Science of Gymnastics Journal

vol. 10, num. 1, year 2018

Published by Department of Gymnastics, Faculty of Sport, University of Ljubljana ISSN 1855-7171

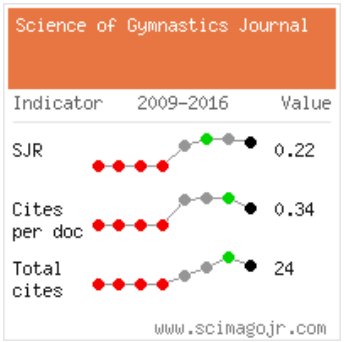
Science of Gymnastics Journal (ScGYM®)

Science of Gymnastics Journal (ScGYM®) (abrevated for citation is SCI GYMNASTICS J) is an international journal that provide a wide range of scientific information specific to gymnastics. The journal is publishing both empirical and theoretical contributions related to gymnastics from the natural, social and human sciences. It is aimed at enhancing gymnastics knowledge (theoretical and practical) based on research and scientific methodology. We welcome articles concerned with performance analysis, judges' analysis, biomechanical analysis of gymnastics elements, medical analysis in gymnastics, pedagogical analysis related to gymnastics, biographies of important gymnastics personalities and other historical analysis, social aspects of gymnastics, motor learning and motor control in gymnastics, methodology of learning gymnastics elements, etc. Manuscripts based on quality research and comprehensive research reviews will also be considered for publication. The journal welcomes papers from all types of research paradigms.

Science of Gymnastics Journal is indexed in
Web of Science (ESCI data base, since 2015), EBSCOhost SPORTDiscus, SCOPUS, COBISS (IZUM), SIRC (Canada), ERIHPLUS, OPEN. J-GATE, GET CITED, ELECTRONIC JOURNALS INDEX, SCIRUS, NEW JOUR, GOOGLE SCHOLAR, PRO QUEST and INDEX COPERNICUS.
ScGYM® (ISSN 1855-7171) is an international online journal published three times a year (February, June, October).

Front page design: Sandi Radovan, Slovenia.

Editorial Office Address
Science of Gymnastics Journal
Faculty of Sport, Department of Gymnastics
Gortanova 22, SI-1000 Ljubljana, Slovenia
Telephone: +386 (0)1 520 7765
Fax: +386 (0)1 520 7750
E-mail: scgym@fsp.uni-lj.si
Home page: http://www.scienceofgymnastics.com



Science of Gymnastics Journal is supported by Foundation for financing sport organisations in Slovenia, Slovenian Research Agency and International Gymnastics Federation.

Fundacija za šport

Slovenian Research Agency

CONTENTS

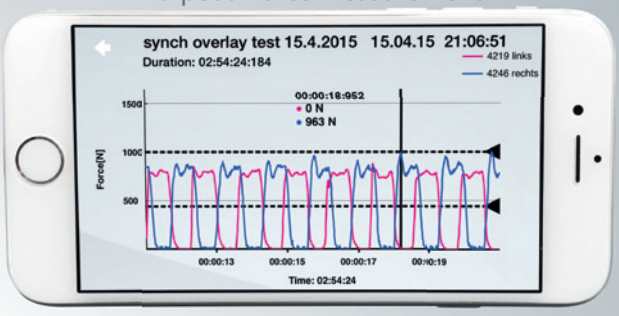
loadsol®.de

The mobile force sensor for smartphones allows long-term load monitoring in orthopedics, biomechanics, and rehabilitation.

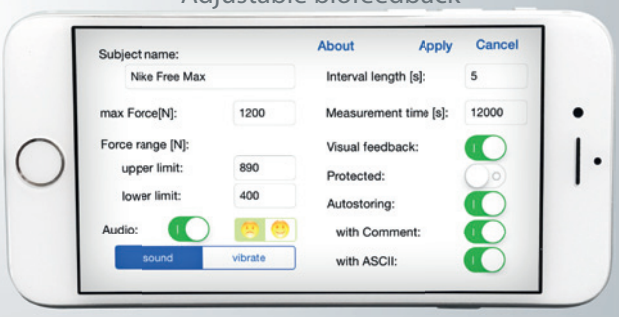
Sound or vibration feedback helps the patient from overloading their limb after surgery.

www.loadsol.de

Bipedal force measurement



Adjustable biofeedback



art science

All systems from novel operate with high quality, calibrated sensors and provide reliable and reproducible results.

novel gmbh • Ismaninger Str. 51 • 81675 Munich, Germany • tel +49 (89) 417767-0 • email: novel@novel.de
novel UK • tel/fax: +44 (115) 9 622 622 • email: noveluk@novel.de

novel.de

EDITORIAL

Dear friends,

With the New Year we are celebrating 10 years of Science of Gymnastics Journal's existence. When we started our journal, we had no idea how long we would be able to publish articles about gymnastics. It seems that the seeds have been well nurtured and today we are proud that we can be of assistance in the international exchange of knowledge, between the science and practice in gymnastics.

In this issue we have ten articles with authors from Spain, Greece, Croatia, Bosnia and Herzegovina, the Czech Republic, Portugal, Germany, Brazil and Slovenia. Articles cover psychology (motor learning), history, philosophy (gymnastics for all), metrology (judging), physiology (heart rate during exercises), kinesiology (balance). Among disciplines in gymnastics most are dealing with man and women artistic gymnastics, but we have also article on trampolining and general gymnastics. As gymnastics derived from the Greek and Asian tradition, we also include an article on Yoga exercises.

For our October issue we are preparing a special issue about gymnastics at the Olympic Games, with special guest editors Myrian Nunomura and Laurita Marconi Schiavon from Brazil to remember the OG in Rio 2016.

Anton Gajdoš prepared a new contribution to the history of gymnastics, refreshing our knowledge of Abie Grossfeld, a gymnast, coach, judge, researcher and passionate gymnastics fan from the USA.

Our fellow researchers were hard working and published a few new books. Istvan Karacsony wrote '130 years of Hungarian Gymnastics' - 904 pages with 4000 pictures/photos; under editor Monem Jemni the new edition of Science of Gymnastics is published; Juraj Kremnický and Sońa Kremnická wrote 'Impact of specialized program on changes of gymnastics skills and development of physical abilities of young gymnasts' and Ivan Čuk and Aleks Leo Vest published 'Prevarani sokoli' (Cheated Sokols) about how communists took over the Sokol organisation in Slovenia.

Just to remind you, if you quote the Journal: its abbreviation on the Web of Knowledge is SCI GYMN J. I wish you pleasant reading and a lot of inspiration for new research projects and articles,

Ivan Čuk
Editor-in-Chief

Photo: Symposium Sokol and Nation, 7.12.2017 at University of Ljubljana, Faculty of Sport, Slovenia, with book Prevarani sokoli introduction. From left: Dean Prof. Milan Žvan, Prof. Ivan Čuk, Ass. Prof. Aleks Leo Vest

SPATIAL PERCEPTION OF WHOLE-BODY ORIENTATION DEPENDS ON GYMNASTS' EXPERTISE

Thomas Heinen[1], Nadja Walter[1], Linda Hennig[1] & Damian Jeraj[2, 3]

[1]Leipzig University, Germany
[2]University of Hildesheim, Germany
[3]German Sport University Cologne, Germany

Original article

Abstract

The perception of spatial orientation of the body is a fundamental process in the precise performance of complex motor tasks, such as those found in acrobatic sports. While visual information is thought to be an important informational source when performing gymnastics skills, it is still questionable, which role visual information plays in the perception of spatial orientation in matters of gymnastics expertise and task specificity. Thus, this study targets the question, which role visual information plays in the perception of spatial orientation as a function of specific task demands and gymnastics expertise. High-skilled and low-skilled gymnasts were compared in their estimation of body tilt while being rotated about the transverse axis and the anterior-posterior axis in a human gyroscope with either full visual information available or occluded visual information. Results revealed that high-skilled gymnasts exhibited a better estimation of body tilt as compared to low-skilled gymnasts. Estimated tilt angles varied as a function of rotation axis and expertise, but not as a function of visual information. It was concluded that an increased spatial orientation ability may result from an increased sensitivity in individual sensory systems, and/or from an optimized processing of interacting sensory information that is specific to gymnasts' experience with particular motor tasks and the corresponding task demands.

Keywords: *human gyroscope, artistic gymnastics, task demands, task specificity.*

INTRODUCTION

The perception of spatial orientation of the body is a fundamental process in the precise performance of complex motor tasks, such as those found in acrobatic sports (Bringoux, Marin, Nougier, Barraud, & Raphel, 2000; von Laßberg, Beykirch, & Campos, 2015). Information on spatial orientation is derived and integrated from multiple sensory cues, such as tactile cues, proprioceptive cues, visual cues, and vestibular cues (Magill, 2011; Sato, Velentzas, & Heinen, 2016), but also cues from other sources are discussed (von Gierke, & Parker, 1994). Perception of spatial orientation is an important prerequisite for precise and rule-consistent

task performance in sports such as artistic gymnastics, where task execution is an important judging criterion (Bučar, Čuk, Pajek, Karacsony, & Leskošek, 2011). While visual information is identified as an important informational source when performing gymnastics skills, it is still questionable, which role visual information plays in the perception of spatial orientation as a function of gymnastics expertise and specific task demands (Gautier, Thouvarecq, & Chollet, 2007; Raab, de Oliveria, & Heinen, 2009).

Theoretical approaches argue that sports performers develop contingencies between sensory information and their corresponding motor actions during motor skill acquisition processes, and during motor training (Hodges & Williams, 2012; O'Regan & Noë, 2001). Thus, gymnasts' exposure to particular motor tasks (with their specific sensory input) shapes the aforementioned contingencies in a task-specific manner, so that skill performance is thought to be specific to the task demands, as well as to the sources of information available during skill acquisition (see also Heinen, Mandry, Vinken, & Nicolaus, 2013; Keetch, Schmidt, Lee, & Young, 2005; Moradi, Movahedi, & Salehi, 2014; Proteau, 1992). On a perception side, the aforementioned contingencies contain information about the input from the different sensory systems, as well as about the interaction of this input (Davids, Button, & Bennett, 2008). Thus, spatial orientation is a multisensory percept (Naylor & McBeath, 2008).

The visual system is, for example, able to provide information on athletes' spatial orientation when fixating gaze on distal environmental cues, or when picking up optical flow information (Latash, 2008; Sato et al., 2016; Wade & Jones, 1997). Visual information, however, is the most trusted information for the human brain, and there is usually an immediate decrease in spatial orientation when people perform with eyes closed (Magill, 2011). Davlin, Sands, & Shultz (2001) analyzed for instance gymnasts' performance in back somersaults under different vision condition such as vision available during the entire somersault, vision available either during the first or the second half of the somersault, and no vision available during the somersault. Results revealed that gymnasts landing performance was significantly constrained when no vision was available or when vision was available during the first half of the somersault, indicating that visual information might be important during the last half of the flight phase in order to contact the landing mat with an adequate body orientation and to perform a precise landing (see also Luis & Tremblay, 2008).

Danion, Boyadjian, and Marin (2000) investigated expert and novice gymnasts' locomotion behavior in the absence of visual information input. Participants were asked to perform three tasks of blindfolded locomotion (walking, steering a wheelchair, and verbally instructing a second person pushing their wheelchair). Results revealed that expert gymnasts exhibited fewer veers during blindfolded walking or blindfolded wheelchair steering as compared to novices. The authors concluded that expert gymnasts are more sensitive to input from other sensory systems in case visual information is not available during spatial orientation tasks.

Naylor and McBeath (2008) examined the perception of spatial orientation as a function of gender, and as a function of different sensory cues. The authors asked students to estimate body tilt about the transverse axis under different sensory cue conditions (i.e., presence or absence of visual and/or auditory cues) while being rotated in a whole-body rotation device (Aerotrim© gyroscope). Results revealed a strong bias when no visual information was available, and participants tended to overestimate body tilt. However, estimating body tilt was, in general, most precise in the presence of visual cues, and there was a slight gender difference in estimating spatial orientation. The authors concluded that perception of body tilt is a multisensory, and gender-dependent process, while visual information plays a stronger role in spatial

orientation as compared to auditory information.

Bringoux et al. (2000) investigated the role of somatosensory and vestibular cues in the perception of body orientation about the transverse axis. Expert gymnasts and non-gymnasts were slowly rotated about the transverse axis in a whole-body rotation device. Participant's task was to detect changes in body orientation with closed eyes. Results revealed that expert gymnasts were more sensitive to changes in body orientation than novices. Furthermore, experts were more precise in the perception of body orientation when compared to novices. The authors concluded that experts' exposure to training may drive their superior ability for spatial orientation, leading to a more precise perception of body orientation about the transverse axis.

To sum up, it is stated that experts or high-skilled gymnasts exhibit an improved ability for spatial orientation as compared to novices or low-skilled gymnasts (Heinen, Jeraj, Vinken, & Velentzas, 2012; von Laßberg et al., 2015). This ability is thought to stem from adaptations in the sensory motor system due to gymnasts' exposure to skill acquisition processes, and these adaptations are thought to manifest in an increased sensitivity to sensory cues (Hodges & Williams, 2012; von Lassberg, Beykirch, Campos, & Krug, 2012; Williams & Ericsson, 2005). Nevertheless, gymnastics skill performance is thought to be specific to the task demands, as well as to the sources of information available during skill acquisition. Thus, this study targets the question, which role visual information plays in the perception of spatial orientation as a function of specific task demands, and gymnastics expertise. The aim of this study was twofold: First, it should be confirmed that high-skilled gymnasts exhibit a better perception of body orientation than low-skilled gymnasts under changing task demands. Second, it should be determined if high-skilled gymnasts exhibit a better perception of body orientation than low-skilled gymnasts as a function of the availability of visual information.

The methodological approach of this study was an extension of the approach utilized in the study by Naylor and McBeath (2008). Additionally, an expert-novice approach was used, and visual information was manipulated while participants were rotated about two different body axes (Bringoux et al., 2000; Williams & Ericsson, 2005). It was expected that perception of spatial orientation is most precise when visual information is available (Naylor & McBeath, 2008). It was furthermore expected that high-skilled gymnasts, in general, outperform low-skilled gymnasts in the spatial orientation task, independent of the availability of visual information (Bringoux et al., 2000). There was no specific prediction of whether perception of spatial orientation differs as a function of the rotation axis, but we sought to explore this effect.

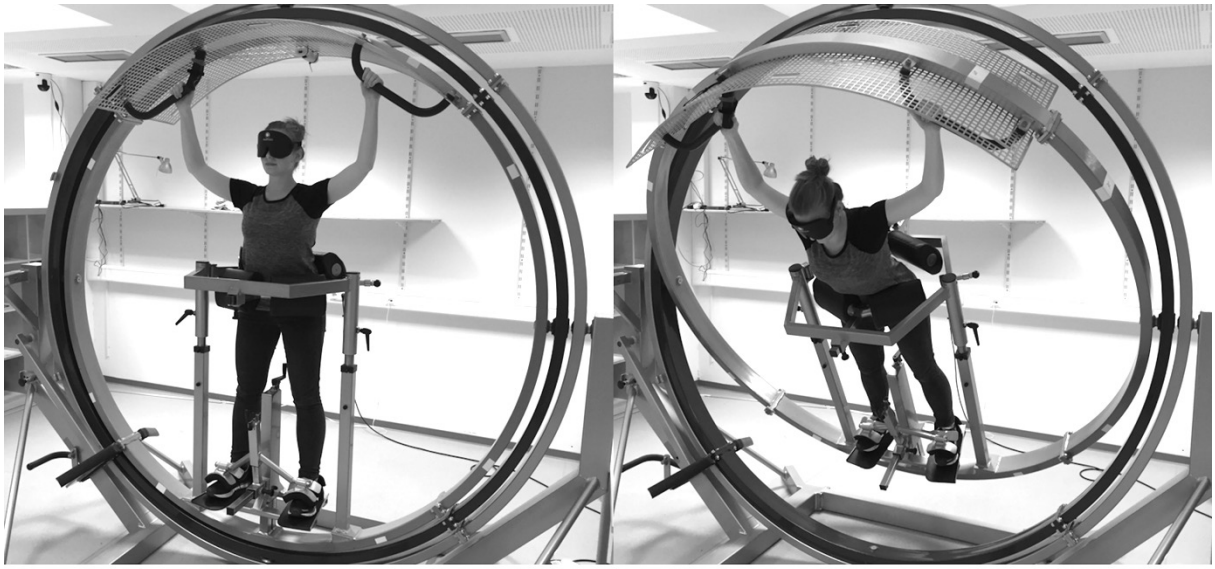
METHODS

The study sample consisted of a total of N = 20 gymnasts. The number of participants was derived from a power analysis when expecting a medium effect (Cohen's f = 0.25) with type I error probability of 5%, and type II error probability of 20%, given the results of the aforementioned studies. A subgroup of n_1 = 10 participants (university students; age: M = 23.2 years, SD = 2.1 years) had basic gymnastics experience due to their successful participation in a level 1 gymnastics course at the local university, in which self-realizing methodical progression of basic gymnastics elements such as rolls and cartwheels was the main content. They were labeled as 'low-skilled' gymnasts. Another subgroup of n_2 = 10 participants (former and current artistic gymnasts; age: M = 23.3 years, SD = 2.2 years) in this study had more comprehensive experience in gymnastics with a minimum training amount of four hours per week and at least six years of participation in competitive gymnastics. They were labeled as 'high-skilled' gymnasts in this study (Heinen et

al., 2012). In order to prohibit potential gender effects, only female gymnasts were recruited (Naylor & McBeath, 2008).

The high-skilled and low-skilled gymnasts were asked to participate in an experiment on spatial perception. They were informed about the procedure of the study, and they were asked to give their written consent prior to the study. The study was carried out in accordance with the local universities' ethical guidelines.

Human gyroscope. This study utilized a 3D-SpaceCurl human gyroscope (approximate weight: 300 kilograms; see Figure 1 and www.spacecurl.de). The SpaceCurl allows for a controlled rotation of the body about any rotation axis (Bersiner & Heinen, 2016). The outer ring of the used gyroscope had a diameter of approximately 2.40 meters. The SpaceCurl gyroscope was located in a laboratory room of the Institute of Sport Science of the local university. Participants were placed in the gyroscope in an upright standing posture. Their standing height in the gyroscope was set by a vertically adjustable platform so that their center of mass position aligned with the rotation axis of the gyroscope. Current tilt angle of the gyroscope was measured by a gyro sensor attached to the outer ring of the gyroscope. The sensor measured at a frequency of 100 Hz and was connected via Bluetooth to a desktop computer.



a) b)

Figure 1. SpaceCurl human gyroscope with a participant in vertical position (a), and in forward rotated orientation (b). The gymnast is wearing the Mindfold® mask. The gyroscope sensor is attached to the top of the inner ring of the gyroscope.

Manipulation of visual information. Visual information was manipulated by either allowing participants to use full visual information, or by blindfolding them (full vision vs. occluded vision; Davlin, Sands, & Shultz, 2002). In order to blindfold participants, a so-called Mindfold® mask was used (see www.mindfold.com). The Mindfold® mask is a flexible black plastic plate backed with a soft foam padding with cut-outs for both eyes. When wearing the Mindfold® mask, the participant experiences total darkness. The mask was held in place with a soft head strap (see Figure 1).

Tilt estimation task. The participant was placed in the gyroscope, and the gyroscope was tilted at a constant velocity

of six degree per second (Naylor & McBeath, 2008). Participants' task was to indicate when her body was tilted 45 degrees away from the vertical, either about the transverse axis ('somersault axis'), or about the anterior-posterior axis ('cartwheel axis'; see also Naylor & McBeath, 2008). The participant was rotated forward and backward from an initial upright position (absolute vertical: zero degrees) about the transverse axis, and she was rotated clockwise and counterclockwise about the anterior-posterior axis (Ito & Gresty, 1997). Participants responded by pressing a small button that was attached to the handle of the dominant hand. The button was connected via Bluetooth to the desktop computer (see above). When the button was pressed, the current tilt angle about the transverse axis was recorded and the rotation of the gyroscope was stopped. Immediately after the rotation was stopped, the participant was rotated back to the initial position. The participant received no feedback on current tilt angle in any of the trials. Twelve trials were realized in each experimental condition. The difference between each of the twelve values of each participant and the criterion angle of 45 degrees was calculated. The twelve difference values of each participant were averaged for further data analysis.

The study was conducted in three phases. In the first phase, each individually tested participant arrived at the laboratory. She was informed about the procedure of the study, and she was asked to complete the informed consent form along with a short demographic questionnaire. After providing informed consent, the participant was shown a diagram of a 45-degree angle. This was done for calibration purposes (Graziano & Raulin, 2008). In the second phase, the data collection took place. The gymnast was placed in an upright standing posture in the gyroscope. She was rotated at a constant velocity either about the transverse axis, or about the anterior-posterior axis, with full vision available or with no vision available. The participant wore earplugs in order to block auditory information. She was asked to indicate when her body was tilted 45 degrees, and she responded by pressing a small button attached to the handle of her dominant hand. This procedure resulted in four conditions that were presented to the participant: (1) rotation about the transverse axis with full vision, (2) rotation about the transverse axis with occluded vision, (3) rotation about the anterior-posterior axis with full vision, and (4) rotation about the anterior-posterior axis with occluded vision. In each condition, twelve trials were realized, leading to a total of 48 trials for each participant. Conditions were presented in a randomized order and the participant was allowed to rest as needed. In the third phase of the study the participant was debriefed, and she received a small token of appreciation for her participation.

A significance level of $\alpha = 5\%$ was established for all results. In order to test the main hypotheses, a 2 (*Group:* high-skilled vs. low-skilled) × 2 (*Rotation Axis:* transverse axis vs. anterior-posterior axis) 2 (*Visual Information:* full vision vs. occluded vision) analysis of variance (ANOVA) with repeated measures was conducted, taking the differences between estimated tilt angles and the criterion angle of 45 degrees as dependent variable. *Group* was treated as a between-subject factor. *Rotation Axis* and *Visual Information* were treated as within-subject factors. Concerning the assumptions of the ANOVA, a Shapiro-Wilk test indicated that the sample data could be assumed to come from a normally distributed population (Atkinson & Nevill, 1998). Furthermore, Mauchly's sphericity test indicated that the sphericity assumption was not violated for the repeated measures factors. Therefore, no correction of the degrees of freedom was necessary (Atkinson & Nevill, 2001). Post-hoc analyses were carried out using Fisher's least significance difference test in order to explore the structure of the significant effects. Cohen's f was calculated as an effect size for all F-values higher than 1.0 (Knudson, 2009; Ludbrook, 1998). All

descriptive statistics are presented as means ± standard errors.

RESULTS

The analysis of variance revealed a significant main effect of the factor *Group* on estimated tilt angle, $F(1, 18) = 7.032$, $p = .016$, Cohen's $f = 0.625$, as well as a significant main effect of the factor *Rotation Axis* on estimated tilt angle, $F(1, 18) = 5.690$, $p = .028$, Cohen's $f = 0.562$. In addition, there was a significant two-way interaction effect of *Rotation Axis* × *Group* on estimated tilt angle, $F(1, 18) = 6.425$, $p = .021$, Cohen's $f = 0.597$. Surprisingly, there was neither a significant main effect of the factor *Visual Information* on estimated tilt angle, nor a significant two-way interaction effect of *Visual Information* × *Group* on estimated tilt angle (all $p > .30$). As a consequence, neither the two-way interaction effect of *Rotation Axis* × *Visual Information*, nor the three way-interaction effect of *Rotation Axis* × *Visual Information* × *Group* reached statistical significance (all $p > .40$).

In average, high-skilled gymnasts' estimated tilt angles were closer to the criterion angle of 45 degrees (-6.78 ± 2.13 degrees), as compared to low-skilled gymnasts (-14.75 ± 2.13 degrees). Estimated tilt angles were in average closer to the criterion angle of 45 degrees when participants rotated about the transverse axis (-9.65 ± 1.44 degrees), as compared to when participants rotated about the anterior-posterior axis (-11.88 ± 1.70 degrees). Differences between estimated tilt angles and the criterion angle of 45 degrees, however, differed as a function of *Rotation Axis* and *Group*. Low-skilled gymnasts exhibited larger differences between estimated tilt angles and the criterion angle about the anterior-posterior axis (-17.05 ± 2.41 degrees) when either compared to high-skilled gymnasts rotating about the transverse axis (-6.84 ± 2.03 degrees), high-skilled gymnasts rotating about the anterior-posterior axis (-6.71 ± 2.41 degrees), or low-skilled gymnasts rotating about the transverse axis (-12.45 ± 2.03 degrees). Figure 2 illustrates the differences between gymnasts' estimated tilt angles and the criterion angle of 45 degrees as a function of *Group* (high-skilled vs. low-skilled), *Rotation Axis* (transverse axis vs. anterior-posterior axis), and *Visual Information* (eyes open vs. eyes closed).

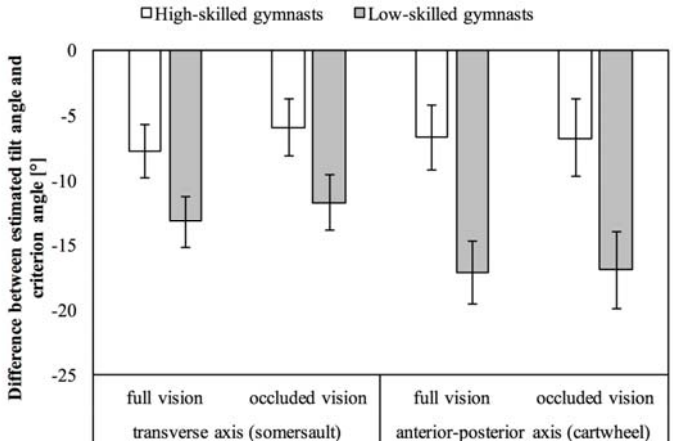


Figure 2. Differences between estimated tilt angles and criterion angle of tilt estimation task (means ± SE) in high-skilled gymnasts and low-skilled gymnasts as a function of *Visual Information* (full vision vs. occluded vision), and *Rotation Axis* (transverse axis vs. anterior-posterior axis). *Note:* Negative values indicate overestimation of body tilt (i.e., participant believes to be tilted further than she actually is).

DISCUSSION

High-skilled gymnasts are thought to exhibit a better ability for spatial orientation than low-skilled gymnasts (Sato et al., 2016). This superiority may stem from adaptations in the sensory motor system due to gymnasts' exposure to skill acquisition processes and/or motor training. The question is, however, which role visual information plays in the perception of spatial orientation in matters of gymnastics expertise and specific task demands? In this study, first, it should be confirmed that high-skilled gymnasts exhibit a better perception of body orientation than low-skilled gymnasts under changing task demands. Second, it should be determined if high-skilled gymnasts exhibit a better perception of body orientation than low-skilled gymnasts as a function of the availability of visual information.

Results revealed that high-skilled gymnasts exhibited higher estimated tilt angles, and thus a more precise estimation of body tilt, as compared to low-skilled gymnasts. This result is in line with theoretical approaches arguing that sport performers develop task-specific contingencies between sensory information and their corresponding motor actions during motor skill acquisition processes, and during motor training (O'Regan & Noë, 2001). The more performers are exposed to skill acquisition and/or motor training, the better their spatial orientation ability should become (von Lassberg et al., 2012). This result is also supported by findings from empirical studies showing that high-skilled gymnasts often outperform low-skilled gymnasts in spatial orientation tasks (i.e., Bringoux et al., 2000; Sato et al., 2016). An increased spatial orientation ability may result from an increased sensitivity in individual sensory systems, and/or from an optimized processing of interacting sensory information that is specific to the task demands (Davids et al., 2008; Latash, 2008).

Furthermore, it became obvious that estimating body tilt was dependent on rotation axis. Rotations about the transverse axis yielded slightly larger estimated tilt angles than rotations about the anterior-posterior axis. However, this aspect was most pronounced in low-skilled gymnasts rotating about the anterior-posterior axis, whereas high-skilled gymnasts exhibited no difference in estimating body tilt about the transverse axis, and the anterior-posterior axis. Low-skilled gymnasts and high-skilled gymnast's performance in the tilt estimation task could reflect their task-specific expertise in performing gymnastics skills with rotation about both rotation axis. While high-skilled gymnasts may have performed hundreds or even thousands of repetitions of skills with rotations about different body axis, the low-skilled gymnasts in this study had only basic gymnastics experience. In particular, the low-skilled gymnasts were exposed to approximately 30 hours of structured gymnastics training. This training comprised the acquisition of different gymnastics skills incorporating rotations about different body axes. However, skills with rotations about the transverse axis usually predominate level 1 gymnastics courses (i. e., forward and backward roll, handstand, handspring, somersault), compared to skills with rotations about the anterior-posterior axis (i. e., cartwheel, sideways roll). Thus, one could speculate that low-skilled gymnasts have accumulated more experience in performing skills incorporating rotations about the transverse axis as compared to skills incorporating rotations about the anterior-posterior axis, thereby exhibiting better tilt estimations when being rotated about the transverse axis.

In addition, and yet quite surprisingly, it became obvious that visual information was of minor influence in estimating body tilt. For example, when participants had their eyes open, the estimated tilt angle was similar to when participants wore a mask occluding visual information pickup. Nevertheless, it becomes also obvious, that the high-skilled gymnasts in this study were not able to perfectly solve the motor task, because high-skilled gymnasts tended to

overestimate body tilt by approximately 6-7 degrees (i. e., the gymnasts thought that were tilted to 45 degrees, but were tilted only 38-39 degrees instead), independent of the availability of visual information, and independent of the rotation axis. In low-skilled gymnasts, this overestimation was even larger. The same overestimation occurred when no visual information was available, therefore supporting the argumentation of Naylor and McBeath (2009), that proprioceptive information, rather than visual information may cause this overestimation. Even low-skilled gymnasts with basic motor experience in gymnastics may not predominantly rely on visual information in the tilt estimation task of this study. However, relying on visual information for spatial orientation may thus be more specific to the task-demands. One could imagine for instance a standing scale in which the gymnast has to show a particular body posture on one leg with an inclined trunk while the other leg is raised and stretched to the back. This clearly brings about the challenge to keep the body in balance. In such a situation, visual information may facilitate task performance (Davlin et al, 2002; Latash, 2008). In tasks such as somersaults, visual information may be of high importance with regard to spatial orientation, because gymnasts might be able to anticipate landing already during the flight phase and therefore align their body posture and body orientation to perform an optimal contact with the landing mat in a given situation (Davlin et al., 2001; Luis & Tremblay, 2008).

There are some methodological limitations of this study and two specific aspects should be highlighted. First, gymnasts were placed in a human gyroscope in upright stance and they were asked to estimate body orientation when being rotated to 45 degrees. While a human gyroscope allows for precise and isolated rotation about the different body axes, one could still argue that motion in a human gyroscope (i.e., when being rather slowly rotated about the anterior-posterior axis) does only partly correspond to a 'real' performance situation in artistic gymnastics (i.e., when actually performing a cartwheel). It could thus be of interest to contrast gymnasts' perception of spatial orientation as a function of differing demands when rotating about the same body axis under different rotation velocities and in different situations. Furthermore, a variety of gymnastics skills such as handstand are performed in a supported overhead position. Subsequent studies should therefore incorporate other experimental variations in their designs, such as comparing high-skilled gymnasts and low-skilled gymnasts when estimating for instance over-head body orientations with occluded vision. This could answer the question, if estimation of spatial orientation varies as an interaction of factors such as sport-specific expertise and (task-specific) rotation angle(s). Manipulating visuo-spatial perception could be one interesting methodological approach to address the aforementioned aspects (Allison, Howard, & Zacher, 1999).

Second, a sample consisting of former and current gymnasts as well as university students was recruited to participate in this study. Nevertheless, one could speculate that spatial orientation ability may develop specifically with regard to the demands in a particular sport, at a particular age, or with regard to factors such as rotational preference (Heinen et al., 2012; Kioumourtzoglou, Kourtessis, Michalopoulou, & Derri, 1998). While former gymnasts might already have made significant developments of (task-specific) spatial orientation ability early in their career, the effect of training on perception of spatial orientation might be different in university students because they are engaged in gymnastics at a later age. It could therefore be of interest to contrast spatial orientation ability in performers from different sports and on different expertise levels to answer the question if this ability is specific to the demands of different sports or if it is more a result of increased physical activity. In addition, it could be fruitful to contrast performers spatial orientation ability as a function of age, and exposure to

a particular sport. In line with the aspects just mentioned, it could also be of interest to target perception of spatial orientation as a potential predictor for gymnastics talent, as well as a criterion in performance diagnostics programs (von Laßberg et al., 2015).

There are some practical consequences of this study, and one specific aspect should be highlighted. Results revealed that high-skilled gymnasts outperform low-skilled gymnasts in spatial orientation and that spatial orientation maybe specific to the amount of exposure to specific gymnastics training, while visual information plays a smaller role in estimating body tilt in a human gyroscope. In acrobatic sports such as artistic gymnastics, performers have to deal with a variety of different situations that could afford a different information pickup under changing environmental constraints and/or task-demands from trial to trial (Davids et al., 2008). It may thus be beneficial if high-skilled gymnasts are able to use information derived from the diverse sensory systems in a way that this information partly compensates each other when information from one or the other system is not available in a particular situation. This should not only facilitate estimating body orientation but it should also be beneficial in complex skill performance. Skill acquisition programs incorporating occlusion strategies may potentially account for the aforementioned aspect (Magill, 2011).

It is stated that an increased spatial orientation ability may result from an increased sensitivity in individual sensory systems, and/or from an optimized processing of interacting sensory information that is specific to gymnasts' experience with particular motor tasks and their corresponding demands.

REFERENCES

Allison, R. S., Howard, I. P., & Zacher, J. E. (1999). Effect of field size, head motion, and rotational velocity on roll vection and illusory self-tilt in a tumbling room. *Perception, 28*, 299-306.

Atkinson, G., & Nevill, A. M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine, 26*(4), 217-238.

Atkinson, G., & Nevill, A. M. (2001). Selected issues in the design and analysis for sport performance research. *Journal of Sports Sciences, 19*, 811-827.

Bersiner, K., & Heinen, T. (2016). Motor expertise and mental rotation performance in gymnastics. In T. Heinen, I. Čuk, R. Goebel, & K. Velentzas (Eds.), *Gymnastics performance and motor learning – principles and applications* (pp. 71-88). New York, NY: Nova Science Publishers Inc.

Bringoux, L., Marin, L., Nougier, V., Barraud, P.-A., & Raphel, C. (2000). Effects of gymnastics expertise on the perception of body orientation in the pitch dimension. *Journal of Vestibular Research, 10*, 251-258.

Bučar, M., Čuk, I., Pajek, J., Karacsony, I., & Leskošek, B. (2011). Reliability and validity of judging in women's artistic gymnastics at University Games 2009. *European Journal of Sport Science, 12*(3), 207-215.

Danion, F., Boyadjian, A., & Marin, K. (2000). Control of locomotion in expert gymnasts in the absence of vision. *Journal of Sports Sciences, 18*, 809-814.

Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: a constraints-led approach*. Champaign, IL: Human Kinetics.

Davlin, C. D., Sands, W. A., & Shultz, B. B. (2002). Influence of vision on kinesthetic awareness while somersaulting. *International Sport Journal, 6*(2), 172-177.

Davlin, C. D., Sands, W. A., & Shultz, B. B. (2001). The role of vision in control of orientation in a back tuck somersault. *Motor Control, 3*, 337-346.

Gautier, G., Thouvarecq, R., & Chollet, D. (2007). Visual and postural control of an arbitrary posture: the handstand. *Journal of Sports Sciences, 25*(11), 1271-1278.

Graziano, A. M., & Raulin, M. L. (2010). *Research methods. A process of inquiry* (7th ed.). Boston, MA: Allyn & Bacon.

Heinen, T., Jeraj, D., Vinken, P. M., & Velentzas, K. (2012). Rotational preference in gymnastics. *Journal of Human Kinetics, 33*, 33-43.

Heinen, T., Mandry, S., Vinken, P. M., & Nicolaus, M. (2013). Motor skill acquisition influences learners' visual perception in gymnastics. *Science of Gymnastics Journal, 5*(1), 19-28.

Hodges, N. J., & Williams, A. M. (Eds.) (2012). *Skill acquisition in sport. Research, theory and practice* (2nd ed.). New York, NY: Routledge.

Ito, Y., & Gresty, M. A. (1997). Subjective postural orientation and visual vertical during slow pitch tilt for the seated human subject. *Aviation, Space, & Environmental Medicine, 68*, 3-12.

Keetch, K. M., Schmidt, R. A., Lee, T. D., & Young, D. E. (2005). Especial skills: their emergence with massive amounts of practice. *Journal of Experimental Psychology: Human Perception and Performance, 31*(5), 970-978.

Kioumourtzoglou, E., Kourtessis, T., Michalopoulou, M, & Derri, V. (1998). Differences in several perceptual abilities between experts and novices in basketball, volleyball and water-polo. *Perceptual and Motor Skills, 86*, 899-912.

Knudson, D. (2009). Significant and meaningful effects in sports biomechanics research. *Sports Biomechanics, 8*(1), 96-104.

Latash, M. L. (2008). *Neurophysiological basis of movement* (2nd ed.). Champaign, IL: Human Kinetics.

Ludbrook, J. (1998). Multiple comparison procedures updated. *Clinical and Experimental Pharmacology and Physiology, 25*, 1032-1037.

Luis, M., & Tremblay, L. (2008). Visual feedback use during a back tuck somersault: evidence for optimal visual feedback utilization. *Motor Control, 12*, 210-218.

Magill, R. A. (2011). *Motor learning and control* (9th ed.). New York, NY: Mc-Graw Hill.

Moradi, J., Movahedi, A., & Salehi, H. (2014). Specificity of learning a sport skill to the visual condition of acquisition. *Journal of Motor Behavior, 46*(1), 17-23.

Naylor, Y. K., & McBeath, K. (2008). Gender differences in spatial perception of body tilt. *Perception & Psychophysics, 70*(2), 199-207.

O'Regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences, 24*, 939-1031.

Proteau, L. (1992). On the specificity of learning and the role of visual information for movement control. In L. Proteau, & D. Elliott (Eds.), *Vision and motor control* (pp. 67-103). Amsterdam: Elsevier Science Publishers B.V.

Raab, M., de Oliveira, R. F., & Heinen, T. (2009). How do people perceive and generate options? In M. Raab, H. Hekeren, & J. G. Johnson (Eds.), *Progress in brain research: vol. 174. mind and motion: the bidirectional link between thought and action* (pp. 49-59). Amsterdam, NL: Elsevier.

Sato, Y., Velentzas, K., & Heinen, T. (2016). Relationships between gaze behavior and motor behavior in complex aerial skills. In T. Heinen, I. Čuk, R. Goebel, & K. Velentzas (Eds.), *Gymnastics Performance and Motor Learning. Principles and Applications* (pp. 1-18). New York, NY: NOVA Science Publishers Inc.

von Gierke, H. E., & Parker, D.E. (1994). Differences in otolith and abdominal viscera graviceptor dynamics: implications for motion sickness and perceived body position. *Aviation, Space, and Environmental Medicine, 65*, 747-751.

von Lassberg, C., Beykirch, K., Campos, J. L., & Krug, J. (2012). Smooth pursuit eye movement adaptation in high level gymnasts. *Motor Control, 16*, 176-194.

von Laßberg, C., Beykirch, K. A., & Campos, J. L. (2015). Comparing vestibulo-ocular eye movement characteristics with

coaches' rankings of spatial orientation aptitudes in gymnastics. In T. Heinen (Ed.), *Advances in visual perception research* (pp. 61-81). New York, NY: Nova Publishers Inc.

Wade, M. G., & Jones, G. (1997). The role of vision and spatial orientation in the maintenance of posture. *Physical Therapy, 77*(6), 619-628.

Williams, A. M., & Ericsson, K. A. (2005). Perceptual-cognitive expertise in sport: some considerations when applying the expert performance approach. *Human Movement Science, 24*(3), 283-307.

Corresponding author:

Thomas Heinen
Leipzig University
Faculty of Sport Science
Jahnallee 59
04155 Leipzig
Germany
phone: +49(0)341/97–31821
e-mail: thomas.heinen@uni-leipzig.de

THE EFFECT OF INTERVENTION BALANCE PROGRAM ON POSTURAL STABILITY

Jaroslav Krištofič, Tomáš Malý, František Zahálka

Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic

Original article

Abstract

The study is focused on evaluation of the effect of intervention balance program on postural stability (PS) among university students of "Specialization of gymnastic sports". The experimental group (n = 18) performed a specific balance program in addition to their regular training sessions and the control group (n = 15) underwent their normal sport regimen. The multi-sensory FOOTSCAN platform was used for the posturographic examination. We evaluated the parameters Centre of Pressure (COP) *in the tests: narrow standing position with (NS-VC) and without (NS-WC) visual control, flamingo stance on the preferred leg (FPL) and non-preferred leg (FNL). The results revealed a significant effect of time on changes in PS in bipedal tests regardless of group and visual control ($F_{1,62} = 4.65$, $p = 0.03$, $\eta^2_p = 0.07$). Visual control had a significant effect on PS in both groups ($F_{1,62} = 12.55$, $p = 0.001$, $\eta^2_p = 0.17$). The intervention program had a significant effect on PS in one leg standing position (FPL: $COP_{pre\text{-}test} = 1006.01 \pm 396.17$ mm, $COP_{post\text{-}test} = 875.78 \pm 284.24$ mm, $t_{17} = 2.34$, $p<0.05$; FNL: $COP_{pre\text{-}test} = 1102.44 \pm 323.82$ mm, $COP_{post\text{-}test} = 987.89 \pm 357.63$ mm, $t_{17} = 2.20$, $p<0.05$) and test NS-WC ($COP_{pre\text{-}test} = 145.67 \pm 34.91$ mm, $COP_{post\text{-}test} = 128.89 \pm 36.03$ mm, $t_{17} = 3.26$, $p<0.05$). In the control group, we found a significant improvement only for FNL test ($p<0.05$). The results of study showed that even a low volume specific balance program performed in addition to regular training sessions may also lead to postural stability enhancement.*

Keywords: *postural stability; gymnastics; balance program; visual control; balance assessment.*

INTRODUCTION

Stability is an ability of the system to stabilize under stimuli to the equilibrium state. Because two-thirds of our body mass is located in two-thirds of body height above the ground we are an inherently unstable system unless a control system is continuously acting. The ability to maintain a balanced position depends on the size of support surface, the center of gravity, height of the central body and its projections on the base of support (Winter, 1995). The level of postural stability refers to the ability of individuals to minimize fluctuations of the center of gravity in other words, the ability to maintain the upright stance and adequately respond to changes in external and internal forces. Vařeka and Vařeková (2009) define three main components of the system upright stance, namely sensory, control and executive component. The sensory component is represented by proprioception and exteroception, vision

and vestibular system. The control function is provided by the CNS – brain and the spinal cord. Finally, the executive component is represented by the movement system. In a broader context, postural stability can be expressed as the level of balance ability, which belongs to basic coordination functions. Nashner (1997) defines balance as the process of maintaining the position of the body's center of gravity vertically over the base of support relying on rapid, continuous feedback from visual, vestibular and somatosensory structures and then executing smooth and coordinated neuromuscular actions.

From a physiological point of view, balancing consists of a number of phases. The first phase is a detection of a specific situation via sensory systems. When maintaining an upright position, a man uses a combination of information from vestibular apparatus, visual and proprioceptive information (Fransson, Kristinsdottir & Hafström, 2004; Vuillerme, Pinsault & Vaillant, 2005). Proprioception is based on a function of mechanoreceptors in skin, muscles and connective tissue and provides information about relative configuration and position of body segments, thus proprioception is essential for coordinated functioning of muscles (Shumway-Cook & Woollacott, 2007). Visual information conveys the spatial coordinates which are necessary for spatial orientation. When the visual control is limited, the correcting movements for maintaining the given position are of greater extent (Vuillerme, Teasdale & Nougier, 2001). The vestibular apparatus is a sensory organ that mediates perception of balance, respectively perception of the position and movements of the head. Strešková (2003) in her study confirmed that physical exercises have a positive effect on the function of vestibular apparatus; moreover, its functions are affected by the position of the head (frontbow, rearbow, handstand). For sporting purposes Hirtz (1997) defines seven coordination abilities: differentiation ability, orientation ability, balance ability, reaction ability, ability to connect movements and ability to transform and adapt movements. Coordination abilities, and thus also balance ability, are genetically determined but with a suitably chosen external stimulus of a sufficient intensity they can be extensively influenced (Hirtz, 2002). The level of coordination is significantly affected by the balance ability, i.e. ability to stabilize and maintain the human body in a balanced position. Experts have shown that there are relationships between the proper functioning of the balance and other coordination motor skills (Bressel, Yonker, Kras & Heath, 2007). Balance ability can be perceived as a prerequisite for an athlete's performance which is particularly determined by movement control processes which make him or her eligible for sport performance at the certain level (Blume, 1981). Several studies have independently demonstrated that strength training improve balance, or that interrelationships between individual physical abilities can be found, respectively (Binda, Culham & Brouwer, 2003; McCurdy & Langford, 2006). The maintenance of balance is a complex physiological process involving the interactions of numerous body sub-systems regarding the difficulty of the task and the environment (Kašček & Supej, 2014). The ability to balance the body plays an important role in the shaping and improving specialized motor habit, as it is the basis for the mastery of complex technical elements necessary to achieve significant sporting results (Poliszczuk, Broda & Poliszczuk, 2012). It is an important attribute in learning sports skills, and shows differences depending on the characteristics of sports branches (Sirmen et al., 2008; McGuine, Greene, Best & Leverson, 2000). According to Strešková (2003) a sensitive period for development of balance is younger school age between 8 and 12 years. Children achieve adult level already at the age of 13. Studies which focused on the comparison of athletes and non-athletes showed that athletes improve balance significantly more than non-athletes due to their training stimuli over time (Balter, Stikroos,

Akkermans & Kingma, 2004; Bressel et al., 2007).

In gymnastic sports, such as artistic and rhythmic gymnastics, the level of balance abilities is one of limiting factors due to movement content and the way of evaluation of the sport performance. Simultaneously, gymnastic activities represent specific stimuli which influence the level of individual's balance abilities. It has been proved that many factors as different physiological and anthropometric factors might influence the gymnast's performance (Cagnoa et al., 2009). Gymnastics requires a great diversity of movements: transition from dynamic and static elements and vice versa, frequent changes of the body position in space (Bučar Pajek, Čuk, Kovač & Jakše, 2010). This represents high demands on coordination, i.e. balance ability, respectively. Tsigilis and Theodosiou (2008) in their study present that the significant difference between gymnasts and non-athletes of the presented study can be explained as the result of repetitive training experiences that influence motor responses. Similarly, other studies showed that gymnasts achieved better results in balance tests than untrained adolescents and that fitness and coordination training could enhance the level of postural stability (Vuillerme & Nougier, 2004; Poliszczuk & Broda, 2010; Ramsay & Riddoch, 2001). Application of balance exercises also has impact in a health-preventive field. Hrysomallis (2007) state that a high level of balance ability decreases sport injury risk and that this relationship was confirmed by a number of studies. Balance requires achieving the most mechanically efficient position of the body, reducing the abnormal wearing of joint surfaces and reducing stress on the ligaments holding the joints of the spine together, becoming a useful skill for the daily life (Mellos, Dallas, Kirialanis, Fiorilli & Di Cagno, 2014). Balance training could prevent low back pain and lessens fatigue because muscles are being used more efficiently, allowing the body to use less energy (Harringe, Nordgren, Arvidsson & Werner, 2007). The aim of presented study is to evaluate whether a low volume balance program performed in addition to regular gymnastic training sessions may lead to postural stability enhancement of gymnasts.

METHODS

The research involved 33 participants, male and female students of the Faculty of Physical Education and Sport, Charles University in Prague (gymnastic specialization), who participated in artistic or rhythmic gymnastics training in their clubs in addition to studying at the time of project implementation. The condition for participation in the project was good current state of health without contraindications that would affect the results of measurements. Participants were randomly divided into two groups; the members of the experimental group performed a specific balance program in addition to their regular club training sessions for 14 weeks (once a week for 30 min) and the members of the control group underwent their normal study and sport regimen. The movement base of gymnastic sports, such as artistic or rhythmic gymnastics, is very similar, with high demands on firming of posture and balancing abilities. The postural stability of the gymnasts (both females and males) is influenced by training and we assume that it can be also affected by a specific intervention program. Division into groups was carried out with no respect to differences in number of men and women, performing artistic or rhythmic gymnastics or individual's level of performance. The experimental group: n = 18; 13 women; 5 men; average age 21.50±1.17 years; average body height 170± 6.57 cm; average body weight 64.60±7.86 kg. The control group: n = 15; 8 women; 7 men; average age 22.50±1.69 years; average body height 171±8.50 cm; average body weight 65.70±8.90 kg. The period between the first and second measurement was 14 weeks in both groups.

The research was approved by the Ethical Committee of the Faculty of Physical Education and Sports at Charles University in Prague. Measurements were carried out in accordance with the ethical standards of Declaration of Helsinki and ethical standards in sport and exercise science research (Harriss & Atkinson, 2011).

COP (Centre of Pressure) measured from a force platform is generally considered the gold standard measure of balance, i.e. postural stability, respectively (Clark et al., 2010). Winter (1995) defines COP as the point location of the vertical ground reaction force vector. It represents a weighted average of all the pressures over the surface of the area in contact with the ground. In addition to a bipedal stance, a one leg stance, which is a part of natural locomotion of a man, is used as a diagnostic means in a series of motor tests for assessing postural stability (Fetz, 1987).

The multi-sensory FOOTSCAN platform (RS scan; Belgium; 0.50 m × 0.40 m; approximately 4100 sensors; sensitivity from 0.10 of N/cm^{-2}; sampling frequency 500Hz) was used for the posturographic examination. Pressure on individual sensors was measured, and the center of pressure (COP) was calculated on the contact area. Resulting force reacting to the ground is calculated from pressure and contact area under both feet by the equation (1):

$$F=p\times S \quad (1)$$

where F is reacting force [N], p is pressure [Pa], S is area [m^2] and this force is called Centre of Force (COF). Testing of postural stability was composed of 4 standardized tests (Kapteyn et al., 1983):

- *T1 (NS-VC) - wide stance with visual control lasting for 30s,*
- *T2 (NS-WC) - wide stance without visual control lasting for 30s,*
- *T3 (FPL) - flamingo stance on the preferred leg lasting for 60s,*
- *T4 (FNL) - flamingo stance on the non-preferred leg lasting for 60s.*

A laterality test was carried out before the measurement using a question which leg is preferred (e.g. when kicking a ball) and which one is non-preferred. Stability was measured before and after experimental period in the above-mentioned order of the tests. During the measurements participants stood at a distance of 3 meters from a wall on which a visual point (a black circle with a diameter of 3 cm) was located at the level of the participant's eyes. The standard standing position with a wide base was measured according to standard practice (Kapteyn et al., 1983) and transparent sheeting for the tracing foot position was used during the examination. We recorded the entire course of total travelled way (TTW) of COP. Measurements were carried out in a laboratory under conditions which minimized the influence of interfering elements. At the same time, it was ensured that the participants did not perform physically demanding activities before the measurement.

Intervention balance program

The experimental group underwent a specific balance program (14 sessions, 1× a week for 30 minutes approximately) during the semester (in addition to their own training sessions):

- ballet exercises (rhythmical slow movements of the unloaded leg in one leg stance according to the demonstrator – 5 min),
- balancing in medicine ball stance with symmetrical arm movements according to instructions (5 min),
- walking on a low balance beam with a book on the head (5×),
- rope skipping on a low balance beam (5 series/30s),
- balancing on inflatable balance boards in bipedal and unipedal stances – throwing and catching a ball in this labile position (5 min),
- balancing on a balance board plate put on a metal cylinder (5 series/30s).

