GENDER DIFFERENCES AND CLASSIFICATION OF POLICE UNIVERSITY STUDENTS RELATING TO JOINT TISSUE FLEXIBILITY

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Abstract: Flexibility influences the amplitude of body parts movement and consequently the efficiency of physical activities which are an integral part of police officers training and professional duties. The aim of this study was to determine the level of flexibility in students of the University of Criminal Investigation and Police Studies (UCIPS), as well as the differences between genders and to establish the criteria for evaluation. The sample consisted of 121 participants, 51 female (age 20.2 ± 1.2 years) and 70 male students (age 20.3 ± 0.9 years). All participants were the second year students. A battery of tests for flexibility assessment included: Sideways Leg Splits (SsLS), Sideward Leg Splits right (SdLS right), Sideward Leg Splits left (SdLS_left), Single-Legged Knee Bend right (SLKB_right), Single-Legged Knee Bend left (SLKB_left), Lengthwise Leg Splits right (LLS_right), Lengthwise Leg Splits left (LLS_left), Sit and Reach (SR), and Shoulder Flexibility (SF). The existence of the differences between groups was determined by ANOVA, at the significance level of $p < 0.05$. The differences were found in tests SsLS ($F = 11.459$, $p = 0.001$), SdLS_right ($F = 8.440$, $p = 0.004$), SdLS_left ($F = 5.502$, $p = 0.021$), SLKB_left ($F = 5.545$, $p = 0.025$), LLS_right ($F = 11.481$, $p = 0.001$), LLS_left ($F = 18.008$, $p = 0.000$), SR ($F = 7.886$, $p = 0.006$) and SF ($F = 25.447$, $p = 0.000$). The obtained results indicated different flexibility levels between male and female students. In relation to martial arts and other athletes the UCIPS students had lower levels of flexibility. The applied percentage distribution results, including six different groups, could be used as a scale for assessment of the achieved level of flexibility in police university students.

Key words: flexibility, gender, students, police

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INTRODUCTION

Physical fitness became a very important factor for police officers (Kukic & Dopsaj, 2017) because some of the tasks can involve running, grappling, wrestling, fighting and carrying loads (Strating, Bakker, Dijkstra, Lemmink & Groothoff, 2010). Based on the nature and requirements of these tasks, police officers need to be physically prepared to perform duties sufficiently and effectively, but with a reduced risk of injuries (Guffey, Larson & Lasley, 2015). Method of operation and the responsibility police officers have require optimum level of physical abilities, which is one of the factors influencing efficient performance (Sorensen, Smolander, Louhevaara, Korhonen & Oja, 2000). In contrast, inadequate levels of physical ability may be a limiting factor in the performance of professional duties and could lead to poor productivity, injuries and long-term disability, which results in the loss of human resources and economic costs (Lonsway, 2003; Lockie at al., 2019). Overall, for successful performance of police work and fulfilling professional obligations of police officers, it is necessary to be of adequate health (Sorensen et al., 2000), morphological characteristics (Dopsaj, Milosevic, Vuckovic, Blagojevic & Mudric, 2005; Malavolti et al., 2008) as well as basic and specific physical abilities (Copay & Charles, 1998; Jankovic et al., 2015).

Professional engagement of police officers requires a necessary level of work qualifications and skills, among which are theoretical and practical knowledge in the field of Specialized Physical Education (SPE). As a result of education, the future police officers must be physically capable of performing all occupational requirements successfully, in a way which is safe and secure for all those concerned (Anderson, Plecas & Segger 2001). The students of the University of Criminal Investigation and Police Studies (UCIPS), i.e. the future police officers, are obliged to fulfil certain criteria on an annual basis, which simultaneously indicate the level of their adjustment to applied training loads during SPE courses (Dopsaj & Vuckovic, 2006; Dimitrijevic, Koropanovski, Dopsaj, Vuckovic & Jankovic, 2014). More precisely, the students have to achieve adequate level in muscle force, muscle power and aerobic endurance. In opposite, join tissue flexibility is not a part of basic motor ability assessment at the course of the SPE.

