Science of Gymnastics Journal

vol. 7, num. 3, year 2015

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

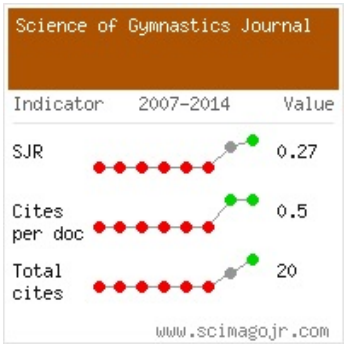
Science of Gymnastics Journal (ScGYM®)

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
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

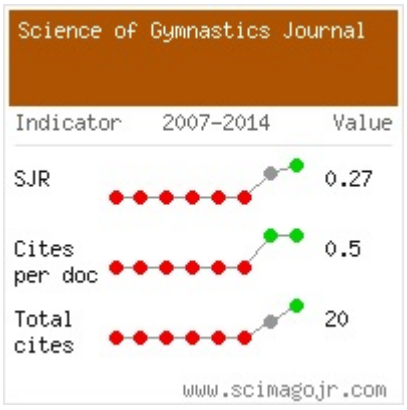
Slovenian Research Agency

CONTENTS

EDITORIAL

Dear friends,

For our last issue in 2015 we prepared the largest volume ever. It has more than 150 pages of gymnastics-related scientific readings. In his issue you will find eight new articles, Anton Gajdoš's Historical Notes, a supplement dedicated to the International Scientific Conference: Sport, Health & Education – Complementary Approach to Gymnastics, and information about the latest books.



Since our last issue, SCOPUS has published journal evaluations for 2014 and upgraded our ranking. We wish to thank our authors and researchers from around the world who are sharing their work and knowledge through our journal or spreading our journal knowledge in other journals. From our editorial board member Marco Antonio Bortoleto we received information that the Brazilian Agency of Scientific Journals Classification categorised the Science of Gymnastics Journal as B1 (on a scale A1, A2, B1, B2, ... B5, C). It is a very good ranking for this type of publication. We also applied for a similar status in Poland and we intend to apply to be included in the Ulrich's Data Base. If we wish to become members of PUBMED data base we will need to publish at least 50 articles per year. At the moment this seems a very ambitious plan.

Our first article comes from Brazil: authors Luiz Henrique Duarte, Myrian Nunomura and Michele Viviene Carbinato explored the different types of fear in artistic gymnastics. The second article is by Evdoxia Kosmidou, Miltiadis Proios, Evgenia Giannitsopoulou, Theofanis Siatras, George Doganis, Michalis Proios, Helen Douda and Anna Fachantidou-Tsiligiroglou: they evaluated body self-esteem in rhythmic gymnasts. The third article is from Japanese researchers Yoshie Motoshima, Junichi Kitagawa and Akira Maeda who compared laboratory tested drop jump in relation to the take off in vivo on vault. Helmut Geiblinger and Tony Dowden from Australia conducted an interesting research study on coaches and how they evaluate proper landing. Klaus Hübner and Christoph Schärer from Switzerland looked at strength training tests for swallow, support scale and iron cross. Dejan Križaj and Ivan Čuk from Slovenia continued with their evaluation of accelerometer Skoci as used in the field and the laboratory. Experts on rythmic gymnastics from Portugal and Spain Catarina Leandro, Lurdes Ávila-Carvalho, Elena Sierra-Palmeiro and Marta Bobo evaluated rhythmic gymnastics judges' efficiency in evaluating difficulties. The last article is from Japanese historian Moriatsu Nakasone who provides an overveiw of the development of high bar elements as presented in Japanese literature.

Anton Gajdoš in Short Historical Notes IV prepared a memo about the team representing Finland in 1948, including Akimoto Kaneko and Helena Rakoczy. In our supplement on the International Scientific Conference: Sport, Health & Education – Complementary Approach to Gymnastics, held at Gdansk University of Physical Education and Sport in Poland between18 and 20 June 2015, you can find lectures and abstracts from the symposium. Please note that this journal would be happy to promote science in gymnastics for other events worldwide as well.

Finally, there is a brief overview of the latest publications: Portuguese authors Maria Raquel Goncalves e Silva and Teresa Paiva contributed two books about nutrition and rest, while Istvan Karacsony and Ivan Čuk published a book on the Horizontal bar.

Just to remind you, if you quote the Journal: its abbreviation on the Web of Knowledge is SCI GYMNASTICS J.

I wish you pleasant reading and a lot of inspiration for new research projects and articles,

Ivan Čuk
Editor-in-Chief

ARTISTIC GYMNASTICS AND FEAR: REFLECTIONS ON ITS CAUSES

Luiz Henrique Duarte[1], Michele Viviene Carbinatto[2], Myrian Nunomura[1]

[1] State University of São Paulo, São Paulo, Brazil
[2] University of São Paulo, São Paulo, Brazil

Original article

Abstract

In the field of sports psychology it is nearly unanimous that both positive and negative emotions directly affect sports performance. In the case of artistic gymnastics (AG), it is not uncommon for athletes to face one specific, characteristic emotion: fear. In this study, we will conduct an analysis of fear felt by gymnasts in training in order to detect subjective perceptions about the causes of fear and the strategies utilized to control it. Sixteen gymnasts who compete in the pré-infantil (9 – 10 years) category of the Sao Paulo State Championship were interviewed. Content analysis was selected as the methodological technique for data. We detected four units of registry for analyzing the causes of fear: fear of injury, fear of error, fear of apparatus and fear of coach. Regarding strategies for controlling fear, we detected seven units: social support (friends and family), instructional support, attention and concentration, positive thinking and self-confidence, mental practice, and relaxation techniques. In general, coaches can interfere as much in the manifestation of fear as in its control. Among possible pedagogical strategies, we can highlight adjustments to the training environment and instructional procedures that facilitate the teaching-learning process, particularly in regards to the athletes' feelings of security.

Keywods: *gymnasts, sport, competition, emotion, psychological approach, qualitative research.*

INTRODUCTION

The highly desired sports performance of elite athletes has started to be analyzed in terms of a variety of factors, such as skill level of the athlete (Hanton, Thomas, & Maynard, 2004; Waples, 2005), competitiveness in a specific context, (Mellalieu, Hanton, & O'Brien, 2004), the gender of the athletes (Woodman & Hardy, 2003) and the type of sport (Hanton, Thomas, & Maynard, 2004). Following this line of inquiry, Hanin (2010) indicates that in the field of sports psychology it is nearly unanimous that both positive and negative emotions produce direct effects on sports performance.

In artistic gymnastics (AG), it is not uncommon for athletes to face one specific, characteristic emotion: fear. The motor skills and movements typical of this modality make the positioning of the

gymnasts' centers of gravity more dynamic, and executing supports, hangings, inversions, flights and rotations are part of this dynamicity. The aerial actions in AG challenge and motivate the athletes, elevate and enrich the presentations, but they can also startle athletes new to the sport and push them away from the sport.

Fear can be described as the state of apprehension and the emotional reaction to threat or stimuli, real or imagined, (Gullone & King, 1993) which lead the individual to flee or avoid the provoking situation (Gray, 1987).

In the practice of sports, understanding the origin of fear, as well as the responses to its manifestation, can aid coaches in adopting strategies to prevent the interference of fear in the athlete's performance (Moll, Jordet, & Pepping, 2010).

In addition to considering the emotions involved in the practice of AG, certain characteristics, such as the early age at which training begins (the Brazilian Gymnastics Federation (CBG) recognizes 7 years as the first category in the sport), should guide conduct and procedures for both training and competition. To this end, the coach needs to understand the profile of the group in order to make successful interventions.

In this study, we conduct an analysis of fear felt by *pré-infantil* (9-10 years) gymnasts in training in order to detect subjective perceptions about the causes of fear and the strategies utilized to control it.

The manifestation of fear is common in AG and present in the daily practice of the gymnasts (Nunomura, Carbinatto, & Duarte). In order to maintain the quality and longevity necessary for an athletic career to reach the elite level it is important to understand ~~to~~ the situations which are most responsive to direct intervention. In Brazil it is not yet possible to encounter evidence of this concern for reinvigorating main teams and the qualitative increase in athletes (Schiavon, Paes, Toledo, & Deutsch, 2013). Furthermore, there is of dropout around the age of 15, which is to say, at an opportune moment for the athlete to reach his / her peak (Arkaev & Suchilin, 2004).

Fear in Artistic Gymnastics

In general, emotions influence the person's objectives and motivations (Lench, Flores & Bench, 2011) and are regulated, consciously or unconsciously, according to the context and prior experiences of the subject.

Studies from Augustine and Hemenover (2008) and Koole (2009) emphasize that there are more than 400 distinct strategies for dealing with emotions, with the most frequently used in sports being self-talk (Tod, Hardy, & Oliver, 2011) and mental practice (Guillot & Collet, 2008).

In this article we focus our attention on the emotion of "fear". Huber (2000) argues that this emotion is related to perception, expectation and imagination that are associated with an unpleasant excitement. Also, it can be described as a state of scared or being apprehensive and as an emotional reaction to the threat of punishment- a stimulus, which one will work to terminate, escape or avoid.

The emotion "fear" can impede the continuity of an action. In some cases the athlete gives up on carrying out the skill, and in others he / she avoids the threatening situation. There is also the possibility that the individual becomes immobilized (frozen) mid-action in specific cases. These reactions to fear can cause diminished self-esteem, as well as discomfort or shame in front of colleagues, and can compromise the athlete's physical well-being.

Fear of injury is the most common in sports and can produce negative effects in the athlete's performance (Magyar & Chase, 1996; Giotis & Nilsson, 2006) and can provoke "mental blocks," or situations in which the athlete refuses to carry out a specific movement which is perceived as a threat to his / her physical health (Marini, Sgambati, Barni, Piazza, & Monaci, 2008).

Gymnasts constantly challenge gravity and any error is evident, particularly when the movement and sequence's fluidity are

interrupted, such as during a fall. In these situations, the fear of losing points can interfere with overall performance and, as such, define the classification of the gymnast (Martinent & Ferrand, 2007).

Fear can also unleash other emotions which affect the athlete's performance, such as anxiety and stress. Hanton, Thomas and Maynard, 2004 and Cerin, 2003 defend that when there is fear and a potential threat, there will be anxiety, which is developed in four domains: physical harm, loss of self-esteem, social evaluation and uncertainty the fear of injury and that of failure (Harringe, Renstrom, & Werner, 2007).

Woodman and Hardy (2003) and Martinent and Ferrand (2007) suggest that although anxiety is traditionally treated as unfavorable to performance, competitive state anxiety can both promote and debilitative functions. It is important to emphasize that high self-confidence, self-efficacy, and positive thinking can, somewhat, control or dismiss the apprehensive emotions for anxiety.

Fear can be perceived subjectively as tension, nervousness and oppression. It is detected more intese activity of the autonomic nervous system. The fearful person has a behavior disturbed by the apprehension of failure and always puts in question his/her abilities, which avoid achieving the best performance. In this regard, the individual is stressed. Despite being associated with a negative phenomenon, stress allows understanding the body limits, and may be considered necessary for life (Machado, 2006).

Elite gymnasts manifest pronouncedly greater fear in competitive context as compared athletes at a similar professional level in other sports (Kolt & Kirby, 1996).

Finally, the constant changes involved AG can be demonstrated by the high level of skill complexity on different apparatus and increasingly demanding rules, facts which increase the level of difficulty in all competitive categories. The number and categories of AG difficulties has indeed increased since 70´s where there were only three kinds of difficulties (A,B and C), whereas they are nowadays more than seven (A to E + super E). This increase in the level of difficulties is shown in the code of point that was updated ever Olympic cycle, where more and more elements are being included.

METHODS

This study represents transversal field research of a qualitative nature. We have opted for a non-probabilistic, or intentional, sample; that is to say, we were interested in the opinion of a specific group.

Data collection was carried out at a training facility and we conducted semi-structured in-deph interviews with questions about fear, training and competition. All interviews were systematically transcripted and analysed by the three investigators separately. A cross-results analysis was then followed to check for accurancy. Themes that did not have a commom opinion were sent to two experts in this methodology to accomplish our table results. When disagreement, two more independent experts were requested to give their own opinion and make a final statement.

Subjects

Participants in this study were sixteen female children (round age 9 years ± 1 year; 4.28 ± 1.34 years of practice), who competed for clubs in the cities of São Caetano do Sul, São Bernardo do Campo and Barueri in the *pré-infantil* (9 – 10 years) category of the São Paulo State Championship in women's AG. Accordingly to Seil, Rupp, Tempelhof, & Kohn (1998), the experience of injury of these girls were between mild (absence from practice less than one week) to serious (absence among 2 to 4 weeks).

Gymnasts were identified with the letter G plus the number indicating the order of the interviews.

Data Analysis

The methodological technique selected for examining the data was Content Analysis (Bardin, 2010; Corbin & Strauss, 2015), specifically its thematic modality in

which assertions made about a determined topic can be represented by a simple sentence, a group of sentences or a paragraph. This technique also incorporates, with greater or lesser intensity, the personal aspect attributed by the respondent about the meaning of a word and / or the connotations attributed to a concept. It involves rational components, as well as ideological, affective and emotional ones.

The technique is made up of the following steps: pre-analysis, exploration of the material, and categorization. Each of these, in turn, is organized into units of register and context.

a. Units of Register (UR): content segment for categorization and counting frequency, when necessary. In our study the unit of register adopted was 'theme', defined as "a unit of meaning that is released freely from a text" (p. 14). It is important to highlight that the counting frequency is characterized as an essential condition, since extremes were considered and could stimulate significant discussion within and with the literature.

b. Units of Context (UC): segments of text or message that confirm the units of registry which, in this case, will be a word, a group of words, a phrase, multiple phrases or a paragraph.

RESULTS

We detected four units of registry for analyzing the causes of fear among gymnasts in the *pré-infantil* (9-10 years) category: fear of injury, fear of error, fear of apparatus and fear of coach. Regarding strategies for controlling fear, we detected seven units of analysis: social support (friends and family), pedagogical support, attention and concentration, positive thinking and self-confidence, mental practice, and relaxation techniques.

DISCUSSION

On the causes of Fear

Injury fear was the most iterant answeramong the gymnasts. In general, the age at which AG practice and the process of sports training begin is increasingly younger (Silva, Fernandes & Celani, 2001). Even when the gymnasts are inserted into an instructionally appropriate environment, they can still be susceptible to exaggerated training times and expectations. These factors could potentially be associated with injury, as they would increase the time exposed to risk and different risk factors, such as the excessive repetition of the same element (Dally, Bass, & Finch, 2001; Caine, Caine, & Lindener, 1996) and the amount of time allotted for rest. Furthermore, according to Kolt and Kirky (1996) the higher frequency and longer duration of training sessions coincided with a higher incidence of injury.

Table 1
Causes of fear among gymnasts in the pré-infantil (9-10 years) category.

Units of Register (UR)	**Frequency**	**Units of Context (UC)**
Fear of injury	n=12	I'm afraid of hitting my back" (G2)
Fear of error/ Fear of failure	n=9	I feel ashamed to do something wrong in front of my coach and friends (G11).
Fear of apparatus and new skills	n=7	I'm afraid of the parallel bars (G8)
Fear of coach	n=7	Well, I'm afraid of my coach, because he gets angry (G12)

Table 2
Strategies for controlling fear.

Units of Register (UR)	Frequency	Units of Context (UC)
Social support	Family: n=4 Friends: n=12	When we are at the championship we talk a lot to each other, we encourage each other (G7)
Pedagogical Support	n=10	When I first did it I was afraid (flic-flac) (... my coach) said I should do it on trampoline and I get better and then I lost my fear (G5)
Attention and Concentration	n=7	There was a time I got late to a championship and so I was really nervous and felt down. I cried. At that day I had three different commitments (...) I had to concentrate harder to do my elements (G3)
Positive thinking and self confidence	n=5	I talk to myself "I can, I'll do it, I'm good" (G4)
Mental practice	n= 2	Before doing somer salt, I thing about it, I see myself doing it (G7)
Relaxation techniques	n =2	We do what our psychologist say: we breathe the blue air and then we feel calmer (G4).

On the causes of Fear

Injury fear was the most iterant answeramong the gymnasts. In general, the age at which AG practice and the process of sports training begin is increasingly younger (Silva, Fernandes & Celani, 2001). Even when the gymnasts are inserted into an instructionally appropriate environment, they can still be susceptible to exaggerated training times and expectations. These factors could potentially be associated with injury, as they would increase the time exposed to risk and different risk factors, such as the excessive repetition of the same element (Dally, Bass, & Finch, 2001; Caine, Caine, & Lindener, 1996) and the amount of time allotted for rest. Furthermore, according to Kolt and Kirky (1996) the higher frequency and longer duration of training sessions coincided with a higher incidence of injury.

Fear of injury exists when the gymnast loses confidence in his / her ability to successfully carry out a skill when faced by a threatening or demanding situation (Magyar & Chase, 1996). This fear was revealed to be commonplace in AG (Cartoni, Mingati, & Zelli, 2005; Chase, Magyar, & Drake, 2005). Manifestations of this type of fear can be so compromising as to cause high-performing athletes to abandon their training in the sport (Duda & Gano-Overway, 1996).

The gymnasts who fit into this unit directly associated the injury to a previous fall. G2 related her worry about the consequences of a more severe injury. "Of doing things incorrectly and getting hurt, then having to leave the competition and see a doctor. That is what I am most afraid of." An additional account corroborated this idea. "I was going to perform a vault and I rammed my belly *(into the vault)*. It really hurt (...) I was afraid to make another mistake (...) to hit myself the same way" (G4).

AG at a high level is characterized by intensive practice, high competitive demand, public exhibition / exposition and evaluation by others (Duda & Gano-Overway, 1996).

At some point in his / her sporting career, a gymnast will be faced with an accident, her own or one suffered by a colleague. This fact was cited by three gymnasts, who felt fear after observing an accident, even when they had not suffered a similar event themselves.

In the literature, the development of a fear in this way is known as conditioning or

indirect experience (Rachman, 1977), in which observation influences behavior. The cases described by the gymnasts seem to have significantly impacted their training routines, considering that the same accidents were mentioned at various moments. G11 cited fracturing her arm on the balance beam; G7 witnessed this accident and then feared executing the same skill.

The fear of re-injury made the gymnasts avoid certain elements or even new skills that might compromise the previously injured body part, as with G6, "And then, because I had hurt both knees...in one I already had a problem there and the other happened when I fell doing a stretching. When I am learning something new, then I have to stop because of the pain in my knee." Throughout her statement, the athlete highlighted that she is recovered but still feels uncomfortable whenever she has to perform some movement that places demands on the knees. G11 highlighted the fear generated by previous experience. "I am afraid because I have already broken my arm (doing a handspring on the balance beam This latest indicates that the gymnasts is, either not fully recovered from an old injury or still fear the skill because of the accident that occurred when performing the skill.

Research from De Pero, Mingati, Pesce, Capranica and Piancentini (2013), which analyzed the fear of injury among athletes from Team Gym, participants in the European Championship, verified significant increases in this emotion among those who had suffered followed injury in a same part of the body. After all, this injury has a reputation for being one of the most responsible for *pars interarticularis* deformities in gymnasts (Martin, Polster, Jackson, Greenleaf, & Jones, 2008). It is interesting to note that even after a contusion, G7 competed, "with pain and everything, but I had to vault (...). They (*the coaches*) said that if 'you are fine by the competition, you will go. And if you are really feeling a lot of pain, then you will not go. Because it is better not to force it so that you don't break it completely'". Care must be taken because a child could ignore symptoms and pain in order to not disappoint parents, coaches and peers, or even to avoid losing a place on the team.

Another complicated case involved G4 who felt embarrassed and therefore continued with her practice despite the pain. "I couldn't do a *jete* because my groin was hurting. Then (coach's name) sent me to the bleachers. I felt awful."

Caine, Caine and Lindender (1996), point out that in AG the lower limbs have the greatest incidence of injury, with the region of the tibial-tarsal joint being the most affected, followed by the knee. This comes as no surprise since these regions receive the most impact from landings (Hunter & Torgan, 1983; Petrone & Ricciardelli, 1987). This fact was observed in six gymnasts, and all pointed out that the fear is of injury during dismounts. "The thing I think about most is the dismount from the balance beam" (G7); "Dismounting from the uneven bars with a layout, back flip, sticking the landing is difficult" (G11).

Falls were the main concern declared by ten gymnasts, whose worries are reflected in the following account, "...I was afraid to do a tuck. Then tried it and landed short. That hurt. Then after that, I had to do a handspring-tuck, which I was even more afraid of" (G9); "before I was afraid of doing a round-off, back handspring, back handspring. So I started to cry, gave up in the middle, fell on my back and hurt myself," (G8).

Considering the array of studies demonstrating the rate of injury in AG and related consequences, it is possible to understand the fear of injury as legitimate and justified among gymnasts.

Fear of error and *fear of failure* were defined by the cases in which gymnasts demonstrated fear in regard to evaluation. Fear of failure is inherent to the human beign. In sports, it is also present in all levels of practice and can cause irreparable social consequences (Conroy, 2001). For example, this emotion- can be associated to burnout among judges (Rainey, 1995),

dropout of young athletes (Orlick, 1974), drug use by competitors (Anshel, 1991), and also stress (Gould & Maynard, 2009).

According to Treasure (2001), despite the fact that sports are important in the development of children and youth, the pressure to reach maximum performance considerably elevates the fear of failure in this population.

In the cases mentioned previously, G1 reported feeling nervousness during competitions. She described a competition when she had fallen from the balance beam without injury but got a low score. In that same competition, when vaulting, the gymnast successfully completed her first vault. However, on her second try, she gave up and was not able to vault. This fact could be associated to the fear of failure when manifests during competitions

Competitions are highly stressful, especially when the result is important but uncertain, as in a meeting or training session that determines classification to join the team, for example, (Murray & Janelle, 2003).

In the age-group investigated, the win-lose binomial has become more important than the process of sports training and future expectations (Mcauley, 1985). As such, results and even the competition itself effectively influence the emotional state of the athletes.

The other gymnasts also felt nervousness, an emotion which appears to be related to the fear of error (Sagar, Lavallee & Spray, 2007) . This manifestation is evidenced by the frustration of the gymnast and, possibly, as a consequence of flaws in the presentation and of disappointing those closest to them. Duda and Gano-Overway (1996) demonstrated that stress-generating sources for gymnasts were related to the fear of evaluation (by parents, judges, coaches, and other significant people), the fear of error and their own and others' expectations.

Studies demonstrate that the fear of error and the fear of evaluations from the social environment foster feelings of shame and humiliation which, in turn, contribute to the dropout of the sport (Feltz & Albrecht, 1986). In the end, the athlete's reduced self-esteem and motivation become incentives for seeking out new horizons (Conroy, 2001), as G11 points out, "Ah, I don't know how to explain it. I feel...I feel sad. I feel a little ashamed" (referring to how she feels around the coach and friends).

Fear of failure is even more emphasized during adolescence (Gullone & King, 1993), a time when the gymnasts start to think about the importance of their professional futures, when the fear of pessimistic evaluations about a career in sports and the athlete's physical condition become more evident.

The next unit of register detected was *fear of a specific skill*, or in other words, the fear of executing a particular skill for the first time. We considered the cases in which fear manifested itself due to a lack of ability with a determined skill. Fear of the unknown tends to diminish as the athlete becomes familiar with the situation. According to Duda and Gano-Overway (1996), young American gymnasts reported stress upon learning new skills. The gymnasts referred to this fear and indicated that not knowing what consequences an action could generate created anxiety about their results. G5 declared that she felt fear, "The first time I did a round-off, back handspring and when I didn't know how to do a tuck on the trampoline. I would go really high and then really far forward." G4 reported, "...when you go to do it for the first time you are afraid to fall, to get hurt." Despite knowing the physical abilities necessary for using the apparatus, she stated that she is learning and that is why it is normal and permissible to feel fear.