The normality of the distributions was assessed using the Shapiro-Wilks test. Descriptive statistics were calculated for both measurements. Two-way mixed-design ANOVA with two between subject effects

(Group [experimental vs. control] and visual control [with and without vision control]) and one within subject effect (intervention) was used for evaluating differences in TTW between the factors. Moreover we did two-way mixed-design ANOVA analysis for with two levels of between subject factor Group (experimental vs. control), two levels of between factor for Laterality (preferred vs. non-preferred leg) and with two levels of within subject factor Intervention (1st and 2nd measurement). Paired differences between the pre- and post-intervention were evaluated using Student's t-test for dependent samples. In case of violation of data distribution we used nonparametric Wilcoxon's test for paired samples. In case of violation of data distribution we used nonparametric MannWhitney U test for unpaired samples. The probability of a type I error was set at α=0.05 in all statistical analyses. The effect size was evaluated using the PartialEta Squared coefficient (η^2_p) Statistical analyses were performed using IBM® SPSS® v21 (Statistical Package for Social Science, Inc., Chicago, IL, USA).

RESULTS

Mixed design ANOVA showed a significant effect of time on changes in postural stability in the bipedal tests regardless of group and visual control ($F_{1,62}$ = 4.65, p = 0.03, η^2_p = 0.07). Between-subject effect in the monitored groups (experimental vs. control group) was significant in the bipedal stance ($F_{1,62}$ = 9.87, p = 0.003, η^2_p = 0.14). Also visual control significantly influenced the level of participants' postural stability ($F_{1,62}$ = 12.55, p = 0.001, η^2_p = 0.17) (Figure 1 A,B). The interaction effect between the main factors TIME×GROUP and TIME×VISUAL CONTROL was not significant (p>0.05). In T1 test (NS-VC), no significant difference was found between the level of postural stability measured in input and output measurements in any of the tested groups (experimental or control). In T2 test (NS-WC), we found a significant improvement in the level of postural stability in the experimental group (p<0.01), while the change in the control group was not significant (Table 1).

Table 1
The level and comparison of postural stability in the selected tests and monitored groups

Group	Test	Pre		Post		t	Sig
		$\bar{x}$	SD	$\bar{x}$	SD		
EG	NS-VC [mm]	115.56	34.91	115.72	28.90	0.04	0.97
	NS-WC [mm]	145.67	46.81	128.89	36.03	3.27	0.01
	FPL [mm]	1006.01	396.17	875.78	284.24	2.34	0.03
	FNL [mm]	1102.44	323.82	987.89	357.63	2.20	0.04
CG	NS-VC [mm]	135.13	38.09	131.00	42.14	0.42	0.68
	NS-WC [mm]	195.86	79.36	175.93	54.58	1.23	0.24
	FPL [mm]	1154.47	390.77	1121.53	396.06	0.46	0.66
	FNL [mm]	1165.53	264.22	1046.27	190.96	2.29	0.04

Legend: EG – experimental group, CG – control group, NS-VC – narrow standing with visual control, NS-WC – narrow standing without visual control, FPL– flamingo test on preferred leg, FNL – flamingo test on non-preferred leg, SD – standard deviation

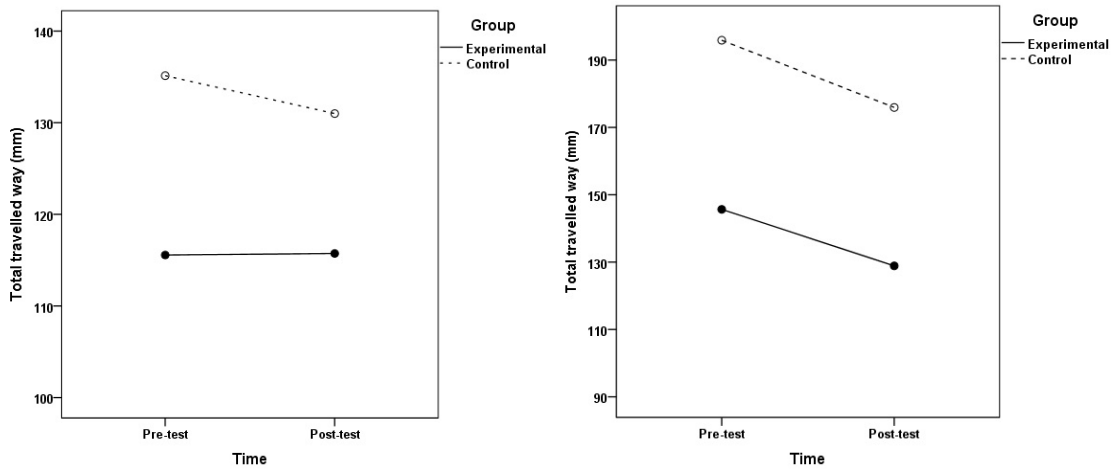


Figure 1. A - changes in body postural stability in the bipedal test with visual control, B - changes in body postural stability in the bipedal test without visual control.

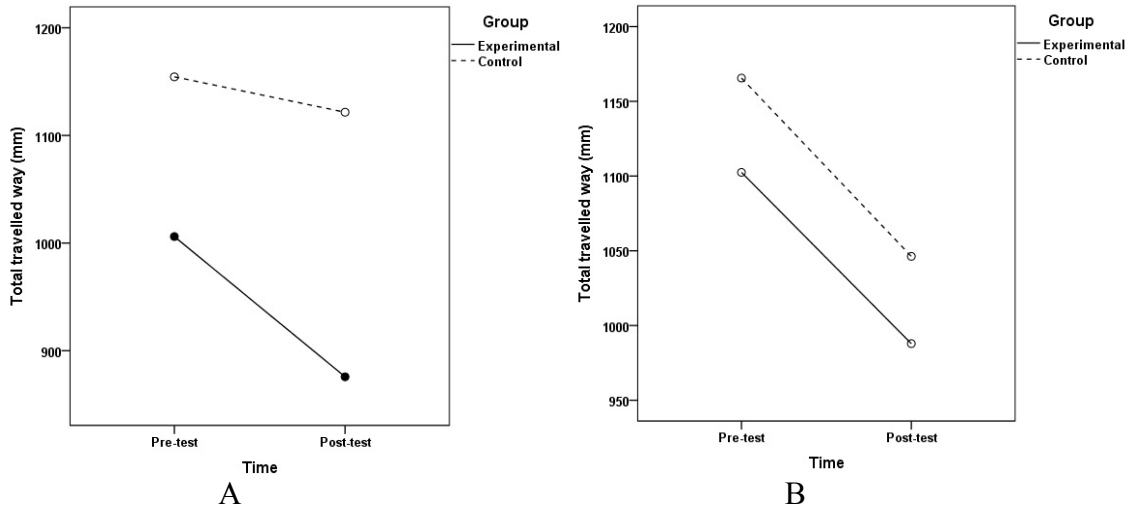


Figure 2. A - changes in postural stability in the flamingo test on the preferred leg, B - changes in postural stability in the flamingo test on the non-preferred leg.

When testing postural stability in one leg stance (flamingo stance) we discovered a significant effect of time on its level ($F_{1,62}$ = 2.64, p = 0.001, η^2_p = 0.16) (Figure 2A,2B). In this type of stance we did not find any significant difference in the level of postural stability between the monitored groups ($F_{1,62}$ = 2.64, p = 0.11, η^2_p = 0.04) and in the standing leg ($F_{1,62}$ = 0.21, p = 0.65, η^2_p = 0.003). The interaction effect between the main factors TIME×GROUP and TIME×LATERALITY was not significant (p>0.05). We found a significant improvement in both tests (FPL, FNL) after intervention in the experimental group (Table 1). In the control group, an insignificant change was found when standing on the preferred leg and a significant change when standing on the non-preferred leg (Table 1).

DISCUSSION

The results of our study showed significant improvements of postural stability in the experimental group in three tests (NS-WC, FPL, FNL) out of four, while in the control group improvement was only found in one test (Table 1). In the bipedal test with visual control, we did not find any improvement of postural stability

performance in any of the groups. In test without visual information after comparing absolute values, we found improvement in both groups (Table 1); however, only in the experimental group the difference was significant and effect size was medium. In the flamingo test on the non-preferred leg, a significant improvement ($p<0.05$) was found in both groups (control group by 10.23 % and experimental group by 10.39 %); in flamingo test on the preferred leg a significant improvement only appeared in the experimental group (by 12.94 %). These results correspond with the results of the study by Mellos et al. (2014), who reported a year-on-year improvement in flamingo test on the preferred leg by 17.32 % in young gymnasts (11-12 years old). The non-preferred leg was not tested. However, among non-sporting youths of the same age the improvement was only minimal. Kochanowicz, A., Kochanowicz, K., Niespodziński, Mieszkowski and Sawicki (2017) in their study comparised the groups of gymnasts and non-gymnasts from the point of view influence of gymnastics expertise of children on the postural control with and without the use of visual information in three age categories of males (8-10, 12-14 and 18-24 years). Results show that in analysis of the center of pressure surface area, all gymnast had significantly better ($p=0.01$) static postural control in regardless visual control (group effect), although, there were no differences in each individual age groups (group vs age; $p=0.55$) and that gymnastic training has positive influence in postural control of young and adults. Hernández Suárez, Guimaraes Ribeiro, Hernández Rodríguez, Rodríguez Ruiz, and García Manso (2013) in their study analyzed the effect of early systematic gymnastic training on postural performance and control by comparing young rhythmic gymnastics (9 years) with non-athletes of the same age. Results both investigated groups were similar as regards their anthropometric data and did not prove improvement compared with non-athletes. Authors report that improvement of performance due to learning is specific to the task and not directly transferred or generalized for example to more usual upright stance in young females. This corresponds with the findings of a recent study Kümmel, Kramer, Giboin and Gruber (2016) in which they report, that in healthy populations balance training can improve the performance in trained tasks, but may have only minor or no effects on non-trained tasks. Consequently coaches should identify exactly those tasks that need improvement, and use these tasks in the training program and as a part of the test battery that evaluates the efficacy of the training program.

Presented study is, unlike the previous studies , focused on verifying the effect of specific balancing training performed in addition regular gymnastic training sessions , which itself has a stimulating effect on postural stability. Bryant, Trew, Bruce, Kuisma and Smith (2005) in their studies reported that there are no gender differences after normalizing (the subject's height) the balance performance in elders or adults. Unlike this study Dallas, G. and Dallas, K. (2016) present findings that elite female gymnasts exhibit better postural stability scores compared to elite males. The authors agree that gender differences of postural stability can be affected by many different circumstances and further research is needed. Priority of this study is to evaluate whether a low volume balance program can influence postural stability of gymnasts, regardless of gender differences.The intervention balance program was performed by the experimental group for 14 weeks, with a frequency of 1× a week. Each session lasted for approximately 30 minutes, which is not a great stimulus. Both groups also performed regular gymnastic training during this period and postural stability performance in both groups improved between pre-test and post-test assessment. A greater improvement seen in the experimental group points to the fact that such a low volume specific balance program performed in addition to regular training activities may also lead to postural stability enhancement. The fact that the improvement

of postural stability was also in the control group (3×small and 1× medium effect size) can be explained as the effect of normal gymnastic training, which was the same as before the experiment, without specific balance exercises. Based on the findings from literary sources (Arazi, Faraji & Mehrtash, 2013; Strešková, 2003), it is supposed that there would be a greater efficiency of similar programs among youths or among male and female gymnasts at lower performance levels. However, it is necessary to confirm these results through further studies. Postural stability, or balance ability, respectively, must be perceived as a dynamic parameter, the value of which is affected by variability of endogenous and exogenous factors throughout the changes over time. The factors are of both physical and psychological nature. The level of concentration and other individual mental functions can significantly affect parameters of postural stability (Zech et al., 2010). Another factor influencing the level of balance ability is fatigue, both acute and cumulative. In an organism under fatigue, chemical-physical changes appear that negatively affect functional systems (Gauchard, Gangloff, Vouriot, Mallié & Perrin, 2002). The fact that regular balance exercises can enhance postural stability has been confirmed by several studies (Granacher, Gollhofer & Strass, 2006; Myer, Ford, Brent & Hewett, 2006) but not with such specific and low-frequency intervention (1x a week) for 14 weeks. Our results confirm that even low-frequency balance training can improve postural control in physical education students with gymnastic specialization. The results may be partly influenced by the different input level of postural stability the control and experimental group, but this is due to a randomized selection of respondents. Also studies focused on the comparison of postural stability between gymnasts and non-athletes or between gymnasts and other athletes are in favor of gymnasts (Mellos et al., 2014; Vuillerme & Nougier, 2004) and thus support the thesis of the necessity of including gymnastic activities in school programs. Bressel et al. (2007) compared the level of static and dynamic balance in female basketball players, soccer players and gymnasts. Gymnasts and soccer players did not differ in terms of static and dynamic balance. In contrast, basketball players displayed inferior static balance compared with gymnasts and inferior dynamic balance compared with soccer players. The authors suggest that gymnasts must learn to keep their balance when performing leaping and tumbling maneuvers, as well as in static poses, barefoot on surfaces that vary in stiffness, or to balance in handstand that require specific balance ability by gymnasts. According to Hrysomallis (2011), based on the available data from cross-sectional studies, gymnasts tended to have the best balance ability, followed by soccer players, swimmers, and then basketball players.

Tests used in our study were only focused on the assessment of static balance; further research could extend this field by assessing the level of dynamic stability. Static balance is the ability to maintain a base of support with minimal movement. Dynamic balance may be considered as the ability to perform a task while maintaining or regaining a stable position or the ability to maintain or regain balance on an „unstable surface" with minimal extraneous motion (Paillard & Noe, 2006). One of reasons of low correlation between static and dynamic balance are, according to Cromwell and Newton (2004), mechanical and physiological differences applied in the process of maintaining static and dynamic balance. It would also be appropriate to focus in the further studies on assessment of asymmetries in postural stability that could be a sign of preferring one of the limbs (footnesses), for instance in jumping exercises (Gryc et al., 2013). To increase the objectivity of postural stability determination Błaszczyk (2016) recommend expanding the COP characteristics about three novel output measures: the sway directional index, the sway ratio, and the sway vector.

CONCLUSION

Physical fitness depends on innate predispositions and environmental factors, such as primarily training. With the development of the human body, over time the level of balance ability changes and the training factor becomes increasingly important. The results of our study showed that balance training with a frequency of 30 min per week lasting for 14 weeks can be a worthwhile adjunct to the usual training of athletes and results in improving body postural stability. However, more research is required to confirm this effect on elite athletes. In elite male and female gymnasts, a relatively high level of postural stability can be assumed as a result of adaptation to specific training stimuli. Gymnastic training up to the stage of elite training is a long-term process which is affected by many factors, including training methods and approaches. Inclusion of specific balance programs in addition to the usual training of individual disciplines is, particularly in youth categories, a worthwhile extension to physical training. Our findings indicate a significant effect of balance intervention program on unipedal postural stability as well as bipedal postural stability without visual control. The results may be beneficial for researchers, clinical and sports science staff in gymnastics and other sports because the balance program is a part of performance preparation as well as injury prevention in a many sports. Results may be also a useful set of reference values for comparison with subjects of particular groups.

REFERENCES

Arazi, H., Faraji, H., & Mehrtash, M. (2013). Anthropometric and physiological profile of Iranian junior elite gymnasts. *Facta universitatis-series: Physical Education and Sport, 11*(1), 35-41.

Balter, S.G.T., Stikroos, R.J., Akkermans, E., & Kingma, H. (2004). Habituation to galvanic vestibular stimulation for analysis of postural control abilities in gymnasts. *Neuroscience Letters, 366*, 71-75.

Binda, S., Culham, E., & Brouwer, B. (2003). Balance, muscle strength, and fear of falling in older adults. *Experimental Aging Research*, *29*, 205-219.

Błaszczyk, J. W. (2016). The use of sway vector for the assessment of postural instability. *Gait & Posture, 44*(2), 1-6.

Blume, D. (1981). Charakteristik der koordinations Fahigkeiten und Möglichkeiten Iber Entwicklung im Trainingsprozes. *Zeitschrift*, *3*, 17–41.

Bressel, E., Yonker J.C., Kras, J., & Heath, E. (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., & Smith, A.W. (2005). Gender differences in balance performance at the time of retirement. *Clinical Biomechanics, 20*, 330-335.

Bučar Pajek, M., Čuk, I., Kovač, M., & Jakše, B. (2010). Implementation of the Gymnastics Curriculum In: The Third Cycle of Basic School In Slovenia. *Science of Gymnastics Journal, 2*(3), 15-17.

Cagnoa, A.D., Baldari, C., Battaglia, C., Monteiro, M.D, Pappalardo, A., Piazza, M., & Guidetti, L. (2009). Factors influencing performance of competitive and amateur rhythmic gymnastics-Gender differences. *Journal of Science and Medicine in Sport*, *12*, 411-416.

Clark, R.A., Bryant, A.L., Pau Y,. McCrory, P., Bennell, K., & Hunt, M. (2010). Validity and reliability of the Nintendo Wii Balance Board for assessment of standing balance. *Gait & Posture*, *31*(3), 307-310.

Cohen, J. (1992). Statistics a power primer. *Psychological Bulletin, 112*(1), 115-59.

Cromwell, R. L., & Newton, R. A. (2004). Relationship between balance and gait stability in healthy older adults. *Journal of Aging and Physical Activity*, *12*, 90–100.

Dallas, G., Dallas, K. (2016). Effects of ankle joint injuries on balance in male and

female gymnasts. *Science of Gymnastics Journal*, *8*(2), 149-156.

Fetz, F. (1987). *Senzomotorisches Gleichgewicht.* Wien: Osterreichischer Bundesverlag. 243 p.

Fransson, P.A., Kristinsdottir, E.K., & Hafström, A. (2004). Balance control and adaptation during vibratory perturbations in middle-aged and elderly humans. *European Journal of Applied Physiology*, *91*, 595-603.

Gauchard, G.C., Gangloff, P., Vouriot, A., Mallié, J.P., & Perrin, P.H.P. (2002). Effects of exercise-induced fatigue with and without hydration on static postural control in adult human subjects. , *International Journal of Neuroscience*, *112*, 1191–1206.

Granacher, U., Gollhofer, A., & Strass, D. (2006). Training induced adaptations in characteristics of postural reflexes in elderly men. *Gait & Posture*, *24*(4), 459-466.

Gryc, T., Zahálka, F., Malý, T., Malá, L., Vaidová, E., & Teplan, J. (2013). Morphological and Postural Asymmetry of Lower Limbs in Elite Female Soccer Players. *Medicine and Science in Sports and Exercise, 45*(5), 168-168.

Harringe, M.L., Nordgren, J.S., Arvidsson, I., & Werner, S. (2007). Low back pain in young female gymnasts and the effect of specific segmental muscle control exercises of the lumbar spine: a prospective controlled intervention study. *Knee Surgery Sports Traumatology Arthroscopy, 5*, 1264-1271.

Harriss, D. J., & Atkinson, G. (2011). Update - Ethical Standards in Sport and Exercise Science Research. *International Journal of Sports Medicine, 32*(11), 819-821.

Hernández Suárez, M., Guimaraes Ribeiro, D.E., Hernández Rodriguez, E., Rodríguez Ruíz, D., García Manso, J. (2013). The effect of early systematic gymnastics training on postural control. *British Journal of Sports Medicine, 47*(10), 31-39.

Hirtz, P. (1997). Koordinationstraining. In: Schnabel, G., Harre, D. & Borde, A. (Hrsg.): Trainingswissenschaft. Leistung. Training. Wettkampf. Berlin, 114-122.

Hirtz, P. (2002). Acht Thesen zu den koordinativen Fähigkeiten zwischen Tradition und Perspektive. *Leipzitger sportwissenschaftliche Beiträge, 43*(2), 107-115.

Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. *Sports Medicine, 7*(6), 547-556.

Hrysomallis, C. (2011). Balance Ability and Athletic Performance. *Sports Medicine*, *41*(3), 221-232.

Kapteyn, T.S., Bles, W., Njiokiktjien, Ch.J., Kodde, L., Massen, C.H., & Mol, J.M.F. (1983). Standardization in platform stabilometry being a part of posturography. *Agressologie*, *24*(7)*,* 321–326.

Kašček, A., & Supej, M. (2014). Comparative restoration of balance after disturbing the vestibular aparatus with passive whole-body station: case study. *Science of Gymnastics Journal, 6*(1), 55 – 66.

Kochanowicz, A., Kochanowicz, K., Niespodziński, B., Mieszkowski, J., Sawicki, P. (2017). Effects of systematic gymnastic training on postural control in young and adult men. *Science of Gymnastics Journal, 9*(1), 5-15.

Kümmel, J., Kramer, A., Giboin, L. S., & Gruber, M. (2016). Specificity of Balance Training in Healthy Individuals: A Systematic Review and Meta-Analysis. *Sports Medicine*, *46*(9), 1261-71.

McCurdy, K., & Langford, G. (2006). The relationship between maximum unilateral squat strength and balance in young adult men and women. *Journal of Sports Science and Medicine*, *5*, 282-288.

McGuine, T., Greene, J., Best, T., & Leverson, G. (2000). Balance as a predictor of ankle injuries in high school basketball players. *Clinical Journal of Sport Medicine, 10*, 239-244.

Mellos, V., Dallas, G., Kirialanis, P., Fiorilli, G., & Di Cagno, A. (2014). Comparison between physical conditioning status and improvement in artistic gymnasts and non-athletes peers. *Science of Gymnastics Journal, 6*(1), 33 – 43.

Myer, G.D., Ford, K.R., Brent, J.L., & Hewett, T.E. (2006). The effects of

plyometric vs. dynamic stabilization and balance training on power, balance, and landing force in female athletes. *The Journal of Strength & Conditioning Research*, *20*(2), 345-353.

Nashner, L.M. (1997). Practical biomechanics and physiology of balance. In: G.P. Jacobson, C.W. Newman, & J.M. Kartush, (Eds.). *Handbook of balance function testing* (p. 261-279). San Diego: Singular Publishing Group.

Paillard, T., & Noe, F. (2006). Effect of expertise and visual contribution on postural control in soccer. *Scandinavian Journal of Medicine and Science in Sports, 16* (5), 345-348.

Poliszczuk, T., & Broda, D. (2010). Somatic constitution and the ability to maintain dynamic body equilibrium in girls practicing rhythmic gymnastics. *Pediatric Endocrinology Diabetesand Metabolism, 16*(2), 94-99.

Poliszczuk, T., Broda, D., & Poliszczuk, D. (2012). Changes in Somatic Parameters and Dynamic Balance in Female Rhythmic Gymnasts Over a Space of Two Years. *Polish Journal of Sport and Tourism*, *19*(4), 240–245.

Ramsay, J.R., & Riddoch, M.J. (2001). Position-matching in the upper limb: Professional ballet dancers perform with outstanding accuracy. *Clinical Rehabilitation*, *15,* 324-330.

Shumway-Cook, A., & Woollacott, M. (2007). Motor Control 3. vyd. Baltimore, Maryland. In *Theory and Practical Applications* (pp. 3-20). Baltimore, Maryland: Lippincott Williams &Wilkins.

Sirmen, B., Atilgan, O., Uzun, S., Ramazanoglu, N., Atil, Z., & Danismen, E. (2008). The Comparıson of Statıc Balance and Postural Sway of Waterpolo Players, Karate, Athletes and Sedentary people. *50th ICHPER-SD Anniversary World Congress Japan.*

Strešková, E. (2003). *Koordinačné schopnosti v športovej príprave mládeže.* Bratislava: NIŠ.

Tsigilis, N., & Theodosiou, A. (2008). The influence of multiple administration of a psychomotor test on performance and learning. *Journal of Strength and Conditioning Research, 22*, 1964-1968.

Vařeka, I., & Vařeková, R. (2009). *Kineziologie nohy*. Olomouc: Vydavatelství UP.

Vuillerme, N., Teasdale, N., & Nougier, V. (2001). The effect of expertise in gymnastics on proprioceptive sensory integration in human subjects. *Neuroscience Letters*, *311*, 73-76.

Vuillerme, N., & Nougier, V. (2004). Attentional demands for regulating postural sway: the effect of expertise in gymnastics. *Brain Research Bull*etin, *63*,161–165.

Vuillerme, N., Pinsault, N., & Vaillant, J. (2005). Postural control during quietstanding following cervical muscularfatigue: Effects of changes in sensoryinputs. *Neuroscience Letters*, *387,* 135-139.

Winter, D.A. (1995). Human balance and posture control during standing and walking. *Gait & Posture, 3*(4), 193-214.

Zech, A., Hubsubscher, M., Vogt, L., Banzer, W., Hansel, F., & Pfeifer, K. (2010). Balance Training for Neuromuscular Control and Performance Enhancement: A Systematic Review. *Journal of Athletic Training*, *4*, 392-403.

Corresponding author:

Jaroslav Krištofič
Charles University
Faculty of Physical Education and Sport
Jose Martinho 31
Prague 6
Czech Republic
phone: +420 721 196 788
e-mail: jkristofic@ftvs.cuni.cz

TEACHING NOVICES THE HANDSTAND: A PRACTICAL APPROACH OF DIFFERENT SPORT-SPECIFIC FEEDBACK CONCEPTS ON MOVEMENT LEARNING

Jonas Rohleder, Tobias Vogt

German Sport University Cologne - Institute of Professional Sport Education and Sport Qualifications, Germany

Original article

Abstract

Due to rare evidence-based implications for the application of augmented feedback in gymnastics teaching, this study investigated whether standardised tactile-verbal feedback vs. visual-comparative feedback short-term enhance novel gymnasts' handstand postural performance and motor imagery. Twenty-six students (7 females, 19 males) were randomly assigned to the tactile-verbal feedback (age: 22.7 ± 3.9 years) or visual-comparative feedback (age: 21.9 ± 1.8 years) group (each n = 13), performing a pre-post designed experimental session of handstand trials. Conducting goniometric analyses for hip, shoulder and head position, feedback effects were monitored using video capture and a motion-doll. Shoulder positioning enhanced after receiving tactile-verbal feedback ($p < .01$), whereas shoulder angle imagery enhanced following visual-comparative feedback ($p < .05$). Furthermore, significant correlations between postural performance and motor imagery were found for head position after receiving tactile-verbal feedback ($p < .01$), whereas hip angle postural performance and motor imagery correlated significantly following visual-comparative feedback ($p < .01$). Tactile-verbal feedback and visual-comparative feedback effect several issues of motor learning in different manners; however, this is true even in a short-term approach. Thus, practical recommendations are suggested to consider combined feedback concepts to allow comprehensive handstand acquisition.

Keywords: *gymnastics, postural stability, balance program;motor imagery, skill assessment.*

INTRODUCTION

Regardless of the performance level, the handstand is one of the most essential gymnastics skills (e.g., Hedbávný, Sklenaříková, Hupka, & Kalichová, 2013). Learning to perform a high-quality handstand which is defined by absent angular deviations from the longitudinal axis (Hedbávný et al., 2013) yet requires sport-specific teaching expertise as well as adequate practicing periods. In this context, augmented feedback plays an important role in motor learning processes and is well accepted as a fundamental practical teaching technique (Magill & Anderson, 2012). However, comprehensive school and university curricula and schedules often do

not permit spending cumulative time practicing for examination in addition to regular teaching times in class. With this, effective teaching designs are necessary to support short-term enhancements in motor skill acquisition. Further, (short-term) feedback concepts to enhance the handstand performance imply interdisciplinary challenges, including, for example, biomechanical and psychological parameters that have been reported to influence motor behaviour and even motor learning processes in gymnastics (Kerwin & Trewartha, 2001; Simonsmeier & Frank, 2016).

There are varied criteria by which motor learning in gymnastics can be determined. To assess progresses in practical handstand acquisition, as is the case in gymnastics lessons, the aesthetic quality of the handstand posture can be taken into account. In general, body position with a straight back and legs specifies the handstand posture enduringly (Johnson & Garcia, 1976). It is well-known that keeping a straight body shape without any angles in shoulder, elbow, hip, and knee joints are fundamentally required for high-quality handstand postures (Hedbávný et al., 2013; Uzonov, 2008). Therefore, the body‘s centre of mass has to be fixed above the hands and the head requires axial alignment to the spine without any gaps between shoulders and ears (Gerling, 2009; Uzonov, 2008). Todays’ research on handstand has mainly focussed on the process of maintaining postural control (e.g., Hedbávný et al., 2013; Kerwin & Trewartha, 2001). Previous biomechanical research analysed the contributions made by joint torques in maintaining a handstand (Kerwin & Trewartha, 2001). There is evidence that wrist and shoulder torques are known to be essential for well-balanced handstand performances (Kerwin & Trewartha, 2001; Mohammadi & Yazici, 2016; Yeadon & Trewartha, 2003), whereas less successful balances are characterized by increasing hip torques (Gautier, Marin, Leroy, & Thouravecq, 2009; Kerwin & Trewartha, 2001). However, the hip strategy is a caused reaction to recover perturbed balances in upright stance (Runge, Shupert, Horak, & Zajac, 1999). Similar to normal upright stance, for the handstand equivalent joint involvement strategies of postural control are suggested (e.g., Gautier, Thouvarecq, & Chollet, 2007). In spite of intensive research on handstand balancing processes, studies dealing with the practical teaching of the reported expertise to learners are still lacking.

Within an effective-teaching approach on skill acquisition, from a psychological point of view conscious self-control of a performed movement always implies internal imagery, which is defined in the context of sport “as the creation and re-creation of an experience generated from memorial information” (Morris, Spittle, & Watt, 2005, p. 19) intending to, for example, generate motor programming and motor representation in the absence of actual movement (Schmidt & Lee, 2011; Jeannerod, 1994). Due to the fact that motor behavioural processes may depend on the structure of the internal motor representation (Noth, 2012; Schack, 2003), several studies have confirmed the quality of motor representation being essential for successful motor learning in technically demanding sports (Noth, 2012). For example, Schack and Mechsner (2006) have emphasised the hierarchical order of representational structures of the tennis serve in high-level compared to low-level tennis players resulting in increased long-term memory of movement patterns in expert players. It is well-accepted that cognitive abilities positively affect the process of motor skill learning (Simonsmeier & Frank, 2016) and imagery abilities are suggested to facilitate physical practice in gymnastics (d’Arippe-Longueville, Hars, Debois, & Calmels, 2009). Meanwhile, combined cognitive perceptual learning and physical practice has been assessed to be most efficient (Frank, Land, & Schack, 2015; Ingram, Kraeutner, Solomon, Westwood, & Boe, 2016). However, practical approaches on teaching strategies that aim for enhanced

motor imagery abilities remain to be elucidated in the context of gymnastics (Simonsmeier & Frank, 2016).

In order to explore promising teaching methods to accelerate gymnastics skill learning in physical education, augmented feedback is suggested as an utterly important methodological resource to provide critical information (Schmidt & Lee, 2011; Veit, Jeraj, & Lobinger, 2016). In addition to the inherent feedback that learners gain through various sensory information during movement execution (Schmidt & Lee, 2011), gymnastics teachers may use different types of augmented feedback to positively affect the performance of students with little or no gymnastics experience (Lee, Keh, & Magill, 1993). On principal, a fundamental distinction is made between focussing on the outcome (knowledge of results) and the characteristics of a movement (knowledge of performance) while providing feedback (Schmidt & Lee, 2011). Augmented feedback traditionally is given by using verbal cues (Phillips, Farrow, Ball, & Helmer, 2013), in gymnastics commonly accompanied by tactile information (Gerling, 2009). Previous research dealing with effective teaching has recommended pertinent verbal instructions as being helpful in skill learning (e.g., Housner, 1990). Furthermore, with respect to the present study's link to postural control patterns, the studies by Rogers, Wardman, Lord, and Fitzpatrick (2001) as well as by Krishnamoorthy, Slijper, and Latash (2002) have shown that tactile sensory input as a feedback concept decreases postural sway in erect stance. Aiming for providing knowledge of performance, the feedback should, for example, illustrate the characteristics of the correct movement by giving verbal and tactile information to contract the most important muscles. Additionally, giving augmented visual information (e.g., by video feedback) is a well-established teaching method that is suggested to enhance observational learning in early phases of motor skill acquisition by providing an image of the movement to the learner (Schmidt & Wrisberg, 2008). Taking into account that model observation has been reported to induce motor response by internal visual representation of the observed movement (Krause & Kobow, 2013), video feedback has been suggested to benefit the physical performance of novices in particular (Darden & Shimon, 2000). Considering that successful feedback is suggested to contain corrective targeted information (Horton & Deakin, 2008), visual information related to knowledge of results should show an expert model (Magill, 2014) performing the skill in excellent execution. However, there is evidence that observing an unexperienced novice is more beneficial to skill learning (Lee & White, 1990). In view of these contradictions, Rohbanfard, and Proteau (2011) suggest a mixed model approach including the visual comparison of an expert and a novice performing the movement in order to ensure a reference of correctness (Schmidt & Lee, 2011).

With regard to the literature, research dealing with practical applications of augmented feedback in gymnastics is rare, in particular referring to handstand performances. Masser (1993) observed that one critical verbal cue (i.e., "shoulders over your knuckles") can be useful to assist practicing a process of learning the handstand in young children. Ghavami, Hosseini, and Mohammadzadeh (2012) suggest that observation of an animated model is more effective than verbal instructions to enhance students' handstand balance. Moreover, observational training is suggested to enhance handstand skill performance one hour after practicing when combined with verbal instructions (Maleki, Nia, Zarghami, & Neisi, 2010). It is further reported that light fingertip contact on the lateral sides of the gymnast's thigh supports balance in inverted stance (Croix, Lejeune, Anderson, & Thouvarecq, 2010). Taking these studies into consideration, the knowledge on feedback-induced changes of motor behaviour and motor imagery in gymnastics is still incomplete. It has to be considered that the above-mentioned reports

used, for example, three-weeks research approaches (Ghavami et al., 2012; Masser, 1993) including combined movement practicing and feedback. Although the combination of feedback with physical practice is required to progress in motor learning in gymnastics (Shea, Wright, Wulf, & Whitacre, 2000), it is not finally clarified if observed motor behavioural changes are due to the received feedback. Up to now, there is no evidence revealing explicit practical recommendations for gymnastics teachers or coaches answering the question how to accelerate motor learning during physical practice of the handstand by using different augmented feedback concepts.

Therefore, the purpose of this study is to investigate a short-term influence of two different types of feedback (i.e., tactile-verbal feedback, TVF vs. visual-comparative feedback, VCF) on the enhancement of handstand postural performance and motor imagery in less-experienced novices. With respect to the reported benefits of observational learning in less-experienced learners (e.g., Ghavami et al., 2012; Schmidt & Wrisberg, 2008; Darden & Shimon, 2000), it is hypothesised that (1) VCF compared to TVF is more effective to enhance the quality of handstand postural performances and (2) the motor imagery of the handstand posture. It is further hypothesised that (3) enhancements in postural performance correlate with enhancements in motor imagery.

METHODS

Twenty-six healthy and uninjured volunteering Sport and Exercise Science students (7 females, 19 males) with no particular history in gymnastics other than a school or university class were recruited. Following randomisation (i.e., drawing numbers), participants were assigned into two matched feedback groups; group 1: tactile-verbal feedback (TVF, n = 13; age: 22.7 ± 3.9 years; height: 180.9 ± 9.2 cm; weight: 74.4 ± 10.2 kg), group 2: visual-comparative feedback (VCF, n = 13; age: 21.9 ± 1.8 years; height: 175.9 ± 9.7 cm; weight: 69.9 ± 13.9 kg). Advanced and competitive gymnasts were excluded. However, participants should be able to perform the lunge entry and upward swing to handstand (Johnson and Garcia, 1976) irrespective of the technique level. All randomised participants completed the exprimental procedure. In Accordance with University Ethics Committee, all participants obtained written informed consent.

Except for the feedback, all participants underwent the same experimental protocol wearing tight and dark sport clothes. Experiments were set up as single appointments, lasting approximately 30 min. Prior to a 10-min warm up (excluding any type of handstand to prevent preparatory learning), all participants received general welcoming instructions. Following warm up, marker points, selective to the present study's content-related joints, were set at anatomical landmarks; 1: knee at capitulum fibulae, 2: hip at iliac crest tuberculum, 3: shoulder at posterior deltoid, 4: head at temple hole between eyes and ear, and 5: wrist at processus styloideus ulnae.

Prior to performing their own handstands, a video showing an expert model demonstrating a technical guideline and referring to 'the perfect handstand' was shown to all participants twice (at first in real-time, secondly in slow-motion). Subjects were informed that the quality of their handstand posture is the key aspect they should focus on. In contrast to previous setups (e.g., Maleki et al., 2010), the model observation was left uncommented to have each participant evolve a self-reliant understanding on how to perform their upcoming best possible handstand posture. Subsequently, participants performed a single test trial of swing up to handstand to familiarise with the set up properties and conditions in the gym.

Following familiarisation, the pre-test examination started. Each participant was asked to perform three trails of handstand, encouraged to accomplish a high-quality

bodyline. They were allowed to leave handstand in different manners, for example, roll down or place their feet back the way they started the lunge entry. After each of the three pre-test trials, participants immediately had to adjust content-related joints in a motion-doll (i.e., head, shoulder, hip; figure 1) in order to assess motor imagery of performed handstand posture. After each participant finished the doll adjustment, a photo of this doll-position was taken from a standardised bird's eye perspective. Following this procedure, participants received either the tactile-verbal feedback or the visual-comparative feedback before repeating another set of three handstands, the post-test.

Feedback 1 - tactile-verbal (TVF): Uzonov (2008) specifies several agonist muscle groups including their function for maintaining the correct handstand posture. Rounding the back and the posterior pelvic tilt are mentioned as essential actions (Uzonov, 2008). The posterior pelvic tilt is predominantly achieved by contraction of musculus rectus abdominis. Rounding the back comes along with shoulder girdle abduction by contracting musculus serratus anterior and musculus pectoralis minor. Additional to abduction, shoulder girdle elevation by musculus rhomboideus, musculus trapecius and musculus levator scapulae is also necessary to keep the well-balanced handstand. In order to focus on selected critical cues, posterior pelvic tilt, rounding the back and the shoulder girdle elevation were chosen for TVF. To implement TVF, participants simulated handstand position alignment while lying in a supine position on a gymnastics mat with arms straight and parallel next to the ears (if possible: shoulder angle = 180°). Maintaining this position, participants were requested to contract special muscles, which are crucial in order to optimise handstand posture. For this purpose, each participant received identical standardised instructions (Table 1). Tapping respective muscles with a pointer baton provided tactile feedbacks.

Table 1
Standardised tactile-verbal feedback (TVF).

Feedback	Tactile feedback	Verbal feedback
1	musculus gluteus maximus	"rotate your pelvis – flatten your back"
2	sternum	"chest in"
3	(pulling the hands)	"push upwards – make yourself tall"

Feedback 2 - visual-comparative (VCF): individual handstand trials were shown to the VCF-group via video. Using a modified mixed model approach (Rohbanfard & Proteau, 2011), participants were requested to find posture deficits by comparing their own trial with a screenshot of the expert model. Individual trial videos were demonstrated twice in chronological order without any commenting by the test operators, thus, there was no specific indication for the participants where to give the focus of attention.

Other than a laboratory examination, this study aimed at a user-oriented applied setting in the gym to simulate a familiar training atmosphere known from practice and physical education. With respect to the literature, large body joints provide information about handstand quality (e.g., Kerwin & Trewartha, 2001; Uzonov, 2008). In order to limit on essential handstand criteria relating to target group-specific skill abilities, this investigation focussed on the measurement of two large body joints being the shoulder and hip and including the head

position as a handstand-related aesthetic feature (Gerling, 2009). Joint angles were specified as shown in Figure 1.

The primary outcome measure was a goniometric investigation, performed with the Kinovea analysis software version 0.8.15. Participants‘ trials were recorded on sagittal plane by a standard commercial mobile phone camera (Samsung Galaxy S5 mini) to examine body posture using economic equipment that may be purchased by teachers and coaches as well. Screen shots of handstand posture at its defined optimum were made to measure joint angles (head-position, shoulder, and hip). Inspired by Masser (1993), optimum handstand positions (i.e., screen shots taken) were defined based on the following criteria:

The participant rolled over: optimum was set where the participants' feet reached their highest point

The participant placed their feet back in the direction where they started: optimum was set at the moment when the movement was reversed

Trial was excluded if handstand posture was not apparent (deviation more than 45° from vertical line between hands and feet at movement reversal point)

Postural performance was assessed by measuring and comparing joint angles of each participants' handstand posture to the expert model handstand posture. Evaluation of motor imagery was examined by adjusting motion-dolls' joint angles and comparing to participants**'** real handstand posture.

Statistical analysis was performed using SPSS for windows (version 22.0). Prior to conducting pairwise comparisons for each angle (i.e., head, shoulder, hip) to display pre to post differences in postural performance and motor imagery, the data was checked for normality. Based on this, either paired-samples *t*-tests or Wilcoxon signed-ranks tests compared pre to post differences for each group. Defectively collected data from two participants had to be excluded from analysis. Thus, a sample size of $n = 24$ ($n = 12$ for each group) was remaining. Data in the figures and tables are presented as mean (*M*) ± standard deviation (*SD*). The level of significance was set at $p < .05$; trends were accepted for $p < .10$.

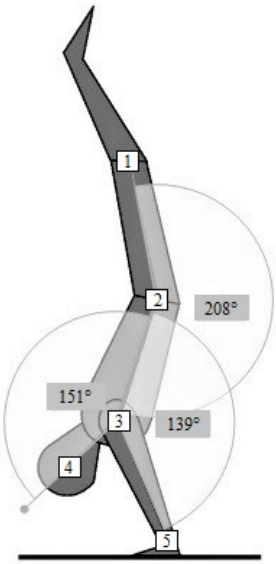


Figure 1. Goniometric analysis of handstand postural performance and motor imagery (joint angle definition in relation to the marker point numbers): shoulder, 2-3-5; hip, 1-2-3; head, 2-3-4).

RESULTS

Results of postural performances and motor imagery are presented for head, shoulder and hip positioning. Feedback-induced pre to post changes on angular deviations are displayed in figure 2 and table 2. Subsequently, correlating results are presented.

Postural performance

1. Head

Wilcoxon signed-ranks test revealed no significant pre to post differences in the TVF group, $Z = 0.63$, $p = .53$, $d = .17$. Further, paired-samples *t*-test showed no significant pre to post differences in the VCF group, $t(11) = -0.78$, $p = .45$, $d = .21$ (Table 2).

2. Shoulder

Wilcoxon signed-ranks test revealed significant increased shoulder angle performances in the TVF group, $Z = 2.70$, p

< .01, *d* = -.43. Further, paired-samples *t*-test showed that the shoulder angle performance increased by trend in the VCF group, *t*(11) = 1.91, *p* = .08, *d* = -.29 (Figure 2A; Table 2).

3. Hip

Wilcoxon signed-ranks test revealed no significant pre to post differences in the TVF, *Z* = 1.18, *p* = .24, *d* = .21, and the VCF group, *Z* = 0.24, *p* = .81, *d* = -.06 (Table 2).

Motor imagery

1. Head

Paired-samples *t*-test revealed no significant pre to post differences in the TVF, *t*(11) = -0.67, *p* = .52, *d* = .12, and the VCF group, *t*(11) = 0.02, *p* = .99, *d* = -.01 (Table 2).

2. Shoulder

Wilcoxon signed-ranks test revealed no significant pre to post differences in the TVF group, *Z* = 0.71, *p* = .48, *d* = -.18. However, paired-samples *t*-test obtained significant increased motor imagery of the shoulder joint in the VCF group, *t*(11) = 2.65, *p* = .02, *d* = -.96 (Figure 2B; Table 2).

3. Hip

Wilcoxon signed-ranks test revealed no significant pre to post differences in the TVF, *Z* = 0.16, *p* = .88, *d* = .06, and the VCF group, *Z* = 0.47, *p* = .64, *d* = -.19 (Table 2).

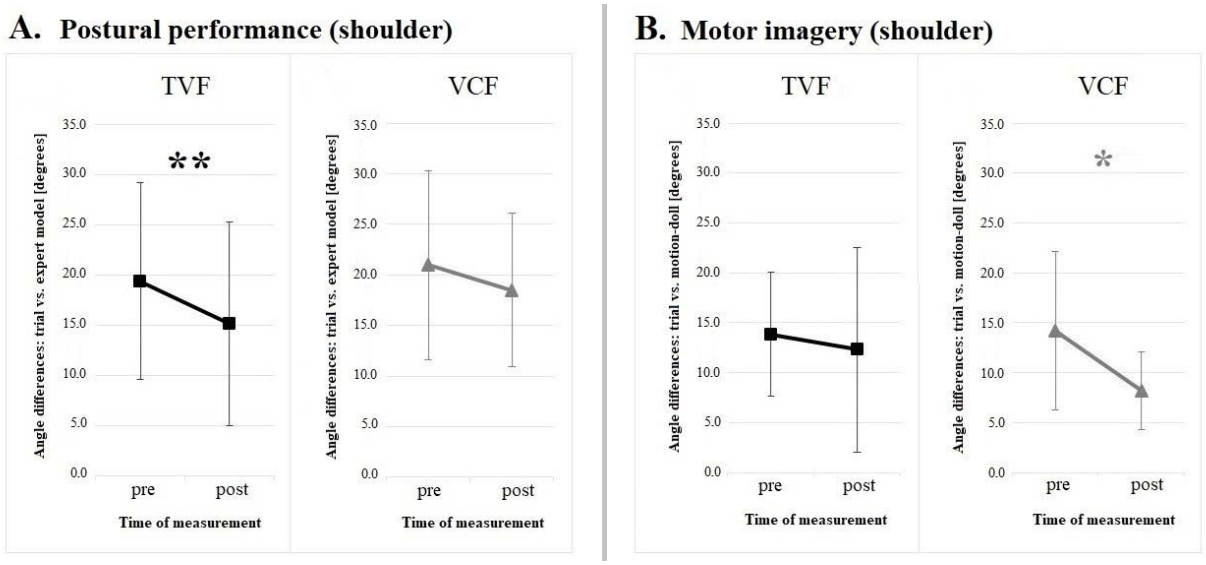


Figure 2. (A) Displayed are shoulder angles for pre to post differences between ideal handstand and handstand trial in the TVF and the VCF group. (B) Displayed are shoulder angles for pre to post differences between handstand trial and motion-doll adjustment in the TVF and the VCF group. Lines depict group average differences between pre- and post-test with *SD* error bars. Level of significance: **p* < .05; ***p* < .01.

Table 2
Feedback-impact on handstand postural performance and motor imagery.

		Postural performance				Motor imagery			
Feedback	Angle	Pre (M ± SD)	Post (M ± SD)	*p*	Cohen's *d*	Pre (M ± SD)	Post (M ± SD)	*p*	Cohen's *d*
	head	27.30 ± 14.01	29.63 ± 13.92	.53	.17	31.08 ± 15.60	32.87 ± 14.49	.52	.12
TVF	shoulder	19.38 ± 9.80	15.13 ± 10.15**	< .01	-.43	13.83 ± 6.21	12.33 ± 10.26	.48	-.18
	hip	10.03 ± 5.12	11.26 ± 6.63	.24	.21	15.48 ± 11.10	16.18 ± 12.06	.88	.06
	head	17.51 ± 10.67	19.84 ± 11.21	.45	.21	23.17 ± 14.01	23.10 ± 14.63	.99	-.01
VCF	shoulder	20.97 ± 9.38	18.53 ± 7.55	.08	-.29	14.20 ± 7.92	8.20 ± 3.92*	.02	-.96
	hip	9.94 ± 7.14	9.55 ± 6.45	.81	-.06	15.87 ± 14.78	13.69 ± 6.77	.64	-.19

M: mean value; *SD*: standard deviation; Level of significance: *p < .05; **p < .01

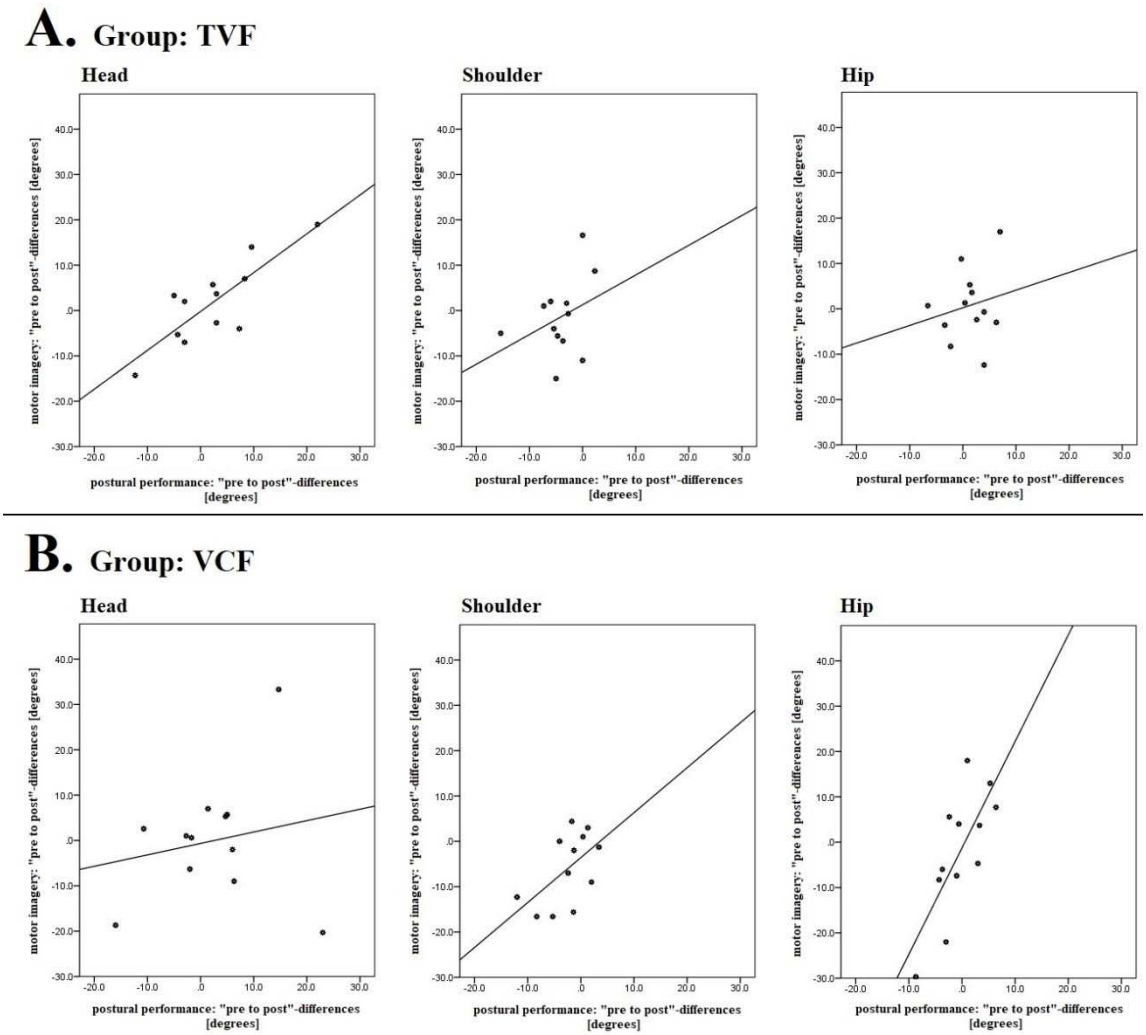


Figure 3. Correlations between the pre- to post-changes in postural performance and motor imagery within head, shoulder and hip positioning in the TVF and the VCF group.

A correlation analysis revealed a significant correlation for postural performance and motor imagery, $r(70) = .48$, $p < .001$. Further, there is a significant correlation between postural performance and motor imagery for TVF, $r(34) = .56$, $p < .001$, and a significant trivial correlation for VCF, $r(34) = .39$, $p < .02$. TVF: Significant correlations between postural performance and motor imagery were found for head position, $r(10) = .83$, $p < .01$, but not for shoulder angle, $r(10) = .35$, $p = .27$, and hip angle, $r(10) = .20$, $p = .54$ (Figure 3A). VCF: Significant correlations between postural performance and motor imagery were found for hip angle, $r(10) = .75$, $p < .01$, but not for head position, $r(10) = .19$, $p = .56$, and shoulder angle, $r(10) = .35$, $p = .27$ (Figure 3B).

To summarise, main findings revealed enhanced postural performance of shoulder positioning following TVF, whereas shoulder motor imagery is enhanced following VCF; postural performance and motor imagery correlated with head positioning following TVF and with hip positioning following VCF.

