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Original article

Correlation of Morphological Characteristics with Police Specific Fitness Test in Police Students

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Abstract

This research delved into the potential correlation between morphological characteristics and the performance in a police specific physical ability test (PSPAT) among students at the University of Criminal Investigation and Police Studies. Of the 362 third-year students, 164 were female and 198 were male. The study assessed seven morphological traits: body height, body mass, body mass index, body fat, skeletal muscle mass, and their respective percentages. Body composition details were obtained using a multi-channel bioelectric impedance analyser. The Pearson correlation analysis was employed to understand the relationships between these features and the PSPAT outcomes. Results revealed that for female students, body fat, skeletal muscle mass, and their percentages significantly impacted their PSPAT performance. Male students, on the other hand, showed correlations with body fat and its percentage, but not with skeletal muscle mass. Interestingly, there were no significant associations between test results and body height, weight, or body mass index for all subjects. These insights emphasize the crucial role body composition plays in the physical capacities of police students, particularly focusing on the balance of muscle and fat content. This study's findings can inform future student selection, training methods, and the importance of comprehensive body composition assessments.

Keywords: Specialized Physical Education, Body Composition, Obstacle Course, Tactical Strength and Conditioning

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Introduction

Throughout their career, police officers (POs) may face critical incidents requiring high levels of strength, endurance, speed, and/or coordination. The level of basic physical abilities (BPA) and specific physical abilities (SPA) has the strongest impact on POs' work efficiency when the use of force is necessary, as well as when assisting endangered citizens during natural disasters (Strating et al., 2010; Lockie et al., 2020). For professional competencies to be developed, high-quality education of POs at specialized institutions is necessary, within which BPA and SPA can be improved (Dimitrijević et al., 2014; Janković & Dopsaj, 2022). This is significant since, after graduation, police students commence their careers as POs, hence potentially facing tasks the resolution of which is conditioned by their levels of physical ability (Koropanovski et al., 2020).

The selection of candidates at the University of Criminal Investigation and Police Studies (UCIPS) is multilayered. The first, eliminatory step, involved a health check, as well as a morphological and psychological characteristics check. Afterward, candidates are assessed by their high school success. Finally, their knowledge of the Serbian language and literature, general knowledge, as well as basic motor abilities are evaluated (Janković & Koropanovski, 2022). The entrance exam thus defined aims at singling out candidates presumed to possess adequate characteristics that would lead to them being efficient in the course of their studies, which, after education completion, enables them to attain appropriate professional competencies (Koropanovski et al., 2020). Considering the distinctiveness of UCIPS teaching curricula, it is essential that students be appropriately physically fit since it conditions the successful realization of certain specific aspe cts of the study program. Therefore, basic motor skills are also eliminatory in the UCIPS entrance exam, which is set at the 33rd percentile, in comparison with the average young and healthy population in the Republic of Serbia (Dopsaj, Vučković, & Blagojević, 2007; Janković. Kukuć, & Koropanovski, 2021).

Throughout their studies, students' physical abilities are assessed within the subject known as Specialized Physical Education (SPE). This assessment is conducted using a standardized battery of tests, which evaluates different types of strength, endurance, and speed. Furthermore, specific physical abilities relevant to their future roles as police officers are assessed through job-related fitness tests. One such test is the obstacle course for the assessment police specific physical ability (PSPAT) where students can demonstrate their specific agility (Janković & Dopsaj, 2022).The tasks conducted at PSPAT are equivalent to the realistic SPA that POs are required to possess during problem-solving incidents (chase, overcoming, removing). Likewise, the performance of all the tasks matches real professional conditions of problem-solving according to their structure (running with direction changes, overcoming obstacles, arrest simulation, etc.), as well as in terms of the time needed for their realization (the time necessary for test completion matches the average time of resolving a critical incident). All of the above is conducted in maximum and submaximum intensity, in the anaerobic-glycolytic regime of work, which is also in accordance with the intensity and physiological stress that occurs during the resolution of critical situations (Dopsaj & Janković, 2014, Janković et al., 2015).