The attitude of the coach also revealed the fear that the gymnasts developed for him, which we have defined as *fear of the coach*.

Smith and Smoll (1996) and Poczwardowski, Barrott and Henschen (2002) recognized that the relationship between the coach and the athlete is important for good performance and

personal satisfaction, since it influences and interferes in the work to be carried out.

When well-managed, that relationship is associated with the satisfaction of the athlete, self-esteem and cohesion in the team (Gardner, Shields, Bredemeier, & Bostrom, 1996) and when antagonized, it results in stress, distraction, lack of communication and respect in all aspects of the sport (Gould & Maynard, 2009).

G1 declared, "(*I am*) afraid of not being able to do some things. (...) Because sometimes you have to stick with it until the end, until you get it. (...) (*If you don't*) you have to climb the rope." This account exemplifies the punishment generated by the athlete's error.

Many gymnasts witnessed extreme attitudes and in some contexts, quite out of normal behavior from their coaches. These behaviors could be witnessed following mistakes made by the gymnasts. In normal conditions, coaches should provide positive support rather than "violent verbs" or "yelling". Some of the interviewed gymnasts mentioned " he gets mad on me, when I make mistakes", other said " he punishes me and/or stops me from training as a punishement.

Upon being questioned about the attitude of her coach while in the gym, G13 said, "The *coach* is sometimes a little stressed out." In another section, she reports, "(*He scolds*) the girls who are playing. He yells and gets really mad at us."

As such, the gymnasts were also able to manifest their fear of being evaluated by this coach. G13 confirmed the fact that, "He would fight with us if we fell right in front of him...He makes a face like this ... (*when observing the athlete's error*)." For this gymnast it seems difficult to dissociate the coach from the judge and sometimes she imagines that she could be reprimanded for making a mistake during competition.

In another case, G12 declared that in addition to aggressive attitudes, the coach inflicted verbal punishment and physical violence. "He (*scolds us*), yells, sometimes pulls our hair. Hits my leg if I make too many mistakes. He has already (*pulled my hair*). many times. Like this. On the vault he told me to look at my hands, and then I looked but didn't look at my hands. And then I tried it again but didn't look at my hands. And then he says, 'Look at your hands" and (*then she demonstrates how he pulled her hair).* When we questioned this gymnast about how her parents and colleagues have helped her control her fears, she again referred to the coach, "(*My mother says*) 'the next time, if you make a mistake, try to do it again'." She adds, "I'm not supposed to worry about getting scolded by the *coach*."

The facts above relate to the delicate situation in the relationship between coach and athlete or, rather, to the failure of this relationship. When the coach's inappropriate conduct comes in contact with the athletes' failure, it starts to shake the core of this relationship, which can lower self-esteem and cause depression on the children, in addition to generating an apprehensive atmosphere.

According to Becker Junior; Teloken (2008), the coaches should support their athletes in these situations and, subsequently move on to correct the skill that was unsuccessful during the competition. In this way, the coach can preserve the self-esteem of the athlete and help him/her deal with failure.

The fact that he/she fears the coach can discourage the athlete from seeking help during training. Furthermore, when the coach perceives and understands this feeling, he can help to change the interpretation of the situation, making it more positive for the athlete (Webb, Miles & Sheeran, 2012). A competition can be seen as a threat or a challenge and depends on the objective and importance attributed to it (Cerin, 2003; Jones, Meijen, McCarthy, & Sheffield, 2009).

Strategies utilized

We have registered the strategies utilized by the gymnasts in the attempt to control their fears, among them: family support, social support (friends), pedagogical support, attention /

concentration, positive thinking and self-esteem, mental practice, and relaxation techniques.

Studies point out that children and adolescents who perceive that they have support from family and friends feel like they have better skills for overcoming barriers that come up during the practice of AG and considerably increase their chances of prolonging their time in the sport (Nunomura, Carbinatto, & Duarte, 2009; Peterson, Lawman, Wilson, Fairchild, & Van Horn, 2013).

As the athlete becomes more involved in the sport, his/her dedication and commitment increase, and therefore, friends and family members should be in agreement with this change.

We have identified that gymnasts find solace in their friendships in order to deal with their fears. In the first place, they feel encouraged by their gymnasts' friends. G3 commented, "They (*friends*) tell me not to let the fear get inside of me." G4 stated, "When we are afraid, we tell our friends first." G7 told us, "I tell them when I am afraid, and they tell me that I have to think before doing anything. Not to be afraid, because if I do I will think I am going to fall." G13 said, "With (*name of friend*), with all of my friends (...) that you have to be calm in order to get it, you have to keep trying."

The gymnasts feel better about sharing their fears with friends from AG because they show them empathy . They have lived through similar situations in their own training. "Sometimes they say that they cry, that they are afraid, that they got hurt," comments (G6). "Only with (*friend's name*). She also tells me when she is afraid (...) she says, 'I'm also afraid to do a back walkover on the balance beam'," adds (G12). Competitive situations were also mentioned. "During competition, we talk a lot with each other. We help each other. When one of us finishes a routine after falling, we tell her not to be nervous, not to go to the next apparatus nervous, not to think about the apparatus that she just competed on, make sure the competition does not end with the previous apparatus," (G4) said.

Family has a major responsibility in orienting children in the sport and can play a highly negative or highly positive role in the sporting experience (Cogan & Vidmar, 2000).

Some of the gymnasts pointed out how their families helped them with their fears and mentioned two different ways this happened: being able to disclose the emotion and trusting their parents. G1 exemplifies the first, "Later, when I get home, I talk to my mom." G5 exemplifies the second, "She says I have to improve and that I will be able to do better the next time".

We discovered that despite the fact that gymnasts indicate support from their friends as essential for dealing with fear, their statements show that they avoid this strategy. G1 states, "You can't talk a lot during training. Just a little." G4 affirms, "We talk, but sometimes we move apart and can't really talk very much. He (*the coach*) says that if we talk too much we are going to have to sit in the bleachers. I've had to sit out for 30 minutes before."

We believe that good discipline is necessary for training, but the coaches should understand the importance of communication amongst the gymnasts, since unpleasant situations, like feeling fear, could be shared, which in results could affect performance. Sometimes it would be better to let the gymnasts talk to each other for a while and share these feeelings when moving from one apparatus to another, or maybe to let a more experienced gymnast talk to a beginner when learning a new skill and share his or her own experiences. .

The *pedagogical support* strategy is one of the strategies that can be used to minimize fear by improving the quality of practice and safety equipment, by using instructional sequences (go from the simple to the complex) and through the changes and adaptations between apparatus (carry out the same skill on the low beam and on the trampoline). These can be seen in the following statements: "The first few times,

they held me. When I started to do it by myself, I started to be afraid because I did it wrong. Then later, he trained me on the trampoline. Then when I went to the mat I saw that I got better and I lost my fear" (G5); "(*coach's name*) kept working with me and I couldn't even jump correctly, because of my foot (...) he stayed on the trampoline with me, helping me" (G2). "I fell, went to drink a little water, and then went back to working on the low beam. Then I went back to the high beam" (G7); "When I do a front tuck, I am more afraid. Then he tells me to do it from a balance beam" (G9).

Spotting (Gerling, 2009) can also be considered as one of the variations in this unit of registry. We have noticed that the gymnasts depend on assistance from the coach to deal with fear. "Then (*coach's name*) helped me do it. When we make one mistake, he helps us twice. Then we do it on the low beam" (G4); "When I make a mistake, I get afraid. I ask for help and then I do it." (G6); "Before I was afraid of doing a round-off, back handspring. Then I started to cry, gave up in the middle, fell on my back and got hurt. Then another coach stayed next to me, trying to let me do the handspring by myself. He said he was going spotting, I thought he was going to put up his hand and then, *hup*, I did it" (G8).

Attention and concentration was another strategy for control identified. G6 constantly displayed her need for attention, practice and overcoming her nervousness. "...I have to pay more attention, you know, and practice."

The fear of injury also relates to the athlete's low level of confidence in his / her abilities. As such, a high level of self-confidence, self-efficacy and positive thinking improve or even eliminate the negative consequences that emotions have on athletic performance (Martinent & Ferrand, 2007).

Another strategy for controlling fear is *self-confidence*. It is important to highlight the importance of the coaches in helping to raise the gymnasts' self-confidence. Furthermore, it is vital that the gymnast recognize her capability to carry out the required task. In this way, the coach can make the gymnast to feel secure and stimulate a positive mental attitude.

Cogan and Vidmar (2000) and Machado (2006) have indicated that positive and negative thinking have enormous power over athletes' performances. Athletes who succeed in their careers demonstrate higher rates of positive thinking about themselves and their own performance and obtain better results. On the other hand, athletes that demonstrate negative thinking show disappointing results.

The utilization of *positive thinking* as a strategy for controlling fear has been widely used in AG, and it appears to have a relationship to heightened levels of self-confidence in gymnasts. When the gymnasts keep their thinking geared towards completing a skill or a series of skills, they dismiss the idea that something bad could happen. In order to do this, they utilize expressions like, "I am capable of doing this," or, "I have done this skill before," or even, "I am ready" (Cogan & Vidmar, 2000).

"Mental practice" was another strategy cited by the gymnasts. Mental practice utilizes the imagination and mental representation in the process of learning, memorizing and developing physical capabilities (Connaughton, Hanton, & Jones, 2002). The athlete simply imagines the movements that would be carried out in a real performance situation and repeats this virtual action over and over.

This type of practice is widespread in AG (Brandão, 2005; Chase, Magyar, & Drake, 2005; Cogan & Vidmar, 2000), and it can be helpful to gymnasts of all levels to improve their performance. Through this strategy, the gymnast learns to calm himself / herself and feels prepared to carry out the required task (Chase, Magyar, & Drake, 2005).

An additional strategy utilized by two of the gymnasts was named *relaxation techniques*. Unlike the other strategies, this technique was taught to the gymnasts by the sports psychologist working at the club we

did the research. The objective of this training is to relax the body and allow for muscle control so that the athlete can maintain relaxed during a difficult situation. This technique utilizes breath control and rational evaluation of the feared situation. In this way, relaxation can be used as a basic step in other types of training, like visualization, improving concentration, and controlling stress (Machado, 2006). The relaxation process prepares the athlete to perform the skill more efficiently than if he / she were to be under a tension process.

Giving her account of the process, gymnast G4 said, "We do what the psychologist told us. For us to breathe in the 'blue air'. (...) We breathe in the normal air. We breathe it in to be calm. Then after we have breathed in the 'blue air', we exhale air of any color." Gymnast G3 explained, "We have to think about what we are going to do three times and then we get it right." However, one of the gymnasts who learned the technique, G2, commented, "The psychologist told us to breathe to get it. (...) Breathe and think about the work you want to do and not get it….Well that won't work. I always try, but right at the moment I can't do it." Upon feeling relaxed, the gymnasts were able to concentrate better which helped them conserve their energy and control fine details of their performance (Duda & Gano-Overway, 1996).

The remarks made by G2 were placed into two other units of registry, mental practice and relaxation techniques. However, the gymnast reported that even though she knows and tries to apply these two strategies, they do not produce any effect, that is to say, the techniques were not productive for her. She reported, "I always try, but at the time it doesn't go anywhere. (...) Then, I can never manage to do it. Because I can never manage to do it, I always fall. Now when there is a competition with a tuck like this, I won't do it. I will take out the tuck." In regards to the other gymnast, the main factor observed was the insecurity in relation to the execution to the various skills. We can observe this fact in the G9's response to our question, *what do you think about when you are performing the skill?* "About falling. (...) Yes. I think about the skill, but I think about falling."

When faced with a threatening situation, these gymnasts demonstrated having negative thoughts. Cogan and Vidmar (2000) cite accounts of gymnasts who presented the same problem and permitted negative thoughts to take on maybe even greater proportions. As observed in the accounts cited above, these types of thoughts increased anxiety and the appearance of fear.

CONCLUSIONS

In this study, the emphasis was particularly on one emotion: fear. Nevertheless, it is only one of many factors involved in sports performance (Cerin, 2003). Connaughton, Hanton and Jones (2002), Gould and Maynard (2009), Jones et al (2009) defend the idea that the ability to control one's emotions is an important requirement to be successful in the sport.

Motor complexity and potential risk to the gymnast's physical integrity are constant consideration to insure safety in AG.. This risk is part of practice and gymnasts should be prepared to encounter this situation. Fear is an emotion that reveals itself in a variety of situations within the modality. And the way in which the gymnast deals with its occurrence will have a fundamental role in his / her development.

Coaches have the responsibility to consider the social and pedagogical environment of the class and the competition in order to minimize fear. They should be attentive to the readiness of their athletes in all aspects – physical, motor, psychological, and social –as well as consider the quality of apparatus resources.

Nunomura, Okade and Tsukamoto (2009) add that coaches can and should strive to provide training centered on each athlete that respects the particularities and individuality of the gymnasts, in order to benefit their overall training. In this way,

promoting positive experiences in the sport should be the focus of the coaches.

It is necessary to understand and view the athlete from a holistic perspective, with all of his / her diversity, uniqueness and experiences. Upon identifying some of a gymnast's symptoms and fears, coaches can project and implement programs geared towards injury prevention, support recovery more successfully, promote healthy relationships between athletes and coaches, and avoid burnout or negative stress (Cremades & Wiggins, 2008; Giotis, 2007).

REFERENCES

Anshel, M. H. (1991). Causes for drug abuse in sport: A survey of intercollegiate athletes. *Journal of Sport Behaviour*, *14*, 283 – 307.

Arkaev, L., & Suchilin, N. (2004). *Gymnastics: how to create champions*. UK: Meyer & Meyer Sport.

Augustine, A.A., & Hemenover, S.H. (2008). On the relative effectiveness of affect regulation strategies: A meta-analysis. *Cognition and Emotion*, *23,* 1181–1220.

Bardin, L. (2010). *Análise de Conteúdo (Content Analysis)*. Lisboa: Edições 70.

Bardin, L. (1993). *L'analyse de contenu.* Paris: Presses Universitaires de France Le Psychologue.

Becker Jr., B., & Telöken, E. A (2008). Criança no esporte (The children in Sport). In A.A. Machado (ed.) *Especialização esportiva precoce: perspectivas atuais da Psicologia do Esporte (Early Sport Specialization: actual perspectives in Sport psychology),* (p .17-34).

Brandão, M.R.F. (2005). Aspectos psicológicos da Ginástica Artística. In M. Nunomura, & V.L. Nista-Piccolo (eds.) *Compreendendo a Ginástica Artística (Understading Artistic Gymnstics)* (p. 107-17). São Paulo: Phorte Editora.

Caine, D., Caine, C., & Lindener, K. (1996). *Epidemiology of Sports Injuries*. Champaign: Human Kinects.

Cartoni, A.C., Minganti, C., & Zelli, A. (2005). Gender, age and professional-level differences in the psychological correlates of fear of injury in Italian gymnasts. *Journal of Sport Behaviour*, *28*(1), 3–17.

Carver, C.S. (2004). Self-regulation of action and affect. In R.F. Baumeister, & K.D. Vohs (Eds.). *Handbook of self-regulation: Research, theory and applications* (p. 13-39). New York: The Guilford Press.

Cerin, E. (2003). Anxiety versus fundamental emotions as predictors of perceived functionality of pre-competitive emotional states, threat, and challenge in individual sports. *Journal of Applied Sport Psychology*, *15*, 223–238.

Chase, M.A., Magyar, T.M., & Drake, B.M. (2005). Fear of injury in gymnastics: Self-efficacyand psychological strategies to keep on tumbling. *Journal of Sport Science*, *23*(5), 465-475.

Cogan, K.D., & Vidmar, P. (2000). *Gymnastics*. Morgantown: Fitness InformationTechnology.

Connaughton, D., Hanton, S., & Jones, G. (2002). The Development and maintenance of mental toughness in the World's best performers. *The Sport Psychologist*, *24*, 168–193.

Conroy, D.E. (2001). Fear of Failure: An Exemplar for Social Development Research in Sport.*Quest*, *53*, 165-183.

Corbin, J., & Strauss, A. (2015). *Basics of Qualitative Research.* San Jose State University, International Institute for Qualitative Methodology.

Cremades, J., & Wiggings, M.S. (2008). Direction and intensity of trait anxiety as predictors of burnout among collegiate athletes. *Athletic Insight: The Online Journal of Sport Psychology, 10*(2). Retrieved July 7, 2014 from http://www.athleticinsight.com/Vol10Iss2/TraitAnxiety.htm.

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

De Pero, R., Mingati, C., Pesce, C., Capranica, L., & Piancentini, M.F. (2013). The Relationships between pre-competition anxiety, self-efficacy, and fear of injury in

elite teamgym athletes. *Kinesiology 45*(1), 63-72.

Duda, J.L., & Gano-Overway, L. (1996). Anxiety in elite young gymnastics: Part II. Sources of stress. *Technique*, *16*, 4-5.

Feltz, D. L., & Albrecht, R. R. (1986). Psychological implications of competitive running.In Weiss, M. R., & Gould, D. (Eds.), *Sport for children and youth*. (p. 225-230). Champaign, IL: Human Kinectics.

Gardner, D. E., Shields, D. L., Bredemeier, B. L., & Bostrom, A. (1996). The relationship between perceived coaching behaviours and team cohesion among baseball and softball players.*The Sport Psychologist*, *10,* 367 – 381.

Gerling, I. (2009). *Teaching Children's Gymnastics: Spotting and Securing*. Germany: Meyer & Meyer Sport.

Giotis, A.M. (2007). *Stopped by a thought: A study about mental blocking in female TeamGym*. (Undergraduate thesis D-level Swedish School of Sport and Health Sciences). Retrieved July 26, 2014 from http://urn.kb.se/resolve?urn=urn:nbn:se:gih:diva-283.

Giotis, A.M., & Nilsson, A. (2006). *Dare to refuse being afraid: A study about fear in female TeamGym*. (Undergraduate Thesis C-level from Swedish School of Sport and Health Sciences). Stockholm.

Gould, D., & Maynard, I. (2009). Psychological preparation for the Olympic Games. *Journal of Sports Sciences*, *27*, 1393–1408.

Gray, J. A. (1987). *The psychology of fear and stress* (2nd edn.).Cambridge: Cambridge University Press.

Guillot, A., & Collet, C. (2008). Construction of the motor imagery integrative model in sport: A review and theoretical investigation of motor imagery use. *International Review of Sport and Exercise Psychology, 1*, 31–44.

Gullone, E., & King, N. J. (1993). The fears of youth in the 1990s: Contemporary normative data. *Journal of Genetic Psychology*, *154*, 137 – 153.

Hanin, Y.L. (2010). Coping with anxiety in sport. In A. Nicholls (Ed.), *Coping in sport: Theory, methods, and related constructs* (p. 159-175). New York: Nova Science Publishers,.

Hanton, S., Thomas, O., & Maynard, I. (2004). Competitive anxiety responses in the week leading up to competition: The role of intensity, direction and frequency dimensions. *Psychology of Sport and Exercise*, *5*, 169–181.

Harringe, M.L., Renstrom, P., & Werner, S. (2007). Injury incidence, mechanism and diagnosis in top-level TeamGym: A prospective study conducted over one season. *Scandinavian Journal of Medicine & Science in Sports*, *17,* 115-119.

Huber, A. (2000). *El miedo (The fear)*. Madri: Acento Editorial.

Hunter, L.Y., & Torgan, C. (1983). Dismounts in gymnastics: should scoring be reevaluated? *American Journal of Sports Medicine*, *4*, 208-2010.

Jones, M.V., Meijen, C., McCarthy, P.J., & Sheffield, D. (2009). A theory of challenge and threat states in athletes. *International Review of Sport and Skill Psychology, 2*, 161–180.

Kolt, G., & Kikby, R. (1996). Injury in Australian female competitive gymnastics: a psychological perspective. *Australian Physiotherapy*. *42* (2), 121-126.

Koole, S.L. (2009). The psychology of emotion regulation: An integrative review. *Cognition & Emotion, 23,* 4–41.

Lench, H.C., Flores, S.A., & Bench, S.W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin*, *137*, 834–855.

Machado, A.A. (2006). *Psicologia do esporte: da educação física escolar ao esporte de alto nível(Sport psycology: from physical education to high performance).* Rio de Janeiro: Guanabara Koogan.

Magyar, M., & Chase, M.A. (1996). Psychological strategies used by competitive gymnasts to overcome fear of injury.*Technique*, *16* (10).

Marini, M., Sgambati, E., Barni, E., Piazza, M., & Monaci, M. (2008). Pain Syndromes in competitive elite level female artistic gymnastics. Role of Specific preventive-compensative activity. *Italian Journal of Anatomy and Embryology*, *113* (1) 47-54.

Martin, B.S., Polster, C.M., Jackson, A.W., Greenleaf, C.A., & Jones, G.M. (2008). Worries and fears associated with competitive gymnastics. *Journal of Clinical Sport Psychology*, *2*(4), 299–317.

Martinent, G., & Ferrand, C. (2007). A cluster analysis of precompetitive anxiety: Relationship with perfectionism and trait anxiety. *Personality and Individual Differences*, *7*, 1676–1686.

McAuley, E. (1985). Success and causality in sport: The influence of perception. *Journal of Sport Psychology*, 7, 13-22.

Mellalieu, S.D., Hanton, S., & O'Brien, M. (2004). Intensity and direction of competitive anxiety as a function of sport type and experience.*Scandinavian Journal of Medicine & Science in Sports, 14,* 326–334.

Moll, T., Jordet, G., & Pepping, G. (2010). Emotional contagion in soccer penalty shootouts: Celebration of individual success is associated with ultimate team success. *Journal of Sports Sciences*, *28*(9), 983-992.

Murray, N.P., & Janelle, C.M. (2003). Anxiety and performance: A visual search examination of the Processing Efficiency Theory. *Journalof Sport & SkillPsychology*, *25*(2), 171–187.

Nunomura, M., Carbinatto, M.V. & Duarte, H. (2009). Vencendo o Medo na Ginástica Artística (Overcoming Fear in Artistic Gymnastics). *Revista Arquivos em Movimento 5*(2), 130-155.

Nunomura, M., Okade, Y., & Tsukamoto, M.H.C. (2009). Competition and Artistic Gymnastics: How to make the mosto f this Experience. *International Journal of Sport and Health Science. 7,* 42-49.

Ollendick, T.H., & King, N.J. (1991). Origin of childhood fears: An evaluation of Rachman's theory of fear acquisition. *Behavior Research and Therapy*, *29,* 117-123.

Orlick, T. D. (1974). The athletic dropout: A high price of inefficiency. Canadian Association for Health, *Physical Educationand Recreation Journal*, 21 – 27.

Peterson, M.S., Lawman, H.G., Wilson, D.K., Fairchild, A., & Van Horn, M.L. (2013). The association of self-efficacy and parental social support in physical activity in male and female adolescents. *Journal of Health Psychology*, *32* (6), 666-674.

Petrone, F & Ricciardelli, E. (1987). Gymnastics injuries: the Virginia experience 1982-1983. *American Journal os Sports Medicine*, *15*, 59-62.

Poczwardowski, A, Barrott, J., & Henschen, K. (2002). The athlete and coach: their relationship and its meaning. Results of an interpretative study. *International Journal of Sport Psychology*, *33*, 116-140.

Rachman, S. (1977). The conditioning theory of fear aquisition: a critical examination. *Behavior Research and Therapy*, *15*, 375-387.

Rainey, D. (1995). Stress, burnout and intention to terminate among umpires. *Journalof Sport Behaviour*, *18,* 312 – 323.

Sagar, S.S., Lavallee, D., & Spray, C.M. (2007). Why young athletes fear failure: consequencxes of failure. *Journal of Sports Sciences*, *25*(11), 1171-1184.