Flexibility is considered as one of the independent components of physical ability, and it is used to describe the amplitude of movement of either one or more joints (Alter, 1996). In other words, it is the ability of expressing muscular and tendon properties throughout the biggest possible joint amplitude (Zaciorski, 1975; Alvar, Sell & Deuster, 2017). The higher level of flexibility provides the more efficient training process (Stefanovic, Jakovljevic & Jankovic, 2010). In that regard, flexibility represents one of many important factors necessary for the successful performance of movement activities. Flexibility is essential for higher amplitudes of movement performance. Having in mind that police work requires the knowledge of a great number of martial arts techniques, greater joint flexibility enables a more efficient and easier performance of the techniques. The performance of techniques at greater distances which provide greater security of police officers

in critical situations is facilitated by the flexibility of muscles. Furthermore, flexibility is important for performing more efficient movement as the individuals with higher levels of flexibility perform movements more efficiently, or quickly, because it enables muscular activity at a longer distance, and consequently at a higher speed. The requirements regarding muscular strength are lower, as it takes less strength to stretch the antagonist muscles which stop the movement. This is important for the fact that police officers are expected to resolve critical situations as efficiently as possible and using minimum level of force. Finally, higher level of flexibility is directly related to reducing the risk of injury due to higher reserve flexibility (Stefanovic et al., 2010). The reduction of medical costs, sick leaves, and reduced work capacity are only some of the factors indicating that the level of flexibility should be developed and kept at a necessary level.

Flexibility could be observed through the functional, reserve and maximal on the one hand, as well as static and dynamic on the other. Functional flexibility is defined as movements with low amplitudes and is manifested in everyday activities (e.g. walking). Reserve flexibility is an addition to functional flexibility and enables movements of higher amplitudes, such as martial art techniques. Maximum flexibility is characterised by extreme joint flexion or extension, abduction, and it is most often performed during physical abilities testing. Static flexibility is manifested in static conditions, and dynamic in the conditions of body movement through space (Stefanovic et al., 2010).

In the last few decades, women have become employed in police workforce more often than before. The dimorphism between male and female human body composition is evident from an early age (Wells, 2007), which particularly manifests in traditionally men's professions (Boyce, Jones, Lloyd & Boone, 2008; Dawes et al., 2017). Recruitment standards for female police officers were set and re-evaluated in order to avoid gender discrimination but also to facilitate the recruitment of women who will be able to perform the job safely (Hauschild et al., 2017; Wells, 2007). However, there are no defined standards for flexibility for both genders.

All of the above mentioned indicate flexibility importance in motoric tasks which security agency personnel realize on their duty. The issue with this research is determining the level of flexibility of the second year students of the UCIPS using standardized flexibility assessment tests intended for upper and lower parts of the body. The aim of this research is to determine the level of the UCIPS students' flexibility, as well as the differences between male and female gender of the tested individuals and to establish the criteria for evaluation of flexibility level.

METHODS

Participants

The testing was performed on 121 students of the second year of the UCIPS. Out of that number, 70 examinees were of male gender (Age = 20.31 ± 0.96), and 51 of female gender (Age = 20.20 ± 1.17). All examinees were informed about the course and the procedure of testing. None of the participants reported any injury or problem which could influence the testing results.

Procedure

The testing included anthropometrical measurements of body height (BH) and body mass (BM), which provided the data for body mass index (BMI) calculation. BH and BM were measured to the nearest 0.5 cm and 100 g, respectively. Thereafter, the body mass index was assessed ($BMI = BM/BH^2$) and expressed in units of kg/m^2. Anthropometric measurements were taken by the same experimenter according to standard procedures (Dimitrijevic et al., 2014).

Flexibility assessment was performed by using the tests already validated by previous research papers as field tests and they are practically applied in various sports (Rosch et al., 2000; Bozic, Pazin, Berjan, Planic & Cuk, 2010), especially where flexibility is one of dominant motor abilities such as martial arts. The testing of flexibility performance was preceded by a standard 10-min warm-up and 10-min active stretching, following a detailed explanation and qualified demonstration of each test.

Single-Legged Knee Bend - This test predominantly assesses the flexibility of the hip flexors muscles. The participant kneels on the right leg, with the left leg extended forward, but the lower leg is kept vertically. From this starting position, the participant slides the knee back as far as possible while supporting himself with his left hand holding the chair and the right hand being supported by the experimenter. The trunk remains in the upright position (i.e., aligned with a vertical line on the wall), no rotation of the hips is allowed, while the lower part of the front leg remains vertical. A kinanthropometer is used for measurement of the height of the symphysis (h), whereas a ruler (fixed on the ground) is used for measurement of the horizontal distance between the back knee and the vertical projection of symphysis (a). The hip extension angle of the back leg is obtained from trigonometric calculation (a = arctan*(a/h)).

