UNICYCLING AND BALANCE IMPROVEMENT

Dražen Čular[1], Alen Miletić[2] and Đurđica Miletić[3]

[1] Faculty of Philosophy, University of Split, Croatia
[2] "Citius – Altius – Fortius" Scientific – Sport Society, Split, Croatia
[3] Faculty of Kinesiology, University of Split, Croatia

Original scientific paper

Abstract
The aim of the study was to determine whether a 15-hour kinesiology unicycling training might have a statistically significant impact on the development of static and/or dynamic balance of the 58 Physical Education University female (N=25) and male (N= 33) students. The subjects were divided in two groups, experimental and control. The experiment involved the measurements of morphological characteristics (body height; body weight; body mass index and body fat percentage) and balance by the Biodex Balance System SD in the control and the experimental group. The unicycling treatment for the experimental group lasted for 5 weeks and only the subjects without any prior motor knowledge of unicycling were included. In experimental group, the dependent sample t-test showed significant differences between the initial and the final measurement in dynamic balance with males (+12.8 %; p<0.01), as well as with females (+27.3%; p<0,01). Statisticaly significant improvement for static balance are found only with female group (+24.0 %, p<0.01). The independent T-test showed the unicycling treatment has a significantly greater impact on dynamic and static balance of the female than the male subsample. Morphological differences between sexes, different positions of the centre of gravity and differences in body geometry may affect the results in dynamic and static balance of males and females. Unicycling is a very efficient method for balance development in relatively short time of training period. Presented results opens up new possibilities of using the unicycle in training methods aimed to improve balance abilities.

Key words: *dynamic balance, static balance, gender differences*

Introduction

Balance is the ability to maintain the centre of gravity of a body. The brain analyses information on body position via the kinaesthetic and proprioceptive receptors. Balance is a mechanism for the control of movements in the motor system, i.e. a sub-mechanism for synergy control and muscle tone regulation, and is divided into balance with eyes open and balance with eyes closed. Even though different papers provide various definitions of balance, the authors agree that there are two main divisions: (1) static and dynamic balance; (2) balance with eyes open and balance with eyes closed. For example, according to Winter et al. (1990), postural control or balance can be static (the ability to maintain stable position with as few movements as possible) or dynamic (the ability to perform a motor task while maintaining stable position). Clark et al. (2001) define balance as a motor ability, highly-integrative dynamic process of coordinating multiple neurological activities enabling positioning of the body's centre of gravity over the supporting base. According to Palmieri et al. (2002), the factors having direct influence on the ability to maintain the balancing position may be sensory (visual and auditory information), coordination, range of joint movements and strength. The correlation of morphological characteristics, above all body weight and height were primarily studied on a sample of overweight persons along with balance. Deforche et al. (2009) studied the difference in balance among obese children and children of normal weight. Six different tests were used to evaluate their balance. For example, the test of standing on one leg on a balance bench and the "heel-to-toe on a walking line" test (according to the Bruininks-Oseretsky group of tests) show that obese boys have much worse results than the boys of normal weight. The authors conclude that expectations on the balancing ability of preadolescent boys can be associated with the morphological category of the body mass index value. Goulding et al. (2003) used the Bruininks-Oseretsky tests (BOT) for assessing balance on a sample of boys and young men between the ages of 10 and 21, and compared them with their findings in terms of fractures and overweight issues. The authors concluded that fractures cannot be associated with balancing skills, but that constitution can. BOT tests for balance assessment are negatively correlated with weight, BMI and body fat percentage. Previous studies, other than the already mentioned BOT tests for balance assessment, include very different protocols and aids for measuring and improving balance. Perrin et al. (2002) compared how dance and judo trainings affect the balance and control groups with the aim to determine influences of individual training exercises on balance development. The test of balance with eyes open demonstrated that judo players and dancers had significantly better values and increased sensory and motor adjustment. In the test of balance with eyes closed only judo players showed significantly better results than the control group. Balance with both eyes open and closed was measured with a statokinesigram.

