

Body Composition in Serbian Police Officers

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Abstract: *Background.* Police work belongs to the category of exceptionally responsible and psychologically, socially and physically strenuous and stressful professions. Occupational pressures can lead to a significant negative change in the level of nutrition, thus affecting body structure. Therefore, the goal of this paper was to analyze body composition in Serbian police personnel as related to their professional duties. *Methods.* 689 healthy male participants took part in this research, a control group of 412 civilians, and a group consisting of 277 male members of the Ministry of Interior of the Republic of Serbia, divided into 4 subgroups: Uniformed Police Administration (Directorate) (N = 38), Police Brigade (N = 127), Gendarmerie (N = 59) and Special Anti-Terrorist Unit (N = 53). The body composition measurements were realized by using multichannel segmental bioimpedance with InBody 720 apparatus. *Results.* Regarding different components of body fat, in comparison to the control group, police officers were found to have a higher value of BFM – body fat mass, VFA – visceral fat area, and BFI – body fat index, as well as a lower value of PFI – protein fat index. *Conclusions.* In view of the fact that body fat is a ballast component in good locomotion and a health risk factor in case of large or extreme surplus, we believe that this problem should be solved systematically through permanent evaluation, improved dietary habits and more regular and intensive physical activity.

Keywords: body composition, bioimpedance, male, Serbian police.

Graphical abstract



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INTRODUCTION

The composition of the human body and its nutritional status are among the most researched areas not only in medicine, but also in most social sciences and humanities, as well as in sports science (Finucane et al., 2011). Anthropology also studies human body composition intensively, with research focused on a range of aspects pertaining to medicine and health, morphology in sports and physical education, or morphological characteristics in people of certain professions, gender, age or health condition (Heymsfield et al., 2005; Dopsaj et al., 2017). There is globally recognized scientific evidence that regular physical activity is a key determinant of energy consumption, and that an increasing percentage of the world population is now obese due to reduced physical activity and increased caloric intake (WHO, 2014).

Police work is an exceptionally responsible and psychologically, socially and physically strenuous and stressful profession (Subošić, 2020; Mladjan, 2021). Owing to its structure, dynamism and stress, police work can cause certain chronic or acute health problems regardless of whether it is performed in the field or in the office, or a combination of both (Violanti et al., 2009). Occupational pressures can often have a cumulative effect, causing a significant decline in the status of physical abilities and work efficiency, or leading to a significant negative change in the level of nutrition and thus affecting the body structure (Kukić et al., 2018a). For these reasons, it is necessary for police officers to be adequately selected, and professionally trained and skilled so that their work efficiency is at required or optimal levels. There are various factors that define the professional profile of a police officer, such as the knowledge of police procedures (e.g. criminalistics, proper legal procedures, tactical procedures, or realistic crisis assessment), health status, appropriate personality traits (e.g. emotional stability, communication, conative and cognitive abilities, or stress resistance), good levels of general and special motor skills and physical fitness, and, very importantly, particular morphological characteristics (Dopsaj & Vuković, 2015; Kukić et al., 2018b).

Consequently, it is necessary to establish a continuous system of control over the physical and health status of the employees of the Ministry of the Interior (MUP). This system should be based on modern scientific methodology, and it should include improvements in the process of performing regular analyses of the condition of body composition, life habits and physical activity patterns in MUP members, in order to be able to define the extent to which different professional work environments affect the changes in the characteristics and abilities mentioned above (Lagestad & Van den Tillaar, 2014; Kukić et al., 2018c; Lockie et al., 2019). Such a systematic scientific approach would result in better management of human resources within the Ministry of the Interior and successful development of an expert system of permanent control over its employees' morphological conditions, or their body composition statuses (Garbarino & Magnavita, 2015; Dopsaj & Vuković, 2015).

New technologies have made it possible to differentiate not only between adipose and lean tissue, but also to distinguish and measure three new tissue segments from the latter: the water component; the contractile tissue component – protein and/or muscle; and, the pure solid component – mineral (Sillanpää et al., 2014). This type of body composition measurement has become a very important method in general medicine and epidemiolo-



gy, as well as in sports practice and in occupational medicine working with special professions such as the military or the police (Vuković et al., 2020).

The importance of body composition in a person's health status primarily lies in the fact that obesity is responsible for the development of numerous health conditions, such as cardiovascular diseases, diabetes, hypertension, or cancer. The global increase in the incidence of obesity and its related diseases has brought body composition into focus and attracted the attention of numerous physical exercise and health experts (NCD-RisC, 2016). Obesity is defined as excessive weight gain due to the deposition of adipose tissue in the body. It is a state of positive energy balance, in which energy intake exceeds expenditure. Obesity has been recognized as a disease caused by the interaction of hereditary and environmental factors (Djordjevic-Nikic & Dopsaj, 2013).