As previously stated, during candidate selection for admission at UCIPS, basic morphological characteristics are observed. Those are body height (BH) and body mass (BM) (Janković & Koropanovski, 2022). The elimination standard is as follows. For women, minimum BH must be above 163 cm, whereas BM must be within the range of 3 kg extra, i.e., up to 12 kg less in accordance with BH subtracted by 100 cm. For men, minimum BH must be above 170 cm, while BM must be within the range of 10 kg more or less in accordance with BH subtracted by 100 cm. Research has shown that morphological characteristics could be linked with the ability of POs to perform their duty, especially if they are required to showcase their physical abilities such as combat, running, lifting heavy objects, etc. (Dawes et al., 2016; Kukić et al., 2018; Kukić et al., 2020). In other words, BH and BM may impact certain physical performances. Observing basic morphological characteristics (BH, BM, and by association, BMI) is the simplest and most commonly used procedure for

body condition assessment. However, these measurements do not entail a more precise insight into body composition from the aspect of muscle and fat tissue. Furthermore, they do not reveal mutual relations of total fat, or fat distribution in certain body segments, which could vary significantly within normal body mass index (Akpinar et al., 2007). Besides, different body composition components may provide a better insight into a potential connection to BPA and SPA. Therefore, this paper aims at investigating the interconnectedness between morphological characteristics on the one hand, and the efficacy of POs at the specific agility test on the other. This work strives to offer a deeper insight into how body composition could influence professional physical performances within police work. The significance of this research might pertain to the enhancement of the selection system and training programs, from the aspect of tracking the changes in morphological characteristics.

Methods

Participants

This study includedd 362 undergraduate third-year students from the University of Criminal Investigation and Police Studies. The total sample was split into two groups, 164 female police students (FPS), with an average age of 21.6 ± 0.8 years; and 198 male police students (MPS), with an average age of 21.9 ± 1.1 years. All of the respondents partook in the research willingly, having been completely familiarized with the study's objectives and the manner of testing.

Measurements and Procedures

Morphological characteristics

Morphological characteristics were measured by means of a standardized method, using a bioelectrical impedance analysis – BIA, on InBody 720 Tetrapolar 8-Point Tactile Electrode System (Biospace, Co., Ltd), which utilizes the method of Direct Segmental Multi-frequency Bioelectrical Impedance Analysis.

The measurement procedure requires a specific preparation, i.e., that a respondent should not be physically active for at least several hours prior to the testing, as well as not to take huge amounts of food. Therefore, the testing took place in the morning hours. The measurement procedure is such that the respondents are in their underwear, with no jewelry, watches, or any other metal objects. Feet are placed on designated spots on the platform, whereas hands hold movable handles with electrodes. The respondents stand still until hearing the sound signal that marks the end of the measurement, after which their body composition is assessed (Völgyi et al., 2008). For the purpose of this work, the following variables were used: body height (BH), body mass (BM), body mass index (BMI), total body fat mass (BFM), total skeletal muscle mass (SMM), percentage of body fat (PBF) and percentage of skeletal muscle mass (PSMM).

Police Specific Fitness Test

The PSPAT was conducted at a designated place of 25x15 meters. The testing procedure included the measurement of the time needed to complete the task as an indicator of efficiency, i.e. the level of specific motor abilities. The candidates performed the PSPAT test presented in Figure 1 in accordance with the standard procedures that entail familiarizing oneself with the tasks, mock performances, adequate recovery, and test realization. The respondents performed the test wearing sports equipment, a belt with a holster, and a CZ 99 gun, together with a spare magazine with no ammunition, carrying official batons and handcuffs (Janković et al., 2020). The efficiency indicator was defined as the time of the PSPAT realization displayed in seconds, which was measured using a computer system for physical ability testing PAT 02 (UNO-LEX, NS, Serbia).