Psalman (2008) analysed the dynamic balance abilities by applying the new 3D diagnostics system to be used in sports training and physical conditioning. Eight young tennis players between the ages of 16 and 18 were made to balance a fitness ball in different positions. One of the most difficult positions, the Buddha position (standing on the ball with isolated upper extremities) is closely connected to the level of balance abilities crucial for top tennis players. This method can be used for precise identification of balance abilities. The tested athletes demonstrated stable posture in values ranging from 146 and 152 degrees. The author confirmed the dominant operation of the left side, which achieves greater acceleration (up 3 m/s^2) than the right side. The high velocity of each segment is required for keeping balance during quick corrections. It is important to measure these parameters because they are essential for improving tennis techniques although they are not visible to the naked eye. The obtained results represent the dynamic balance of top athletes. Strešková & Chren (2009) used the FiTRO sway check stabilographic system method for measuring the balance ability of professional Latin American dancers and analysed the expert evaluation of sport performance in particular Latin American dances. The measurements of body stability after the performance and special load conditions confirmed positive changes in static balance (the third measurement after fitness conditioning showed that static balance improved drastically between the second and the third measurement) and dynamic balance (statistically significant improvement after fitness conditioning between the second and the third measurement). The greatest changes were observed during the measurement conducted after the experiment which consists of a fitness programme and a gymnastics programme. This programme was included in the fitness conditioning of the dancers instead of special preparations lasting for three months. The improvements in static and dynamic balance manifested themselves as increase of dance efficiency. The increase in postural control and balance as a motor ability is often programmed for the purpose of decreasing the risk of injuries among athletes (Bressel et al. 2007). Former studies (Lephart et al. 1996; Aydin et al. 2002) have shown that balance development training increases the proprioception of the ankle and knee joints because it stimulates sensory and motor reaction. Unicycling is a sports activity which is developing in the same manner as biking. Many different styles have developed, such as mounting unicycling or long-distance unicycling. Even though it started as a fun recreational activity, unicycling has become a sports competition, trained either individually or in teams (like hockey, basketball, handball, etc.). The International Unicycling Federation was founded in 1982 in Japan and today it includes over 30 member states. Sports training should include balance development exercises for which additional training practices may be established. This study is particularly concerned with the examination of certain additional training possibilities which might improve balance.

Is unicycling one of them? There are only a few studies which deal with the impact of unicycling on balance development, and they were conducted by authors from Japan where unicycling represents an everyday recreational physical activity. Ohsaki et al. (2008) claim that unicycling improves balance, coordination and ambidexterity, the ability to manipulate the left and the right side of the body equally well. The authors developed a dynamic unicycle simulator which can program the external factors in accordance with movement characteristics. Hence, the simulator can be used in training and teaching. Ohsaki et al. (2009) also examined the influence of unicycling on balance, agility and the ability to coordinate movements in accordance with external conditions. The study interpreted the connection between the centre of gravity and the centre of pressure in unicycling by using the structure and the limitations of the reaction force on the simulator. Given that both of these studies were conducted on the unicycle simulator, additional experiments are needed to justify and analyse the use of the unicycle for improving balance in sports training. The objective of this paper is to determine whether a 15-hour kinesiology unicycling training might have a statistically significant impact on the development of static and/or dynamic balance of the subjects.

Methods

The sample (N=58) is divided into two groups: (1) the experimental group: (M=17; F=17) and (2) the control group (M=16; F=8) of second-year regular students of the Faculty of Kinesiology (academic year 2009/10). All of the subjects are aged 20 to 23. The variables applied for the purpose of this paper may be divided into two groups: (1) variables for balance assessment and (2) variables for evaluation of morphological characteristics. The variables for balance assessment were measured by the Biodex balance system SD™ device. Prior studies have confirmed satisfactory metrological characteristics of said measuring instrument (Hinman, 2000). The balance training on the Biodex system is dedicated to and designed for improving postural stability, proprioception and centre of gravity control (Finn et al. 1999). It can also be used to assess balance on a single or on both legs. The test results in a “stability index”. Two variables were defined for the purpose of this study: (SBI-2L) static balance index in two-legged stance calculated by the device by taking account of: the (APSI-2L) anterior-posterior stability index and the (MLSI-2L) medial-lateral stability index, (DBI) dynamic balance index calculated by the device by taking account of: (F)- front index, (B)- back, (R)- right, (L) – left index, (FR)- front-right index, (FL)- front-left index, (BR)- back-right, (BL)- back-left index. (BSSD Operation/Service Manual). In order to evaluate morphological characteristics, we have selected the following variables: body height (BH); body weight (BW); body mass index (BMI) and body fat percentage (BFP). BMI (body mass index) is the most suitable measure for indirect evaluation of overweight and obesity (Marrow et al. 2005).