Schiavon, L.M., Paes, R.R., Toledo, E., & Deutsch, S. (2013). Panorama da ginástica artística brasileira de alto rendimento esportivo: progressão, realidade e necessidades (Overview of the high performance Brazilian women's artistic gymnastic: progression, reality and necessities). *Rev Bras de Educ Fís Esporte*. *27,* 423-436.

Seil, R., Rupp, S., Tempelhof, S., & Kohn, D (1998). Sports injuries in team handball: A one year prospective study in sisteen men's senior teams of superior nonprofessional level. *American Journal of Sports Medicine, 26* (5), 681-687.

Silva, F.M., Fernandes, L., & Celani, F.O. (2001) Desporto de crianças e jovens: Um estudo sobre as idades de iniciação

(Sport for children and young: a study about the iniciation. *Revista Portuguesa de Ciências do Desporto*, *1*(2), 45–55.

Smith, R. E., & Smoll, F. L. (1996). The coach as the focus of research and intervention in youth sports. In F. L. Smoll & R. E. Smith (Eds.), *Children and youth in sport: A biopsychological perspective* (p.125-141). Dubuque, IA: McGraw-Hill.

Tod, D., Hardy, J., & Oliver, E. (2011). Effects of self-talk: A systematic review. *Journal of Sport & Skill Psychology*, *33*, 666–687.

Treasure, D. C. (2001). Enhancing young people's motivation in youth sport: An achievement goal approach.In G. C. Roberts (Ed.), *Advances in motivation in sport and skill* (p. 177-198). Champaign, IL: HumanKinetics.

Waples, S.B. (2005). *Psychological characteristics of elite and non elite level gymnasts.* On-line Texas Digital Library. Retrieved February 17, 2015 from https://repository.tamu.edu/handle/1969.1/1634.

Webb, T.L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*. *138*, 775-808.

Woodman, T., & Hardy, L. (2003). The relative impact of cognitive anxiety and self-confidence upon sport performance: A meta-analysis. *Journalof Sports Sciences*, *21*, 443–457.

.

Corresponding author:

Michele Viviene Carbinato
University of São Paulo – Sport Departament
Av. Prof. Mello Moraes, 65
Cidade Universitária CEP: 05508-030
São Paulo - SP ,
São Paulo
São Paulo 05345000
Brazil
E-Mail: mcarbinatto@usp.br

EVALUATION OF AN INTERVENTION PROGRAM ON BODY ESTEEM, EATING ATTITUDES AND PRESSURE TO BE THIN IN RHYTHMIC GYMNASTICS ATHLETES

Evdoxia Kosmidou[1], Miltiadis Proios[1], Evgenia Giannitsopoulou[1], Theofanis Siatras[1], George Doganis[1], Michalis Proios[1], Helen Douda[2], Anna Fachantidou-Tsiligiroglou[1]

[1] Aristotle University of Thessaloniki, Thessaloniki, Greece
[2] Democritus University of Thrace, Komotini, Greece

Original article

Abstract

The aim of the present study was to evaluate the outcomes following a 3-months intervention program addressed toward body esteem, eating attitudes and pressure to be thin by others in Greek rhythmic gymnastics athletes. In the program participated 49 athletes (29 in the intervention group and 20 in the control group). Both groups completed self reported questionnaires at baseline and after the intervention. From the results it was shown that after the intervention participants in intervention group increased body esteem, decreased eating attitudes (in general, diet, boulimia and preoccupation) and pressure to be thin by experts and parents. On the other hand, participants in control group decreased body esteem and self-esteem of body image, while they increased eating attitudes (general, and diet scale) and perceived pressure to be thin by coaches and experts. The program was assessed by participants in intervention group as very relevant to rhythmic gymnastics, high in believability and high in promoting emotions. The source of the intervention was evaluated as informed, persuasive and reliable. This is the first controlled intervention applied to rhythmic gymnastics athletes in Greece and elements for future initiatives are identified and discussed.

Keywords*: rhythmic gymnastics, intervention, body esteem, eating attitudes, pressure to be thin.*

INTRODUCTION

A slimming culture and the promotion of diet, play an important role in the way women and girls evaluate their bodies (Noordenbos, 2002). Between Body Mass Index (BMI) and body image there is a consist link, even concerning children from 6 to 11 years old, meaning that the higher the BMI is the more negative the body image is also (Ricciardelli, McCabe, & Holt, 2003). Negative body image is associated with disordered eating during the adolescent years (Flament, Hill, & Buchholz, 2012). So, the importance of monitoring, prevention and early intervention mechanisms within the context of practice, particularly for adolescent girls,

is proposed (Lanfranchi, Maïano, Morin, & Therme, 2014).

Sport participation for women includes risk and protective elements (Smolak, Murnen, & Ruble, 2000). Although sport participation provides physical and psychological benefits, it can also include a potential risk factor for developing eating disorders (Garner & Rosen, 1991; Smolak, Murnen, & Ruble, 2000). This happens because according to Thompson and Sherman (1999) female athletes not only experience general societal pressure regarding thinness, but sport-specific ones as well. Athletes in aesthetic, weight-dependent, or endurance sports have been found to be more likely to use pathogenic weight-control methods than athletes from other sports (Sundgot-Borgen, 1994). Intervention programs developed for athletes need to address toward general and sport-specific factors (Smith & Petrie, 2008). Studies before 2001 showed that female athletes had a more positive body image than non athletes (Monteiro, Novaes, Santos, & Fernandes, 2014) but since then the pressure for thin body from athletes has increased and as a result is female athletes to perceive more pressure than non athletes about their image (Smith & Petrie, 2008). Belief among athletes and coaches that a reduction in weight or body fat could enhance athletic performance, increased athlete's risk in prevalence of eating disturbances (Thompson & Sherman, 1999), particularly in judged sports where performance may be influenced by body size, shape, or weight (Buchholz, Mack, MvcVey, Feder, & Barrowman, 2008). Body esteem refers to self-evaluation's of one's body (Mendelson, Mendelson & Whote, 2001) and encompasses how satisfied a person is with diverse qualities of the body and body image. This evaluation does not use one single construct. People use distinct dimensions of body (Wiggins & Moode, 2000). It seems that body esteem is a construct that

Rhythmic gymnastics (RG) is an aesthetic female sport in which many girls participate from early childhood to early adulthood. Participating in RG includes early specialization, big volume of training, many hours of intensive training per week, many element repetitions, high level of technical elements performed, and finally variant abilities are required (Bobo-Arce & Méndez-Rial, 2013). In gymnastics, both rhythmic and artistic, perceived pressure to be thin by coaches, parents and judges is a fact (Salbach, Klinowski, Pfeiffer, Lehmkuhl, & Korte, 2007; Theodorakou & Donti, 2013).

There are recognized risks of dieting during a period of growth and the unquestionable increased susceptibility of dieters is developing eating disorders. Unfortunately there have been not as many efforts to intervene as should have been (Baranowski & Hetherington, 2001). Most intervention programs are school-based, trying to improve body image and prevent eating disorders among adolescent females (e.g. Killen, Taylor, Hammer, Litt, Wilson, Rich et al., 1993; Paxton, 1993; Neumark-Sztainer, Wall, Story, & Sherwood, 2009). The early drafts of such interventional programs were based on providing information and typically consisted of one-time or short-term curriculum based sessions. They improved relevant knowledge but they did not change beliefs, attitudes and intentions to change behaviors (O' Dea & Abraham, 2000). O'Dea (2002) suggests that educational initiatives to improve body image in adolescent girls may have negative effects, so planning of preventive interventions should involve program recipients. Few researchers have considered theories of persuasion as a framework on which to design effective interventions (Jones, Sinclair, & Courneya, 2003). Elaboration Likelihood Model of Persuasion is such a useful method of analyzing the components of intervention programs. Persuasion theory posits that persuasive messages can be divided into at least four components: message source (i.e. characteristic of the presenter), content, mode of delivery (i.e. written, via videos, etc.) and recipient characteristics (Petty & Cacioppo, 1986). It is suggested that

prevention programs should involve parents, include messages about healthy eating, body image and self-esteem skills development, and should incorporate multiple school subjects (Collins, 1991).

Despite studies showing a link between disordered eating and involvement in appearance-related sports, there are even less than school-based studies examining the effectiveness of interventions in sports, such is Bucholz and her colleagues' study (Buchholz et al., 2008) and Smith and Petrie's (2008) study. Smith and Petrie (2008) evaluated a three-session program, based on cognitive dissonance or healthy weight or control, among female college athletes who were at-risk. Intervention consisted of three 1-hour meetings over three consecutive weeks. Each meeting consisted of an educational component, discussion, activity/practice, review of homework, and assignment of homework for the upcoming week. The facilitators were psychology students who had training and experience with both eating disorders and sport psychology. They only reported limited positive effects by the cognitive dissonance program. A great limitation, as it is mentioned by the researchers, was the small samples.

Bucholz and her colleagues (2008) evaluated the effectiveness of a selective prevention program designed to reduce pressure to be thin in sport, and to promote positive body image and eating behaviors in young female gymnasts. The program provided education in the areas of eating attitudes, unique body size and shape, body health, resisting pressures to diet, physical activity for enjoyment, positive self-esteem, stress management, modeling attitudes and behaviors and promoting balance between sport participation and life outside of sport. In their program athletes perceived a reduction in pressure to be thin from their clubs but no changes were found in body esteem and eating attitudes. Their prevention program was led by a trained educator in the area of eating attitudes and there was a consulting committee of community-based health professionals.

According to relevant theories, an intervention program trying to enhance positive body esteem and positive eating attitudes should be addressed specifically to target group including general and sport-specific factors (Smith & Petrie, 2008), should be delivered by a person who would be recognized by the athletes as relevant, credible and reliable. A program should provide not only knowledge and must include the teaching of life skills which would be useful when athlete deal with pressure as when they perceive pressure to be thin by significant others (Stice, Rohde, Gau, & Shaw, 2009). Such skills were included in other programs also (e.g. Sjostrom, & Steiner-Adair, 2005). Finally, a program's messages should be delivered in multiple ways and also (Stice, Rohde, Gau, & Shaw, 2009). Intervention programs need to address socio-environmental factors (family and peers) as well as personal factors (Neumark-Sztainer, Wall, Story, & Perry (2003).

Purpose of the present study was to evaluate the short-term efficacy of a psycho-educational program, designed to enhance body esteem, positive eating attitudes and decrease perceived pressure to be thin by significant others in a group RG adolescent athletes. It was expected that at the completion of the program, athletes in the intervention group compared to athletes in the control group would evidence higher body esteem and body image, lower eating attitudes and lower perceived pressure by significant others. No differences would be noticed in global self-esteem as the program was not addressed toward global self-esteem and the intervention lasted not so long to enhance global self-esteem. Finally, participants in the intervention group would evaluate the program as persuasive and the source as also persuasive, because most guidelines based on Persuasion theory were considered in program's design.

METHODS

Participants

Forty nine RG athletes participated in the study.. In the intervention group (IG) participated twenty-nine athletes and in the control group (CG) twenty athletes. The mean age was 12.35 years (SD=1.67). The athletes participated in rhythmic gymnastics on average 6.45 years and trained, on average, 5.89 days per week for 4.21 hours per day. The athletes were asked to provide their estimated weight and height and based on these measurements Body Mass Index was calculated. The mean BMI of the athletes was 16.15 (SD=1.65), 15.87 (SD=1.67) for IG and 16.56 (SD=1.58) for the CG. Athletes in the two groups did not differ in any of the above variables, age, training age, days and hours per training. Athletes were divided in two groups with as equal characteristics as possible, and in such way that there would be no effect between the two groups. During the intervention the two groups did not meet each other in anyway (e.g. practice, competition, camp, etc).

Measures

Self reported questionnaires were used assessing demographic and personal characteristics (age, training age, training days per week and hours per training, weight and height for calculating Body Mass Index [kgr/m2]). Also the following questionnaires were used:

Body esteem. A validated Greek version (Karamitziou, 2008) of the Body–Esteem Scale for Adolescents and Adults (Mendelson, et al., 2001) was used to assess the body esteem which includes 23 items. An overall score was calculated which represented "Body esteem". All responses were given in a five-point Likert scale, from 0 (never) to 4 (always). Higher scores indicated a higher level of body esteem. Cronbach's alpha was .92 for pre-test measure and .93 for post-test measure.

Eating attitudes. A validated Greek version (Varsou & Trikkas, 1991; Douka, 2007) of Eating Attitudes Test-26 (Garner & Garfinkel, 1979; Garner, Olmsted, Bohr, & Garfinkel, 1982) was used. It consists of 26 items using six answer options by the following scores: 0=never, rarely, or sometimes, 1=often, 2=usually, and 3=always. Higher score indicates abnormal eating attitudes and a total score ≥20 is indicative of symptoms and concerns about eating disorders. Cronbach's alpha was for pre-test .83 and for post-test .76. The questionnaire includes three factors: Dieting scale (Cronbach's alpha was in pre-test .81, in post-test .74), Boulimia and Food Preoccupation (Cronbach's alpha was in pre-test .69, in post-test .76), and Oral Control Scale (Cronbach's alpha was in pre-test .54, in post-test .65).

Self esteem of body image. It was measured by Papanis's questionnaire (Papanis, 2004). It measures self-esteem of body image in children 12 to 17 years old using 9 items. Answers were given on a 6-point Likert scale ranging from strongly disagree (1) to strongly agree (6). Higher scores indicated higher self esteem of body image. Cronbach's alpha was for pre-test measure .71, and for post-test measure .76.

Pressure for thin body by coaches, parents, friends and RG experts. It was measured by using Durkin, Paxton and Wertheim's questionnaire (2005). In their study they assessed only peer and parental pressure to be thinner, by two items for each group ("Do you think your coach/parents/RG experts/friends would like you to be thinner than you are now?", "Does you coach/parents/RG experts/friends encourage you to lose weight?"), rated from 1 (never) to 5 (very often). Higher scores indicated higher pressure to be thin by coaches, or parents, or friends, or experts. In the present study pressure to be thin was measured for each significant person (coach, parents, friends and RG experts) separately. As experts it was mentioned that RG expert were mostly judges. Cronbach's alpha was for coaches in pre-test .82 and in post-test .88, for parents in pre-test .83 and in post-test.85, for RG experts was in pre-test .57 and in post-test .72 , and finally for friends was in pre-test .67 and in post-test .50.

Global self-esteem. The Rosenberg Self-Esteem Scale (1965) was applied which measures global self-esteem. The instrument has ten statements related to overall feelings of self-worth or self-acceptance. The answers were answered on a 4-point scale ranging from "strongly disagree" to "strongly agree". Higher scores indicated higher self-esteem. Cronbach' s alpha was for pre-test measure .81 and for post-test measure .76.

Intervention evaluation: In order to evaluate responses to the intervention program 10 items were used, based on the items used in Paxton et al.'s study (Paxton, Wertheim, Pilawski, Durkin, & Holt, 2002). Each item was rated on a Likert scale from 1 to 5, and higher scores indicated a more positive response. Three of the items labeled "Relevance" and had Cronbach's alpha .64. Three items labeled "Believability" and had Cronbach's alpha .63. Four items labeled "Emotional response" and had Cronbach's alpha .60

Source's evaluation: Four questions were used assessing how informed, persuasive, with knowledge and reliable the source of the program was. Answers were given on a Likert scale from (1) to (7). The questions were based on Rosen's study (2000) and were previously used in Greek population by Kosmidou (2007).

Procedure

After meeting with club directors, coaches and athletes' parents and thoroughly outlining the purpose of the research, they all agreed to participate in the program giving their approval. To test the effectiveness of the intervention program athletes were assigned in each group in such a way that there could not be effect between the two groups. More specific they were practicing in different gymnasiums far apart the one from the other. The study lasted 12 weeks (pre-test, 10weeks intervention, post-test). Participation by the athletes was completely confidential. All questionnaires were given to participants by the researcher. She gave oral instructions to the participants on how to fill in the questionnaire and was also available to answer questions while the questionnaires were being filled in.

Intervention program[1]

The intervention program (table 1) lasted 10 weeks, one meeting per week for each group, each meeting lasting approximately 60 min. Athletes were organized in small groups (4-5 athletes per group) as homogeneity to age as possible. Meetings were conducted in an isolated place into the gymnasium, and the place was a peripheral cue of persuasion. The program was carried out by a female researcher (source) with experience in health education (as an educator with PhD) and expert in rhythmic gymnastics (former athlete, former coach and current judge). By this way the source's credibility (expertise, trustworthiness, and sincerity) was increased. Based on Elaboration Likelihood Model to increase recipients' persuasion relevance toward the topic, motivation to think and ability to think, should be increased. More specific, motivation to think was enhanced by approaching every topic by a rhythmic gymnastics aspect, e.g. by using examples from rhythmic gymnastics, personal examples and statements by former gymnasts. During the meetings different types of messages were included, written, oral, pictures and videos, in order to increase the interest of the recipients. To increase ability to think, each session was checked to be appropriate for the participants' age (wording and content information). Each participant had her own portfolio which included written assignments and information. At the beginning of each session, there was a quick repetition of the previous subjects. At the end of each session, each group should conclude to its own "message". At the end of the program all "messages" were included in a large poster which was placed into the gymnasium. The program included information and skills. The program contained information about self, esteem, bodies in sports, bodies in RG nowadays and in the past, eating disorders, dealing with marketing messages, goal setting,

overcoming problems, anxiety, attention, concentration, positive self-talk, and imagery. All issues were connected to sports and more specifically to rhythmic gymnastics. Parents were involved after the 4th session as participants. Coaches were not involved and they were given instruction not to change routines during practice by anyway.

Statistical analysis

SPSS 15 was used to examine the effectiveness of the intervention. Repeated measures were used to examine the possible differences between intervention and control group after the intervention in Body esteem, Eating attitudes, Global self-esteem, Self esteem of body image and Pressure for thin body by coaches, parents, RG experts and friends. In order to evaluate the perceived effectiveness of the intervention and the source by the intervention group one-sample t-test were used.

RESULTS

Means and standard deviations are presented in Table 2. for all participants and separately for IG and CG. Thirteen athletes had eating attitudes indicating symptoms and concerns about eating disorders, meaning sum ≥ 20 (five from IG and eight from CG). These percentiles did not change after the intervention.

Table 1
Title of the 12 sessions of the interventional program.

Session	*Title of the session*
1st session	Pre measure, meeting the researcher
2nd session	Myself, enhancing group cohesion
3rd session	Different bodies in sport, in rhythmic gymnastics now and then
4th session	Goal setting
5th session	Overcome problems in goal setting
6th session	My body image
7th session	Attention and concentration
8th session	Stress and anxiety in rhythmic gymnastics and not only
9th session	Relaxation- self talking
10th session	Imagination
11th session	Eating disorders
12th session	Post measure

Table 2
Means (M) and standard deviation (SD) for all variables in pre-test and post-test.

	All participants		Intervention group		Control group	
	Pre-test	*Post-test*	*Pre-test*	*Post-test*	*Pre-test*	*Post-test*
BMI	16.15 (1.66)	-	15.87 (1.67)	-	16.56 (1.58)	-
Global self-esteem	2.76 (.45)	3.06 (.49)	2.86 (.46)	3.20 (.39)	2.69 (.48)	2.83 (.55)
Body esteem	3.96 (.79)	3.89 (.80)	3.72 (.70)	3.84 (.77)	4.29 (.79)	3.96 (.85)
Esteem of body image	3.04 (.79)	3.11 (.80)	3.28 (.71)	3.16 (.77)	2.77 (.79)	3.04 (.85)
Eating attitudes	16.27 (10.40)	13.36 (8.39)	15.93 (11.05)	11.17 (7.66)	16.75 (9.65)	16.89 (8.52)
Dieting scale	.79 (.62)	.64 (.50)	.75 (.63)	.49 (.43)	.85 (.61)	.88 (.52)
Boulimia and Food Preoccupation	.45 (.51)	.29 (.47)	.47 (.46)	.18 (.20)	.42 (.59)	.47 (.68)
Oral Control Scale	.74 (.53)	.62 (.57)	.78 (.59)	.67 (.66)	.69 (.45)	.53 (.38)
Pressure to be thin by coaches	2.94 (1.26)	2.89 (1.25)	2.84 (1.24)	2.62 (1.21)	3.07 (1.32)	3.33 (1.24)
Pressure to be thin by parents	2.09 (1.13)	1.82 (1.06)	2.24 (1.15)	1.83 (1.05)	1.87 (1.09)	1.83 (1.11)
Pressure to be thin by friends	1.52 (.78)	1.29 (.58)	1.69 (.88)	1.36 (.65)	1.27 (.55)	1.17 (.42)
Pressure to be thin by RG experts	2.73 (1.16)	2.46 (1.14)	2.59 (1.02)	2.14 (.86)	2.95 (1.33)	2.97 (1.33)

Table 3
Correlations between all variables before intervention, for all participants.

	1	2	3	4	5	6	7	8	9	10
1. Global self-esteem	1									
2. Body esteem	.45**	1								
3. Esteem of body image	-.13	-.31*	1							
4. Eating attitudes	-.16	-.13	.30*	1						
5. Dieting scale	-.10	-.22	.35*	.92**	1					
6.Boulimia and Food Preoccupation	-.29*	-.10	.16	.58**	.32*	1				
7.Oral Control Scale	.16	.34*	.14	.61**	.44**	.31*	1			
8.Pressure to be thin by coaches	-.06	-.42**	.37**	.41**	.55*	.05	-.12	1		
9.Pressure to be thin by parents	-.02	-.46**	.48**	.35*	.55**	-.02	-.06	.74**	1	
10.Pressure to be thin by friends	.28	-.06	.22	.21	.29*	-.12	.15	.43**	.54**	1
11.Pressure to be thin by RG experts	-.11	-.39**	.21	.43**	.51**	.12	.04	.79**	.55**	.31*

**: p<.01, *:p<.05

Table 4
Correlations between all variables after intervention, for all participants.

	1	2	3	4	5	6	7	8	9	10
1. Global self-esteem	1									
2. BES	.51**	1								
3. Esteem of body image	-.24	-.21	1							
4. Eating attitudes	-.22	-.18	.06	1						
5. Dieting scale	-.25	-.31*	.13	.88**	1					
6.Boulimia and Food Preoccupation	-.45**	-.38**	.20	.52**	.34*	1				
7.Oral Control Scale	.17	-.32*	-.06	.52**	.25	-.12	1			
8.Pressure to be thin by coaches	-.27	-.45**	.20	.41**	.56**	.31*	-.14	1		
9.Pressure to be thin by parents	-.09	-.28	.18	.40**	.45**	.21	.13	.63**	1	
10.Pressure to be thin by friends	-.01	-.02	-.09	.02	-.01	-.04	.06	-.02	.27	1
11.Pressure to be thin by RG experts	-.32*	-.46**	.21	.31*	.35*	.35*	-.12	.61**	.41**	-.07

**: p<.001, *:p<.05

Correlations were examined using Pearson's criterion (r). Correlations between all variables for all participants are presented for pre-test in Table 3 and for post-test in Table 4. It must be mentioned that BMI was computed only in pre-test and was correlated significantly to Global self-esteem (r=-.39, p=.006), oral control scale (r=-.30, p=.036), pressure to be thin by coaches (r= .52, p=.000), pressure to be thin by parents (r= .29, p=.042) and pressure to be thin by experts (r=.62, p=.000).

Differences between groups before and after intervetion

Body esteem: In global measure of body esteem repeated measures analysis revealed significant interaction perceived body esteem by time (Pillai's trace=.20, F1,45= 11.10, p<.01, partial eta squared= .20). There was no difference in pre-test between IG and CG (*p= .97*) but in post-test IG had higher body esteem means than CG (F1,45 =6.99, p≤.01). Paired t-test showed for IG higher scores in post-test than pre-test (t28= -2.29, p<.05) while for CG showed lower scores in post-test than pre-test (t18= 3.99, p≤.001).