Sideward Leg Splits - The test predominantly assesses the flexibility of the hamstring muscles of the front leg and the adductor muscles of the back leg. The participant stands on a smooth board and supports himself with the left hand holding the chair and the right hand being supported by the experimenter. His back (i.e., right) foot is turned out and forms an angle of 90° with the forward (i.e., left) foot. Thereafter, he slowly slides both feet apart. The trunk remains upright (vertical line on the wall) and no hip rotation is allowed. A kinanthropometer is used for measurement of the distance between the symphysis and the ground (h),

whereas a ruler (fixed on the ground) for measurement of the distance between the heel of the back leg and point of the vertical projection of symphysis on the ground (a) and the distance between the heel of the front leg and point of the vertical projection of symphysis on the ground (b). The angle formed by the legs is assessed by means of a trigonometric formula (a = arctan*(a/h) + arctan*(b/h)).

Sideways Leg Splits - This test mainly allows the assessment of flexibility of the adductor muscles (Rosch et al., 2000). The participant stands on a smooth board and supports himself with the left hand holding the chair and the right hand being supported by the experimenter. The feet are placed parallel. Thereafter, he slides both of his feet slowly apart while the trunk remains in the upright position aligned with a vertical line depicted on the wall. A kinanthropometer is used for measurement of the distance between the symphysis and the ground (h), whereas a ruler (fixed on the ground) is used for measurement of the distance between the heels and the point of the vertical projection of symphysis on the ground (a, b). A trigonometric calculation (a = arctan*(a/h) + arc- tan*(b/h)) is used to calculate the angle formed by the legs.

Lengthwise Leg Splits - This test allows the assessment of flexibility of the hamstring and quadriceps muscle (Rosch et al. 2000). The participant kneels on the right leg, with the left leg stretched out forward while supporting oneself with the left hand holding the chair and the right hand being supported by the experimenter. Thereafter, he slides the extended leg forward, while the other knee remains at the floor and the upper leg remains vertical. No hip rotation is allowed. A kinanthropometer is used for measurement of the distance between the symphysis and the ground (h), while a ruler (fixed on the ground) is used for measurement of the distance between the back knee and the point of the vertical projection of symphysis on the ground (a), and the distance between the front heel and the vertical projection of symphysis (b). A trigonometric calculation (a = arctan*(a/h) + arctan*(b/h)) is used to calculate the angle formed by 2 legs.

Sit and Reach - This test mainly allows the assessment of flexibility of the hamstring and the spine muscles (Jackson & Langford, 1989). A box which has a scale marked out on the upper side ("0" marks of the ruler are 10 cm toward the hips) is placed against the wall. The participant sits on the floor with his fully extended legs and feet placed together next to the box. The participant's hands are on top of each other (tips of the middle fingers aligned) and palms down. The participant reaches slowly forward and touches the front of the box with both hands as far as possible. The examiner measures the point where the tip of the middle fingers touches the scale. The precision of the measurement is 0.5 cm.

Shoulder flexibility (twist with the stick) - This test assesses the flexibility of arms and shoulder region. The participant holds a stick in his hands extended forward and his right hand holds the end of the stick, and his left hand holds the stick right next to measurement scale. From the initial position, holding the hands extended forward, the participant slowly raises the stick and parts his hands by sliding his right hand (his left hand remains fixed to the end of the stick). The task requires

that the participant performs a twist above his head holding the stick with hands extended forward, thereby trying to keep as little distance between the inner sides of his hands as possible.

Statistics

The descriptive statistic was conducted in Microsoft Excel (Microsoft software package, Office 365), while univariate analysis of variance (ANOVA) was conducted using Statistical Package for Social Sciences (IBM, SPSS Statistics 20). The significance level was set at $p < 0.05$. The percentile distribution procedure was conducted in order to establish the levels of flexibility.

RESULTS

Table 1 shows the results of median value and standard deviations of morphological characteristics of the participants, as well as the difference in results between the male and female participants.

Table 1: *Demographic and anthropometric profiles of the university academy students*

	Male (N=70)		Female (N=51)		
	Mean	SD	Mean	SD	p-value
Body Height (cm)	182.58	5.18	170.05	4.23	0.00*
Body Mass (kg)	82.24	11.13	64.96	7.76	0.00*
BMI (kg/m^2)	24.62	2.63	22.45	2.39	0.00*

* - *significant difference between groups*

Based on the data from Table 1, a statistically important difference in BH and BM is noticeable between the male and female students. Also, statistically significant differences were obtained regarding BMI.

