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CHARACTERISTICS OF SHOOTING EFFICIENCY DURING A BASIC SHOOTING TRAINING PROGRAM INVOLVING POLICE OFFICERS OF BOTH SEXES

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Abstract. *Using duty weapons is part of the obligatory professional skills of police officers, for which they must be trained in the appropriate way. The aim of this paper is to define the efficiency of the basic training program in handling weapons involving police officers of both sexes. The research population included 71 subjects (25 female subjects and 46 male subjects), students of the Academy of Criminalistics and Police Studies in Belgrade, who attended the basic course in handling duty weapons, and who had no prior knowledge of shooting. The subjects were tested 3 times during the course: at the beginning of the course (Test I), in the middle (Test II), and at the end of the course (Test III). The tests included precise shooting at a circle target with 10 bullets and at a distance of 10 meters. Each test was applied under standardized conditions of the rifle range, without a time limit on the shooting. The results were analyzed using multivariate statistic methods (the GLM multivariate model). Generally speaking, the results showed a statistically significant difference in shooting training efficiency between different sex subjects, at a Wilks' Lambda level of 0.849, F = 6.046, p = 0.040. The results showed that the subjects showed significant differences only at the initial measuring (Test I), whereas under the influence of training, the shooting skills of both groups had become homogeneous. In the case of the female subjects, the initial shooting efficiency was 29.32% (Test I), 63.04 % (Test II), and 69.32% (Test III), while for the male subjects it was 50.74% (Test I), 70.37 % (Test II), and 73.92% (Test III). In other words, the same shooting program increased the final shooting efficiency level by 136.43% among the women, while among the men the increase was 45.69%.*

Key words: *police training, shooting efficiency, shooting training effects*

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INTRODUCTION

Generally speaking, police officers perform one of the most physically demanding jobs. Not only is their occupation physically demanding, but it is also dangerous. Each year scores of law enforcement officers lose their lives in the line of duty (**www.medtox.com/policetest.html)**. Beside other necessary professional skills, using duty weapons belongs to the group of obligatory professional skills of police officers, which they must be properly trained for (Vučković et al., 2005; Vučković & Dopsaj, 2007). Contemporary developments in society have brought about the inclusion of women in formerly predominantly male occupations. One of these occupations is related to the activities and tasks assigned by the Ministry of Internal Affairs of the Republic of Serbia (henceforth MUP R Srbije). When performing these duties in keeping with the legal provisions, women are allowed to use force and firearms. In order to achieve the required standards of proficiency in weapon handling, they have to undergo training procedures, which are the same for both male and female officers, and which include basic training in handling a handgun (Dujković et al., 2005).

Differences in morphological and functional features among the sexes, as well as oxygen consumption, anaerobic power potential (Sagiv et al., 2007), maximal voluntary isometric muscle force, cross-sectional area and specific strength (Kenet-Braun and Ng, 1999), where men have a higher level of the aforementioned physical characteristics, give an advantage to the male population over the female one. In addition, there are some reasons why males, generally speaking, are able to make more accurate and efficient use of firearms (Vučković et al., 2001; Vučković & Dopsaj, 2007a; Vučković & Dopsaj, 2007b). It is important to point out that stances for shooting a handgun engage muscle groups necessary for connecting the mobile parts of the shooter so as to create a compact system. These groups of muscles include leg muscles, back and side muscles, as well as muscles moving the fingers of the right (or left) hand (Vučković et al., 2001a; Vučković et al., 2001b).

Application of modern methodological approaches in sports training as well as certain technological procedures in military or police officer training (Milosević, 1985; Williams, 2005; Milišić, 2007) which include specific training means (in this case, a shooting program) as well as load (in this case the duration of the shooting and the number of bullets) are aimed at bringing about certain changes (in both quantity and quality) in the capacity for precision in firearms handling, i.e. in handling the duty 9 mm CZ 99 handgun (Vučković et al., 2005, Vučković & Dopsaj, 2007).

Hands-on training is meant to produce a cumulative effect, as well as immediate and lasting effects of a number of training stimuli, which have been used in the programd shooting, resulting in an improved shooting technique and enhanced tactical efficiency in handling a weapon (better tactical estimates related to use which, when used, enhance shooting accuracy) (Anderson & Plecas, 2000; Vučković et al., 2005)

The aim of this paper is to define the characteristics of the motor learning process i.e. the efficiency of a basic training shooting program and of handling a duty fire weapon by policemen of both sexes.