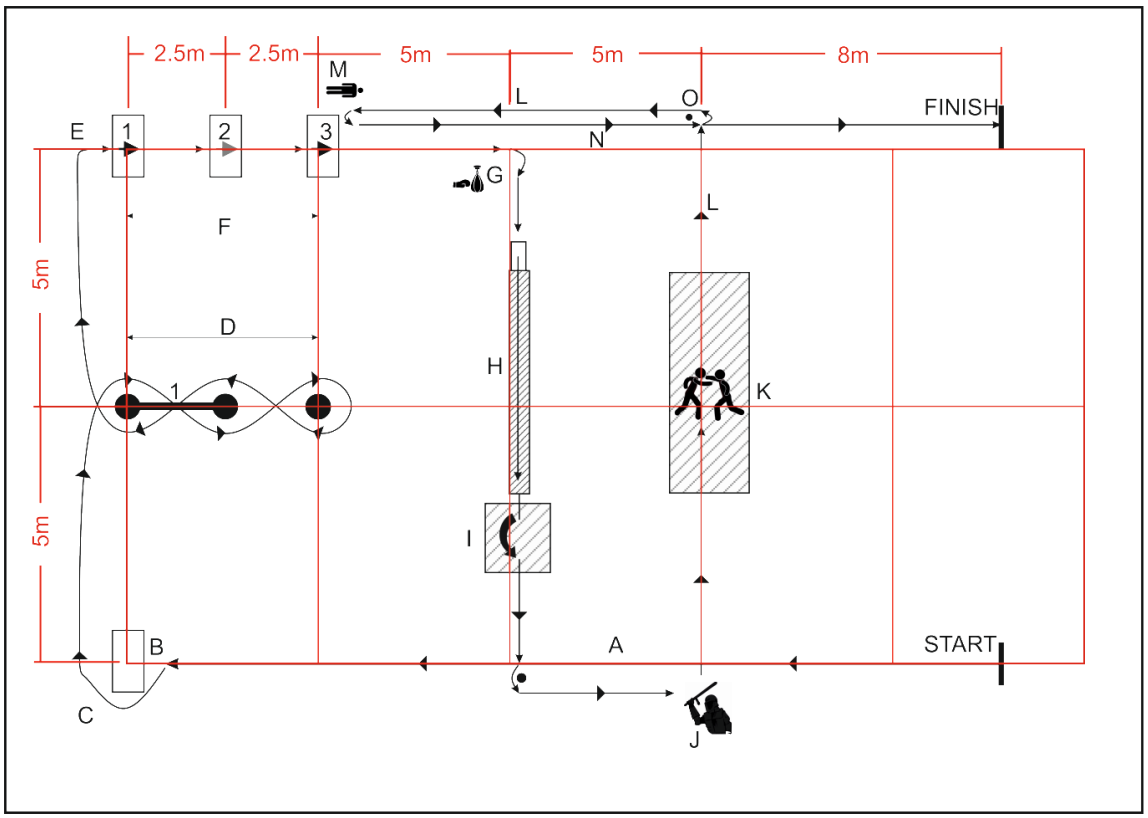

Figure 1. Obstacle course for the assessment of specific abilities of POs: A. Start at the sound signal and sprint 20 m in a straight line; B. Stop, take cover, and reach for a firearm; C. While holding the gun in the firing position, leave the cover from the left; D. Pass the cones from the outer side and crawl underneath the rope set at a height of 55 cm in marked spots. Distance between the cones is 250 cm; E. Stop and take cover, change the magazine, and put the firearm back into the duty belt; F. Three-part task: 1) Cross over a 110 cm-high obstacle; 2) Crawl beneath a 55 cm-high obstacle (F'); 3) Cross over a 110 cm-high obstacle. Distance between the obstacles is 250 cm; G. Approach the focus pad (held by an assistant), throw 4 punches and 2 kicks with maximum speed and intensity; H. Climb a 70 cm-high platform and cross a 120 cm-high and 500 cm-long balance beam; I. Leap on a mat with a forward roll; J. Approach a punching bag, take a baton, hit the bag 4 times with maximum efficiency and put the baton back on the duty belt; K. Reach the mats and defend against a predetermined attack, overcome the attacker using defence tactics, control and handcuff the suspect; L. Sprint 15 m at maximum speed, with a change of direction, towards the dummy (weighing 60 kilos); M. Reach the dummy; N. Carry the dummy (or drag it – optional for women) to a marked point (10 m); O. Safely place the dummy on the ground and run through the finish line.

Statistical analyses

The first step of data processing utilized a descriptive statistical analysis to calculate the parameters of measures of central tendency, measures of dispersion, and measures of distribution shape: arithmetic mean (Mean), standard deviation (SD), minimum and maximum values (Min, Max), the measure of results' skewness – asymmetry coefficient (Skew) and measure of the tailedness of results' – kurtosis coefficient (Kurt). The relation between the variables of morphological characteristics and the results of the PSPAT was ascertained utilizing the correlation analysis method *(Pearson correlation*) at the statistical significance level of $p < 0.05$. All statistical analyses were conducted using Statistical Package SPSS Statistics for Windows, Version 20.0.