DISCUSSION

In view of handstands' importance in gymnastics (e.g., Uzonov, 2008; Hedbávný et al., 2013; Johnson & Garcia, 1976) and the role of augmented feedback in motor learning and physical education (Housner, 1990; Lee et al., 1993; Magill & Anderson, 2012; Veit et al., 2016), the present study aimed to discover short-term effects of standardised tactile-verbal feedback (TVF) vs. visual-comparative feedback (VCF) on handstand postural performance and motor imagery. The main findings were that postural performance enhanced in the shoulder angle after TVF, whereas VCF enhanced imagery of the shoulder angle. Furthermore, changes in postural performance and motor imagery correlated in head (i.e., TVF) and hip positions (i.e., VCF). However, changes in other joint angles were not statistically significant.

In the present study, handstand postural performance was significantly enhanced in the shoulder angle after TVF, but not following VCF. These findings contradict the present study's initial hypothesis (1) assuming an enhanced alignment of the handstand posture following visual information. Participants who received a modified observational learning comparing their pre-test handstand trials to the ideal handstand of the expert model (Lee & White, 1990; Magill, 2014; Rohbanfard & Proteau, 2011) only enhanced shoulder angle positioning by trend. Thus, these findings are contradictory to previous research suggesting video feedback and observational learning to accelerate novices' learning of motor tasks or even handstand acquisition (Darden & Shimon, 2000; Ghavami et al., 2012; Schmidt & Wrisberg, 2008). While this research used a visual feedback concept without additional verbal instructions, previous (gymnastics-specific) motor behavioural research displayed enhanced motor learning using combined (visual and verbal) feedbacks (e.g., Maleki et al., 2010). Additionally, with respect to the short time period between the pre- and post-tests, missing time for visuomotor processes and movement representation (Jeannerod, 1994; Krause & Kobow, 2013; Noth, 2012; Schack & Mechsner, 2006) might further explain why no better performances were observed after VCF. Moreover, the participants' focus of attention while receiving VCF has not been clarified. Due to the fact that successful feedback is suggested to contain corrective targeted information (Horton & Deakin, 2008), participants who observed their own handstand trial predominantly instead of comparing themselves to the expert model might have achieved worse postural performance results.

Nevertheless, the present findings are in line with well-accepted practical knowledge about beneficial effects of verbal and tactile information on motor learning and postural movement patterns (Croix et al., 2010; Housner, 1990; Krishnamoorthy et al., 2002; Masser, 1993; Phillips et al.,

2013; Rogers et al., 2001). Thus, critical cues as well as tactile stimulation are presumed to even support short-term enhancements in handstand motor behaviour (Croix et al., 2010; Masser, 1993; Rogers et al., 2001). However, in this study, the enhancement of postural performance after TVF only applied to the shoulder joint angle, but not to hip joint angle and head position. Irrespective of possible lacks of physical aspects, for example insufficient core stability to hold the hip in place, these findings add to current biomechanical results revealing that shoulder torque plays a more important role than hip torque in postural control mechanisms of the handstand (Kerwin & Trewartha, 2001; Mohammadi & Yazici, 2016; Yeadon & Trewartha, 2003). With respect to the less influential role of the hip torque for decreasing postural disturbances (Gautier et al., 2007), this might explain why no better hip postures were observed after TVF. Although the participants were instructed to focus on the quality of joint angles instead of aiming at a long-lasting handstand, they, primarily and implicitly, seemed to aim at balancing the centre of mass in equilibrium. With regard to the knowledge about an "ankle strategy" and a "hip strategy" in upright stance (Runge et al., 1999), gymnasts' hip joints appear to remain relatively uncoordinated and arbitrary as long as wrists' and shoulders' work predominantly to regulate postural balance (Gautier et al., 2009). Thus, it can be further discussed whether a different research approach including wrist work is needed. However, our results provide reasons to support earlier findings that handstands' postural control is based on a postural regulation system similar to that in upright stance (e.g., Gautier et al., 2007; Hedbávný et al., 2013; Kerwin & Trewartha, 2001; Mohammadi & Yazici, 2016) that obviously has to be considered for providing pertinent feedback.

Furthermore, handstand motor imagery was enhanced in the shoulder angle following VCF, but not following TVF. Supporting the present study's second hypothesis (2), these results are in line with previous motor behavioural research and confirmed findings concerning the beneficial effects of video feedback on novice gymnasts' internal visualisation of motion and posture (Darden & Shimon, 2000; Schmidt & Wrisberg, 2008). However, VCF has not been shown to positively affect motor imagery of other joint angles (i.e., hip, head), which is in conflict to our hypothesis (2). Missing time for developing a relationship between observed kinematical aspects and a motor representation of the movement might serve as an explanation (Jeannerod, 1994; Noth, 2012; Schack, 2003; Schack & Mechsner, 2006); however, this again raises the question why shoulder imagery enhanced. In order to interpret the findings for the hip joint, another approach has to be taken into account challenging whether poor or good trials (or even both) could not be mentally visualised. Based on the underlying assumption that motor imagery of perturbed hip and head stabilisations was defective, the loss of (visual) orientation during erroneous head positioning caused by insufficient experience in handstands might obstruct good motor imagery despite visual feedback. With respect to presumed handstand postural control mechanisms (Gautier et al., 2007; Kerwin & Trewartha, 2001), one explanation for the absent benefit in the hip joint while receiving VCF might be the less influential role of this joint for postural control in handstands. There are reasons to believe that, in case of insufficient muscular triggering of the hip, defective cognitive processing that fails to combine inherent and augmented feedback information (Schmidt & Lee, 2011) makes it more difficult to develop motor imagery of the hip positioning. However, these interpretative approaches can only be presumed owing the lack of according evidence that has to be addressed by future studies.

Moreover, in the TVF group, the performance of head position correlated with motor imagery of the head position. In the TVF group, participants' performance

and motor imagery was unaffected by visual information. Furthermore, participants were not given a standardised tactile-verbal instruction concerning the position of the head. With regard to the present study's third hypothesis (3) assuming accompanied enhancements in motor behavioural and motor imagery efforts (d'Arippe-Longueville et al., 2009; Frank et al., 2015; Ingram et al., 2016; Noth, 2012; Schack, 2003; Schack & Mechsner, 2006; Simonsmeier & Frank, 2016), reasons for this finding have to be discussed. It seems reasonable to assume that, on the one hand, TVF participants consciously perceived positive changes in head position performance due to feeling their shoulders next to their ears while performing the handstand (Uzonov, 2008), considering that similar sensory information during handstand are missing for the shoulder and hip joint. As reported above, while receiving TVF, the participants were asked to place their arms straight and parallel next to their ears. This light sensory information (Krishnamoorthy et al., 2002; Rogers et al., 2001) indicating an enhanced aligned head positioning (Gerling, 2009) might sensitise learners for the correct head postion and, thus, increase participants' motor imagery of this postural enhancement what is reflected in the corrected adjustment of the motion-doll. On the other hand, if this sensory input is not received as it occurs in less successful handstand performances, motor imagery of the head positioning is assumed to be much more difficult for less-experienced novices. Thus, for future studies it is suggested to challenge the question whether tactile feedback to the head affect motor behaviour in novel gymnasts. In light of the present study's findings, the matter of teaching the head positioning in handstands remains to be elucidated in additional research.

In the VCF group, the present study detected a correlation between postural performance and motor imagery for hip angle, but not for shoulder angle and head position. In light of these findings, absent correlations for shoulder and head positioning might be explained by the study of Shea et al. (2000) showing that observational training is less effective than physical practice, considering that the benefits of observational practice can only be exploited by alternating observational with physical practice (Shea et al., 2000). However, obtained correlations for the hip joint have to be discussed. Taking into account that impaired (respectively enhanced) hip joint performances seem to be accompanied by poor (respectively good) motor imagery results, contrasting observation of the expert model compared to the learners handstand seems to focus the hip joint, presumably due to the fact that good postures concerning the largest involved body joint are particularly apparent. However, these findings are in line with the previously discussed assumption that perturbed hip positioning is difficult to perceive. Accordingly, with respect to the model of handstand postural control and with respect to previous discussed findings regarding motor imagery of the hip joint in VCF, mental visualisation of the hip joint (what is minor utilized to balance handstand posture) seems to be challenging in the presence of postural sway. In view of absent correlations in shoulder and head positioning after VCF, perception of actual perturbations in these body segments varied arbitrarily. However, these thoughts have to be investigated in future research to clarify the present study's third hypothesis (3). In particular, future studies should challenge the question if (visual) feedbacks' efficiency depends on the relevance to perform motor skills in certain parts of the body.

In summary, with regard to postural regulation patterns in inverted stance, the obtained data indicate TVF to positively affect the shoulder angle, but not the hip angle and head regulation in handstand performances. Despite marginally enhanced shoulder positioning in VCF, missing verbal cues and an assumed inappropriate attentional focus might explain absent postural enhancements following VCF. Apart from enhanced shoulder angle

imagery after receiving VCF, lacking orientation (i.e., head) and insufficient inherent feedback (i.e., hip) due to occurred postural sway presumably impeded further benefits of VCF in motor imagery. Furthermore, tactile contact between shoulders and ears received in TVF is suggested to provide sensory feedback enabling novices' self-control in aligned head positioning. As these findings have obtained a complexity for providing augmented feedback efficiently, future studies should continue approaching applied research focussing on the optimal sensory input with the objective on accelerating novices' motor learning and, thus, skill acquisition.

CONCLUSIONS

The present study revealed enhanced shoulder positioning in handstands after TVF, whereas motor imagery of the shoulder angle enhanced following VCF. The findings suggest commented tactile feedback to be beneficial for short-term increases of handstands' postural quality; however, video feedback is useful to provide short-term corrected motor imagery of the handstand posture. Taken together, this study confirmed the importance of augmented feedback in acquisition of motor skills suggesting sensory information to assist accordance between postural performance and motor imagery in handstands. To conclude, in order to accelerate progressing handstand acquisition in early stages of learning, different types of feedback effect several issues of motor learning in different manners, but even in a short-term approach and without the influence of physical practice. Thus, practical recommendations are suggested to consider combined feedback concepts that mutually provide tactile-verbal as well as visual information to allow comprehensive motor learning in less-experienced learners.

LIMITATIONS

Retrospectively, we are well aware that the missing of finger and wrist work appears to be important to discuss findings on postural performance. However, in view of palms acting as interface between body and support surface (Kerwin & Trewartha, 2001), the hands represent a steady point, which does not affect the visual impression of varying handstand postures. Furthermore, due to the intentional focussing on the shoulder and hip joint, in this study ankle and foot work were left aside, although both might influence the actual knee joint position and the visual impression of the handstand in less-experienced learners. It also has to be taken into account that the used motion-doll can only be a mock-up, but not a template to represent a human body's proportions; however, this method turned out to be useful in this applied approach. In addition to this study aiming to examine differences between different feedback concepts, further research may include sufficient control conditions (e.g., no provided feedback at all), possibly adding valuable insights to the comparison of two impacting feedback concepts.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to all participants for spending some of their valuable time upside down in favour of this research. We further thank everyone who gave valuable comments when proofreading our manuscript.

REFERENCES

Croix, G., Lejeune, L., Anderson, D. I., & Thouvarecq, R. (2010). Light fingertip contact on thigh facilitates handstand balance in gymnasts. *Psychology of Sport and Exercise, 11*(4), 330-333.

Darden, G., & Shimon, J. (2000). Revisit an "Old" Technology Videotape Feedback for Motor Skill Learning and Performance. *Strategies*, *13*(4), 17-21.

d'Arippe-Longueville, F., Hars, M., Debois, N., & Calmels, C. (2009). Perceived development of psychological characteristics in male and female elite gymnasts. *International Journal of Sport Psychology, 40*(3), 424-455.

Frank, C., Land, W. M., & Schack, T. (2015). Perceptual-cognitive changes during motor learning: The influence of mental and physical practice on mental representation, gaze behavior, and performance of a complex action. *Frontiers in Psychology, 6*.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. *Human Movement Science, 28*(1), 129-140.

Gautier, G., Thouvarecq, R., & Chollet, D. (2007). Visual and postural control of an arbitrary posture: The handstand. *Journal of Sports Sciences, 25*(11), 1271-1278.

Gerling, I. E. (2009). *Teaching children's gymnastics* (2nd ed.). Maidenhead: Meyer & Meyer Sport.

Ghavami, A., Hosseini, F., & Mohammadzadeh, H. (2012). The effect of animated model observation and verbal instruction on motor learning of handstand balance skill. *International Journal of Sport Studies, 2*(2), 84-88.

Hedbávný, P., Sklenaříková, J., Hupka, D., & Kalichová, M. (2013). Balancing in handstand on the floor. *Science of Gymnastics Journal, 5*(3), 69-80.

Horton, S., & Deakin, J. M. (2004). Expert coaches in action. In D. Farrow, J. Baker, & C. MacMahon (Eds.). *Developing Sport Expertise. Researchers and Coaches Put Theory into Practice* (pp. 75-88). London: Routledge.

Housner, L. D. (1990). Selecting master teachers: Evidence from process-product research. *Journal of Teaching in Physical Education*, *9*(3), 201-226.

Ingram, T. G., Kraeutner, S. N., Solomon, J. P., Westwood, D. A., & Boe, S. G. (2016). Skill acquisition via motor imagery relies on both motor and perceptual learning. *Behavioral Neuroscience, 130*(2), 252.

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences*, *17*(2), 187-202.

Johnson, B. L., & Garcia, M.J. (1976). *Gymnastics for the beginner: A coeducational approach*. Sterling, Texas: Sterling Swift.

Kerwin, D. G., & Trewartha, G. (2001). Strategies for maintaining an handstand in the anterior-posterior direction. *Medicine & Science in Sports & Exercice, 33*(7), 1182-1188.

Krause, D., & Kobow, S. (2013). Effects of model orientation on the visuomotor imitation of arm movements: the role of mental rotation. *Human Movement Science*, *32*(2), 314-327.

Krishnamoorthy, V., Slijper, H., & Latash, M. L. (2002). Effects of different types of light touch on postural sway. *Experimental Brain Research, 147*, 71-79.

Lee, A. M., Keh, N. C., & Magill, R. A. (1993). Instructional effects of teacher feedback in physical education. *Journal of Teaching in Physical Education*, *12*(3), 228-243.

Lee, T. D., & White, M. A. (1990). Influence of an unskilled model's practice schedule on observational motor learning. *Human Movement Science*, *9*(3), 349-367.

Magill, R. A. (2014). *Motor learning and control. concepts and applications* (10th ed.). Boston: McGraw-Hill.

Magill, R. A., & Anderson, D. I. (2012). The roles and use of augmented feedback in motor skill acquisition. In N. J. Hodges, & A. M. Williams (Eds.), *Skill Acquisition in Sport. Research, Theory and Practice* (2nd ed., pp. 3-21). Abingdon, Oxon, New York: Routledge.

Maleki, F., Nia, P., Zarghami, M., & Neisi, A. (2010). The comparison of different types of observational training on motor learning of gymnastic handstand. *Journal of Human Kinetics, 26*, 13-19.

Masser, L. S. (1993). Critical cues help first-grade students' achievement in handstands and forward rolls. *Journal of Teaching in Physical Education, 12*(3), 301-312.

Mohammadi, M., & Yazici, A. G. (2016). A Dynamic Model for Handstand in Gymnastics. *Journal of Sports and Physical Education, 3*(6), 8-11.

Morris, T., Spittle, M., & Watt, A. P. (2005). *Imagery in Sport*. Champaign, Il: Human Kinetics.

Noth, N. (2012). *Mentale Bewegungsrepräsentation und Techniktraining.* Hamburg: Dr. Kovač.

Phillips, E., Farrow, D., Ball, K., & Helmer, R. (2013). Harnessing and understanding feedback technology in applied settings. *Sports Medicine*, *43*(10), 919-925.

Rogers, M. W., Wardman, D. L., Lord, S. R., & Fitzpatrick, R. C. (2001). Passive tactile sensory input improves stability during standing. *Experimental Brain Research, 136*, 514-522.

Rohbanfard, H., & Proteau, L. (2011). Learning through observation: a combination of expert and novice models favors learning. *Experimental brain research*, *215*(3-4), 183-197.

Runge, C. F., Shupert, C. L., Horak, F. B., & Zajac, F. E. (1999). Ankle and hip postural strategies defined by joint torques. *Gait & Posture, 10*(2), 161-170.

Schack, T. (2003). The relationship between motor representation and biomechanical parameters in complex movements: towards an integrative perspective of movement science. *European Journal of Sport Science, 3*(2), 1-13.

Schack, T., & Mechsner, F. (2006). Representation of motor skills in human long-term memory. *Neuroscience Letters*, *391*(3), 77-81.

Schmidt, R. A., & Lee, T. D. (2011). *Motor Control and Learning. A Behavioral Emphasis* (5th ed.). Champaign, Il: Human Kinetics.

Schmidt, R. A., & Wrisberg, C. A. (2008). *Motor learning and performance: situation-based learning approach* (4th ed.). Champaign, Il: Human Kinetics.

Shea, C. H., Wright, D. L., Wulf, G., & Whitacre, C. (2000). Physical and observational practice afford unique learning opportunities. *Journal of Motor Behavior*, *32*(1), 27-36.

Simonsmeier, B. A., & Frank, C. (2016). Imagery in gymnastics: Theories and empirical findings. In T. Heinen, I. Čuk, R. Goebel, & K. Velentzas (Eds.), *Gymnastics Performance and Motor Learning. Principles and Applications* (pp. 53-69). New York: Nova Science Publishers.

Uzonov, V. (2008). The handstand: A four stage training model. *Gym Coach, 2*, 52-59. Retrieved from https://www.researchgate.net/profile/Valentin_Uzunov/publication/281149650_The_Handstand_A_Four_Stage_Training_Model/links/55d8b23808aeb38e8a87b368.pdf

Veit, J., Jeraj, D., & Lobinger, H. (2016). Augmented feedback for movement error correction in gymnastics. In T. Heinen, I. Čuk, R. Goebel, & K. Velentzas (Eds.), *Gymnastics Performance and Motor Learning. Principles and Applications* (pp. 45-52). New York: Nova Science Publishers.

Yeadon, M. R., & Trewartha, G. (2003). Control strategy for a hand balance. *Motor control, 7*(4), 421-442.

Corresponding author:

Jonas Rohleder
German Sport University Cologne - Institute of Professional Sport Education and Sport Qualifications
Am Sportpark Müngersdorf 6
50933 Köln
Germany
phone: +49 (0) 221 4982 4170
e-mail: j.rohleder@dshs-koeln.de

STRATEGIES FOR LEARNING GYMNASTIC SKILLS THROUGH TECHNOLOGIES IN INITIAL TEACHER TRAINING

María Alejandra Ávalos Ramos, Lilyan Vega Ramírez

University of Alicante, Spain

Original article

Abstract

The objective of this research was to present the study carried out for groups of first year students of the degree of Physical Activity and Sport Sciences of the University of Alicante (Spain). The purpose of the project was to determine the usefulness of self-assessment and the peer evaluation in teaching and learning of gymnastic skills. The methodology used was quantitative and qualitative. Analysis of Qualitative Data (AQUAD 6) software was employed to analyse the qualitative data and the office software Microsoft Excel for MAC (© 2015 Microsoft, Version 15.32) was used to the quantitative data. Observation as a strategy of information collection and the subsequent analysis of what is observed is an essential element in the process. Similarly, the use of technological instruments such as video camera and smart phone, the latter within the reach of the majority of students, were a facilitating element of the activity. On the other hand, students made a critical reflection on the method used by teachers, indicating under their perspective the strengths and weaknesses of the whole process. Audio-visual strategies and media have been such a positive issue in this study as well as self-assessment and peer evaluation, as they are adequate strategies to contribute to a proficient learning and management of the information.

Keywords: *Coevaluation, self-assessment, technological instruments, artistic gymnastics, regulation of learning.*

INTRODUCTION

Today, educational models, under the Bologna Process guidelines, emphasize competence-based learning. This process is characterized by developing, among other aspects, a more autonomous work of students, as well as an increase in the use of information and communication technologies. Due to this reason, university teachers seek more collaborative and participatory teaching-learning systems, where the student has a leading role. In this sense, students must make decisions in the teaching-learning process about what, how, how much, and when to learn; that is, themselves should regulate their motivations towards this process.

Currently, various types of technological tools are used to complement and improve the contents of physical education classes in initial teacher training

such as blogs, web pages, etc. Some other authors have done the same by using teaching resources resembling those used in everyday life (videos, chats...) (Bergmann & Sams, 2014; Moffett & Mill, 2014).

In the field of Physical Activity and Sports, as in other subjects, many authors defend theories where high school and university students develop more autonomous behaviours and communication skills through collaborative strategies (Fernández-Río, 2006; Grineski, 1996; Hargreaves, 2005; Slavin, 1990; Vernetta, Gutiérrez, López, & Ariza, 2013). In the context of gymnastic skills, collaborative strategies and the use of learning registration tools (observation sheets, self-assessment and peer evaluation sheets, etc.) can help students to learn more meaningfully and with greater responsibility as has already been demonstrated in a number of studies (Dyson, Griffin, & Hastie, 2004; Vernetta, López, & Delgado, 2009; Vernetta, López, & Robles, 2009). Additionally, the recording instruments (video cameras, smart phones...) used by the student as tools for the observation and evaluation of their own learning can favour self-regulating behaviours in their training (Azevedo, Guthrie, & Seibert, 2004; Wilson, 1997). According to Prat, Camerino and Coiduras (2013), the advantages of flexibility, immediacy, adaptability, interactivity and others that contribute to the use of technological tools to the teacher, mean an improvement in the different aspects of the teaching-learning process. Likewise, Marinsek and Slana (2014) and Krizaj and Čuk (2015) claim that smart phones and videos are valid and reliable devices to improve the capacity of visual evaluation and the processing of all technical phases of the gymnastic movements. Information communication technologies (ICT), when used as constructivist tools, create a different experience in the learning process among students, relate to the way in which they learn best, and function as important elements for building their own knowledge (Hernández, 2008).

The evaluation is also an aspect of the teaching-learning process that worries teachers and it has been a matter of research by numerous authors in the field of Physical Education (Hernández, Velázquez, Alonso, & Castejón 2004; López, et al., 2007; Mosston & Ashworth, 1993). In agreement with the participatory strategies, we consider that the evaluation process should also be focused towards more formative and collaborative evaluation systems that contribute to the achievement of a more autonomous learning of the university student. Self- assessment and peer evaluation are presented in various studies as means that encourage the student to participate directly in the perception of their educational evolution and as systems that contribute to greater social development, autonomy and responsibility (Fraile, 2006; López et al., 2007; Slavin, 1990; Vernetta, Gutiérrez, López, & Ariza, 2013). The absence of autonomy in the learning of our university students, reflected and not obtained with the use of situations of conventional learning, leads us to reflect and introduce in our teaching more participatory and cooperative teaching methods, relying on technological instruments that could reinforce the learning of these competences. In this sense, observation as a strategy of information collection and subsequent analysis of what has been observed is presented as an essential element in the process. Likewise, the use of technological instruments such as video camera and smart phones, the latter within the reach of the majority of students, can be a facilitating element of the activity.

Therefore, this work aims to present an investigation carried out with groups of first year students of the degree in Science of Physical Activity and Sport of the University of Alicante. The aim of the project was, on the one hand, to design templates for observing the techniques of execution of different gymnastic skills and, on the other hand, to determine the usefulness of self-assessment and peer evaluation using templates designed together with the use of information

technologies and of communication, in the teaching-learning of such skills.

METHODS

This study is a quantitative and qualitative research and presents a quasi-experimental design. The selected sample is not accidental due to convenience and availability and is composed of 104 registered students: 80 men and 24 women (age average: 22,2 years old) in the subject *Artistic and Gymnastic Skills* of first of the Grade in Science of Physical Activity and Sport of the University of Alicante (Spain), in the academic course 2015-2016. The students were informed about the purpose of the study and that it was carried out according to the Helsinki declaration.

The instruments designed and used for this work were:

- Observation template of the gymnastic skills.
- Video camera and smart phone.
- Closed questionnaire with five questions about the student's perception of the usefulness of different evaluation tools for their teaching and learning process: effectiveness of the recorded initial self-assessment, error detection through recording, utility for the correction of own errors and other's errors through the recording, utility for personal progress using recording, adequacy of self-assessment and peer evaluation strategies.
- Open question: What would you highlight from the use of self-assessment and peer evaluation strategies through recordings and which difficulties have you encountered in the process?

The research is divided into two main phases: the first part corresponds to the design of the observation templates for self-assessment and the peer evaluation of four gymnastic techniques. The second phase has consisted of using and evaluating the template of observation of gymnastic abilities by the group of students enrolled in the subject of *Artistic and Gymnastic Skills*.

The practice group performs an initial self-assessment of the technical execution of four gymnastic skills: forward roll, backward roll, cartwheel and handstands. The gymnastics skill was recorded with the camera of the students' smart phones and then self-assessed by the students. It is then recorded in an observation template (offered by the university teacher), to verify if the different technical phases of these skills are met. Subsequently, in groups of four students, they carried out a peer evaluation.

After completing this initial process, the contents of the subject are implemented for two and a half months. The group can use the recordings and the observation sheets as teaching tools to know, at all times, the evolution of their teaching and learning. After the training period, the students perform a self-assessment and final evaluation of the skills learned, using the same registration form and recording as tools to analyse their learning progress. Finally, they were given the questionnaire about their perception of the usefulness of technological tools in their self-assessments and peer evaluations and how it impacted on the learning process of the proposed skills. On the other hand, the students made a critical reflection on the method used, indicating under their perspective the strengths and weaknesses of the whole process.

For the analysis of the data of the questionnaire a contingency table was used through the office software Microsoft Excel for MAC (© 2015 Microsoft, Version 15.32) and the data collected from the open question was analysed by three teachers of the *Area of Body Expression*, compiling the most relevant narratives of the participants. The Analysis of Qualitative Data (AQUAD 6), computer software developed by Huber (2004), was used to process the information. This computer programme has allowed us to organise and categorize the data in codes so that we could finally determine the point of view of participants.

RESULTS

The results are then grouped into three main blocks. The first findings show the design of the observation templates where the different technical phases of each of the developed acrobatics are broken down. Secondly, the results of the questionnaire are presented and finally the students' perceptions and reflections of the process carried out are reflected.

1. Result of design observation template

The template designed in order to evaluate the four gymnastic abilities based in Vernetta, López and Panadero (2000), Estapé (2002) and Karácsony and Čuk (2005) are divided in three technical phases (initial phase, main phase and final phase):

Forward roll
Evaluation criteria
Initial position
Stand outstretched arms
Main phase
Center of gravity moves forward
Hands on the floor at shoulder width
Flexion of the head and cervical-dorsal support
Back curved, legs grouped
Final phase
Buttocks heels
Finish standing without hand support

Backward roll
Evaluation criteria
Initial phase
Standing back to the mat
Main phase
Squatting, arms to the front
Center of gravity back, sitting action
Turn completely with curved back
Support of hands next to the ear
Final phase
The feet look for the ground, not receptive with the knees

Cartwheel
Evaluation criteria
Initial phase
Stand outstretched arms
Main phase
Broad forward step
Elevation of the back leg
Alternative hand support
Legs open and straight upright
Final phase
Alternative foot supports
Finish standing up and arms up

Handstand
Evaluation criteria
Initial phase
Stand outstretched arms
Main phase
Support of hands far from the front foot
Hands resting on shoulder width
Angle arms-trunk-open
Line arms-trunk-legs straight
Keep the vertical 2" without aid
Final phase
Reception of alternative legs

2. Questionnaire result about the use of the observation templates

97 students (93.3%) state that they have been able to detect their technical failures and 7 students (6.7%) say that they have not been effective at it. 81 students (77.9%) affirm that, the strategies of the self-assessment and the peer evaluation along with the recordings and the use of the registration and observation templates are of great use for the individual improvement of the acrobatics. On the contrary, 23 students (22.1%) have a less satisfactory view.

To conclude, 94 students (90.4%) perceived that, the evaluation strategies used are adequate as learning tools for the gymnastic skills developed in the subject of *Artistic and Gymnastic Skills*, while 10 students (9.6%) have a contrary view. The results can be seen in Table 1.

Table 1.
Perception of the student of the usefulness of the evaluation tools for their learning.

	Men		Women		TOTAL	
Questions	YES N (%)	NO N (%)	YES N (%)	NO N (%)	YES N (%)	NO N (%)
Self-assessment and peer evaluation to identify mistakes.	74(92.5%)	6(7.5%)	23(95.8%)	1(4.2%)	97(93.3%)	7(6.7%)
Self-assessment and peer evaluation for the individual improvement.	58(72.5%)	22(27.5%)	23(95.8%)	1(4.2%)	81(77.9%)	23(22.1%)
Self-assessment and peer evaluation adequate as learning strategies.	70(87.5%)	10(12.5%)	24(100%)	0(0%)	94(90.4%)	10(9.6%)

3. Results of open question

Concerning the analysis of the open question on what would you highlight about the use of self-assessment strategies and peer evaluation through recordings and which difficulties have you encountered in the process? The following observations are reflected:

The initial self-assessment carried out through their own recordings gave them a perception of difficulty towards the subject:

After the initial self-assessment, I thought that it would be impossible to achieve all the gymnastic elements (Student03).

The information given by the teacher, together with the observation templates and the recordings for the analysis of their learning, allowed them to progress successfully and to identify the main errors in technical performances:

Little by little with class practices, the use of smart phone to see the mistakes made and the contributions of classmates in analysing our executions have helped us to move forward. In addition, I think I have made progress in this matter with the invested effort (Student15).

I felt admiration for my personal progress while watching the videos (Student02).

The peer evaluation strategy has developed aspects related to group cohesion, fellowship and trust in others in these students:

The reward has been greater sight through the eyes of my companions. I have seen the progress in the others thanks to my indications and my evolution, and thanks to the corrections that my companions made to me (Student21).

We worked in class and also in our free time with our classmates to evaluate and correct our mistakes. I think that thanks to this I have succeeded in advancing at this subject (Student35).

As for the difficulties encountered in the process by the students, in their reflections there were no problems to highlight, but there are some allusions made to the difficulty in reserving sport- spaces outside the class schedule in order to reinforce and practice stunts:

We had a lot of problems when it came to using the tatami, it was always full and we had to stay all day at the university (Student11).

DISCUSSION AND CONCLUSIONS

This study, which was put into practice in the second semester of the academic year 2015-2016 and which was used in the subject *Artistic and Gymnastic Skills*, has aimed to determine the effectiveness of self-assessment and peer evaluation, in teaching-

learning gymnastic skills. The findings of the students' perception of whether the self-assessment and the peer evaluation with digital support are effective and facilitate the correction of errors in the technical execution of the four proposed acrobatics indicate that all students have a positive vision regarding this. On the other hand, the presented results, which refer to whether, the strategies used to learn the gymnastic skills, have allowed identifying their own mistakes thanks to the recordings and their subsequent analysis. Likewise, the students' critical reflections on the different assessment strategies and tools used during their formative process have also been reflected. Considering that the evaluation offers relevant information on the different aspects of the educational process (Blanco, Sánchez, Rodríguez, & López-Guzmán, 2006; Gessa, 2011) this should be carried out in a continuous and permanent way to make possible modifications or necessary changes in student learning.

As Zubiaur (1998) states, learners should know the execution techniques as well as its results (evaluation), in the motor learning. In this sense and as the author defends, there are few researches which refere themselves to the knowledge of the execution process of motor-gesture-learning (feedback), despite this is a more relevant aspect than the knowledge on the final results of the action.

The strategies of self-assessment and peer evaluation involve the students in their formation, turning them into protagonists of this and generators of their own feedback, aspects that allow them to assimilate and understand knowledge (Vernetta, López, & Delgado, 2009). Our results reinforce these claims, since almost all the participants have considered that the self-assessment and the peer evaluation, through the recordings, have helped them to detect and correct their errors in the learning of gymnastic skills. As for the perception of personal progress, the students mostly concluded that this type of tools facilitated the improvement and evolution in the technique of execution. Bandura (1986) pointed out self-observation, self-assessment and self-reactions as a key for the learning process. In our research the process we have carried out respects the observing, evaluating and reacting phases, facing the learning of a work involving the student in an active way from the cognitive and motivational aspect (Zimmerman, 2013) and therefore it has been successful inside the process which has been carried out. In this sense, the multitude of technological applications that smart phones offer today, so within the reach of our students, could favour a greater assimilation of knowledge and learning (Azevedo, Guthrie, & Seibert, 2004). Likewise, the participants report improvements in aspects related to their training in values such as overcoming, self-esteem and effort, as well as other studies (Cuesta & Zamora, 2016; Vernetta, López, & Robles, 2009).

To sum up, this research is designed to verify if observation, audio-visual media, self-assessment and peer evaluation are adequate strategies to contribute to a more effective, more conscious and more self-regulated learning and control of information to work. This work has been beneficial in the process carried out. The thoughts and experiences of the students can bring us closer to improving our methodological approaches in the teaching of gymnastic contents.

To conclude:

The students' perception of the self-evaluation and the peer evaluation with digital support is effective, as well as shown in some other studies as it facilitates the correction of errors of the gymnastic abilities.

Our future intention is to implement self-assessment and peer evaluation of all students in other subjects with the aim of forming more autonomous and responsible students for their own learning.

ACKNOWLEDGEMENTS

We would like to express our gratitude to all the students who voluntarily participated in the study by sharing their

experiences. Their participation was an object of reflection that has allowed us to expand the knowledge about students and their needs in order to improve physical education pre-service teacher training.

REFERENCES

Azevedo, R., Guthrie, J. T., & Seibert, D. (2004). The role of self-regulated learning in fostering students. Conceptual understanding of complex systems with hypermedia. *Journal of Educational Computing Research*, *30*(1), 87-111.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology*, *4*(3), 359-373.

Bergmann, J., & Sams, A. (2014). *Dale la vuelta a tu clase*. Madrid: Ediciones SM.

Blanco, O., Sánchez, S., Rodríguez, M. L., & López-Guzmán, T. (2006). La evaluación del aprendizaje del alumnado universitario. *Congreso Internacional de Educación y Sociedad.* La educación: Retos del siglo XXI, Granada,

Cuesta, M., & Zamora, R. (2016). La evaluación pedagógica en el proceso docente educativo. *Santiago*, *139*(1), 153-163.

Dyson, B., Griffin, L., & Hastie, P. (2004). Sport Education, Tactical Games, and Cooperative Learning: Theoretical and Pedagogical Considerations. *Quest*, *56*, 226-240.

Estapé, E. (2002). *La acrobacia en gimnasia artística: su técnica y didáctica*. Barcelona: INDE.

Fernández-Río, J. (2006). *Estructuras de trabajo cooperativas, aprendizaje a través de claves y pensamiento crítico en la enseñanza de los deportes en el ámbito educativo*. Actas del V Congreso Internacional de Actividades Físicas Cooperativas. Oleiros, A Coruña.

Fraile, A. (2006). Cambios en el aula universitaria ante los nuevos retos europeos. *Tándem, Didáctica de la Educación Física*, 20, 57-72.

Gessa, A. (2011). La coevaluación como metodología complementaria de la evaluación del aprendizaje. Análisis y reflexión en las aulas universitarias. *Revista de Educación*, *354*, 749-764.

Grineski, S. (1996). *Cooperative learning in physical education.* Champaign II, Human Kinetics.

Hargreaves, H. (2005). Personalising learning. iNet, UK, Retrieved from, http://www.sstinet.net/resources/publications/personalisinglearningseries.aspx

Hernández, S. (2008). El modelo constructivista con las nuevas tecnologías: aplicado en el proceso de aprendizaje. *Revista de Universidad y Sociedad del Conocimiento*, *5*(2), 26-35.

Hernández, J. L., Velázquez, R., Alonso, D., & Castejón, F. J. (2004). *La evaluación de la Educación Física. Investigación y práctica en el ámbito escolar.* Barcelona: Garó.

Huber, G. L. (2004). *AQUAD 6. Programme manual qualitative data analysis.* Tübingen: Ingeborg Huber Verlag.

Karácsony, I., & Čuk, I. (2005). *Floor exercises. Methods, ideas, curiosities, history.* Slovenia: ŠTD Sangvinčki.

Krizaj, D., & Čuk, I. (2015). Can miniature accelerometers attached to the gymnastics springboard be used for take-off analysis? *Science of Gymnastics Journal*, *7*(3), 69-79.

López, V. M., Barba, J. J., Monjas, R., Manrique, J. C., Heras, C., González, M., & Gómez, J. M. (2007). Trece años de evaluación compartida en Educación Física. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*, *7*(26), 69-86.

Marinsek, M., & Slana, U. (2014). Smart phone as a standing balance assessment device. *Science of Gymnastics Journal, 6*(3), 39-47.

Moffett, J., & Mill, A. C. (2014). Evaluation of the flipped classroom approach in a veterinary professional skills course. *Advances in Medical Education and Practice, 5*, 415-425.

Mosston, M., & Ashworth, S. (1993). *La enseñanza de la Educación Física. La reforma de los Estilos de Enseñanza*. Barcelona: Hispano Europea.

Prat, Q., Camerino, O., & Coiduras, J. L. (2013). Introducción de las TIC en educación física. Estudio descriptivo sobre la situación actual. *Apunts. Educación Física y Deportes, 113*, 37-44.

Slavin, R. (1990). *Cooperative learning: theory research and practice.* New York: Plenum.

Vernetta, M., Gutiérrez, A., López, J., & Ariza, L. (2013). El aprendizaje cooperativo en educación superior. Una experiencia en la adquisición de habilidades gimnásticas. *Cultura y Educación: Culture and Education*, *25*(1), 3-16.

Vernetta, M., López, J., & Delgado, M. A. (2009). La coevaluación en el aprendizaje de las habilidades gimnásticas en el ámbito del espacio europeo universitario. *European Journal of Human Movement*, *23*, 123-141.

Vernetta, M., López, J., & Panadero, F. (2000). *Aprendizaje de las habilidades gimnásticas. Una propuesta a través de minicircuitos. Unidades didácticas para Secundaria XI*. Barcelona: INDE.

Vernetta, M., López, J., & Robles, A. (2009). Evaluación compartida con fichas de observación durante el proceso de aprendizaje de las habilidades gimnásticas. Un estudio experimental. *Revista Iberoamericana de Educación, 50*(2), 1-14.

Wilson, J. (1997). Self-regulated learners and distance education theory. Retrieved from http://www.usask.ca/education/coursework/802papers /wilson/wilson.html

Zimmerman, B. J. (2013). From cognitive modeling to self-regulation: a social cognitive career path. *Educational Psychologist*, *48*(3), 135-147.

Zubiaur, M. (1998). El conocimiento de la ejecución. *European Journal of Human Movement*, *4*, 97-111.

Corresponding author:

María Alejandra Ávalos
Area of Physical Activity and Sport Science
University of Alicante
Carretera de San Vicente del Raspeig, s/n, 03690 Alicante
Spain.
phone number: 965903400
email: sandra.avalos@ua.es

GENDER DIFFERENCES IN CONSECUTIVE PARTICIPATION IN ARTISTIC GYMNASTICS AT THE OLYMPIC GAMES FROM 1996 TO 2016

Sunčica Delaš Kalinski[1], Almir Atiković[2], Igor Jelaska[1]

[1] Faculty of Kinesiology, University of Split, Split, Croatia
[2] Faculty of Physical Education and Sport, University of Tuzla, Tuzla, Bosnia and Herzegovina

Original article

Abstract

The main goal of a gymnast's career is participation in the Olympic Games (OG) at least once. Survey results determined a significant difference between genders in the number of gymnasts who competed in only one OG (277 males and 408 females); also, between those who consecutively participated in two OG (104 males and 70 females), three OG (28 males and 11 females), and four OG (six males and zero females). There were no gender differences found in the number of those who consecutively participated in five OG (one male and one female) and six OG (zero males and one female). For both genders, for consecutive participants of three and more OG longevity of high-quality performance, seen through their rank in different finals, was presented showing how it is not endangered with their above average age. The obtained results should be the encouragement for the coaches to plan quality training for more than one Olympic cycle during which the constant increase in the quality of the performance, for both genders, can and should be expected.

Keywords: *average age, gymnasts, male female.*

INTRODUCTION

Participation in the Olympic Games (OG) is the most common dream of a majority of gymnasts of both genders, particularly because a large number of dropout factors that have been present since the sport's beginnings. While participation in the OG is considered a significant achievement, consecutive participation has been consider to be even a greater one.

The competition events of male and female artistic gymnastics are reportedly designed to emphasize the gender's natural qualities, such as the flexibility and gracefulness in female gymnasts (Kinnick, 1998) and the endurance and strength in male gymnasts. The different genders thus work to express these different qualities, whereas female gymnasts focus on exercises that develop their legs and the ability to flip and twist, while male gymnasts focus on the development of extreme strength and power in the upper body.

In order to succeed in gymnastics, children of both genders need to have sports talent, show dedication and persistence in

training, regardless of the size and severity of factors that influence their career.

There is no single definition for a sports talent**.** Generally**,** the term talent refers to an aptitude or a special gift of an above-average ability in a certain area. In sports, a talent generally refers to above-average abilities in the area of motor actions, and to the person possessing these abilities (Haag & Haag, 2003). However, a talent does not largely explain performance differences among people, and it does not lead to improvements in performance or to the attainment of expertise; high-quality practice - deliberate practice - does it (Ericsson, 2007, 2008; Ericsson, Krampe, & Teschromer, 1993).

The same factors have a different impact on male and female gymnasts. The following results and conclusions (of previous studies) show a complexity of male and female gymnasts career path, and consequently the "amount" of achievement of a single and (even more) of a consecutive participation at the OG.

Genders, in artistic gymnastics, differ in duration and the amount of deliberate practice spent on the path of achieving highest levels. Arkaev and Suchilin (2004) and Martindale, Collins, and Abraham (2007) state that it takes at least 8-10 years to reach top artistic gymnastics ability in girls and 10-12 years in boys. Malina et al. (2013) analyzed training loads and sequencing of training activities used in the past 30-40 years, during the period of reaching top levels, and concluded how they were highly variable among individuals. Furthermore, the authors indicated that training variability and lack of information related to gymnastics performance limited comparisons and conclusions about the necessary amount of deliberate practice required for attaining superior levels of performance in artistic gymnastics.

Gender training variability partly arises from different initial hormonal status, a timing of maturation and changes associated with achieving maturity. Namely, although gymnasts of both sexes typically have short statures, later maturation, and a slower rate of growth than the normal population (Malina, 2014), maturation experience is very different. Both genders gymnasts delayed puberty is probably: 1) a result of long hours of training (Georgopoulos et al., 2002; Caine, Bass, and Daly, 2003; Theodoropoulou et al., 2005) and 2) a result of selecting short, normal, late-maturing individuals for participation in gymnastics (Malina et al., 2013). Female gymnasts, even as children, have enough estrogen and ability to develop muscles, and their training from the beginning mostly consists of learning all required skills. In puberty, all female gymnasts achieve peak height velocity (PHV), regardless of their chronological age. The year before, during and the year after PHV, linear growth is rapid and can be as much as three inches at once (Malina & Bouchard, 1991). Rapid growth, together with increased levels of additional hormones, potentially affect female gymnasts in several ways: 1) rapid changes that occur in body structure can make consistent performance of even basic gymnastic elements difficult; in particular expansion of the hips that influence on the lowering of the centre of gravity; 2) body size increase may contrast with the ideal body type in women's artistic gymnastics (WAG): feminine, youthful, cute, and superhuman power in tiny 'pixie-like' bodies (Barker-Ruchti, 2009; Cohen, 2013; Ryan, 1995; Weber & Barker-Ruchti, 2012). For female gymnasts, main increase in strength occurs during a few months following or even just before PHV (Blimke, Roache, Hay, & Bar-Or, 1988). Between 12 and 15 years of age, muscle strength in a female gymnast only reaches 60% of the adult strength (Portmann, 1993).

Puberty affects male gymnasts in several ways that are different from female gymnasts. During pubertal stage male gymnasts also experience PHV. However, peak velocity for leg length occurs earlier than PHV while peak velocity for sitting height or trunk length, skeleton breadths and circumferences of the trunk, and upper extremities occurs after PHV. The capacity for strength increases rapidly with male

gymnasts' sexual maturation (Portmann, 1993), but it is also dependent on the time of PHV. In general, 70% of boys reach peak strength development velocity between 0.5-1.5 years after PHV (Malina & Bouchard, 1991). In the arm muscle, peak velocity occurs about 3 to 4 months after PHV. Accordingly, intensive, rigorous training male gymnasts typically experience during maturation growth spurts (not before 14 or 15) when boys experience increased testosterone levels and significant gains in muscle mass and muscular strength (Malina, Bouchard, & Bar-Or, 2004).

Compared to female gymnasts, later intensive training of male gymnasts effects later participation at competitions, giving to male gymnasts more time to prepare for competition with advanced levels of training. As a result, there is a general assumption that male gymnasts' careers last longer than female gymnasts' careers. Generally, once adolescent boys begin puberty, their testosterone production increases and is markedly higher than in girls; boys will quickly become more muscular and stronger (Borms, 1986). However, independently from differences in growth and increase in strength, in puberty fluctuating skill characteristics and "weak" performances can be expected for both genders.

In post pubertal stage males gymnasts growth continue (on the average 8 more years) while females gymnasts growth may continue after PHV. In this stage both genders reach maturity. Following puberty, strength continues to increase, right into the third decade of life (Dworetzky, 1990; Malina & Bouchard, 1991). In post pubertal stage modern mature female gymnasts look older, more muscular, and potentially larger (Kerr, Barker-Ruchti, Schubring, Cervin, & Nunomura, 2015) and it is in contrast with the WAG preference of young and small gymnasts. Very often pressure to have 'pixie-like' bodies put female gymnasts at risk for eating disorders (Kerr, Berman, & De Souza, 2006).

Another factor that significantly influences both genders training is the Code of Points (CoP): a collection of rules and requirements produced by the Fédération Internationale de Gymnastique (FIG) for Women Artistic Gymnastics (WAG) and Men Artistic Gymnastics (MAG); updated every four years following the OG. For both genders, the CoP requirements change two to three times during the period of initial training to Olympic level training. Its changing require making decisions on what gymnasts should be learning at a given time and how they should learn it in order to be successful after 6–8 years of training when it is time to compete (Donti, Donti, & Theodorakou, 2014).

In the period analyzed in this study, both genders experienced: 1) exclusion of the compulsory routines from the official competitions after 1996 OG; 2) exercising under "new" scoring system (FIG, 2006); 3) execution and appearing of new elements of E-value difficulty category (WAG CoP 1997-2000); F-value difficulty category (MAG CoP 1997-2000; WAG CoP 2001-2004); G-value difficulty category (WAG CoP 2005-2008; MAG CoP 2009-2012); H-value difficulty category (WAG CoP 2013-2016); 4) the prohibition of the repetition of an element (Donti et al., 2014; Kunčić, 2014).

Change in CoP, that probably have influenced male and female gymnasts' careers is a change of minimum senior competition age (chronological age needed for participation in senior competitions sanctioned by the FIG). This change: 1) was initiated by concerns from medical researchers who determined that intensive training at young ages was causing a range of physical and psychological problems for WAG gymnasts (FIMS/WHO, 1998); 2) was based on the results of some studies which have determined that, due to intensive training at young age, female gymnasts experience stunted growth, bone deformity, and a delayed onset of menarche (Cassas & Cassettari-Wayhs, 2006; Caine, Lewis, O'Connor, Howe, & Bass, 2001; Daly, Bass, & Finch, 2001; Dresler, 1997; Lindholm, Hagenfeldt, & Hagman, 1995; Tofler, Stryer, Micheli, & Herman, 1996);

3) was based on declined mean ages, heights, and weights of world class female artistic gymnasts declined from the mid-1960s through the 1980s (Barker-Ruchti, 2009; Claessens, Lefevre, Beunen, & Malina, 2006; Kerr et al., 2006; Malina, 1994; Ryan, 1995); 4) was made with the aim to protect the musculoskeletal development of young competitors, to lengthen their careers, to prevent burnout, to help reduce injuries, and to redirect the image of the sport positively for the public, spectators, and media (Eagleman, Rodenberg, & Lee, 2014). Although the change was mostly based on the results determined on female gymnasts, during the last three decades the FIG gradually increased minimum age requirements for both genders in artistic gymnastics. Prior to 1981, the minimum required age was 14 (gymnasts had to turn 14 by the start of the OG to be eligible). In 1981, the minimum required age was increased to 15 years of age (gymnasts had to turn 15 in the calendar year in order to compete in senior-level events). In 1997, the minimum required age changed again. Both female and male gymnasts older than 16 could participate in World Championships. However, female gymnasts who turned 16 and male gymnasts who turned 18 in the current year could participate in the OG but only as members of national teams.

Factor or a fact that is unavoidable and plays a role in the artistic gymnastics in both genders represents an extreme selection (Pion, Lenoir, Vandorpe, & Segers, 2015). In the USA, among 9 and 10 level gymnasts, only 79 out of 4.932 women (1.6%) and 136 out of 1.418 men (9.6%) were categorized as elites (USA Gymnastics, 2009). Crane and Temple (2015) analyzed through systematical review factors associated with dropout from organized sports among children and adolescents and identified five major reasons: lack of enjoyment, perceptions of competence, social pressures, competing priorities, and physical factors (maturation and injuries). Claessens and Lefevre (1998), on a sample of young competitive female gymnasts (10.5 years±2.6 years), determined that 'surviving' female competitive gymnasts were smaller with a lower body weight, a lower value of subcutaneous fat, narrower hips, and broader shoulders than their counterparts. The decision to end a career might be the outcome of severe physical and mental exhaustion in older gymnasts (18-22 years), resulting from heavy training at an early age (Koukouris, 2005). However, the available literature does not allow conclusions on the question whether individuals drop out by their choice or are selectively excluded.

Based on all aforementioned factors, for which authors presuppose that have the highest influence on the career of gymnasts (and all those factors that probably also exist but have not been discussed), posted problem of the study is Olympic gymnastics career of both genders: the beginning, duration and quality (seen through the rank of multiple consecutive participants in the OG). Thereat, we will not analyze characteristics of the Olympic path and the reasons for gymnasts' longevity; we will analyze only differences which arise from influence of different factors on male and female gymnasts' career. Accordingly, the specific study objectives are: 1) for each gender of non-consecutive and consecutive Olympians to determine age at each analyzed OG and differences in age within analyzed OG; also to determine differences in age between genders; 2) for each gender and between genders to determine differences in the overall number of OG participations; 3) for each gender and between genders to determine differences in the number of consecutive participants from one to another OG in the period from 1996 to 2016.

METHODS

The sample included participations of all elite senior male gymnasts (*N*=598) and female gymnasts (*N*=592) at the Competition 1 – Qualifications (C-I) in the OG held in 1996, 2000, 2004, 2008, 2012,

and 2016. However, due to the male and female gymnasts who had consecutive participation in the OG, the total sample number was lower: in total 416 male gymnasts and 491 female gymnasts have participated in the mentioned competitions. Consecutive participants of both genders were analyzed as subgroups of the total sample.

Gymnasts age was calculated from competitor's date of birth and date of C-I competitions at the certain OG using MS Excel function *YEAR*.

The variable sample is represented by an average age (AA) of all non-consecutive male and female Olympian gymnasts and all consecutive male and female Olympian gymnasts who competed in C-I competitions in the OG held in 1996, 2000, 2004, 2008, 2012, and 2016. Data was gathered from the official Olympic Games web site: https://www.olympic.org/gymnastics-artistic.

For all male and female Olympians, a total number of participations in the OG was determined. Rank of three and more consecutive male and female gymnasts Olympians was also recorded and presented with the aim of highlighting longevity of their quality.

Data analysis of AA included calculations of Means±Standard Deviations. Data were checked for univariate outliers, and normality of variables was confirmed using the Kolmogorov-Smirnov test. Two significant factors were identified: *gender* (male and female) and *OG Year* (1996, 2000, 2004, 2008, 2012, and 2016); and two-way 2×6 ANOVA analysis was performed. The significance of specific differences between the main factors and possible interaction effects were examined using the Fisher least significant difference (LSD) post hoc test. The partial eta squared (partial η^2) coefficient was used for effect size assessment. Groups of Olympians were compared according to their total number of participations at the OG, by using Fisher test for the significance of the difference between two independent proportions. The frequencies of all repeated gymnasts Olympians were determined for each analyzed OG. Results were considered significant if $p<.05$. All data analysis was performed using Statistica 13.0 software (Dell Inc., Tulsa, OK, USA).

