waist circumference explained 28% of the variance of the maximum respiratory capacity ($p < .01$). The data can be used as a reference for specific decision-making during PO assessment.

Keywords: Occupational health; Fitness testing; Personnel selection; Agility; Muscular strength.

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INTRODUCTION

The evaluation and diagnosis of physical fitness acquire special importance when the results depend on recruitment, selection, physical performance, and promotion processes. Regarding police officers, areas of opportunity have been reported because of the application of unadapted assessment protocols to evaluate physical fitness (Peterson et al., 2016), such as non-optimal cut-off points (Dominski et al., 2018; Bissett et al., 2012; Losty et al., 2016) and the use of diverse tests (Marins et al., 2019) that produce unclear or limited normative assessment standards. The lack of normative validity in establishing standards can mask the problematic situation that affects not only the quality of attention and service efficiency but also the social image of the police officers.

Police activity requires individuals to be prepared to act when facing society's irregular or criminal behaviour (Lipp et al., 2017). In Mexico, the federal code of police conduct establishes that a police force member must develop his maximum abilities, competence, and skills (Código de Conducta de la Policía Federal, 2019). Therefore, in addition to theoretical training, a police officer needs to maintain and improve functional aspects such as physical fitness and body composition. Regarding normative values for first-year police officers, a lack of interaction between age and health-related physical fitness was reported (Stefan et al., 2020); a systematic review on the physical fitness of police officers indicated that the values for this population are on average similar to or higher than those of the general population (Marins et al., 2019).

An increase in physical inactivity has been reported in this group (Yoo et al., 2009), including poor motor ability, obesity and overweight (Berria et al., 2011), and cardiovascular diseases with high morbidity and mortality (Franke et al., 1998; Franke et al., 2002). Thus, the report that this group is potentially affected by diseases such as hypertension, obesity, diabetes, smoking, dyslipidaemia, metabolic syndrome, sedentary lifestyle, and sudden physical and psychological stress (Crawley et al., 2016; Yoo et al., 2009). In work carried out to maintain public security, the life of the employer and other officers belonging to the police force is at risk, and worse still, the life of civilians (Berria et al., 2011; Peterson et al., 2016).

Locke (2020) states the need for modified or adapted tests to assess physical fitness in this group. Given the lack of national reports to guide evaluation, this work represents the first effort to establish physical performance parameters for police officers in the Mexican context. Therefore, it was proposed to present the results of applying a battery of specific physical tests for police officers in percentiles to provide a basis for identifying normative values for this group. In addition, hypotheses were established regarding the contribution of age, body mass index, and waist circumference to the results of physical tests.

MATERIAL AND METHODS

A descriptive cross-sectional study was designed, with a sample of policemen officers that was participating in a promotion and permanence process of the state police of Nuevo Leon, Mexico. Ages of 20 and 39 years, who obtained medical approval with the Spanish version of the Revised Physical Activity Readiness Questionnaire (PAR-Q+; Adams, 1999) and who agreed to participate voluntarily in the study were included. Participants who did not complete a test were excluded. All participants signed written informed consent before the evaluation.

The project was approved by the Ethics and Research Committee of the Research Coordination of the School of Sports Organization of the Autonomous University of Nuevo León. From a population of 870 candidates participating in the promotion process, only 828 officers met the selection criteria and were considered for the analyses. Body composition, maximum grip strength, agility, vertical jump, and time of a 1000-m run were evaluated on the same day and in the same order. The participants' data that led to a ceiling effect were eliminated to analyses homogeneous information, considering a Z-score of 2.5 for body composition and physical tests.

Measurements

Participants were asked to abstain from eating three hours before the measurement and empty their bladder. Height was measured with a stadiometer (20-205 cm ± 5 mm; SECA 225; London, England) and body weight with a Tanita scale (TBF-410, 2-200 ± 0.1 kg; Arlington Heights, IL, USA). Body mass index was estimated with the person's weight divided by the square of height. The waist circumference was measured between the lower point of the last rib and the upper point of the participant's iliac crest with a Lufkin anthropometric measuring tape (6 mm x 2 m, Apex Tool Group, Sparks, MD, USA). A waist circumference greater than 90 centimetres was considered a morbidity risk in accordance with the provisions of the Official Mexican Standard 043-SSA2-2012.