Results

The descriptive statistics for PSPAT and morphological characteristics are shown in Table 1 for FPS, and in Table 2 for MPS. The results of the Pearson correlation between PSPAT and the morphological characteristics of the respondents of both sexes are shown in Table 3.

Table 1. Descriptive statistics for PSPAT and morphological characteristics for female students.

Variables	Mean	SD	Min	Max	Skew	Kurt
PSPAT (s)	94.5	8.5	71.3	118.4	-0.019	0.086
BH (cm)	169.6	5.1	162.2	183.2	0.219	-0.593
BM (kg)	63.1	6.8	48.2	87.6	0.538	0.584
BMI (kg/m^2)	21.9	2.1	17.7	28.3	0.843	0.798
BFM (kg)	15.5	4.1	6.2	29.1	0.687	0.761
SMM (kg)	26.2	2.6	20.3	33.6	0.215	-0.077
PBF (%)	24.3	4.6	12.6	36.2	0.169	-0.149
PSMM (%)	41.6	2.7	34.9	48.2	-0.162	-0.229

PSPAT – Specific physical abilities test; BH – Body high; BM – Body mass; BMI – Body mass index; BFM – Body fat mass; SMM – Skeletal muscle mass; PBF – Percent of body fat; PSMM – Percent of skeletal muscle mass.

Table 2. Descriptive statistics for PSPAT and morphological characteristics for male students.

Variables	Mean	SD	Min	Max	Skew	Kurt
PSPAT (s)	87.1	7.7	64.7	109.4	0.063	0.034
BH (cm)	182.3	6.6	172.9	197.3	0.147	-0.598
BM (kg)	82.4	9.3	62.7	112.7	0.735	0.699
BMI (kg/m^2)	24.7	2.3	19.4	32.1	0.537	0.140
BFM (kg)	12.4	4.4	4.5	26.7	0.792	0.464
SMM (kg)	39.9	4.3	30.4	56.7	0.785	1.097
PBF (%)	14.8	4.4	6.1	30.4	0.512	0.170
PSMM (%)	48.5	2.6	39.2	53.9	-0.457	0.173

PSPAT – Specific physical abilities test; BH – Body high; BM – Body mass; BMI – Body mass index; BFM – Body fat mass; SMM – Skeletal muscle mass; PBF – Percent of body fat; PSMM – Percent of skeletal muscle mass.

Table 3. Pearson correlation results between OC_{SAPO1} and morphological characteristics for FPS and MPS.

	FPS	BH	BM	BMI	BFM	SMM	PBF	PSMM
PSPAT	PCC	-0.007	0.006	0.002	0.212**	-0.194*	0.283**	-0.302**
	Sig.	0.931	0.944	0.982	0.007	0.013	0.000	0.000
	MPS	BH	BM	BMI	BFM	SMM	PBF	PSMM
PSPAT	PCC	0.091	0.073	0.017	0.165*	-0.017	0.170*	-0.189**
	Sig.	0.204	0.304	0.807	0.020	0.812	0.016	0.008

PSPAT – Specific physical abilities test; BH – Body high; BM – Body mass; BMI – Body mass index; BFM – Body fat mass; SMM – Skeletal muscle mass; PBF – Percent of body fat; PSMM – Percent of skeletal muscle mass.

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed)

Discussion

The primary findings of this study, in both FPS and MPS, show that BH, BM, and BMI do not significantly correlate to PSPAT ($p > 0.05$), i.e., that the mentioned morphological characteristics are not related to the specific agility test performance. On the other hand, the study reveals a link between PSPAT and BFM, PBF, and PSMM. The ascertained correlations point to the fact that a higher percentage of body mass leads to weaker results in the PSPAT, whereas a higher percentage of muscle mass causes the opposite effect. Finally, the study found a different correlation between PSPAT and SMM in FPS and MPS. Namely, as far as this variable in MPS is concerned, no statistically significant correlation was found, whereas there was a correlation in FPS (Table 3).