METHODS

Subjects

The research was carried out during the summer field training of the students of the Academy of Criminalistics and Police Studies in Belgrade. The sample included 71 stu-

dents (25 female subjects and 46 male subjects) who had no previous experience in weapon handling. The basic descriptive features for the male subjects were the following: age=21.3±0.8, BH=1.785±0.017m, BM=78.1±6.6 kg, and for the female subjects: age=21.2±0.8, BH=1.691±0.037 m, BM=61.1±7.8 kg.

The Training Program

The training took place at the handgun shooting range in the Center for Police Officer Training Mitrovo Polje. The training program for handling a duty weapon – the 9 mm CZ 99 handgun - consisted of 6 stages and a shooting test. During the training, the subjects were required to undergo a program consisting of 34 exercises and fire about 360 bullets each (Dujković et al., 2005; Vučković et al., 2005).

Training efficiency evaluation methods

All of the subjects were tested three times: at the beginning, on the very first day, in order for us to define their initial efficiency levels (TEST 1); next, upon completing 50% of the training program, on the sixth day (after the third stage) in order for us to define their transition efficiency levels (TEST 2); and finally upon completing the training – on the twelfth day, in order for us to define their final level of shooting proficiency (TEST 3).

The test included precision shooting into a bullseye target with 10 bullets from a distance of 10 meters (Figure 1). The test was carried out under standard shooting range conditions with no time limit. The results of the test were calculated based on the value of the rings shot and were presented as the shooting efficiency percentage (the ratio of the rings shot and the hypothetical maximum result).

Fig. 1. Sample subjects shooting training/testing procedure

Statistical methods

All of the analyses were carried out by using statistical software, SPSS for Windows - Release 10.0.1 Standard Version (Copyright © SPSS Inc., 1989-1999). We used the statistical analyses which calculate and measure the basic descriptive statistics. The difference of general variability between the defined precision in the function of test shootings was established by means of multivariate statistic methods (the GLM multivariate model), using the Wilks' Lambda criterion, in addition to the Students' t test for paired samples. For the trend line definitions, we used linear regression modeling (Hair et al., 1998).

RESULTS

Generally speaking, the results showed a statistically significant difference in shooting efficiency between subjects of the opposite sex, at a Wilks' Lambda level of 0.849, F = 6.046, p = 0.040. The obtained results indicated that the tendencies in the change of shooting efficiency vary in the tested population with respect to gender. In other words, they showed that the tendencies in changing shooting efficiency and the use of a side arm differed among male and female subjects, or that they acquired shooting skills at different speeds.

The results of the basic descriptive statistics (Table 1) showed that the average shooting efficiency value in the observed population at the initial test (Test 1) for the male subjects was 50.74 ±20.60 of the shot rings sum, with the scores ranging from 2 to 83 rings. The value of the variation coefficient (cV%) was 40.60, which indicates that the observed population had the characteristics of an average homogenous group. For the female subjects, the results showed that the average value of shooting efficiency was 29.32±16.76 of the shot rings sum, with the scores ranging from 0 to 64. The value of the variation coefficient (cV%) was 57.17, which indicated that originally this population also had the features of an averagely homogenous group (Hair et al., 1988).

The second test (Test 2) showed an average value of scores of the male subjects, 70.37 ± 14.11 of the sum of shot rings. The results ranged from 33 to 92 points whereas the cV% value was 20.06%. This result showed that halfway through the training program, the group acquired the features of a homogenous group. For the female subjects, the average value amounted to 63.04 ± 16.34 points. The results ranged from 31 to 86 points and the cV% value was 25.92%. The results for this group also showed that it had acquired the characteristics of a homogenous group upon completing one half of the training program.

In comparison to the initial test, the final test for the male subjects (Test 3) showed an average value of shooting efficiency of 73.92 ± 12.96 points, with the scores ranging from 34 to 97 points, and a cV% value of 17.53%. The final test showed that the subject population had the characteristics of an outstandingly homogenous group. The average value for the female subjects was 69.32 ± 10.82 points. The results ranged between 51 and 88 points, and the cV% value was 15.60%; thus, this sample also showed that it had acquired the characteristics of a homogenous group.