It is calculated from the values of body height and body weight according to the following formula: BMI = weight/height^2. An Omron HBF-306 device was used to measure the percentage of subcutaneous fat tissue. The researcher entered the data on the age, height and weight of the subject. The subject stood in an upright position with their arms raised in front of them and held the device by its handles. They grasped the metal part of the handles with their thumbs. After about ten seconds the result was displayed in percentage. The experiment lasted for 7 weeks. It could be divided into three stages: (1) initial measurement; (2) treatment; (3) final measurement. The initial measurement was completed during the first week and it involved the measurements of morphological characteristics and balance by the Biodex Balance System SD in the control and the experimental group. The experimental treatment for the experimental group began in the second stage and lasted for 5 weeks. The subjects learned how to unicycle during fifteen 60-minute training sessions.

The initial measurement showed that the subjects do not have any prior motor knowledge of unicycling and that they had never had contact with unicycling. The female experimental group practiced in the morning, and the male experimental group practiced in the evening. The height of the unicycle seat was adjusted according to the height of a particular subject. Training consisted of an introductory part – a 4-5-minute warm-up, the main part lasting for 45-50 minutes during which the subjects learned how to unicycle, and a 4-5-minute wrap-up. The first five hours were used for training in groups of three, the second five hours were used for working in pairs, and the final five hours were used for individual training. Different methodical aids and exercises (steps, riding close to the wall, riding while leaning on one or two partners, riding while holding an object, such as a ball or a stick, in hands, etc.) were used during the treatment in accordance with the individual needs of the subjects. The measurement of morphological characteristics and the measurement of balance with the Biodex Balance System SD in the control and the experimental group were conducted during the seventh week. The study only took account of the subjects who completed all of the 15 training sessions and who underwent all of the planned tests in the initial and final measurements.

Statistical analysis

The descriptive parameters were calculated for every group and variable according to sex of the subjects. The normality of variable distribution was determined by a Kolmogorov-Smirnov test. The differences between the initial and the final measurement were determined by dependent samples T-test, and the differences by sex and the differences between the control and the experimental group were determined by independent samples T-test. The significance level is $p<0.05$. The data were processed by a statistical analysis package Statistica 6.0 for Windows.

Results

There is no statistically significant difference between all of the observed variables and normal distribution. The subjects in both experimental groups are 22 years old at average (SD men ±0.93, women ±1.40) and the significance level of $p<0.05$ shows no statistically significant difference between the male and the female experimental group. We can conclude that at the significance level of $p<0.05$ the male experimental group indicates statistically significant difference from the female experimental group in all observed morphological variables (BH, BW, BFP, BMI), as well as variables of dynamic balance (DBI). With regard to the variable of static balance (SBI-2L), men and women in the experimental groups differ at the significance level of $p<0.05$. The male experimental sample is more heterogeneous that the female one in reference to the variable of static balance SBI-2L (table 2: Mean ± SD men 1.87±0.91, women 1.33±0.47), and more homogenous compared to the female experimental sample in reference to the variable of dynamic balance (table 1: Mean ± SD men 26.05±6.66; women 35.81±8.63). The results presented in table 2 indicate that the subjects from the male experimental group demonstrated a statistically significant improvement in the variable of dynamic balance (DBI) at the significance level ($p<0.05$) during the final measurement or, relatively speaking, enhanced their performance by 12.8% compared to the initial measurement. The final measurement of the static balance variable (SBI-2L) in men has shown significant improvement of 14.4% compared to the initial measurement, but not at the statistically significant level ($p>0.05$). Unlike the male experimental group which demonstrated statistically significant improvement in the dynamic balance variable (DBI) only, the women have achieved statistically significant improvement at the significance level of $p<0.01$ in both of the observed variables of balance (static SBI-2L +24% and dynamic DBI +27.3%) according to the results in table 3. Tables 2 and 3 reveal that the male experimental sample achieved poorer results in the initial measurement of static (1.87 against 1.33 or by 28.87%) and dynamic balance (26.05 against 35.81 or by 27.25%) compared to the female sample (the results of static balance are an inversely scaled variable). We can see that the unicycling treatment has a significantly greater impact on dynamic and static balance of the female than the male subsample even though the arithmetic means of the initial results achieved by women were better in both variables. Generally speaking, a specific treatment may lead to proportional increase of poorly developed motor abilities, but this does not apply to balance.