Eating Attitudes: In global eating attitudes repeated measures analysis revealed significant interaction global eating attitudes by time (Pillai's trace =.14, F 1,45= 7.51, p<.01, partial eta squared=.14). There was no difference in pre-test between IG and CG (F1,48=.07, p=.79) but in post-test IG had lower eating attitudes than CG (F1,46= 5.67, p<. 05). Paired t-test showed for IG lower scores in post-test than pre-test (t28= 2.64, p<.01) while for CG showed higher scores in post-test than pre-test (t17= -2.80, p<.01).

Dieting scale: Repeated measures analysis revealed significant interaction dieting scale by time (Pillai's trace= 1.93, F1,45=10.75, p<.01, partial eta squared=.19). There was no difference in pre-test between IG and CG (p=.59) but in post-test IG had lower mean scores in dieting scale than CG (F1,45= 8.11, p<. 01). Paired t-test showed for IG lower scores in post-test than pre-test (t28= 2.73, p≤.01) while for CG showed higher scores in post-test than pre-test (t17= -4.51, p<.001).

Boulimia and Food Preoccupation: Repeated measures analysis revealed significant interaction boulimia and food preoccupation by time (Pillai's trace= .14, F1,45= 7.24, p≤.01, partial eta squared=.14). There was no difference in pre-test between IG and CG (p=.79) but in post-test IG had lower means than CG

(F1,45= 4.49, p<. 05). Paired t-test showed for IG lower scores in post-test than pre-test (t28= 3.51, p<.01), while for CG higher there were no significant differences between post-test than pre-test (p= .80).

Oral Control Scale: Repeated measures analysis revealed significant interaction oral control by time (Pillai's trace= .05, p=.91). No further analyses were examined.

Global self-esteem: Repeated measures analysis showed no significant interaction global self-esteem by time (p=.26).

Self-esteem of body image: Repeated measures analysis revealed significant differences self-esteem of body image by time (Pillai's trace=.15, F1,45= 7.53, p<.01, partial eta squared= .15). In pre-test there was significant difference between IG and CG (F1,46= 6.76, p<.01) while there was no significant difference in post-test (p= .64). Paired t-test showed that for IG pre-test mean and post-test mean did not differ (p= .43) and for CG pre-test mean was significant higher than post-test mean (t18= 4.58, p<.001).

Pressure to be thin: Pressure to be thin by coaches: Repeated measure analysis revealed significant interaction perceived pressure by time (Pillai's trace= .17, F1,45= 9.36, p<.005, partial eta squared= .17). There was no difference in pre-test between IG and CG (p=.54) and in post-test (p= .06). Paired t-test showed that there was significant difference between pre-test and post-test in CG (t28= -4.50, p<.001).

Pressure to be thin by parents: Repeated measures analysis revealed significant differences pressure to be thin by parents by time (Pillai's trace= .10, F1,45= 4.81, p<.05, partial eta squared= .10). There were no significant differences between IG and CG in pre-test (p= .27) and post-test (p= .98). Paired t-tests showed that in IC there was significant higher mean in pre-test than post-test (t18= 2.67, p<.05), while in CG there was no significant difference between pre-test and post-test (p= .56).

Pressure to be thin by friends: Repeated measures analysis revealed no significant differences pressure to be thin by friends by time (p= .18).

Pressure to be thin by RG experts: Repeated measures analysis revealed significant differences pressure to be thin by experts by time (Pillai's trace=.18, F1,45= 9.86, p<.005, partial eta squared= .18). In pre-test there was no significant difference between IC and CG, while in post-test IG had significant lower mean in pressure to be thin by RG experts than CG (F1,45= 6.80, p≤.01). Paired t-test showed that for IG pre-test mean was significant higher than post-test mean (t29= 3.04, p≤.005) and for CG post-test mean was significant higher than pre-test mean (t17= -2.38, p<.05).

Intervention's evaluation: participants in IC evaluated the program high in relevance to rhythmic gymnastics (t28= 8.00, p<.001), in believability (t28= 8.69, p<.001) and emotional response (t28= 7.89, p<.001).

Source's evaluation: participants in IC perceived the source as well informed (t28= 59.02, p<.001), well persuasive (t28= 36.48, p<.001), with knowledge (t28= 40.29, p<.001) and well reliable (t28= 35.13, p<.001).

DISCUSSION

Purpose of the present study was to evaluate the short-term effects of an intervention to enhance positive body esteem, positive eating attitudes and decrease perceived pressure to be thin by significant others. Participants in both groups, intervention and control, were rhythmic gymnastics athletes. The intervention had, in general, positive effects. More specifically, the results of the study suggested that the intervention increased in IG body esteem, and decreased eating attitudes in general, dieting scale and boulimia and food preoccupation, and perceived pressure to be thin by experts and parents. Also, CG in post-test comparing to pre-test decreased body esteem, self-esteem of body image and increased eating attitudes, more specifically dieting scale and boulimia and food preoccupation, and perceived pressure to be thin by experts. The intervention was very relevant to RG,

high in believability and high in promoting emotions. The source of the intervention was evaluated as informed, persuasive and reliable.

The present intervention was designed taking under consideration persuasion theory and more particularly Elaboration Likelihood Model and all possible suggestions about health education programs. The program included multiple teaching methods and approaches, all focusing on RG athletes of the specific age. The intervention program was applied by a female person who was former RG athlete, former RG coach and current RG judge, with expertise in health education. So, there were strong cues that she was relevant to RG and well informed to the issues discussed. Short-term effects of the program were encouraging although there longer effects of the present or other programs must be examined, as it will be mentioned below in the discussion.

In the present study body esteem was increased for IG and that is in contrast to Bucholz et al.'s (2008) study where there was found no changes. Our program's sessions were specified on rhythmic gymnastics. The session on body image was discussed by such a way identifying body image in RG and throughout the Olympic Cycles from the early '80s to now. Body image was explained in different sports but also was explained scientifically what happens when an RG athlete gains weight. The changes that have been detected to the measure of body esteem can be attributed to the inclusion of teaching certain life skills important for rhythmic gymnastics athletes, beside only providing knowledge through out the program.

Interventional programs in RG are rare and this is a fact under consideration as RG athletes are in a fragile age and they experience high volumes of training loadings for long periods of their lives. Rhythmic gymnastics athletes seem to be at risk for eating disorders, even among other gymnastics disciplines (Nordin, Harris, & Cumming, 2003). An in-depth phenomenological study showed that Greek former RG athletes had run the risk of suffering from eating disorders, at the time of the study they had low body weight but only two of five were satisfied by their body image (Kouloutbani, Efstathiou, & Stergioulas, 2012). The present study showed that the program reduced pressure to be thin from RG experts and this is consist to Bucholz and her colleagues (2008) results where athletes perceived a reduction in pressure to be thin from their clubs. Eating attitudes were improved for IG comparing to CG by decreasing the mean score. Again, in Bucholz et al.'s (2008) study there was not found any changes. An interesting point of the present interventional program is that the percentage of participants who were in risk for eating disorders did not change after the intervention. A program must focus particularly to a target group, so probably RG athletes who were at risk for eating disorders needed more targeting content.

Global self esteem of IG was not affected by the program. No changes in global self esteem were expected by the program as global self esteem is related more strongly to measures of well-being (Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995). By the relevant literature becomes obvious that global self-esteem is the individual's positive or negative attitude toward the self as a totality (Rosenberg et al., 1995). The present intervention focused to specific self-esteem, body esteem.

When non-elite athletes practice an aesthetic sport, they develop a body closer to the social ideal, making these athletes less likely to be victims of critical comments but elite athletes and elite dancers are in a greater risk for developing eating disorders, disorders were predicted mostly by body image dissatisfaction and parental influences (Francisco, Narciso, & Alarcão, 2013). Pressure to be thin in RG is a fact. In a qualitative study RG athletes mentioned intense pressure of measuring body weight by coaches and parents (Kouloutbani et al., 2012). The intervention was implemented by an RG expert and parents were involved in some point of the intervention. The

intervention had no results on pressure to be thin by coaches, as coaches were not involved neither they were given relevant instructions about their behavior during practice on body image and body esteem issues. In a next step of the program could and should be involved coaches.

Despite the positive effects of the interventional program, there are several limitations. First of all there was not follow up measurement examining long-term effects of the intervention. This was not possible because after the completion of the intervention competition season started for the older participants and a little later for all participants. Also during competition season, climate in practice changes, and this would have unpredictable effect. Secondly, right after competition period some participants dropped out the sport. A second limitation is that the study used only quantitative methods. Similar studies should include qualitative components, as it is proposed also by Smith and Petrie (2008). Such components could be end-of-treatment interviews to better understand the athletes' experiences with the interventions. Such a preventive program should contain booster sessions to maintain the positive effects for a longer time. Finally another limitation is the low number of participants. Rhythmic gymnastics athletes during adolescence have been participating in championships for at least 5 years, so they are not considered as novice. The number of participants is similar to other relevant studies in which participated RG athletes (e.g. Bucholz et al., 2008; Koumpoula, Tsopani, Flessas, & Chairopoulou, 2011; Donti, Theodorakou, Kambiotis, & Donti, 2012).

The program was the first attempt in RG in Greece. Rhythmic gymnastics is a very popular sport in Greece and has to present successful participations in World and European championships, even Olympic medals. As a consequence is a lot of young girls to participate in RG clubs. More researches should be addressed to RG athletes, in order to enhance positive consequences by participating in RG.

[1] For more details on the intervention program please contact the first author.

REFERENCES

Baranowski, M. J., & Hetherington, M. M. (2001). Testing the efficacy of an eating disorder prevention program. *International Journal of Eating Disorders, 29*(2), 119-124.

Bobo-Arce, M., & Méndez-Rial, B. (2013). Determinants of competitive performance in rhythmic gymnastics. A review. *Proceedings of performance workshop, Alicante, Spain, 8*(3), S711-S727.

Buchholz, A., Mack, H., MvcVey, G., Feder, S., & Barrowman, N. (2008). Bodysense: An evaluation of a positive body image intervention on sport climate for female athletes. *Eating Disorders, 16*, 308-321.

Collins, M. E. (1991). Promoting healthy body image through the comprehensive school health program. *Journal of Health Education*, *22*(5), 297-302.

Donti, O., Theodorakou, K., Kambiotis, S., & Donti, A. (2012). Self-esteem and trait anxiety in girls practicing competitive and recreational gymnastics. *Science of Gymnastics Journal, 4*(1), 33-43.

Douka, A. (2007). *Effect of eating disorders in health and sports development of Greek female athletes high competitive level*. Unpublished doctoral dissertation. National and Kapodistrian University of Athens: Faculty of Physical Education and Sport Science.

Durkin, S., Paxton, S., & Wertheim, E. (2005). How do adolescent girls evaluate body dissatisfaction prevention messages? *Journal of Adolescent Health, 37*, 381-390.

Flament, M. F., Hill, E. M., Buchholz, A., Henderson, K., Tasca, G. A., & Goldfield, G. (2012). Internalization of the thin and muscular body ideal and disordered eating in adolescence: The mediation effects of body esteem. *Body Image, 9*(1), 68-75.

Francisco, R., Narciso, I., & Alarcão, M. (2013). Specific predictors of disordered

eating among elite and non-elite gymnasts and ballet dancers. *International Journal of Sport Psychology, 43*(6), 479-502.

Garner, D. & Garfinkel, P. E. (1979). The Eating Attitudes Test: An index of the symptoms of anorexia nervosa. *Psychological Medicine*, *9*, 279-279.

Garner, D., Olmsted, M., Bohr, Y., & Garfinkel, P. (1982). The Eating Attitudes Test: psychometric features and clinical correlates. *Psychological Medicine, 12*, 871-878.

Garner, D. M. & Rosen, L. W. (1991). Eating disorders among athletes: research and recommendations. *Journal of Applied Sport Sciences Research*, *5*(2), 100-107.

Jones, L., Sinclair, R., & Courneya, K. (2003). The Effects of Source Credibility and Message Framing on Exercise Intentions, Behaviors and Attitudes: An Integration of the Elaboration Likelihood Model and Prospect Theory. *Journal of Applied Social Psychology, 33*, 179-196.

Karamintziou A. (2008). *Body image and school bullying: by which way bullying and violence correlate to perceived weight and global appearance in girls and boys 14 to 16 years old*. Unpublished Master Thesis. Thessaloniki: Interdisciplinary graduate program in educational gender equality.

Killen, J. D., Taylor, C. B., Hammer, L. D., Litt, I., Wilson, D. M., Rich, T., et al. (1993). An attempt to modify unhealthful eating attitudes and weight regulation practices of young adolescent girls. *International Journal of Eating Disorders, 13*(4), 396-384.

Kosmidou, E. (2007). *Smoking and exercise: effective messages for attitude change in health education programs that are addressed in secondary and university students*. Unpublished doctoral dissertation. Komotini: Department of Physical Education & Sport Sciences, Democritus University of Thrace.

Kouloutbani, K., Efstathiou, T., & Stergioulas, A. (2012). Eating disorder in the world of sport: the experiences of rhythmic gymnasts. *Biology of Exercise, 8*(2), 19-31.

Koumpoula, M., Tsopani, D., Flessas, K., & Chairopoulou, C. (2011). Goal orientations and sport motivation, differences between the athletes of competitive and non-competitive rhythmic gymnastics. *Journal of Sports Medicine and Physical Fitness, 51*(3), 480-488.

Lanfranchi, M. C., Maïano, C., Morin, A. J. S., & Therme, P. (2014). Prevalence and sport-related predictors of disturbed eating attitudes and behaviors: Moderating effects of sex and age. *Scandinavian Journal of Medicine & Science in Sports, 24*(4), 622-633.

Mendelson, B., Mendelson, M., & White, D. (2001). Body-esteem scale for adolescents and adults. *Journal of Personality Assessment, 76*(1), 90-106.

Monteiro, L. A., Novaes, J. S., Santos, M. L., & Fernandes, H. M. (2014). Body dissatisfaction and self-esteem in female students aged 9-15: the effects of age, family income, body mass index levels and dance practice. *Journal of Human Kinetics, 43*(1), 25-32.

Neumark-Sztainer, D., Wall, M. M., Story, M., & Perry, C. L. (2003). Correlates of unhealthy weight-control behaviors among adolescents: implications for prevention programs. *Health Psychology*, *22*(1), 88.

Neumark-Sztainer, D., Wall, M., Story, M., & Sherwood, N. (2009). Five-year longitudinal predictive factors for disordered eating in a population-based sample of overweight adolescents: Implications for prevention and treatment. *International Journal of Eating Disorders, 42*, 664-672.

Noordenbos, G. (2002). From Screening to Empowerment: Strategies for the Prevention of Eating Disorders. *In EWHNET (Hg.): Health Promotion and Prevention of Eating Disorders. European Symposium (Vol. 14, pp. 8-20).*

Nordin, S., Harris, G., & Cumming, J. (2003). Disturbed eating in young, competitive gymnasts: Differences between three gymnastics disciplines. *European Journal of Sport Science, 3*(5), 1-14.

O'Dea, J. (2002). Can body image education programs be harmful to adolescent females? *Eating Disorders, 10*, 1-13.

O'Dea, J., & Abraham, S. (2000). Improving the body image, eating attitudes, and behaviors of young male and female adolescents: A new educational approach that focuses on self-esteem *International Journal of Eating Disorders, 28*, 43-57.

Papanis, E. (2004). *Self-esteem and it's measurement*. Athens: Atrapos.

Paxton, S. J. (1993). A prevention program for disturbed eating and body dissatisfaction in adolescent girls: a 1 year follow-up. *Health Education Research*, *8*(1), 43-51.

Paxton, S., Wertheim, E., Pilawski, A., Durkin, S., & Holt, T. (2002). Evaluations of dieting prevention messages by adolescent girls. *Preventive Medicine, 35*, 474-491.

Petty, R. E. & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer- Verlag.

Ricciardelli, L. A., McCabe, M. P., Holt, K. E., & Finemore, J. (2003). A biopsychosocial model for understanding body image and body change strategies among children. *Journal of Applied Developmental Psychology, 24*(4), 475-495.

Rosen, C. (2000). Integrating stage and continuum models to explain processing of the exercise messages and exercise initiation among sedentary college students. *Health Psychology, 19*, 172-180.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Rosenberg, M., Schooler, C., Schoenbach, C., & Rosenberg, F. (1995). Global self-esteem and specific self-esteem: Different concepts, different outcomes. *American Sociological Review, 60*, 141-156.

Salbach, H., Klinkowski, N., Pfeiffer, E., Lehmkuhl, U., & Korte, A. (2007). Body image and attitudinal aspects of eating disorders in rhythmic gymnasts. *Psychopathology, 40*, 388-393.

Sjostrom, L., & Steiner-Adair, C. (2005). Full of Ourselves: A Wellness Program to Advance Girl Power, Health & Leadership: An Eating Disorders Prevention Program That Works. *Journal of Nutrition Education and Behavior , 37*, S141-S144.

Smith, A., & Petrie, T. (2008). Reducing the risk of disordered eating among female athletes: A test of alternative interventions. *Journal of Applied Sport Psychology, 20*, 392-407.

Smolak, L., Mumen, S., & Ruble, A. (2000). Female athletes and eating problems: A meta-Analysis. *International Journal of Eating Disorders, 27*, 371-380.

Stice, E., Rohde, P., Gau, J., & Shaw, H. (2009). An effectiveness trial of a dissonance-based eating disorder prevention program for high-risk adolescents girls. *Journal of Consulting and Clinical Psychology, 77*(5), 825-834.

Sundgot-Borgen, J. (1994). Risk and trigger factors for the development of eating disorders in female elite athletes. *Medicine and Science in Sports and Exercise*, *26*, 414–419.

Theodorakou K, Donti O. (2013). Prevalence of eating disorders and psychological parameters in elite female gymnasts: Their relation to body image and body mass index. Athlitiki Psychologia. 3, 24, 11-23.

Thompson, R. A., & Sherman, R. (1999). Athletes, Athletic Performance, and Eating Disorders: Healthier Alternatives. *Journal of Social Issues, 55*(2), 317-337.

Thompson, R. A., & Trattner Sherman, R. (1999). Athletes, Athletic Performance, and Eating Disorders: Healthier Alternatives. *Journal of Social Issues, 55*(2), 317-337.

Varsou E. & Trikkas G. (1991). Questionnaires exploring food intake disorders, EDI, EAT-26 and BITE in Greek population: Preliminary findings. Paper presented at the 12th National Congress of Psychiatry. Volos.

Corresponding author:

Evdoxia Kosmidou
Aristotle University of Thessaloniki - Department of Physical Education and Sport Science
57001 THERMI Thessaloniki
Greece
Email: ekosmido@phed.auth.gr

THE RELATIONSHIP BETWEEN THE MECHANICAL PARAMETERS IN THE TAKE-OFF OF A VAULT AND THE DROP JUMP ABILITY

Yoshie Motoshima [1], Junichi Kitagawa, Akira Maeda [2]

[1] Graduate School of Physical Education, National Institute of Fitness and Sports in Kanoya, Kanoya, Japan
[2] National Institute of Fitness and Sports in Kanoya, Kanoya, Japan

Original article

Abstract

In the vault in gymnastics, the take-off motion is important to the success of the vault and to perform more difficult vaults. Vaulting ability has been studied by motion analysis, but this method is not effective for easy evaluation. Therefore, the purpose of this study was to investigate the relationship between the mechanical parameters in the take-off of a vault and the drop jump ability, by focusing on the rebound drop jump index (RDJ index) calculated from the two variables of contact time and flight time. Male gymnasts performed the Kasamatsu vault, and their vaulting motion was captured using the 3-dimensional optical motion capture system MAC3D. In addition, they performed a drop jump from a height of 0.4 m without arm swing under two conditions (vault board and non-spring floor), and the RDJ index was calculated. As a result of calculating the regression equation for estimating the vertical impulse of the Kasamatsu vault by using the RDJ index of the drop jump, a significant regression equation was obtained in the RDJ index of the drop jump on the vault board ($y = 0.290x + 5.368$, $p < 0.05$). This result suggests the possibility that the vertical impulse of the take-off on the vault board can be evaluated by measurement under conditions whose characteristics are similar to those of actual vaulting, such as a drop jump on a vault board, in high-level gymnasts.

Keywords: *vault, vertical impulse, drop jump, RDJ index.*

INTRODUCTION

The drop jump is used as one of the methods of evaluating the ability of a stretch-shortening cycle performed in a very short time, producing an estimated rebound drop jump index (RDJ index) (Zushi, Takamatsu, & Kotoh, 1993). RDJ index is an index that indicates the spring characteristics of the lower limbs, and is calculated by dividing the jumping height by the contact time. There are two drop jump techniques: "counter movement drop jump," which has a long contact time, and "bounce drop jump," which has a short contact time (Bobbert, Huijing, & van Ingen Schenau, 1987). It is said that gymnasts use the latter technique (Marina, Jemni,

Rodríguez, & Jimenez, 2012). When we consider the sports characteristics of the jump ability among different sports, we can use the drop jump as an effective evaluation method. However, as sprint performance is correlated with the drop jump height (Holm, Stalbom, Keogh, & Cronin, 2008; Barr & Nolte, 2011), if we want to target a specific athlete, results consistent with the actual sports performance are required. Therefore, this study focused on the vault, in which jumping motion has a major impact on the performance among the gymnastics events.

In the vault in gymnastics, the take-off motion is important for the success of the vault (Prassas, 1999). Takei, Dunn, & Blucker (2003) compared high-scoring and low-scoring Roche (the handspring with 5/2 tucked forward somersaults) vaults. As a result, they were clarified that high-scoring group obtain larger vertical force in take-off than low-scoring group, and reported the importance of the force obtaining from vault board. Furthermore, it has been reported that the correlation is observed between the judges' score and the variables in the post-flight (Takei, 2007). From these, we thought that the judges' score is related to the mechanical parameters in the take-off.

As the characteristic of take-off motion in the vault, it is mentioned to be SSC exercises performed in a short time of 0.10 to 0.14 seconds (Cheetham, 1983; Dillman, Cheetham, & Smith, 1985; Takei, 1988; Takei, 1991; Bradshaw, Hume, Calton, & Aisbett, 2010; Farana, Uchytil, Jandačka, Zahradník, & Vaverka, 2014), to convert the horizontal velocity to the vertical velocity of the center of mass and product the angular momentum (Brüggemann, 1987; Takei, 1988; Takei, 1991; Takei et al., 2003; Irwin & Kerwin, 2009), and to be performed on an instrument that is highly elastic with springs. To date, vaulting ability, including take-off motion and mechanical parameters, has been investigated by performing motion analysis. From the take-off motion in the vault and the drop jump is similar in a point being SSC exercise performed in a short time, we thought that consideration of the relationship between the mechanical parameters measured by motion analysis and the drop jump ability is useful when performing training and evaluation. Furthermore, Coventry, Sands, & Smith (2006) have investigated about the relationship between the behavior of the vault board and the foot placement on the vault board. Sano, Ikegami, Nunome, Apriantono, & Sakurai (2007) have established the method of measuring the force applied from the vault board to the gymnast during the board contact. Thus, because it is considered that the effective use of the vault board leads to performance in the vault, the research focusing on the vault board has been conducted. Considering the principles of the training (the principle of specificity), when targeting gymnasts, we thought that not only measuring the drop jump on a non-spring surface, as performed in a number of studies, but also measuring the drop jump on a vault board is effective. Therefore, the purpose of this study was to investigate the relationship between the mechanical parameters in the take-off of a vault and the drop jump ability on a take-off surface with two different conditions. This study's hypothesis was that the drop jump on a vault board would be valid to evaluate the mechanical take-off parameters.