The results of numerous previous studies have demonstrated high prevalence rates of obesity in police personnel. It was shown that over 80% male and over 30% female police officers were obese or at risk of obesity (Boyce et al., 2008; Dopsaj & Vuković, 2015; Kukić & Dopsaj, 2016). Based on the data from a study conducted on Serbian police force personnel (Dopsaj & Vuković, 2015), it could be concluded that the overall prevalence of overweight and obesity ($BMI \geq 25.0 \text{ kg/m}^2$) was 81.6%, with the prevalence of pre-obesity at 61.8% ($BMI = 25.0\text{-}29.9 \text{ kg/m}^2$), and of obesity at 19.8% ($BMI \geq 30.0 \text{ kg/m}^2$). It should be emphasized that the study also found that the prevalence, as a representative measure of the state of nourishment (BMI) according to which police officers were grouped in categories, grows with an increase in age and length of service and thus indicates the negative professional aspect of the phenomenon. This is an indication of the detrimental effect of a given profession on body composition, i.e., the state of nourishment, which negatively affects both the fulfilment of professional requirements and the overall health status. Previous research has also stated that the parameters of body composition in police officers significantly deteriorate with age, as the increase in the number of working years in the police positively correlates to the increase in body weight, total and percentage fat mass, as well as waist and hip circumferences (Boyce et al., 2008). The results obtained in these studies are unsettling, especially in view of the fact that the increase in body mass on the account of the fat component can lead to higher health risks and a decline in basic motor skills, which combined may reduce professional efficiency in police officers (Glaner et al., 2010).

The highly negative occupational impact on health status and higher health risk factors in police officers were presented in a study conducted in the United States, which compared the prevalence of certain health conditions in the general population and in police officers (Hartley et al., 2011). It was determined that police officers had one of the highest prevalence rates for cardiovascular disease (CVD) compared to the general active working population in America, regardless of professional orientation. The prevalence of obesity in the American police force was at the level of 40.5%, in comparison to 32.1% in the general working population, and as many as 26.7% of police officers were diagnosed with the metabolic syndrome with total blood cholesterol of 200.8 mg/dL, while the respective values of 18.7% and 193.2 mg/dL were reported in the general working population. The authors concluded that there was an obvious difference between police officers and the general population of workers in America regarding the professional aspect associated



with the prevalence for various diseases and health conditions, and that health risk factors were clearly higher in police work.

Research on the characteristics of body composition, as part of a continuous system of information gathering, has been carried out in all police forces in the world (Hartley et al., 2011; Garbarino & Magnavita, 2015; Kukić & Dopsaj, 2016; Lockie et al., 2020; Johnson et al., 2020; Kukić et al., 2020; Vuković et al., 2020).

In view of the previously mentioned research, there is a strong rationale for focusing on body composition in numerous studies on police personnel. Another very important subject of both general and specific occupational research is the relevance of body composition to the performance of police duties. Therefore, the primary goal of this paper was to determine the current state of body composition in Serbian police officers, while the secondary consideration was to compare the body composition of police officers in relation to their work profiles. In view of work organization, this will enable the Ministry of Internal Affairs of the Republic of Serbia to use methods based on scientific evidence in the continuous process of improving its work technology, which should eventually result in increased professional efficiency of police personnel.

METHODS

Approach to the Problem

This was a non-experimental study, in which data were sampled within a defined area to describe the current state of the system, as well as the relations among the observed elements of the system. The primary research technique was direct measurement using the laboratory method to evaluate body composition in Serbian police personnel from different occupational categories.

Participants

The sample consisted of 689 healthy males, 412 of whom belonged to the control group, while 277 employees of the Republic of Serbia Ministry of the Interior were divided into four subgroups:

- Police Administration (Police Directorate) (N = 38)
- Police Brigade (N = 127)
- Gendarmerie (N = 59)
- Special Anti-Terrorist Unit (SAJ) (N = 53).

The sample included participants with at least two years' work experience in the defined police organizational units. Written informed consent for participation was obtained. All the measurements complied with the ethical rules of the Helsinki Committee for Research with Human Subjects and the Ethics Committee of Faculty of Sports and Physical Education, University of Belgrade (Ethical Permit Number 484-2).



Measurements and Procedures

Body composition was measured by multisegmental bioelectric impedance analysis (BIA) using a digital scale and bioimpedance analyzer (InBody 720, 2005). The tests were performed in the morning, in the test room temperature between 20° and 25° Celsius.

The pre-testing procedure required that the participants:

- Did not eat at least two hours before measurement;
- Did not engage in long or intense physical activity for at least 12 hours before measurement;
- Did not consume alcohol for at least 48 hours before measurement;
- Did not take diuretics for at least 24 hours before measurement;
- Did not use the sauna for at least 24 hours before measurement;
- Emptied their bladder before measurement, and emptied their bowels at least two hours before measurement.