RESULTS

The AA of all non-consecutive male Olympian gymnasts (n=277) who competed in the OG from 1996 to 2016 was from 23.78 years to 25.21 years (minimum=17.26 years; maximum=33.34 years), and the AA of all non-consecutive female Olympian gymnasts (n=408) was from 17.35 years to 20.94 years (minimum=14.35 years; maximum=39.38 years).

Data analysis revealed how at the 1996 OG no male gymnast with the minimum allowed age was determined; the youngest two male gymnasts aged from 17 to 18 years. Male gymnasts with the minimum allowed age were determined at the 2000 OG (n=5) and at the 2004 OG (n=2) while on all other analyzed OG the youngest male gymnasts were between 18 and 19 years old (at the 2008 OG: n=2; at the 2012 OG: n=4; at the 2016 OG: n=2). When from one OG all male gymnasts under the age of 19 were added, the following percentages of the youngest male gymnast on the OG have been obtained: at the 1996 OG=5%, at the 2000 OG=12%, at the 2004 OG=9%, at the 2008 OG=2%, at the 2012 OG=4%, at the 2016 OG=1%. There were no significant differences between percentages of the youngest male gymnasts from 1996 OG and 2016 OG (p= .07).

Female gymnasts with the minimum allowed age have been determined on all analyzed OG: at the 1996 OG seven gymnasts were between 14 and 15 years old (valid minimum age rule for that OG was turning 15 years in the Olympic year). At all other analyzed OG minimum age requirement was 16 years in the OG year, and the following number of the youngest female gymnasts have been determined: at the 2000 OG ten gymnast were under 16 years old (investigation of the FIG

determined that female gymnast Dong Fangxiao at those OG was 14.66 years old); at the 2004 OG 11 gymnasts were 15 to 16 years old; at the 2008 OG nine gymnasts were 15 to 16 years old; at the 2012 OG four gymnasts were 15 to 16 years old; at the 2016 OG two gymnasts were 15 to 16 years old. When, from one OG, all female gymnasts under the age of 16 were added, the following percentages of the youngest female gymnasts on the OG have been obtained: at the 1996 OG=28%, at the 2000 OG=10%, at the 2004 OG=11%, at the 2008 OG=9%, at the 2012 OG=4%, at the 2016 OG=2%. Significant differences have been determined between percentages of the youngest female gymnasts from 1996 OG and 2016 OG ($p < .001$).

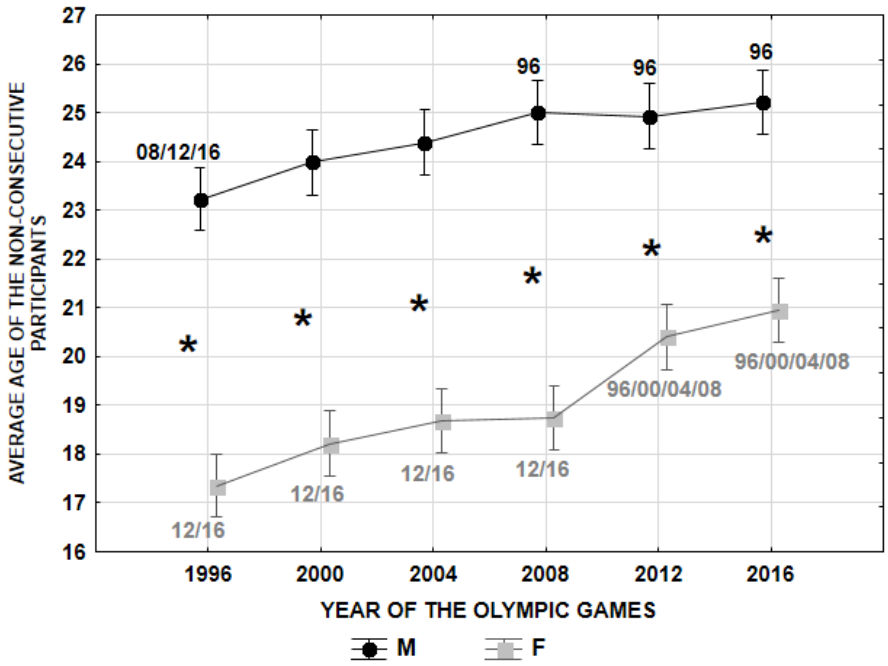


Figure 1. Average age of all male and female gymnasts (non-consecutive participants) in the OG from 1996 to 2016.

Legend. Data are presented as means ± standard deviations, M - male gymnasts, F - female gymnasts, *- significant differences between variables of average age of male and female gymnasts at certain OG, 96 - significantly different from the average age determined at OG1996, 00 - significantly different from the average age determined at OG2000, 04 - significantly different from the average age determined at OG2004, 08 - significantly different from the average age determined at OG2008, 12 - significantly different from the average age determined at OG2012, 16 - significantly different from the average age determined at OG2016.

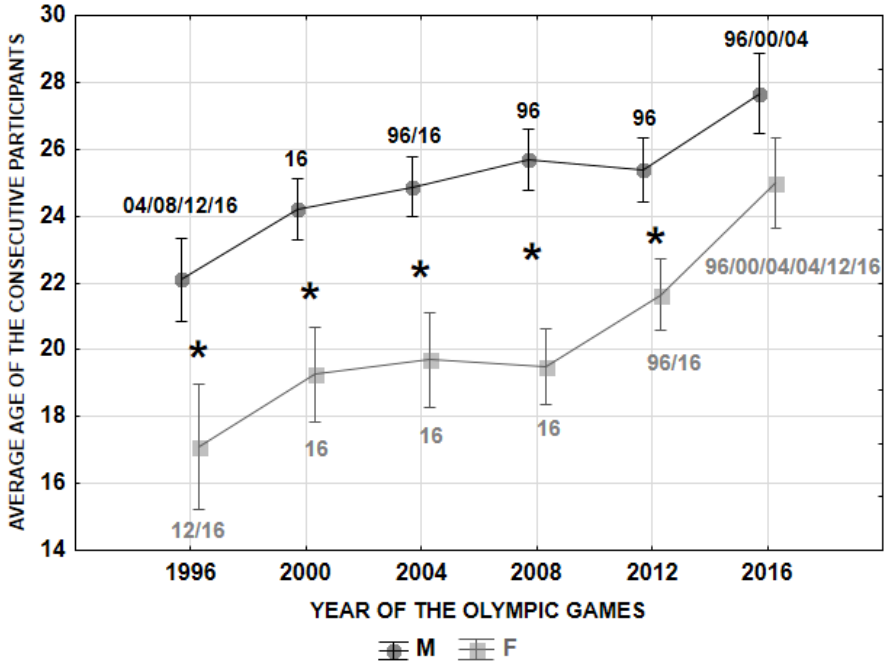


*Figure 2***.** Average age of male and female gymnasts who were consecutive participants in the OG from 1996 to 2016.

Legend. Data are presented as means ± standard deviations, M - male gymnasts, F - female gymnasts,*- significant differences between variables of average age of male and female gymnasts at certain OG, 96 - significantly different from the average age determined at OG1996, 00 - significantly different from the average age determined at OG2000, 04 - significantly different from the average age determined at OG2004, 08 - significantly different from the average age determined at OG2008, 12 - significantly different from the average age determined at OG2012, 16 - significantly different from the average age determined at OG2016.

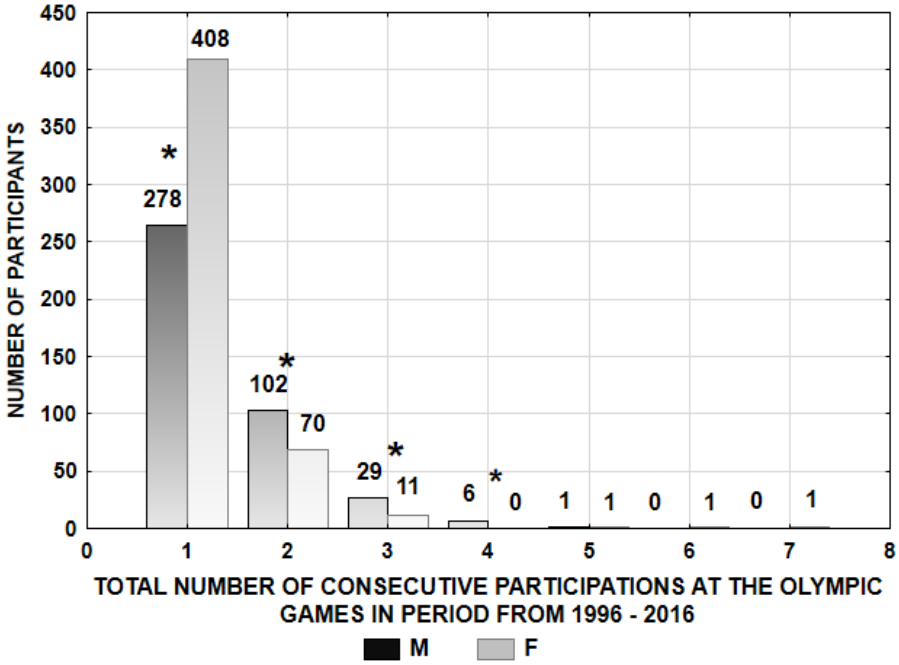


Figure 3. Overall number of participations in the OGs and differences by gender.

Legend. Data are presented as the number of competitors who participated in certain numbers of OG, M - male gymnasts, F - female gymnasts, *- significant differences between male and female gymnasts in the total number of participations in the OG.

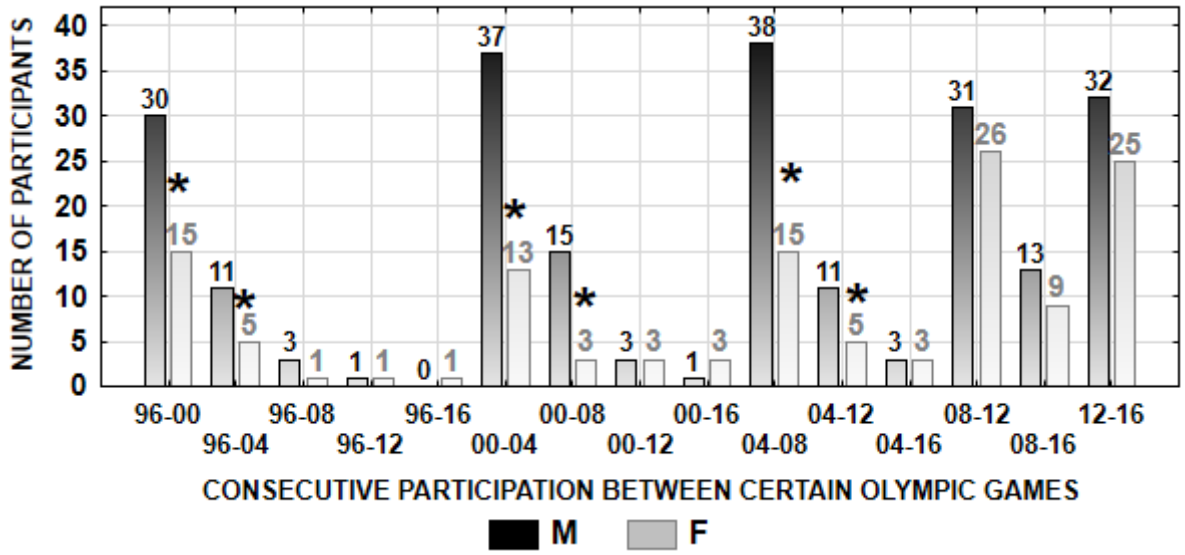


Figure 4. Number of male and female gymnasts who consecutively participated in two or more OG from 1996 to 2016.

Legend. Data are presented as the number of competitors who participated at certain numbers of OG; M - male gymnasts, F - female gymnasts;* - significant differences found between male and female gymnasts in the total number of OG participation using Fisher test for the significance of the difference between two independent proportions.

During the analyzed period the difference in the AA within male Olympian gymnasts was 2.00 years and within female Olympian gymnasts 3.58 years. A significant difference in the AA of all non-consecutive male Olympian gymnasts was determined between participants in the 1996 OG (AA=23.22 years) and participants in the 2008 OG (AA=25.00 years), 2012 OG (AA=24.92 years), and 2016 OG (AA=25.22 years). A significant difference in the AA of all non-consecutive female Olympian gymnasts was determined between participants in 1996, 2000, 2004, and 2008 OG and participants from the 2012 OG and 2016 OG.

Significant differences in AA between all non-consecutive male and female Olympian gymnasts were determined on all analyzed OG held from 1996 to 2016. Regarding the chronological age of all non-consecutive Olympians, all main factor effects and their interactions were found to be significant: *gender* ($F_{1,1164}$=774.47; p< .01; partial η^2=.40); *OG year* ($F_{5,1164}$=18.72; p< .01; partial η^2=.07); *OG year* × *gender* ($F_{5,1164}$=2.84; p= .01; partial η^2=.01).

The AA of consecutive Olympian gymnasts who participated in the OG from 1996 to 2016 ranged from 22.10 years to 27.65 years for males (minimum=16.84 years; maximum=39.47 years) and ranged from 17.10 years to 24.99 years for females (minimum=15.28 years; maximum=41.16 years). Significant differences between consecutive male and female Olympian gymnasts were not found only in the 2016 OG.

Regarding the AA of repeated Olympians, all main factor effects, and their interactions were found to be significant: *gender* ($F_{1,477}$=161.11; *p*< .01; partial η^2=.25); *OG year* ($F_{5,477}$=19.97; *p*< .01; partial η^2=.17); *OG year*×*gender* ($F_{5,477}$=2.21; *p*= .05; partial η^2=.02).

The AA of consecutive participants of both genders was higher than the AA of non-consecutive Olympian gymnasts, but it didn't have an influence on the quality and the longevity of their competitive gymnastics. Exactly the opposite: their

performances were highlighted at the OG they have participated (what will be presented for each gender within the results about the total number of participations of consecutive participants at the OG).

Of the total number of male gymnasts participations in the OG from 1996 to 2016 (*N*=598), 46% (*n*=277) participated in only one OG, 17% (*n*=104) participated in two OG, 5% (*n*=28) participated in three OG, 1% (*n*=6) participated in four OG, 0.17% (*n*=1) participated in five OG, and 0% (*n*=0) participated in six OG.

With the aim to emphasize the quality of the consecutive participants, achievements of male gymnasts who participated three and more times in the OG will be presented.

Of the 28 male gymnasts who were triple participants in the OG, 20 competed in different final competitions and 15 of them won medals in different Apparatus Finals (Kyle Shewfelt, Li Xiaopeng, Louise Smith, Kohei Uchimura, Gervasio Deferre, Alexei Nemov, Yang Wei, Marius Daniel Urzica, Marcel Nguyen, Diego Hypolito, Filip Ude, Epke Zonderland, Matteo Morandi, Valeriy Goncharov, and Igor Cassina). Three of those 15 gymnasts, at different OG, also won a total of seven medals in the most demanding finals, the All-Around Finals: Kohei Uchimura won silver at the age of 19.63 years (2008 OG), won gold at the age of 23.60 years (2012 OG), and won gold at the age of 27.63 years (2016 OG); Alexei Nemov won silver at the age of 20.09 years (1996 OG) and won gold at the age of 24.33 years (2000 OG); Yanda Wei won silver at the age of 20.63 years (2000 OG) and won gold at the age of 28.54 years (2008 OG). The five triple participants in the OG took a part in different final competitions but did not win medals.

Of six male gymnasts that participated in four consecutive OG (Alberto Busnari, Marian Dragulescu, llia Giorgadze, Fabian Hambuechen, Yann Cucherat, and Vlasios Maras), three of them (Busnari, Hambuechen, and Dragulescu) competed in the All-Around Finals but were not medalists. Two participants won a total of five medals in different Apparatus Finals (Fabian Hambuechen won bronze on the high bar in the 2008 OG, silver on the high bar in the 2012 OG, and gold on the high bar in the 2016 OG; and Marian Dragulescu won silver on the floor and vault in the 2004 OG).

In the analyzed period, only one male competitor, Iordan Iovtchev, whose age was 39.48 years in the 2012 OG, participated in five consecutive OG and won a total of four medals. Iovtchev also participated in the 1992 OG and became the first man in the history of sports with six appearances at the Summer OG; he was admitted into the International Gymnastics Hall of Fame in 2016.

The quality of performance of male participants who consecutively participated at three or more OG is indicated by the fact that, of 35 of them, 14 invented in total 17 new gymnastics elements. Two new elements were invented by Xiaopeng, Urzica, and Iovtchev; Shewfelt, Tsukahara, Deferre, Nemov, Nguyen, Hypolito, Zonderland, Morandi, Cassina, Busnari, and Dragulescu each invented one new element (Fédération Internationale de Gymnastique, 2017).

Of the total number of female gymnasts participations in the OG from 1996 to 2016 (*N*=592), 68% (*n*=408) participated in only one OG, 12% (*n*=70) participated in two OG, 2% (*n*=11) participated in three OG, 0% (*n*=0) participated in four OG, 0.17% (*n*=1) participated in five OG, and 0.17% (*n*=1) participated in six OG.

Like for male gymnasts, accomplishments of female gymnasts' participants at three and more OG will be presented to emphasize their quality.

A group of 11 female gymnasts had three appearances at the OG in the analyzed period and thus contributed to the overall increase in the AA for female Olympian gymnasts (especially in their last OG). These gymnasts included the following: Svetlana Khorkina (25.59 years in the 2004 OG); Lisa Skinner (23.51 years in the 2004 OG); Monica Bergamelli (24.23 years in the 2008 OG); Daiane dos Santos (29.40 years

in the 2012 OG); Elizabeth Tweddle (27.50 years in the 2012 OG); Vanessa Ferrari (25.84 years in the 2016 OG); Jessica Brizeida Lopez Arocha (30.56 years in the 2016 OG); Vasiliki Millousi (32.36 years in the 2016 OG); Gaelle Mys (24.74 years in the 2016 OG); Catalina Ponor (28.99 years in the 2016 OG); and Sherine Elzeiny (25.47 years in the 2016 OG). It is important to point out that, despite three appearances at the OG, in the analyzed period the career of Catalina Ponor actually lasted for four Olympic cycles (due to injury, she did not participate in the 2008 OG, which would have been her second consecutive OG, but she participated at the 2012 and 2016 OG).

In the analyzed period, there were no female gymnasts with four consecutive Olympic appearances. However, there were five consecutive appearances in the OG by Hypolito Daniele (32.02 years in the 2016 OG), and six consecutive participations at the OG by Oksana Chusovitina (41.16 years in the 2016 OG). Chusovitina's number of participations and her comparatively older age make her an outlier not only in artistic gymnastics but in most elite sports. Her participation at the Summer OG in Rio made her the oldest female gymnast in Olympic history.

Mature look and age above the AA of other female Olympian gymnasts did not prevent consecutive participants to achieve top results, even on their consecutive OG: Khorkina won gold in her second OG (2000) on the uneven bars and won silver in the All-Around Finals and floor routine; she also won silver in the All-Around Finals in her third OG (2004); Skinner won eighth place in the All-Around Finals and eighth place on the floor during her second OG (2000); Dos Santos won sixth place on the floor during her second OG (2008); Tweddle finished fourth in her second OG (2008) and won bronze on the uneven bars in her third OG (2012); Ferrari was eighth in the All-Around Finals and fourth on the floor during her second OG (2012), and was 16th in the All-Around Finals and fourth on the floor during her third OG (2012); Lopez Arocha was 18th in the All-Around Finals during her second OG (2012) and was 17th in the All-Around Finals and sixth on the uneven bars during her third OG (2016); Ponor won silver on the floor and was fourth on the balance beam during her second OG (2012), and was seventh on the balance beam during her third OG (2016).

Groups of male and female gymnasts Olympians were compared according to their total number of participations at the OG, by using Fisher test for the significance of the difference between two independent proportions. Compared to the number of participants at two consecutive OG, the number of male and female gymnasts who participated in three, four, five and six OG was significantly lower. A significant difference was determined between those male and female gymnasts who consecutively participated in two (25% of total number of male and 14% of total number of female gymnasts), three (7% of total number of males and 2% of total number of female gymnasts), and four (1% of total number of male and 0% of total number of female gymnasts) OG, while there was no significant difference found in the number of male and female gymnasts who participated in five (0.2% of total number of male and of female gymnasts) and six (0% of total number of males and 0.2% of total number of female gymnasts) consecutive OG.

The largest number of consecutive Olympians (of both genders) was determined at the transition of two successive OG (1996-2000, 2000-2004, 2004-2008, 2008-2012, and 2012-2016), while a smaller number of consecutive Olympians was determined at the transition of non-consecutive OG. In males, the number of consecutive participants in the OG was from 30 (1996-2000 OG) to 38 (2004-2008 OG) and generally represented between 30% and 38% of the total number of male gymnasts who participated in the upcoming OG. In females, the number of consecutive participants in the OG ranged from 13 (2000-2004 OG) to 26 (2008-2012 OG) and generally represented between 8% and 27% of the total number of female

gymnasts who participated in the upcoming OG.

Significant differences between genders (of consecutive Olympian gymnasts) were determined in the number of those who consecutively participated in the OG from 1996 to 2000, from 1996 to 2004, from 2000 to 2004, from 2000 to 2008, and from 2004 to 2008.

DISCUSSION

Survey results found that the number of male gymnasts who participated at more than one OG was significantly higher than the number of female gymnasts.

The AA of all non-consecutive male Olympian gymnasts from 1996 to 2016 (expected) is in accordance with the results of Arkaev & Suchilin (2004) and Andreev (2015). Furthermore, the linear and second-order polynomial-regression increase in the AA of male and female gymnasts who had participated at the OG and at the World Championships was also determined by Atiković, Delaš Kalinski and Čuk (2017). However, determined ascending trend of AA is opposite from the downward AA trend of male Olympian gymnasts population determined in the period from 1964 OG (AA=25.6 years±2.9 years) to 1976 OG (23.7 years±5.5 years; Arkaev & Suchilin, 2004); also from the decline trend of AA of Olympic medal winners (determined by Andreev (2015)). Reason for male gymnasts ascending trend of the AA partly probably need to search in ever-increasing technical difficulty demands that arise from changes in CoPs every Olympiad. Namely, after 1996 OG and exclusion of the compulsory routines from the official competitions, MAG witnessed to the appearance of not only new elements but also of new difficulty categories in the CoP. With the aim of fulfilling the FIG demands of each new CoP, male gymnasts training are mostly based on the repetition of strength-related skills, because of what is, almost constantly, characterized as specific strength conditioning training (Jemni, Sands, Friemel, Stone, & Cooke, 2006). Such trainings are not being implemented just lately; for the last 4 decades male gymnastics training has been characterized with nearly constant maximal oxygen uptake values and the increasing peak power (Jemni, Friemel, Sands, & Mikesky, 2001). Only those male gymnasts who possess high levels of speed and strength are able to perform high difficulty values elements of modern MAG, what mostly leads to a higher competitive score (Jemni et al., 2006). Becuase achieving of such extreme levels of strength (obviously) need a longer time, increase of male gymnasts AA is the logical result.

Although successive increases in AA were established between 1996 OG and 2016 OG analysis of the AA trend of all non-consecutive male Olympians did not determine a significant difference between two successive OG. A significant difference was determined between the AA from the 1996 OG and the AA from the 2008 OG, 2012 OG, and 2016 OG. This result is somewhat unexpected since a significant difference in the AA appeared 11 years after the 1997 increase in the minimum age. However, since the AA of non-consecutive male Olympians was significantly higher than the minimum age requirements (even in the 1996 OG, the AA was 23.22 years), then it is logical that the 'normative' increase determined in the AA after 1997 contributed to the determination of significant differences in the AA after a certain (longer) period of time. Because, in MAG, a significant difference has not been determined between percentages of the youngest male gymnasts before and after 1997 rule (male gymnasts have to turn 18 years to participate at OG) the influence of the rule (on the percentage of the youngest male Olympian gymnasts) is unknown. Also, it remains unknown whether the AA of male Olympian gymnasts would be increased without changes in the minimum age requirements. It is possible that AA might have changed regardless changes to the minimum age requirements, all due to increased scientific knowledge about biological maturity and the longevity of

development of the maximum power needed for the performance of the most demanding elements of MAG (Malina et al., 2004).

Like for male gymnasts, the study determined the ascending trend of AA of all non-consecutive female Olympian gymnasts which is opposite from a descending trend of AA determined from the mid-60s through the 1980s (from 1964 OG (AA=22.2 years±2.8 years) to 1976 OG (AA=18.3±5.5 years; Arkaev & Suchilin, 2004). Authors suspect that the increase of AA, in the analyzed period, is partly a consequence of: 1) decreased percentage of the female gymnasts with the minimum allowed age for participation in the OG (from 28% at the OG1996 to 2% at the OG2016); 2) increased percentage of female gymnasts older than 20 years (from 11% that have been determined at the 1996 OG over 18% at the 2000 OG, 21% at the 2004 OG, 23% at the 2008 OG, 48% at the 2012 OG, right until 51% of 20+ years old gymnasts that have been determined at the 2016 OG); all probably related to the increase of the minimum age. Confirmation for the same arises from the significant difference that has been determined among percentages of the youngest female gymnasts from the time before 1997 rule, and ones from the time after this rule (rule from 1997 determined that female gymnasts have to turn 16 years to participate at OG). Since this is a sample of the youngest female gymnasts, who in career participated only once in the OG, and since the problem and increasing of the minimum age was initiated by concerns from medical researchers determined in WAG on similar sample (FIMS/WHO, 1998), obtained results confirm the effectiveness of the increase of the minimum age for the female gymnasts who tend to participate in the OG. However, further investigation is needed to determine whether minimum age requirements have had other effects, including effects on the musculoskeletal development of young competitors, on injury reduction, and on positively changing the image of the sport for the public, fans, and media (Eagleman et al., 2014).

Similar to male gymnasts, AA of non-consecutive female gymnasts didn't show a significant increase immediately after the 1997 rule. However, differently than in male gymnasts, an increase was found between two consecutive OG: 2008 OG (AA=18.74 years) and 2012 OG (AA=20.40 years). This result is likely due to the number of female gymnasts who had consecutive appearances from 2008 OG to the 2012 OG (n=26), which is almost doubled compared to the number of female gymnasts who had participations at two successive OG in the earlier periods (n=15 for 1996-2000 OG; n=13 for 2000-2004 OG; n=15 for 2004-2008 OG).

Similar to AA of male gymnasts, and expected, due to the previous results about percentages of the youngest and the 20+ years old female gymnasts, the AA of non-consecutive female gymnasts was also found to be significantly different from the normative minimum age requirement for all analyzed OG.

Due to multiple participations at the OG, higher AA values of consecutive Olympian gymnast of both genders (AA_{MALES}=24.99 and $AA_{FEMALES}$=20.66) compared to AA of non-consecutive Olympian gymnasts (AA_{MALES}=23.78 and $AA_{FEMALES}$=18.34) are logical and expected result. Although the trend of AA, in the analyzed period, for both genders was upward, and although the significant differences in AA between genders have been determined on almost all analyzed OG, the range of the AA increase for female gymnasts (AA_{FEMALE} increase ranged from 0.42 years to 3.34 years) was bigger than for male gymnast (AA_{MALE} increase ranged from 0.68 years to 2.26 years). The same suggests approaching of the AA of consecutive female gymnasts towards AA of consecutive male gymnasts, and accordingly, possible equality in the longevity of theirs careers. However, further studies, on the Olympian gymnasts of both genders, on the upcoming OG, are needed to be conducted to confirm this assumption.

Results of consecutive gymnasts of both genders, who participated at three and

more OG, clearly show the positive influence of maturity on the performances of the high-class gymnasts. For male gymnasts who start with intensive training later than female gymnasts, and whose maturity is "welcomed", because enable them to develop extreme levels of strength needed to fulfill CoP requirements, longevity associated with the continuous advancement in the performance is expected and in accordance with Andreev (2015). The author determined that AA of male Olympic medal winners (from 1960 to 2012) was approximately 23.9 years; 23-year-olds won 50 medals, 24-year-olds won 41 medals, and 22-year-olds won 35 medals. With this data, the author characterized the ideal age for achieving success in MAG in the OG (Andreev, 2015). Opposite to that, for the highest results of consecutive female gymnasts may be assumed that are somewhat surprising, especially if are seen through the concept of artistic gymnastics that prefer the tiny 'pixie-like' body that demonstrates femininity, youthfulness, cuteness, and superhuman power (Barker-Ruchti, 2009; Chisholm, 1999; Weber & Barker-Ruchti, 2012). However, independently from being characterized as older, more muscular, and potentially larger (Kerr et al., 2015), those consecutive female gymnasts obviously possess some other characteristics that enable them to be within best modern female gymnasts.

As one of the key factors that lead to improvements in performance and to the attainment of expertise, the training of 'older' female gymnasts has been a subject of research. According to Kerr et al. (2015), in many cases older female gymnasts trained significantly less than when they were younger or less than their younger teammates, due to increased knowledge, gained through experience; also to reduce demands on the body, due to a strong belief (held by many gymnasts) that an older body cannot complete as many repetitions as a younger body. According to the same study, the area where older gymnasts had potentially higher forms of capital was in their ability to express themselves artistically (Kerr et al., 2015). The importance of artistry in women's gymnastics has been a concern of the FIG and was incorporated in its execution score since 2009 (WAG FIG, 2009-2012).

Results of consecutive female gymnasts, on their consecutive OG, further confirm that female gymnasts can have prolonged careers and skills development after the age of 16, and that it is possible to have top-level achievements after the age of 20 (Zurc, 2017).

Atiković, Kalinski, Petković and Čuk (2017) examined the AA medalist and non-medalist teams, consisting of consecutive and non-consecutive Olympians, that participated at the Olympic Games between 1996 and 2016, and determined there were no significant differences in the chronological age between the medalist and non-medalist teams, that participated at the Olympic Games between 1996 and 2016 with the exception of OG2000 and OG2012. On the other hand, the significant differences were not determined between teams of female gymnasts either (Atiković, Delaš Kalinski, Petković, & Čuk, 2017).

Based on presented accomplishments (ranks) of consecutive gymnasts of both genders, authors support the conclusion that, despite early identification of talent, excellence in sports is not a product of a standard set of factors; it can be achieved in individual or unique ways through different combinations of factors (this effect has been termed the "compensation phenomenon" (Vaeyens, Lenoir, Williams, & Philippaerts, 2008)). The gymnasts with the very best profiles on most performance-related parameters (the best compensators) are those that might have the highest chances of progressing from their training efforts (Pion et al., 2015). However, regardless of initial individual characteristics, "unless there is a long and intensive process of encouragement, nurturance, education, and training, individuals will not attain extreme levels of capability in specific fields" (Bloom, 1985).

CONCLUSION

Changes in the CoP by the FIG, through time, have significantly increased the age and (probably) prolonged the careers of male and female gymnasts. However, due to differences in the development of gymnasts' careers, the number of female Olympian gymnasts who have participated in two, three, and four consecutive OG was significantly lower than the number of male Olympian gymnasts. When all consecutive gymnasts are analyzed together, non-significant difference in AA between male and female gymnasts determined at last OG (2016 OG) can lead to the assumption that the lengths of current and future female gymnasts' careers will be equal to the length of male gymnast career. Until this assumption be confirmed, based on the majority of obtained results, remains to be concluded that the careers of female gymnasts are significantly shorter than careers of male gymnasts. This conclusion confirms previous empirical findings in this area. From several factors that have an influence on the gymnasts' career, one factor (change of the rule about minimum age requirements) was analyzed. Obtained results were different for genders highlighting the following: the change of minimum age influenced on the percentage of the youngest Olympian female gymnasts, but didn't have the influence on the percentage of the youngest Olympian male gymnasts.

Rank of the best consecutive male and especially consecutive female gymnasts is not dependable or endangered by their age; their quality of performance is the main factor of their success.

Obtained results of increased AA, present an extension of the duration of the available training years-favorable condition for all the parameters affecting gymnasts' well-being. Together with the increased number of older gymnasts and consecutive gymnasts of both genders should encourage coaches to redefine athletes' technical skill development (according to international standards) and to plan quality training for more than one Olympic cycle. We assume that those training changes will help to protect gymnast health, to reduce dropout and to prolong gymnast career at the highest international levels. However, it remains to be explored in further studies.

REFFERENCES

Andreev, P. (2015). Age analysis of the Olympic medal holders-men in artistic gymnastics for the period 1960-2012. *Activities in Physical Education and Sport, 5*(2), 138-143.

Arkaev, L., & Suchilin, N.G. (2004). *Gymnastics: how to create champions*. Oxford: Meyer & Meyer Verlag.

Atiković, A., Delaš Kalinski, S., & Čuk, I. (2017). Age trends in artistic gymnastic across World Championships and the Olympic Games from 2003 to 2016. *Science of Gymnastics Journal*, *9*(3), 251-263.

Atiković, A., Kalinski, S.D., Petković, E., & Čuk, I. (2017). The Differences between Teams in Men's and Women's Medallists and Non-medallists at the 1996–2016 Olympic Games Artistic Gymnastics Tournament. *Central European Journal of Sport Sciences and Medicine*, *18*(2), 89–97.

Barker-Ruchti, N. (2009). Ballerinas and pixies: A genealogy of the changing female gymnastics body. *The International Journal of the History of Sport, 26*(1), 45-62.

Blimkie, C.J., Roache, P., Hay, J.T., & Bar-Or, O. (1988). Anaerobic power of arms in teenage boys and girls: relationship to lean tissue. *European journal of applied physiology and occupational physiology*, *57*(6), 677-683.

Bloom, B.S. (1985). *Developing Talent in Young People*. New York: Ballantine Books.

Borms, J. (1986). The child and exercise: an overview. *Journal of Sports Sciences, 4*(1), 3-20.

Caine, D., Bass, S.L., & Daly, R. (2003). Does elite competition inhibit growth and delay maturation in some

gymnasts? Quite possibly. *Pediatric Exercise Science, 15*(4), 360-372.

Caine, D., Lewis, R., O'Connor, P., Howe, W., & Bass, S. (2001). Does gymnastics training inhibit growth of females? *Clinical Journal of Sport Medicine, 11*(4), 260-270.

Cassas, K.J., & Cassettari-Wayhs, A. (2006). Childhood and adolescent sports-related overuse injuries. *American Family Physician, 73*(6), 1014-1022.

Chisholm, A. (1999). Defending the nation: National bodies, US borders, and the 1996 US Olympic women's gymnastics team. *Journal of Sport and Social Issues, 23*(2), 126-139.

Claessens, A.L., & Lefevre, J. (1998). Morphological and Performance Characteristics as Drop-out Indicators in Female Gymnasts. *The Journal of Sports Medicine and Physical Fitness, 38*(4), 305-309.

Claessens, A.L., Lefevre, J., Beunen, G.P., & Malina, R.M. (2006). Maturity-associated variation in the body size and proportions of elite female gymnasts 14-17 years of age. *European Journal of Pediatrics, 165*(3), 186-192.

Cohen, R.L. (2013). Femininity, Childhood and the Non-Making of a Sporting Celebrity: The Beth Tweddle Case. *Sociological Research Online, 18*(3). doi:10.5153/sro.3193. Retrieved from http://openaccess.city.ac.uk/3120/3/Cohen%2C%20Rachel%202013%20Femininity%2C%20Childhood%20%26%20the%20Non-Making%20of%20a%20Sporting%20Celebrity.pdf

Crane, J., & Temple, V. (2015). A systematic review of dropout from organized sport among children and youth. *European Physical Education Review, 21*(1), 114-131.

Daly, R.M., Bass, S.L., & Finch, C.F. (2001). Balancing the risk of injury to gymnasts: how effective are the counter measures? *British Journal of Sports Medicine, 35*(1), 8-19.

Donti, O., Donti, A., & Theodorakou, K. (2014). A Review on the Changes of the Evaluation System Affecting Artistic Gymnasts' basic preparation: The Aspect of Choreography Preparation. *Science of Gymnastics Journal*, *6*(2), 63-72.

Dresler, C.M. (1997). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine, 336*(2), 140-140.

Dworetzky, J.P. (1990). *Introduction to child development*. Minnesota: West Publishing Company.

Eagleman, A.N., Rodenberg, R.M., & Lee, S. (2014). From 'hollow-eyed pixies' to 'team of adults': Media portrayals of Olympic women's gymnastics before and after an increased minimum age policy. *Qualitative Research in Sport, Exercise and Health, 6*(3), 401-421.

Ericsson, K.A. (2007). Deliberate practice and the modifiability of body and mind: toward a science of the structure and acquisition of expert and elite performance. *International Journal of Sport Psychology, 38*(1), 4-34.

Ericsson, K.A. (2008). Deliberate Practice and Acquisition of Expert Performance: A General Overview. *Academic Emergency Medicine, 15*(11), 988-994.

Ericsson, K.A., Krampe, R.T., & Teschromer, C. (1993). The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Review, 100*(3), 363-406.

Fédération Internationale de Gymnastique 2009-2012 *Code of Points Women Artistric Gymnastics*. (2017, March 1). Retrieved from https://issuu.com/2008agwc/docs/01-1_wag_cop_2009-2012__english_.

Fédération Internationale de Gymnastique 2017-2020 Code of Points Mens Artistric Gymnastics. (2017, March 1). Retrieved from http://www.fig-gymnastics.com/publicdir/rules/files/mag/CoP_MAG_2017-2020_ICI-e.pdf.

FIMS/WHO Ad Hoc Committee on Sports and Children. (1998). Sports and children: Consensus statement on organized sports for children. *Bulletin of the World Health Organization, 76*(5), 445-447. Retrieved from

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2305775/

Georgopoulos, N.A., Markou, K.B., Theodoropoulou, A., Benardot, D., Leglise, M., & Vagenakis, A.G. (2002). Growth retardation in artistic compared with rhythmic elite female gymnasts. *Journal of Clinical Endocrinology & Metabolism, 87*(7), 3169-3173.

Grossfeld, A. (2014). Changes during the 110 years of the world artistic gymnastics championships. *Science of Gymnastics Journal, 6*(2), 5-37.

Haag, H., & Haag, G. (2003). *Dictionary: sport, physical education, sport science: with indices in German, French, Spanish and a CD with indices in twelve languages*. Kiel: Intitut für Sport und Sportwissenschaften.

Jemni, M., Friemel, F., Sands, W.A., & Mikesky, A. (2001). Evolution of the physiological profile of gymnasts over the past 40 years. A review of the literature. *Canadian Journal of Applied Physiology*, *26*(5), 442-456.

Jemni, S., Sands, W.A., Friemel, F.,Stone, M.H., & Cooke, C.B. (2006). Any effect of gymnastics training on upperbody and lower-body aerobic and power components in national and international male gymnasts? *Journal of Strength and Conditioning Research*, *20*(4), 899-907.

Kerr, G., Berman, E., & De Souza, M.J. (2006). Disordered eating in women's gymnastics: Perspectives of athletes, coaches, parents, and judges. *Journal of Applied Sport Psychology, 18*(1), 28-43.

Kerr, R., Barker-Ruchti, N., Schubring, A., Cervin, G., & Nunomura, M. (2015). *Coming of age: Towards best practice in women's artistic gymnastics*. Canterbury: Lincoln University. Retrieved from https://researcharchive.lincoln.ac.nz/bitstream/handle/10182/6515/Leap%2037-Coming-of-age.pdf;jsessionid=2BF5B101236CE59B27C31B5FED480534?sequence=3

Kinnick, K.N. (1998). Gender bias in newspaper profiles of 1996 Olympic athletes: A content analysis of five major dailies. *Women's Studies in Communication, 21*(2), 212-237.

Koukouris, K. (2005). Premature athletic disengagement of elite Greek gymnasts. *European Journal for Sport and Society, 2*(1), 35-56.

Kunčić, A. (2014). *Razvoj tekmovalnih rezultatov telovadca Aljaža Pegana na drogu* (Diplomsko delo). Univerza v Ljubljani, Fakulteta za šport. Ljubljana. Retrieved from https://www.fsp.uni-lj.si/COBISS/Diplome/Diploma22100186KuncicAndrej.pdf

Léglise, M. (1998). Limits on young gymnast's involvement in high-level sport. *Technique, 18*(4), 8-14.

Lindholm, C., Hagenfeldt, K., & Hagman, U. (1995). A Nutrition Study in Juvenile Elite Gymnasts. *Acta Paediatrica, 84*(3), 273-277.

Malina, R.M. (1994). Longitudinal Observations on Physical Growth and TW2 Skeletal Maturation of Girls in Tokyo - Radiographic Atlas of Hand and Wrist - Eto, M, Ashizawa, K. *American Journal of Human Biology, 6*(3), 408-408.

Malina, R.M. (2014). Top 10 Research Questions Related to Growth and Maturation of Relevance to Physical Activity, Performance, and Fitness. *Research Quarterly for Exercise and Sport, 85*(2), 157-173.

Malina, R.M., & Bouchard, C. (1991). *Growth, maturation, and physical activity*. United States: Human Kinetics.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. United States: Human Kinetics.

Malina, R.M., Baxter-Jones, A.D.G., Armstrong, N., Beunen, G.P., Caine, D., Daly, R.M., . . . Russell, K. (2013). Role of Intensive Training in the Growth and Maturation of Artistic Gymnasts. *Sports Medicine, 43*(9), 783-802.

Martindale, R.J.J., Collins, D., & Abraham, A. (2007). Effective Talent Development: The Elite Coach Perspective in UK Sport. *Journal of Applied Sport Psychology, 19*(2), 187-206.

Martinsen, M., Bratland-Sanda, S., Eriksson, A.K., & Sundgot-Borgen, J. (2010). Dieting to win or to be thin? A study of dieting and disordered eating among adolescent elite athletes and non-athlete controls. *British Journal of Sports Medicine, 44*(1), 70-76.

Pion, J., Lenoir, M., Vandorpe, B., & Segers, V. (2015). Talent in Female Gymnastics: a Survival Analysis Based upon Performance Characteristics. *International Journal of Sports Medicine, 36*(11), 935-940.

Portmann, M. (1993). *Athlete long-term development.* National Coaching Certification Program-Level 4-5. Ottawa: Coaching Association of Canada.

Ryan, J. (1995). Pretty girls in little boxes: The making and breaking of elite gymnasts and figure skaters. New York: Doubleday.

Theodoropoulou, A., Markou, K.B., Vagenakis, G.A., Benardot, D., Leglise, M., Kourounis, G., . . . Georgopoulos, N.A. (2005). Delayed but normally progressed puberty is more pronounced in artistic compared with rhythmic elite gymnasts due to the intensity of training. *Journal of Clinical Endocrinology & Metabolism, 90*(11), 6022-6027.

Tofler, I.R., Stryer, B.K., Micheli, L.J., & Herman, L.R. (1996). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine, 335*(4), 281-283.

USA Gymnastics (2009). Do you know your stats? Indianapolis: USA Gymnastics. Retrieved from https://usagym.org/pages/home/publications/usagymnastics/2009/1/32_stats.pdf 2009.

Vaeyens, R., Lenoir, M., Williams, A.M., & Philippaerts, R.M. (2008). Talent identification and development programmes in sport-Current models and future directions. *Sports Medicine, 38*(9), 703-714.

Weber, J., & Barker-Ruchti, N. (2012). Bending, flirting, floating, flying: A critical analysis of female figures in 1970s gymnastics photographs. *Sociology of sport journal, 29*(1), 22-41.

Zurc, J. (2017). It was worth it– i would do it again!: phenomenological perspectives on life in the elite women's artistic gymnastics. *Science of Gymnastics Journal, 9*(1), 41-59.

Corresponding author:

Sunčica Delaš Kalinski
Faculty of Kinesiology
University of Split - Aesthetic movements
Teslina 6
Split 21000
Croatia
Phone: +385 91 502 97 51
Email: suncica@kifst.hr

INTER-RATER RELIABILITY AND VALIDITY OF SCORING MEN'S INDIVIDUAL TRAMPOLINE ROUTINES AT EUROPEAN CHAMPIONSHIPS 2014

Bojan Leskošek[1], Ivan Čuk[1] & César J.D. Peixoto[2]

[1]Faculty of sport, University of Ljubljana, Slovenia
[2]Faculty of Human Kinetics, University of Lisboa, Portugal

Original article

Abstract

Execution scores of men's individual trampoline routines at the European Championships (EC) 2014 in Guimarães, Portugal were analysed. In total, 66 men competed in the qualifying round. The old, classic format of scoring, by which the execution score is the sum of the scores of individual judges (discarding the lowest and highest scores), was compared with the new format, by which only the median scores of each skill are tripled and then summed for the final score. Execution was found to be the most significant component of the total score, surpassing degree of difficulty and time of flight in both routines. Intra-class correlation (ICC) coefficients and Kendall's coefficient of concordance W were computed. The bias of judging was small with only one judge found who scored significantly higher than the other judges did. Inter-rater reliability was found good for single skills (ICC around .9 and Kendall W around .7), while for the sum of all ten skills it was excellent (all ICC coefficients above .99 and Kendal W above .97) for both routines. Although the correlation coefficients between old and new format scores were high (r=.965 and r=.997 for first and second routine, respectively), there were some substantial differences in rankings of competitors between old and new scoring format (Spearman rank correlation rho=.94 and rho=.96 for first and second routines, respectively). Despite the reliability and validity of judging trampoline routines were high, some possible means of improvement are suggested. Regarding the differences between old and new formats, no clear (dis)advantages of one or another were found.

Keywords: *trampoline, judging, accuracy, objectivity.*

INTRODUCTION

Trampolining is a well-known sport, especially individual trampoline, which was accepted into the 2000 Summer Olympic Games as one of several gymnastic disciplines. The competition usually consists of two qualification routines and one final (voluntary) routine, each consisting of ten different skills (jumps).

The performance of each routine is the sum of three components: degree of difficulty (DD, also called *tariff*), execution (form), and time of flight (TOF). TOF is

objectively measured with a time measurement device, while the other two components are evaluated by judges. Evaluating the DD of a routine is usually less problematic, as competitors must announce the difficulty of their routines in advance (usually 2 hours before the competition starts) and the D-judges may check the official video recording of a routine in the case any deviation between scores of D-judges and the supervisor of the Technical Committee.

The most difficult part of evaluating performance is evaluating execution, as judges (usually five of them) generally disagree in their deductions (in the [.0, .5] range) which they give for the mistakes (e.g., poor form, incomplete moves, and moving too far from the trampoline's centre mark) in each skill. To resolve this disagreement, two formats are possible: the score of each skill is the sum of the middle (eliminating the highest and the lowest) three judges' scores or *tripled median score* (eliminating the two highest and two lowest scores). The tripled median score was introduced at the 2014 European Trampoline Championships, which also introduced the summing of each single skill score instead of the sum of 10 skills' score of (middle three) judges, which was the usual format in previous competitions.

Several studies were carried out to evaluate judges' performance in different gymnastics disciplines since the 1950s. These studies are rare in trampolining, but are more common in some other gymnastics disciplines, especially in artistic gymnastics. The studies mostly deal with bias and the reliability of judging. In respect to bias, different types of bias were detected. Several authors (Ansorge & Scheer, 1988; Leskošek, Čuk, Pajek, Forbes, & Bučar-Pajek, 2012; Scheer & Ansorge, 1975) found (inter)national bias, i.e., higher scoring of gymnasts from judges' countries and lower scoring of all others or just the closest competitors. A similar type, home advantage bias, was also proven for the 1896-1996 Olympic games (Balmer, Nevill, & Williams, 2003). Others (Bučar, Čuk, Pajek, Karacsony, & Leskošek, 2012; Leskošek, Čuk, Karácsony, Pajek, & Bučar, 2010; Leskošek et al., 2012) found substantial overall judge's bias, i.e., systematic under- or over-scoring of judges. Another bias was found based on the position of judge in accordance with the apparatus (Plessner & Schallies, 2005).

Several authors reported sequential order bias (Ansorge, Scheer, Laub, & Howard, 1978; Damisch, Mussweiler, & Plessner, 2006; Morgan & Rotthoff, 2014; Plessner, 1999) and open feedback / conformity bias (Boen, Van Hoye, Vanden Auweele, Feys, & Smits, 2008). Conformity bias was also found in one of the rare studies specifically dedicated to officiating in trampolining (Johns & James, 2013), in which it was found that the differences between scores in real-time competition and the scores given in post-event video analysis could be high and were causing several and large differences in rankings of competitors, even in medal positions. Authors attributed those differences to social conformity, as well as poor arithmetic skills (when calculating results in real-time under time pressure) and suggested a remedy in using technical equipment (computers and video) to calculate scores and to check for possible deductions both in real competitions and in training courses for the judges.

In addition to bias as a systematic source of errors many studies have addressed unreliability, a random source of errors in judging. Most of these studies are focused on *inter*-rater reliability, i.e., differences in scores between several judges consisting judges' panel, with each member of the panel giving a score to the group of same competitors. This kind of reliability is usually measured by intra-class correlation coefficients (ICC), which may evaluate performance of only one (i.e., "typical") judge (so-called single ICC or single measure ICC) or the whole panel of judges (average ICC or simply ICC). The reliability of the panel of judges may also be evaluated non-parametrically by Kendall coefficient of concordance (W), which is computed on the ranks of competitors (not on the original

scores). There are no known studies of *inter*-rater reliability in trampolining, although regarding intra-rater reliability, i.e., consistent scoring of routines given by the *same judge* at different times, one study (Johns & James, 2013) found excellent reliability. Recent studies (Bučar et al., 2012; Leskošek et al., 2010) in artistic gymnastics reveal good inter-rater reliability with ICC around .95 in qualifying rounds of competitions; however, in apparatus finals several ICCs were much lower, going as low as .72 (in women's vault finals). The reason for this was probably low variability (small differences) in scores between competitors in the final round, which may be much lower than variability in the qualifying round, and the well-documented fact (Shrout, 1998) that low levels of between-subject variability causing depression of the ICC coefficients, even if the differences between judges' scores across the same competitor are small.

The aims of this study were to analyse the men's qualifying round of European Championships (EC) 2014 in Guimarães, Portugal with respect to: (a) importance of routine execution in relation to other components of total score (DD, TOF); (b) quality of judging, especially inter-rater reliability and validity (bias); (c) comparison of execution scores and ranks of competitors given within old (middle three skill deductions count) and new (only median score counts) format of scoring.

METHODS

The initial sample consists of all 66 men competing in qualifying round of European Championships 2014 in Guimarães, Portugal. The competition was organised according to FIG Code of Points 2013-2016. Scores of all competitors, i.e., including those 4 and 15 competitors who did not complete all 10 skills in their first and second routines, respectively, were considered for the data analysis.

Official result sheets from the European Union of Gymnastics (UEG) were collected. New format scores (i.e., sum of tripled median score of each skill) and old format scores (sum of middle 3 judges' sum of scores for all 10 skills) were computed. In addition to deductions made by each of the 5 judges for the execution of each of the 10 skills, DR (reception) deductions were also analysed, while DA (additional) deductions, which are given only by the chair of the judges' panel, were excluded from the analysis, as it was not possible to establish intra-rater reliability in this case.

In the preliminary study, the importance of different components of total scores (i.e., execution, degree of difficulty and time of flight) were established by multiple linear regression.

To access intra-rater reliability, Kendall's coefficient of concordance *W* and intra-class correlation (*ICC*) coefficients were computed. ICC coefficients were evaluated under the two-way random model, both for consistency (ICC_C) and agreement (ICC_A). If not otherwise noted, only ICC_A coefficients were reported and interpreted. Under the agreement model, standard error of measurement (*SEM*) was computed as $SD \times (1 - ICC_A)^{1/2}$ and *minimal differences needed to be considered real* (*MD*) as $MD = SEM \times 1.96 \times 2^{1/2}$ (Weir, 2005).

The bias of judging was evaluated parametrically using the repeated measures ANOVA (RANOVA) *F*-test and non-parametrically using the Friedman test. Effect sizes in these two tests were evaluated by partial eta-squared and Kendall's W coefficient, respectively.

Agreement between old and new format in final scores was accessed using Pearson (product-moment) correlation coefficients *r*, while agreement between competitors' final rankings was accessed by Spearman rank correlation ρ_S.

All analyses were separated for first (i.e., includes special requirements as required by Code of Points) and second (voluntary) routines.