METHODS

Subjects

Seven collegiate male gymnasts (age 19.9 ± 1.5 years, height 1.64 ± 0.04 m, body mass 59.4 ± 3.5 kg, competition history 10.9 ± 2.7 years) volunteered to participate in this study. All gymnasts could perform the Kasamatsu vault (Figure 1) or a vaulting technique of a higher degree of difficulty of the sideways handspring vault type. Two gymnasts could perform the Kasamatsu vault (difficulty (D)-score 4.4, FIG, 2013), 2 gymnasts could perform the Kasamatsu vault with half a turn (D-score 4.8, FIG, 2013), 2 gymnasts could perform the Kasamatsu vault with a whole turn (Akopian, D-score 5.2, FIG, 2013), and one gymnast could perform the Kasamatsu vault

with one and a half turns (Driggs, D-score 5.6, FIG, 2013).

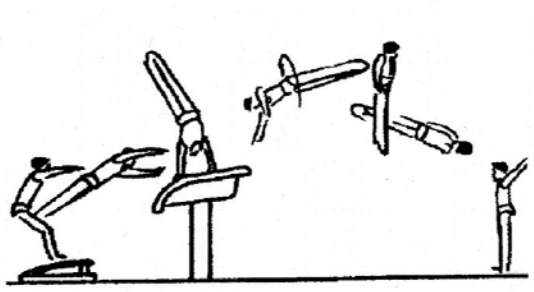


Figure 1. Kasamatsu vault (D-Score 4.4, FIG, 2013).

Before carrying out the experiments, informed consent was obtained from each subject. This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of the National Institute of Fitness and Sports in Kanoya.

Measurement of vaults

Subjects were instructed to perform a Kasamatsu vault twice in experimental condition. A certified judge of the Japan Gymnastics Association scored all vaults' execution (E) score, which evaluated the quality of the vault. All trials were recorded using the 3-dimensional optical motion capture system MAC3D (Motion Analysis, USA; 400 Hz).

A reflective marker with a diameter of 18 mm, which was attached to the body of the subject, was captured by synchronized Raptor-12 cameras, and the 3-dimensional coordinates were measured using Cortex 3.1.1 (Motion Analysis, USA) key software. The reflective markers were attached to the parietal, front head, rear head, acromion (left and right), lateral epicondyle of the humerus (left and right), ulnar styloid process (left and right), third metacarpal bone (left and right), offset, sacrum, lower rib (left and right), anterior superior iliac spine (left and right), greater trochanter (left and right), lateral epicondyle of the femur (left and right), heel bone (left and right), external condyle fibula (left and right), and third metatarsal bone (left and right) (Figure 2). The coordinate system was set to a static coordinate system consisting of the X-axis vector in the horizontal direction with respect to the advancing direction, Y-axis vector in the advancing direction, and Z-axis vector in the vertical direction.

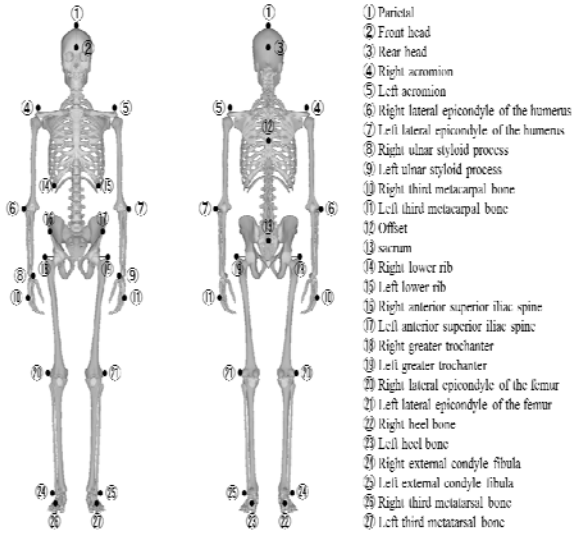


Figure 2. Marker set.

The 3-dimensional coordinate values obtained by MAC3D were smoothed using a fourth-order low-pass Butterworth filter with 8.2 - 19.5 Hz cut-off frequency calculated by residual analysis (Winter, 2009). On the basis of the smoothed three-dimensional coordinates, the body was regarded as a rigid body composed of 15 segments, and the acceleration of the center of mass was calculated using the inertia coefficient of the body segments in Japanese athletes (Ae, Tang, & Yokoi, 1992). The vertical impulse in the take-off phase was calculated from the acceleration of the center of mass (Takei, 1988) and was normalized by dividing by the mass of the subject. When considering the relationship between the vertical impulse and E-score of the Kasamatsu vault, two trials for each subject were used. And when considering the relationship between the vertical impulse of the Kasamatsu vault and the measured value of the drop jump or D-score when gymnasts performed the vault in competition, the vertical impulse was set as the mean value of the two trials for each subject.

Measurement of drop jumps

The subjects performed drop jumps from a height of 0.4 m without arm swing under two conditions (vault board and non-spring floor, Figure 3). In the measurement of drop jumps, a vault board (AJ0700; Senoh, Japan) certified by the International Gymnastics Federation was used and the vault board was the same in the measurement of the vaults. The number of trials was set to 3 times for each condition, and we selected the trial in which the RDJ index was the highest. The instruction given to the subjects was "jump as high and fast as you can." The drop jump on the non-spring floor was performed on a force platform (Kistler, Switzerland; 1000 Hz), and the data were recorded through an A/D converter (Powerlab; ADInstruments, Japan). The drop jump on the vault board was recorded with a high-speed camera (EX-FH25; Casio, Japan; 240 fps). RDJ index (Zushi et al., 1993) was calculated as follows:

$$\text{RDJ index (m/s)} = (1 / 8 \bullet g \bullet t_a^2) / t_c,$$

where 't_c' is take-off time, 't_a' is flight time, and 'g' is acceleration due to gravity.

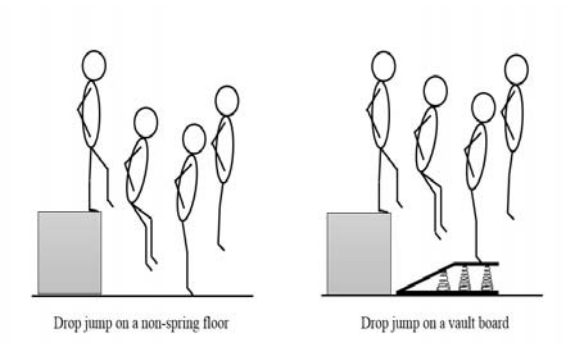


Figure 3. Drop jumps.

Statistical analysis

The relationship between the vertical impulse of the Kasamatsu vault and the D-score (FIG, 2013) of the vault performed in competition was investigated using Spearman's rank correlation coefficient, and the relationship between the vertical impulse and the E-score of the Kasamatsu vault and between the RDJ index of the drop jump in both conditions was investigated using Pearson's product-moment correlation coefficient. To investigate the relationship between the vertical impulse of the Kasamatsu vault and RDJ index of the drop jump, regression analysis was performed for each item, as the dependent variable was the vertical impulse and the independent variable was the RDJ index of the drop jump in each condition. This statistical analysis was performed using SPSS 15.0J for Windows software package (SPSS, Japan) and the significance level was set at $p < 0.05$.

RESULTS

In the Kasamatsu vault, the E-score used to evaluate the quality of the vault was 8.0 points or more (8.6 ± 0.3 points) in all trials. No correlation was observed between the vertical impulse and the E-score of the Kasamatsu vault (Figure 4); on the other hand, a positive correlation was observed between the vertical impulse of the Kasamatsu vault and the D-score of the vault performed in competition ($r = 0.899$, $p < 0.01$; Figure 5).

Figure 6 shows the results of regression analysis to predict the vertical impulse of the Kasamatsu vault from the RDJ index of the drop jump in each condition. A significant regression equation was obtained for the RDJ index of the drop jump on a vault board ($y = 0.290x + 5.368$, $p< 0.05$), and the standard error of the estimate (SEE) by this regression equation was 0.097 Ns/kg. On the other hand, in the RDJ index of the drop jump on the non-spring floor, no significant regression equation was obtained. Furthermore, no correlation observed between the RDJ index of the drop jump in both conditions (Figure 7).

DISCUSSION

Gymnastics performances are scored by the sum of the D-score, indicating the difficulty of the technique, and the E-score, indicating the quality of the performance (FIG, 2013). The D-score is determined for

each vault and may be considered to represent the quality of gymnasts' vaults. A positive correlation was observed between the vertical impulse of the Kasamatsu vault and the D-score of the vault that they performed in competition (Figure 5). In the vault, the take-off motion is important to the success of the vault and for practicing more difficult vaults (Prassas, 1999). It has been shown to be one of the most important factors in the take-off motion for obtaining greater force from the vault board (Takei et al., 2003), which is in agreement with our results. From this, it is suggested that it is important to obtain a larger vertical impulse on take-off in order to perform more difficult vaults. On the other hand, a correlation was not observed between the vertical impulse and the E-score of the Kasamatsu vault (Figure 4). Takei (2007) was considered the relationship between the judges' score and some parameters of the post-flight targeting the Roche vault performed during the 2000 Olympic Games. As a result, he has reported the relationship between the judges' score and the normalized horizontal displacement of body center of mass from the knee grasp to peak of post-flight or the horizontal distance of the post-flight. However, a deduction item of E-score in the present study was about the leg separations in the vault contact phase and landing rather than the height or distance in the post flight phase, which is important for performing the rotation and twisting in post flight, this is considered to be influenced the result.

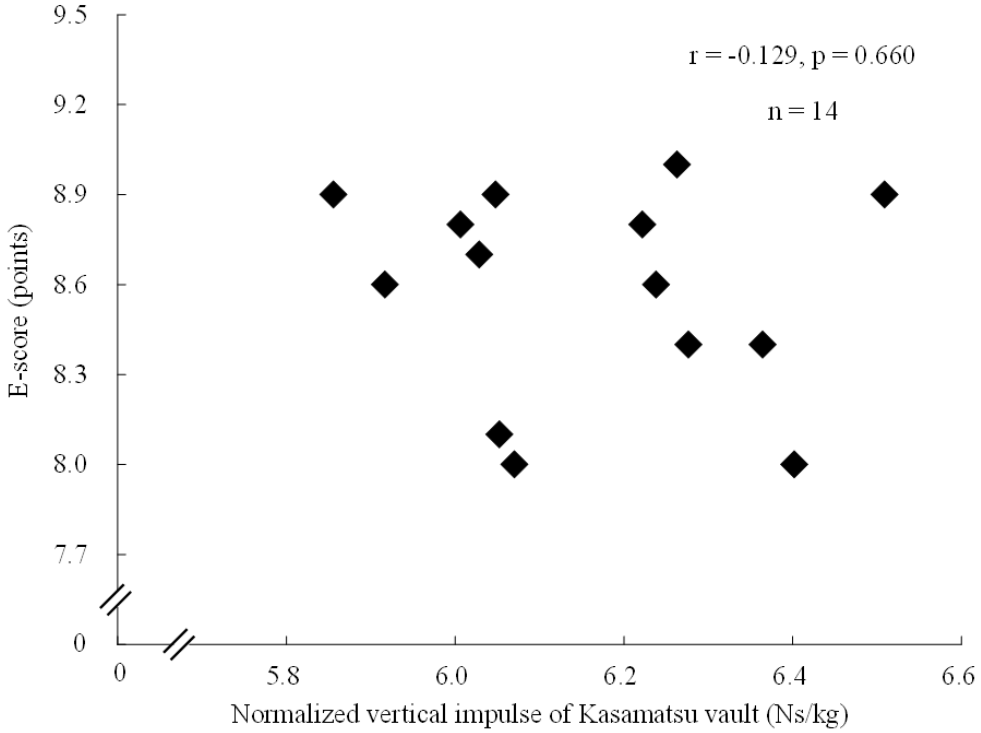


Figure 4. Relationship between vertical impulse and E-score of Kasamatsu vault.

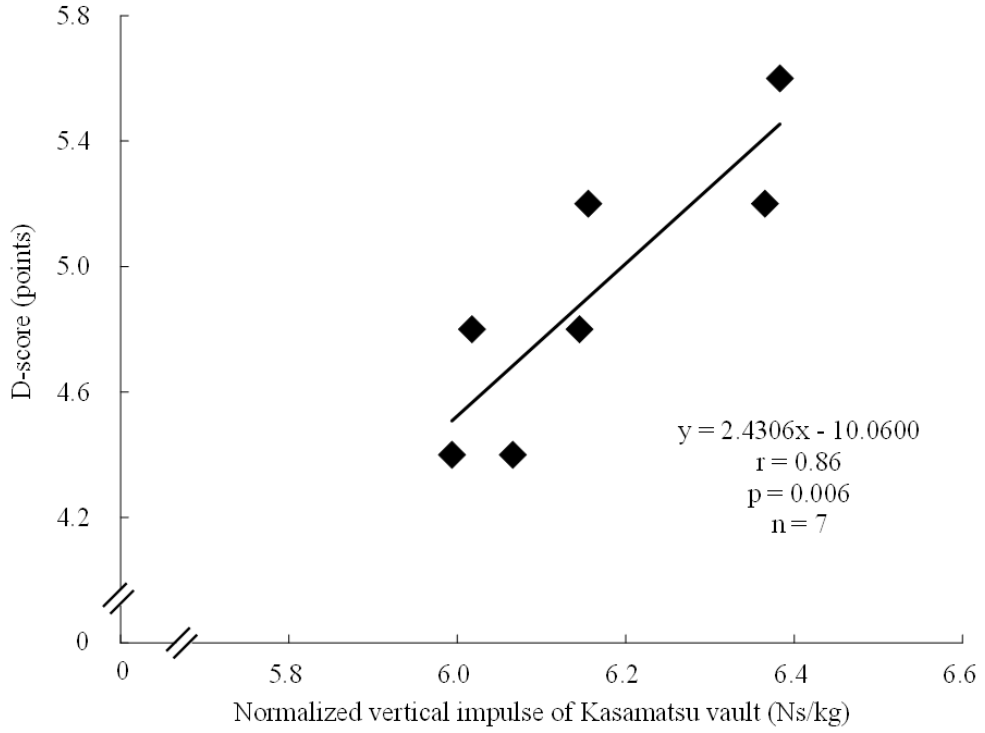


Figure 5. Relationship between vertical impulse of Kasamatsu vault and D-score of vault performed in competition.

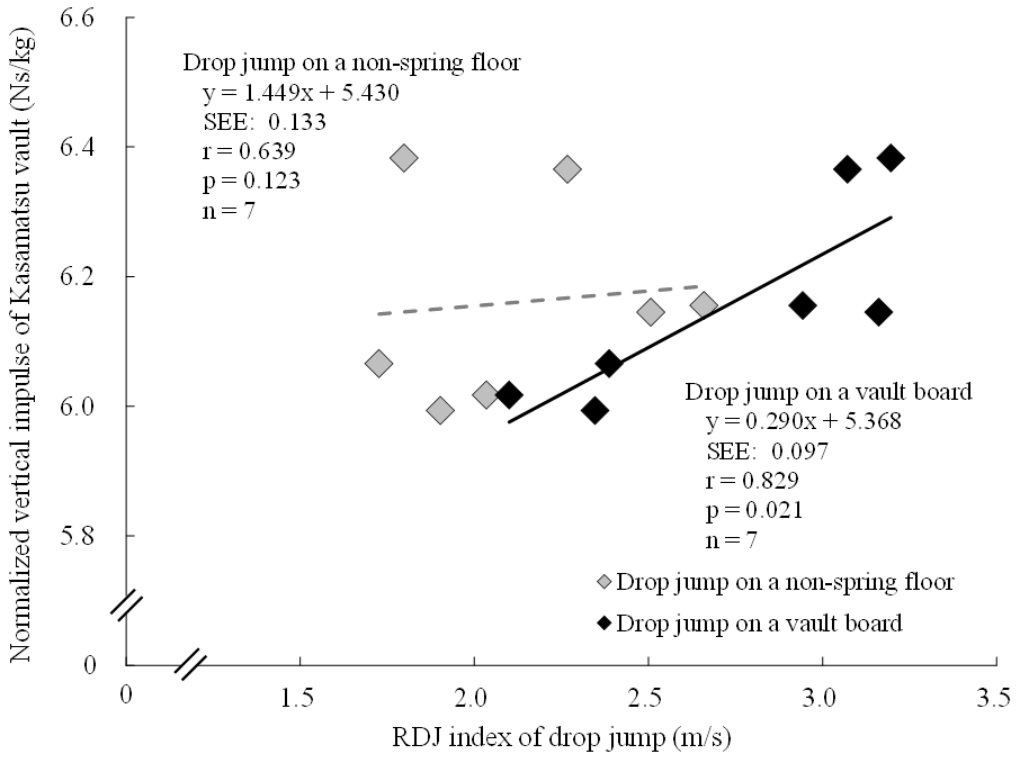


Figure 6. Relationship between RDJ index of drop jump and vertical impulse of Kasamatsu vault.

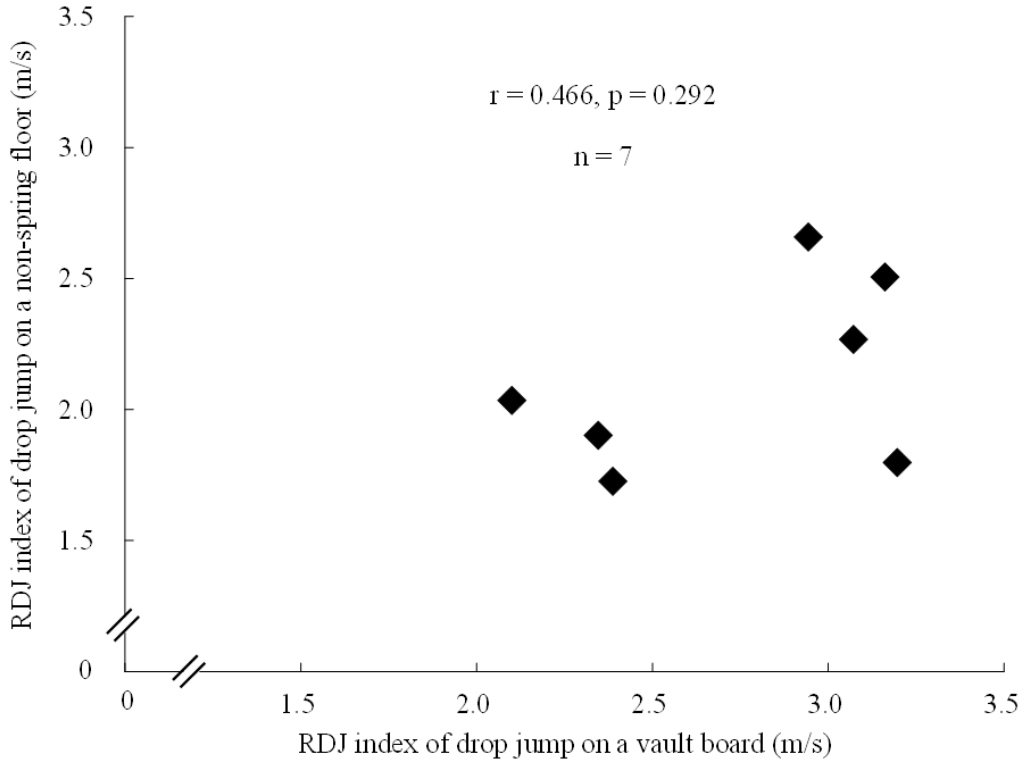


Figure 7. Relationship between RDJ index of drop jump in both conditions.

As a result of examining the relationship between the vertical impulse of the Kasamatsu vault and the drop jump measurement, a significant regression equation was obtained for the RDJ index of the drop jump on a vault board (Figure 6). It has been reported that the function of the neuromuscular system and the biomechanical characteristics of drop jump are affected by the training background (Komi & Bosco, 1978; Kyröläinen & Komi, 1995a; Kyröläinen & Komi, 1995b). In a non-spring surface, in order to increase the jumping performance, it is effective to use the bending and stretching motion of the lower limbs. On the other hand, in an instrument provided with springs, in order to store large elastic energy, it is effective to increase the leg stiffness. In addition, in the vault, it has been reported that gymnasts perform vaults making maximum use of the elasticity of the vault board (Sano, Ikegami, Nunome, & Sakurai, 2011). Gymnasts often perform jumping motion on an instrument provided with springs, and they have mastered the motion required to make use of the spring in the surface effectively. This is considered to be a factor behind the results obtained in the drop jump on a vault board. This study targeted gymnasts who can perform the Kasamatsu vault. In gymnastics, the important factors are not only acquiring height and distance of the second flight phase, but also adding somersaults and twists. In other words, gymnasts need to obtain not only the jumping height but also the angular momentum, and individuals who have high ability at simple jumping may not be able to perform high-difficulty vaults. Therefore, the results obtained in this study indicate that it is necessary to increase the RDJ index in order for high-level gymnasts to perform higher-difficulty vaults. Furthermore, from the regression equation obtained for the drop jump on a vault board (Figure 6), it is considered that increasing the RDJ index for a vault board is likely to lead to the acquisition of more effective take-off motion on a vault board, so it appears necessary to consider the drop jump motion in the future.

As limitations of this study, the results are only from a small number of subjects and trials, and a different measurement method in each condition was used in the

drop jump measurement. In terms of this different measurement method, we used a digital video camera because we thought that measurement would be difficult using only a force platform. On the other hand, we used a force platform as a surface with as high stiffness as possible and for convenient measurement. It is considered possible that this difference in the measurement method affected the result. Therefore, we need to consider these points further. However, in the drop jump measurement for a vault board, the use of a digital video camera is reasonable, and it is believed that the result obtained in the vault board condition in this study constitutes an effective index. In the take-off of vault, it is considered that the arm swing has an important role. However, how to use the arm is different by gymnasts. Therefore, because there is a possibility that the arm swing during the take-off of vault does not match the arm swing during the take-off of drop jump, it was performed drop jumps without arm swing in this study, but we need to consider these points again.

CONCLUSIONS

In high-level gymnasts, it was clarified that the mechanical parameters of the take-off from a vault are strongly related to the RDJ index of the drop jump on a vault board. From this, in the evaluation and plyometric training, it is considered that it is effective to be performed on an instrument that is highly elastic with springs under conditions with characteristics similar to those of actual vaulting.

REFERENCES

Ae, M., Tang, H., & Yokoi, T. (1992). Estimation of inertia properties of the body segments in Japanese athletes (in Japanese). *Society of Biomechanisms Japan, 11,* 23-33.

Barr, M. J. & Nolte, V. W. (2011). Which measure of drop jump performance best predicts sprinting speed? *Journal of Strength and Conditioning Research, 25*(7), 1976-1982.

Bobbert, M. F., Huijing, P. A., & van Ingen Schenau, G. J. (1987). Drop jumping. The influence of jumping technique on the biomechanics of jumping. *Medicine and Science in Sports Exercise, 19*(4), 332-338.

Bradshaw, E., Hume, P., Calton, M., & Aisbett, B. (2010). Reliability and variability of day-to-day vault training measures in artistic gymnastics. *Sport Biomechanics, 9*(2), 79-97.

Brüggemann, P. (1987). Biomechanics in gymnastics. *Medicine and Sport Science, 25,* 142-176.

Cheetham, P. J. (1983). The men's handspring front one and a half somersault vault: relationship of early phase to postflight. *Applied Proceedings of the I International Symposium on Biomechanics in Sports,* (p. 231-247).

Coventry, E., Sands, W. A., & Smith, S. L. (2006). Hitting the vault board: Implications for vaulting take-off - a preliminary investigation. *Sports Biomechanics, 5*(1), 63-76.

Dillman, C. J., Cheetham, P. J., & Smith, S. L. (1985). A kinematic analysis of men's Olympic long horse vaulting. *International Journal of Sport Biomechanics, 1,* 96-110.

Farana, R., Uchytil, J., Jandačka, D., Zahradník, D., & Vaverka, F. (2014). Differences in the key kinematic parameters of difficult Handspring and Tsukahara vaults performed by elite male gymnasts. *Science of Gymnastics Journal, 6*(2), 53-61.

Fédération Internationale de Gymnastique (2013). *Code of Points Men's Artistic Gymnastics.* Lausanne: FIG.