Physical tests

The maximum handgrip strength was evaluated using a JAMAR hydraulic dynamometer (Chicago, IL, USA). The participant was asked to maintain each squeeze of the handle for one to five seconds. Three attempts with each hand were recorded with one-minute rest intervals between each attempt. The highest value (kg) was used to determine the maximum grip force. The participants performed the test in a standing position with their shoulder adducted and neutrally rotated, the elbow semi-extended (170°) with the forearm and wrist in a neutral position; the grip position was adjusted with the middle finger at a right angle as recommended in the protocol of the Canadian Physical Activity Fitness and Lifestyle Approach.

The hurdles and flags agility circuit, also known as an obstacle course, validated by Gonzales (2008), was used to evaluate the participants' agility. The execution time was tracked with the Witty kit (a timer and photoelectric cells from Microgate, SARL, Italy). The circuit consisted of traveling a previously delimited perimeter in the shortest possible time (Figure 1). Two attempts were made with a three-minute rest between attempts, and the best time of the two was recorded. An attempt was declared void if the subject changed the course or knocked over or displaced a hurdle or cone. On the other hand, if he rubbed against but did not displace or knock over either a hurdle or a cone, the attempt was valid; This protocol was adapted from the Spanish National Police Corps (CNP, 2019).

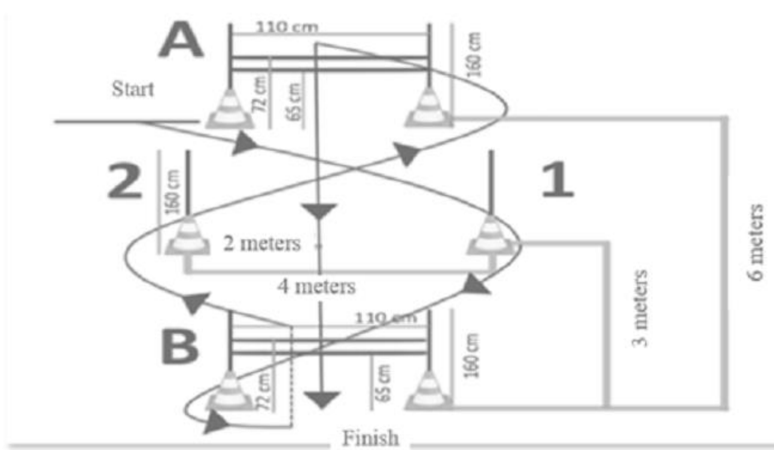

Figure 1. Graphic representation of the hurdles and flags agility circuit.

The Abalakov vertical jump (ABK) was used to assess lower-body power; jump height was quantified with the Microgate (SARL) Optojump System. The participants performed the test in an upright position in the execution zone. They performed flexion and extension, trying to jump as high as possible with free momentum from the arms. Three attempts were made, separated by a 30-second rest period. Of the three jumps, the one with the best flight height and the best jumping technique was considered. This protocol was adapted as suggested by Bosco and Riu (1994).

Respiratory capacity was evaluated over time in the 1000-m run. The participants' objective was to run the distance in the shortest time possible. The execution time was evaluated with a Casio stopwatch (HS-3V-1R, Japan). The validity of this test has been confirmed in the Mexican population (Díaz et al., 2000). For the prediction of maximal oxygen consumption (VO_{2max}), the equation suggested by Murua (2018) was applied: VO_{2max} = 71.662 - 5.850 * the time duration of the test in minutes (value expressed in ml/kg/min). The VO_{2max} was estimated using the time duration.

Statistical analysis

The collected data were processed with the SPSS 21.0 statistical program. Outliers were visually identified (scatter plots) with a Z-score < 2.5 as an acceptable value. Inter-rater reliability was assessed by the technical error of measurement in piloting carried out by three exercise science professionals with individuals with characteristics similar to those of the final sample. Reproducibility was determined with the Pearson correlation coefficient (r) with values of 0.84 to 0.96. After assessing data quality, descriptive statistics were performed using the arithmetic mean and the standard deviation (SD). The significance of the differences was determined with the Kruskal-Wallis test. A punctual and graphical description of seven percentiles is presented: P5, P10, P25, P50, P75, P90, and P95.

Additionally, linear regression analyses were developed to explore the effects of age, body mass index, and waist circumference in relation to the physical test results in the entire sample. Compliance with the criteria of linearity, normality, independence of errors, and homoscedasticity was reviewed. A p-value < .05 was considered statistically significant.