Table 2 shows the results of median values, standard deviations, as well as the difference in results in indicators between the male and female participants.

Table 2: *Flexibility measures of the university academy students*

	Male (N=70)		Female (N=51)		
	Mean	SD	Mean	SD	p-value
SsLS (°)	118.35	1.77	127.37	1.95	0.001*
SdLS_right (°)	122.04	1.47	128.80	1.84	0.004*
SdLS_left (°)	124.90	1.53	130.71	2.00	0.021*

SLKB_right (°)	47.94	0.72	52.04	1.01	0.001*
SLKB_left (°)	49.11	0.71	53.41	0.69	0.000*
LLS_right (°)	119.70	1.31	130.69	1.52	0.000*
LLS_left (°)	120.51	1.23	132.50	1.70	0.000*
SR (cm)	10.41	0.79	13.67	0.82	0.006*
SF (cm)	94.38	1.61	82.04	1.83	0.000*

SsLS - Sideways Leg Splits; SdLS - Sideward Leg Splits;
SLKB - Single-Legged Knee Bend; LLS - Lengthwise Leg Splits;
SR- Sit and Reach; SF- Shoulder flexibility; ° - degrees.
** - significant difference between groups*

Table 2 shows the statistically significant difference for all variables of flexibility which is noticeable between the male and female students.

Table 3 shows the results of percentile distribution of flexibility in the male and female participants.

Table 3: *Percentile distributions of the flexibility measures of the police university students*

		SsLS (°)	SdLS_right (°)	SdLS_left (°)	SLKB_right (°)	SLKB_left (°)	LLS_right (°)	LLS_left (°)	SR (cm)	SF (cm)
Percentiles Female	10	112.66	114.70	116.82	47.78	48.74	116.46	118.50	6.20	65.00
	25	117.63	120.47	121.48	50.60	50.53	122.01	124.33	10.00	73.00
	50	126.04	127.68	126.57	53.13	53.39	131.90	129.71	14.00	82.00
	75	132.95	134.14	138.28	55.62	57.34	137.06	139.08	18.00	94.00
	90	141.80	142.70	146.39	57.25	59.04	144.79	149.13	21.80	98.80
Percentiles Male	10	102.68	106.46	108.59	39.84	42.75	104.70	106.81	0.55	76.40
	25	110.38	112.32	116.03	44.11	46.32	114.72	113.03	5.38	85.75
	50	119.21	121.39	124.52	48.73	49.98	120.15	120.29	11.00	95.00
	75	126.58	129.54	133.10	52.66	52.86	124.94	126.77	15.00	101.75
	90	135.93	140.92	141.88	54.46	55.09	133.56	135.91	17.90	112.00

On the basis of the results shown in Table 3, the students classification in joint tissue flexibility could be expressed as excellent (over 90 percentile), exceptionally good (between 75-89.99 percentile), very good (between 50-74.99 percentile), good (between 25-49.99 percentile), sufficient (between 10-24.99 percentile) and insufficient (below 9.99 percentile).

DISCUSSION

The aim of this research was to determine the level of flexibility in the second year UCIPS students, the differences between the male and female students, as well as to establish the criteria of flexibility level evaluation. The ANOVA results

showed a statistically significant difference between the male and female students in all flexibility related variables. The female students demonstrated a higher level of flexibility in all tests when compared to the male students. The tests which showed statistically significant differences were SsLS (F = 11.459; p = 0.001), SdLS_right (F = 8.440; p = 0.004), SdLS_left (F = 5.502; p = 0.021), SLKB_right (F = 11.481; p = 0.001), SLKB_left (F = 18.008; p = 0.000), LLS_right (F= 29.837; p = 0.000), LLS_left (F = 34.361; p = 0.000), SR (F = 7.886; p = 0.006) and SF (F = 25.477; p = 0.000). Similar results were also obtained in previous studies with distance runners and karatekas, where the female participants achieved better results in comparison with the male participants in flexibility related tests (Tamra & Robert, 2009; Timotijevic, Aleksic, Jovanovic & Suzovic, 2015). Also, our results strongly agree with the findings of the other study, in which Timitojevic and Koropanovski (2017) investigated the initial level of flexibility on the same population.