The participants spent five minutes before measurement in standing position to allow body fluids to redistribute. The participants wore only underwear during the test and had been instructed to remove all metal objects from their person. Before testing, all participants were familiarized with the measurement technique. They were then asked to step on the scale and place their hands and feet on contact surfaces, in accordance with the procedure and recommendations of the measuring device manufacturer (InBody 720, 2005).

During the measurement, the participants were asked to stand upright, be calm and relaxed (not to tighten their arms, legs and torso), look forward, breathe normally and not talk. All measurements were performed with regularly calibrated equipment under the same conditions by the same experienced staff in the Methodology and Research Laboratory of Faculty of Sports and Physical Education, University of Belgrade.

Variables

With respect to body composition, this study examined 19 variables, out of which 11 were basic and eight derived, or index, variables.

Basic variables

- 1) BH – body height, expressed in cm;
- 2) BM – body mass, expressed in kg;
- 3) ICW – intracellular water, expressed in L;
- 4) ECW – extracellular water, expressed in L;
- 5) Prot – proteins, expressed in kg;
- 6) Min – minerals, expressed in kg;
- 7) Oss – Osseous t., mass of minerals contained in bone tissue, expressed in kg;
- 8) BFM – body fat mass, expressed in kg;
- 9) SMM – skeletal muscle mass, expressed in kg;
- 10) VFA – visceral fat area, the estimated area of fat surrounding internal organs in the abdomen, expressed in cm²;
- 11) BCM – body cell mass, expressed in kg.



Derived (index) variables

- 1) BMI – body mass index, expressed in kg/m^2 ;
- 2) PBF – percent body fat, calculated as BFM/BH , expressed in %;
- 3) PSMM – percent skeletal muscle mass, calculated as SMM/BM , expressed in %;
- 4) FFM – fat-free mass, calculated as the sum of ICW, ECW, Minerals and Proteins, expressed in kg;
- 5) FFMI – fat-free mass index, calculated as FFM/BH^2 , expressed in kg/m^2 ;
- 6) PFI – protein fat index, calculated as $\text{Proteins}/\text{BFM}$, expressed in kg;
- 7) SMMI – skeletal muscle mass index, calculated as SMM/BH^2 , expressed in kg/m^2 ;
- 8) BFI – body fat index, calculated as BFM/BH^2 , expressed in kg/m^2 .

Statistical Analyses

In addition to calculating basic descriptive statistics (Mean, SD, cV%, Min, Max), multi-factor and single factor analysis of variance (MANOVA and ANOVA) were used to examine general differences both between the control group and the police personnel group, and within four subgroups of police personnel stratified according to occupational category. The between-pair differences were defined using t-test with Bonferoni correction. Statistical significance was accepted for $p \leq .05$ and 95% confidence interval (Hair et al., 1998). All statistical procedures were realized using the SPSS 23 package (IBM).

RESULTS*Descriptive Results for Body Composition Characteristics – Basic Variables*

Table 1 shows the descriptive results for the basic variables of body composition characteristics analyzed according to the control group ($N = 412$) and the police personnel group ($N = 277$).

The descriptive results support the conclusion that in both subject groups (control and police personnel) there was high level of homogeneity (below 30%) for nine (9) basic variables, while inhomogeneity was demonstrated for only two ($\text{BFM} = 37.9 - 66.7$ and $\text{VFA} = 57.2\%$, Table 1).

The analyses of between-group differences for the basic body composition variables in the control group compared to the total sample of police officers (Table 1) proved the existence of general statistical significance (MANOVA – Wilks' lambda value = .889, $F = 7.72$, $p < .001$). It was found that the given set of 11 variables accounted for 11.1% of the total variance of between-group differences (Partial $\text{Eta}^2 = .111$) at 100% confidence interval (Observed Power = 1.000). Between-pair analysis revealed partial statistically significant differences for only four variables: BH ($p = .024$), BM ($p < .001$), BFM ($p < .001$) and VFA ($p < .001$), among which the largest effect on between-group differences was determined for VFA at 19.0%, followed by BFM at 7.3%, BM at 4.3%, and BH at 0.7% (Table 1, Partial Eta^2).