Table 1. The basic descriptive indicators in the function of the realized tests for both sexes

Sex	TEST	$\overline{X}$ (N)	SD (N)	cV% (%)	Min (N)	Max (N)
Males	Test 1	50.74	20.60	40.60	2	83
	Test 2	70.37	14.11	20.06	33	92
	Test 3	73.92	12.96	17.53	34	97
Females	Test 1	29.32	16.76	57.17	0	64
	Test 2	63.04	16.34	25.92	31	86
	Test 3	69.32	10.82	15.60	51	88

Based on the results of the shooting efficiency differences between different sex subjects , it was concluded that there is a statistically significant difference at the initial test (Test 1) at the F-19.845, p = 0.000 level (for the first test, the shooting efficiency of the male subjects was statistically on a much higher level: the male subjects – 50.74 %, the

female subjects – 29.32%, Table 2), whereas this difference decreased immediately after the second test (Test 2, F-3.905, p=0.052, Table 2), and after the final, i.e. third, test it became even less (Test 3, F-2.283, p=0.135, Table 2).

Table 2. The results of the ANOVA between groups factor (within-groups effects)

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig
TEST_1	Between Groups	7430.930	1	7430.930	19.845	.000
	Within Groups	25836.310	69	374.439		
	Total	33267.239	70			
TEST_2	Between Groups	869.947	1	869.947	3.905	.052
	Within Groups	15373.532	69	222.805		
	Total	16243.479	70			
TEST_3	Between Groups	342.894	1	342.894	2.283	.135
	Within Groups	10363.400	69	150.194		
	Total	10706.294	70			

With respect to the efficiency of the applied basic training program in the function of particular gender (single group factor effects), the results showed that there was statistically significant improvement in the shooting efficiency of both the male and female subjects between Test 1, 2 and Test 3, which amounted to the level of F – 52.20, p = 0.000 for the female subjects (Table 3), and F – 27.18, p = 0.000 for the male subjects. However, this statistical significance is accounted for merely by the differences between the initial and the transition tests, i.e. Tests 1 and 2, both for the male and female subjects, up to the level of (tests of between-subjects effects) - t = 8.55, p = 0.000 for the female subjects, and t = 5.59, p = 0.000 for the male ones (Table 5).

Table 3. The results of the ANOVA within single group factor – female subjects

ANOVA: Single Factor					
Groups	Count	Sum	Average	Variance	
Test 1	25	733	29.32	280.89	
Test 2	25	1576	63.04	267.04	
Test 3	25	1733	69.32	116.98	
Source of Variation	SS	df	MS	F	P-value
Between Groups	23137.31	2	11568.65	52.20	0.000
Within Groups	15957.84	72	221.6367		
Total	39095.15	74			

Table 4. The results of the ANOVA within single group factor – male subjects

ANOVA: Single Factor					
Groups	Count	Sum	Average	Variance	
Test 1	46	2334	50.74	424.33	
Test 2	46	3236.951	70.37	199.21	
Test 3	46	3400.366	73.92	167.91	
Source of Variation	SS	df	MS	F	P-value
Between Groups	14341.75	2	7170.874	27.18	0.000
Within Groups	35615.25	135	263.8167		
Total	49957	137			

Table 5. The results of the Student's t test – female and male subjects

Paired Samples Test

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	FEM_Test 1-FEM_Test 2	-33.72	19.73	3.95	-8.55	24	.000
Pair 2	FEM_Test 2-FEM_Test 3	-6.28	18.39	3.68	-1.71	24	.101
Pair 3	FEM_Test 1-FEM_Test 3	-40.00	18.01	3.60	-11.11	24	.000
Pair 4	MAL_Test 1-MAL_Test 2	-19.63	23.83	3.51	-5.59	45	.000
Pair 5	MAL_Test 1-MAL_Test 3	23.18	24.82	3.66	-6.34	45	.000
Pair 6	MAL_Test 2-MAL_Test 3	-3.55	13.74	2.03	-1.75	45	.086

In other words, the statistically significant improvements to the shooting efficiency were noted only in the first part of the program (Test 1 versus Test 2), whereas no such change was noted in the second part of the training program (Test 2 versus Test 3) for either gender - $t = 1.71$, $p = 0.101$ for the female subjects, and $t = 1.75$, $p = 0.086$ for the male ones (Table 5).

The first defined characteristics and modeled power functions of the predicted training efficiency equation in the function of the percent of training realization, as a motor learning aspect of the applied basic shooting training program, had the following form: Male subjects, $y = 46.9710 \cdot x^{0.1005}$; Female subjects, $y = 24.5894 \cdot x^{0.2315}$, where: y was used for shooting efficiency (in %) and x was used for the % of training program realization (in %).