In regard to anthropometric parameters, the male students were statistically significantly higher (F = 200.855; p = 0.00) and heavier (F = 90.655; p = 0.00) than the female students. Also, statistically significant difference was found for variable BMI (F = 21.619; p = 0.00), which was higher in male students. Both the males and females belonged to standard weight class in accordance with the World Health Organization's standards, whereby the male students' results were very close to the upper bound. Average morphological parameters in the male students (TV = 182.58 cm, TM = 82.24 kg, BMI = 24.62 kg/m^2) were very similar with the data in Dimitrijevic et al. (2014) research on the Academy of Criminalistc and Police Studies (ACPS) students (Generation 1995: BH = 182.01 cm, BM = 80.95 kg, BMI = 24.38 kg/m^2; Generation 2005: BH = 182.25 cm, BM = 80.63 kg, BMI = 24.23 kg/m^2; Generation 2010: BH = 182.62 cm, BM = 78.89 kg, BMI = 23.61 kg/m^2). The average morphological parameters in the female students (BH = 170.05 cm, BM = 64.96 kg, BMI = 22.45 kg/m^2) were similar to the data in Dopsaj and Vuckovic (2006) research on the ACPS students (BH = 169.5 cm, BM = 62.5 kg, BMI = 21.7 kg/m^2).

Due to the specific nature of police work, hip flexibility is necessary for kicks and punches as well as throwing techniques. Biomechanical requirements for performing kicks include a certain level of flexibility of front and back hamstrings, as well as inner part of upper legs. Efficient rotations in hips which add to previous movements of other body parts, apart from circular punch, are also characteristic of punches and some throwing techniques, and largely depend on the flexibility of this joint. With the fact that the techniques taught in SPE lessons are taken over from martial arts and are adjusted to the requirements of police work, the athletes in relevant disciplines can be considered as a representative sample. In comparison between karate athletes and the UCISP students, karate athletes achieved better results in all tests (Timotijevic et al., 2015).

Sit and reach is the tests for the assessment of hamstrings flexibility, where this kind of ability is of great importance for throwing and foot techniques. The

advantage of this test is simple application, and the disadvantage is the fact that the test does not precisely assess the flexibility in each participant individually. Because of that the participants with longer limbs have the advantage in achieving good results over those participants with shorter limbs. Also, the result of this test depends on the flexibility of spine and shoulder regions. When the results in sit and reach tests were compared, the UCIPS students achieved lower test results than distance runners, judokas (Tamra & Robert, 2009), karatekas (Nikookheslat, Faraji, Fatollahi & Alizadeh, 2016), basketball players, handball players, soccer players, volleyball players (Jaric, Ugarkovic & Kukolj, 2001) and better results than football players (Katralli, Goudar & Itagi, 2015). These differences might be attributed to the influence of training process of the athletes of the categories mentioned above. In comparison with the results of Timotijevic and Koropanovski research (2017), it is noticeable that the male students of the second year of the UCIPS had similar level of lower body flexibility and better results in upper body flexibility than the novices. In contrast, the level of flexibility in female students seems to have decreased from the enrolment.

Shoulder is one of the most flexible joints in human body, and is therefore often prone to injuries. Insufficient level of shoulder muscles flexibility may adversely influence the performance of certain techniques (punches, blocks, throwing and holds), and finally lead to injuries. According to shoulder flexibility, the male UCIPS students achieved similar results to handball players (Grujic, Ohnjec & Vuleta, 2011), whereas the female tennis players achieved better results than the female UCIPS students (Filipcic & Filipcic, 2005). These differences might be attributed to the influence of training process in which the athletes were involved.

The determination of minimum level of flexibility for successful performance of motor tasks would be of particular importance for the improvement of professional work and training process control. This research provides classification of flexibility level for both genders (Table 3). In that regard, police student's flexibility level should be ranged as insufficient, sufficient, good, very good, exceptionally good or excellent. Additionally, the given rank matches the existing marks classification (i.e. 5-10). Finally, the future research should give scientifically valid answers about the importance of flexibility in relevant space, as well as the type of flexibility of importance to the efficient performance of work by security services officers.

CONCLUSION

The main aim of this research represents the establishment of the level of the second year UCIPS students' flexibility. The female students expectedly achieved better results in flexibility tests than the male students. The level of student flexibility was lower in comparison with athletes. In comparison with novices, the second year UCIPS students' posses lower level of flexibility. The classification of

police students' flexibility level given in this research could be involved in evaluation process.

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