Discussion and conclusion

A prerequisite for the study was the homogeneity of the sample in relation to the prior knowledge of unicycling. Potential earlier training experience may have an impact on the learning process.

Table 1. Basic descriptive parameters of morphological and balance variables in female and male students and results of t-test analysis for experimental group

	INITIAL MEASURING		FINAL MEASURING	
	MALE (N=17)	FEMALE (n=16)	MALE (n=17)	FEMALE (n=16)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
AGE	20±0.93	20±1.40	20±0.93	20±1.40
BW	80.11±7.06	61.51±7.19*	79.82±7.16	61.54±7.22*
BH	182.24±6.50	168.67±5.11*	182.24±6.50	168.58±5.04*
PBF	12.67±3.10	19.99±3.67*	12.70±3.08	20.05±3.67*
BMI	24.11±1.64	21.57±1.94*	24.04±1.62	21.58±1.95*
SBI-2L	1.87±0.91	1.33±0.47*	1.60±0.53	1.01±0.34*
DBI	26.05±6.66	35.81±8.63*	29.41 ±5.77	45.62±8.30*

*significant differences ($p<0.05$)

Table 2. Basic descriptive parameters of morphological and balance variables for male student's in control and experimental group and results of t-test analysis for depended variables between initial and final measuring (in percentage)

MALE	Control group (n=17)			Experimental group (n=17)		
	INI	FIN	% INI-FIN	INI	FIN	% INI-FIN
Variables	Mean ±SD	Mean ±SD		Mean ±SD	Mean ±SD	
AGE	21±0,90	21±0,90	0%	21±0.93	21±0.93	0 %
BW	82.14±13.29	82.32±12.95	0 %	80.11±7.06	79.82±7.16	0 %
BH	183.87±7.99	183.87±7.99	0 %	182.24±6.50	182.24±6.50	0 %
PBF	15. 41±4.19	15.48±4.01	0 %	12.67±3.10	12.70±3.08	0 %
BMI	24.21±3.56	24.39±3.52	0 %	24.11±1.64	24.04±1.62	0 %
SBI-2L	1.98±0.79	1.88±1.01	+5%	1.87±0.91	1.60±0.53	+14 %
DBI	26.29±5.72	27.58±6.12	+4%	26.05±6.66	29.41 ±5.77*	+12 %

Table 3. Basic descriptive parameters of morphological and balance variables for female student's in control and experimental group and results of t-test analysis for depended variables between initial and final measuring (in percentage)

FEMALE	Control group (n=8)			Experimental group (n=16)		
	INI	FIN	% INI-FIN	INI	FIN	% INI-FIN
Variables	Mean ±SD	Mean ±SD		Mean ±SD	Mean ±SD	
AGE	21±1,83	21±1,83	0 %	21±1.40	21±1.40	0 %
BW	70.37±8.60	70.12±8.045	0 %	61.51±7.19	61.54±7.22	0 %
BH	173.42±9.69	173.42±9.69	0 %	168.67±5.11	168.58±5.04	0 %
PBF	18.75±3.27	18.9±3.45	0 %	19.99±3.67	20.05±3.67	0 %
BMI	23.30±0.77	23.27±0.09	0 %	21.57±1.94	21.58±1.95	0 %
SBI-2L	1.27±0.30	1.22±0.09	+ 5 %	1.33±0.47	1.01±0.34*	+24 %
DBI	32.25±7.93	32.00±9.93	- 1 %	35.81±8.63	45.62±8.30*	+27 %

That process can be including the efficiency of treatment implementation, as well as balance development. Therefore, the study included only those subjects without prior experience in unicycling. According to Bressel et al. (2007), different sports activities (e.g. football, basketball and gymnastics) have different effects on balance abilities. Different earlier training experiences could have affected the results of this study. Earlier training experience did not have a significant impact on the results of this study, which is evident from the initial status of subjects in the experimental and the control group showing that, according to the results of the independent samples T-test, there was no significant difference between the groups of subjects in any of the variables prior to the treatment.