RESULTS

The age and body composition of the sample population is shown in Table 1. The data had a homogeneous distribution regarding the height between groups (p > .05). Body composition suggests that, on average, only the participants from the 20 to 24 age group were free of morbidity risk with respect to waist circumference (< 90 cm).

Table 1. Characteristics of the sample by age range and the complete sample of police officers aged 20 to 39 years from Nuevo Leon, Mexico.

Age group (years)	***n***	**Age** (years)	**Weight** (kg)	**Height** (cm)	**BMI (kg/m²)**	**Waist** (cm)
20-24	120	23.13 ± 0.81	78.03 ± 12.35	171.06 ± 5.55	26.64 ± 3.81	88.54 ± 8.99
25-29	292	26.97 ± 1.38	79.61 ± 11.30	171.07 ± 5.73	27.18 ± 3.41	90.81 ± 8.11
30-34	255	32.13 ± 1.40	79.02 ± 10.76	170.94 ± 5.31	27.02 ± 3.27	90.97 ± 8.03
35-39	161	36.73 ± 1.39	82.31 ± 10.45	171.83 ± 5.17	27.86 ± 3.10	93.58 ± 7.77
Todos	828	29.90 ± 4.69	79.72 ± 11.20	171.18 ± 5.47	27.19 ± 3.39	91.07 ± 8.27

Note. BMI = body mass index. Values are presented with Mean ± SD.

The maximum handgrip strength mean was 43.97 kg (SD = 5.64). The police officers completed the agility test in 12.11 seconds (SD = 1.11), while in the lower body power test, the mean was 32.07 cm (SD = 4.74). The mean maximum respiratory capacity estimated was 45.34 ml/kg/min (SD = 3.47). A detailed description of the results by percentiles is presented in Table 2.

Table 2. Percentile values of the maximum handgrip strength test, agility, lower body power, 1000-meter run time, and the maximum respiratory capacity by age range in police officers between 20 and 39 years of age from Nuevo Leon, Mexico.

Age group (years)	*M* ± *DE*	P5	P10	P25	P50	P75	P90	P95
Grip strength (kg)								
20-24	43.24 ± 5.23	35.05	36	40	42	47.75	50	52
25-29	44.11 ± 5.94	34	36	40	44	48	50.7	54.35
30-34	43.80 ± 5.53	36	38	40	44	48	50.4	54
35-39	44.53 ± 5.55	36.1	38	40	44	49	52	54
Agility (s)								
20-24	12.10 ± 1.11	10.21	10.78	11.3	12.16	12.83	13.58	14.09
25-29	12.06 ± 1.07	10.41	10.71	11.32	12.06	12.74	13.48	13.87
30-34	11.99 ± 1.08	10.36	10.63	11.24	11.81	12.65	13.41	13.91
35-39	12.39 ± 1.16	10.59	10.85	11.54	12.4	13.21	13.97	14.33
Lower body strength (cm)								
20-24	31.97 ± 4.74	23.32	25.93	29.03	32	34.8	38.29	40.07
25-29	32.54 ± 4.81	24.33	26.43	29.23	32.2	35.68	38.9	41.1
30-34	32.44 ± 4.52	24.92	26.66	29.2	32.3	35.5	38.28	40.12
35-39	30.68 ± 4.73	23.51	24.92	27.1	30.4	34	37.14	38.93
1000-meter run time								
20-24	4:22 ± 30”	5:23	5:04	4:43	4:22	3:56	3:45	3:41
25-29	4:26 ± 35”	5:29	5:09	4:46	4:23	4:01	3:44	3:38
30-34	4:31 ± 34”	5:36	5:19	4:52	4:27	4:02	3:50	3:40
35-39	4:39 ± 39”	5:55	5:34	5:04	4:34	4:13	3:51	3:44
Maximum respiratory capacity estimated (ml/kg/min)								
20-24	46.05 ± 2.99	50.1	49.65	48.57	46.06	44.07	41.99	40.17
25-29	45.65 ± 3.41	50.39	49.78	48.16	45.97	43.73	41.45	39.56
30-34	45.23 ± 3.38	50.13	49.15	47.98	45.57	43.14	40.52	38.82
35-39	44.40 ± 3.86	49.74	49.12	46.95	44.9	41.98	39.06	36.96

Note: P = Percentile. 20-24 age group, n = 120; 25-29 years, n = 292; 30-34 years, n = 255; 35-39 years, n = 161. The average per percentile, group average and standard deviation are presented.