All analyses were carried out with *IBM SPSS Statistics Version 23* software package and R library IRR (Gamer, Lemon, Fellows, & Singh, 2012) and BlandAltmanLeh

(https://CRAN.R-project.org/package=BlandAltmanLeh).

RESULTS

Execution was found to be the most important part of the total score, followed by the time of flight and degree of difficulty (Figure 1). Although this order is valid both in first and second routines, the differences were much more expressed in the first routine, in which the difficulty matters only in the last two of ten skills.

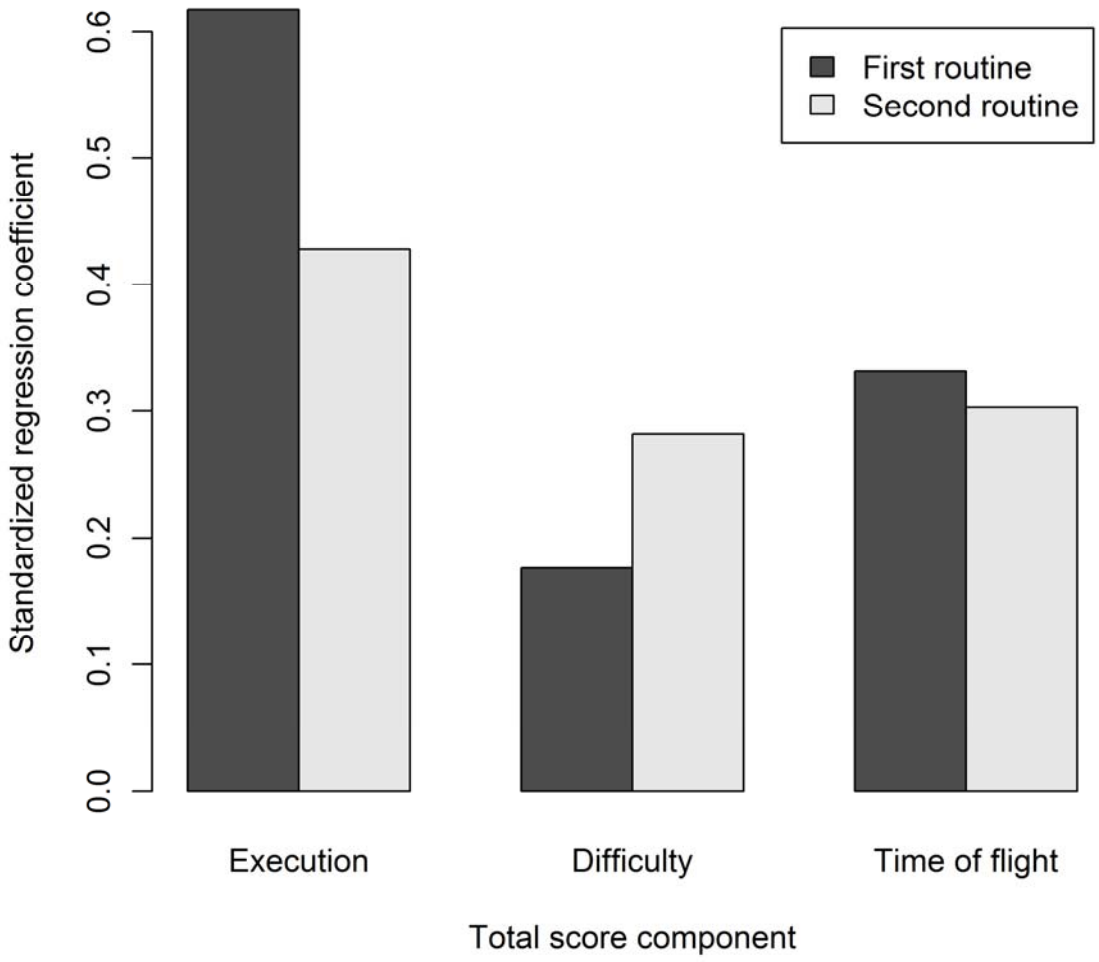


Figure 1. Relative importance of different components of trampoline total score in compulsory and voluntary routines in male individual qualifying round at the 2014 Trampoline European Championships.

Table 1
Statistics related to bias of judging: average deduction by judge, repeated measures ANOVA and Friedman test.

		Average deduction (points) – Judge No.					Repeated measures ANOVA			Friedman test		
Routine	n	1	2	3	4	5	*F*	*p*	$\eta^2_{part.}$	χ^2	*p*	*W*
1	66	1.35	1.34	1.32	1.34	1.38	4.88	.001	.070	15.01	.005	.06
2	66	2.22	2.22	2.23	2.22	2.25	1.56	.196	.023	18.72	.001	.07

Legend. *n*=number of competitors; $\eta^2_{part.}$=partial eta-squared; *W*=Kendall's coefficient (as a measure of effect size in Friedman test).

Table 2
Intra-rater reliability statistics for single skills.

				Intra-class correlation coefficient (*ICC*), value and 95% CI							
				Consistency model				Agreement model			
Routine	Skill	*n*	*W*	Single		Average		Single		Average	
1	1	66	.72	.68	[.59, .77]	.92	[.88, .94]	.67	[.57, .76]	.91	[.87, .94]
1	2	66	.66	.65	[.55, .74]	.90	[.86, .94]	.62	[.51, .72]	.89	[.84, .93]
1	3	66	.68	.68	[.59, .77]	.92	[.88, .94]	.66	[.56, .75]	.91	[.86, .94]
1	4	66	.66	.61	[.51, .71]	.89	[.84, .93]	.60	[.50, .70]	.88	[.83, .92]
1	5	66	.64	.62	[.52, .72]	.89	[.85, .93]	.62	[.51, .72]	.89	[.84, .93]
1	6	66	.66	.59	[.49, .70]	.88	[.83, .92]	.57	[.46, .68]	.87	[.81, .91]
1	7	65	.73	.67	[.57, .76]	.91	[.87, .94]	.66	[.56, .75]	.91	[.86, .94]
1	8	65	.69	.61	[.51, .71]	.89	[.84, .92]	.59	[.47, .69]	.88	[.82, .92]
1	9	63	.68	.59	[.48, .69]	.88	[.82, .92]	.58	[.47, .68]	.87	[.81, .92]
1	10	62	.71	.62	[.52, .72]	.89	[.84, .93]	.59	[.48, .70]	.88	[.82, .92]
1	DR†	66	.77	.96	[.94, .97]	.99	[.99, .99]	.96	[.94, .97]	.99	[.99, .99]
2	1	66	.68	.61	[.51, .71]	.89	[.84, .92]	.60	[.50, .70]	.88	[.83, .92]
2	2	63	.72	.64	[.54, .74]	.90	[.86, .93]	.63	[.52, .73]	.89	[.85, .93]
2	3	61	.74	.68	[.58, .77]	.91	[.88, .94]	.68	[.58, .77]	.91	[.87, .94]
2	4	56	.74	.69	[.59, .78]	.92	[.88, .95]	.67	[.57, .77]	.91	[.87, .94]
2	5	56	.74	.66	[.55, .76]	.91	[.86, .94]	.63	[.51, .74]	.89	[.84, .93]
2	6	55	.76	.67	[.56, .76]	.91	[.86, .94]	.64	[.53, .75]	.90	[.85, .94]
2	7	52	.67	.60	[.49, .72]	.88	[.83, .93]	.60	[.48, .71]	.88	[.82, .92]
2	8	52	.67	.63	[.52, .74]	.90	[.84, .93]	.63	[.51, .74]	.89	[.84, .93]
2	9	52	.70	.61	[.49, .72]	.89	[.83, .93]	.59	[.47, .71]	.88	[.81, .92]
2	10	51	.76	.71	[.61, .80]	.93	[.89, .95]	.69	[.58, .79]	.92	[.88, .95]
2	DR†	66	.72	.96	[.94, .97]	.99	[.99, .99]	.96	[.94, .97]	.99	[.99, .99]

Legend.. *n* = number of competitors; *W* = Kendall's coefficient of concordance; CI = confidence interval.
† DR reception deductions

Table 3
Intra-rater reliability statistics for total execution scores (sum of scores for all skills).

				Intra-class correlation coefficient (*ICC*), value and 95% CI							
				Consistency model				Agreement model			
Complete?	Routine	*n*	*W*	Single		Average		Single		Average	
Yes[†]	1	62	.977	.981	[.973, .988]	.996	[.994, .998]	.980	[.971, .987]	.996	[.994, .997]
Yes	2	51	.984	.986	[.978, .991]	.997	[.996, .998]	.983	[.973, .990]	.997	[.995, .998]
No	1	66	.977	.982	[.974, .988]	.996	[.995, .998]	.981	[.972, .987]	.996	[.994, .997]
No	2	66	.991	.990	[.986, .993]	.998	[.997, .999]	.990	[.985, .993]	.998	[.997, .999]

Legend. *n* = number of competitors; *W* = Kendall's coefficient of concordance; CI = confidence interval.
[†] 'Yes' means, that only those competitors, who finished all ten skills, were included in the computation.

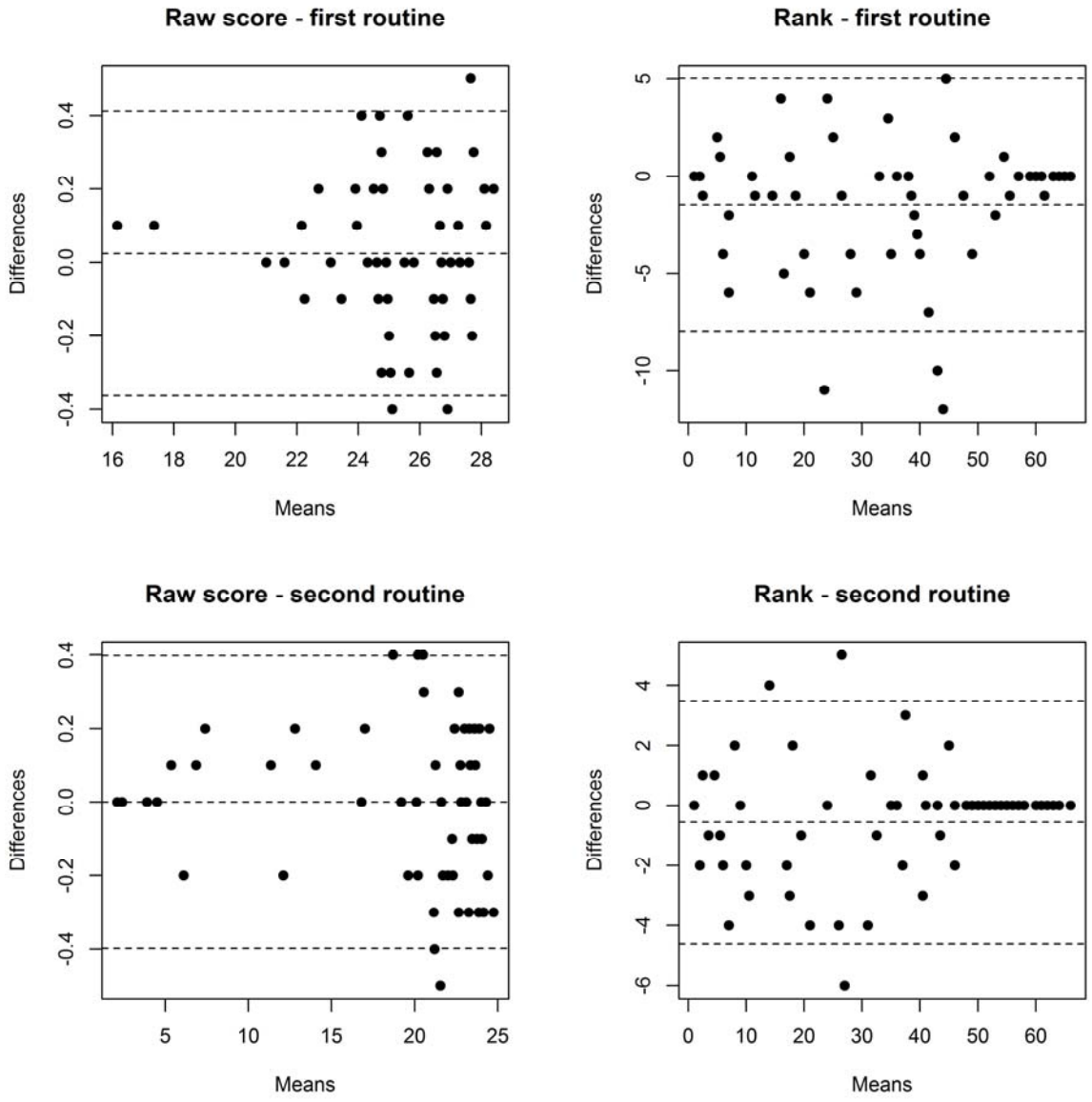


Figure 2. Bland-Altman plot for the differences in raw scores and ranks of execution scores in first and second routines.

Statistics related to bias, i.e., *systematic* under- or overestimation of some judges (Table 1), reveal a small but statistically significant bias of judging, except for the *F*-test in RANOVA of the second routine (p = .196). The most notable bias was found for Judge No. 5, whose deductions in both routines are higher than in other judges.

Intra-rater reliability statistics for *single* skills (Table 2) show moderate and statistically significant (in all cases $p < .001$) agreement between judges. In both routines, Kendall's coefficients of concordance W were around .70. The ICC coefficients for single judges under the consistency model were similar to the W coefficients, while the average ICCs (for all 5 judges) were around .90. Under the agreement model, the ICC coefficients were only slightly lower than under the consistency model.

Intra-rater reliability statistics for the sum of execution scores of *all* skills (Table 3) show very high agreement between judges. This agreement is somewhat higher in the second routine, where deductions for execution are generally almost one full point higher than in the first routine (see first 5 columns of Table 1) and are also much more variable (coefficient of variation CV= 35.3% vs, CV=9% in the first routine). Under the agreement model, ICC coefficients were only slightly lower than under the consistency model.

The standard error of measurement (SEM) computed under agreement model was .037 and .043 in the first and second routines, respectively. Minimal differences needed to be considered real (MD) was .102 and .120 in the first and second routines, respectively.

Execution scores as computed by new and old format scoring are generally different both in raw scores (points), as well as ranks of these scores (Figure 2) In raw scores (left two plots in Figure 2), differences between new and old format scores in the first and second routines range from –.4 to +.5, and –.5 to +.4 points, respectively. In the ranks of execution scores (right two plots in Figure 2), differences between the new and old format ranks in first and second routines range from –12 to +5, and –6 and +5, respectively. Tied ranks are much more frequent with the new format, e.g., in the first routine there are nine competitors tied for 38th place and seven competitors tied for 9th place in the second routine, while in the old format the maximum number of tied competitors are 5 and 3 in the first and second routines, respectively. Ties in the new format are especially frequent for competitors with highest execution scores.

The highest differences between the old and new formats usually occur when there are several disagreements between groups of two and three judges, e.g., French competitor A. M. received in four skills of his first routine a .1 deduction from two judges and no deduction from other three judges, resulting (together with differences in some other skills) in a +.5-point higher score in the new format compared to the old one.

DISCUSSION

Execution scores of the 2014 Trampoline European Championships were analysed; only the qualifying round of male individual trampoline were included in the analysis, as this was the round and discipline with the most (66) competitors in the event; therefore, the most valid results can be expected in this case.

Execution was found to be a much more important component of total score than time of flight and degree of difficulty (Figure 1). While this might be expected in the first routine, where difficulty only matters in the last two of ten skills, it is very informative in the second routine, where execution is substantially more important than difficulty; all ten skills' difficulty count in the second routine. This finding may have two important consequences: first, the execution of routines should be in the primary focus of athletes when preparing for competitions and second, all trampoline federations from the local (regional) to the global level should ensure that the judging

at competitions is as fair as possible, both with regards to the reliability and the unbiasedness of judging.

Unbiasedness (objectivity, validity) of judging seems to be a minor problem in execution scoring in this discipline of the 2014 European Championships. Although three of four tests (one parametric and two nonparametric) showed statistically significant bias, the bias was low and mostly attributable only to one of five judges, who tended to make higher deductions than other the four judges in both the first and second routines. This type of bias, i.e., over- or underestimation in scoring, may not be a major problem that would jeopardise the fairness of the competition results if the bias of a single judge is persistent in all (or at least the majority) of competitors, at it seems was the case in the competition. Namely, extreme scores (four in each skill in new format and two extreme sums of judges' scores in old format) are excluded from the execution score. However, if deductions of one or even more judges are excluded from the execution score in the majority of cases, it may raise questions about the reliability of judging, as (according to the classical test theory and the Spearman-Brown formula (Weir, 2005)) a lower number of judges means lower reliability. Therefore, it is important for the bodies governing the quality of judging to ensure consistent, harmonised criteria of judging and implement mechanisms to educate, check, inform and penalise, if necessary, the judges who persistently deviate from other judges.

Bias at the 2014 European Championships was similar to that found at qualification round of the 2011 European Championships in men's artistic gymnastics (Leskošek et al., 2012), were Kendall's W coefficients were between .01 and .11, with four of six apparatus' coefficients (all but vault and parallel bars) being statistically significant.

Intra-rater reliability was found high for single skills and very high for the sum of all skills, both in the first and second routines and with all statistics used (Kendall coefficient of concordance W, ICC coefficients under consistency and agreement model). Compared to recent research findings in other gymnastics disciplines and artistic gymnastics (Bučar et al., 2012; Leskošek et al., 2010), it seems that reliability in trampolining with ICC coefficients above .99 is (much) better than in artistic gymnastics, where ICC coefficients rarely exceed .98 and may be lower than .95, even if there are similar numbers of judges (4 to 6, compared to 5 in trampolining). The factors that influence higher reliability in trampolining vs. artistic gymnastics may be: higher duration of each skill in trampolining (take-off, flight, and landing takes around two seconds) compared to artistic gymnastics (some elements may take just a fraction of a second); in trampolining, the athlete's body is in the air all the time, not obstructed by an apparatus and is well visible for all judges from the raised judges' platform; and, most skills are performed with several rotations in different planes, so even if the judges are on the different position on the platform, any lack of form of the athlete's body is more likely to be seen by all of the five execution judges.

High reliability coefficients do not necessarily mean there is no room for improvement. Especially in single skills, many disagreements (and, therefore, relatively low reliability) may be seen.

Somewhat lower reliability in the first than in the second routine may be expected, as in the first routine execution deductions were much lower than in the second routine (Table 1) and, therefore, also have lower variability (coefficients of variation were 9.0% and 35.3%, in the first and second routines, respectively), which in turn depresses reliability coefficients (Shrout, 1998). Similarly, lower reliability may be expected in the most important, decisive final round of competition (not analysed in this study), in which differences in scores between competitors are usually smaller than in the qualification round (Bučar et al., 2012).

Following high reliability, standard errors of measurement (SEM) were low, i.e., .037 and .043 points in the first and second routines, respectively. However, even with small SEM, minimal differences needed to be considered real (MD), and are higher than .1 points in both routines, which may cause some unfair rankings of competitors.

As expected, the total scores computed under the new format are different from those computed under the old format. Generally, these differences are small and never exceed +/- .5 point. However, even these small differences in scores may produce big differences in rankings (computed only for execution, while excluding difficulty and TOF). In both routines, differences in rankings were even higher than 10 ranks (places) in some cases, which may also, of course, produce differences in final rankings (including difficulty and TOF). As there is no golden standard for evaluating execution, there are no means to say which format is better or more accurate. However, there are two possible problems, which may speak against new format. The first one is that new format produces many more tied scores (and ranks); however, these ties may be split on the basis of difficulty or TOF. The second possible problem is that many different deductions of single judges produce the same deductions in execution scoring. For example, all the following deductions (in tenths of point) for the five judges (0, 0, 1, 1, 1), (1, 1, 1, 1, 1) and (1, 1, 1, 2, 2), which were quite frequent in that competition, resulted in the same .3 points deduction in the new format, but very different deductions in the old format, namely .2, .3 and .4 points, which may seem more realistic (fair), especially if several large differences between the old and new scoring in different skills of the same competitor exist.

CONCLUSIONS AND RECOMMENDATIONS

The execution score was found to be the most important component of success in trampolining, at least in the qualifying round of this competition, surpassing both degrees of difficulty and TOF in both the first and second routines. Therefore, fair evaluation (judging) of execution is of paramount importance for the fair ranking of competitors. In both aspects of quality of judging, i.e., validity and reliability, trampolining was found very good, even better than in artistic gymnastics, a gymnastic discipline with the longest tradition. However, even if the quality of judging was generally high, small flaws that were found in some cases may jeopardise fair scoring and rankings; therefore, maintaining the high quality of judging is vital. This may be accomplished by judges' education and selection, evaluation, as well as penalising, when necessary.

Differences in scoring in the new and old formats were generally small, so it may be expected that they only produce rare and small differences in (execution and total) rankings of competitors. Although it seems it does not matter much which format to use in the future, some subtle differences were addressed (fewer ties, probably fairer scores when the five judges disagree) that may be in favour of the old format. However, the scoring of each skill in the new format, which replaces sums of scores for all ten routines in the old format, may speak in favour of the new format, as it should reduce social conformity bias in the old format.

Although the overall quality of judging was good both in terms of reliability and validity, that does not mean there is no room for improvement. One opportunity for even better judging is the integration of video and computers into the real-time judging, as well as judges' education and monitoring. Currently, video is not used in real-time by E-judges. As several other studies have shown, video and scoring machines in different sport disciplines (e.g., trampolining (Johns & James, 2013), boxing (Di Felice & Marcora, 2013) and artistic gymnastics (Pajek, Forbes, Pajek, Leskošek, & Čuk, 2011)) may improve reliability and

reduce conformity bias and arithmetic errors in the scoring of athletes' performance.

REFERENCES

Ansorge, C. J., & Scheer, J. K. (1988). International bias detected in judging gymnastic competition at the 1984 Olympic Games. *Research quarterly for exercise and sport, 59*(2), 103-107.

Ansorge, C. J., Scheer, J. K., Laub, J., & Howard, J. (1978). Bias in judging women's gymnastics induced by expectations of within-team order. *Research Quarterly. American Alliance for Health, Physical Education and Recreation, 49*(4), 399-405.

Balmer, N. J., Nevill, A. M., & Williams, A. M. (2003). Modelling home advantage in the Summer Olympic Games. *Journal of Sports Sciences, 21*(6), 469-478.

Boen, F., Van Hoye, K., Vanden Auweele, Y., Feys, J., & Smits, T. (2008). Open feedback in gymnastic judging causes conformity bias based on informational influencing. *Journal of sports sciences, 26*(6), 621-628.

Bučar, M., Čuk, I., Pajek, J., Karacsony, I., & Leskošek, B. (2012). Reliability and validity of judging in women's artistic gymnastics at University Games 2009. *European Journal of Sport Science, 12*(3), 207-215.

Damisch, L., Mussweiler, T., & Plessner, H. (2006). Olympic medals as fruits of comparison? Assimilation and contrast in sequential performance judgments. *Journal of Experimental Psychology: Applied, 12*(3), 166.

Di Felice, U., & Marcora, S. (2013). Errors in judging Olympic boxing performance: False negative or false positive? In Peters, D. M. & P. O'Donoghue (Eds.), *Performance Analysis of Sport IX* (pp. 190-195): Routledge.

Gamer, M., Lemon, J., Fellows, I., & Singh, P. (2012). irr: Various Coefficients of Interrater Reliability and Agreement. R package version 0.84. *Internet resource: https://cran.r-project.org/web/packages/irr/index.html*, 2017

Johns, P., & James, B. (2013). The efficacy of judging within trampolining. In D. M. Peters & P. O'Donoghue (Eds.), *Performance Analysis of Sport IX* (pp. 214-221): Routledge.

Leskošek, B., Čuk, I., Karácsony, I., Pajek, J., & Bučar, M. (2010). Reliability and validity of judging in men's artistic gymnastics at the 2009 university games. *Science of Gymnastics Journal, 2*(1), 25-34.

Leskošek, B., Čuk, I., Pajek, J., Forbes, W., & Bučar-Pajek, M. (2012). Bias of judging in men's artistic gymnastics at the european championship 2011. *Biology of Sport, 29*(2), 107.

Morgan, H. N., & Rotthoff, K. W. (2014). The harder the task, the higher the score: Findings of a difficulty bias. *Economic Inquiry, 52*(3), 1014-1026.

Pajek, M. B., Forbes, W., Pajek, J., Leskošek, B., & Čuk, I. (2011). Reliability of real time judging system. *Science of Gymnastics Journal, 3*(2), 47-54.

Plessner, H. (1999). Expectation biases in gymnastics judging. *Journal of Sport and Exercise Psychology, 21*(2), 131-144.

Plessner, H., & Schallies, E. (2005). Judging the cross on rings: A matter of achieving shape constancy. *Applied Cognitive Psychology, 19*(9), 1145-1156.

Scheer, J. K., & Ansorge, C. J. (1975). Effects of naturally induced judges' expectations on the ratings of physical performances. *Research Quarterly. American Alliance for Health, Physical Education and Recreation, 46*(4), 463-470.

Shrout, P. E. (1998). Measurement reliability and agreement in psychiatry. *Statistical methods in medical research, 7*(3), 301-317.

Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength and Conditioning Research, 19*(1), 231-240.

Corresponding author:

Bojan Leskošek
University of Ljubljana, Faculty of sport
Gortanova 22
1000 Ljubljana
Slovenia
tel. +386 1 520-77-00
fax +386 1 520-77-40
e-mail: bojan.leskosek@fsp.uni-lj.si

HISTORICAL OVERVIEW OF GYMNASTICS AND (SCHOOL) PHYSICAL EDUCATION IN SLOVENIA

Tomaž Pavlin

Faculty of Sport, University of Ljubljana, Slovenia

Historical article

Abstract

The paper discuss relation of gymnastics and Physical education (PE) in schools in Slovenia in the period 1869-1941 while for the decade after the World War II. (WWII) we only present general situation after the political changes in Yugoslavia. In the period until World War I. (WWI), gymnastics as a new form of physical activity was introduced in schools. With the new school legislation of 1869 it became an obligatory school subject. This called for the establishment of curricula and hiring of professional staff, which was influenced also by the development of gymnastics in the civil society. The school subject was initially named "gymnastics" (as translated appropriately to German turnen and Slovenian telovadba). However, the term PE started to be used soon, until it ultimately replaced the previous name after WWI. PE was supposedly a broader expression that covered the educational aspects of this activity as well, while gymnastics was supposedly a narrower term, related solely to the physical aspects. In view of its previous development in the relevant societies as well as schools, gymnastics was the central activity in the context of PE. In the Slovenian case it involved exercises with or without gymnastics equipment, games, as well as certain martial arts elements or disciplines. With the paper we also want to encourage comparative analyses of similar situations especially between regions under former Austro-Hungarian and Yugoslavia as they share the common legislation and school milieu with cultural diversity.

Keywords: *gymnastics, physical education, school curriculum, Sokol movement, Slovenia.*

INTRODUCTION

Gymnastics as a modern activity and an extensive system of exercises (with or without gymnastics equipment, games, as well as certain martial arts elements or disciplines) with the aim of ensuring a comprehensive workout asserted itself in the society with the onset of the age of enlightenment. In the 19th century, several systems of gymnastics, developed in the context of gymnastic societies, had already been formed. In the Central Europe, the so-called *Turnverein* societies – German gymnastic societies – and partly also the Swedish gymnastics prevailed, while the Sokol organisation was prevalent among the Slavs. In the German lands, the *Turnverein* societies were established as early as in the first half of the 19th century, while in the

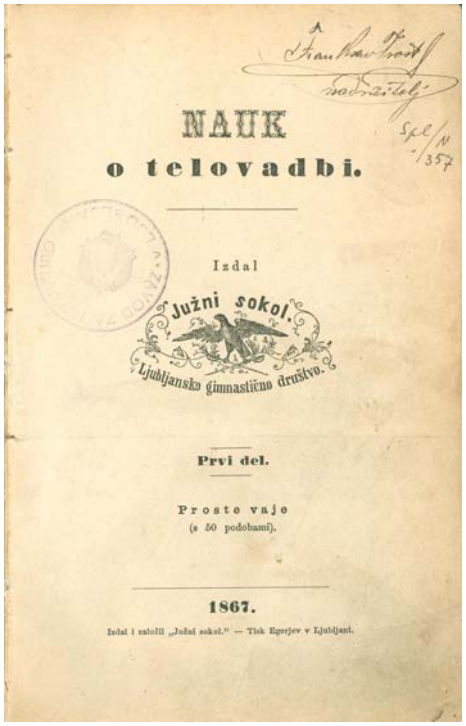
Habsburg Empire they were not implemented until the democratisation of the Empire after 1861. In the 19th century, simultaneously with the development of gymnastics in the dedicated societies and the onset of pedagogical philanthropy, the demands to permanently introduce gymnastics into the school curricula as an obligatory rather than merely an optional subject asserted themselves during the formation of the modern state and public education. In the Austrian Empire government or Ministry for Education accepted gymnastics or new system of physical exercises and activity in the school curriculum after March revolutions in 1848. Implementation was facultative, students could visited or practiced it according to principal's approvement as gymnastic courses were organised outside schools or on another school or on private. For example in Ljubljana, at the time the capital of Carniola, the first courses according to school approval were organised by Štefan Mandič, who also had seminars for citizens – for example from a group of gymnastic amateurs came an idea to form the first gymnastic society in 1862. Mandič's gymnastics was not attractive and already in 1851/52 his students had abandoned him. But the facultative opportunity of the gymnastics remained and students could visit seminars organised by private persons or school teachers' gymnastic amateurs. We can find similar tensions in Trst/Trieste, Celovec/Klagenfurt and Maribor. In Ljubljana in 1860 professor Jan Vavru, a Czech by nationality, who taught classical languages in gymnasium, took over gymnastic seminars. He also wrote a manual Gymnastic Exercises for the Gymnastic Society of the Ljubljana General Upper Secondary School/*Gymnastische Übungen für die Turnanstalt am k.k. Gymnasium zu Laibach*/ (1861) and the gymnasium also purchased some gym apparatus, while Vavru had to obtain gym grounds. In Maribor the teacher Markl was an important organiser of gymnastic seminars, similar seminars also took place in Celje and Ptuj. In this period, organisers or gymnastic teachers were good improvisers as schools did not yet have gym grounds at school nor any gym halls. The first school gym hall in Ljubljana was opened in 1874. (Stepišnik, 1974)

In the second half of 19th century gymnastics by establishing gymnastic societies spread throughout the Austro-Hungaria. On the territory of present-day Slovenia, two gymnastic societies, i.e., the German Turnverein and the Slovene Južni Sokol (South Falcon), were established in Ljubljana in 1862 and 1863 respectively. In the period before the First World War, a mass national and liberal Sokol movement was set up. In Slovene society, the Sokol societies brought about a new profession, which was spread and developed with the help of courses for instructors. The first professional works such as Science of gymmastics *(Nauk o telovadbi*) were published as early as 1867 (free exercises) and 1869 (pole and apparatus exercises) - the second edition was also accepted in schools in some parts of Slovenian teritory. For the Sokol professional development, courses for instructors organized by Viktor Murnik after 1896 are important. They were based on Tyrš's Sokol system, which became the basis of work in societies and professional work as well as the basis of contacts with Sokol movements in other regions/countries. (Pavlin, 2013)

Gymnastics in school before World War I.

Although we saw the first attempt of introducing gymnastics into schools after 1848 March revolution, new era in forming school gymnastics begun with 1869, when a school act was passed regulating primary schools and introducing a new curriculum with 2 hours of gymnastics for boys and needlework with housekeeping for girls. Later, girls were allowed to take part in gymnastics, the situation could be different in the Slovenian regions, but after 1883, this was again limited and allowed only if approved by their parents on the condition there were enough candidates. In 1870, the state introduced gymnastics into secondary

schools – first into natural science secondary schools and teacher training secondary schools. In grammar schools, gymnastics was optional at first and became obligatory in the 1909/10 school year. For educational needs teacher Janez Zima 1872 publish professional publication Gymnastics in the primary schools *(Telovadje v ljudskej šoli)*. On the other side Sokol in Ljubljana already in the 1860s organised gymnastic seminars for school students. The attendance at seminars depended not only of the professional knowledge of teachers or professionals but also of the national consciousness of students or their families. (Stepišnik, 1978)


NAUK

o telovadbi.

Izdal

Južni sokol.

Ljubljansko gimnastično društvo.

Prvi del.

Proste vaje

(s 50 podobami).

1867.

Figure 1. The cover page of the first professional work in slovene language Science of gymnastics/ Nauk o telovadbi (Faculty of Sport).

In school system the methodology of Adolf Spiess prevailed and the subject was based on free exercises and marching drills, pole exercises, apparatus exercises and games popular in schools. Sticking to Spiess's methods resulted in the rejection of gymnastics and in students being absent. For this reason, the »game afternoons« (*spielnachmitags*) were introduced in 1890 by educational government and were organized as after-school activities; in a number of places, they became on one side centres of increasingly popular English sports and on the other centres where secondary school students themselves organized sports activities. »Game afternoons« introduced disciplines of athletics/track and field, football, swimming, in winter skating and other activities. Already in 1895 in Ljubljana students competed in an antique pentathlon and at the end of the century football was also mentioned. Later, several student football clubs were formed; for example, among Slovenian students in the Ljubljana club *Hermes* and in the Gorica club *Yugoslavia*, both in the 1908/09 school year. In Ljubljana since at least 1910 there was also an action to organise rowing for students since in 1907 *LSK* (Ljubljana sport club) was established, with sections for rowing, tennis and sledging. Some *LSK* members also started with skiing, which after World War I. became very popular. An important fact when organising rowing was that students had to be good swimmers so the inclusion of rowing also influenced the growth of the swimming sport. (Stepišnik, 1974; Pavlin, 2005)

According to the preserved curriculums *(učni načrti/Lehrplans für Volkschule)* for primary schools (stored in Slovenian school museum and transcribed by Kompara & Čuk, 2006), we see gymnastics was in this period the fundament of curicullums. The purpose of gymnastics as school subject was strengthening the body, enhancing self-confidence, improving of motion and attitude to good body and mind and to enhance or keep in good condition body and mind and reinforcing bravery. Similar purposes we can see through curriculums in 1880s for girls: to strengthen the body and bravery, to enhance skills and flexibility, to improve or to enhance body and mind. Gymnastic lessons in these period in general based on free exercises (*proste vaje/frei übungen*) and marching drills or group free exercises (*redovne vaje/ordnungsübungen*), rope climbing and jumping, exercises with

bat and stick, apparatus exercises: pole, rings, ladder, balance beam, skip rope, parallel bars, pommel horse and games: gymnastic games and popular folk or child games and among them also ball games, but that were not sports, as sport was only introducing in the daily life. As we stressed above, sport found place in »game afternoons« in 1890s. With gymnastic festivals and on the other side sport events and Olympics arised questions about matches, races or competitions. In the Instructions for 1911 it was for example stressed that gymnastics were from the point of harmonically progression (combining body and mind) indispensable part of education and lessons; further on Instructions stressed gaining of force and influence on virility, discipline and mutually respect. We also see that competition was tolerated but not forced as Instructions mentioned it as "artificial gymnastics", which goal is only competition.

The organisation and implementation of gymnastics as school subject had quite a few difficulties as in 1869 not one Slovenian primary or secondary school had gymnastic grounds not to mention a gym hall. Another problem was lack of gym apparatus. The situation slowly improved and by 1880 37 gym halls were arranged on Slovenian territory or in the lands within Austria with a predominantly Slovene population; that were Carniola, southern Carinthia, southern Styria, Gorica region, Trieste region with the Karst and northern Istria. The situation was different from region to region: in Carniola 4 schools had a gym hall, in Carinthia 8, in Styria 10, in the Gorica region 1, in the Trieste region 14; in Carniola 31 schools had arranged gym grounds or workout facility outside school, in Carinthia 60, in Styria 132, in the Gorica region 23 and in the Trieste region 4, making a total of 251. A decade later in 1890 the situation was similar. The number of halls increased in Styria (13) and Carinthia (13). In 1891 in Carniola among the 298 primary schools only 8 had a gym hall, but on the other hand in 1874 a unique gym hall of the secondary (non-classical) school (*realka)* was built, becoming the first modern school gym hall in Ljubljana and Slovenia. State educational policy dictated the building of gym halls in every new secondary school, which was harder to implement in practice. In the period before WWI, beside the »realka« gym hall, new secondary school gym halls were built in Maribor (1887 and 1888), Ptuj (1890), Kranj (1899), Idrija (1902), Ljubljana (1899, 1905, 1907), and Trieste (1912). (Stepišnik, 1978)

Figure 2. The school garden in one of the primary school in southern Styria with some gym facilities, around 1890 (Slovenian school museum).

Inclusion of gymnastics or physical activity in curriculums raised also a question of a new profession: gymnastic teacher. According to the decree of the Ministry of Education (1870), the candidates who wanted to get qualifications in gymnastics or later Physical education (PE) had to pass an exam in front of the commission appointed for this purpose. In 1871, the first professional two-year course was organized in Vienna followed by a theoretical and practical exam. The candidates gained a detailed insight into the development of gymnastics, pedagogic principles, they became familiar with gymnastic systems, gymnastics terminology and they were trained in practical matters. The emphasis was also laid on human anatomy, physiology and biology. Many Slovenes from different parts of present-day Slovenia also enrolled on the courses. Among them

was also Franc Brunet, who taught gymnastics in Ljubljana and published a reference book in Slovene Gymnastics in elementary schools with five classes and with fewer than five classes *(Telovadba v petrazrednih in manj kot petrazrednih ljudskih šolah),* in 1900 reprint in 1907. (Ulaga, Knez-Bergant, 1992).

Gymnastics and PE in the Yugoslav state

By the end of WWI and decline of Austro-Hungaria Southern Slavs established the Kingdom of Serbs, Croats and Slovenes, from 1929 on the Kingdom of Yugoslavia. Similarly in the middle of 1919, Slovene, Croatian and Serbian Sokols merged into a uniform Yugoslav Sokol Union. On the founding general meeting they also discussed the relationship with school in new geopolitical space and time. The general meeting laid down a principle called »Sokol and schools« emphasizing the fact that the Sokol and school should be connected reciprocally. The Sokol movement had had a nation-forming task for over 50 years and in the new state, it should therefore penetrate all national schools with its spirit and take over PE in schools. Sokol teachers should also be PE teachers and vice versa. The Sokol movement should play a leading professional role in resolving issues concerning PE as well as within the framework of the authority structures from the lowest to the highest ones at ministry or government level. (Pavlin, 2013)

New authorities already in 1919 introduced two hours of gymnastics into schools but in contrast to the Austrian school system, Yugoslav one did not adopt game afternoons. Schools in the territory of present-day Slovenia took on a Slovenian character with so called process of Slovenianisation. Proces was important from the national and cultural points of view and it pushed out of schools Germanism. The process included also PE, where Sokol movement played important professional and cultural role. As we stressed above, the Sokol already at the general meeting in 1919 discus new school situation and laid down a principle. Obviously it was taken into account since in January 1920, the government ordered that school gymnastics should be carried out in accordance with the Sokol system. (Pavlin, 2013) By coming into schools and by introducing Sokol gymnastics and national education, Sokols were – in the catholic part of the country (Slovenia, Croatia and parts of Bosnia and Herzegovina) – confronted with the traditional educator, i.e., the Catholic Church, and its intention to use the principles of the catholic Orel in this part of education. This led to an eruption of the cultural fight between the Sokol and Orel movements which had a political liberal and catholic background, what was presented in our older paper (Pavlin, 2013; Dolenc, 1996).

Figure 3. Example of Sokol's free exercises, 1920s (Faculty of Sport).

The professional situation of school gymnastics or PE, which became the main expression in period 1918-1941, confronted the continuing lack of halls and gym

grounds and the lack of academic and scientific recognition of the subject, which means it was further on recognised as a skilful profession. In Slovenia in 1938 there were 871 primary schools and only 5.6% of them had a gym hall. Comparing to Austro-Hungarian time, when the 4.8% of schools had gym halls, shows that there had been no impressive development of the subject. A similar story applied to gym grounds. The conditions were relatively better in secondary schools but still not promising. So in this case in some places schools could PE situation save by *Sokols* gym halls and grounds. The professional basis of school gymnastics or PE was a *Sokol* gymnastics. Favourising of Sokol's gymnastics and also participation in Sokol societies blocade introducing of some sports in schools so sport, especially football, spread around primarily through civil society. In Slovenia there were good facilities for the development of winter sports. In 1925 the school authorities allowed the introduction of skiing. (Stepišnik, 1978) The permission positively influenced on organisation of skiing sport. Skiing was also more and more included in *Sokol* gymnastics and in the 1930s *Sokol* began with its own skiing sections and competitions.

Figure 4. Photography of first gym hall in Ljubjana from 1960s, still in function (Slovenian school museum).

The purposes of curriculums in 1920s stressed physical strengthens, improving motoric, developing self-confidence, physical and mental health, determination, distant and nice behaviour. After 1929 the political changes on state level brought into daily life Sokol of Kingdom of Yugoslavia. In 1932 followed new school law, which according to the political changes explicitly stressed the Sokol gymnastics and system in school PE. The curriculum purposes or goals in 1930s were harmonically (body/mind) development and body strengthening, upright body posture and fine moving or motoric improvement, agility and self-confidence, endurance, socialising, self-esteem and discipline. These goals were in years expanded with strengthening of breath and blood circulation from the view of health, cheering up nerves by singing, developing of sense for nature, environment and homeland. In all period 1918-1941 the basic activity of PE were gymnastics, in the 1930s explicitly Sokol gymnastics. The PE hours in the whole period were composed by free and group exercises, exercises with stick or other instruments, skipping rope and some apparatus as balance beam, ladder, pole and games. In 1930s it was expanded with swimming and rowing, where it was possible, in the winter skating and skiing and especially in second half of 1930s shooting as the geopolitical relations in Europe by growing Nazism were becoming strained; the curriculum included also camping, as it became also part of Sokol system, and competition. We also cannot neglect the fact that the Sokol system tended for physical and symmetric improvement of whole body and appropriately to that favorised all-round exercising instead of specialisation, what in today modern gymnastics is omitted (Bučar et al., 2016).

Sokol also took care of the professional basis and their 1921 general meeting made an appeal to the Ministry of Education for organizing courses for gymnastic teachers and for employing gymnastic teachers trained according to Sokol principles in all teacher secondary training schools in the country. They also made an appeal to the authorities for special supervisors for PE and proposed that a department of PE should be established in at least one faculty of arts – in cooperation with the faculty of

medicine; lecturers should be established Sokol experts. The Ministry of Health should awarded grants to young doctors skilled at physical exercises who could specialize as physiologists and develop the physiology of PE. However, the demands were because of world economic crises too radical for new authorities and in practice, the education of staff based on Sokol professional courses (in Ljubljana, a one-month training course for Sokol instructors was organized already as early as autumn 1919; it consisted of 10 lessons every day covering theoretical and practical aspects) which were also recognized in schools as appropriate for teaching PE. At the end of November 1920, Yugoslav Sokols met with the Czechoslovak Sokols in Ljubljana and in a solemn declaration, they stressed, among other, the tendency towards the creation of a new and complete type of a Slav who would strive to achieve human completeness. One of the central points of Sokol work was a physical rebirth of a nation and education of young generations that is why both Sokol organizations demanded that the states should pay attention to these issues and they would help them. They also stressed the fact that among the goals are the commitment to reforming schools and army according to Sokol principles, an obligatory law on PE of all citizens and the establishment of a college of PE either in Czechoslovakia or in the Kingdom of Serbs, Croats and Slovenes. Actually, a six-month Sokol school was organized in Prague in the late 1920s, where also Yugoslav Sokols were trained. This training, however, was carried out primarily in a civil society manner. On the basis of Sokols' initiatives, the Yugoslav state got involved in solving the problems regarding professionalism in PE in the late 1920s. In June 1927, it introduced a one-year course in PE for PE teachers in secondary schools. At the same time, Sokols emphasized that PE teachers and professionals in the field of civil PE should study for two years either at university or teacher training short-cycle College until a suitable short-cycle college of PE was established (Pavlin, 2014).

Figure 5. Secondary school students in group free exercises on the occasion of 1. festival of Yugoslav Sokol 1922 in Ljubljana (Faculty of Sport).

In order to calm a tense political situation in the Yugoslavian state in the 1920s which culminated with the shooting in the parliament in Belgrade in the middle of 1928 causing the death of two leading Croatian politicians, King Alexander staged a coup, established a dictatorship and dissolved the parliament and political parties on 6 January 1929. The Yugoslav Sokols met with King Alexander in March 1929 and prepared a memorandum with a law draft dealing with school youth PE and a law draft concerning a PE military school, which would mean that Sokol PE extended to include the military. They emphasized the general need for PE and claimed that history taught us that great cultures prospered as long as PE was a component part of general education. If a country wants to popularize PE among all strata of the nation, it must take care primarily of professionalism and suitable infrastructure in schools and in the army as well as of material and moral support of the Sokol movement, which promotes PE in the civil sphere. The memorandum included a plan for a three-year study programme comprising six semesters and 108 theoretical and practical lessons. The curriculum included 22 theoretical and practical subjects as gymnastics, games, athletics/track and field and sport, fencing, gymnastic systematics and theory, methodology of physical exercises, history and literature of physical exercises, aesthetics of physical exercises, general pedagogy, physics, biology, anatomy and histology with practical

classes, anatomy of the appearance of a human being, general physiology with practical classes, general and special physiology of physical exercises, general hygiene, school hygiene and hygiene of physical exercises, physical development and hygiene in pre-school period, anthropometry, orthopaedics, massage and medical exercises, first aid with practical exercises, the building and equipment of gymnastics and gymnastic facilities. (Memorandum, 1929)

At the beginning of the 1930s, the Sokol movement, which made an appeal for a school for professional staff, was joined by the Association of Sports Associations and by sports organizations in general that were organized independently of gymnastic organizations. While civil organizations kept demanding and emphasizing the need to establish PE studies, the latter already existed in many other countries. As a result of numerous initiatives and pressures and probably also as a result of the Slavic examples in Czechoslovakia and Poland, the Ministry of Physical Education of the Nation finally responded and in 1938 the Short-cycle College of Physical Education was established in Belgrade. Apart from the finished secondary school, a medical check-up and an examination in physical abilities and personal sports history were the requirements for enrolment. (Pavlin, 2014). With including Gymnastics into school and strong intentions for a school for profesional staff we would also like to open the question of teaching methodology or teaching styles, but contrary to actual researches - for example Santana et al. (2015), there is a problem of relevant sources.

Post-war restoration of PE

After the end of World War II and liberation the school system undergone restoration as well as political and ideological treatment. The restoration was based on the values of the antifascist/anti-Nazi fight for liberation and post-war sovietisation. The ‘new school’ according to new political and economic system would have to bring equality for students and expand education in all spheres of society and country. But in practice some 100 schools were war damaged and many others needed to be repaired. Another problem was the staff. Even though there was less teachers than before World War II., the new authorities combed the teachers and dismissed teachers suspected of unsuitable behaviour or acting during the war. To compensate the lack of staff authorities organised one-year specialist courses (Gabrič, 2005; Okoliš, 2009).

So PE after the war shared the circumstances of the war damage, restoration and political and economic situation. We must also stress that by the end of the 1940s the politico-economic situation in Yugoslavia become harder because of the Cominform conflict between the Soviet Union and its allies and Yugoslavia. PE in the new Yugoslavia after the first decade slowly acquired a new social and political position as it had to become part of general education of full value with important social aims and tasks. But that was harder to implement as in school milieu was strong stereotype of PE as non-scientific subject. The number of hours of PE in schools ranged from 1 to 3, depending of the type and grade of school or classroom rank. From the point of infrastructure in 1951 there were 1334 primary and secondary schools and only 166 had gym halls that allowed year-round practice of PE independently of climate conditions. During the 1950s some new gym halls were being built with citizens self-contributions but still there was a lack of PE staff and infrastructure. Schools were also included in the all-round competitions for the so-called ZREN acknowledgement (from acronyms For Republic Ahead/ Za REpubliko Naprej), which started after 1946 on the state level, while after the Cominform dispute in 1948 the curriculum also included pre-military education. The introduction of a monthly sports day as an obligatory part of school education in 1953, intended to promote spare-time sports activities among the youth, was an

important step. In accordance with the "physical culture" policy (with sovietisation "physical culture" became the umbrella term for physical activity with the subsystems of *physical education, recreation* and *sport*) the PE curricula in the first decade after WWII generally strove to unify the pre-war polarisation between gymnastics and sports. Although gymnastics remained a basic activity, unlike the pre-war years the curriculum was now expanded with a variety of sports. In the long term, in Slovenia this eventually led to the renaming of the subject to "Sports Education" (in 1990s) and today "Sports". And on the other hand, was or was not the "sportization" the beginning of "gradual disappearance of gymnastics« in curriculum like in some cases in Spain (Ramos et al., 2016)?

REFERENCES

Bučar Pajek, M., Hedbávný, P., Kalichová, M., Čuk, I. (2016). The asymmetry of lower limb load in balance beam routines. *Science of Gymnastics Journal, 8* (1), 5 – 13.

Dolenc, E. (1996*). Kulturni boj. Slovenska kulturna politika v Kraljevini SHS 1918-1929* [Cultural struggle. Slovenian cultural policy in Kingdom of SCS 1918-1929]. Ljubljana: Cankarjeva založba.

Gabrič, A. (1992). Šolska reforma. [School reform]. In J. Fischer et al. (Eds.), *Slovenska novejša zgodovina: od programa Zedinjena Slovenija do mednarodnega priznanja Republike Slovenije 1848–1992* [Slovenian contemporary history 1848-1992], part 2. (pp. 1035–1037). Ljubljana: Mladinska knjiga, Inštitut za novejšo zgodovino.

Kompara, A. & Čuk, I. (2006). Športna gimnastika v učnih načrtih osnovnih šol od leta 1874 do 1941 [Sports gymnastics in primary-school curricula from 1874 to 1941]. *Šport, 54* (2), 30-42.

Križnar, I., Serpan, E. (1978). Telesna vzgoja v šolah od osvoboditve do danes. [Physical education in schools from liberation to date]. In S. Pavlič (Ed.), *Razvoj šolske telesne vzgoje na Slovenskem* [Development of school physical education in Slovenia] (pp. 24-56). Ljubljana: Slovenski šolski Muzej.

Okoliš, S. (2009). *Zgodovina šolstva na Slovenskem* [History of Education in Slovenia]. Ljubljana: Slovenski šolski muzej.

Pavlin, T. (2005). *"Zanimanje za sport je prodrlo med Slovenci že v široke sloje"* ["The Interest for Sport has gone through Slovenes in wide classes"]. Ljubljana: Fakulteta za šport.

Pavlin, T., & Žvan M. (2014). Herald of new, healthier mode of life (Academization of physical education and formation of the Faculty of Sport), *Kinanthropologica, 50* (2), 21-29.

Pavlin, T. (2013). "The duty of a Sokol is to yet again step into the national frontline" (Sokol movement in Slovenia – 150th anniversary of Južni Sokol), *Science of Gymnastics Journal, 5*(3), 5-19.

Ramos M.A.A., Ruiz M.A.M., Molina G.M. (2016). Gymnastics dispositions and skills: a case study listening to the voices of teachers. *Science of Gymnastics Journal, 8*(1), 57 – 70.

Sanatana, V. M., Gutiérrez-Sánchez, A., López-Bedoya, J. (2015). Reciprocal teaching of gymnastic links in higher education. *Science of Gymnastics Journal, 7*(2), 33 – 44.

Spomenica JSS o telesnom vaspitanju sa nacrtom zakona o telesnom vaspitanju školske omladine i sa nacrtom pravilnika za telesno vaspitnu vojničku školu. [Memorandum on physical education (with a law draft concerning physical education of school youth and with a regulations draft concerning a military physical education school]. Jugoslovanski sokolski savez [Yugoslav Sokol Association], Ljubljana, 13.4.1929.

Stepišnik, D. (1968). *Oris zgodovine telesne kulture na Slovenskem* [An overview of history of physical culture in Slovenia]. Ljubljana: DZS.

Stepišnik, D. (1974). *Školsko fizičko vaspitanje na području Slovenije u periodu*

1848–1914 [School physical education in Slovenia 1848-1914]. Unpublished doctoral dissertation, Beograd.