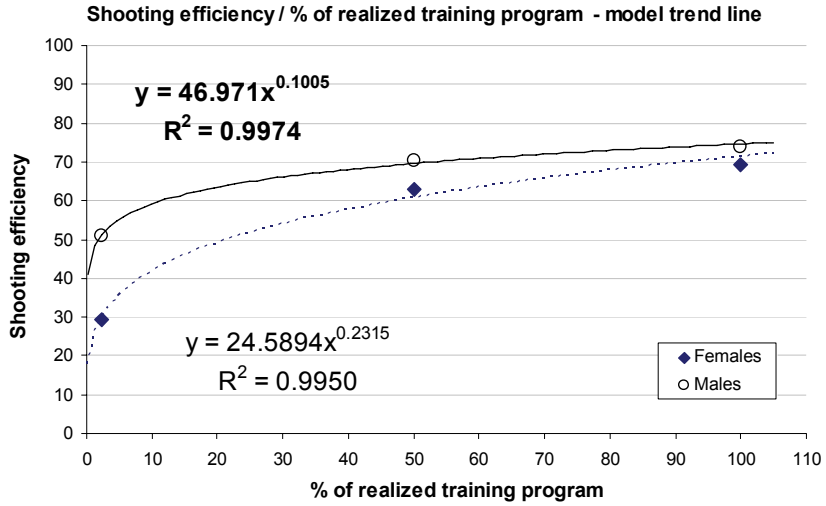

Fig. 2. The defined power functions of the predicted shooting efficiency equation in the function of the % of the realized training program.

The second defined characteristics and modeled power functions of the predicted training efficiency equation in the function of the shot bullet, as a training load aspect of the applied basic shooting training program, had the following form: Male subjects, $y = 41.2877 \cdot x^{0.0993}$; Female subjects, $y = 18.2544 \cdot x^{0.2289}$, where: y was used for shooting efficiency (in %) and x was used for the number of shot bullets.

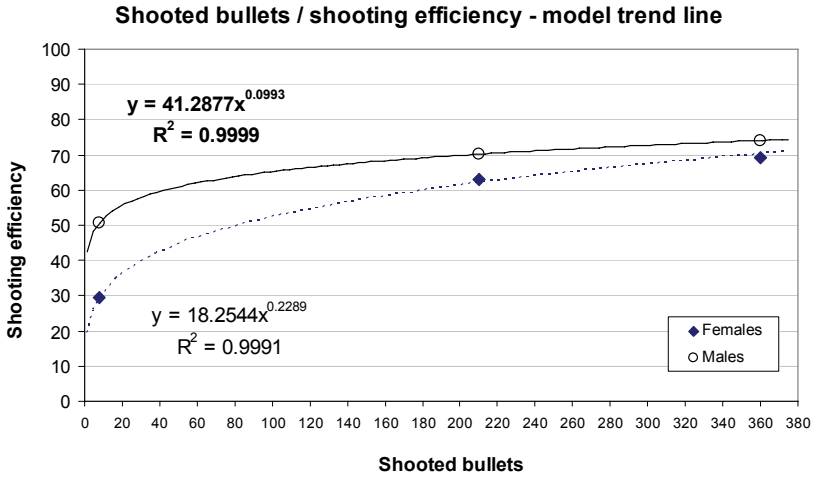

Fig. 3. The defined power functions of the predicted shooting efficiency equation in the function of the shot bullets.

It must be pointed out that the applied training program for the use of firearms had a significant effect on the homogenization of the observed quality (Čoh et al., 2004), i.e. the shooting efficiency of both genders, so that the coefficient of variety for non-homogenous groups (cV% 40.60 % for the male, and 57.17 % for the female subjects) obtained in Test 1 decreased so as to match the values typical of extremely homogenous groups (cV% 17.53 % for the male, and 15.60 % for the female subjects) in Test 3 (Table 1).

DISSCUSION

A sample consisting of 71 subjects – students of the Academy of Criminalistics and Police Studies in Belgrade, 46 male subjects and 25 female subjects, with no previous experience in handling firearms, were trained to use firearms. The training was performed by using the standardized training program consisting of 6 stages, the sixth being the shooting test, and all of the stages consisted of 34 different drills in which the subjects shot 360 bullets each (Dujkovic et al., 2005).