The trend of changes in physical tests between the groups along the different percentiles is presented in Figure 2.

The contribution of age, body mass index and waist circumference to the physical test results is described in Table 3. The body mass index stood out because of its contribution to the agility, jumping, and maximum respiratory capacity results ($p < .01$). Waist circumference contributed to the maximum handgrip strength result ($p < .05$), while the maximum respiratory capacity was affected by age ($p < .05$). Age, body mass index and waist circumference explained 28.2% of the variance of the maximum respiratory capacity.

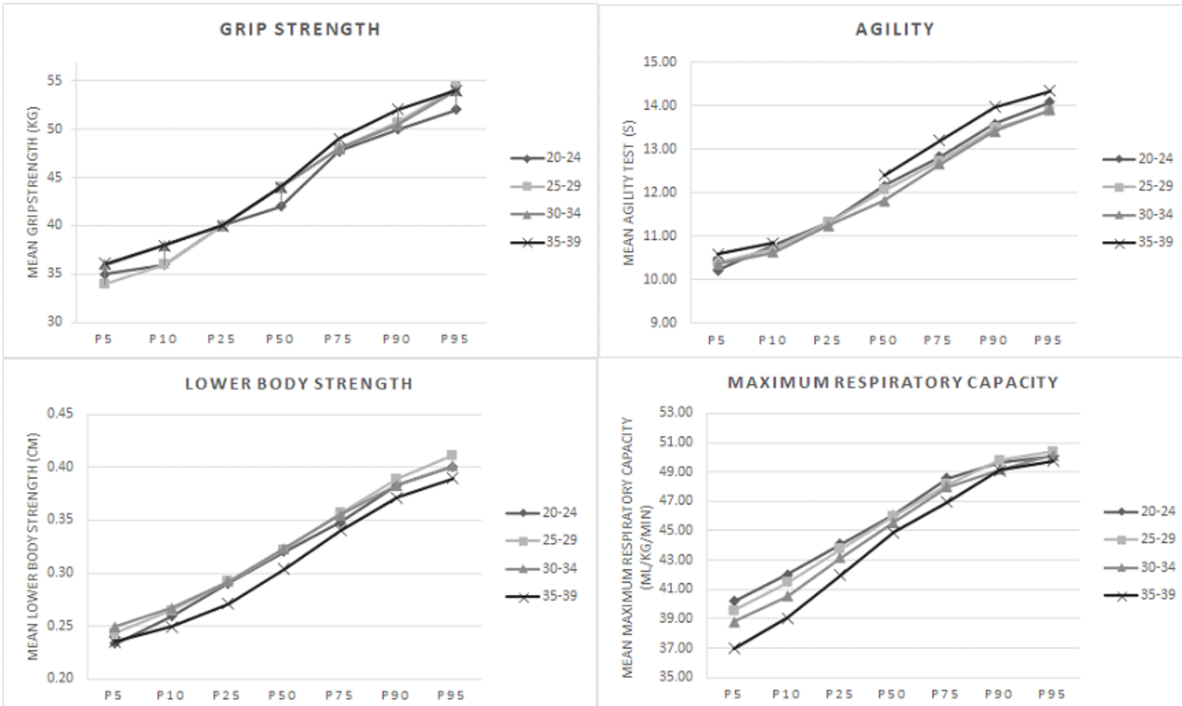

Figure 2. Representation of trends by physical test and category in police officers aged 20 to 39 in Nuevo Leon, Mexico.