Table 1. Results for Basic Body Composition Variables in the Control Group and the Police Personnel Group

Control Group (N = 412, Age = 30.2 ± 8.5)											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	183.2	85.8	32.7	19.5	14.1	4.82	3.98	14.7	40.6	78.3	46.8
SD	6.7	14.8	4.1	2.6	1.8	0.64	0.61	9.8	5.4	44.8	5.9
cV%	3.7	17.2	12.5	13.3	12.8	13.3	1.5	66.7	13.3	57.2	12.6
Min	163.9	49.9	20.9	12.5	9.0	2.94	2.38	2.3	20.7	5.0	29.9
Max	201.0	176.9	48.9	32.1	21.2	7.20	10.10	85.9	61.8	402.0	70.1
Police Total (N = 277, Age = 34.3 ± 6.9)											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	182.0	91.9	33.1	19.8	14.3	4.88	4.03	19.8	41.1	104.3	47.4
SD	6.8	12.4	3.9	2.4	1.7	0.63	0.53	7.5	5.1	29.8	5.7
cV%	3.7	13.5	11.8	12.1	11.9	12.9	13.2	37.9	12.4	28.6	12.0
Min	167.1	62.6	23.4	14.0	10.1	3.40	2.87	4.4	28.6	35.0	33.6
Max	206.2	146.3	50.4	31.0	21.8	8.14	6.80	56.6	63.7	234.0	72.2
MANOVA Multivariate test											
Wilks' lambda Value = 0.889, F = 7.72, p < .001, Partial Eta ² = 0.111, Observed Power = 1.00											
ANOVA Univariate test											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
F	5.11	31.18	1.29	1.81	1.62	1.71	1.01	54.11	1.63	71.62	1.719
P value	0.024	0.000	0.257	0.179	0.204	0.192	0.317	0.000	0.202	0.000	0.190
Par Eta ²	0.007	0.043	0.002	0.003	0.002	0.002	0.001	0.073	0.002	0.190	0.002
Power	0.617	1.00	0.205	0.269	0.246	0.257	0.170	1.000	0.247	1.000	0.258

Table 2 shows the descriptive results for the basic body composition variables in the police personnel subgroups: Police Administration (N = 38), Police Brigade (N = 127), Gendarmerie (N = 59), and Special Anti-Terrorist Unit (N = 53).

Between-subgroup descriptive statistics for the basic body composition variables across the police personnel subgroups (Table 2) proved the existence of general statistically significant differences (MANOVA – Wilks' lambda value = .791, F = 3.71, p < .001). The given set of 11 variables was found to account for 5.7% of the total variance of between-subgroup differences (Partial Eta² = .057) at 100% confidence interval (Observed Power = 1.000). Also, statistically significant differences were observed among each of the basic composition variables across all the subgroups (Table 2).

The variables that contributed to the most significant differences were VFA with 10.8% of total variance explained, BFM with 9.7%, and BM with 5.1%. The variables that showed the least sensitivity to the given partial differences were Minerals, BH, and Osseus with respective 3.0%, 2.6%, and 2.4% of total variance explained.



Table 2. Results for Basic Body Composition Variables in the Police Personnel Subgroups

<i>Police Administration (N = 38, Age = 31.3 ± 8.5)</i>											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	184.1	92.9	34.0	20.2	14.7	5.04	4.16	18.88	42.4	98.5	48.8
SD	6.6	11.3	3.0	2.0	1.3	0.55	0.48	7.37	4.0	34.1	4.4
cV%	3.6	12.2	8.8	9.9	8.8	10.9	11.5	39.0	9.4	34.6	9.0
Min	171.3	63.5	27.7	15.6	12.0	3.81	3.10	4.40	34.1	36.1	39.7
Max	202.4	120.3	39.6	24.1	17.1	6.24	5.30	34.80	49.6	183.6	56.7
<i>Police Brigade (N = 127, Age = 34.7 ± 6.4)</i>											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	180.9	91.2	31.8	19.1	13.7	4.72	3.89	21.9	39.4	111.1	45.5
SD	6.9	13.9	3.9	2.4	1.7	0.64	0.54	7.6	5.1	29.9	5.6
cV%	3.8	15.2	12.3	12.6	12.4	13.6	13.9	34.7	12.9	26.9	12.3
Min	167.1	62.6	23.4	14.0	10.1	3.40	2.87	6.3	28.6	37.6	33.6
Max	206.2	145.9	50.4	31.0	21.8	8.14	6.80	56.6	63.7	233.1	72.2
<i>Gendarmerie (N = 59, Age = 37.3 ± 6.8)</i>											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	183.8	95.1	34.8	20.8	15.0	5.11	4.21	19.4	43.3	104.7	49.8
SD	6.8	11.5	3.7	2.2	1.6	0.58	0.49	7.8	4.8	31.1	5.3
cV%	3.7	12.1	10.6	10.6	10.7	11.4	11.6	40.2	11.1	29.7	10.6
Min	171.0	75.6	28.6	17.2	12.4	4.00	3.28	7.2	35.3	51.9	41.0
Max	202.4	146.3	3.2	25.4	18.7	6.62	6.62	52.7	54.4	234.0	61.9
<i>Special Anti-Terrorist Unit (N = 53, Age = 32.7 ± 4.9)</i>											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
Mean	181.1	89.1	33.8	20.0	14.6	4.94	6.06	15.9	42.0	91.6	48.3
SD	5.7	9.6	3.9	4.0	1.7	0.60	0.50	4.8	5.2	18.4	5.7
cV%	3.1	10.8	11.5	20.0	11.6	12.1	8.3	30.2	12.4	20.1	11.8
Min	171.8	70.5	70.5	16.0	12.0	4.00	3.28	5.9	34.1	35.0	39.6
Max	194.0	112.9	48.0	27.9	20.7	7.15	5.90	26.0	60.6	131.9	68.7
MANOVA Multivariate test											
Wilks' lambda Value = 0.791, F = 3.71, p < .001, Partial Eta ² = 0.057, Observed Power = 1.00											
ANOVA Univariate test											
Variable	BH	BM	ICW	ECW	Prot	Min	Oss	BFM	SMM	VFA	BCM
F	4.53	9.27	7.54	6.04	7.63	5.29	4.18	18.38	7.48	20.64	7.51
P value	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Par Eta ²	0.026	0.051	0.042	0.034	0.043	0.030	0.024	0.097	0.042	0.108	0.042
Power	0.943	1.000	0.997	0.986	0.997	0.972	0.922	1.000	0.997	1.000	0.997