Holm, D. J., Stalbom, M., Keogh, J. W., & Cronin, J. (2008). Relationship between the kinetics and kinematics of a unilateral horizontal drop jump to sprint performance. *Journal of Strength and Conditioning Research, 22*(5), 1589-1596.

Irwin, G. & Kerwin, D. G. (2009). The influence of the vaulting table on the handspring front somersault. *Sports Biomechanics, 8*(2), 114-128.

Komi, P. V. & Bosco, C. (1978). Utilization of stored elastic energy in leg extensor muscles by men and women.

Medicine and Science in Sports, 10(4), 261-265.

Kyröläinen, H. & Komi, P. V. (1995a). Differences in mechanical efficiency between power and endurance-trained athletes while jumping. *European Journal of Applied Physiology, 70*(4), 36-44.

Kyröläinen, H. & Komi, P. V. (1995b). The function of neuromuscular system in maximal stretch-shortening cycle exercises: Comparison between power- and endurance-trained athletes. *Journal of Electromyography and Kinesiology, 5*(1), 15-25.

Marina, M., Jemni, M., Rodríguez, F. A., & Jimenez, A. (2012). Plyometric jumping performances of male and female gymnasts from different heights. *Journal of Strength Conditioning Research, 26*(7), 1879-1886.

Prassas, S. (1999). Biomechanical research in gymnastics: what is done, what is needed. *Applied Proceedings of the XVII International Symposium on Biomechanics in Sports,* (p. 1-10).

Sano, S., Ikegami, Y., Nunome, H., Apriantono, T., & Sakurai, S. (2007). The continuous measurement of the springboard reaction force in gymnastic vaulting. *Journal of Sports Sciences, 25*(4), 381-391.

Sano, S., Ikegami, Y., Nunome, H., & Sakurai, S. (2011). The interaction between the vault board and the gymnast's body (in Japanese). *Gifu City Women's College, 60,* 21-23.

Takei, Y. (1988). Techniques used in performing handspring and salto forward tucked in gymnastic vaulting. *International Journal of Sport Biomechanics, 4,* 260-281.

Takei, Y. (1991). A comparison of techniques used in performing the men's compulsory gymnastic vault at the 1988 Olympics. *International Journal of Sport Biomechanics, 7,* 54-75.

Takei, Y. (2007). The Roche vault performed by elite gymnasts: Somersaulting technique, Deterministic model, and Judge´s scores. *International Journal of Applied Biomechanics, 23,* 1-11.

Takei, Y., Dunn, H., & Blucker, E. (2003). Techniques used in high-scoring and low-scoring 'Roche' vaults performed by elite male gymnasts. *Sports Biomechanics, 2*(2), 141-162.

Winter, D. A. (2009). *Biomechanics and motor control of human movement 4th ed.* New Jersey: John Wiley & Sons.

Zushi, K., Takamatsu, K., & Kotoh, T. (1993). The specificity of leg strength and power in several sportathletes (in Japanese). *Japanese Society of Physical Education, 38,* 265-278.

.

Corresponding author:

Akira Maeda
National Institute of Fitness and Sports in Kanoya
1 Shiromizu, Kanoya, Kagoshima 891-2393, Japan Telephone and fax number: +81-994-46-4945
E-mail address: amaeda@nifs-k.ac.jp

CONSIDERATIONS FOR CONTROLLED COMPETITION LANDINGS IN GYMNASTICS: AGGREGATED OPINIONS OF EXPERTS

Helmut Geiblinger & Tony Dowden

University of Southern Queensland, Australia

Original article

Abstract

Dismounts from apparatus containing multiple rotations, performed by elite gymnasts during competition, require great courage and virtuoso displays of precisely organized movements and skills. The dismount and landing leave the final impression in a routine and are often the key to a successful evaluation by the judges. Landings require precise body control and the skillful dissipation of substantial body momentum. The aim of this research study was to investigate landing techniques and strategies used by elite male gymnasts through the eyes of gymnastics experts. It drew from the accrued knowledge and experience of 21 male expert participants who were elite coaches, elite gymnasts, international judges or combinations of these. The experts made a number of subtle points, many of which are not in the extant literature. The experts highlighted concerns about safety and the study concluded that on-going monitoring of the rules on competition landings within the Code of Points (Fédération Internationale de Gymnastique, 2015) would be beneficial to the sport.

Keywords: *controlled competition landings, landing technique, landing strategies, optimal body segment coordination.*

INTRODUCTION

Arguably, the most important and crucial part of gymnastics routines is the landing which signals the termination of the routine and leaves a final impression in the minds of the judges.

For instance, Takei and Dunn (1997) suggest that an expertly executed dismount ending with a well-controlled landing may persuade judges to be more lenient and deduct fewer points for technical mistakes made earlier in the routine. Competition landings occur at the end of routines on all apparatus with the exception of the floor exercise, where landings occur frequently but also include a final landing. Landings in gymnastics are expected to be controlled, thus enabling the performer to land safely without incurring injury. Gymnasts must meet the specific landing performance criteria imposed by the International Gymnastic Federations' (Fédération Internationale de Gymnastique [FIG], 2015) Men's Technical Committee's Code of Points for men's artistic gymnastic competitions. According to Article 9.2, Point 16 in the Code: for safety reasons a gymnast may land and or dismount with their feet apart (enough to properly join

their heels together) upon landing from any salto. The gymnast must complete the heels together without lifting and moving the front of his feet. This is done by raising the heels off the mat and joining them together without lifting the front of the feet. The arms must also be in complete control with no unnecessary swings (p. 31)

The successful achievement of controlled competition landings is contingent on the correct positioning of the extended body position during flight in preparation for landing. To obtain a good score from the judges, the gymnast must absorb the impact forces of the dismount without losing balance or moving their feet during the landing. A controlled competition landing results as the product of the process of a gymnast consciously and deliberately reducing all body momenta, either from a dismount off apparatus or from an acrobatic tumbling skill on floor, over time to zero, terminating with a single simultaneous placement of both feet. This process should occur with a visually controlled upright body position, exhibiting symmetry of the whole body and its segments, performed in a rhythmical, harmonious, safe and aesthetic manner, from landing touch-down to landing minimum, and resulting in a final stand-still position (Geiblinger, 1998; Gittoes, Irwin, & Kerwin, 2013).

The aim of this research study was to investigate the landing techniques and strategies used by male gymnasts. It draws from relevant literature, discussions and questionnaires from 21 male participants consisting of elite coaches, elite gymnasts and international judges.

Although there is abundant experimental, laboratory-based and theoretical research on landings in general, the complex and multiple strategies utilised by gymnasts during competition landings are well documented (Cuk & Marinsek, 2013; Gittoes & Irwin, 2012; McNitt-Gray, Hester, Mathiyakom, & Munkas, 2001; McNitt-Gray, Requejo, Flashner, & Boni, 2004; McNitt-Gray, Yokoi, & Millward, 1994; Prassas, Young-Hoo, & Sands, 2006), there are still weaknesses in the literature concerning landing techniques and strategies that could be strengthened by accessing the accumulated knowledge of gymnastics experts.

Geiblinger (1998) reported that the interplay of the angular velocities between the ankle, knee, hip and shoulder joints, and the temporal patterns of the kinematic chain, which enables the subject to displace the centre of mass at will in order to maintain balance and stability during the landing process, are crucial in the production of an optimal landing performance.

Most dismounts include multiple somersaults or twists, and often both. Prassas et al. (2006) report that for gymnasts to successfully perform rotational skills, it is crucial to control angular momenta resulting from somersaults or twists. When performing dismounts, the gymnast must generate sufficient angular momentum to execute the number of somersaults and twists required by the skill, and also attain enough height for sufficient air time to complete the rotation. The transfer of angular momentum from the body to the body segments can slow down the rotation of the gymnast's body, thus increasing the possibility of a successful landing. The most challenging landings, which follow difficult three-dimensional rotational skills, have a maximum force of seven times the body weight for the giant swing prior to release, with maximum heights from dismounts recorded in excess of four metres (Alp & Brüggemann, 1993; Brüggemann, Cheetham, Alp, & Arampatzis, 1994; Geiblinger, 1998; Gervais, 1993). Fink (2009) states that during landings, forces are applied – not absorbed – to reduce all momenta to zero. A body that is tilted due to twisting must be un-tilted prior to landing. Residual rotation after touch-down can be reduced by intersegmental transfer of angular momentum, in this instance by circling the arms in the direction of the undesired rotation.

Only a low proportion of competition landings are successful and the main reason for this is landing asymmetries (Cuk & Marinsek, 2013). The key predictors for

these asymmetries are differences in vertical hip velocity, ankle angle position, knee angle change, the difference in ankle angle between the legs in the lowest position, knee angle change of the non-leading leg from the first contact, and the difference in knee angle between the leading and non-leading leg at first contact (ibid.). In almost all successfully balanced landings, ground contact occurs with the CM position above the feet and between the toe and heel, because the linear impact impulses that stop the feet also contribute to an angular impulse that slows angular momentum (Sheets & Hubbard, 2007). In the case of the largest pre-impact angular velocities, for example following a double-somersault dismount, contact occurs with the CM in front of the toe. The gymnast is in a balanceable pre-impact orientation longer when rotating more slowly and with a smaller angular momentum, therefore balance will be more likely after performing a single-somersault dismount with a large moment of inertia (ibid.).

Landings cause great stress to the lower extremities and can generate reaction forces up to 10 times bodyweight leading to an overload of the lower extremities and causing overuse injuries (Kerwin, Yeadon, & Lee, 1990). Brüggemann (1990) suggests that it is important for landings to be practiced on different surfaces, therefore the gymnast must learn to adapt and train the tension of the leg extensor muscles to the specific landing situations which are environment (landing surface) and skill performance dependent. Chapman (2008), P. Perez, Llana, Klapsing, J. Perez, Cortell, and Van Den Tillaar (2010), and McNitt-Gray, Yokoi, and Millward (1994) indicate that gymnast-mat interaction, the gymnast's ability, and mat properties (such as surface and thickness) each influence shock absorption and stability, and therefore play an important role in achieving a successful landing.

Successful landings are performed with a high level of body stiffness in the first part of the landing with a knee angle greater than 63 degrees and, for a soft landing, an angle of less than 63 degrees (Cuk & Marinsek, 2013). Gymnasts are exposed to a high incidence of impact landings due to the execution of repeated dismount performances during training which can potentially lead to overuse injuries in the lower extremities (ibid.). Lees (1981) and Nigg (1985) reported that landing techniques permitting greater knee flexion reduce the vertical load and peak impact force transmitted to the joints and that hard landings are characterised by minimal joint flexion, whereas soft landings permit greater joint flexion.

The ability to accommodate unexpected events and distribute loads between musculo-skeletal structures is of great importance when gymnasts repeatedly perform difficult skills at high velocities. In landings after somersaults on the floor, considerable reaction forces and segmental accelerations occur. Gymnasts tending to perform over-rotated landings may benefit from flight phase control strategies that reduce the rate of total body rotation or redistribute angular momentum among the body segments such that the initial conditions at touch-down are conducive for controlling momentum during contact (Requejo, McNitt-Gray, & Flashner, 2004).

Landing errors on the floor are often caused by wrong decisions during the flight phase. Marinsek and Cuk (2010) investigated the characteristics of somersault landings performed by 97 senior gymnasts and found that axis of rotation, number of turns about the longitudinal axis, and initial landing height have a significant impact on the magnitude of landing mistakes, and that neuromuscular control plays an important role in landing performances.

Dismounts from the horizontal bar require the dissipation of substantial velocities and, therefore, large forces. Kerwin, Yeadon, and Harwood (1993) provide a detailed description of the release phase and its importance in the correct release timing for triple back somersault dismounts. They reported that body angles at the moment of release are important

factors to landing difficult dismounts successfully. It is therefore necessary for a gymnast to have several strategies of preparatory giant swings for the execution of different dismounts.

Takei, Nohara, and Kamimura (1992) examined the techniques used by elite gymnasts at the 1992 Olympic Games in the compulsory dismount from the horizontal bar. They reported that successful dismount performance is more likely when gymnasts have a large vertical velocity at bar release, which ensures optimal height and flight time, so that they can maintain an extended body position during the remainder of the flight to display body style for virtuosity bonus points, and to simultaneously prepare for a controlled landing. Because of the large landing impact forces during the landing process from the horizontal bar, the forces have to be dissipated over a relatively long time through greater knee and hip joint flexion. Takei and Dunn (1997) suggest that a full body extension, completed early during the second salto (in a double salto tucked) well above the bar, serves two purposes: first, due to the conservation of angular momentum, it brings about a small and steady angular velocity; and second, it provides an opportunity for the gymnast to spot the point of landing and prepare for a controlled touch-down on the landing surface.

Gymnasts are more stable at landing under conditions that allow them to spot the floor during either the entire backward somersault or the last half of the forward somersault (Davlin, Sands, & Shultz 2001; Luis & Tremblay, 2008). Visual feedback during a back tuck somersault is used for improving landing stability at all angular head velocities, but optimal feedback occurs when retinal stability is achieved as the head is held still. Low landing success may be attributed to the gymnast's reduced ability to obtain the kinaesthetic feedback necessary for spatial orientation to spot the mat as early as possible in the landing phase in order to make necessary adjustments (McNitt-Gray, Hester, Mathiyakom, & Munkas, 2001).

In summary, the literature shows considerable effort has been expended in the pursuit of scientific study of various aspects of landings, yet comparatively little effort has been made to access the accrued wisdom and experience of gymnastics experts and their opinions about achieving safe and successful competition landings.

METHOD

The expert participants in this study were 21 males consisting of elite gymnasts, state, national and international coaches, and FIG-accredited international judges. Accordingly, they were elite gymnasts, coaches, judges or, in some cases, all of these. The criteria used to select these participants was based on their status and standing in the Australian and wider international gymnastics community. The Australian gymnastics community includes international experts from Europe, Russia, China and the USA. These expert participants had valuable lived experiences and expertise pertaining to competition landings, thus a qualitative methodology was used to investigate their experience, expertise, perception and beliefs how competition landings should be performed. Such an approach is recommended for the qualitative investigation of beliefs and understandings (Cresswell, 2009). A key component within the methodology was conducting expert interviews. As Bogner and Menz (2009) explain, the expert interview is a powerful social research tool for exploring expert knowledge that is typically codified, systematized and combines theory and practice.

Data were gathered from questionnaires with all the experts and follow-up interviews with eight of the experts. The questionnaire was constructed from information derived from a theoretical biomechanical model of the release, flight and landing phases experienced by elite gymnasts (Geiblinger, 1998). This model shows how the various determinants are related to each other and how each parameter is determined from the release

phase through to completion of the landing. It represents how the landing develops both spatially and temporally. The questionnaire was structured so that the experts could provide detailed recommendations for gymnasts' body and body segment positioning and actions. The interview served the purpose of verifying and triangulating the questionnaire data.

The study was conducted in the Australian context. Interviews with the experts were conducted at the Queensland Academy of Sport and the Australian Institute of Sport. The interviews investigated the experience, expertise, beliefs and understandings from the perspectives of the experts. Also, short-answer format questionnaires consisting of 16 questions were emailed to the experts in Australia and overseas. Participation was voluntary and identities were kept anonymous. The responses from the experts for each question from the short-answer format questionnaire were analysed and then converted into key summary statements (see Table 1). These key **s**ummary statements, collated from the aggregated responses from the experts, were then synthesised and presented in sequential order according to the landing process.

The first author had insider researcher status (Crotty, 1998; Geiblinger, 2009) because he had an expert knowledge and understanding of the research context. His background as an international gymnast, coach, FIG-accredited judge and scientific researcher, at five world gymnastics championships spanning a period of over 20 years, along with his professional knowledge and understanding of how the human body functions and works, gave him considerable credibility with the expert participants (Bognor & Menz, 2009; Littig, 2009). This not only ensured a high level of participation and compliance in the project, it also strengthened the validity of the method and confers added authority to the recommendations provided at the end of this study.

RESULTS

The results of this study present the combined opinions of the experts on techniques, strategies and considerations for controlled competition landings. The responses from the experts for each question were analysed and aggregated and then presented as key summary statements (see Table 1). The experts' opinions had a high degree of agreement. This was apparent in both the responses to the questionnaires and the interviews which were used to verify and triangulate the data.

The landing phase of the competition routine relates to the temporal and spatial parameters from initial contact (first foot contact or touch-down on the landing surface) of the CM to the CM minimum position during the landing. This point in time is theoretically associated with the time the velocity of the CM becomes zero. Subsequently, the gymnast returns to a standstill position (Geiblinger, 1998). The following description for a successful competition landing from the experts' perspectives is synthesized from excerpts from the key **s**ummary statements:

- Successful achievement of controlled competition landings is contingent upon the correct positioning of the extended body position during the flight phase in preparation for landing.
- Preparation for the landing should include skilled execution of the dismount with hips slightly flexed but segment joints extended and tight but not stiff.
- At landing touch-down, the body position should change from an extended body position gradually flexing, symmetrically and square to the direction of travel.

Table 1
Key summary statements on competition landings from aggregated responses.

Questions	Key summary statements
1. How should a gymnast perform a competition landing?	The gymnast should perform the landing so that there are no point deductions, exhibiting a straight back with straight shoulders, head in a neutral position but 'spotting the floor', arms held oblique at approximately 45 degrees, hips and knees flexed with knees shoulder-width apart over toes, feet turned slightly outwards with control, and ankles slightly plantar flexed. Energy is absorbed, speed is slowed and the gymnast flexes more. Once the rotation and linear motion is stopped, the gymnast stands erect with arms out sideways and approximately 30 degrees above horizontal. The gymnast remains stationary for several seconds to demonstrate control of the landing.
2. What does a perfect landing position look like?	A perfect landing position should be balanced from a stretched position with knees together (knees pressed together is for "strong" legs) and feet slightly apart to a weightlifting set-up position with buttock out square and straight, with the head straight in a neutral position and spotting an object. Presentation is very important, esthetically pleasing, straight body alignment as in ballet.
3. How should the arms be positioned at landing touch-down?	The arms should be downwards, close to the body, strong and tight arms to absorb energy, generally in front and to counter rotation up or down.
4. How should be the arm movement during landing?	The arm movement during the landing should be downwards, close to the body, strong and tight and no arm movement. It was also suggested that a counter arm movement sideways and upwards with 'tight and strong arms' may occur.
5. How should the arms be positioned at completion of landing?	The arms should be sideward up about 30-45 degrees oblique, aesthetic looking with shoulders down.
6. How should the head be positioned at landing touch-down?	The head should be ideally straight in a neutral position or slightly forwards and flexed at the neck.
7. How much should the legs be bent during landing?	The legs should be bent according to the difficulty and height (vertical velocity) of the dismount and flexibility of the gymnast; generally at about an inside angle 135 degrees or a bit less.
8. How much should the hips be bent during landing?	The higher the dismount, the more hips should be bent; depends on many factors but generally about 30 degrees of forward lean.
9. How should the body position be at landing touch-down?	The body position at landing touch-down should be from an extended body position gradually flexing, square and straight upright with the head straight in a neutral position and spotting an object. Back should be straight and as the dismount is higher the more forward the body position. Gymnast's personal preference of knees together or apart. Just before touch-down everything slightly bent and prepared for landing. During landing ankles 60 degrees, knees 90 degrees, hips 90 degrees, arms parallel to floor.
10. How should the body position be at completion of landing?	The body position at completion of the landing should be upright and straight body alignment (as in ballet) with arms sideward and head straight. Aesthetic looking is very important, as in the letter Y.
11. What should be the preparation before landing?	The preparation before the landing should have a good execution of the dismount skill before the landing, the body slightly bent with joints extended and tight but not stiff.

12. Are there any visual cues you give to gymnasts?	Visual cues for a gymnast are important by spotting the floor (backward rotations) or spotting a wall (forward rotations). On landings from backward somersaults or front somersaults with a half twist, the gymnast should spot the ground. On forward landings the gymnast senses where he is and spots the wall or whatever is in front and above. All somersaults must be spotted and sensed.
13. What should the tempo be of a landing?	The tempo of the landing should be fast but with control, for example, land, hold squat, and stand up in to a Y-position (0.5 seconds each). It depends on the dismount skill before the landing. The landing must absorb the energy of the fall and the somersault. It is rapid at first but slows down as the speed is decelerated coming to a final stop in the bent position. The gymnast then stands to the upright position. This should be done in a confident manner, not too slowly.
14. Any Floor specific landing instructions?	Floor landings are more difficult because of the springiness of the floor, landing a little earlier (short) before somersault is completely finished to absorb horizontal velocity. Tumbling causes fast somersaults sometimes with a large horizontal velocity. This means that the landing point of the feet should be further away from the centre of gravity in order to allow the gymnast to stop the travel without stepping forward but not too far so as to avoid falling back.
15. Any Horizontal Bar specific landing instructions?	Horizontal bar landings require arm action to be 'stronger' and closer to the body and more hip and knee flexion because of greater vertical velocity, dismount parameters (rotations, body position extended) should be finished before landing.
16. Any other points?	General points on successful landings were: • Gymnast to develop with their skill level, to develop their own landing technique and strategies that are progressive with gymnast's development. • In front landings, gymnast needs to avoid landing on the heels as that will cause excessive force to be transmitted into the lower back and may cause injury. Similarly, back landings should be on toes (balls of the feet) first, dorsi-flexing in a controlled manner. • Aerial awareness is very important and landing drills on trampoline such as sticking the landing from saltos forwards and backwards and double saltos with and without twists, should be practiced. The gymnast needs to land properly every time, also in training. This should be taken further to the next level by practicing 'blind' landings' for kinaesthetic awareness. • Always focus on a good landing position even when doing basic skills and particularly, when landing on training surfaces such as foam rubber pits or soft landing mats. • Position knees together, feet slightly apart, arms parallel and strong and be ready to take one small step immediately rather than waiting and being forced to take a large step. If the skill is difficult, keep the arms as close as possible to the body which enhances the ability to make adjustments. • Always remember toes, fingers, hands, arms and posture at all times, not only in dismount and landing, but also in presentation. • Quality of dismount execution before landing. Insufficient training for difficult dismounts is detrimental to landing performance and a potential source of injury. • Physical fitness is important, for example, to have strong legs – in particular at the end of a routine. Develop more ankle flexibility, range of ankle flexion (dorsi-flexion).

- The head should ideally be straight in a neutral position or slightly forwards and flexed at the neck and spotting an object such as the floor or a wall. Visual cues for a gymnast are important by spotting the floor when performing back somersaults (backward rotations) or spotting a wall when performing forward somersaults (forward rotations).
- On forward landings, the gymnast can sense where he is and spot the wall or whatever other object is in front and above. All somersaults must be spotted and sensed (kinesthetic awareness).
- During landing, the arms should remain downwards, staying close to the body, strong and tight with no arm movement.
- The hips should generally be flexed at approximately 30 degrees. However, the higher the dismount, the more hip flexion is required to absorb impact velocity.
- The knees should be flexed according to the difficulty level and height (vertical displacement and velocity) of the dismount and flexibility of the gymnast, generally approximately 45 degrees, knees pressed together (for "strong" legs) and feet slightly apart as in a weightlifting set-up position with buttock out square and straight.
- In front landings, avoid landing on the heels as that will cause excessive forces to be transmitted into the lower back and may cause injury; back landings should be on toes and balls of the feet, dorsi-flexing in a controlled manner.
- The tempo of the landing should be fast but with control, for example, land, hold squat, and stand up in to a Y- position (0.5 seconds each). It depends on the complexity and difficulty of the dismount skill before the landing. The landing must absorb the energy by reducing all body momenta. It is rapid at first but slows down as the speed is decelerated coming to a final stop with hip, knees and ankle joints in a flexed position.
- At completion of the landing, the gymnast stands up to a still position. The gymnast should be upright with straight body alignment with arms sideward and head straight. This should be done in a confident manner, not too slowly. Presentation is very important and should be aesthetic and artistic. The gymnast remains stationary for several seconds to demonstrate control of the landing.