Table 3. Regression analysis for maximum grip strength, agility, lower body power, and maximum respiratory capacity.

	b	*SEb*	*ß*	*p*
Grip strength (R^2 = .062)				
Constant	30.658	2.338		0
Age	-0.009	0.041	-0.008	.824
Body mass index	0.076	0.047	0.111	.11
Waist	0.245	0.115	0.147	.033*
Agility (R^2 = .093)				
Constant	8.318	0.45		0
Age	0.001	0.008	0.004	.896
Body mass index	0.045	0.009	0.336	.000**
Waist	-0.012	0.022	-0.037	.584
Lower body strength (R^2 = .095)				
Constant	49.454	1.929		0
Age	-0.041	0.034	-0.041	.228
Body mass index	-0.228	0.039	-0.398	.000**
Waist	0.17	0.095	0.122	.073
Maximum respiratory capacity (R^2 = .282)				
Constant	65.947	1.259		0
Age	-0.046	0.022	-0.062	.039*
Body mass index	-0.185	0.026	-0.44	.000**
Waist	-0.089	0.062	-0.087	.149

*Note. B = coefficients that give weight to the independent variables; SEb = standard error of b; ß are scaled values of b. R^2 adjusted was used. *p < .05, **p < .01.*

DISCUSSION

This study applied a battery of physical tests to explore normative values in police officers and establish reference data for practical application for job selection and promotion and, at the same time, for research. These data form a basis for designing effective interventions to improve each aspect related to physical condition and body composition. The battery of tests includes the evaluation of upper limb strength, lower limb strength, agility, and cardiorespiratory fitness. The applied tests show acceptable values of technical measurement error and high intra- and inter-evaluator reproducibility. It is considered that these tests can be applied in our setting with no inconvenience.

The need to generate body composition and fitness profiles in police officers can improve physical performance and overall professional performance. The published percentiles could be used as reference values according to the following criteria: < P10 = deficient, P10 to P25 = poor, P25 to P50 = fair, P50 to P75 = good, P75 to P90 = very good and > P90 excellent.

The predictive value of the variables related to body composition on the results in physical fitness was determined with regression analysis. The contribution of waist circumference to the maximum grip strength values in police officers was identified. This finding contrasts with Lockie et al. (2020), who reported a lack of association of this variable with the maximum grip strength of both arms in a sample of American recruits. The participants in that sample were younger and weaker than those in this study; also, in the Lockie et al. (2020) project, handgrip strength was performed twice in each hand, while in this project, it was repeated three times. However, the relationship between waist circumference and decline in health and physical fitness has been previously reported by Losty et al. (2016). Therefore, it could be that race and aspects related to measurement are the cause of these differences.

On the other hand, the low predictive value between age and maximum grip strength has been previously reported by Teixeira et al. (2019) in their sample of Portuguese police officers. Likewise, a negative influence was observed between the body mass index and lower limb power, which suggests the effect of excess weight on power. The predictive strength of age and body mass index on maximum respiratory capacity agrees with other reports in the literature (Araujo et al., 2018; Sörensen et al., 2000; Teixera et al., 2019). This finding suggests that older police officers with a greater BMI may have greater difficulty performing tasks that require high oxygen consumption. Thus, BMI negatively affects lower body power. This finding is consistent with previous publications in this population (Lockie et al., 2018; Losty et al., 2016; Teixera et al., 2019). Hence, the higher the BMI or waist circumference, the longer the agility test, implying lower performance.

The intention of seeking sample representativeness caused the results of this study to be limited to the population of male police officers aged 20 to 39 years; future studies should consider female personnel and other age groups. The proposal of batteries of physical tests arises from the need to assess and diagnose physical performance in populations. Given the physical demands of police performance, specific assessment tests and the development of normative tables to verify the relevance of these assessment results are necessary. The results of this research will serve as a reference to direct the evaluation, diagnosis, and training processes in this important professional group.

Although many personal factors can influence the results of a physical assessment, this project sought to control personal characteristics and body composition to obtain homogeneous samples. It is considered that the voluntary factor of the physical tests was minimal because the study participants perceived the need to prove their physical condition to be promoted in their organization. Therefore, the participants should be motivated and in the best conditions to face the physical challenges that the assessment demands.

CONCLUSIONS

The results of this study reflect that obesity and the risk of comorbidity drastically affect this group, highlighting that 85.5% of the participants presented a BMI ≥ 27.00 kg/m2 and a waist circumference ≥ 90.01 cm. Furthermore, it seems that these indicators increase with age and hinder the performance of POs in some physical tests. Security and surveillance organizations can incorporate an assessment of these indicators as parameters in health diagnosis and consider them predictive tools of physical fitness.

The classification of the results by percentiles informs and raises awareness about the optimal, outstanding, or diminished physical characteristics in police officers with higher values than the general population. This classification can improve the selection and permanence processes, considering that this group performs their occupational tasks in settings and conditions different from other occupations.

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