Descriptive Results for Body Composition Characteristics – Derived Variables

Table 3 presents the descriptive results for the derived variables of body composition characteristics in the control group (N = 412) and the police personnel group (N = 277).

The analysis of the descriptive statistics results for the derived body composition variables in the control and police personnel groups revealed high homogeneity for four variables (below 30%), while inhomogeneity was also observed for four variables (BFI = 37.2 - 68.0, PFI = 44.0 - 66.4, and PBF = 46.2%, Table 3).

Table 3. Results for Derived Body Composition Variables in the Control Group and the Police Personnel Group

Control Group (N = 412, Age = 30.2 ± 8.5)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	25.55	16.27	47.79	71.19	21.17	1.34	12.08	4.40
SD	4.03	7.51	4.57	8.90	1.92	0.89	1.20	2.99
cV%	15.8	46.2	9.6	12.5	9.1	66.4	9.9	68.0
Min	16.89	2.96	24.44	45.34	14.44	0.17	6.18	0.62
Max	52.03	54.33	57.81	105.36	29.73	6.73	16.94	27.92
Police Total (N = 277, Age = 34.3 ± 6.9)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	27.69	21.18	44.99	72.04	21.70	0.84	12.39	5.99
SD	3.01	5.95	3.59	8.61	1.75	0.37	1.08	2.23
cV%	10.9	28.1	8.0	12.0	8.1	44.0	8.7	37.2
Min	19.43	6.93	33.53	50.91	17.43	0.29	9.73	1.45
Max	44.26	40.20	53.72	111.34	28.02	2.73	16.31	15.94
MANOVA Multivariate test								
Wilks' lambda Value = 0.814, F = 17.26, p < .001, Partial Eta ² = 0.186, Observed Power = 1.00								
ANOVA Univariate test								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
F	57.12	83.78	73.34	1.55	13.68	80.10	12.60	57.07
p value	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000
Par Eta²	0.077	0.109	0.096	0.002	0.020	0.104	0.018	0.077
Power	1.000	1.000	1.000	0.237	0.958	1.000	0.943	1.00

The between-group differences for the derived body composition variables in the control group compared to the total sample of police officers (Table 3) proved the existence of general statistical significance (MANOVA – Wilks' lambda value = .814, F = 17.26, p < .001). It was found that a given set of eight variables accounted for 18.6% of the total variance of between-group differences (Partial Eta² = .186) at 100% confidence interval (Observed Power = 1.000). Between-pair analysis found partial statistically significant differences for seven variables, and the largest and the smallest partial effects on the general difference were found for PBF (10.9%, p < .001), PFI (10.4%, p < .001) and PSMM 9.6%, p < .001), and for FFM (0.2%, p = .214), respectively (Table 3, p value, Partial Eta²).



Table 4 shows the descriptive results for the derived body composition variables analyzed across the police personnel subgroups: Police Administration (N = 38), Police Brigade (N = 127), Gendarmerie (N = 59), and Special Anti-Terrorist Unit (N = 53).