A statistically significant difference in the increase of efficiency of using a duty handgun for all of the subjects, that is, the efficiency of shooting precisely under the given conditions was 50.74% at the initial test, 70.37% at the transition test, and 73.92% at the final test for the male subjects, whereas for female subjects, it was 29.32% at the initial test, 63.04% at the transition test, and 69.32% at the final one.

The results indicated that there was a statistically significant difference, i.e. that a change in shooting efficiency, occurred only between the initial and the transitional tests (TEST 1 versus TEST 2), whereas no such change was found between the transitional and the final tests (TEST 2 versus TEST 3) for all of the tested sub samples (male and female subjects – Table 2).

In both subject populations we tested, the program had good effects (the observed quality improved), following the model of a reverse exponential curve (Figure 2, Figure 3). What is typical of this training program is that it consists of three different stages of learning. Stage one is characterized by an intense growth of the observed capacity, i.e. the pro-

gress is the fastest and it is reversely proportional to the time spent practicing, which means that the progress is significant during this first stage. The final stage leads to the stability of the observed capacity and the progress slows down, so that the practice time is reversely proportional to the rate of progress, because the function of practice time shows very little progress (Milošević et al., 1995; Vučković et al., 2005; Saider, 2007). According to defined model results, shooting efficiency in the function of the % of the realized training program (Table 2), the female subjects had a 47.65 % lower initial shooting ability level (24.5894 versus 46.9710, respectively), but they increased their shooting efficiency 2.30 per time unit faster during the training program (0.2315 versus 0.1105, respectively).

In other words, for both groups of subjects, the results showed that the initial shooting efficiency level under the given conditions (pin peace, with no previous fatigue, from a distance of 10 m and with no time limit) was increased for Δ 115.01% and Δ 38.69 % for the female and male subjects respectively, during the first phase of the training program (Test 1 versus Test 2), while during the second phase (Test 2 versus Test 3), where no statistically significant changes occurred in the observed ability, the female subjects improved their shooting efficiency by Δ 9.96% and the male subjects by Δ 5.05 % (Figure 4).

The final values for shooting efficiency showed an increase at the end of the training program: with reference to the absolute values, the increase amounted to – Δ 136.43 % and Δ 45.69 % for the male and female subjects respectively (TEST 1 versus TEST 3).

The obtained results indicate that the applied training program brought about improvements to the efficient use of a duty sidearm among both male and female police officers under the set testing conditions only in the first part of the program, whereas the second part showed no statistically significant increase of the observed quality.

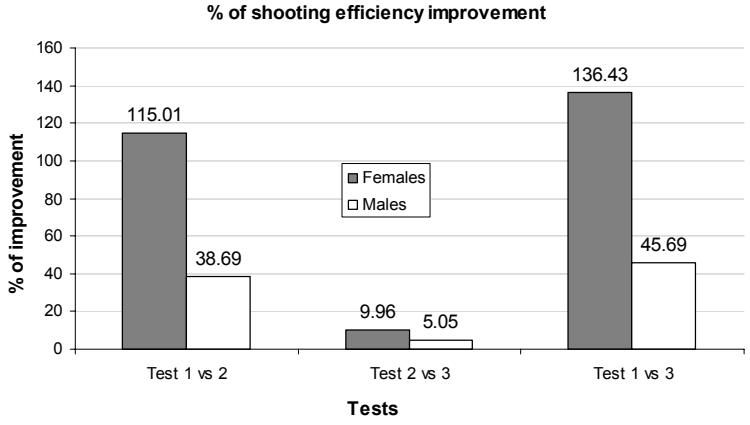

Fig. 4. The Δ of shooting efficiency improvement in the function of the tests (in %)

This research cannot establish the cause of the observed facts, that is, it cannot determine why the same training program for the use of firearms has different effects during different stages of the program, so we suggest further research in this area with different modalities of firearms training programs that would result in defining the optimal training and education program that would grant continuous improvement in shooting efficiency throughout the whole training process.

Practical Application

From the aspect of shooting efficiency control by means of applied programs, Table 6 shows a cybernetic model defined on the basis of mathematical models calculated in this research. By their implementation, the given shooting training program can be used to identify a deterministic system of training (a system of trainings with precisely defined and known final effect). For example, in case the male subjects need to be trained at the level of 70% of shooting efficiency (7 hits out of 10 bullets), it is necessary to realize 53% of the applied training program for the male subjects and 92% of the training program for the female ones; or in case male subjects need to be trained at the level of 70% of shooting efficiency (7 hits out of 10 bullets), it is necessary to use 204 bullets for the male and 355 bullets for the female subjects… etc.