Difference in balance between men and women

A few studies (Overstall et al. 1977; Peeters et al. 1984; Mechling et al. 1986; Ekdahl et al. 1989) have shown that there is a certain connection between sex and the results of the balance test, making several authors conclude that women yield better results. Unlike the aforementioned studies, other experiments (Hageman et al. 1995; Bryant et al. 2005; Rogind et al. 2003) did not prove there was a difference between the balance of men and women, while another study (Wereeck et al. 2008) even assumes that women produce poorer results in particular variables. A paper by Wikstrorm et al. (2006) examines whether gender affects the results of dynamic postural stability during jump landing. Given that the female sample had achieved better results, it was concluded that they use a different strategy than men in keeping dynamic balance.

Menegoni et al. (2009) studied the impact of overweight on balance based on the fact that men and women have a topologically different weight distribution. The authors found that overweight (obesity) has a negative impact on the balance results regardless of the sex. The analysis of a greater number of earlier experiments points to the fact that authors disagree as to whether sex has an impact on the results of the balance variables despite the evidence that men and women have different body geometry and the predisposition for storing body fat in different topological regions. The results of our study have demonstrated that women produce better results than men in the analysed variables in reference to both dynamic and static balance. Hypothetically speaking, the body centre of gravity is located at 55% of the body height of women, and 57% of the body height of men (Hay and Reid 1988). In addition to the difference in body centre of gravity, our female sample (age = 21 ± 1.40) has a statistically significant lower body height and, consequently, shorter "levers". Therefore, it is expected that they shall demonstrate more quality synergy control and a faster nerve impulse flow than men, which might explain better results of said subsample. The aforementioned statements lead to the conclusion that, along with anthropometric condition, there is also a connection between balance, reaction time, accuracy and agility during movement of the human body while keeping balance, particularly during unicycling. Future studies should be able to prove this hypothesis.

Characteristics of the impact of unicycling treatment on balance

The subjects riding a unicycle are very unstable and even the slightest uncontrolled movement may disturb their balance. Balance disturbance occurs during movement and in a three-dimensional space where the subjects have to take a great number of quick and accurate coordinated operations in different directions in order to keep their balance and continue unicycling. In other words, reaction time, movement coordination, accuracy and agility are also activated during unicycling, along with balance and proprioceptive abilities. Women have improved their balance (static by 24%, dynamic by 27%) compared to men who despite of the lower initial level did not reach such a significant improvement (14% and 12%) in the same variables. The greater degree of improvement of the female subsample may be explained by the neuropsychological study of the frontal lobe function (Ryan et al. 2004) conducted on the sample of 262 athletes (157 men and 105 women) from different sports. The authors found that at the significance level of $p<0.01$ women, unlike men, perform perception and motor tasks more quickly and precisely, and these are the abilities needed when learning how to unicycle. Due to the aforementioned fact and better initial balance, the authors believe, women were more successful in mastering the basics of unicycling. Consequently, they spent more time unicycling which led to even better final results. On the other hand, men spent most of their time "trying" to unicycle.

The authors believe that the key finding of this study is the time period during which dynamic balance can develop. Even a relatively short period (of five weeks) is sufficient to make positive changes in balance. The researchers are faced with a question, the answer to which provides valuable information for application in training: what would be the extent of the changes if the subjects experienced training stimulus on a daily basis? The subjects in this study trained three times a week. Is balance as a motor ability extremely sensitive at an age when growth and development are completed in full? These are the questions that might serve as a starting point for new balance experiments, which might be of great importance for sports competitions in which balance has a direct impact on the success of the competitor. Based on the results of the conducted study, we may conclude that: 1) Morphological differences between sexes, different positions of the centre of gravity and differences in body geometry may affect the results in dynamic and static balance of men and women, 2) The results indicate that balance, unlike some other abilities, follows specific rules and has a development curve depending on the level and the specific impact on said curve, which should be accurately verified by constructing a test for measuring knowledge of unicycling and possibly repeating this experiment over a longer period of time with more transition measurements in order to find out whether the development of balance has a linear, exponential or some other development trend, 3) The evident improvement of dynamic and static balance in a relatively short time period opens up new possibilities of using the unicycle in training.