Table 4. Results for Derived Body Composition Variables in the Police Personnel Subgroups

Police Administration (N = 38, Age = 31.3 ± 8.5)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	27.39	19.76	45.94	73.99	21.80	0.947	12.49	5.57
SD	2.81	6.15	3.69	6.79	1.28	0.480	0.767	2.19
cV%	10.3	31.1	8.0	9.2	5.9	50.7	6.1	39.3
Min	20.97	6.93	37.66	59.11	19.18	0.391	10.810	1.45
Max	33.83	33.95	53.70	86.95	24.81	2.732	14.374	11.00
Police Brigade (N = 127, Age = 34.7 ± 6.4)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	27.80	23.58	43.46	69.26	21.11	0.689	12.01	6.68
SD	3.24	5.25	3.04	8.61	1.65	0.224	1.00	2.19
cV%	11.7	22.3	7.0	12.4	7.8	32.5	8.3	32.8
Min	19.43	10.06	33.53	50.91	17.43	0.290	9.73	1.96
Max	40.42	40.20	50.97	111.34	26.19	1.761	14.98	15.68
Gendarmerie (N = 59, Age = 37.3 ± 6.8)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	28.17	20.04	45.74	75.67	22.38	0.906	12.81	5.78
SD	3.32	6.17	3.73	7.92	1.86	0.379	1.51	2.43
cV%	11.8	30.8	8.2	10.5	8.3	41.8	11.8	42.0
Min	23.31	8.12	36.84	62.24	17.87	0.354	10.03	2.23
Max	44.26	36.02	53.44	93.40	28.02	2.281	16.31	15.94
Special Anti-Terrorist Unit (N = 53, Age = 32.7 ± 4.9)								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
Mean	27.12	17.71	47.15	73.27	22.28	1.038	12.77	4.84
SD	1.99	4.73	2.96	8.55	1.70	0.415	1.07	1.44
cV%	7.3	26.7	6.3	11.7	7.6	40.0	8.4	29.8
Min	19.69	7.98	41.86	59.72	18.07	0.564	10.20	1.65
Max	30.70	25.97	53.72	103.75	27.91	2.301	16.30	7.42
MANOVA Multivariate test								
Wilks' lambda Value = 0.715, F = 6.59, p < .001, Partial Eta ² = 0.080, Observed Power = 1.00								
ANOVA Univariate test								
Variable	BMI	PBF	PSMM	FFM	FFMI	PFI	SMMI	BFI
F	14.92	30.16	28.35	7.05	10.29	22.97	10.49	19.47
p value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Par Eta²	0.080	0.150	0.142	0.040	0.057	0.118	0.058	0.102
Power	1.000	1.000	1.000	0.995	1.000	1.000	1.000	1.000



The analysis of the descriptive statistics results for the derived body composition variables across all observed strata of police personnel (Administration, Brigade, Gendarmerie and Anti-Terrorist Unit) indicated high homogeneity (below 30%) for five (5) variables, while inhomogeneity was found for only three variables (PBF, PFI and BFI, Table 4); for PFI this result occurred regardless of the subgroup, while for PBF and BFI it depended on the subgroups.

The between-subgroup statistics for the derived body composition variables across the police personnel subgroups (Table 4) indicated the existence of general statistically significant differences (MANOVA – Wilks' lambda value = .715, $F = 6.59$, $p < .001$). The given set of eight variables accounted for 8.0% of the total variance of between-subgroup differences for all subgroups (Partial $\eta^2 = .080$) at 100% confidence interval (Observed Power = 1.000). Between-pair analysis found partial statistically significant differences for all eight variables, and the variables that had the largest and the smallest partial effects on the general difference were PBF (15.0%, $p < .001$), PSMM (14.2%, $p < .001$), PFI (11.8%, $p < .001$) and BFI (10.2%, $p < .001$), and BMI (8.0%, $p < .001$) and FFM (4.0%, $p < .001$), respectively (Table 4, p value, Partial η^2).

DISCUSSION

Based on the descriptive results for basic and derived body composition variables in the control group ($N = 412$) and the police personnel group ($N = 277$) shown in Tables 1 and 3, it can be argued that the two groups generally differed statistically significantly in body composition. Specifically, police service is performed by persons whose general body composition characteristics were statistically significantly different from the control group, consisting of randomly selected civilians. Police officers were found to be generally significantly shorter than the control group (Table 1, BH lower by 1.2 cm or 0.65%, $F = 5.11$, $p = .024$), but they also had significantly higher body mass (Table 1, BM higher by 6.1 kg or 7.11%, $F = 31.18$, $p < .001$), and consequently had higher levels for state of nourishment – BMI value (Table 3, BMI higher by 2.14 kg/m² or 8.38%, $F = 57.12$, $p < .001$). The results show that these differences in body mass and state of nourishment in favor of police officers were not caused by a higher proportion of water (ICW and ECW), mineral (Min and OSS) or contractile components (Prot and SMM), but by a statistically significantly higher proportion of the fat component in the body, both in absolute values (Table 1) and relative values (Table 3). The following differences were identified in:

- Absolute body fat mass (Table 1, BFM: higher by 5.1 kg, or by 34.69%, $F = 54.11$, $p < .001$, Partial $\eta^2 = 7.3$);
- Visceral fat area, as the area of fat mass on and in internal organs (Table 1, VFA: higher by 26.0 cm², or by 33.21%, $F = 71.62$, $p < .001$, Partial $\eta^2 = 19.0$);
- Percent body fat, as relative amount of body fat (Table 3, PBF: higher by 4.91 %, or by 30.18%, $F = 83.78$, $p < .001$, Partial $\eta^2 = 10.9$);
- Body fat index, as a measure of body fat per square meter of body height, or per body surface unit (Table 3, BFI: higher by 1.59 kg/m², or by 36.14%, $F = 57.07$, $p < .001$, Partial $\eta^2 = 7.7$).