In this way, it is possible to define training models of a deterministic type in the function of other kinds of training such as – situational terrain shooting training, situational training of shooting in urban conditions, sniper shooting etc. Thus, the technology of training for using official police weapons would be improved, which would bring enormous professional benefits on both a training and economical level.

Table 6. The results of the deterministic type cybernetic model created on the basis of the research results

	Shooting efficiency			Shooting efficiency	
% of the realized training program	Males	Females	Number of shot bullets during the training program	Males	Females
5	**55.22**	***35.69***	5	48.44	*26.39*
10	**59.20**	***41.90***	10	51.89	*30.92*
15	**61.66**	***46.03***	15	54.03	*33.93*
20	**63.47**	***49.20***	20	55.59	*36.24*
25	**64.91**	***51.80***	25	56.84	*38.14*
30	**66.11**	***54.04***	30	57.88	*39.76*
35	**67.14**	***56.00***	35	58.77	*41.19*
40	**68.05**	***57.76***	40	59.55	*42.47*
45	**68.86**	***59.36***	45	60.25	*43.63*
50	**69.59**	***60.82***	50	60.89	*44.70*
60	**70.88**	***63.44***	60	62.00	*46.60*
70	**71.99**	***65.75***	70	62.96	*48.27*
80	**72.96**	***67.81***	80	63.80	*49.77*
90	**73.83**	***69.69***	90	64.55	*51.13*
100	**74.62**	***71.41***	100	65.23	*52.38*
120	**76.00**	***74.49***	120	66.42	*54.61*
140	**77.18**	***77.19***	140	67.44	*56.57*
160	**78.22**	***79.62***	160	68.34	*58.33*
180	**79.16**	***81.82***	180	69.15	*59.92*
200	**80.00**	***83.84***	200	69.87	*61.39*
250	**81.81**	***88.28***	250	71.44	*64.60*
300	**83.33**	***92.09***	300	72.74	*67.36*
400	**85.77**	***98.43***	400	74.85	*71.94*
500	**87.72**	***103.65***	1000	81.98	*88.73*

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EFEKAT OSNOVNE OBUKE ZA UPOTREBU SLUŽBENOG ORUŽJA NA EFIKASNOST PUCANJA POLICAJACA OBA POLA

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Upotreba službenog oružja pripada kategoriji profesionalih policijskih veština i sposobnosti, za koje policajci moraju biti osposobljeni na adekvatan način. Cilj ovog rada je definisanje efikasnosti primenjenog programa osnovne obuke za upotrebu službenog oružja kod populacije policajaca oba pola. Istraživanje je realizovano na uzorku od 71 ispitanika (25 devojaka i 46 mladića), studenata Kriminalističko policijske akademije iz Beograda, koji su pohađali osnovni kurs obuke u rukovanju službenim oružjem, a bez prethodnog iskustva u pucanju iz pištolja. Ispitanici su testirani tri puta za vreme obuke i to na početku (Test I), u sredini (Test II) i na kraju obuke (Test III). Testiranje je realizovano primenom preciznog pucanja u kružnu metu sa 10 metaka i sa distance od 10 metara. Svaki test je izvršen u standardizovanim uslovima pištoljskog strelišta i bez vremenskog ograničenja pucanja. Sirovi rezultati su analizirani primenom multivarijantne statističke metode – generalnog linearnog modelovanja (GLM). Na generalnom nivou je utvrđena statistički značajna razlika između efikasnosti pucanja između polova na nivou Wilks Lambde od 0,849, F=6,046, p=0.040. Takođe analize su pokazale da je razlika utvrđena jedino na inicijalnom testiranju na Testu I. U odnosu na ispitanice vrednost efikasnosti upotrebe službenog oružja je bila 29,32% (Test I), 63,04% (Test II) i 69,32% (Test III), dok je za ispitanike bila na nivou od 50,74% (Test I), 70,37% (Test II) i 73,92% (Test III), respektivno. Isti program osnovne obuke za upotrebu službenog oružja je kod ispitanica povećao efikasnost pucanja za 136,43%, dok je kod ispitanika taj napredak bio na nivou od 45,69%.

Ključne reči: *osnovna obuka policajaca, efikasnost pucanja, efekti treninga pucanja*