Unicycling is a very efficient method for balance development of the sample of kinesiology students. It is necessary to conduct further studies, offer more frequent training sessions and samples of different ages and training types in order to illustrate the dynamics and the training possibilities of balance development.

Literature

Aydin, T., Yildiz, Y., Yildiz, C., Atelsap, S., & Kalyon, T.A. (2002). Proprioception of the ankle: a comparison between female teenage gymnasts and controls. *Foot Ankle Int*, 23, 123-129.

Bressel E., Yonker, J.C., Kras, J., & Heath, E.M. (2007). Comparison of Static and Dynamic Balance in Female Collegiate Soccer, Basketball, and Gymnastics Athletes. *Journal of Athletic Training, 42*(1), 42-46.

Bryant, E.C., Trew, M.E., Bruce, A.M., Kuisma, R.M.E., & Smith, A.W., (2005). Gender differences in balance performance at the time of retirement, *Clinical Biomechanics, 20*(3), 330-335.

Clark, M.A. (2001). *Integrated neuromuscular stabilization training*. Thousand Oaks, CA: National academy of sports medicine.

Deforche, B.I., Hills, A.P., Worringham, C.J. et al. (2009). Balance and postural skills in normal-weight and overweight prepubertal boys. *International Journal of Pediatric Obesity*, *4*(3), 175-182.

Ekdahl, C., Jarnlo, G.B., & Andersson, S.I. (1989). Standing balance in healthy subjects: evaluation of a quantitative test battery on a force platform, *Scandinavian journal of reh medicine, 21*(4), 187-195.

Goulding, A., Jones, I.E., Taylor, R.W., Piggot, J.M., & Taylor, D. (2003). Dynamic and static tests of balance and postural sway in boys: Effects of previous wrist bone fractures and high adiposity. *Gait and Posture, 17*(2), 136-141.

Hageman, P.A., Leibowitz, J.M., & Blanke, D. (1995). Age and gender effects on postural control measures, *Archives of physical medicine and rehabilitation, 76*(10), 961-965.

Hay, J.G., & Reid, J.G. (1988). *Anatomy, mechanics, and human motion (2nd edition)*. Englewood Cliffs, N.J: Prentice Hall.

Hinman, M.R, (2000). Factors affecting reliability of the Biodex Balance System: A summary of four studies, *Journal of Sport Rehabilitation, 9*(3), 240-252.

Lephart, S.M., Giraldo, J.L., Borsa, P.A., & Fu, F.H. (1996). Knee joint proprioception: a comparison between female intercollegiate gymnasts and controls. *Knee Surg Sports Traumatol Arthrosc, 4*, 121-124.

Marrow, J.R., Jackson, A.W., Disch, J.G., & Mood, D.P. (2005). *Measurement and evaluation in human performance*. Champaign Il: Human Kinetics.

Mechling, R.W. (1986). Objective assessment of postural balance through use of the variable resistance balance board. *Physical therapy, 66*(5), 685-688.

Menegoni, F., Galli, M., Tacchini, E., Vismara, L., Cavigioli, M., & Capodaglio, M. (2009). Gender-specific effect of obesity on balance, *Obesity, 17*(10), 1951-1956.

Ohsaki, H., Kinoshita, M., Sugimoto, Y., et al. (2008). Development of a control system for supporting to grow human skill of a unicycle. *SICE Annual Conference*, Tokyo.

Ohsaki, H., Iwase, M., Sadahiro, T., & Hatakeyama, S. (2009). A consideration of human-unicycle model for unicycle operation analysis based on moment balancing point. *IEEE International Conference on Systems, Man and Cybernetics*, San Antonio.

Overstall, P.W., Exton-Smith, A.N., Imms, F.J., & Johnson, A.L. (1977). Falls in the elderly related to postural imbalance. *British medical journal, 1*(6056), 261-264.

Palmieri, R.M., Ingressoll, C.D., Stone, M.B., & Krause, B.A. (2002). Centre-of-pressure parameters used in assessment of postural control. *J Sport Rehabil*, *3*, 2-17.