Stepišnik, D. (1978). Šolska telesna vzgoja do leta 1945 [School physical ducation till 1945]. In S. Pavlič, (Ed.), *Razvoj šolske telesne vzgoje na Slovenskem* [Development of school physical education in Slovenia] (pp. 5-21). Ljubljana: Slovenski šolski muzej.

Ulaga, D., Knez-Bergant, M. (1992). Izobraževanje strokovnih kadrov za šolsko športno vzgojo pred ustanovitvijo Zavoda za fizkulturo v Ljubljani [Education of proffesionals for school physical education]. *Šport (Ljublj.)*, *40*(1-2), 54-55.

Corresponding author:

Tomaž Pavlin
University of Ljubljana
Faculty of Sport
Gortanova 22
1000 Ljubljana
Slovenija
phone: +386 (01) 52 07 700
e-mail: tomaz.pavlin@fsp.uni-lj.si

FORMS OF AND EXERCISES ON THE HORIZONTAL BAR DURING THE SECON HALF OF THE 19th CENTURY

Vasilios Kaimakamis[1], George Dallas[2], Dimitris Kaimakamis [1]

[1] Aristoteleio Unversity of Thessaloniki - Department of Physical Education and Sport Science Thessaloniki, Greece
[2] National and Kapodistrian University of Athens - Physical Education and Sport Scienc, Athens, Greece

Historical article

Abstract

The horizontal bar, from its invention until the middle of the 19th century, underwent several phases of evolution; it remained however, wooden and fixed to the ground. The exercises were static, dynamic, close to the bar, and without amplitude and swing. In the middle of the 19th century, metal bars and then height-adjustable horizontal bars started to appear. From this new and more favourable apparatus more difficult exercises and combinations with swing and amplitude emerged, while the static and dynamic exercises continued. In the 80s, the stabilizers for the wooden pillars appeared, while in the last decade of the 19th century, the iron flexible horizontal bar was constructed with stabilizing chains and a height-adjusting mechanism. Such a horizontal bar was also used in the 1896 Olympics, where exercises with amplitude and swing but also static and dynamic exercises were performed. The aim of this work was to research and highlight the main features of the evolution of the horizontal bar (exercises, regulations and apparatus) in the second half of the 19th century.

Keywords: *pillar, metal bar, dynamic-static exercises, regulations, artistic gymnastics.*

INTRODUCTION

From its invention (1811-1812), by the founder of the German gymnastics system Ludwig Jahn, the horizontal bar was regarded as an apparatus useful, simple and easy to use. It was thus, improved and promoted both by Jahn (mainly through his workbook) (Jahn & Eiselen, 1816) and by his students and then gained a prominent position both in the German gymnastics system and in the sport of artistic gymnastics that developed later (Borman, 1978). The horizontal bar currently holds same prominent position in modern artistic gymnastics competitions since the alternations of various exercises and grips, the speed of the giant swings and especially the spectacular flight phases of the program, as well as the exits make it fascinating and popular piece of aparatus. It is also noteworthy that several pieces of apparatus (both for women and men) have been enriched with many elements from the horizontal bar (Kaimakamis, 2003). The fact that this apparatus (and the parallel bars)

was promoted and featured as an emblem of the German gymnastics system which was since its birth embraced by a national and political-social ideology (Krüger, 1993), was the cause of many enemies.

Over the years, all these enemies of the above system failed to halt the evolution of the horizontal bar which, as mentioned above, took a leading position both in the German gymnastics system and in the field of competitive artistic gymnastics.

METHOD

The present study attempted to research, record and highlight the evolution of horizontal bar in the second half of the 19th century. It also explores the position of this apparatus in physical education, in gymnastic systems and in sports. The method used is that of the research field while data collection was based on archival historical research and focused on the forms and ways of construction of the horizontal bar, as well as the type of exercises performed on it. In order to provide correct and objective interpretations, a brief reference to the German gymnastic system and its founder was made in the introductory part.

In this study, data collection was based mainly on the written primary sources of authors as: Jahn / Eiselen, Neuendorf, Kluge / Euler, Gregenow / Samel, Paging, Anne and Chrysafis. Also, several early authors of the modern era were included, such as Diem, Göhler, Gasch, Huquenin, Gajdos, Pahncke, Spieht, Borrmann, Kaimakamis. Useful information was also found in the work titled "Jahn's horizontal bar and its forerunners" in which various forms of horizontal bar (mainly for acrobats) from ancient times to Jahn's era (Kaimakamis et al, 2012), are researched.

Introduction and establisment of the metal bar

In the first half of the 19th century, the horizontal bar had various shapes and sizes and was wooden and fixed to the ground while the exercises were more static and dynamic, without amplitude and swing, since this apparatus did not allow for such exercises (Spieht, 1989). Since the mid 19th century, mainly due to the introduction of the metal bar, there has been a rapid development of the exercises performed on this apparatus. Those involved in the sport of artistic gymnastics know that the quality and functionality of the apparatus has a direct impact on the quality and quantity of exercise performed, as well as the athletes' injury safety (Götze, 1983). According to the German historian Edmund Neuendorff (1875-1961), the first person to introduce the iron bar to Germany and perhaps to the whole world, in 1850, was J. Carl Lion. Another author, Wassmannwdorff, reports that in 1852 in Heidelberg a steel bar was used (Neuendorff, 1929). As mentioned above, in the sport of artistic gymnastics, exercises and pieces of apparatus are in constant interaction (Gross & Leikov, 1994). Thus, when the bar became metallic, that is, thinner, more flexible, more durable and more user-friendly, the quality and type of exercises and the way of their execution also changed greatly.

With the advent of the metal bar, there was no particular change in the general shape of the horizontal bar; initially, it remained stably fastened (planted) to the ground on wooden pillars (Figure 1a) and a little later a height-adjustable metal bar (Figure 1b) (Gregenov & Samel, 1919) was introduced.

The enhancement of the bar, from wooden to metal, was a turning point and exercises with more amplitude and swing started to appear. Thus, in the 1850s, the kip and the giant swing, two spectacular and useful "key" exercises were performed and they have been used in athletes' programs ever since. It is noteworthy, that acrobats of earlier years (Diem, 1967), were already familiar with the giant swing which is also illustrated in Eiselen's tables (1837) although it is not clear if athletes of that era were performing it. After the 1850s, athletes began to perform the giant swing more often using both A and B grip, ie front and back. According to the historian of artistic

gymnasics Josef Göhler (1992), the kip was performed for the first time in Leipzig by the German gymnast Karl Kunz. In the years that followed, this exercise was performed with variations; even with one hand (the other hand grabbed the forearm of the performing hand). The new bars featured several advantages but they were still far from perfect and effective since they were used as out of the foundry, that is, without any special processing. In fact, the bar was painted with a special dye or was wrapped with genuine leather (Gasch, 1920) in order for the athletes to avoid sliping off.

The Czech gymnastic's historian Anton Gajdos (1997) reports that in 1862 the Gymnastics Federation of his country (founded in 1843) organized gymnastic competitions which included exercises on a 6 cm diameter wooden horizontal bar. The type of exercises and the order of performance of the athletes came from a kind of lottery. The judges wrote several exercises, perhaps on papers, which were placed in a hat. Each athlete took a piece of paper from the hat and performed the exercises in the sequence written on the paper. There were three judges who scored on a scale of 1 to 5.

The horizontal bar in the 1870s and 1880s

In 1872, in Berlin, the Germans H.O. Kluge and C. Euler (1872) issued an in-depth piece of work titled "Turngeräte und Turneinrichtungen für Schul-und Militär Turn-Anstalten" which, among other things, devotes 15 pages and many images to the horizontal bar. The aforementioned authors divide the horizontal bars, depending on their form, use and location, into two categories: those that are fixed and located in outdoor gymnasiums, and those that are portable and located inside, in indoor gymnasiums. The authors also mention that sometimes the stable horizontal bars can be placed indoors while the portable ones, outdoors. Specifically, indoor horizontal bars have various forms and functional particularities (wall, ceiling, floor etc.) so that when they need to be removed, this can be done easily and quickly. It is important to note that apart from all of these horizontal bars there is also a wooden portable one with an iron bar which can be easily set up and removed but is not suitable for high speed exercises or exercises with amplitude (Figure 2b). In total, Kluge and Euler exhibit 15 different horizontal bars, ie wooden with wooden bar, wooden pillars with iron bar, wall, and side-by-side at various heights; some of which are shown in Figure 2.

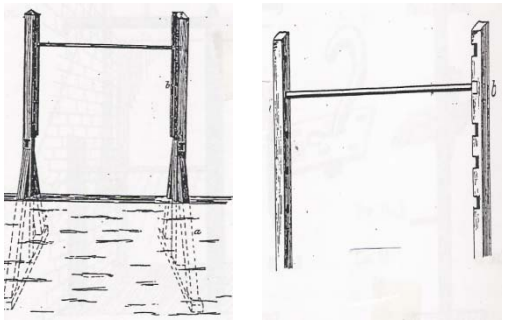
The wooden bar which was mainly made of beech or apple tree was often poured with hot oil to make it durable. The construction and processing of the wooden bar and the wooden horizontal bar in general, which continued to be used despite the fact that the metal bar had been introduced, went through the following three phases (Spieht, 1989):

-Phase 1(Gasch, 1920): they cut trunks from tall, straight and new trees (pines, beech, elms, maples, apple trees) which they peeled and left to dry. They then cleaned them well, coated them with oil and finally sanded them down. There was a similar process for the pillars which were thick and fixed to the ground. The exercises performed on this horizontal bar were static, dynamic, and without amplitude and swing.

-Phase 2 (Schwobe, 1988): They chose trunks of young trees without knots (mostly pine, beech, oak) which they stored for a long time. After the relevant treatment, they joined two pieces together making sure that the woodgrains were in the same direction; making the bar more durable. The bar however, was still very thick and fragile (6-8 cm in diameter) which made performing exercises with great swings and amplitude, difficult.

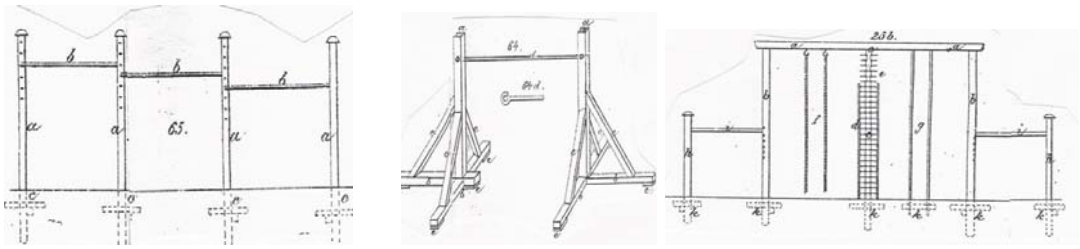
-Phase 3 (Schwobe, 1988): after the relative processing of the wood intended for the bar, they placed in the center an iron or steel rod, as in a writing pencil. The bar above was more durable and could be made a bit thinner, making the grip more convenient which was favourable for the execution of more and even more difficult and complex exercises.

Gajdos provides information about a gymnastics competition held in his country, the Czech Republic in 1875 (Gajdos, 1987). The most spectacular of the compulsory and free programs performed on the horizontal bar was: back uprise in B grip and direct swing to handstand, half turn right, back giant swing (in A grip), dismount with tuck position over the bar. Over time and particularly because the giant swings created a problem in the stability of the apparatus, three support bars (pricks) which were the forerunners of the chains and the wires that were introduced later, were placed to right and left of each wooden pillar (mainstay) (Figure 6). Such a horizontal bar is also refered to in the "Updated Encyclopaedic Dictionary (in Greek)" which among other things states (Neoteron): "HORIZONTAL BAR: a gymnastic apparatus consisting of two solid wooden posts embedded in the ground and coupled to a three centimeters in diameter steel bar ..." (in Greek).



(a) (b)

Figure 1. Stable horizontal bars with wooden pillars (a) and a metal bar (b). In the first figure the dotted lines illustrate the part and the shape of the pillars beneath the ground. In the second figure the metal bar is height-adjustable (Gregenow / Samel, p. 7).



(a) (b) (c)

Figure 2. Various types of horizontal bars, according to Kluge and Euler (Kluge / Euler, 1872).

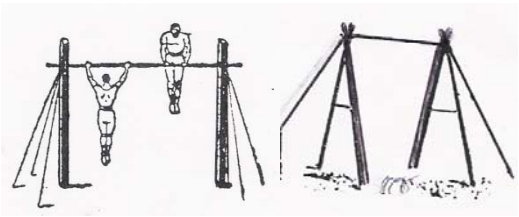


Figure 3. Various types of horizontal bar with support bars which were the precursors of the stabilization chains and wires (Updated Encyclopaedic Dictionary, Vol. 3, p. 39; Spieht, p. 70).

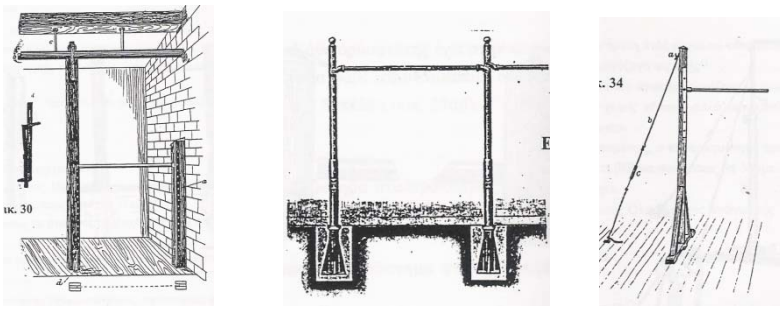


Figure 4. Various types of horizontal bar (fixed, portable, wooden, wall, exterior, etc.) (Gregenow/Samel, p.7-35).

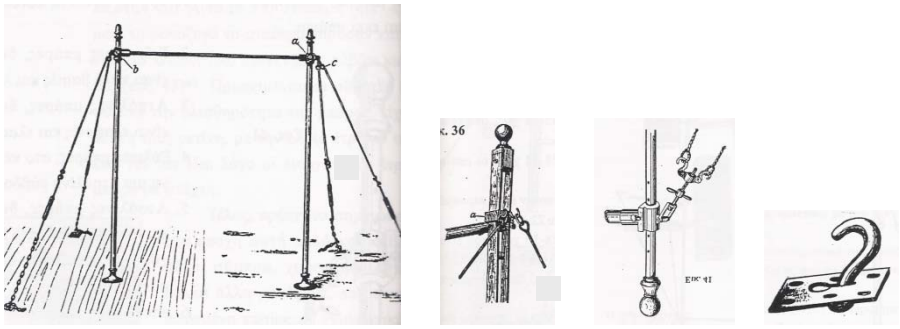


Figure 5. The almost perfect horizontal bar (metallic, portable) with height-adjustable bar and a stabilisation system used in the 1896 Olympics (Gregenov & Samel, 1919).

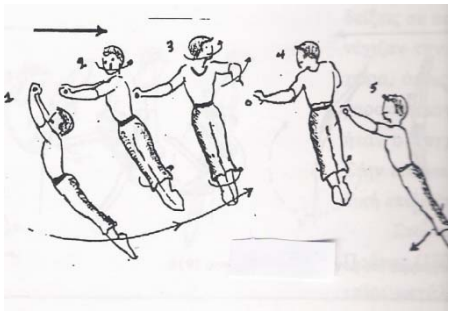


Figure 6. One of the first flight phases on the horizontal bar in the last decade of the 19th century (Kaimakamis, Main charact.., p. 417).

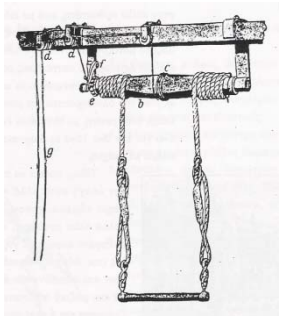


Figure 7. The swinging horizontal bar which in the 19th century was included in the main pieces of apparatus of gymnastics, and was then and until today used by acrobats (Gregenow/Samel, p.7-35).

In 1883, Ioannis Fokianos published a comprehensive, for its period, book entitled "Handbook of Gymnastic" where he devoted a 15-page chapter (Fokianos, 1883) to the horizontal bar. He did not describe the horizontal bar and its construction but divided the exercises into two major categories ie those that are performed by hang position and those that are performed by support position, while naming and illustrating the main grips (Fokianos, 1883). The remaining pages were devoted to the way a school class can be organized, composed and can practice on more than one horizontal bar.

The horizontal bar in the last decade of the 19th century

In the last decades of the 19th century, many types of horizontal bar are manufactured and used depending on the purpose, economic potential and space. Thus, there are high, low, wooden, metal, fixed, portable, wall, exterior etc. (Figure 4) (Gregenov & Samel, 1919).

In the last decade of the 19th century, in addition to the above-mentioned horizontal bars, the most developed competitive horizontal bar appeared which gratly resembled the one used in modern competitions. It was a metallic, portable horizontal bar with an adjustable-height bar and stabilising-chain systems (Figure5) (Gregenov & Samel, 1919). Such a horizontal bar was used, as will be discussed later, in the first international Olympic Games in Athens in 1896 (Kaimakamis et al, 2003).

It is worthwhile noting that on the aforementioned horizontal bar, exercises and programs were already being performed at an enviable level which marked a particular development in this apparatus (compared to other gymnastic pieces of apparatus) giant swings, and even exercises with a flight phases (Kaimakamis et al, 2003). In fact, one of the first exercises was the following: swing backwards in B grip, resease, full turn on the longitudinal axis (at the bar height) and regrasp in A grip (Figure 6) (Göhler, 1980). Note that the above exercise resulted from a backward dismount with twist.

In parallel, static and dynamic elements continued to be performed, sometimes mixed with swing elements and sometimes completely separate (Gotze & Herolz, 1992). It should be noted that the static and dynamic elements were retained (based on the regulation requirements) for the horizontal bar programs until the Berlin Olympics (1936) (Kaimakamis, 2005). Moreover, in those days, regulations were not uniform across federations and the pieces of gymnastic apparatus had neither common dimensions nor standards. This created major problems during competitions, even between clubs of the same country (Huguenin, 1981). Nonetheless, meetings and competitions between clubs and, more importantly, the organisation of sports festivals under the auspices of a European sports federation that cultivated the German gymnastics system had become an institution in several European countries (Kaimakamis, 2005).

Researching the historical evolution of the 19th-century horizontal bar, one also encounters the swinging horizontal bar, described in detail by Gregenow and Samel (Figure 7) (Gregenov & Samel, 1919).

One type of swinging horizontal bar was the swinging triangle that the Swiss Phokion Heinrich Clias (1785-1854) claimed to have invented in 1816 (Clias Phokion Heinrich, 1816). The apparatus was later developed into an "*aeropetastis*" and even the rings later invented by Spiess (Chrisafis, 1965). It is known that the swinging bar was established and evolved and is used, to this day, by circus acrobats. This was about the state of the pieces of apparatus, especially the horizontal bar, when in 1896 the first international Olympic Games took place in Athens and the so-called gymnastic sports (artistic gymnastics) were conducted according to the German gymnastic system.

The horizontal bar at the first international Olympic Games (Athens 1896)

The regulations drafted by a special Greek committee under President John Fokianos did not allow acrobatic and dangerous exercises. However, especially the Germans who were very skillful performed spectacular giant swings switching grips and directions (Kaimakamis, 2005). The panel of judges consisted of seven people from different countries including the successor to the Greek throne, Constantine, who was chairman of the committee. The score ranged from zero to 20 and each judge assessed three factors simultaneously: synchronisation (overall picture), rhythm and technical training (Chrisafis, 1930).

The horizontal bar competition was divided into: the team performance on 10 horizontal bars and in the individual performance. Only the German team of 10 athletes, which was in any case unrivalled, took part in the first competition. The 10 athletes, under the guidance and command of the coach Fritz Hofmann, performed on 10 horizontal bar a impressive 4-minute program and became the Olympic Champions since their program more than covered all the requirements (Kaimakamis et al, 2003).

In the individual race, which was quite similar to today's apparatus final, 17 athletes from four different countries took part. The Germans, Weingärdner and Flatow (first and second respectively) (Krüger, 1994) emerged as Olympic champions. The program lasted up to 2 minutes and the judges assessed equally the following two factors: control and strength exercises, and flexibility and skill exercises. Each judge gave two points from zero to 20, one for each factor (Anninos, 1896). Overall, at these first Olympic Games, it was the Germans athletes who particularly impressed on all pieces of apparatus and thus won the most victories.

CONCLUSION

In the first half of the 19th century, the horizontal bar was wooden and fixed to the ground in various shapes and dimensions while the exercises were mainly static and dynamic, without amplitude and swing, since this apparatus did not allow for such exercises. In the middle of the 19th century, the metal bar was introduced which a direct impact on the exercises had performed. As a result, exercises with a great deal of amplitude and swing could be performed in parallel to the static and dynamic ones. Although the metal bars developed, the various forms of horizontal bars with wooden bars continued to be used. In the last decade of the nineteenth century, an iron, portable horizontal bar was constructed which used stabilising chains and a height-adjusting bar mechanism. On this horizontal bar, even more spectacular exercises and combinations were performed and the first flight phases and difficult discmounts were introduced. Until the end of the 19th century, there were no commonly used regulations, dimensions and functional specifications for the horizontal bar. Overall, during the 19th century, the horizontal bar dominated artistic gymnastics and the German gymnastics system, in general, in local and international competitions, as well as in the 1896 Olympics.

REFERENCES

Anninos, X. (1896). *Desription of competitions.* In: Olymbic Games. (eds: Mpek, pp. 38-39).

Borrman, G. (1978). *Gerätturnen,* Berlin, 15-26.

Chrisafis, I. (1930). *The modern international Olympic Games*, Athens.

Chrisafis , I. (1965). *Gymnastics of the Ancient*, Athens.

Clias, P.,H. (1816). *Anfangsgründe der Gymnastik oder Turnkunst,* Bern.

Diem, C. (1967). *Weltgeschichte des Sports und der Leibesübungen,* Verl. Cotta. Stuttgart.

Fokianos, I. (1883). *Manual of Gymnastics,* Athens..

Gajdos, A. (1987). Die Entwicklung der Turnkunst am Reck. *Leistungssport, 7*, 546.

Gajdos, A. (1993). Entwicklung und Prognose der Turnübungen am Reck. *Olympisches Turnen Aktuell, 2*, 28.

Gajdos, A. (1997). *Artistic Gymnastics. A history, of development and Olympic competition,* British Amateur Gymnastic Association.

Gasch, R. (1920). *Handbuch des gesamten Turnwesens und der Verwanden Leibesübungen,* Wien und Leipzig.

Göhler, J. (1980). Die Turnkunst bei den Olympischen Spielen. *Stadion*, VI: 158.

Göhler, J. (1992). Wer turnte die erste Riesenwelle. *Olympisches Turnen Aktuell*, *6,* 28.

Göhler, J. (1987). Die Geburtsstunde des Reck vor 175 Jahren. *Turnen & Sport*, *4,* 49.

Götze A. & Herolz E. (1992). *Das Turnjahrhundert der Deutschen*. Berlin.

Götze A., & Zeume J. (1983). *Flick flack*, Berlin.

Gross H. & Leikov H. (1994). Niedersprungmatten- von Entwicklung und

Normierung zu Einsatz im Training und Ettkampf, *Leistungssport,* 625, *26*.

Huguenin A. (1981). *100 Years of the International Gymnastics Federation 1881-1981,* Schwizerland, 31-36.

Jahn L. & Eiselen E. (1816). *Die Deutsche Turnkunst.* Berlin, 147-167.

Kaimakamis B. & al. (2003). The Rules of Gymnastics in the first international Olympic Games in Athens (1896). *Annual of CESH*, *1*, 167-76.

Kaimakamis, V. (2003). *Artistic Gymnastics (8th ed.).* Thessaloniki: Meandros.

Kaimakamis V. (2001). Main features of the evolution of artistic gymnastics in the first half of the 20th century. *Doctoral dissertation* (in Greeke). Aristotelio University of Thessaloniki.

Kaimakamis, V. (2005). *Artistic gymnastics on Olymbic games of the modern Greeke state*. Thessaloniki.

Kaimakamis V. Kirialanis, P. and Kaimakamis D. (2012). Jahn's high bar and their precursors. *Athlisi & Koinonia, 52*, 15-21.

Kluge H.O.& Euler C. (1872). *Turngeräthe und Turneinrichtungen für Schul-und Militär Turn-Anstalten*, Berlin, 55-70.

Kluge V. (1996). *Albert Meyer war der Fotograf der ersten Olympischen Spiele, in 1896 Athen*. Brandenburg, 100-113.

Gregenow R. & Samel W. (1919). *Gerätkunde für Turnlehrer und Turnvereine*. Berlin.

Krüger, A. (1994). Olympische Bewegung- 100 Jahre Völker Verständigung und Wett-kamf Pädagogik. *Leistungsport, 33,* 343.

Krüger, M. (1993). *Einführung in die Geschichte der Leibeserziehung und des Sports*, Schorndorf, 111- 112.

Neuendorff, E. (1929). *Geschichte der neueren deutschen Leibesübungen, vom Beginn des 18 Jahrhunderts bis zur Gegenwart*, Leipzig..

Newer Encyclopedic Dictionary, vol. 3, 39.

Schwobe, F. (1988). Turngeräte wiederentdecken (Reckturnen), *Turnen & Sport, 4,* 226.

Spieht, R. (1989). *Geschichte der Turngeräte*, West Germany, 70-71.

Corresponding author:

George Dallas
National and Kapodistrian University of Athens - Physical Education and Sport Scienc
41, Ethnikis Antistaseos Dafne
Athens 17237
Greece
Phone: +0030 210 66 43 704
Fax: ++0030 210 727 6028
Email: gdallas@phed.uoa.gr

HEART RATE RESPONSE DURING A VINYASA YOGA SESSION

Angela Tsopanidou, Kalliopi Theodorakou, Elias Zacharogiannis

School of Physical Education and Sport Science, National and Kapodistrian University, Athens, Greece

Original article

Abstract

The practice of Yoga seems to have beneficial effects on holistic health and wellness. The purpose of this study was to evaluate the exercise intensity of a Vinyasa yoga session. Heart rate (HR) response of 24 moderately trained adults (12 male, 12 female; mean age ± sd; 39±7.33 years) was recorded during two Vinyasa yoga sessions consisted of four phases (warm up, surya namaskar, 45-minute remaining exercise and cool down). HRmax had been estimated seven days earlier after a maximal effort treadmill test. Data analysis included the mean of HR (b.p.m) and %HRmax in each phase of the two sessions and an ANOVA with repeated measures (gender X Vinyasa phases) was applied. The results revealed that there was no significant interaction between the two factors or significant main effect of gender either in HR or %HRmax. Significant, though, differences ($p<0.01$) were found between the four phases of Vinyasa session, with surya namaskar presenting the highest mean values. Vinyasa yoga participants in the present study used 68.8%-71.7% of their %HRmax for at least 60 minutes. The above exercise intensity and duration are within the widely accepted guidelines for improving cardiorespiratory endurance parameters in moderately trained people. It seems that systematic participation in Vinyasa yoga may effectively improve aerobic fitness and promote health.

Keywords: *exercise intensity, endurance, energy expenditure, aerobic capacity.*

INTRODUCTION

Yoga is one of the six fundamental, traditional Hindu philosophical systems and a form of asceticism (Iyengar, 2005; Ninan, 2003; Filinis, 2009).It includes body postures (asanas), breathing control techniques (pranayama), deep relaxation (nidra yoga) and meditation (chanda) which aim at connecting the "outer" human (physical existence) with the "inner" human being (soul-spirit) (Margioris, 1983; Varenne, 1978).Although yoga is clearly a Hindu traditional philosophical system, it is considered in the western world as one of the most popular alternative forms of exercise. There are many different types of yoga emphasising different parameters and aspects, such as breathing techniques, relaxation techniques, flexibility, alignment,

muscle strength and endurance orflow of motion in combination with breathing (Berger & Owen, 1992; Groessl, Weingart, Aschbacher, Pada, &Baxi, 2008; Roland, Jakobi, & Jones, 2011). The term "vinyasa" is a general term for every type of yoga in which practitioners follow a sequence of asanas linked to each other by flow and proper breathing (Fraser, 2005). This sequence of Vinyasa yoga postures usually includes a wide range of motions performed at a fast pace with frequent changes of levels in space, which increases the heart rate of practitioners and potentially benefits the cardiorespiratory and metabolic system(Caroll, Blansit, Otto, &Wygand, 2003; Mody, 2011).

The practice of Yoga seems to have beneficial effects on holistic health and well-being (Iyengar, 2005; Mehta, 2002) including the improvement of physical fitness parameters (Cowen & Adams, 2004; Gruber, 2008; Oken et al., 2006; Tran, Holly, Lashbrook, &Amsterdam, 2001); the cardiovascular and respiratory system (e.g. Abel, 2011; Cowen & Adams, 2004;Shinde, Shinde, Khatri, & Hande, 2013; Tran et al., 2001); weight reduction (Benavides & Caballero, 2009; Bernstein, Bar, Ehrman, Golubic, & Roizen, 2013; Gokal, Shillito, & Maharaj, 2007; Seo et al, 2012) and decrease in anxiety, stress and depression in healthy individuals and patients with mild symptoms (Gruber, 2008; Oken et al., 2004; Silva et al., 2009).

Despite indications that yoga practice can improve cardiorespiratory endurance in healthy practitioners, few studies have measured heart rate (HR) response duringspecific types of yoga practice (Blank, Raman, Chock, & Krieger, 2001; Caroll et al., 2003; Mody, 2011). Carroll et al. (2003) evaluated the HR and volume of oxygen uptake (VO_2) during a 15-minute videotaped session of 6 Astanga vinyasa yoga asanas repeated through verbal guidance. The authors concluded that this type of yoga can be used as a moderate training stimulus (143±14bpm HR, 77%HRmax) contributing to the improvement of the cardiorespiratory system through its aerobic and anaerobic energy requirements. Blank, Raman, Chock and Krieger (2001) also studied HR response and energy requirements during a sixty-minute power yoga session (a type of vinyasa yoga that emphasises muscle strength and flexibility) and found that the mean percentage of the maximum heart rate (%HRmax) during the entire session was about 60-70%.Anders (2005) comparedthe exercise intensity and energy expenditure of two fifty-minute videotaped Hatha and Power Yoga sessions respectively, and concluded that the mean %HRmax was 48±3.4% during Hatha yoga and 62±5.4% during Power yoga. Using a thirty-minute videotaped Hatha yoga session Clay, Lloyd, Walker, Sharp and Pankey (2005), measured the average HR response at 105.29bpm and the corresponding mean %HRmax at 56.89%, concluding that the intensity of this session was too low to be a training stimulus capable of improving the parameters of cardiorespiratory endurance.They did, however, highlight the importance of practising Surya Namaskar, which is a specific series of 12 vinyasa yoga postures, to increase the intensity of exercise during a yoga session. The potential effects of Surya Namaskar on the cardiorespiratory and metabolic system were recently studied by Mody (2011) who observed that practitioners exercised Surya Namaskar for 12minutes and with intensity corresponding to 80% of age-predicted HRmax;a percentage able to elicit a cardiorespiratorytraining effect in healthy adults (Haskell et al., 2007; Thomson, Gordon, & Pescatello, 2010).The findings of Cowen and Adams (2007) relative to the heart response of sixteen adults practitioners in three different types of yoga, i.e. Astanga, Hatha and Gentle, corresponded to low-intensity aerobic physical activity, as the %HRmax of the participants was estimated at 54%, 45% and 42% respectively for each session. Ward, McCluney and Bosch (2013) also reached similar conclusions when studying the HR response in a fifty-minute Vinyasa yoga session. During the session, the mean ± sd HR of the participants was

calculated at 107±23 bpm while the corresponding% HRmax reached 58% (±12). This percentage corresponds to low-intensity aerobic activity which can improve the cardiorespiratory system of individuals with a low baseline fitness level (30-40 $ml.kg.^{-1}.min.^{-1}\dot{V}O_2max$) or those with sedentary lives (Hagins, Moore, & Rundle, 2007; Haskell et al., 2007; Thomson et al., 2010).Finally, Ward et al. (2013) suggest further researchinto the individual HR response during this type of exercise.

Although these results indicate that some types of yoga can be used as an aerobic form of physical activity capable of improving cardiorespiratory endurance in healthy practitioners, the findings are conflicting and it remains unclear which ones meet the American College of Sport Medicine (ACSM; Thomson et al., 2010) and the American Heart Association's (AHA) physical activity guidelines (Haskell et al., 2007). In order to improve the cardiorespiratory system, these guidelines recommend moderate intensity (64-76% HRmax) aerobic activity of at least 30 minutes for five days a week, or higher intensity activity (77-93% HRmax) of at least 20 minutes for three days a week. The purpose of this study was to investigate the intensity of exercise through the HR response to a 90-minute Vinyasa yoga session held under a real classroom environment with the supervision and guidance of an experienced yoga teacher in order to establish the contribution of this kind of exercise to maintaining and improving the parameters of cardiorespiratory endurancein untrained or moderately trained adult practitioners.

METHODS

Twenty-four adults (12 males and 12 females) aged 30-50 years (mean ± sd, 39 ± 7.33) volunteered to take part in this study. All participants were healthy individuals, with no medical history. Furthermore, they had experience in performing various forms of physical activity for more than four hours a weekand had practiced yoga for at least one year, with an exercise frequency of 2-4 times a week. The specific sample selection criteria ensured the safety of the participants and the certainty that the measurements would not be affected by their lack of experience. The participants were members of gyms and yoga practice centres belonging to 5 municipalities of Attica, Greece (Heraklion, Nea Ionia, Kifissia, Athens & Glyfada).

During the sample collection process all practitioners were briefed on the content of the study. Following the briefing, practitioners who volunteered for the study completed a short questionnaire with their personal data**.** The study participants were randomly selected from the volunteersand were the first 12 females and 12 males who fulfilled the participation criteria. All participants, having been informed of the procedures, the difficulties and risks of the study, and having understood and agreed upon the conditions of their participation, signed a written informed consent.

The experimental design consisted of four distinctphases with seven days between eachphase: (a) the familiarisation with the measuring instruments phase; (b) the laboratory measurement phase; c) the 1stand 2ndVinyasa yoga session with seven days apart. (Figure 1)

All laboratory measurements were performed in the presence of a physician and an experienced Exercise Physiologist, while the Vinyasa yoga sessions were held in a specially designed room in to SPESS (School of Physical Education and Sport Science) under the supervision of an internationally recognised yoga teacher (Yoga Alliance). The environmental conditionswere kept constant using a central air-conditioning system with the temperature set at 20±1° C and the relativehumidity at 60%±2.

Prior to the start of the laboratory measurements, the participants were provided with nutritional and physical activity guidelines for the day preceding the test and during the test day. In particular, carbohydrate-rich meals and abundance of

fluids were recommended prior to the tests while they were also advised to avoid caffeine and alcohol containing beverages and cigarette smoking on the test day. The participants were requested to have their last meal at least 5 hours prior to the start of the measurements while the consumption of liquids was allowed ad libitum until the start of the tests, to avoid dehydration. Additionally, it was recommended that the participants abstain from intense physical activity at least 24 hours prior to the test (Williams & Wilkins, 2000).

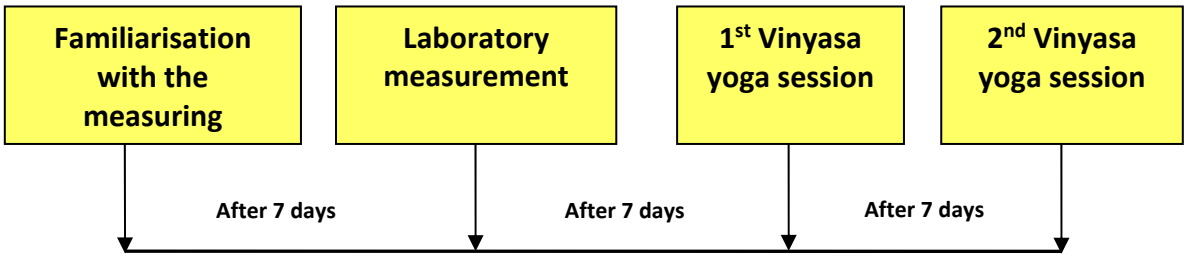


Figure 1. Experimental Design Phases.

The participants' somatometric characteristics (height, body mass, %body fat) and basic parameters of cardiorespiratory endurance (HRmax, VO_2peak) were measured in the laboratory. Height was measured barefoot, after full inhalation, to the nearest millimetre with a height measure (Seca Leicester, U.K).The body mass measurement was done using a mechanical column scale (Seca 710, U.K.) and the participants wore only shorts and a t-shirt. A skinfold caliper (Harpenden, U.K.) was used to measure the percentage of body fat. Four skinfolds (biceps, triceps, subscapular, suprailiac) on the right side of the body were measured. The calculation of the percentage of body fat was made according to the equations of Durnin and Womersley (1974). In order to find HRmax and VO_2peak, the participants performed a maximal effort test on a treadmill (Technogym runrace 1200, Italy), starting at a speed corresponding to about 30% of HRmax and with progressively increasing intensity. The treadmill's incline was maintained at 0% throughout the test and the speed increased 1km.h^{-1} every 2 minutes to the point where the participant was unable to follow the pace of the treadmill (Scott & Houmard, 1994). During the test, the participants were breathing through a face mask (full face Hans Rudolph, U.S.). The volume of exhaled air and the determination of VO_2 and VCO_2 was made by an online metabolic cart (Quark CPET, Cosmed, Italy). VO_2peak was calculated from the mean of the two highest values per 30 seconds of the parameter. The HR measurement was performed throughout VO_2peak test. The participants wore a belt around their chest (Polar, Finland) which had built-in electrodes to detect the electrical charge of each cardiac contraction and a transmitter to send the corresponding signal to a receiver that was connected to the program of the spirometer. Thus, along with other values, HR was also stored for later analysis. The HRmax value for each participant was determined during the last ten seconds of the VO_2peak test.

For the measurement of the HR during the two Vinyasa yoga sessions a HR telemetry device (HOSAND TM 200, Italy) was used to send, every four seconds, the HR values to a PC, where they were stored for future analysis.

Vinyasa yoga session protocol

Initially, participants were informed of nutrition and physical activity recommendations for the day prior and the day of the sessions which were similar to those given prior to the laboratory measurements. Vinyasa yoga sessions and

laboratory measurements were conducted on the same time of day.

The 90 minutes duration Vinyasa yoga sessions (this is the usual duration of a traditional yoga session) during phase 3 and 4 of the experimental design, were held on the same day of the week at the same time, with seven days apart (Figure 1) and consisted of four phases:1) Warm up**:** for fifteen minutes with a three-minute practice of ujjayi pranayama (breathing control technique) in supine position, as well as specific yoga postures and basic exercises from a stand position that activated all body muscle groups and joints; 2) Main part: for sixty minutes which included a) practice in Surya namaskar for fifteen minutes b) the remaining of the exercise of the main part for forty-five minutes, including standing asanas, supports, balances, positions in prone and supine, inverse and sitting asanas, practicing ujjayi pranayama; 3) Cool down: for 15-minutes including asanas in supine and sitting positions, breathing control techniques (nadisodhana pranayama) and relaxation techniques (nidra yoga) in supine position (savasana).

Statistical analysis was performed with Microsoft Office Excel 2003 and the SPSS 21 statistical software. Initially the descriptive statistics of the variables (mean±sd) were calculated. Data analysis included the mean of HR (b.p.m) and %HRmax in each phase of each session, as well as the mean values between the two sessions. A2 (Gender) x 4 (Vinyasa phases) analysis of variance (ANOVA), with repeated measures on the second factor was calculated. Post hoc analyses were also conducted with the use of the Bonferroni test, with alpha set at $p \leq 0.05$ (Keppel, 1991).

RESULTS

The participants somatometric characteristics are presented in Table 1. The basic parameters of the participants cardiorespiratory response are presented in Table 2.

Table 1
Somatometric characteristics of females (n_1=12), males (n_2=12) and all participants (n=24): Mean values (± sd) and range of values (minimum- maximum) of age, body mass, height and percentage of body fat.

Variable	FEMALES (n_1=12)	MALES (n_2=12)	ALL PARTICIPANTS (n=24)
Age (years)	39.2 ± 7.6 (30- 50)	38.17 ± 7.31 (31- 50)	39±7.33 (30- 50)
Body mass (kg)	56.6 ± 10.73 (38.40- 83.0)	76.63 ± 8,90 (61.10- 85.00)	66.60±14.07 (38.40-85.00)
Height (cm)	160 ± 5.48 (146 -167)	174.42 ± 5.85 (161- 181)	167.38±9.32 (146 -181)
% Body fat	26.7 ± 5.3 (18.73- 37.18)	19.9 ± 4.27 (13.21- 26.86)	23.30±5.86 (13.21-37.18)

Table 2
Cardiorespiratory response parameters for females (n_1=12), males (n_2=12) and all participants (n=24): Mean values (± sd) and range of values (minimum-maximum) of HRmax and VO_2peak.

Variable	FEMALES	MALES	ALL PARTICIPANTS
	(n_1=12)	(n_2=12)	(n=24)
HRmax (bpm)	182.58 ± 11.1	184.50 ± 9.51	183.54±10.13
	(165 -199)	(164 - 197)	(164 - 199)
VO_2peak (ml.kg^{-1}.min^{-1}) (peak oxygen uptake)	41.3 ± 4.9	49.7 ± 6.63	45.48±7.12
	(32.52 – 49.32)	(39.50 – 59.84)	(32.52 – 59.84)

Table 3
Mean values (± sd) and statistically significant differences in HR (bpm), relative to the four phases, among males, females and all participants.

	Vinyasa session phases				
		Main Part			
SEX	Warm up	Surya Namaskar	45΄ Remaining exercise	Cool down	Whole session
Females (n_1=12)	109.02±6.65	135.77±9.58	129.09±7.57	101.55±7.62	118.86±5.93
Males (n_2=12)	105.15±8.38	127.41±12.02	123.06±11.96	99.32±9.22	113.87±8.62
All participants (n=24)	107.08±7.66^{1,2}	131.59±11.45^{1,3}	126.35±10.18^{1,3,4}	100.43±8.35^{2,3,4}	116.36±7.67

Table 4
Mean values (±sd) and statistically significant differences in the %HRmax of males, females and all participants, in the four phases.

	Vinyasa session Phases				
		Main Part			
Sex	Warm up	Surya Namaskar	45΄ Remaining exercise	Cool down	Whole session
Females (n_1=12)	59.55±5.69	74.12±8.87	70.39±4.70	55.47±5.37	64.88±4.95
Males (n_2=12)	56.98±3.93	69.23±7.46	67.17±7.45	54.09±6.85	61.87±5.69
All participants (n=24)	58.27±4.96^{1,2}	71.68±7.45^{1,3}	68.78±6.31^{1,3,4}	54.78±6.06^{2,3,4}	63.38±5.44

Statistically significant difference ^{1,3,4}: p< 0.01
Statistically significant difference ^{2}: p< 0.05

The participants' mean VO_2peak (45.48±7.12 ml.kg^{-1}.min^{-1}) indicates that they initially had a moderate level of aerobic capacity (McArdle, Katch, & Katch, 1986).

According to the results of the ANOVA, there was no significant interaction between the two factors (p=0.419) or significant main effect of gender (p=0.113) in participants' HR. However, significant differences (p<0.01) were found between the four phases of Vinyasa session ($F_{3,66}$=125.86, p<0.01). Specifically, the Bonferroni analysis revealed that in all participants (male and female) (Table 3) (a) warm up had lower values than Surya Namaskar (p <.001) and the 45 min remaining of the main exercise (p <.001) and higher values than cool down (p = .029), (b) Surya Namaskar had higher values than the 45 min remaining exercise (p = .002) and cool down (p <.001) and (c)

the 45 min remaining exercise had higher values than the cool down ($p < .001$).

Regarding the %HRmax, the results revealed that there was no significant interaction between the two factors ($p=0.394$) or significant main effect of gender ($p=0.180$) in %HRmax. However, significant differences were found between the four phases of Vinyasa session ($F_{3,66}=124.16$, $p<0.01$). Specifically, the Bonferroni analysis revealed that in all participants (male and female) (Table 4) (a) warm up had lower values than Surya Namaskar ($p < .001$) and the 45 min remaining exercise of the main part ($p < .001$) and higher values than cool down ($p = .040$), (b) Surya Namaskar had higher values than the 45 min remaining exercise ($p = .002$) and cool down ($p < .001$) and (c) the 45 min remaining exercise had higher values than cool down ($p < .001$).

DISCUSSION

In recent years, in the various sports venues, there has been an increase in popularity of alternative ways of exercising, including the practice of yoga which seems to have beneficial effects on health and well-being (Iyengar, 2005; Mehta, 2002). The purpose of this study was to investigate the intensity of the exercise through the HR response to a 90-minute Vinyasa yoga session under a real classroom environment with the supervision and guidance of an experienced teacher and to study also the use of this type of exercise to maintain and/or improve the parameters of cardiorespiratory endurance of untrained or moderately trained adult practitioners. The results of this study revealed that for at least 60 min (main part) during a Vinyasa yoga session, the participants used 68.8% to 71.7% of their %HRmax, while the mean absolute HR value ranged between 126.35±10.18 and 131.59±11.45 bpm. The intensity and duration of this form of exercise is within the limits proposed by the ACSM and AHA (Haskell et al., 2007; Thomson et al, 2010) for maintaining or improving the parameters of cardiorespiratory endurance in moderately trained subjects. It seems that systematic participation in Vinyasa yoga sessions can help preserve and improve these parameters. Although these results indicate that some types of yoga, such as Vinyasa, can be used as an aerobic form of physical activity capable of improving cardiorespiratory endurance in healthy practitioners, the literature review reveals that the findings are conflicting and it remains unclear which of these values are in line with the guidelines of the ACSM and AHA (Haskell et al., 2007; Thomson et al, 2010). Recently, Ward et al. (2013) studied the HR response of thirty-eight healthy adults (31.4 ± 8.7 years) during a fifty-minute Vinyasa yoga session. The mean HR value was calculated at 107±23 bpm while the corresponding %HRmax reached 58% (±12). This percentage is similar to the values (63.38 ± 5.44%, 116.36 ± 7.67 bpm) of the present study. The slightly larger values of our study may be explained from the duration of the session (90 min vs 50min) and the mean age of the subjects (39.2 ± 7.33vs 31.4 ± 8.7 years). Ward et al. (2013) also noted that further investigation of individual HR during a Vinyasa yoga session was needed due to the diversity found in exercise intensity, from the individual participant values throughout the session, which ranged from 50-93% of HRmax. In the study by Blank et al. (2001) all six participants during a sixty minute Power yoga session had similar rate of intensity (60-70% HRmax) compared with the present study. In agreement with the findings of the present study are the results of Anders' (2005) who compared the exercise intensity and the energy expenditure of two fifty-minute videotaped Hatha and Power Yoga sessions. During the sessions, the fifteen highly experienced yoga practitioners had a mean HR value (bpm) and corresponding %HRmax, 89 ± 5.8 bpm, 48 ± 3.4% and 115 ± 8.0 bpm, 62 ± 5.4% for Hatha and Power yoga respectively. The mean HR (bpm) value and the corresponding %HRmax value of the Power yoga session reported by Anders (2005), are consistent with

corresponding mean values (116.36±7.67 bpm, 63.38±5.44%) of the Vinyasa yoga session of this study.Conversely, Cowen and Adams (2007), studying the HR response of sixteen male and female adults (31.8±11.96 years) over three eighty-minute Astanga, Hatha and Gentle yoga sessions respectively, found that the mean HR and %HRmax during sessions was 95±12.84 bpm, 80±9.32 bpm and 74±7.41 bpm, and 54±0.09%, 45±0.06% and 42±0.06% respectively. These values do not match the corresponding values (116.36±7.67 bpm, 63.38±5.44%) of this study, as different type of yoga and different asanas were practiced. The study of Cowen and Adams (2007) also recruited small (n=16) sample size and younger (31.8±11.96 years) compared with the participants in this study (n=24; 39±7.33 years respectively). The average HR when recorded and stored every minute during a single session compared to every 4 seconds during the two sessions of this study may be another source of error regarding this value. The conclusion of the study by Carroll et al. (2003) also differed to that of the present study. They evaluated the HR and volume of oxygen uptake (VO_2) of thirteen experienced adult (36.7±6.5 years) practitionerspracticing yoga 3-36 months and concluded that Vinyasa yoga can be a moderate training stimulus (143±14 bpmHR, ~77% HRmax) capable of eliciting an improvement to the cardiorespiratory system. The values of this study (HR, 116.36 ± 7.67 bpm; 63.38 ± 5.44% HRmax) are significantly lower than those of Carroll et al. (2003), even if compared to the sixty-minute practice of the main part of the study during which participants were exercising with higher intensity (68.78±6.31% - 71.68±7.45% HRmax). Such differences are expected, as Carroll et al.'s (2003) routine lasted 15 minutes and included only six asanas and even videotaped guidance, while the routine in this study lasted 90 minutes under the supervision of an experienced teacher and included, among other things, techniques related to the control of breathing and relaxation. During a videotaped 30-minute Hatha Yoga session, Clay et al. (2005) measured 26 adult women (23.39±4.30 years) and reported mean HR response 105.29±14.92bpm and the corresponding mean %HRmax 56.89±8.37%. The corresponding mean values(HR, 116.36 ± 7.67 bpm; 63.38±5.44% HRmax) of this study are in line with the findings of Clay et al. (2005), while the differences can be justified by the type of yoga, the shorter session duration, the videotaped guidance and the female-only participation in the Clay et al. (2005) study.

A number of researchers (Hagins et al, 2007; DiCarlo et al, 1995; Mody, 2011; Walls, 2007) have focused on the importance of Surya Namaskar practice in order to increase the exercise intensity during a yoga session. Clay et al. (2005) found that during the five-minute practice of surya namaskar the highest mean values were observed in both HR (123.85±16.67bpm) and %HRmax (66.99±9.99%). The present study also came to the same conclusion, as the highest mean HR (131.59±11.45bpm) and %HRmax (71.68±7.45%) were observed during surya namaskar's fifteen-minute practice. The potential effects of surya namaskar on the cardiorespiratory and metabolic system were also studied by Mody (2011) who reported that during a 12 minute practice of surya namaskar, the mean HR (bpm) and %HRmax of six adults practitioners (19.8±1.5 years) with surya namaskar practice experience of at least two years, was 156±19 bpm and 80% HRmax. These values are significantly higher than the corresponding mean values (131.59±11.45bpm; 71.68±7.45%) obtained in the present study. This difference is likely to be due to the lower age and the number of participants participating in the Mody (2011) study compared to this study (39±7.77 years; n=24, respectively), the experience in yoga practice (>2 years) of the Mody (2011) study, compared to this study (>1 year), and the fact that the participants in the Mody (2011) study repeated surya namaskar forty-eight times without teacher guidance, while the participants in the

present study repeated surya namaskar twenty-four times under the supervision of an experienced teacher. Significant methodological differences were also observed in the HR recording during the two sessions, as well as in the way the predicted HRmax was determined for each participant. In the present study, the individual HR of each participant was recorded during the two Vinyasa yoga sessions while in the Mody (2011) study it was recorded in only one session. Furthermore, the predicted HRmax for each participant in the Mody (2011) study was determined using the equation: 220-age participant, while in the present study the individual value of HRmax was measured during the VO_2peak test. This most likely affected the accuracy of the mean %HRmax calculation of the participants in the Mody's (2011) study. Both studies though, concluded that the systemic practice of surya namaskar can elicit cardiorespiratory adaptations.

The present study is the first in yoga practice that attempted to investigate the differences in HR response and %HRmax between female and male participants. The relevant findings show that during the Vinyasa yoga sessions, no significant difference was observed either in the mean HR value of female (118.86±5.93) and male (113.87±8.62), or in the corresponding mean %HRmax (64.88±4.94%; 61.87±5.69%) for female and male respectively. Significant differences ($p<0.01$) were only observed for the mean HR value and the corresponding %HRmax when grouping all participants (n=24) between the four phases. Surya namaskar's practice showed the highest mean value in HR and %HRmax, compared to the corresponding mean value of the individual phases (warm up, 45-minute remaining exercise, cool down) of the session for both male andfemale participants and for all participants in the study. It is clear from the findings of this and other studies (Clay et al., 2005; Hagins et al., 2007; Mody, 2011) that surya namaskar practice for more than ten minutes is likely to increase the intensity of exercise and the corresponding energy expenditure during a yoga session, and to improve the cardiorespiratory system parameters of the participants.