The results show that the impact of morphological characteristics on PSPAT varies between men and women, i.e., there is less correlation in MPS than in FPS. Previous research maintained that body composition differences between the sexes may influence professional task performance when running with direction changes is required. Besides, an additional professional load has a higher impact on women, which could be caused by the relatively heavier load they carry, when accompanied by their lower muscle mass (Kukić et al., 2020). Likewise, minimum professional load (a belt with equipment) has been proven to influence acceleration, running speed, and direction changes. As expected, the heavier the load, the more negative impact on physical performances, even more so in women than men (Kukić et al., 2023). A possible explanation for the higher correlation between morphological characteristics and PSPAT in FPS could lie in the manner of test realization, i.e., in the equipment the test is performed with. In the standard test procedure (Janković et al., 2015), respondents solve tasks with an additional load of a belt with equipment. This leads to FPS carrying a relatively heavier load in comparison with their body composition components, thus explaining their OC_{SAPO1} results' higher positive correlation to SMM and PSMM, as well as the negative correlation to BFM and PBF.

According to Strating et al. research (2010), in which 1432 female and 5567 male police officers participated, BMI is related to Physical Competency Test results (PCT). The findings of this study show that differences in time taken to complete PCT between men and women could indicate differences in physical readiness. What is more, higher BMI is linked to slower PCT performances for both women and men. Taking into account that body composition was not considered in this study (only BH, BM, and BMI), the supposition is that slower test completion may indicate a higher amount of fat mass, consequentially influencing their physical performances. The interconnectedness of body composition and BPA was established by Dawes et al. (2016). It was found that higher BFM diminishes performances in certain physical abilities (sit-up, vertical jump, 1.5-mile run, and estimated maximal voluntary oxygen uptake), indicating that increased BFM may have a negative impact on physical performances, probably due to the additional load that a body needs to carry. In combat sports, there are different categories, since higher BH and BM may be advantageous in contact (Dubnov-Raz et al., 2015), hence it is expected that more corpulent POs show greater efficiency in applied combat. However, Dillern et al. (2014) did not establish correlations between BH, BM, and BMI on the one hand, and SPA on the other (combat techniques application and arresting efficiency). Although it had been expected that POs with higher BMI would be more efficient in incidents where an opponent needs to be overpowered, the reason behind not establishing the mentioned correlation lies in the choice of partners during the overpowering and arresting test. The opponents were persons of a height and weight similar to the one of tested POs, in all likelihood resulting in more corpulent POs not having an advantage from a higher BM.

Problem-solving incidents most often consist of three relatively separate segments: 1. chase – running with direction changes and obstacle avoidance; 2. gaining control over a suspect – martial arts techniques application; 3. removal – taking the suspect away (Anderson, Plecas, & Segger, 2001), which are precisely the segments of the job-related fitness test OC_{SAPO1} (Figure 1). Not only has it been determined that higher height and mass could be useful in situations where the police must use physical force, but also that shorter POs

with lower BM frequently obtain better results in tests for assessment of other physical abilities (Lagestad, 2012). We could presume that the advantage of BM and BH in overpowering and removing segments within PSPAT may also be a disadvantage in segments requiring faster direction changes, jumping over obstacles, etc. Therefore, one may conclude that no statistically significant correlations have been found between PSPAT and BH, BM, and BMI. However, there are correlations with body composition, especially with the relativized measures of PSMM and PBF. What is more, the lack of correlations may additionally be explained away by the fact that the testing was conducted with an extremely homogenous group in terms of age and selection process, which includes BH and BM, together with BPA assessment on an eliminatory level. The predefined standards excluded the option of entrance to obese candidates whose physical abilities could be assumed to have been at an insufficient level.

Conclusion

The core findings of this study indicate that morphological characteristics such as BH, BM, and BMI are not significantly linked to PSPAT in both sexes ($p > 0.05$). On the other hand, a statistically significant correlation has been found between PSPAT on the one hand, and BFM, PBF, and PSMM on the other. These correlations suggest that a higher amount and percentage of fat mass could negatively impact the performance of PSPAT, whereas a higher percentage of muscle mass has the opposite effect. Likewise, a greater correlation has been found in women than in men. Solely BMI (without body composition analysis) does not allow for a precise insight into the condition and mutual interconnectedness of structural components, such as total fat mass or fat distribution in particular body segments, and which can significantly affect certain physical abilities. It could be recommended to include the analysis of body composition in the process of selection and testing throughout the work career, from the aspect of establishing the amount and percentage of fat and muscle mass. This could further lead to more efficient identification of candidates best suited for specific physical requirements of police work, as well as those who might need special nutrition and training programs for the purpose of morphological characteristics regulation.

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