Due to higher fat values determined in police officers in comparison to the control group, along with similar values for contractile body components (proteins and skeletal muscles) in both groups, a statistically significant difference was also found in PFI, an index that defines the ratio of protein, as a pure contractile body component that has the potential for quality locomotion, to body fat, as a ballast component in relation to locomotion and a health risk factor in case of large or extreme surplus. The observed difference was in favor of the control group at the level of 0.50 kg, or 37.31% (Table 3, $F = 80.10$, $p < .001$, Partial $\eta^2 = 10.4$).

The between-subgroup analysis showed that, at a general level, police personnel differed statistically significantly in body composition (Table 2, Wilks' lambda value = .791, $F = 3.71$, $p < .001$, Partial $\eta^2 = .057$, Observed Power = 1.00). In other words, the police personnel sample stratified according to occupational category were statistically significantly different in relation to their morphological body characteristics and body composition. With regard to basic variables, the highest sensitivity in defining the differences among the subgroups was found in visceral fats (Table 2, VFA: $F = 20.64$, $p < .001$, Partial $\eta^2 = .108$) and total body fat mass (Table 2, BFM: $F = 18.38$, $p < .001$, Partial $\eta^2 = .097$), which are mainly undesirable body components both professionally and medically. The other two variables with a statistically significant level of sensitivity, both professionally important and desirable, are those that define total body mass (BM), and the amount of pure contractile, i.e., muscle tissue (Table 2, Prot and SMM). The effect on the defined differences for BM was 5.1%, while for Prot and SMM it was 4.3% and 4.2%, respectively (Table 2).

With regard to VFA, SAJ participants were found to have statistically significantly lower levels of visceral fat compared to Police Brigade participants ($VFA = 91.6 \pm 18.4 \text{ cm}^2$ vs $111.1 \pm 29.9 \text{ cm}^2$, $p = .025$), while no statistically significant difference was determined among the other subgroups. Exactly the same between-subgroup relationship was observed for BFM, in which only SAJ and Police Brigade differed statistically significantly ($BFM = 15.9 \pm 4.8 \text{ kg}$ vs. $21.9 \pm 7.6 \text{ kg}$, $p < .001$).

Among the derived variables that define the relative value of body adipose tissue, the highest sensitivity in defining differences among police personnel subgroups was found for PBF (Table 4, $F = 30.16$, $p < .001$, Partial $\eta^2 = .150$), PFI ($F = 22.97$, $p < .001$, Partial $\eta^2 = .118$) and BFI ($F = 19.47$, $p = .000$, Partial $\eta^2 = .102$). A statistically significantly higher level of PBF was determined in Police Brigade compared to three other subgroups, namely Police Administration, Gendarmerie and SAJ, the latter of which had the lowest level of the variable (Table 4, PBF in Police Brigade: $23.58 \pm 5.25\%$ vs. Police Administration: $19.76 \pm 6.15\%$, $p = .024$; vs. Gendarmerie: $20.04 \pm 6.17\%$, $p = .010$ vs. SAJ: $17.71 \pm 4.73\%$, $p < .001$). No statistically significant differences were found among the other subgroups of police officers.

On the other hand, percent skeletal muscle (PSMM) and body protein/fat index (PFI) are the two variables that showed the highest levels of sensitivity in defining differences among police personnel subsamples (Table 4, PSMM and PFI: $F = 28.35$, $p < .001$, Partial $\eta^2 = .142$, and $F = 22.97$, $p < .001$, Partial $\eta^2 = .118$, respectively). The values for these two variables determine the amount of useful contractile body mass upon which motor and physical potentials can be fully realized (Kukić et al., 2018^b). The highest average level of skeletal body muscle was found in SAJ participants ($PSMM = 47.15 \pm 2.96$), as well as the most favorable ratio of protein to fat ($PFI = 1.038 \pm 0.415$), while the lowest averages



for these two variables were observed in members of the Police Brigade (Table 4, PSMM = 43.46 ± 3.04 , and PFI = 0.689 ± 0.224).

Furthermore, it was observed that Police Brigade had statistically significantly lower PSMM levels than any of three other police personnel subgroups: Police Administration, Gendarmerie and SAJ ($p = .011$, $p = .004$ and $p < .001$, respectively).

However, the fat/protein index (PFI) revealed a statistically significant difference only between the average values in Police Brigade and SAJ subgroups (Table 4, PFI: 0.689 ± 0.224 vs 1.038 ± 0.415 kg, $p = .032$).