Summarising the findings of the present study, it is concluded that Vinyasa yoga is a form of low to moderate intensity exercise which corresponds to 63-72% of HRmax and is suitable to improve the level of cardiorespiratory endurance parameters in people with low to moderate baseline fitness level (30-45 $ml.kg^{-1}.min^{-1}$ $\dot{V}O_2$max; McArdle et al., 1986). Furthermore, systematic participation in Vinyasa yoga sessions may be used as an alternative form of exercise, similar to moderate intensity and continuous aerobic activity, which can contribute to maintaining and/or improving the parameters of the cardiorespiratory system of untrained or moderately trained adult practitioners. The findings of this study could help exercise specialists and yoga professional teachers to better understand the practice of Vinyasa yoga with regard to the physiological requirements and prescription of this type of exercise. Moreover, as yoga practice studiestend to quantify the intensity of exercise during a session, both exercise practitioners and yoga teachers will be able to better define the content of a session based on the individual needs and limitations of each practitioner. Vinyasa yoga is one of the most popular and enjoyable types of yoga for practitioners and since there is an absence of studies relating to its effects on the cardiorespiratory and metabolic system, further research is essential.

Directions for future research

The present study included male and female adults, with a mean age of 39.9±7.33 years and a moderate baseline fitness level (45.48±7.12 $ml.kg^{-1}.min.^{-1}VO_2$peak). Future research could focus on younger or older participants or participants with a higher level of baseline fitness. It would also be interesting to evaluate and compare the HR response of beginners and experienced practitioners in a 90-minute Vinyasa yoga

session. Further research into the practice of Vinyasa yoga, could include a larger number of participants, or more sessions. The findings of the present study were based on participation in two yoga sessions, however the HR response to routine (3-5 sessions/week) vinyasa yoga participation remains unclear.

REFERENCES

Abel, A.N. (2011). *The Effects of Bikram Yoga on Selected Cardiopulmonary Measures and Psychological Constructs*. Unpublished doctorial dissertation. Texas State University.

Anders, M. (2005). Does yoga really do the body good? *ACE FitnessMatters*, 7-9.

Benavides, S., & Caballero, J. (2009). Ashtanga yoga for children and adolescents for weight management and psychological well being: an uncontrolled open pilot study. *Complementary Therapies in Clinical Practice*, *15*(2), 110-114

Berger, B.C., & Owen, D.R. (1992). Mood alteration with yoga and swimming: aerobic exercise may not be necessary, *Perceptual and Motor Skills*, *75*, 1331-1343.

Bernstein, A., Bar, J., Ehrman, J., Golubic, M., &Roizen, M. (2013).Yoga in the Management of Overweight and Obesity.*American Journal of Lifestyle Medicine*, *8*(1), 33-41.

Blank, Raman, Chock, & Krieger (2001). Heart rate and oxygen cost responses to power yoga asanas in beginning practitioners. *Medicine & Science in Sports & Exercise 33*(5), S107.

Carroll, J., Blansit, A., Otto, R., & Wygand, J. (2003).The metabolic requirements of Vinyasa yoga. *Medicine & Science in Sports & Exercise*, *35*(5), S155.

Clay, C.C., Lloyd, L.K., Walker, J.L., Sharp, K.R., & Pankey, R.B. (2005).The metabolic cost of hatha yoga.*The Journal of Strength & Conditioning Research*, *19*(3), 604-610.

Cowen, V., & Adams, T. (2004). Physical and perceptual benefit of yoga asana practice: results of a pilot study. *Journal of Bodywork and Movement Therapies, 9*, 211-219.

Cowen, V., & Adams, T. (2007). Heart rate in yoga asana practice: A comparison of styles. *Journal of Bodywork and Movement Therapies*, *11*(1), 91-95.

DiCarlo, M.S., Sparling, P.B., Hinson, B.T., Snow, T.K., & Rosskopf, L.B. (1995). Cardiovascular, Metabolic, and Perceptual Responses to Hatha Yoga Standing Poses. *Medicine ExerciseNutrition & Health, 4,* 107-11.

Durnin, V., & Womersley, J. (1974). Body fat assessed from total body density and its estimation from skinfold thickness: measurement on 481 men and women aged from 16 to 72 years. *British Journal of Nutrition, 32*, 77-97.

Filinis, M. (2009).*Οι διδακτικές τεχνικές της Hatha γιόγκα [Hatha Yoga Teaching Techniques]*.Αθήνα: Αθλότυπο (in Greek)

Filinis, M. (2011).*Τα Φιλοσοφικά Κείμενα της Γιόγκα* (τόμ. Α΄) *[Philosophical Writings ofYoga*(volA)]. Αθήνα: Ghyta (in Greek)

Fraser (2005).*Total Astanga*. London: Duncan Baird Publishers

Gokal, R., Shillito, L., & Maharaj, S. (2007). Positive impact of yoga and pranayam on obesity, hypertension, blood sugar, and cholesterol: a pilot assessment. *The Journal of Alternative and Complementary Medicine*, *13*(10), 1056-1058.

Groessl, E., Weingart, K., Aschbacher, K., Pada, L., & Baxi, S. (2008). Yoga for veterans with chronic low-back pain.*Journal of Alternative and Complementary Medicine, 14,* 1123–1129.

Gruber, K. (2008). *The Physiological and Psychological Effects of Ashtanga Yoga*. Unpublished master's thesis. Cortland, NY. State University of New York at Cortland.

Hagins, M., Moore, W., & Rundle, A. (2007). Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness?.*BMC*

Complementary and Alternative Medicine, *7*(1), 40.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., *et al*. (2007). ACSM/AHA Recommendations. *Circulation, 116(9), 1081-1093*

Iyengar, B.K.S. (2005). *Light on life.* London, UK: Rodal International.

Iyengar, B.K.S. (2005). *The illustrated Light on yoga.*New Delphi: HarperCollins Publishers.

Keppel, G. (1991). *Design and analysis: A researcher's handbook* (3rded). NewYork: Prentice-Hall.

Margioris, N. A. (1983). *Κάρμα – Ο νόμος της ανταποδοτικής δικαιοσύνης* [*Karma – The Law of Reciproca lAction*].Αθήνα: Εκδόσεις Κληρονόμων.(in Greek)

McArdle, W.D., Katch, F.I., & Katch, V.L. (1986). *Exercise Physiology: Energy, Nutrition, and Human Performance.* Baltimore, Williams and Wilkins.

Mehta, M. (2002). *Health through yoga.* London, UK: Thorsons.

Mody, B.S. (2011).Acute effects of Surya Namaskar on the cardiovascular & metabolic system.*Journal of Bodywork and Movement Therapies*, *15*(3), 343-347.

Ninan, M.M. (2003). *Hinduism: The Story of Indian Thomas Churches What Really Happened in India.* BooksurgeLIc.

Oken, B., Kishiyama, S., Zajdel, D., Bourdette, D., Carlsen, J., Haas, M., *et al.* (2004). Randomized controlled trial of yoga and exercise in multiple sclerosis. *Neurology*, *62*(11), 2058-2064.

Oken, B., Zajdel, D., Kishiyama, S., Flegal, K., Dehen, C., Haas, M., *et al.*(2006). Randomized, controlled, six-month trial of yoga in healthy seniors: effects on cognition and quality of life. *Alternative Therapies in Health and Medicine*, *12*(1), 40.

Roland, K. P., Jakobi, J. M., & Jones, G. R. (2011). Does yoga engender fitness in older adults? A critical review.*Journal of Aging and Physical Activity*, *19*(1), 62.

Scott, B. K., & Houmard, J. A. (1994). Peak running velocity is highly related to distance running performance. *International Journal of Sports Medicine*, *15*(08), 504-507.

Seo, D., Lee, S., Figueroa, A., Kim, H., Baek, Y., Kwak, Y., *et al*. (2012). Yoga training improves metabolic parameters in obese boys. *The Korean Journal of Physiology & Pharmacology*, *16*(3), 175-180

Shinde, N., Shinde, K., Khatri, S., & Hande, D. (2013). A Comparative Study of Yoga and Aerobic Exercises in Obesity and its Effect on Pulmonary Function. *Journal of Diabetes & Metabolism.*

Silva, T.L., Ravindran, L.N., & Ravindran, A.V. (2009). Yoga in the treatment of mood and anxiety disorders : A review. *Asian Journal of Psychiatry, 2,* 6-16.

Thompson W, Gordon N, & Pescatello L. (2010). *ACSM's Guidelines for Exercise Testing and Prescription*. (8thedn). Baltimore: Wolters Kluwer Lippincott Williams & Wilkins.

Tran, M., Holly, R., Lashbrook, J., & Amsterdam, E. (2001). Effects of Hatha Yoga Practice on the HealthRelated Aspects of Physical Fitness. *Preventive Cardiology*, *4*(4), 165-170.

Varenne, J. (1978). *Ουπανισάντ του γιόγκα* [*Upanishads to yoga*] (μτφ.:Γ. Τζαμαλούκας). Αθήνα: Δωδώνη. (in Greek)

Walls, M.R. (2007). *Heart rate response during hatha yoga and the effects of hatha yoga on health-related physical fitness.*Unpublished master's thesis. Cortland, NY. State University of New York at Cortland.

Ward, S., McCluney, N., & Bosch, P. (2013). Heart Rate Response to Vinyasa Yoga in Healthy Adults. *Journal of Yoga & Physical Therapy*, *3*(3), 139-14.

Williams & Wilkings, 2000. *American College of Sports Medicine. Guidelines for Exercise, Testing and Perscription* (6thed.). Philadelphia.

Corresponding author:

Angela Tsopanidou
National and Kapodistrian University of Athens
Physical Education and Sport Science
Metsovou 18, Glyfada
Athens 16674,
Greece
e-mail: angelatsopanidou@hotmail.com

PURSUING A GYMNASTICS FOR ALL AND BY ALL

Mauricio Santos Oliveira, Yan Tavares Galdino da Silva & Paula Cristina da Costa Silva

Federal University of Espírito Santo, Centre for Physical Education and Sports, Vitória, Brazil

Case study

Abstract

Gymnastics can promote the improvement of body awareness and better mastery of movements and has potential to go beyond the physical aspects by enhancing the socio-affective factors that permeate its practice. In disciplines organized by the Fédération Internationale de Gymnastique (FIG), Gymnastics For All (GFA) is the foundation for all others. It is a unique form of gymnastics that seeks harmony, creativity, freedom, and diversity inside heterogeneity, always having regard for the physical, psychological and social well-being of its practitioners. Written in a predominantly pedagogical perspective of GFA, this paper aims to share and reflect on the work and philosophy of Gymnastic Group LABGIN, based in Souza(1997). This university extension project involves the initial training of Physical Education students. The training includes a social practice that is inclusive, democratic, and able to infuse these individuals with elements of the body culture, which hopefully influence their future teaching practice. Through training practice it seeks to promote experiences with social values to them.

Keywords: *Gymnastics for all; Gymnastic Group; Teaching-learning Methodology.*

INTRODUCTION

Gymnastics is universal. It is educational, sportive and it is, in some way, life, with its shadows and lights. It is equally an example, a life model for all (Bruno Grandi in Ahlquist, 2000, p. 177).

Above mentioned speech by former President of the Fédération Internationale de Gymnastique (FIG) signals the character and the worldwide scope of Gymnastics For All (GFA). Through its different nuances, GFA is capable of exerting a significant benefit to the life of its practitioners.

Gymnastics is capable of promoting improvement of physical abilities and body awareness, as well as providing better control and mastery of the body. It has the potential to enhance the complete development of human beings, since it goes beyond physical aspects into socio-affective factors that permeate the practice environment (Nunomura, Ferreira-Filho, Duarte, Tanabe, & Oliveira2016).

Among the different disciplines of gymnastics, GFA is consolidated as the foundation for the other forms of Gymnastics. Other than the joy of practicing

it, the core of this discipline is the gymnastics Foundations (Russell, 2010), which constitutes the common basis of all gymnastics activities. In this sense, Stanquevisch and Martins (2010) affirm this gymnastics discipline allows individuals to acquire a base that permits them to continue in other sports, being competitive or not.

In addition, Souza (1997) alludes GFA as a rich physical activity full of different forms of work, style and trends, which are influenced by a wide range of cultural values, traditions and symbolism, always having as premise the inclusion. Ahlquist (2000) cites one of the most significant characteristics of GFA that it can be practiced by any individual regardless of age, size, sex or skill level. According to Ayoub (2003), GFA can be addressed as a gymnastics discipline

[...] accessible to all people, open to participation; As a group gymnastics, with groups; As a simple gymnastics, without rules restrictions and, therefore, creates space for diversity and for creativity. In particular, as a gymnastics of pleasure, happiness and fun (p. 48).

In search of definition for this physical activity, Gallardo and Souza (1995) define GFA as

[...] a manifestation of body culture, which brings together the different interpretations of Gymnastics (Natural, Constructed, Artistic, Rhythmic, Aerobics, etc.), integrating them with other forms of physical expression (Dance, Folklore, Games, Theater, Mimic, etc.), in a free and creative way, according to the characteristics of the social group, and contributing to the increase of social interaction between the participants (p. 292).

This gymnastics discipline focuses on the individual who practices it, and seeks to promote interpersonal relationships which favors integration and inclusion (Ayoub, 2003). Furthermore, this gymnastic discipline enhances interest for regular practice of physical activity and healthy habits via pleasure, fun and creativity.

Santos and Santos (1999) state that one of the objectives of GFA is to promote healthy leisure and enhance physical, psychological, and social well-being of gymnasts. FIG (1993) itself indicates that the practice of GFA should be permeated by a cheerful and carefree spirit. And, therefore, the individual becomes aware of the value of sport and physical activity while acquiring the feeling of being part of this gymnastics universe. Souza (1997) reflects that the act of meeting people, communicating, feeling part of the group, making friends and reducing stress are goals of GFA, and affect human existence.

Definition and characteristics of GFA, mentioned above, show a way of practicing gymnastics, so that it provides a more humanistic approach with emphasis on social relations. Therefore, Ayoub and Graner (2013) argue that GFA can broaden other body practices through interweaving physical education and different areas of knowledge, such as dance and art.

In this context, GFA presents particularities that can contribute, in a significant way, to development of physical education students at University. It happens mostly through physical experiences allowing them to give meaning to their actions (Paoliello, 2008). Barbosa-Rinaldi and Paoliello (2008), when reflecting about teachers training in physical education, allude that gymnastics knowledge must be mastered by the future teachers. And, for this to be possible, it is necessary to focus efforts in this level of academic development. In summary, grounded on Barbosa-Rinaldi and Paoliello (2008) statements, we consider that physical education students must acquire technical-scientific knowledge with didactic-methodological foundations aiming to have tools to select, organize, and systematize the gymnastics knowledge in their classes.

In order to facilitate the contact of undergraduate students in physical education with gymnastics knowledge, the Gymnastics Laboratory (LABGIN) created, in 2010, the Gymnastics Group LABGIN at the Centre for Physical Education and

Sports of Federal University of Espírito Santo. A project that transits between extension, teaching, and research aiming to contribute to (re)thinking and understanding of gymnastics.

This article aims, through an experience report method, to share and reflect on the work of Gymnastics Group LABGIN, describing its characteristics and methodology developed over the seven years of its existence. This discussion can help (re)thinking GFA, and also support the emergence of groups or university extension projects with a pedagogical approach of this gymnastics discipline.

The work philosophy of Gymnastics Group LABGIN is based on the proposal from Gymnastics Group of University of Campinas (UNICAMP). The group from Campinas, Brazil, is pioneer in diffusion of a pedagogical approach of GFA (the UNICAMP Gymnastics Group is coordinated by M.Sc. Larissa Graner and Ph.D. Marco Antonio Coelho Bortoleto, a member of Gymnastics For All Committee of International Gymnastics Federation FIG).Therefore, this article will point out aspects that Gymnastics Group LABGIN developed and based on the principles of Souza (1997), in which GFA excels as social practice, integrating, democratic, and transforming of the individual and hopefully, his/her immediate society.

METHODS

The study object was the Gymnastics Group LABGIN that consists of a university extension activity composed by thirty (30) undergraduate physical education students from the Federal University of Espírito Santo (Brazil), which is coordinated by two professors with doctor degree.

For the study development, we chose the path of qualitative research, which allows the analysis of phenomenon without losing sight of its subjectivity and, primarily, the perception and personal perspective of researchers. Minayo (1994, p. 22) points out that qualitative research involves "a deeper space of relationships, processes, and phenomena that cannot be reduced to the operationalization of variables". Thomas and Nelson (2002, p. 322) add that “the most significant feature of qualitative research is the interpretive content instead of an excessive concern about the procedure " and it "focuses on the "essence" of the phenomenon”.

In this direction, the experience report was selected as methodological procedure to describe and discuss the work of Gymnastics Group LABGIN, unfolding its characteristics and methodology developed over the seven years of its existence (2010-2017). It is important to highlight that experience report consists of a descriptive research (Triviños, 1987) that enabled a descriptive-reflexive analysis of a real situation discussing experiences, results, and reflections related to the association between theory and practice.

To support discussion, the indirect documentation technique was selected for collecting information linked to the subject of interest. This form of documentation can be done in two ways: documentary research, and bibliographical research (Marconi & Lakatos, 1991).

The bibliographic research consisted of selecting, indexing, and archiving topics of interest to the research based on information, knowledge, and data that have already been collected by other people, in previous research, presented in books, articles, abstracts, and audiovisual media. The documentary research involved the use of private texts and documents related to training plans and evaluation reports of Gymnastics Group LABGIN.

For data processing the Content Analysis technique proposed by Bardin (2010) was used, following the main steps: pre-analysis, encoding, thematic categorization, and interpretation.

RESULTS

Gymnastics group labgin: research, education, and extension

Over the years, the CEFD / UFES has established itself as an institution for training teachers and researchers through activities related to education, research, and extension in Physical Education. Currently it offers two undergraduate programs, and at the graduate level it offers master and doctorate degrees.

In order to broaden and consolidate the relationship between the institution and society, the CEFD follows the policy of sharing knowledge, ideas, projects, and experiences in university extension projects.

The Forum of Deans of Extension of the Brazilian Public Universities (2016) conceptualizes extension as educational, cultural, and scientific process that has as its premise to articulate teaching and research in order to achieve a transforming relationship that is established between the University and society. In this sense, the

[...] extension is a two-way street, with assured traffic to academic community, which will find the opportunity to elaborate the praxis of an academic knowledge in society. Upon returning to the University, teachers and students will bring an apprenticeship that will be referred to theoretical reflection, and will be added to that previous knowledge (Forum of Deans of Extension of the Brazilian Public Universities, 2016, p. 11).

It is possible to infer that University extension programs have become an instrument that allows the interrelation between University and society, catalyzing the democratization of academic knowledge. Moreover, it could serve to refresh the idea and the system of University itself through the exchange with the community in which it is inserted (Forum of Deans of Extension of the Brazilian Public Universities, 2013).

According to the Institutional Extension Development Plan of UFES, the extension

[...] is based on the principles of reciprocity, emancipation, interdisciplinarity, transdisciplinarity and multiprofessionalism. It is an academic activity identified with the purposes of University, developing educational, artistic, cultural, and scientific processes articulated with teaching and research in an inseparable way. Its purpose is to contribute to promotion of dialogic interaction within University and other sectors of society, fostering the emergence of innovative responses to local, regional and national challenges (UFES, 2016, p. 30).

The University has the responsibility to propose and develop extension activities. Because, according to Brazilian Constitution of 1988, in its article 207, the Universities "(...) shall follow the principle of inseparability between teaching, research, and extension" (Brazil, 2013). Therefore, the extension is one of the supports of the tripod on which the Brazilian Universities are sustained, together with research and education.

Analyzing the curriculum of teaching degree in Physical Education of CEFD / UFES, it was possible to observe the emergence of five theoretical axes, which give life to the curricular matrix. The "Knowledge Resulting from Experience" is one of those axes and, in turn, relates to

[...] practices of teaching activities articulated with theoretical knowledge that corresponds to 400 hours that are experienced by undergraduate students in teaching degree, with effective involvement in the following didactic situations: projects developed within the subjects of the course; projects developed in subjects of other undergraduate courses; involvement in studies/researches that focus on school environment promoting experiences, observations and reflections of teaching practices in Physical Education; extension projects; and workshops offered by the course (Paiva, Andrade-Filho & Figueiredo, 2006, p. 224).

As well as a teaching degree, the curriculum of bachelor degree in Physical Education of this same institution expects

student participation in extension projects and internship subjects in Leisure, Sports and Health areas. As a result, students are involved in extension activities at University. And they have the opportunity to improve their teaching practice through participation in different extension projects. In addition, some Scientific Initiation Projects and Final Undergraduate Projects are linked to University extension, which favors the inseparability between education, research, and extension.

In the list of extension activities offered at CEFD / UFES, one has been consolidated since 2010, and offers to University community the practice of GFA through the Gymnastic Group LABGIN that is organized by the Gymnastics Laboratory (LABGIN). The origin of the group precedes the year 2010, as the founder of the group was inspired by UNICAMP Gymnastics Group. Furthermore, after four years the group was strengthened by a former gymnast from UNICAMP who also has experience in teaching gymnastics, who joined forces in the development of the group activities.

In report by Paoliello et al. (2014), Paula Cristina da Costa Silva, Gymnastic Group LABGIN co-coordinator, points out that she noticed the potential of extension project in GFA when she began her teaching activities at UFES. In her analysis, it could collaborate with the democratization of gymnastics knowledge, and to contribute with initial training of undergraduate students. In order to fulfill these objectives, she grounded the project on the work proposal of UNICAMP Gymnastics Group (Paoliello, 1998).

The beginning of Gymnastics Group LABGIN was mainly encouraged by the students' interest in exploring spaces and equipment available in the CEFD / UFES gymnastics gym. And also in order to experience the different gymnastics disciplines and improve their knowledge. Beyond the compulsory curricular classes, GFA approach implemented in Gymnastic Group LABGIN aims to offer applied practices and teaching-learning experiences in gymnastics in its different areas, which are: competitive, physical awareness, physiotherapeutic, and physical conditioning. Furthermore, theater, dance, martial arts, folklore, and circus are part of the group activities.

It can be noticed that student involvement in the activities of this project becomes important, since it complements the learning carried out in the classroom. It is a moment in which the knowledge, whether acquired in the curricular subjects and / or those obtained in the study group, is discussed and shared. And, therefore, new knowledge is acquired and exchanged through these experiences.

Agreeing with Paoliello (2008) who cites that "[...] it is interesting to observe that the experience as a gymnast is constantly transferred to his/her professional qualification" (p.210). And the opportunity of experiencing this subject of body culture contributes to the professional and scientific training of the individuals that take part in a GFA group.

It is important to highlight that Gymnastics Group LABGIN became institutionalized when it was invited to participate in the University Gymnastic Groups Festival of 5th International General Gymnastics Forum, in July 2010, held by UNICAMP and SESC / Campinas / São Paulo. Until then, there was only training twice a week with students interested in learning more about gymnastics. However, with the possibility of participating in an international event, the group mobilized and began to create a choreographic composition to be presented.

At this moment, the group gained strength by composing the choreography even though most participants had never seen a live gymnastics presentation or had been part of a gymnastics group before. For this reason, it was a challenging process to mediate the actions of 25 inexperienced gymnasts with a coordinator who also had little experience with GFA back then.

Like all human processes, this first stage of this group had successes and mistakes. But intuition was one of the

weapons used to accomplish certain goals. Grounded on Souza's (1997) proposal, the methodology used was divided into two parts: "... one aimed the increasing social interaction, the experience and exploration of innumerable possibilities of movement. And the other directed towards use and exploration of resources (materials)" (p. 05).

The group work was also based on Marcassa´s study (2004), a former student from FEF / UNICAMP who had contact with UNICAMP Gymnastics Group. The author considers that the choreographic composition

[...] configures itself as a language that has almost the same structures of written language. We often say that choreography is like a text. And if for a written text it is necessary to have content, narrative, internal coherence, "situalization", intentionality, cohesion, contextualization, intertextuality, i.e., in the body language of gymnastics some of these elements are also present (Marcassa, 2004, p. 180).

After a series of experiences, the first choreography was prepared and it produced great satisfaction in all participants of the group. It had a plot, a "story" that was narrated to the public. This confirmed what Ayoub (2003) suggests as a constituent part of GFA which is the presentation by itself. The author highlights that presentation consists as a synthesis of what had been collectively developed. But, it is necessary to be aware that GFA is not only to be seen as "product" disconnected from a process. Instead, Ayoub (2003) says that presentation needs to be treated as an integral part of GFA education process. Moreover, the author highlights that in the development of choreography the students´ experiences and interests should be encouraged. And also the group work, so cooperation, proactivity, and autonomy will support the co-authorship of the composition looking for new comprehensions, different interpretations, and new meanings previously unknown to them.

At this point, GFA becomes "a great stage" in which it's possible to share knowledge and experiences of different practices. It is an environment where the different disciplines of gymnastics dialogue and interact with other forms of physical expressions (Fiorin-Fulgsang & Paoliello, 2008), always valuing individual and group experiences. Paoliello (2008) says that this valorization procedure enriches motor repertoire and expression of the group, since it comes from individual experiences, and not only from the teacher/coach.

On the stage of GFA, it is possible to study, experience, know, understand, confront, interpret, problematize, share, and learn different gymnastics disciplines. And, according to Ayoub (2003), based on this knowledge that emerges from the practice, it is possible to seek new meanings and also develop other possibilities of gymnastics expressions.

According to Fiorin-Fulgsang and Paoliello (2008) the possibility of seeing, appreciating, talking, opining, and creating together is what differentiates GFA from other gymnastics disciplines. And, from this perspective, the work of the Gymnastic Group LABGIN is oriented so that individual and group experiences are cherished along the teaching-learning process.

A gymnastic for and by all

The fantasy and power of invention mixed with knowledge and the interest of getting people in motion is the answer (Ahlquist, 2000, p 172).

Toledo and Schiavon (2008) mention that Brazilian GFA was influenced in great extent by competitive gymnastics disciplines, which are: Artistic Gymnastics, Acrobatic Gymnastics, Trampoline Gymnastics, and Rhythmic Gymnastics. But, today, it is possible to observe that GFA groups try to break free from rules, standardizations, and homogenizations inherent to these competitive disciplines. In current context, Toledo and Schiavon (2008) consider that GFA no longer shows the exacerbated quest for technique and perfection of movements required in competitive gymnastics. Toledo, Tsukamoto

and Gouvea (2009) comment that when there is no competition, the comparison between individuals or praise of the winner doesn't happen. And make possible to all groups members to participate within their own possibilities, limits, experiences, potentialities, and ideals.

The absence of competitive nature has brought relaxation and greater freedom to GFA. It is important to highlight that freedom is one of the features of this gymnastics discipline. According to Toledo, Tsukamoto and Gouvea (2009), it distinguishes GFA from other gymnastics that are delineated according to their rules, which are arranged in scoring systems. The authors consider that this ability to act freely in the context of GFA, without fixed rules, emerges in different aspects such as: the use or not of equipment; the absence of age limits; the nonexistence of rules related to group size; the lack of costumes standards; free will in the choice and use of music; and many other factors.

This freedom permits participation and autonomy in search of body liberty, as well as valuing the individual and the group experiences (Nista-Piccolo, 1995). There is a stimulus to creativity that, according to Toledo, Tsukamoto and Gouvea (2009), occurs due to diversity of concepts and different physical practices that can be developed within GFA.

A gymnastics discipline developed to and by all is essentially pedagogical, which in Gallardo's (2008) conception is characterized by the establishment of human values that foster interaction and integration between the individuals that make part of the group. Paoliello (2008) lists responsibility, discipline, patience, cooperation, trust, and freedom as examples of values that can be experienced within GFA. In addition, the author cites that it is common to share feelings inside the group, such as: joy, pleasure, satisfaction, fears, anguishes, desires, fellowship, and friendship. These are aspects related to collective coexistence that allow the knowledge and appropriation of tools important to live and act in community, which also promotes personal and professional growth of future teachers.

It is important to mention that group work becomes an essential part in the search for human development in sport context, which in the conception of Souza (1997) is one of the pillars of GFA, because while everyone is learning, everyone is teaching. Therefore, group activities should be addressed by everyone and to everyone, with the intention of sharing responsibility in the process of planning, organizing, implementing and evaluating the training. And, consequently, contribute to the initial training of undergraduate students. Pinto and Bortoleto (2010) highlight that the sense of group is not restricted only by rehearsing, training, and presenting together, because it contemplates the act of overcoming the individual towards the group or social sake.

Gallardo (2014) explains that along the group activities and choreographic composition, the actors of the group define together "what" and "how" will be the final product, as well as the presentation of their work, which has no choreographer or teacher with autocratic characteristics. This allows the group members to perceive themselves at the core of the choreography. And also to incorporate messages, which will be communicated through a physical discourse.

The Gymnastic Group LABGIN members have their praxis through activities and experiences during approach of different gymnastics disciplines and other forms of physical practices in the perspective of the GFA. Ayoub (2008) says that the act of working together opens space for discussions, tensions, and concessions that are essential aspects for the future teaching performance. Students are invited and encouraged to experience the motor actions of gymnastics, as well as other practices to later compose the choreographic in co-authorship. The process of choreography composition creates an environment conducive to the improvement of important elements in human and professional development.

The Gymnastics Group LABGIN supports a democratic practice of GFA, in which the group members develop the activities together, in symbiosis, but without disrespecting their individualities, which favors a process of inclusion and socialization. Probably, the charm of GFA is in the encounter of individual particularities and common aspects that are shared by the group members. Toledo (2005) reflects that this characteristic has the potential to provide, through participation, the exchange of experiences based on the autonomy of its members and the establishment of group identity.

Toledo (2005) considers the encouragement of dialogue another pillar of GFA. This democratic ethos of GFA facilitates integration among the group members, and is catalyzed through the teacher-student relationship. In which the teacher act as a mediator and conciliator who, while having authority, acts in a coherent and democratic way without being authoritarian, and promotes the unity of all those who conform the group (Toledo, 2005; Fiorin, 2001).

According to Ayoub (2003) it is also important to encourage "(...) a gymnastics that is open to multidimensional teachings of body culture [...], which is not in tune with body stereotypes present today" (p. 39). And that support the establishing of spaces where the playful component of body culture are present making possible to (re)discover the pleasure, the wholeness and the artistry of body language.

The GFA based on a pedagogical-human approach emerges as a practice capable to consolidate these objectives by allowing the implementation of creative, formative, and social actions that promote autonomy and criticality of its practitioners. Furthermore, it is a gymnastic discipline that establishes the perception of being part of a historical process that is related to everything that is consolidated by the group, which concerns the relationships, choreographic creations, researches, among others (Toledo, Tsukamoto & Gouveia, 2009).

Fiorin (2001) says that GFA is a gymnastics discipline that brings in its repertory the art of exercising, which recalls the time when gymnastics was done freely and spontaneously whether in the street or in the center of a stage. Thus, the Gymnastics Group LABGIN seeks to provide a GFA that does not contradict the competitive disciplines, but that goes beyond them. Specially, going in the direction of a pedagogical and social perspective that encounter the individuals without the chains of rules and body standardizations.

CONCLUSIONS

Gymnastics cuts across all social boundaries and cultural backgrounds, uniting those who take part and increasing global understanding through shared experiences (Langsley, 2000, p. 11).

This article aimed, through an experience report method, to share and reflect on the work of Gymnastics Group LABGIN developed over the seven years of its existence, describing its characteristics and methodology used on the initial training of physical education students.

Braga (2008) expresses that there is a convergence between Physical Education and GFA, in a critical perspective, since both have a methodological foundation based on the pedagogical-human perspective centered on the individual.

This gymnastics discipline is capable of catalyzing the union between different people through the valorization of diversity and the constitution of the group identity. And it is possible to identify with its philosophy the respect for human essence and dignity.

GFA is a body practice oriented to any person, in which is established an environment of freedom of gymnastics exercise that does not focus on the performance, or perfections, or that is constrained by the rules, or by defined shapes. And this freedom of movement is legitimized even more in the gymnastics universe (Bortoleto & Mateu, 2001).

Thus, the approach of GFA in the initial training of physical education students, through an extension project, contributes to the reflection and resignification of gymnastics and its values, in search of new forms of intervention that are inclusive and democratic. And this experience with GFA will serve as reference for these future teachers.

University courses have the responsibility to prepare future educators to act autonomously, critically, and always based on solid theoretical foundations. Barbosa-Rinaldi and Paoliello (2008), consider that teacher training should not lose sight of human values. This aim can be achieved with the work proposal of Gymnastic Group LABGIN, which is based on Souza (1997).

The work of Gymnastic Group LABGIN respects individualities, comprehensiveness, accessibility, group work, unlimited creativity, playful activity, freedom, valorization of individual and group characteristics, emphasis on learning and interaction, greater concern with the process than with the product, pleasure, physical expression, plurality, and general education. These characteristics constitute some of its presuppositions. It is important to highlight that GFA always has as premise the appropriation of physical activities and gymnastics forms that are important for the group members. This supports the feeling of belonging to the community and the group by sharing interests.

Finally, when analyzing the UNICAMP Gymnastics Group, which served as a reference in the format and work philosophy for the creation of Gymnastic Group LABGIN, Braga (2008) states that the possibility of participating in a GFA group contributes to the practical intervention of future professional of Physical Education, because it provides ideas, proposals, reflections, and experiences.

Gallardo (2014), former coordinator of UNICAMP Gymnastics Group, emphasizes that orientation of a GFA group, directed to students in initial training in Physical Education, should have as a premise the education of these future teachers, who must be sensitive and committed to their community and country. From this perspective, it is necessary that the group philosophy of work is oriented to the education of these individuals that must be capable of planning and proposing cultural actions that promote the well-being of their future students and, consequently, cause social changes in the immediate society.

According to the Forum of Deans of Extension of the Brazilian Public Universities (2013), University extension projects have a pronounced role in the education of individuals emancipated and critical about their reality. In this way, initiatives that promote student praxis, such as the actions of Gymnastics Group LABGIN, can collaborate with an education guided to the plurality of content in a pedagogical perspective capable of producing significant changes in society.

It is important to highlight that Gymnastics Group LABGIN has developed a series of actions to disseminate GFA through scientific works, events, presentations, and workshops. And some of their former members are working with GFA at schools, social projects, and teaching gymnastics in other contexts. It is a sign that the experience they had during their undergraduate program was important to become professionals of this area, and they are engaged in the diffusion of gymnastics.

Venâncio (2014) cites that former gymnasts of GFA in this pedagogical perspective "are like seeds that, wherever they are, reveal their potentialities, united by action" (p. 272). Therefore, the philosophy of a GFA that privileges human development expands through sharing experiences, techniques, friendships, and solidarity in new soils.

REFERENCES

Ahlquist, M. S. (2000). A sport for anyone. In E. Langsley (Ed.). *Gymnastics in perspective* (pp. 170-179). Moutier: FIG.

Ayoub, E. (2003). *Ginástica geral e educação física escolar* [General gymnastics and physical education at school]. Campinas: UNICAMP.

Ayoub, E. (2008). Ginástica geral na formação em pedagogia [General gymnastics in pedagogy students training]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections] (pp. 37-54). São Paulo: Phorte.

Ayoub, E., & Graner, L. (2013). Transformando poema em gesto, corda em estrela, conduíte em flor... [Transforming poem in gesture, movement in star, conduit in flower]. In E. Toledo, & P.C.C, Silva (Eds.). *Democratizando o ensino da ginástica* [Democratizing the teaching of gymnastics] (pp. 23-48). Várzea Paulista: Fontoura.

Barbosa-Rinaldi, I. P., & Paoliello, E. (2008). A ginástica geral nos cursos de formação profissional de licenciatura em educação física [General gymnastics on vocational courses in physical education]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões.* [General gymnastics: experiences and reflections] (pp. 17-36). São Paulo: Phorte.

Bardin, L. (2010). *Análise de Conteúdo* [Content Analysis]. Lisboa: Edições 70.

Bertolini, C. M. (2005). Ginástica geral na escola: uma proposta pedagógica desenvolvida na rede estadual de ensino [General Gymnastics: a pedagogical proposal developed at the public educational system]. *Unpublished master's thesis*. Brazil: State University of Campinas.

Bortoleto, M. A. C, & Mateu, M. (2001). La gimnasia general en España [General gymnastics in Spain]. In E. Paoliello, & E. Ayoub, (Eds.). *Annals of International Forum of General Gymnastics*. Campinas: SESC/UNICAMP.

Braga, J. M. P. (2008). Música e movimento [Music and moviment]. In E. Paoliello, (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections] (pp. 121-143). São Paulo: Phorte.

Constitution of the Federal Republic of Brazil (2013). Retrived from http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm

Federal University of Espírito Santo (2016) Anexo da resolução nº 28/2010-CUn: plano de desenvolvimento institucional da UFES 2010-2014 [Annex to resolution No. 28/2010-CUn: UFES institutional development plan 2010-2014]. Retrived from http://www2.daocs.ufes.br/sites/daocs.ufes.br/files/field/anexo/anexo_i_28_10.pdf

Fiorin-Fulgsang, C. M., & Paoliello, E. (2008). Possíveis relações entre a ginástica geral e o lazer [Possible relations between general gymnastics and leisure]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections] (pp. 97-120). São Paulo: Phorte.

Fiorin, C. M. (2001). Possíveis caminhos da ginástica geral no próximo século [Possible ways of general gymnastics in thenextcentury]. In E. Paoliello, & E. Ayoub (Eds.). *Annals of International Forum of General Gymnastics*. Campinas: SESC/UNICAMP.

Forum of Deans of Extension of the Brazilian Public Universities (2013, October, 28). *Política nacional de extensão universitária* [University extension national policy]. Retrived from http://www.proec.ufpr.br/downloads/extensao/2012/legislacao/Politica%20Nacional%20de%20Extensao%20Universitaria%20maio2012.pdf

Forum of Deans of Extension of the Brazilian Public Universities (2016, May, 14). *Documento final do I Encontro de Pró-Reitores de Extensão das Universidades Públicas Brasileiras* [Final document of the first meeting of Deans of Extension of the Brazilian public universities]. Retrieved from http://www2.unifap.br/dex/files/2015/04/1987-I-Encontro-Nacional-do-FORPROEX.pdf

Gallardo, J. S. P. (2008). A educação física escolar e a ginástica geral com sentido pedagógico [The physical education at

school and general gymnastics with pedagogical sense]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections]. (pp. 55-78). São Paulo: Phorte.

Gallardo, J. S. P. (2014). Formação humana e transformação social [Human development and social transformation]. In E. Paoliello, E. Toledo, E. Ayoub, M.A.C. Bortoleto, & L. Graner (Eds.). *Grupo Ginástico UNICAMP: 25 anos* [UNICAMP Gymnastics Group: 25 years]. (pp. 9). Campinas: UNICAMP.

Gallardo, J. S. P., & Souza, E. P. M. (1995). La experiencia del Grupo Ginástico UNICAMP en Dinamarca [The experience of UNICAMP Gymnastics Group in Denmark). *In Annals of Latin-American Congress,* Foz do Iguaçu, Brazil. pp. 292-298.

International Gymnastics Federation (FIG). (1993). *General gymnastics manual*. Montier: FIG.

Langsley, E. (2000). A personal perspective. In E. Langsley (Ed.). *Gymnastics in perspective.* (pp. 10-11). Montier: FIG.

Marcassa, L. (2004). Metodologia do ensino da ginástica: novos olhares, novas perspectivas [Methodology of teaching gymnastics: new looks, new perspectives]. *Revista Pensar a Prática, 7*(2), 171-186.

Marconi, M. A., & Lakatos, E. M. (1990). *Técnicas de pesquisa: planejamento e execução de pesquisa, amostragem e técnicas de pesquisa, elaboração, análise e interpretação de dados* [Research techniques: planning and research development, sampling and research techniques, preparation, analysis, and interpretation of data]. 2. ed. São Paulo: Atlas.

Minayo, M. C. S. (1992). *O desafio do conhecimento: pesquisa qualitativa em saúde* [The challenge of knowledge: qualitative research in health]. São Paulo: Hucitec.

Nista-Piccolo, V. (1995). A educação motora na escola: uma proposta metodológica à luz da experiência vivida [Motor education at school: a methodological approach in the light of lived experience]. In A. Marco (Ed.). *Pensando a educação motora* [Thinking the motor education] (pp. 113-120). Campinas: Papirus.

Nunomura, M., Ferreira-Filho, R. A., Duarte, L. H., Tanabe, A. M., & Oliveira, M. S. (2016). Os fundamentos da ginástica artística [Fundamentals of artistic gymnastics]. In M. Nunomura (Ed.). *Fundamentos das ginásticas* [Fundamentals of gymnastics] (pp. 23-49). Jundiaí: Fontoura.

Paiva, F. S. L., Andrade-Filho, N. F., & Figueiredo, Z. C. C. (2006). Formação inicial e currículo no CEFD/UFES [Inicial training in CEFD/UFES curriculum]. *Pensar a Prática, 9*(2), 213-230.

Paoliello, E. (2008). Nos bastidores da ginástica geral: o significado da prática [Behind the scenes of general gymnastics: the meaning of the practice]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections] (pp. 191-215). São Paulo: Phorte.

Paoliello, E., Toledo, E., Ayoub, E., Bortoleto, M. A. C., & Graner, L. (2014). *Grupo Ginástico UNICAMP: 25 anos* [UNICAMP Gymnastics Group: 25 years]. Campinas: UNICAMP.

Pinto, L. G., & Bortoleto, M. A. C. (2010). Sobre o processo criativo: descrição e elaboração da coreografia Caixas de Brinquedos do Grupo Ginástico UNICAMP [In relation to the creation process: description of the choreographic composition "box of toys" of the gymnastic group of UNICAMP (GGU)]. *In Annals of IV International Forum of General Gymnastics.* Campinas: UNICAMP.

Russell, K. (2010). *Gymnastics foundations.* Saskatoon: Ruschkin.

Santos, J. C. E., & Santos, N. G. M. (1999). *History of General Gymnastics in Brazil.* Rio de Janeiro: Fontoura.

Souza, E. P. M. (1997). Ginástica geral: um campo de conhecimento da educação física (General gymnastics: a knowledge of physical education. *Unpublished doctoral*

dissertation. State University of Campinas, Campinas, Brazil.

Souza, E. P. M. (1998). A proposta de ginástica geral do Grupo Ginástico UNICAMP [The general gymnastics proposal of Unicamp Gymnastics Group]. *In Annals of I Brazilian Motor Education Congress.* Campinas: UNICAMP.

Stanquevisch, P. S., & Martins, M. T. B. (2010). Ginástica geral: uma reflexão sobre formação e capacitação profissional [General gymnastics: a reflection on professional education and training]. In R. Gaio, A.A. Góis & J.C.F. Batista, (Eds.). *A ginástica em questão: corpo e movimento* [Gymnastics in question: body and movement] (pp. 463-474). São Paulo: Phorte.

Thomas, J. R., & Nelson, J. K. (2002). *Métodos de pesquisas em atividade física* [Research methods in physical activity] 3. ed. Porto Alegre Artmed.

Toledo, E. (2005). A ginástica geral e a pedagogia da autonomia [General gymnastics and the pedagogy for autonomy]. *In Annals of III International Forum of General Gymnastics*. Campinas, pp. 73-76.

Toledo, E., & Schiavon, L. M. (2008). Ginástica geral: diversidade e identidade [General gymnastics: diversity and identity]. In E. Paoliello (Ed.). *Ginástica geral: experiências e reflexões* [General gymnastics: experiences and reflections] (pp. 217-238). São Paulo: Phorte.

Toledo, E., Tsukamoto, M. H. C., & Gouveia, C. R. (2009). Fundamentos da ginástica geral [Fundamentals of general gymnastics]. In M. Nunomura, & M.H.C. Tsukamoto (Eds.). *Fundamentos das ginásticas* [Fundamentals of gymnastics]. (pp. 23-49). Jundiaí: Fontoura.

Triviños, A. N. S. (1987). *Introdução à pesquisa em ciências sociais: a pesquisa qualitativa em educação* [Introduction to social science research: qualitative research in education]. São Paulo: Atlas.

Corresponding author:

Mauricio Santos Oliveira
Federal University of Espírito Santo
Centre for Physical Education and Sports
Av. Fernando Ferrari, 514
Campus Universitário Goiabeiras – Vitória – ES
CEP: 29075-810
Phone: +55 27 98111-1635
Email: mauricio_olliveira@yahoo.com.br

SHORT HISTORICAL NOTES XI

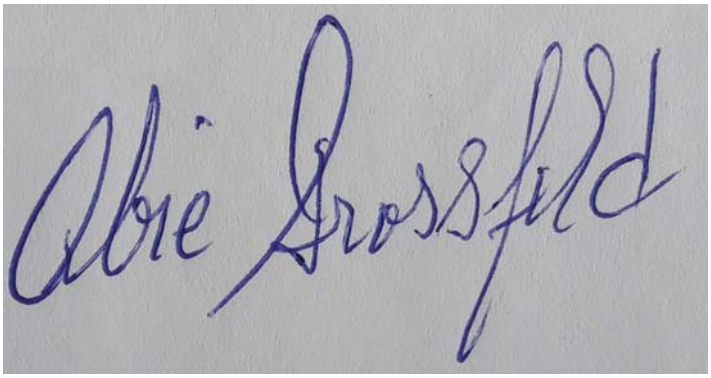
Anton Gajdoš, Bratislava, Slovakia

Ph.D. Anton Gajdoš born on 1.6.1940 in Dubriniči (today Ukraine) lives most of his life in Bratislava (ex TCH, nowadays SVK). He comes from gymnastics family (his brother Pavel have world championship medals) and he devoted his life to gymnastics. His last achievement is establishment of Narodna encyklopedia športu Slovenska (www.sportency.sk). Among his passion is collecting photos and signatures of gymnasts. As we tend to forget old champions and important gymnasts, judges and coaches, we decided to publish part of his archive under title Short historical notes. All information on these pages is from Anton's archives and collected through years.

ABIE GROSSFELD (born 1.3.1934, New York, USA)

Grossfeld received both his BS and MS degrees from the University of Illinois, and is Professor Emeritus of Southern Connecticut State University

Gymnastics legend Frank Cumiskey (1932, 1936 and 1948 gymnastics Olympian) stated, "After six decades of being in the trenches, Abie Grossfeld has influenced an untold number of gymnasts, coaches and judges who have notably impacted the positive development of gymnastics. Abie's level of excellence in the primary areas of gymnastics, as a whole, has been truly exceptional and, in my experience, has not been matched by any other individual." Abie Grossfeld has been active in gymnastics for 65 years and counting. While many of his accomplishments and contributions have been outstanding, it is his whole body of work that has been truly extraordinary. Paraphrased statements by Olympians: 1984 Olympian and NBC commentator Tim Daggett said, "After each encounter with Abie, as I was developing through the years, I always left with a better understanding of the wonderful sport of gymnastics. The success of Abie and his gymnast Peter Kormann (at the 1976 Olympics) was my catalyst to dream bigger dreams, which ultimately took me all the way to the Olympics itself - on a team Abie coached. We won Gold as a team and Abie made us a team. In gymnastics, he's done it all. He imparted technique, wisdom and guidance in me." 1984 Olympic Team Captain Peter Vidmar said, "Abie held the collection of the 1984 team members together…Abie knows every significant gymnastics person – officials, judges,



competitors – in the world…Abie brought a sense of neutrality to the team. He didn't play favorites. Subtly and very effectively, Abie created an atmosphere of camaraderie, …not dissension. The team wound up having "good chemistry, and Abie was the chief chemist." Don Tonry, 1960 Olympian said, "If there ever was a legend in gymnastics, or any sport, it is Abie."

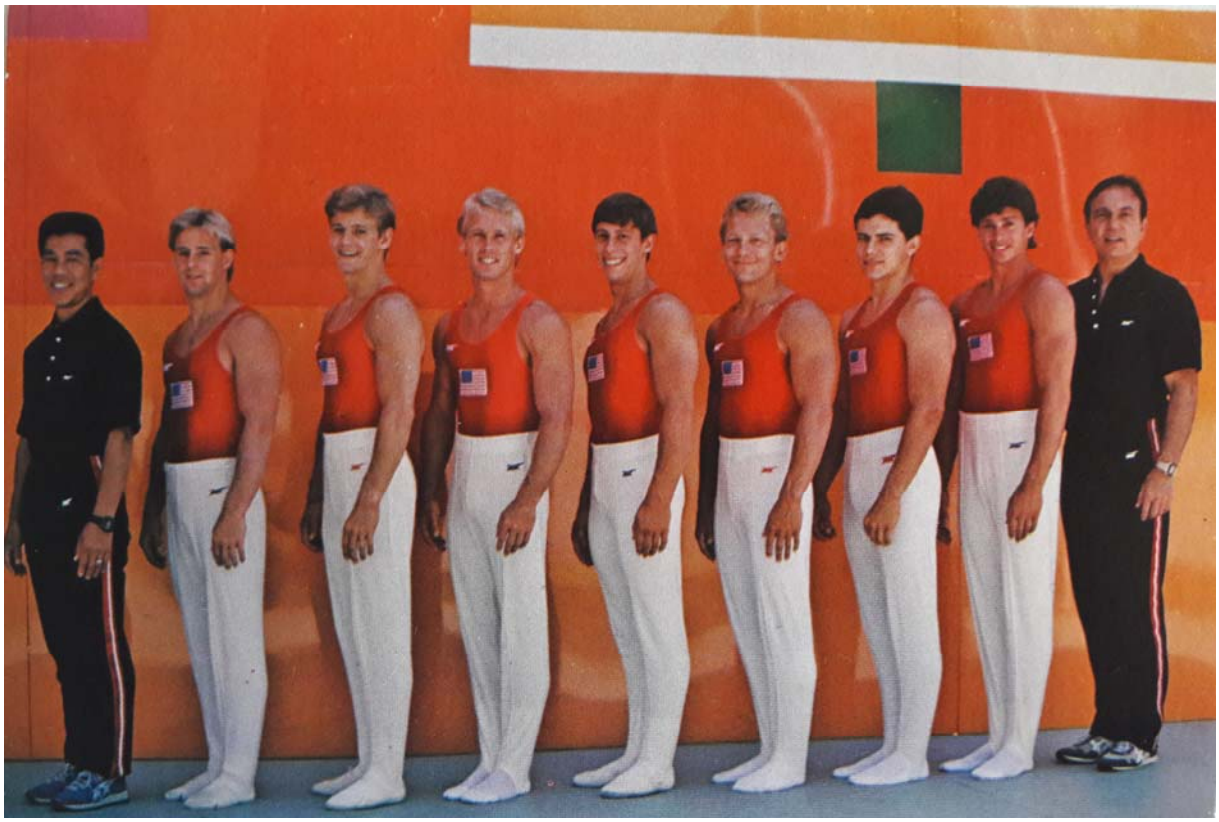


Figure: 1984 US Men's Olympic Team: (from the left) Makato Sakamoto (assistant coach), Scott Johnson, Peter Vidmar, Bart Conner, Tim Daggett, Jim Hartung, Jim Mikus, Mitch Gaylord, Abie Grossfeld (head coach).

Abie Grossfeld's official capacity as an athlete, a coach, judge or head of delegation involved 8 Olympic Games, 11 World Gymnastics Championships, and 5 Pan American Games.
Abie Grossfeld represented the U.S.in international competitions spanning 15 consecutive years (1953-1967). Among the quadrennial games in which he competed as a gymnast were two Olympic Games (1956 and 1960); two World Championships (1958 and 1962); and three Pan-American Games (1955, 1959 and 1963). He won four NCAA titles (all- around, floor exercise and high bar twice)

Abie served as a coach (spanned 28 years) within national team in 5 Olympic Games, three times Olympic Head Men's Coach - 1972, 1984 (won the team Gold medal – America's first) and 1988. Note: At the 1984 Games, the U.S. team defeated the reigning, the clear favorites and the same World Champion Chinese team who had defeated the Soviet Union's team (in Europe) at the 1983 World Championships eight months before. U.S. Olympic victory was a major upset, seven Olympic individual medals for men, including two Gold (Peter Vidmar on PH and Bart Conner on PBs) in 1984. Two times Olympic Assistant Coach (for men in 1964, for women in 1968). Five times World Gymnastics Championships Head Coach - 1966, 1981, 1983, 1985 and 1987. World Cup Head Coach - (Zagreb) 1982. The inaugural Goodwill

Games Head Coach – (Moscow) 1986. He was personal coach of Peter Kormann who in 1976 was the first post WWII U.S. Olympic gymnastics individual medalist since 1932 or in 44 years. Also personal coach of John Crosby who tied an all sports record by winning a clean sweep of eight medals at a single Pan American Games, including two Gold medals (for floor exercise and rings in 1971). Forty-two years was a collegiate gymnastics head coach – one year at the U.S. Coast Guard Academy and 41 years coach at Southern Connecticut State University, where he was also a professor of exercise science and athletics.