Additional considerations were:

- Floor landings are more difficult because of the springiness of the floor, landing a little short before the somersault is completely finished to absorb horizontal velocity.
- Horizontal bar landings require arm action to be 'stronger' and closer to the body with more hip and knee flexion because of greater vertical velocity.
- Other general points on successful landings were reported by the experts. These include: (a) focus on a good landing position even when doing basics, including during training; (b) land with knees pressed together, feet slightly apart, arms parallel and strong; (c) keep the arms as close as possible to the body if the skill is difficult. The ability to adjust body and segment position at an instant is essential; (d) be mindful of toes, fingers, hands and arms position and body posture at all times not only in dismount and landing but also in presentation; (e) gymnasts should develop their own landing strategies and technique that are progressive with gymnast's development; and (f) quality of dismount execution before landing is important. Insufficient training for difficult dismounts is detrimental to landing performance and a potential source of injury.

DISCUSSION

Our findings indicate that successful attainment of controlled competition landings is likely when efforts are made to achieve optimal release conditions, optimal rotational flight requirements, and optimal body segment coordination and timing during the landing phase. Accordingly, factors that must be considered when investigating the landing process include: competition landing technique, landing

strategies, body segment coordination, reduction of velocities, landing height, angular momentum, impact forces, reaction time and anticipation, balance, coordination, orientation, quickness, temporal and spatial parameters, proprioception and kinesthetic awareness, physical fitness, symmetry, postural adjustment before action, and sensory contribution, specifically during the landing.

The expert participants provided detailed descriptions concerning precise body and body segment positions as well as discrete and accurate actions from the moment of dismount release through to completion of the landing phase. This is congruent with Prassas et al. (2006) who indicated that biomechanics is well suited to examine, describe, develop and improve technique. Some of the experts' opinions have been reported in the extant literature but others are unreported.

Some of the similarities between the experts' opinions and the literature were: (a) landing performance such that there are no point deductions; body and segmental positioning; body stiffness at landing touch-down (Cuk & Marinsek, 2013); (b) high velocities and impact forces (Prassas et al., 2006); (c) safety issues and past injuries such as ankles or feet (Cuk & Marinsek, 2013); (d) mat properties (Brüggemann, 1990; Chapman, 2008; Perez et al., 2010); (e) environmental conditions, vision and spotting (Davlin, Sands, & Shultz, 2001; Luis & Tremblay, 2008); and (f) other factors such as the quality of landing surface, influence successful landing performance.

In order to implement corrective landing strategies, the gymnast may employ actions such as rotating the arms, using the transfer of angular momentum principle by transferring angular momentum from the body to the upper extremities, or excessively flexing the hips or knees to decrease the ground reaction force braking the body and subsequently increases the landing time (Prassas et al., 2006).

Some of the differences between the literature and the experts' opinions included: (a) a perfect landing position should be balanced from a stretched position with knees pressed together for 'strong' legs with feet slightly apart as in a weightlifter's 'set-up' position with buttocks out, body squarely aligned and straight, with the head straight in a neutral position and spotting an object; (b) at landing touch-down, the arms should be downwards, close to the body, with 'strong and tight' arms to absorb energy, in front and to counter rotation up or down; (c) once the rotation and linear motion ends, the gymnast stands erect with arms up about 30 degrees above horizontal and out sideways. The gymnast remains stationary for several seconds to demonstrate control of the landing; (d) presentation is important and should be aesthetic and artistically pleasing; (e) physical fitness and dismount skill readiness are important considerations, for example, 'strong' legs at the end of a routine; and (f) landing practice on the trampoline for aerial awareness is important for sticking landings from somersaults (saltos), both forwards and backwards, and double saltos, with and without twists. The gymnast needs to land properly every time, including in training when recovery practice from 'bad' landings should occur along with practicing 'blind' landings for kinaesthetic awareness.

Many of the expert participants had concerns about the prevalence of injuries during competition landings (Gittoes & Irwin, 2012). The risk of injuries and other safety concerns were considered to be issues by the experts, specifically the coaches and gymnasts. The experts commented that greater consideration should be given to improving landing technique due to the undue risk of injury during competition landings. In addition, gymnasts often carry overuse injuries that are not deemed serious enough to prevent training or competition but are serious enough to affect landing performance and may cause chronic damage to the body and segment joints in the longer term (Cuk & Marinsek, 2013). Other factors such as the quality of the landing surface and past injuries (especially to the ankles or feet) are likely to influence landing

performance. In order to "avoid asymmetric landing(s)", gymnasts need to attain sufficient height, generate higher angular momentum around the transverse and longitudinal axes, and have greater control of angular velocity about the longitudinal axis; but to achieve this, they must first "improve their motor abilities and technique" (ibid., p. 31). Over the long term, asymmetric landings can cause acute injuries in the ankles and knees or chronic injuries to the spine (ibid.). These statements are consistent with the experts' opinions on this issue. The most recent version of the Code of Points (FIG, 2015) has an additional focus on safety considerations during landings (see Article 9.2, Point 16 quoted above in the Introduction) but it remains to be seen how much impact this measure will have on reducing injuries sustained during competition landings.

CONCLUSION

This study reveals a tension in the execution of gymnastics landings in regard to aesthetic, execution and safety considerations. Traditionally, aesthetic considerations have predominated but this often leads to situations where gymnasts are injured or perform more conservatively because they are afraid of incurring point deductions. If the sport of artistic gymnastics takes steps to give added weight to safety considerations by reducing or abolishing point deductions for certain competition landing errors, it would enhance the evolution of more difficult, complex and novel dismounts. As the evolution of gymnastics evolves in terms of better landing mats, advances in medical science and improved sports science, it would be logical to encourage the evolution of skills by introducing a wider range of allowable landing strategies that do not incur point deductions.

The findings of this study indicate that greater consideration should be given to the risk of gymnasts sustaining permanent damage associated with deceleration injuries during the landing process. In order to reduce the risk of injury, recent changes to landings in the Code of Points for men's artistic gymnastics should be monitored for the incidence of injury (FIG, 2015). Further changes to landing requirements could include mandating a softer surface with more give in order to reduce the potential for ankle and Achilles tendon injuries. Accordingly, further research that harnesses the accrued knowledge of experts to identify optimal safety parameters for both training and competition landings is worthy of attention.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Associate Professor Margaret Baguley and Susan Wilson-Gahan (both University of Southern Queensland) for their support, and to Professor Stephan Riek (University of Queensland) for his assistance with interviews.

REFERENCES

Alp, A., & Brüggemann, G.-P. (1993). Biomechanische Analyse von Landematten im Geräteturnen (Biomechanical analysis of landing mats in gymnastics). In G-P. Brüggemann & J. K. Ruehl (Eds.), *Biomechanics in gymnastics: Conference proceedings* (pp. 259-270). Köln, Germany: Strauss.

Bogner, A., & Menz, W. (2009). The theory-generating expert interview: Epistemological interest, forms of knowledge, interaction. In A. Bogner, B. Littig, & W. Menz (Eds.), *Interviewing experts* (pp. 43-80). Basingstoke, Hants, UK: Palgrave Macmillan.

Brüggemann, G-P. (1990). A classification of gymnastics skills based on biomechanics. *Gymnastics Coach*, April/October, 25-28. Australian Gymnastic Federation.

Brüggemann, G-P., Cheetham, P. J., Alp, Y., & Arampatzis, D. (1994). Approach to a biomechanical profile of dismounts and release-regrasp skills of the

high bar. *Journal of Applied Biomechanics, 10*(3), 219-312.

Chapman, A. (2008). *Biomechanical analysis of fundamental human movements.* Champaign, IL: Human Kinetics.

Creswell, J. (2009). *Research design: Qualitative, quantitative and mixed method approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* St Leonards, NSW: Allen & Unwin.

Cuk, I., & Marinsek, M. (2013). Landing quality in artistic gymnastics is related to landing symmetry. *Biology of Sport, 30*(1), 29-33.

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, 5*(4), 337-346.

Fédération Internationale de Gymnastique (FIG). (2015). Code of Points for men's artistic gymnastics. Author. Retrieved from http://www.fig-gymnastics.com/publicdir/rules/files/mag/MAG%20CoP%202013-2016%20%28FRA%20ENG%20ESP%29%20July%202015.pdf

Fink, H. (2009). Fédération Internationale de Gymnastique (FIG) Academy for Artistic Gymnastics, Level 3 Coaches' Course MAG/WAG, Section 3, Australia.

Geiblinger, H. (2009). Tumbling through life … and expecting a safe landing: A narrative journey of an educational researcher. *Proceedings of 2009 Australian Association of Research in Education International Education Research Conference* (Nov 29-Dec 3), Canberra, ACT, Australia.

Geiblinger, H. (1998). Biomechanical perspectives of competition landings in gymnastics. Unpublished doctoral thesis, Victoria University, Melbourne, VIC.

Gervais, P. (1993). Calculation of reaction forces at the hands on the horizontal bar from position data. In International Society of Biomechanics (Eds.), *XIV International Congress on Biomechanics* (pp. 468-469). Paris: Author.

Gittoes, M. J. R., Irwin, G., & Kerwin, D. G. (2013). Kinematic landing strategy transference in backward rotating gymnastic dismounts. *Journal of Applied Biomechanics, 29*(3), 253-260.

Gittoes, M. J. R., & Irwin, G. (2012). Biomechanical approaches to understanding the potentially injurious demands of gymnastic-style impact landings. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy and Technology, 4*(4).

Kerwin, D. G., Yeadon, M. R., & Lee, S. C. (1990). Body configuration in multiple somersault high bar dismounts. *International Journal of Sport Biomechanics, 6*, 147-156.

Kerwin, D. G., Yeadon, M. R., & Harwood, M. J. (1993). High bar release in triple somersault dismounts. *Journal of Applied Biomechanics, 9*, 279-286.

Lees, A. (1981). Methods of impact absorption when landing from a jump. *Engineering in Medicine, 10*(4), 207-211.

Littig, B. (2009). Interviewing the elite – interviewing experts: Is there a difference? In A. Bogner, B. Littig, & W. Menz (Eds.) *Interviewing Experts*. (pp. 98-113). Basingstoke, Hants, UK: Palgrave Macmillan.

Luis, M., & Tremblay, L. (2008). Visual feedback use during a back tuck somersault: evidence for optimal visual feedback utilization. *Motor Control, 12*(3), 210-218.

Marinsek, M., & Cuk, I. (2010). Landing errors in the men's floor exercise are caused by flight characteristics. *Biology of Sport, 27*(2), 123-128.

McNitt-Gray, J. L., Hester, D. M. E., Mathiyakom, W., & Munkas, B. A. (2001). Mechanical demand and multi-joint control during landing depend on orientation of the body segments relative to the reaction force. *Journal of Biomechanics, 34*, 1471-1482.

McNitt-Gray, J. L., Requejo, P. S., Flashner, H. & Boni, H. (2004). Multi-joint control of momentum balance during landing on gymnastics mats. In M. Hubbard, R. Mehta, and J. Pallis (eds.), *The*

Engineering of Sport (pp. 421-427). Sheffield, UK: ISEA.

McNitt-Gray, J. L., Yokoi, T., & Millward, C. (1994). Landing strategies used by gymnasts on different surfaces. *Journal of Applied Biomechanics*, 10, 237-252.

Nigg, B. M. (1985). Biomechanics, load analysis and sport injuries in the lower extremities. *Sports Medicine, 2*, 367-379.

Perez, P., Llana, S., Klapsing, G. M., Perez, J. A., Cortell, J. M., & Van Den Tillaar, R. (2010). Effects of mat characteristics on plantar pressure patterns and perceived mat properties during landing in gymnastics. *Sports Biomechanics, 9*(4), 245-257.

Prassas, S., Young-Hoo, K., & Sands, W. (2006). Biomechanical research in artistic gymnastics: A review. *Journal of Sports Biomechanics, 5*(2), 261-291.

Requejo, P. S., McNitt, J. L., & Flashner, H. (2004). Modification of landing conditions at contact via flight phase control. *Biological Cybernetics, 90*, 327–336.

Sheets, A., & Hubbard, M. (2007). A dynamic approximation of balanced gymnastics landings. *Sports Engineering, 10*(4) 209-220.

Takei, Y., Nohara, H. & Kamimura, M. (1992). Techniques used by elite gymnasts in the 1992 Olympic compulsory dismount from the horizontal bar. *International Journal of Sports Biomechanics, 8*, 207-232.

Takei, Y., & Dunn, J. H. (1997). A 'kickout' double salto backward tucked dismount from the horizontal bar performed by elite gymnasts. *Journal of Sports Sciences, 15*, 411-42.

Corresponding author:

Helmut Geiblinger
University of Southern Queensland - School of Linguistics, Adult and Specialist Education
Sinnathamby Boulevard
Springfield, QLD 4300
Brisbane Queensland 4300
Australia
T: +61 7 3470 4320
F: +61 7 3470 4301
E-Mail: geibling@usq.edu.au

RELATIONSHIP BETWEEN SWALLOW, SUPPORT SCALE AND IRON CROSS ON RINGS AND THEIR SPECIFIC PRECONDITIONING STRENGTHENING EXERCISES

Klaus Hübner, Christoph Schärer

Swiss Federal Institute of Sports, Magglingen, Switzerland

Original article

Abstract

International men's gymnastics has evolved rapidly on all six apparatus. On rings, strength elements are primarily determining. Various preconditioning strengthening exercises are performed routinely in training. However, the relationship between these exercises and the strength elements on rings, which would be of interest for coaches, are not well studied. The objective of this study was to investigate the correlation between strength in seven preconditioning exercises and performance of three important hold elements: Swallow, Support Scale and Iron Cross. Ten male gymnasts of the Swiss national team performed a 1RM test for each of the seven strength exercises and a maximum static hold of the strength elements on rings. A significant correlation was observed only between Swallow with the preconditioning exercises Swallow supine position (r: 0.71, p: 0.031) and Bench press (r: 0.71, p: 0.046); as well as between Support Scale and Swallow supine position (r: 0.69, p: 0.039). Iron Cross correlated highest with the Cross belt (r: 0.66, p: 0.051) and Bench press (r: 0.67, p: 0.069). Further, it was observed that a minimal 1RM of 73.4% body weight is needed for the exercise Swallow supine position in order to complete a hold of the element Swallow on rings. For execution of the element Support Scale, a 1RM of 67.4% body weight for the exercise Swallow supine position is needed.

Keywords*:Gymnastics, 1RM, Swallow, Support Scale, Iron Cross.*

INTRODUCTION

In the past few years, men's gymnastics has evolved immensely. On all six apparatus, acrobatic elements are constantly becoming more spectacular; however, on rings, strength elements play the most important role (FIG, 2013). These strength elements are divided into hold elements that need to be held for at least 2 seconds (isometric muscle contractions) and different forms of lifting (concentric muscle contractions) and lowering (eccentric muscle contractions) (Dunlavy, 2007).

These elements require a high level of strength and in order to learn them, athletes employ facilitated versions of the actual elements on the rings (by being supported by the coach or using a pulley system which reduces the athlete's body weight) and by performing preconditioning strengthening exercises to achieve the optimal physical condition for the elements.

On the one hand, these preconditioning strengthening exercises should be closely related (Colombo, 1994; Starischka, 1978) to the actual element on rings and induce a large enough training stimulus. On the other hand, they should not be overly strenuous on the athlete's body, by producing large levers or joint torques.

While there are many preconditioning strengthening exercises for the elements swallow (S), support scale (SS) and iron cross (C), some of these cause pain for the athletes. In order to optimize an athlete's training, only effective exercises should be used for preparation. Hence, it is important to know which exercises have the greatest correlation with success on the respective elements on rings.

Unfortunately, the relationship between strength in the commonly used preconditioning strengthening exercises and for the ring elements has thus far not been studied. However, knowledge about such relationships could be interesting and helpful for coaches.

The aim of this study is to analyze the commonly used preconditioning strengthening exercises for the elements S, SS and C on rings and their actual effect on the execution of the elements on rings. Seven commonly used preconditioning strengthening exercises were selected and their effectiveness on the elements as well as their tolerability on the human body were investigated.

Main question is how strong is the relationship between the elements Swallow, Support Scale and Iron Cross on rings and the selected preconditioning strengthening exercises (Swallow supine position (S_{sup}), Swallow supine position-anteversion ($S_{sup\ ant}$), Swallow Machine (S_{mach}), Support Scale Stand (SS_{stand}), Cross Machine (C_{mach}), Cross Belt (C_{belt})and Bench-press (BP))?

We hypothesized that, due to similarities in body position, Swallow and Support Scale would correlate well with S_{sup}, $S_{sup\ ant}$ and S_{mach} and that Iron Cross would correlate well with C_{mach} and C_{belt}.

METHODS

Experimental Approach to the Problem

The study was designed to compare the performance of three important elements on rings with their respective preconditioning strengthening exercises. Three elements, S, SS and C, along with the preconditioning strengthening exercises S_{sup}, $S_{sup\ ant}$, S_{mach}, SS_{stand}, C_{mach}, C_{belt} and BP were investigated. The elements and exercises are explained more closely below. All preconditioning exercises are designed to train all three elements on Rings.

Subjects

All top-level male athletes in the Swiss national team who were not injured or suffering from pain in the upper extremities or back voluntarily took part in the study (n=10). Athletes were informed about all study procedures, which were approved by an ethics committee. Their age, height and body mass were 21.5 ± 2.5 years, 168.6 ± 4.5 cm and 65.0 ± 5.0 kg.

Procedures

The study was conducted on two separate days, with a two-day break in between. On the first day, subjects performed the elements S, SS and C on rings in a randomized order. Three days later the subjects performed with a 1RM-Test maximal single repetitions of the preconditioning strengthening exercises (S_{sup}, $S_{sup\ ant}$, S_{mach}, SS_{stand}, C_{mach}, C_{belt} and BP), also in a randomized order. Athletes' performance of S and SS were filmed from the side (camera at ring height), and C was filmed from the front, in order to evaluate execution.

The three rings elements were carried out with a special pulley-system, where the athlete's body weight can be increased by additional weight or decreased by a counterweight. If the athlete was able to hold the position for longer than three seconds they repeated the element with less counterweight or more additional weight, until they could just manage to hold the element for three seconds, which was the required duration for a valid hold. The real holding time was measured (by Video frames) from the moment that a correct, stable position had been reached until the athlete deviated from the hold position by more than 45°, as shown in figure 1 below. Athletes had a maximum of three attempts.

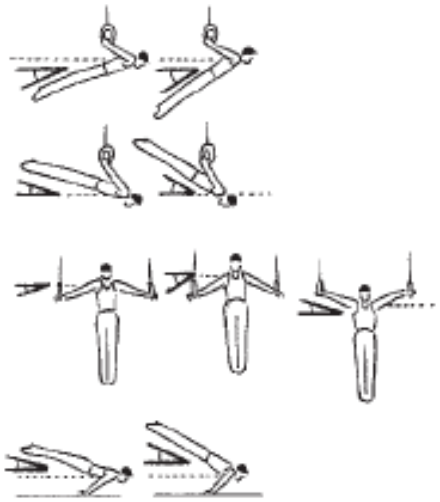


Figure 1. Deviation from the correct hold position was deemed and time stopped if these angles increased beyond 45° (FIG, 2013, p. 29).

For the preconditioning strengthening exercises, athletes had a maximum of three attempts to perform a correct repetition with the highest possible resistance (one week before, all subjects performed a preliminary test to determine their approximate 1 RM. This helped to minimize the number of attempts needed to achieve the true 1 RM in the actual trial). After each successful attempt, the load was increased with at least 2.5 kg (rest > 5 min).

Exercises were executed as follows:

Swallow supine position (figure 2 and 3)

- Material: bench, 15-kg barbell, weights.
- Starting position: supine on the bench, with the hands positioned on the bar one hand-width wider than the shoulders.
- Execution: flex shoulders lifting the bar vertically until arms are vertical (90 degrees) while maintaining contact with the bench with the back and head at all times.

Figure 2. Swallow supine position: starting position.

Figure 3. Swallow supine position: end position.

Swallow supine position, Anteversion (figure 4 and 5)

- Material: bench, at least 100 cm above the floor, weights, 10-kg barbell, two cables (16 cm in length) connecting the rings to the bar, 41cm from the center of the bar.
- Starting position: supine position with arms extended at 90 degrees holding the rings.
- Execution: flex the shoulders lifting the rings until the bar makes contact with the bench while maintaining contact with

the bench with the back and head at all times.

Figure 4. Swallow supine position anteversion: starting position.

Figure 5. Swallow supine position anteversion: end position.

Swallow Machine (figure 6 and 7)

- Material: double cable-pull (two independent overhead pulleys) with ring attachments, three benches stacked on top of one another (total height 107 cm), 10 cm away from the machine.
- Starting position: prone on the bench, chin in contact with the bench, head not extend past the edge of the bench, arms extended behind the back.
- Execution: flex the shoulders pulling the rings downward while keeping the rings as close to the hips as possible until arms are vertical (90 degrees).

Support scale stand (figure 8 and 9)

- Material: wall, barbell and weights.
- Starting position: Standing with the back against the wall, bar held at shoulder width with a supine grip, feet one foot-length from the wall.
- Execution: Keeping the arms straight, flex shoulders lifting the bar until the arms are completely vertical and the bar is over the head, while maintaining contact to the wall with shoulders, head and lower back at all times.

Figure 6. Swallow machine: starting position.

Figure 7. Swallow machine: end position.

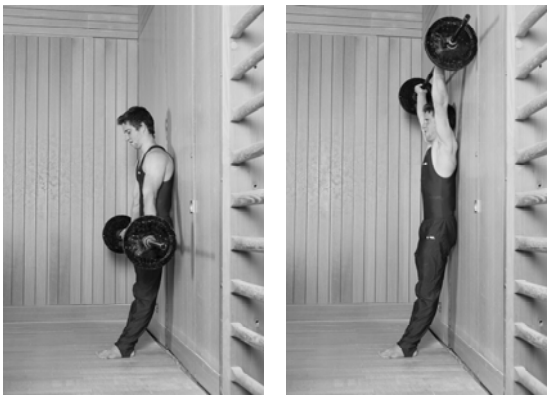


Figure 8, 9. Support scale stand: starting position, ending position.

Cross Machine (figure 10 and 11)

- Material: double cable-pull machine (two independent overhead pulleys) with ring attachments, 2 benches stacked on top of one another, placed as close as possible to the machine, with a 10-20 cm long mat on top.
- Starting position: sitting on the bench, with the arms abducted horizontally, and legs squeezing the bench (squeezing the bench with the legs is necessary to prevent the body from lifting during lifts with heavy loads.).
- Execution: adduct the arms pulling the rings downward towards the side of the body until arms are vertical (90 degrees).

Figure 10, 11. Cross machine: starting position, end position.

Cross Belt (figure 12)

- Material: rings, belt, loaded with additional weight or linked over pulley to counterweight (Bernasconi et al, 2006).
- Starting position: support sink.
- Execution: lower body into the cross position, hold for 2 s, lift body back into support sink position with straight arms.

Figure 12. Cross belt.

Bench press (figure 13 and 14)

- Material: Bench, barbell, weights.
- Starting position: supine on the bench, barbell held above chest with extended arms.
- Execution: gradually lower the bar until the elbows reach 90 degrees, await signal from coach, push the bar up until the arms are straight.
-

Figure 13. Bench press: starting and end position.

Figure 14. Bench press: mid position.

Statistical Analyses

Descriptive statistics were run on all variables. Because of the small n, as often seen in investigation with elite athletes, Spearman's rho was used to assess correlations between hold elements and exercises. Correlation significance of was set to $p<0.05$. All statistics were performed using SPSS 22 software (SPSS, Inc., Chicago, IL).

RESULTS

Descriptive data from anthropometric measures, preconditioning exercises and rings elements are shown in tables 1 and 2. Table 2 displays the achieved weights, as well as the effective holding times, as not all subject achieved a holding time of 3 s exactly.