With regard to previously published data related to different levels of trained motor skills and physical activity in male Serbian adults, which can be accepted as initial national standards (Dopsaj et al., 2018) for average PFI values in general economically active population, the following percentile distributions were determined for the participants of this study: control group (1.34 ± 0.89) at 85.0 ‰, and total sample of police personnel (0.84 ± 0.37) at 55.0 ‰ of general population; Police Administration (0.947 ± 0.480) at 65.0 ‰, Police Brigade (0.689 ± 0.224) at 49.0 ‰, Gendarmerie (0.906 ± 0.379) at 60.0 ‰, and SAJ (1.038 ± 0.415) at 70.0 ‰ of general population (Table 4).

The neutral PFI value (the index value is 1.0) indicates that the amounts of protein and fat in the body are absolutely proportional, namely, there is 1 kg of protein per 1 kg of fat. It follows that higher PFI values indicate that a given person is “more muscular” or has athletic, mesomorphic build, which further assumes a higher level of physical activity and a more proper diet. Lower PFI values not only indicate the opposite physical activity and dietary habits, but also define a different body type of a given person, which is “fatter” or stouter, of pyknic body build (Ikeda et al., 2018).

Relatively poor values for body composition in police personnel can be attributed to the influence of various factors. Late shifts and work-related psychological stress are among the contributors to deterioration in body composition in police officers (Garbarino & Magnavita, 2015). Some of the most important factors that increase the risk of obesity in police personnel are insufficient physical activity and poor living habits, especially poor diet (Lagestad & Van den Tillaar, 2014). Research on police population has found an association between insufficient physical activity on the one hand, and weight gain due to fat deposition, as well as increased pre-hypertension and hypertension prevalence on the other (Kales et al., 2009). It has been shown that the level or frequency of physical activity decrease significantly after only three years of police service. During this period, the number of police officers engaged in regular high-level physical activity decreases, while the number of those with low-level physical activity doubles (Lagestad & Van den Tillaar, 2014). Regarding the prevalence of certain non-communicable diseases, it has been observed that approximately 75.0% of public servants in emergency response professions (ambulance, police and fire services) have pre-hypertension or hypertension. For instance, firefighters have been found to have pre-hypertension prevalence of 58.0% and hypertension prevalence of 20.0% to 23.0% (Kales et al., 2009).

Police work entails responding to security risks that may arise from physical contacts with other persons, often in a highly intensive and socially and physically aggressive environment, or in states of emergency, such as fires, flooding or other natural disasters (Mladjan, 2021). As a result, the selection procedure for police service includes rigorous tests of physical abilities, while specialized in-service training aims to develop professional gen-



eral and specific physical abilities and skills (Subošić, 2020). Such occupational physical engagement along with regular professional requirements leads to physical transformation in police officers, so as to develop body composition characteristics that contribute to high levels of general and work-specific physical fitness, and to minimize the effects of those that compromise it (Lockie et al., 2018, 2019). Moreover, it has been found that high BMI values in selected and highly professionally trained persons, such as SAJ members or students of University of Criminal Investigation and Police Studies, negatively affect aerobic performance (Mitrović et al., 2016; Lockie et al., 2018), as well as agility, repetitive strength and specific dexterity (Kukić et al., 2018b; Kukić et al., 2018c; Lockie et al., 2019, 2020).

Most studies that aimed to examine and determine the relationships between physical abilities and power and/or strength, manifestations of strength/endurance, aerobic or anaerobic endurance, or agility, found high statistically significant correlations with variables that define the levels of contractile body components in police officers (skeletal muscle mass, fat-free muscle mass and other muscle mass indices). Regardless of whether a study tested the torso or the extremities, hand grip strength or maximum leg or back extensor endurance, police officers who had higher muscle mass and lower body fat mass also showed higher levels of physical and motor abilities (Vuković et al., 2020; Marins et al., 2020; Lockie et al., 2020).

CONCLUSIONS

The results showed that with regard to body composition, police officers differed most from the control group of civilians in having statistically significantly higher values of BFM – body fat mass, VFA – visceral fat area, and BFI – body fat index, as well as lower values of PFI – protein fat index. Moreover, general statistically significant differences in body composition were observed among the subgroups of police personnel, and the most sensitive variables were those that defined the amount of body fat (VFA and BFM), which are indicators of professionally undesirable components, as well as BM, Prot and SMM, which are considered professionally desirable. The results suggest that there is a need for an established system of permanent body composition evaluation in Serbian police personnel, as well as for the provision of an organizational and educational foundation for developing high-quality dietary and physical activity habits. The benefits of building a better body structure would be considerable, as this would lead to improved health status and work efficiency. In future, a modality should be defined that would provide police personnel with regular and optimal physical activity and a balanced diet within the frame of regular work activities.

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