Grossfeld has been an FIG Brevet judge (highest certification) fromthe first course and examination were given in the United States in 1969 (and through 2011). He has officiated at the highest levels of competition, including: two World Championships (1994 and 1999); three Pre-Olympics (1991, 1995 and 1996); the Pan American Games (1983); two Pacific Alliance (1996, 2002); German Unification Cup (1990); World (Moscow) Cup (2007); and two International Goodwill Games (1990 and 1998); numerous American Cups, U.S. National Championships and Olympic trials.

As an official he was member of FIG Coaches Commission, 2000. U.S. Olympic Gymnastics Committee, 1968-1976 (disbanded after 1976). Board of Directors for New York City's bid for the 2012 Olympic Games, 2000-2005. USA Gymnastics Board of Directors, 1976-1978, 1990-1995, 2001-2008. Head of USA Delegations at two World Gymnastics Championships, 1995 and 1997. Acting Head of Olympic Gymnastics Delegation for men – 1996. World Acrobatic Society Vice President, 2003-2006; WAS Committee member (2003-2014) USA Gymnastics National Hall of Fame Committee, 1988-2008. USA Gymnastics Ethics Committee, 1990-2001. National Gymnastics Judges Association National Director-At-Large, 1993-1996. College Gymnastics Association Vice President, 2000-2004. USA Gymnastics Men's Program Committee, 1974-77, 1981-1988. U.S. National Coaching Staff, 1966-1972, 1981-1988, 2000.

Photo: Abie and Anton at WC 2009 in London

He worked also as commentator or with media as NBC production staff at the Barcelona Olympic Games, 1992, ABC production staff at the Fort Worth World Gymnastics Championships, 1979. U.S. representative to Japan to report on the Japanese system of gymnastics, 1970. Two U.S. Department of State tours of the U.S. National Gymnastics Teams to the Middle East: Afghanistan, Iran and Turkey in 1958; and Kuwait, Lebanon, Syria, Jordan, Cyprus, Turkey, Pakistan and East Pakistan (Bangladesh) in 1961.

He is also author of numerous articles, books, video and audio material, among them most important are: Dintiman, G., et al, A Comprehensive Manual of Foundations and Physical Education Activities for Men and Women (Wrote Chapter, "Gymnastics and Tumbling"), 1979. George, G, USGF Safety Manual (Wrote Chapter, "Horizontal Bar") 1985 and 1990 Eds and Wettstone, E., Gymnastics Safety Manual, (Wrote Chapter, "Progressions in Teaching Skills – Parallel Bars"), 1977 and 1979 Eds., video Gymnastics Safety First, Second and Always (USAG), 1987.

Honors: U.S. Olympic Hall of Fame, 2009 (only the third all sports coach, and the only gymnastics coach, inducted). International Gymnastics Hall of Fame, Frank Bare Award, 2015. The only American to achieve the status of FIG Master Coach, 2000. FIG Insignia of Merit (awarded for world class performance as a gymnast in Olympic Games), 1960. USA Gymnastics Hall of Fame (as an athlete, coach and contributor)), 1979. National Gymnastics Judges, Frank Cumiskey, Hall of Fame. Both USA Gymnastics (1984) and NCAA (1973, 1975 and 1976) National Coach of the Year. USA Gymnastics prestigious Spirit of the Flame Award, 1999. World Acrobatic Society Gallery of Legends Award. The New York Benevolent Association Medal for saving a human life in peril, 1951 Named by "Sports Illustrated" (2000) as among the 50 Greatest Sports Figures of the 20th Century (from his birth state of New York, which included Vince Lombardi, Sandy Koufax, Lou Gehrig, Sugar Ray Robinson, Jim Brown, Kareem Abdul Jabbar, Pop Warner, Sid Luckman, Hank Greenberg, among other sports legends.) Honored with a street name, Abie Grossfeld Circle, in New Haven, Connecticut. Four Nissen Award winners (analogous to football's Heisman Trophy), which set a record of four recipients in 1980 and, as of 2015 has not been surpassed by any coach - achieved without the benefit of athletic scholarships.

Happy birthday Abie!

Slovenski izvlečki / Slovene Abstracts

Thomas Heinen, Nadja Walter, Linda Hennig & Damian Jeraj

PROSTORSKO ZAZNAVANJE CELEGA TELESA JE ODVISNO OD KVALITETE TELOVADCA

Zaznavanje prostorske usmerjenosti telesa je temeljni pogoj natančne izvedbe zahtevnih gibalnih nalog, kot so tiste, ki jih najdemo v akrobatskih športih. Čeprav se vidne informacije štejejo za pomemben vir podatkov pri opravljanju telovadnih prvin, je še vedno vprašljivo, katere vloge imajo vidni podatki pri dojemanju prostorske usmerjenosti, posebej glede na težavnosti prvine in posebnosti prvine. Študija se osredotoča na vprašanje, kakšno vlogo imajo vidni podatki v zaznavanju prostorske usmerjenosti. Visoko kvalitetne in nizko kvalitetne telovadce smo primerjali pri oceni naklona telesa med vrtenjem okoli čelne osi v smeri naprej in nazaj v giroskopski napravi z bodisi popolnimi vidnimi informacijami, ki so na voljo ali so brez vidnih podatkov. Rezultati so pokazali, da so visoko kvalitetni telovadci izkazali boljšo oceno naklona telesa v primerjavi z nizko kvalitetnimi telovadci. Ocenjeni koti naklona se spreminjajo kot funkcija osi vrtenja in prostorskega zaznavanja, vendar ne kot funkcija vidnih podatkov. Ugotovljeno je bilo, da je lahko povečana prostorska orientacijska sposobnost telovadcev posledica povečane občutljivost v posameznih senzoričnih sistemih in/ali najprimernejša obdelava medsebojno povezanih čutnih podatkov, ki so specifične za izkušnje telovadcev s posebnimi gibalnimi nalogami in ustreznimi zahtevami le-teh.

Ključne besede: giroskop, orodna telovadba, zahtevnost naloge, posebnosti naloge.

Jaroslav Krištofič, Tomáš Malý, František Zahálka

VPLIV VADBE RAVNOTEŽJA NA DRŽO TELESA

V članku se je preveril učinek programa vadbe ravnotežja na držo telesa (PS) med univerzitetnimi študenti usmerjenimi v orodno telovadbo. Poskusna skupina (n = 18) je poleg svoje redne vadbe opravila tudi posebno vadbo ravnotežja, kontrolna skupina (n = 15) pa je imela običajen režim samo redne vadbe. Za oceno drže telesa je bila uporabljena več senzorna plošča FOOTSCAN. V preskusih smo ovrednotili parametre COP (skupno potovanje centra pritiska telesa): pri snožni stoji z vidnim nadzorom (NS-VC) in brez (NS-WC), flamingo test na prevladujoči nogi (FPL) in neprevladujoči nogi (FNL). Rezultati so pokazali pomemben učinek časa na spremembe v PS pri snožnih testih, ne glede na skupino in vidni nadzor ($F_{1,62} = 4,65$, $p = 0,03$, $\eta 2p = 0,07$). Vidni nadzor je imel pomemben učinek na PS v obeh skupinah ($F_{1,62} = 12,55$, $p = 0,001$, $\eta 2p = 0,17$). Dodatna vadba ravnotežja je pomembno vplivala na PS v enonožno stojo (FPL: COPpre-test = 1006,01 ± 396,17 mm, COPpost-test = 875,78 ± 284,24 mm, $t_{17} = 2,34$, $p < 0,05$, FNL: COPpre-test = 1102,44 ± 323,82 mm, COPpost-test = 987,89 ± 357,63 mm, $t_{17} = 2,20$, $p < 0,05$) in preskus NS-WC (COPpre-test = 145,67 ± 34,91 mm, COPpost-test = 128,89 ± 36,03 mm, $t_{17} = 3,26$, $p < 0,05$). V kontrolni skupini smo ugotovili pomembno izboljšanje samo pri FNL testu ($p < 0,05$). Rezultati študije so pokazali, da lahko tudi vadba ravnotežja z nizkim obsegom, izvedena poleg redne vadbe, vodi tudi k izboljšanju drže telesa.

Ključne besede: drža telesa, telovadba, ravnotežje, vidna zaznava, ocenjevanje ravnotežja.

Jonas Rohleder, Tobias Vogt

UČENJE ZAČETNIKOV STOJE NA ROKAH: UPORABNI PRISTOP RAZLIČNIH ZAMISLI O ŠPORTNO-POVRATNIH PODATKIH PRI UČENJU GIBANJA

Zaradi redkih dokazov o pomenu ojačanih povratnih podatkih pri poučevanju telovadbe je bila opravljena raziskava ali standardizirani tipalno-besedni povratni podatki ali kratkotrajni vidni povratni podatki povečuje uspešnost izvedbe stoje na rokah in predstavo o izvedbi le-te. Šestindvajset študentov (7 žensk, 19 moških) je bilo naključno razdeljenih v skupino tipalno–besedne povratnih podatkov (starost: 22,7 ± 3,9 leta) ali v skupino s kratkotrajnimi vidnimi povratnimi podatki (starost: 21,9 ± 1,8 letna skupina) (vsaka n = 13). Vsi so predhodno izvedli stojo na rokah. Izvedli smo goniometrične analize za položaj kolka, ramen in glave, učinke povratnih podatkov pa smo spremljali z uporabo video zajemov in lutke s katero ponazorimo gibanje. Postavitev ramena pri izvedbi gibanja se je izboljšala po prejemu tipalno-besedni povratne zveze ($p < 0,01$), medtem ko se je predstava o kotu v ramenih povečala pri vidnih povratnih podatkih ($p < 0,05$). Poleg tega so bile po prejemu tipalno-besedni povratnih podatkov ($p < 0,01$) ugotovljene pomembne povezave med izvedbo stoje na rokah in gibalnimi posnetki položaja glave, medtem ko so položaj kolka in gibalni posnetki bili povezani z vidno povratno informacijo ($p < 0,01$). Tipalno-besedni povratni podatki in vidni povratni podatki vplivajo na več vprašanj gibalnega učenja na različne načine; vendar je to res tudi v kratkoročnem pristopu. Tako se priporoča za učenje različne povratne podatke, ki omogočajo celovito pridobitev želenega gibanja in položaja.

Ključne besede: telovadba, drža, predstava o položaju, ocenjevanje znanja.

María Alejandra Ávalos Ramos, Lilyan Vega Ramírez

STRATEGIJE UČENJA TELOVADNIH PRVIN S POMOČJO TEHNOLOGIJE PRI BODOČIH PROFESORJIH TELESNE VZGOJE

Namen raziskave je bil določiti uporabnost samoocenjevanja in medsebojnega ocenjevanja pri poučevanju in učenju telovadnih prvin. Uporabljene so bile metode ocene kakovosti in količine. Za razčlenitev kakovostnih podatkov je bil uporabljen program AQUAD 6, za količinske podatke je bila uporabljena pisarniška programska oprema Microsoft Excel za MAC (© 2015 Microsoft, različica 15.32). Opazovanje kot strategija zbiranja podatkov in nadaljnja njihova členitev je bistven del tega razvoja. Podobno je olajševalno dejavnost predstavljala tudi uporaba tehnoloških naprav, kot so video kamera in pametni telefon, slednji v dosegu večine študentov. Po drugi strani pa so učenci kritično razmišljali o metodi, ki so jo uporabili učitelji, kar kaže na njihove prednosti in pomanjkljivosti celotnega procesa. Avdiovizualne strategije in mediji so se v tej študiji tako pozitivno pokazali za samoocenjevanje in medsebojno ocenjevanje, saj so ustrezne strategije, ki prispevajo k obvladljivemu učenju in upravljanju podatkov.

Ključne besede: samoocenjevanje, medsebojno ocenjevanje, tehnološki instrumenti, učenje gibanja.

Sunčica Delaš Kalinski, Almir Atiković, Igor Jelaska

RAZLIKE MED TELOVADCI IN TELOVADKAMI PRI VEČKRATNI UDELEŽBI NA OLIMPIJSKIH IGRAH V OBDOBJU 1996 DO 2016

Glavni cilj telovadčeve poti je sodelovanje na olimpijskih igrah (OG) vsaj enkrat. Rezultati raziskave so pokazali pomembno razliko med spoloma pri številu telovadk, ki so tekmovale le na enih igrah (277 telovadcev in 408 telovadk); tudi med tistimi, ki so se redno udeležili dveh OG (104 telovadci in 70 telovadk), treh OG (28 telovadcev in 11 telovadk) in štirih OG (6 telovadcev in 0 telovadk). V številu tistih, ki so se redno udeležili petih OG (en telovadec in ena telovadka) in šest OG (nič telovadcev in ena telovadka) ni bilo pomembnih razlik med spoloma. Za oba spola je bil za zaporedne udeležence treh in več OG značilna visoko kakovost uspešnosti, ki je bila vidna v mnogih finalnih nastopih, in jih ne omejuje njihova nadpovprečna starost. Dobljeni rezultati bi morali spodbuditi vaditelje, da načrtujejo kakovostno vadbo za več kot eno olimpijsko obdobje, v katerem se lahko in bi morali pričakovati nenehno povečevanje kakovosti uspešnosti za oba spola.

Ključne besede: povprečna starost, telovadec, telovadka.

Bojan Leskošek, Ivan Čuk & César J.D. Peixoto

ZANESLJIVOST IN VELJAVNOST OCENJEVANJA MOŠKIH SESTAV NA VELIKI PROŽNI PONJAVI NA EVROPSKEM PRVENSTVU LETA 2014

Analizirali smo rezultate sestav moških posamezno na veliki prožni ponjavi na evropskem prvenstvu 2014 v Guimarãesu na Portugalskem. Skupno je v predtekmovanju tekmovalo 66 moških. Stari klasični način točkovanja, s katerim je rezultat izvedbe skupna vsota posameznih sodnikov (z izločanjem najnižjih in najvišjih ocen) za celotno sestavo, se je primerjala z novim načinom, s katerim se samo kot mediana ocen odbitka za posamezen skok pomnoži z tri in nato sešteje odbitke za vseh 10 skokov. Ugotovljeno je bilo, da je izvedba najpomembnejši del skupne ocene, ki presega stopnjo težavnosti in časa leta v obeh sestavah. Izračunani so bili koeficienti povezanosti znotraj razreda (ICC) in Kendallov koeficient skladnosti W. Pristranost je bila nizka, saj je bil le en sodnik, ki je dosegel znatno višje rezultate kot drugi sodniki. Zanesljivost je bila dobra za posamezne skoke (ICC okrog 0,9 in Kendall W okrog 0,7), medtem ko je bil za vsoto vseh deset skokov odličen (vsi ICC koeficienti nad 0,99 in Kendal W nad 0,97) za obe sestavi. Čeprav so bili koeficienti povezanosti med starim in novim načinom visoki ($r = .965$ in $r = .997$ za prvo in drugo sestavo), je bilo nekaj bistvenih razlik v uvrstitvi med tekmovalci med starim in novim načinom točkovanja (Spearman rank korelacija rho = 0,94 in rho = 0,96 za prvo in drugo sestavo). Kljub visoki zanesljivosti in veljavnosti ocenjevanja so bile predlagane nekatere možne izboljšave. Kar zadeva razlike med starim in novim načinom, ni bilo nobenih jasnih (ne) prednosti enega ali drugega.

Ključne besede: velika prožna ponjava, presojanje, natančnost, objektivnost.

Tomaž Pavlin

ZGODOVINSKI POGLED NA TELOVADBO IN ŠOLSKO TELESNO VZGOJO V SLOVENIJI

Prispevek obravnava odnos telovadbe in telesne vzgoje (TV) v šolah v Sloveniji v obdobju 1869-1941 in desetletju po drugi svetovni vojni ter predstavlja samo splošne razmere po političnih spremembah v Jugoslaviji. V obdobju do prve svetovne vojne je bila v šolah uvedena telovadba kot nova oblika telesne dejavnosti. Z novo šolsko zakonodajo leta 1869 je postala obvezen šolski predmet. To je zahtevalo oblikovanje učnih načrtov in najemanja strokovnega osebja, na kar je vplival tudi razvoj telovadbe v civilni družbi. Šolski predmet je bil prvotno imenovan telovadba. Vendar pa se je izraz telesna vzgoja začel uporabljati kmalu, dokler ob koncu prve svetovne vojne ni nadomestil prejšnjega imena. TV naj bi bil širši izraz, ki je obsegal tudi izobraževalne vidike te dejavnosti, medtem ko je bila telovadba domnevno ožji izraz, ki je bil povezan samo s telesnimi vidiki. Glede na prejšnji razvoj v ustreznih družbah in šolah je bila telovadba osrednja dejavnost v okviru TV. Izvajali so vaje z ali brez orodij za telovadbo, igre, kot tudi nekatere prvine ali discipline borilnih veščin. S člankom želimo spodbuditi tudi primerjalne analize TV, zlasti med regijami pod nekdanjima Avstro-Ogrsko in Jugoslavijo, saj delijo skupno zakonodajo in šolsko okolje s kulturno raznolikostjo.

Ključne besede: telovadba, telesna vzgoja, šolski učni načrt, gibanje Sokol, Slovenija.

Vasilios Kaimakamis, George Dallas, Dimitris Kaimakamis

OBLIKA DROGA IN GIBANJA NA NJEM V DRUGI POLOVICI 19. STOLETJA

Drog je od izuma (lesene izdelave) do sredine 19. stoletja prešel več delov razvoja. Vaje na drogu so bile statične, dinamične, blizu droga, brez koleba. Sredi 19. stoletja so se začeli pojavljati kovinski drogovi in nato drogovi nastavljive višine. Zaradi novega in ugodnejšega orodja so se pojavilo težje prvine in njih povezave s kolebom, statične in dinamične vaje pa so se nadaljevale. V osemdesetih letih so se pojavili dodatni nosilci za lesene stebre, medtem ko je bil v zadnjem desetletju 19. stoletja železni elastični drog postavljen s stabilizacijskimi verigami in mehanizmom za prilagajanje višine. Tak drog je bil uporabljen tudi na olimpijskih igrah leta 1896, kjer so bile opravljene vaje s kolebom in zamahom, pa tudi statične in dinamične vaje. Namen tega dela je bil raziskati in poudariti glavne značilnosti razvoja droga (vaje, predpisi in orodja) v drugi polovici 19. stoletja.

Ključne besede: drog, kovinska palica, dinamično-statične vaje, predpisi.

Angela Tsopanidou, Kalliopi Theodorakou, Elias Zacharogiannis

SRČNI UTRIP MED VADBO VINYASA JOGE

Zdi se, da ima praksa joge ugodne učinke na celovito zdravje in dobro počutje. Namen te študije je bil ovrednotiti intenzivnost vadbe Vinyasa joge. Pri dveh vadbah Vinyasa joge je bil zabeležen srčni utrip (HR) 24-ih odraslih zmerno telesno pripravljenih odraslih (12 moških, 12 žensk, povprečna starost ± sd, 39 ± 7,33 leta), ki sta bili sestavljeni iz štirih delov (ogrevanje, surya namaskar, 45 minut vadba in umiritiev). Največji HR je bil ocenjen sedem dni pred tem pričetkom vadbe na tekoči preprogi. Analiza podatkov je vključevala povprečje HR (u.n.m) in% največjega HR v vsakem delu obeh vadb in narejena je bila ANOVA (spola X Vinyasa). Rezultati so pokazali, da med obema dejavnikoma ali pomembnim glavnim učinkom spola ni bilo pomembnih interakcij v HR ali v največjem % HR. Pomembne pa so bile razlike ($p < 0,01$) med štirimi deli vadbe Vinyasa, pri čemer je surya namaskar predstavljala najvišje srednje vrednosti. Udeleženci Vinyasa joge so v tej študiji imeli 68,8% -71,7% njihovega najvišjega HR vsaj 60 minut. Zgornja intenzivnost in trajanje vadbe je v splošno sprejetih smernicah za izboljšanje parametrov vzdržljivosti srca in ožilja pri zmerno telesno pripravljenih osebah. Zdi se, da sistematična udeležba v Vinyasa jogi lahko učinkovito izboljša sposobnost sprejema kisika in spodbuja zdravje.

Ključne besede: intenzivnost gibanja, vzdržljivost, poraba energije.

Mauricio Santos Oliveira, Yan Tavares Galdino da Silva & Paula Cristina da Costa Silva

PRIPRAVA TELOVADBE ZA VSE IN Z VSEMI

Telovadba lahko spodbuja izboljšanje zaznavanje telesa in boljše obvladanje gibanj in ima zmožnost, da preseže telesne vidike s povečanjem socialno-čustvenih dejavnikov, ki jo prežemajo. V disciplinah, ki jih organizira Fédération Internationale de Gymnastique (FIG), je telovadba za vse (GFA) osnova za vse ostale. Je edinstvena oblika telovadbe, ki v heterogenosti išče harmonijo, ustvarjalnost, svobodo in raznolikost, vedno ob upoštevanju telesnega, duševnega in družbenega blagostanja svojih telovadcev. Prispevek v pretežno pedagoški prihodnosti si GFA prizadeva deliti in razmišljati o delu in filozofiji skupine Gymnastic Group LABGIN s sedežem v Souzi (1997). Ta univerzitetni načrt vključuje začetno usposabljanje študentov telesne vzgoje. Usposabljanje vključuje socialno delo, ki je vključujoče, demokratično in je sposobno zajemati posameznike z deli telesne kulture, ki upajo, da vplivajo na njihovo prihodnje delo. Skozi izobraževanje si prizadeva za spodbujanje izkušenj z družbenimi vrednotami.

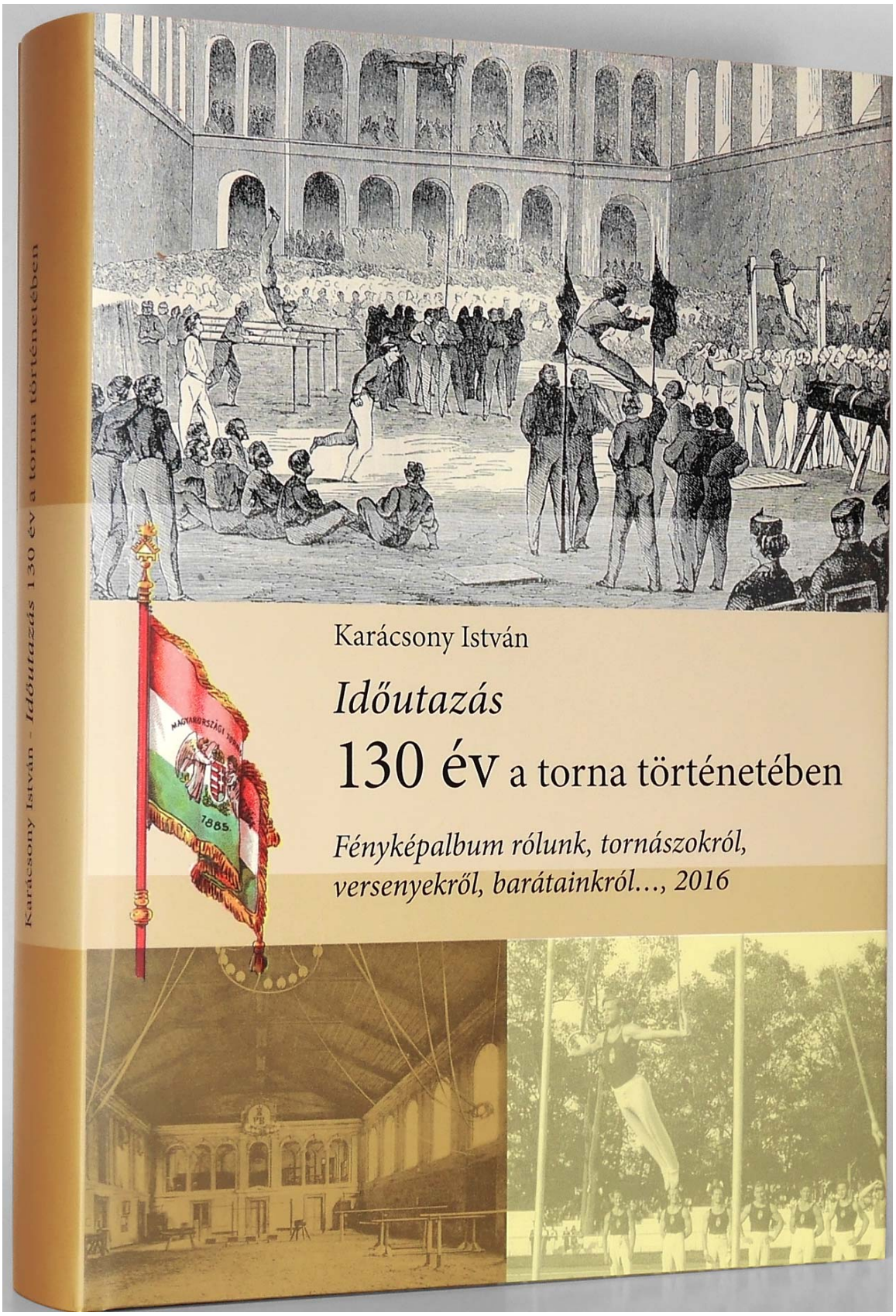
Ključne besede: gimnastika za vse; metodologija poučevanja in učenja.

REVIEWERS 2017

DEAR FRIENDS, THANK YOU FOR YOUR DILIGENT WORK.

Araújo, Carlos
Atiković, Almir
Ávalos, María Alejandra
Ávila-Carvalho, Lurdes
Bango, Benjamin
Bobo, Marta
Bortoleto, Marco
Bučar Pajek, Maja
Carbinatto, Michele
Dallas, George
Delaš Kalinski, Sunčica
Dolenec, Ales
Donti, Olyvia
Ferreirinha, José
Fink, Hardy
Gajdos, Anton
Geiblinger, Helmut
Grande, Ignacio Rodriguez
Hadžič, Vedran
Hasandra, Mary
Heinen, Thomas
Hennig, Linda
Jeraj, Damian
João, Andrea
Kajtna, Tanja
Kalichová, Miriam
Kochanowicz, Andrzej
Kovač, Marjeta
Kovač, Marjeta
Kremnicky, Juraj
Leandro, Catarina
Lebre, Eunice
Leskošek, Bojan
María Ángeles, Martínez
Marina, Michel
Marinsek, Miha
Milić, Radoje
Mkaouer, Bessem
Mujanovic, Edin
Naundorf, Falk
Niespodziński, Bartłomiej
Nunomura, Myrian
Omrčen, Darija
Pajek, Jernej
Pavlin, Tomaž
Pineda-Espejel, Heriberto
Russell, Keith
Sato, Yusuke
Sato, Yusuke
Scharenberg, Swantje
Schiavon, Laurita
Schiavon, Laurita
Šibanc, Karmen
Silva, Maria-Raquel G.
Simonsmeier, Bianca
Tabaković, Muhamed
Trajković, Nebojša
Tušak, Matej
Vernetta Santana, Mercedes
Vinken, Pia
Vodeb, Roman
Živčić, Kamenka
Zurc, Joca

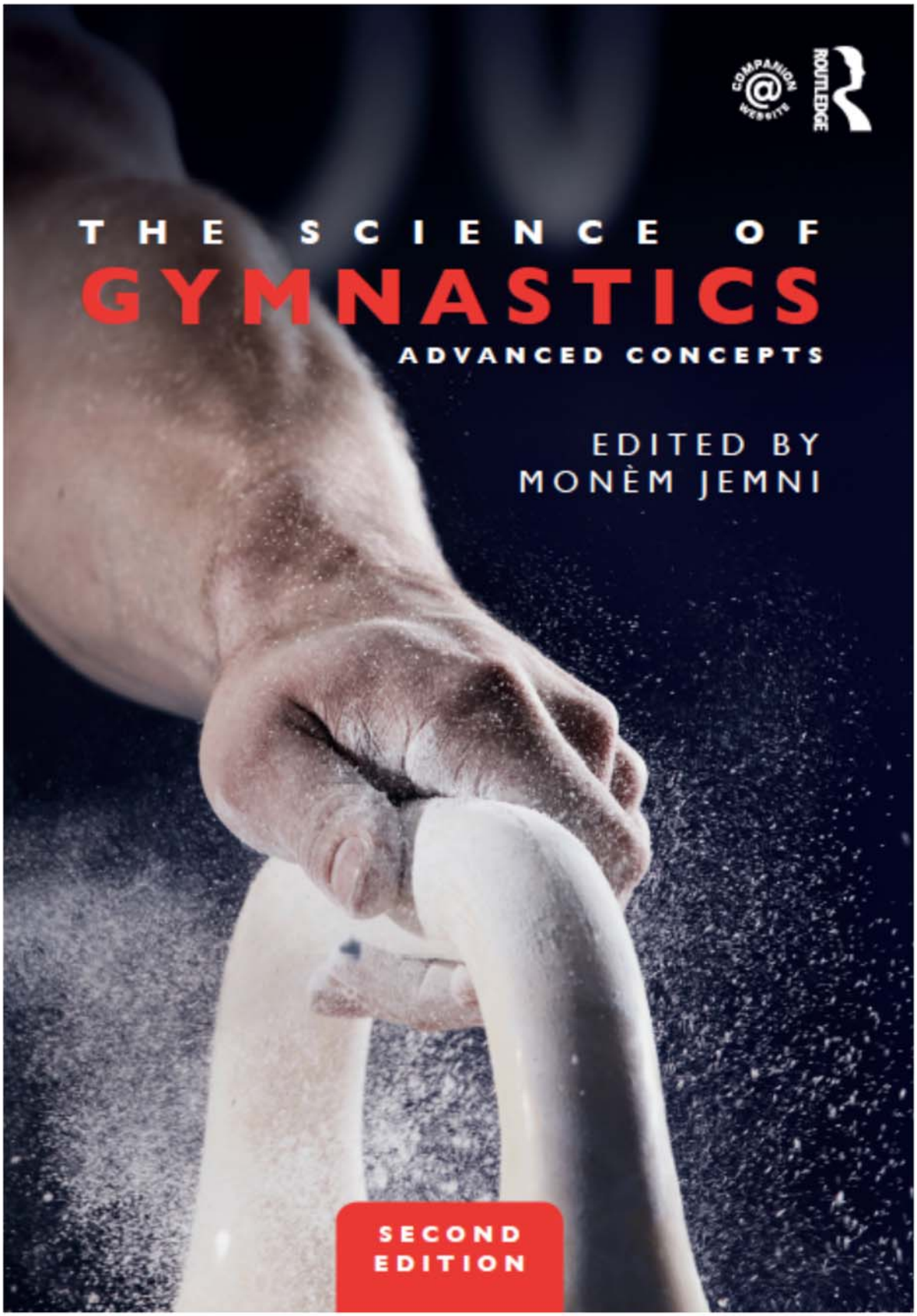
Ivan Čuk
Editor-in-Chief


Karácsony István - Időutazás 130 év a torna történetében
Karácsony István
Időutazás
130 év a torna történetében
Fényképalbum rólunk, tornászokról, versenyekről, barátainkról..., 2016
1885

Book: István Karácsony. 130 Years of Hungarian Gymnastics Federation. 904 pages and 4000 photos.

More info:

Dr. István Karácsony
FIG Honorary Member
1165 Budapest
Prodám u. 12
HUNGARY
MOB:+36 30 74 74 058
e-mail: istvan.karacson@gmail.com


COMPANION @ WEBSITE
ROUTLEDGE
THE SCIENCE OF
GYMNASTICS
ADVANCED CONCEPTS
EDITED BY
MONÈM JEMNI
SECOND
EDITION

Second edition published 2018
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

First edition published by Routledge 2011

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
[CIP data]

ISBN: 978-1-138-70192-2 (hbk)
ISBN: 978-1-138-70193-9 (pbk)
ISBN: 978-1-315-20380-5 (ebk)

Typeset in Bembo
by Keystroke, Neville Lodge, Tettenhall, Wolverhampton

Visit the companion website: www.routledge.com/cw/jemni

PART I

Physiology for gymnastics

PART II

Applied coaching sciences in gymnastics

PART III

Biomechanics for gymnastics

PART IV

Psychology for gymnastics

PART V

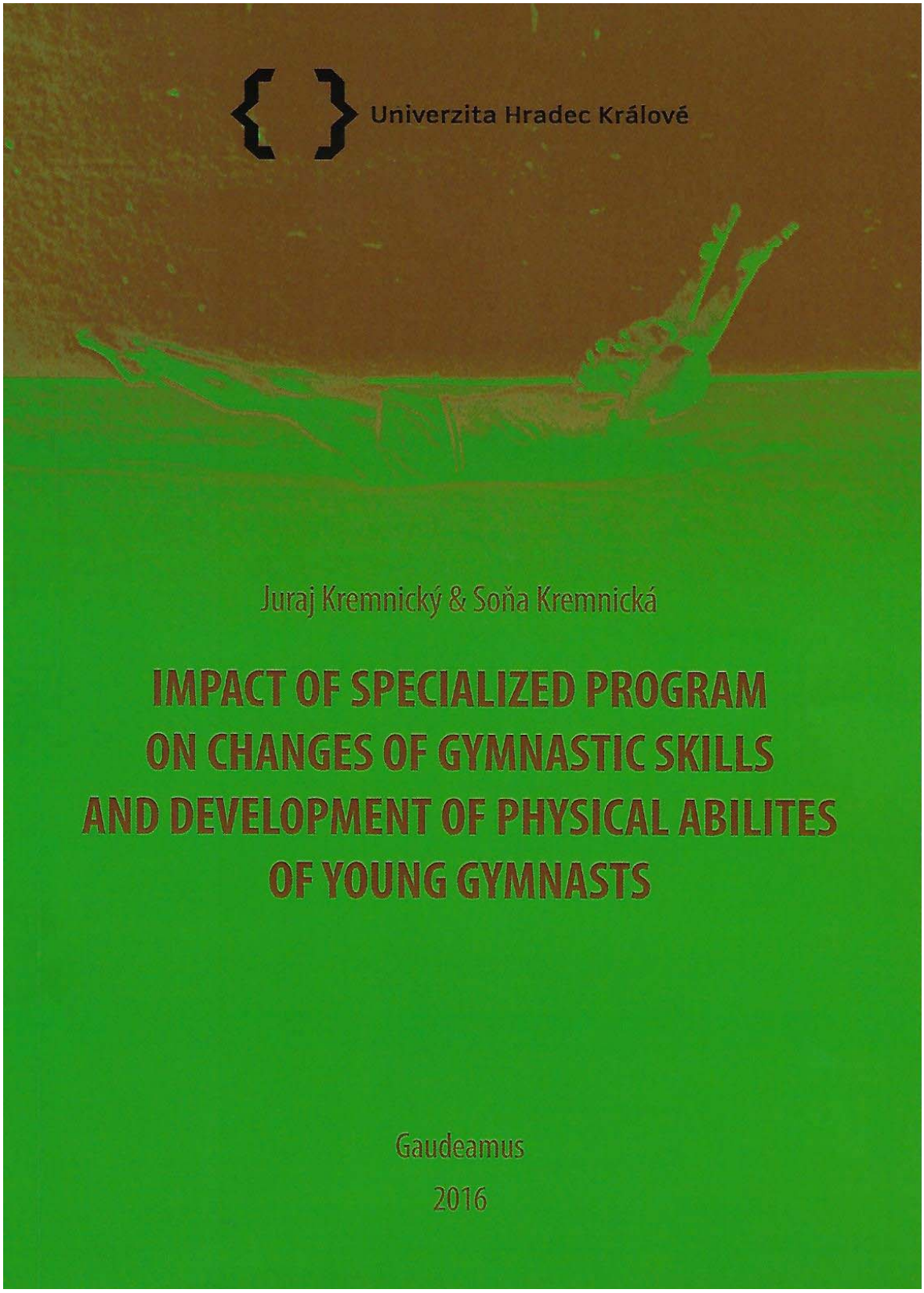
Interaction between physiological, biomechanical and psychological aspects of gymnastic performance

PART VI

Motor learning in gymnastics

PART VII

Injuries in gymnastics


Univerzita Hradec Králové
Juraj Kremnický & Soňa Kremnická
IMPACT OF SPECIALIZED PROGRAM ON CHANGES OF GYMNASTIC SKILLS AND DEVELOPMENT OF PHYSICAL ABILITES OF YOUNG GYMNASTS
Gaudeamus
2016

ABSTRACT

KREMNICKÝ Juraj & KREMNICKÁ Soňa: *IMPACT OF SPECIALIZED PROGRAM ON CHANGES OF GYMNASTIC SKILLS AND DEVELOPMENT OF PHYSICAL ABILITES OF YOUNG GYMNASTS* – scientific monograph / Matej Bel University in Banská Bystrica Faculty of Arts. Department of physical education and sport. Banská Bystrica 2016. 170 p. 8 AH

The objective of the research was to determine the level of acquisition of gymnastic skills in stage of gymnastic pre-preparation by influence of specialized program. The research group was formed from 17 six and seven years old gymnasts. We applied double-group pedagogic experiment for determination of 9 months long specialized program. We determined the effectiveness of specialized program by using motoric testing and using the technical appraisal method for determination of level of acguisition of gymnastic skills. We determined the input level of gymnastic skills after three months in october from the begining of the research and the output level in june / end of monitored period/. We devided the sum of gained points into four percentage ranges. Each range indicates certain level of acquisition of gymnastic skills. By analysis of inputs of gained gymnastic skills we determined that control group gained 12,5p more than experimental group, which was statistically significant difference on the level of 0,05. The comparison of outputs showed that control group gained 89,7p and experimental group gained 141,7p, the difference in levels of gained gymnastic skills was statistically significant on level of 0,001. We determined equally high statistical significance on level 0,001 on account of experimental group also by comparison of differences in improvement between inputs and outputs – the median of improvement in experimental group was 104,3p, in control group 41,5p. On the basis of percentage evaluation of gained level of gymnastic skills we recommend to advance into stage of beginning gymnastic specialization 8 probands of experimental group and one proband of control group. Our specialized program had a positive impact on the development of motor skills shown in output evaluation of experimental group in all the motor skills statistically significant at the $p < 0.01$ in comparision with input data.

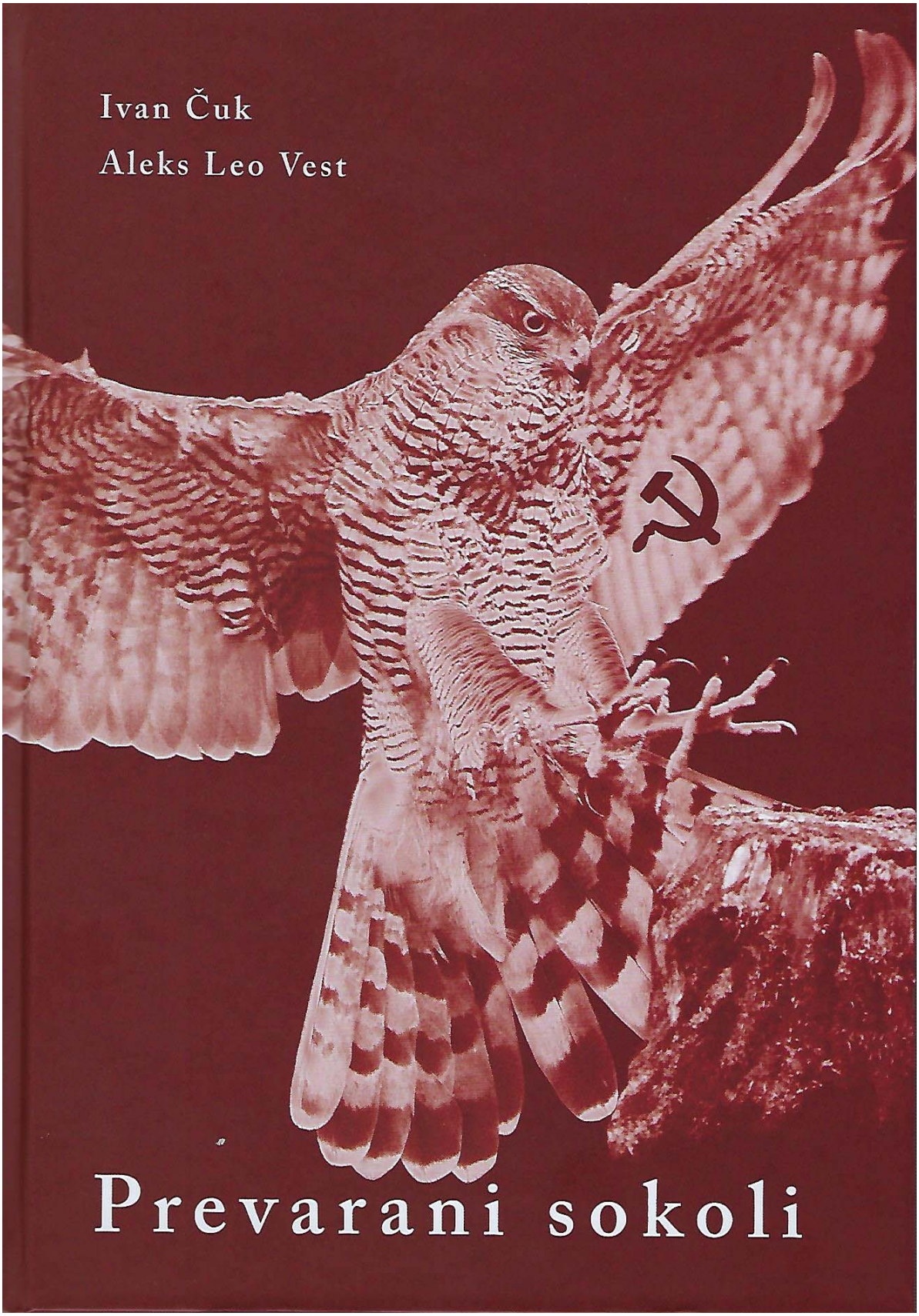
Key words: Gymnastic pre-preparation. Gymnastic skills. Motor tests. Specialized program of motor preparation.

Correspondence to:
Mgr. Juraj Kremnický, PhD.
Department of Physical Education and Sports
Faculty of Arts
Matej Bel University
Tajovského 40
97401 Banská Bystrica
Slovak republic (SVK)
e-mail: juraj.kremnicky@umb.sk
phone:+421 048 446 7530

Title:	IMPACT OF SPECIALIZED PROGRAM ON CHANGES OF GYMNASTIC SKILLS AND DEVELOPMENT OF PHYSICAL ABILITES OF YOUNG GYMNASTS (scientific monograph)
Authors:	Mgr. Juraj Kremnický, PhD. Mgr. Soňa Kremnická, PhD.
Reviewers:	Assistant Professor, Almir ATIKOVIĆ, Ph.D. Mgr. Jiří BUBEN, Ph.D.
Pages:	170 pages; 8 AH
Impression:	100 pcs.
Edition:	first
Year:	2016
Size:	A5
Edition:	GAUDEAMUS – University of Hradec Králové

Vydalo nakladatelství Gaudeamus, Univerzita Hradec Králové jako svou 1597 publikaci.

ISBN 978-80-7435-658-2


Ivan Čuk
Aleks Leo Vest
Prevarani sokoli

Summary

The history as recorded by the Communist winners of the WWII and the revolution hang heavily over any sensible discussion that could contribute to overcoming the divisions among the Slovenian people that occurred due to the civil war and revolution. The present and the future are shackled by the fact that communists managed to maintain the mechanism of reproducing communist faithfuls who perceive communist ideological constructs and distortions as indisputable dogma. The question of whether the Communist Party, especially its Slovenian part, (ab)used the left-wing Sokols to carry out the communist revolution of Leninst-Stalinist type remains unanswered.

On the territory of what we today know as Slovenia the Sokol movement was initially explicitly nationalistic and Pan-Slavic and under dominant influence of the National Progressive Party (*Narodno napredna stranka*). Later the liberal Yugoslav National Party (*Jugoslovanska nacionalna stranka*) also joined in with this movement. Nevertheless, the Sokol members were throughout this period allowed to align themselves politically in accordance with their own religious beliefs while respecting the boundaries set by the general Sokol principles. King Alexander Karadjordjevic even decided to build the united Yugoslav nation on the basis of the Sokol ideology. The King's idea of the Yugoslav nation was later continued in the Socialist Federal Republic of Yugoslavia.

All history books on Sokols so far have always claimed that the Sokols as an organisation were the founding members of the Liberation Front (*Osvobodilna fronta – OF*). The discovery of documents in the archive of late Dr. Viktor Murnik, however, opened the essential question whether the Sokol organisation actually joined the OF at all. Our research of materials preserved in archives and libraries in Ljubljana, Maribor, Lenart, Ptuj and Metlika has revealed that the Slovenian communists conned the Sokols.

In their education program, the Sokols were concerned with four types of education: the national, the democratic, the physical and the moral education which together form an inseparable whole. If one type of education is missing it can no longer be called the Sokol education.

After the World War I, in particular after the Announcement (*Obznana*), the communist activity was focussed on the destruction of the Sokol organisation. In 1931, at a uniting Sokol progressive course in Maribor, Lado Ambrožič, Milan Apih and Franjo Vrunč were introduced to the communist ideology. Apih and Vrunč joined the CPY (*KPJ*) in 1932 and started to spread the communist ideology among the youth and their peers, such as Sokol members from Ljubljana: Josip Rus, Franjo Lubej and Zoran Polič. These can be called the communist wing of the Sokol movement.

In 1932, the Communist Party made a comprehensive analysis of the Sokol organisation and came to the conclusion that it was: financially strong, had professional senior staff, had big influence over the youth, left the question of religion to its membership, was of liberal thinking and open to new ideas. Following this analysis, the Communist Party tried to take over the Sokol or at least imprint the communist ideas on the young Sokol minds, so that the moment the situation became ripe for a workers revolution these young Sokols could serve as the new revolutionary army. Documents show that by 1936, the police caught and charged many communist Sokols; this made the Communist Party change its strategy and through a few

individual leading communists (e.g., Maks Nahlik) started instead to direct operations of unorganised communist enthusiasts. Communist operations in the Sokol movement had many different facets, including stealing their legal newspapers for their own activity; communist infiltration of Sokol groups by using fake membership cards; taking advantage of the Sokol infrastructure (e.g., libraries) to borrow illegal literature; organising meetings and influencing young people. The Party recognised the exceptional national awareness among Sokols so it changed its propaganda tactics: it abandoned its international idea and promoted the national agenda instead by encouraging the feeling of national inferiority among Slovenians in comparison with other nations in the kingdom.

Communist enthusiasts Rus, Lubej and Polič tried to take over the most important group Sokol I Tabor and the key county Ljubljana. As the surrounding area of Ljubljana was already quite communist, they initially succeeded in Tabor and on the county level by 1939, but later in the same year Polič and Lubej were expelled from the Sokol I in Tabor. Consequently all their functions in the Sokol organisation ceased. Rus who was a member of Sokol II Bežigrad did not hold any position in the county or in the organisation.

On 13 January 1941, following the elections to the new Sokol county administration, Rus, Polič and Lubej signed a cooperation agreement with communists. This agreement was the result of almost year-long cooperation in establishing the Friends of the Soviet Union Organisation. County elders, the official Sokol representatives, however, had a meeting in Belgrade on 30 March 1941 where they pledged to put all their available resources to the service of the King, the Nation and the Homeland. Unlike them, the "democratic" Sokols Franc Lubej, Zoran Polič and Josip Rus decided to participate in the execution of a Stalinist revolution within the Liberation Front (*OF*) framework. When the Kingdom of Yugoslavia came under attack on 6 April 1941, the Sokols of the Kingdom of Yugoslavia went underground and started the Sokol Legion while the communist Sokol wing joined the Anti-Imperialist Front on 26 April 1941. In June 1941 this Front renamed itself after Germany attacked the Soviet Union to the Liberation Front (*OF*). It should be noted that the communist Sokols were neither legal nor legitimate signatories of any documents on behalf of the Sokol organisation. The Sokols in Slovenia were grouped into five independent counties at the time: Ljubljana, Maribor, Celje, Kranj and Novo mesto. None of the county elders who were the only persons holding the right to sign Sokol documents signed the founding documents of the Liberation Front.

The servility of the communist Sokols ensured that the communists in the leading OF bodies had the required majority in making decisions that were in line with the execution of the Stalinist revolution program. This is further confirmed by claims by Edvard Kardelj, one of the communist leaders, that OF was no coalition and that the Sokol representatives agreed in principle also to the part of the Soviet revolution. Perceived political independence of the Sokols in the OF was required only in the first stage of the revolution so that it would appear as a bourgeoise revolution.

As early as 1936, the "democratic" Sokols started to educate Sokol youth following the Bolshevik model. They masked the idea of organising troikas as a play called "fox hunt". The troikas became solid indivisible units; their member names were not to be given to anybody for any price, not even to their own family. Every person existed only as a member of the troika. The purpose of the game was secrecy. During World War II the Communist Party enlisted at least 1229 Sokol members. Their average age at the beginning of the war was 20 years.

When the Security-Intelligence Service (*Varnostnoobveščevalna služba - VOS*) was established, it was led by party trained Sokol members, in particular members of the pro-communist workers cultural organisation Vzajemnost, such as Franc Stadler-Stane, Edi Brajnik-Štefan and Zvonko Runko (all three came from the Spodnja Šiška Sokol group) who murdered their Sokol brothers and sisters, such as Fanuš Emmer (December 1941), Avgust Praprotnik (in February 1942) and Minka Dovč (June 1942). The worst partizan attack on Sokols who joined the Yugoslav army in their homeland took place between 8-10 October 1943 in Grčarice. Eleven soldiers died on the battlefield, the majority of 171 prisoners were killed later. Many among them were Sokol leaders.

At the end of WWII, the communist Sokols called a meeting of Slovenian Sokol organisation for 8 July 1945. Only those representatives who had the party permit could attend. At the meeting the Sokol organisation disbanded itself.

In his speech, Josip Rus maintained that the Sokol movement found its fulfillment in the Communist Party; according to Polic the Sokol had realised its role in the history. Dr Viktor Murnik, however, laconically commented: The King is dead, long live the King!

Together with Italian fascism, German Nazism and Russian communism, the Slovenian communism too disbanded the Sokol organisation and thus joined all other totalitarian ideologies that cannot tolerate an organisation that attends to the national, the democratic, the moral and the physical education. Following the Soviet Union model, the organisation that replaced it used Russian word ‘fiskulturno’ rather than Slovenian word for physical ‘telesno’ (they didn’t even want to keep the Slovenian name). Communists then founded The Organisation for Physical Education Partizan - in the new system only physical health was still desired.

Bearing all this in mind, can there still be any doubt that the Sokol organisation was used and abused for the needs of the Stalinist revolution?

Naslov: Prevarani sokoli

Avtorja: prof. dr. Ivan Čuk in doc. dr. Aleks Leo Vest

Založil in izdal: Študijski center za narodno spravo, Ljubljana 2017

Uredila: doc. dr. Tamara Griesser Pečar, dr. Damjan Hančič

Recenzenta: dr. Jože Dežman, ddr. Igor Grdina

Fotografija na naslovnici: Kragulj, fotograf: Matej Vraničar

Likovna oprema in priprava za tisk: Inšitutut Karantanija

Prevod: Metka Čuk

Lektorirala: Marica Maver

Angleški prevod: Metka Čuk, MA Linguistics

Tisk: Nonparel d. o. o.

Naklada: 500 izvodov

Ljubljana 2017

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

94(497.4)"19"
061.2:796(497.4)(091)

ČUK, Ivan, 1961-
Prevarani sokoli / Ivan Čuk in Aleks Leo Vest ; [prevod Metka Čuk]. -
Ljubljana : Študijski center za narodno spravo, 2017

ISBN 978-961-93925-8-4
1. Vest, Aleks Leo
292610560

282703104