Peeters, H., Breslau, E., Mol, J., & Caberg, H. (1984). Analysis of posturographic measurements on children. *Mmedical and biological engineering and computing, 22*(4), 317-321.

Perrin, P., Deviterne, D., Hugel, F., & Perrot, C. (2002). Judo, better than dance, develops sensorimotor adaptabilities involved in balance control. *Gait and Posture 15*, 187-194.

Psalman, V. (2008). Dynamic balance and its diagnostics by using 3D biomechanical analysis. *Facta Universitatis Series Physical Education and Sport*, *6*(2), 105-113.

Røgind, H., Lykkegaard, J.J., Bliddal, H., & Danneskiold-Samsøe, B. (2003). Postural sway in normal subjects aged 20-70 years, *Clinical physiology and functional imaging, 23*(3), 171-176.

Ryan, J.P., Atkinson, T.M., & Dunham, K.T, (2004). Sports-related and gender differences on neuropsychological measures of frontal lobe functioning. *Clinical journal of sport medicine, 14*(1), 18-24.

Strešková, E., & Chren, M. (2009). Balance ability level and sport performance in Latin-American Dances. *Facta Universitatis Series Physical Education and Sport*, *7*(1), 91-99.

Vereeck, L., Wuyts, F., Truijen, S., & Van De Heyning, P. (2008). Clinical assessment of balance: Normative data, and gender and age effects, *International journal of audiology, 47*(2), 67-75.

Wikstrom, E.A., Tillman, M.D., Kline, K.J., & Borsa, P.A. (2006). Gender and limb differences in dynamic postural stability during landing. *Clinical journal of sport medicine, 16*(4), 311-315.

Winter, D.A., Palta, A.E., & Frank, J.S. (1990). Assessment of balance control in humans. *Med Prog Technol*, *16*, 31-51.

Received: February 22, 2010.
Accepted: May 10. 2010.
Correspondence to:
Assoc.Prof. Đurđica Miletić, PhD.
University of Split
Faculty of Kinesiology
21000 Split, Teslina 6, Croatia
Phone: 00 385 (0)21 302 440
E-mail: mileticd@kifst.hr

VOŽNJA MONOCIKLA I POBOLJŠANJE RAVNOTEŽE

Sažetak

Cilj ovog rada bio je utvrđivanje može li 15-satni kineziološki trening monocikla možda imati statistički značajan utjecaj na razvoj statičke i/ili dinamičke ravnoteže 58 ispitanika studenata Tjelesnog odgoja i to 25 ženskog i 33 muškog spola. Ispitanici su podijeljeni u dvije skupine, eksperimentalnu i kontrolnu. Eksperiment je uključivao mjerenje morfoloških značajki (visina tijela, masa tijela, indeks tjelesne mase i postotak masnog tkiva) kao i ravnotežu na Biodex Balance Sustavu SD kod kontrolne i eksperimentalne skupine. Tretman na monociklu za eksperimentalnu skupinu trajao je 5 tjedana i samo ispitanici bez ikakvog prethodnog motoričkog znanja monocikla su uključeni. U eksperimentalnoj skupini, t-test za zavisne uzorke je pokazao značajnu razliku između početnog i završnog stanja u dinamičkoj ravnoteži kod muškaraca (+12.8%; $p<0.01$), kao i kod žena (+27.3%; $p<0,01$). Statistički značajno poboljšanje u statičkoj ravnoteži pronađeno je samo kod ženskog uzorka (+24.0%, $p<0.01$). Nezavisni t-test je pokazao da tretman monociklom ima značajno viši utjecaj na dinamičku i statičku ravnotežu kod ženskog nego kod muškog subuzorka. Morfološke razlike po spolu, različita pozicija središta mase i različita geometrija tijela mogu utjecati na rezultate u dinamičkoj i statičkoj ravnoteži mužkaraca i žena. Vožnja monocikla je jako učinkovita metoda razvoja ravnoteže s postignućem u relativno kratkom vremenu. Predstavljeni rezultati otvaraju nove mogućnosti uporabe monocikla u trenažnim metodama za poboljšanje sposobnosti ravnoteže.

Ključne riječi: *dinamička ravnoteža, statička ravnoteža, spolne razlike*