All athletes could perform C on rings, whereas only three managed to perform SS and only one could perform S, the most difficult element. The required holding time of 3 s was reached in most cases; thus, the calculations refer here forth only to the resistance (counterweight or additional weight) used for the elements.

Spearman correlation and significance between maximal resistance (counterweight or additional weight) for the elements S, SS and C on Rings and the 1 RM for preconditioning exercises is described in table 3.

Table 1

Anthropometric data of the subject pool and 1 RM of the preconditioning exercises Swallow supine position, swallow supine position – anteversion, Swallow Machine, Support Scale Stand, Cross Machine, Cross Belt and Bench-press in kg (n=10).

Athlet	Age	Body mass	Height	Swallow supine position	Swallow supine position anteversion	Swallow machine	Support scale stand	Cross machine	Cross belt	Bench press
		(kg)	(cm)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
1	20.9	65.0	168.1	35.0	25.0	34.5	23.0	52.0	-12.5	105.0
2	27.0	68.2	168.9	40.0	40.0	49.0	25.5	54.0	-7.5	130.0
3	20.7	61.4	170	32.5	35.0	42.0	23.0	49.0	-10.0	
4	21.6	62.6	162.5	35.0	32.5	39.5	25.5	51.0	-10.0	107.5
5	22.8	66.0	167.1	45.0	35.0	44.5	25.5	67.5	1.0	130.0
6	23.7	65.1	174.5	35.0	35.0	42.0	25.5	56.0	-5.0	95.0
7	19.3	74.4	174.1				25.5			
8	20.6	55.9	160.3	40.0	35.0	39.5	23.0	56.0	-5.0	115.0
9	19.5	62.0	169.8	22.5	22.5	27.0	20.5	44.0	-11.3	95.0
10	18.4	69.3	170.2	37.5	35.0	46.5	18.0	51.0	-7.5	120.0
Mean	21.5	65.0	168.6	35.8	32.8	40.5	23.5	53.4	-7.5	112.2
SD	2.5	5.0	4.5	6.3	5.5	6.6	2.6	6.5	4.1	14.0

Table 2

Achieved weights (counterweight or additional weight) in kg and holding times in s for the elements Swallow, Support Scale and Cross on Rings (n=10).

Athlet	Swallow		Support Scale		Cross	
	weight 3"	time 3"	weight 3"	time 3"	weight 3"	time 3"
1	-17.5	3.3	-10.0	3.6	0.0	3.1
2	-7.5	3.7	-8.8	3.6	3.0	2.3
3	-11.3	1.5	-7.5	3.1	6.0	2.5
4	-7.5	4.3	0.0	3.6	4.0	3.8
5	-7.5	3.7	1.0	2.9	8.0	3.9
6	-17.5	4.2	-10.0	2.8	1.0	3.0
7			-5.0	2.2		
8	0.0	3.1	1.0	3.6	7.0	3.5
9	-25.0	3.9	-17.5	3.1	0.0	3.5
10	-12.5	3.4	-5.0	2.2	1.0	3.0
Mean	-11.8	3.5	-6.2	3.1	3.3	3.2
SD	7.4	0.8	5.9	0.5	3.1	0.6

Table 3

Spearman correlation (r) and significance (p) between maximal resistance (counterweight or additional weight) for the elements Swallow, Support Scale and Iron Cross on Rings and the 1 RM for preconditioning exercises Swallow supine position, Swallow supine position – anteversion, Swallow Machine, Support Scale Stand, Cross Machine, Cross Belt and Bench-press (n=9).

		Swallow supine position	Swallow supine position – anteversion	Swallow Machine	Support Scale Stand	Cross Machine	Cross Belt	Bench-press
Swallow weight 3s	r	0.71*	0.56	0.38	0.42	0.48	0.54	0.71*
	p	0.031	0.117	0.31	0.259	0.186	0.134	0.046
Support Scale weight 3s	r	0.69*	0.39	0.34	0.24	0.46	0.60	0.7
	p	0.039	0.304	0.372	0.508	0.215	0.085	0.056
Iron Cross weight 3s	r	0.58	0.52	0.38	0.42	0.48	0.66	0.67
	p	0.099	0.147	0.317	0.255	0.188	0.051	0.069

* Significant at the 5% level ($p<0.05$)

Table 4

Spearman Correlation (r) and significance of the maximal strength (counter or additional weight, hold time 3 s) for three elements on Rings Swallow, Support Scale and Iron Cross (n=9).

		Swallow weight 3s	Support Scale weight 3s	Iron Cross weight 3s
Swallow weight 3s	r		0.87**	0.86**
	p		0.002	0.003
Support Scale weight 3s	r	0.87**		0.87**
	p	0.002		0.002
Iron Cross weight 3s	r	0.86**	0.87**	
	p	0.003	0.002	

** Significant at the level of $p < 0.01$

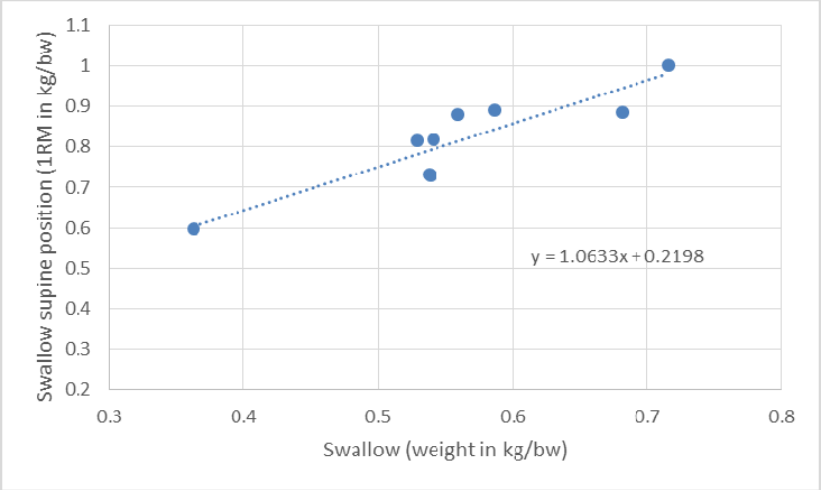


Figure 15. Correlation between maximal resistances for the preconditioning exercise Swallow supine position (1RM) and the element Swallow on rings (hold time 3 s). Both values are normalized to body weight (n=9).

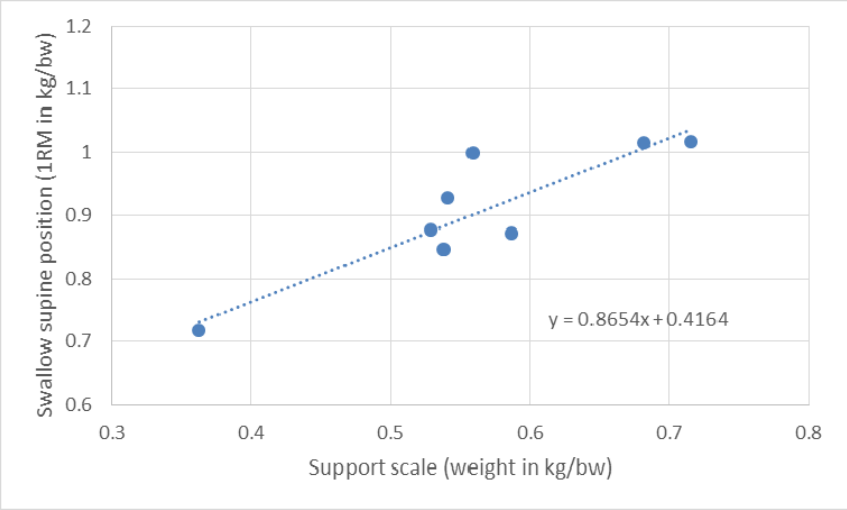


Figure 16. Correlation between maximal resistances for the preconditioning exercise Swallow supine position and the element Support Scale on rings (hold time 3 s). Both values are normalized to body weight (n=9).

The correlation between relative maximal resistance in the preconditioning exercise S_{sup} and the element S on Rings is depicted in figure 15. According to this correlation, the maximal resistance for S (holding time 3 s) can be calculated. Namely, it suggests that an athlete must have a 1RM for the exercise S_{sup} of 73.4% of body weight in order to successfully perform S on rings.

Conducting the same analysis for the element SS on Rings figure 16, the results suggest that a minimum 1RM of 67.4% of body weight (S_{sup}) is required.

Correlations between the three elements on rings (table 4) revealed strong relationships.

Body weight did not correlate with the maximal resistance for elements on Rings and their preconditioning exercises. Body size correlated with maximal resistance only for the element S (r: -0.69, p: 0.04), whereas age correlated only with the preconditioning exercise SS_{stand} (r: 0.69, p: 0.028).

DISCUSSION

Significant correlations were only observed between S and the preconditioning exercises S_{sup} (r: 0.71, p: 0.031) and BP (r: 0.71, p: 0.046); and between SS and S_{sup} (r: 0.69, p: 0.039). C had the highest correlation (but not significant) with the C_{belt} (r: 0.66, p: 0.051) and Bench press (r: 0.67, p: 0.069).

The hypothesis that the ring strength correlates well with the exercises of nearly identical body position could only partially be confirmed (S_{sup} with S and SS; C_{belt} tend to correlate with C). A possible cause for the lower correlations with the preconditioning strengthening exercise $S_{sup\ ant}$ is that athletes tended to associate pain or inflammation with this exercise in daily training.

Other than the nearly identical body position, another reason for the very high correlation between the exercises S_{sup} and the S on Rings is that the athlete's body weight stabilizes the scapula between the thoracic wall and the bench (Bernasconi et al, 2013). The low correlation between the preconditioning exercise SS_{stand} and the elements on Rings is probably due to the standing position which makes it possible for athletes to create an impulse to lift the dumbbells using their legs. This impulse however cannot be created during the exercise on Rings. The strong correlations between the bench press exercise and all three ring strength elements (though only one was significant) were surprising, since bench press is rather unspecific at first glance. However, the importance of the

pectoral muscles for the holding elements on rings could help explain these relationships.

Altogether, the preconditioning strengthening exercises S_{sup}, BD and C_{belt} (and perhaps C as well) appear to be useful as preparatory exercises for the three elements S, SS and C on Rings.

The correlation calculations yielded equations which can be used to determine minimum 1RM values needed to be achieved on the preconditioning exercises in order to be able to hold the elements on Rings. These values should only be used as guidelines because other factors, such as body structure/lever ratio and coordinative skills (sense of position), may influence these values slightly. Traditionally, according to the French training practice, 75% of the athlete's body weight needs to be moved in the preconditioning exercise S_{sup} in order for the athlete to be able to hold the element S on Rings. This value is very close to the 73.4% being predicted by the equations from the correlation calculations. Gorosito (2013) found that 60% of body weight needs to be moved in a similar (starting position) isometric maximal strength test using dumbbells, in order to be able to hold the element S on Rings. These minimum values are useful objectives to be used for training practice.

The very high correlation between the elements on rings is not surprising, since the movement execution between the elements S and SS are very similar, and certain characteristics (lever relation, specialization on rings) have similar influence on all strength elements on Rings. Similarities include the starting position and general muscle activity.

From an ethical health-conscious standpoint, is fortunate that body weight does not correlate with strength elements on Rings (similar results were found in a study about S on Rings by Bango, Sillero-Quintana & Grande (2013)) and the preconditioning strengthening exercises and that body size only correlated with the element S on rings. In our subjects, age did not correlate with ring strength, which is contrary to the findings of (Bango, 2013). One reason could be the more homogenous performance level of our subjects.

From a methodological standpoint, the use of video for determining the arm-torso angle during the ring elements reduced the measurement error that can arise with subjective assessments (Dallas, 2011; Plessner & Schallies, 2005). The 1RM testing (especially bench press) is a reliable measurement for upper body strength (Seo et al, 2012; Augustsson & Svantesson, 2013; Taylor & Brandy, 2005).

This study was conducted with all 10 top-level athletes from the Swiss national team. Nonetheless, follow-up studies using a larger cohort, where all athletes are able to conduct these difficult elements on Rings, would be of interest. Additional, a training intervention study analyzing the effects of these preconditioning strengthening exercises on ring strength over a certain time span would be interesting.

CONCLUSIONS

In summary, it can be concluded that:

- The high correlations between the preconditioning strengthening exercises S_{sup} and BP with the elements S, SS and C on Rings confirm the usefulness of these training exercises.
- The equations can be used to predict a minimal value needed in the 1RM for all preconditioning exercises, which are important for the training process. For the preconditioning exercise with the highest correlation (S_{sup}) to the strength element on Rings, a minimal 1RM of 73.4% of body weight is needed in order to be able to hold the element S on Rings for the required 3 s. The corresponding value for SS on Rings is a minimal 1RM 67.4% of body weight of the S_{sup}.

REFERENCES

Fédération Internationale de Gymnastique (FIG). (2013). *Code de pointage 2013-2016.* Lausanne: FIG.

Dunlavy, J. K., Sands, W.A., McNeal, J.R., Stone, M.H., Smith, S.L., Jemni, M., & Haff, G.G. (2007). Strength performance assessment in a simulated men's gymnastics still rings gross. *Journal of Sports Science and Medicine, 6*, 93-97.

Colombo, C. (1994). L'entraînement de la Force. *Gym Technic FFG, 9*, 22-29

Starischka, S. (1978). Überlegungen zur Erstellung disziplinspezifischer Krafttrainingsprogramme im Kunstturnen. *Leistungssport, 8*(5), 405-411.

Bernasconi, S. M., Tordi, N.R., Parratte, B.M., Rouillon, J.-D., & Monnier, G.G. (2006). Effects of Two Devices on the Surface Electromyography Responses of Eleven Shoulder Muscles During Azarian in Gymnastics. *Journal of Strength and Conditioning Research, 20*(1), 53-57.

Bernasconi, S. M., Tordi, N.R., Parratte, B.M., & Rouillon, J.-D. (2009). Can Shoulder Muscle Coordination During the Support Scale at Ring Height be Replicated During Training Exercises in Gymnastics? *Journal of Strength and Conditioning Research, 23*(8), 2381-2388.

Gorosito, M. A. (2013). Relative Strength Requirement for Swallow Element Proper Execution: A Predictive Test. *Science of Gymnastics Journal, 5*(3), 59-67.

Bango, B., Sillero-Quintana, M. & Grande, I. (2013). New Tool To Assess The Force Production In The swallow. *Science of Gymnastics Journal 5*(3), 47-58.

Dallas, G., Mavidis, A., & Chairopoulou, C. (2011). Influence of Angle of View on Judges' Evaluations of inverted Cross in Men's Rings. *Perceptual and Motor Skills, 112*, 109-121.

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

Seo, D., Kim, E., Fahs, C. A., Rossow, L., Young, K., Ferguson, S.L., Thiebaud, R., Sherk, V.D., Loenneke, J.P., Kim, D., Lee, M., Choi, K., Bemben, D.A., Bemben, M.G., & So, W. (2012). Reliability of the one-repetition maximum test based on muscle group and gender. *Journal of Sports Science and Medicine, 11*, 221-225.

Augustsson, S.R., & Svantesson, U. (2013). Reliability of the 1 RM bench press and squat in young woman. *European Journal of Physiotherapy, 15*, 118-126.

Taylor, J.D., & Bandy, W.D. (2005). Intrarater Reliability of 1 Repetition Maximum Estimation in Determining Shoulder Internal Rotation Muscle Strength Performance. *Journal of Strength and Conditioning Research, 19*(1), 163-168.

.

Corresponding author:

Klaus Hübner
Swiss Federal Institute of Sports, Magglingen, Switzerland
2532 Magglingen Magglingen 2532 Switzerland
T: +41 58 46 76 121
E-Mail: klaus.huebner@baspo.admin.ch

CAN MINIATURE ACCELEROMETERS ATTACHED TO THE GYMNASTICS SPRINGBOARD BE USED FOR TAKE-OFF ANALYSIS?

Dejan Križaj[1] & Ivan Čuk[2]

[1]Faculty of Electrical Engineering, University of Ljubljana, Slovenia
[2]Faculty of Sport, University of Ljubljana, Slovenia

Original article

Abstract

An investigation of metric characteristic of a device for measuring vault characteristics during the jump on and take-off from the springboard using a miniature Micro-Electro-Mechanical (MEMS) type accelerometer(s) attached onto the springboard is presented. The measured acceleration is integrated once to obtain the velocity of the springboard during the jump and integrated twice to obtain the springboard displacement. Due to several sources of noise the measured signals were filtered using a Butterworth filter of fourth order with a cut off frequency of 250 Hz and a moving average filter. Several parameters of the jump were extracted from the filtered data such as time to maximal springboard compression, maximal positive and negative velocities and times to achieve these velocities. The obtained parameters are evaluated for their variability and reliability by comparing them to the data obtained by a reference high precision laser sensor measuring springboard displacement. The measurement technique is capable of determining several relevant parameters of the springboard usage with an accuracy of less than 5.3 % for all evaluated parameters except for maximal positive velocity for which an error up to 15.3 % has been obtained. Analysis of 43 jumps of single gymnast proved the reliability of the extracted parameters. MEMS accelerometers can thus be used for analysis of the take-off from the springboard taking into account appropriate filtering of the data is performed before extraction of some parameters that are relevant for the analysis.

Keywords*: metric characteristics, reliability, variability, vault.*

INTRODUCTION

Vault is an artistic gymnastics discipline used by both men and women gymnasts (FIG, 2012a, FIG, 2012b, Dolenec, Čuk, Karacsony, Bricelj, & Čoh, 2006, Ferkolj, 2010). The vault is typically composed of seven phases: runway, jump on the board, take-off from the board, the first flight, support phase, the second flight and the landing (Čuk et al., 2011). During runway the gymnast gains momentum for the vault and with a jump onto the springboard prepares for a change of mostly horizontal linear momentum into a linear horizontal and vertical and rotational (around longitudinal and sagittal axis) momentum. Given that the gymnast cannot

significantly change basic parameters of the vault after the take-off, proper gymnast action on the springboard is essential (Dolenec et al., 2006). The gymnast's action on the springboard can be divided into two phases: the first phase in which the gymnast is pressing the springboard from the normal position down to the most compressed position, and the second phase in which the springboard expands back toward its normal position (Čuk & Karacsony, 2004). The time of the gymnast spends on the springboard is short (less than 200 ms) and cannot easily be analyzed in detail by visual observation alone (Atiković & Smajlović, 2011). The most important is the impulse force on the springboard (which is in phase with springboard pressure and displacement) which is defined as product of time and force: $I = Ft = amt = vt^{-1}mt = vm$. As mass is known, the velocity is the main ammount to be evaluated. By determining the proper velocity of the springboard it is possible to analyze springboard behaviour in detail (e.g., time of compression and decompression, length of compression) (Čuk & Karacsony, 2004). According to Ferkolj (2010), one of the most difficult jumps is handspring forward with double salto forward tucked having maximum vertical velocity of about 4.7m/s at the take off. If we presume contact time on springboard of about 200 ms, and if we take 100 ms as the time for take off after maximum springboard compression a 5g accelerometer would be efficient for all women vaults and men vaults up to the handspring double salto forward tuck.

There is a constant need for development of new and/or improved measurement techniques, methods and devices that can improve our understanding and improvement of sport techniques. Several methods and technologies can be used to analyze the vault characteristics. Typically, a video system is used analyze fast movements in slow motion (Sands, Smith, & Piacentini, 2010). High-speed cameras easily achieve speeds of 400 frames/sec which is sufficient to analyze the vault phases in detail (Sands, Smith, & Piacentini, 2010). A drawback of using video is the relatively complicated setup (proper positioning of the camera, light sensitivity, etc.) and a need for complex data processing. On the other hand, an advantage of video systems is the capability of visual evaluation and processing of all phases of the jump not only those depending on the positioning of a particular sensor. Additional information can be gained by using various transducers for displacement, force, velocity, rotation (Marinšek & Slana, 2014) or acceleration. Each of those transducers has some advantages as well as limitations. A force plate is frequently used in biomechanical investigations (Greenwood & Newton, 1996, Pérez et al., 2008, Seeley & Bressel, 2005). Its advantage is well documented usage enabling precise determination of the force pressed to the plate. Some experiments have been performed with electromechanical films; however, the price and complexity of the system preclude more general use of the system (Keränen et al., 2008). In presented investigation, miniature accelerometers were used for evaluation of springboard movement. Nowadays, they are mostly manufactured with Micro-Electro-Mechanical (MEMS) technology making them very small in size and light in weight. Due to the use of semiconductor technology the chips tend to be low cost and therefore suitable for use in mass production devices. Use of miniature accelerometers for movement analysis has been proposed in several studies (James et al., 2004, Kavanagh & Menz, 2008, Pober et al., 2006, Ward et al., 2005, Žagar & Križaj, 2005). One of the disadvantages of accelerometers is that they measure acceleration relative to their position. When an accelerometer is moving together with the object, reliable and precise determination of their position in time presents considerable technical challenges. To reconstruct the correct position of the device it is often necessary to use additional transducers (such as gyroscopes)

which measure angular velocity. Some errors in velocity and position determination may occur due to several possible sources of noise. Intrinsic noise is due to the movement of miniature masses inside the accelerometer and incorporated electronics while a discretization error is due to conversion of an analog signal to a digital one. These errors contribute most when the data from measured acceleration are integrated to obtain the velocity and displacement parameters (Žagar & Krizaj, 2005) but can be reduced by usage of suitable accelerometers, proper electronics designs and filtering (Čuk et al., 2011, Preece et al., 2009, Žagar & Krizaj, 2005).

All measurement methods must have appropriate metric characteristics, including validity, reliability, variability and objectivity. Validity checks if the measured characteristics correspond to the actual objective, reliability verifies whether repeated measurements of the same characteristics yield the same results and variability evaluates how different participants can be distinguished from the results of the measurements. Objectivity verifies the measurement results do not depend on the subject (person) performing the measurements (Cozby, 2009).

This report presents an investigation of vault characteristics during the jump and takeoff from the springboard using miniature accelerometer(s) attached onto the springboard. The accelerometer measures acceleration (also gravitational) that is converted to velocity by time integration and measures springboard's displacement through velocity integration. Thereby other important parameters of the jump and takeoff, such as time to reach minimum, maximum and zero vertical springboard velocity, the minimal and maximal springboard velocity and the maximal vertical displacement of the springboard, can be obtained. These metrics are evaluated by comparing the measurements and processed parameters obtained from accelerometers with those obtained from a precision laser displacement sensor.

METHODS

A device (named SkoCi) dedicated for evaluation of springboard movements based on miniature accelerometers was designed and developed (Figure 1). The device is based on a Phillips ARM7 processor which enables low power design and large computational power. It uses ADXL family MEMS type accelerometers from Analog Devices (www.analog.com) which are known to be very reliable and accurate (Kavanagh & Menz, 2008, Žagar & Križaj, 2005). In this investigation a 5g, two axes accelerometer chip ADXL305 was used. The developed device is capable of measuring four signals simultaneously at a frequency of 1000 Hz. In the described experiment two signals were measured: one from the accelerometer for measuring vertical acceleration and one from a reference laser distance meter for measuring the springboard displacement. Measuring the two signals simultaneously with the same device reduced the problems of time synchronization which is often difficult when the signals are measured with different equipment having different sampling rates. Springboard displacement was measured with a laser sensor RF603 from Riftek (www.riftek.com) which uses optical triangulation for precision distance measurements. Laser measurements are due to their reliability often used for evaluation of other measurement devices such as accelerometers (Cheol-Hwan et al., 2012, Gioffre et al, 2000). During measurements the laser sensor pointed directly onto the miniature box containing an accelerometer chip with associated electronics. In our experiments, a sensor with a measurement range of 25 cm and resolution 25 μm or of 0.01% of the measurement range for a digital output was used.

Figure 1. Device (named SkoCi) with an acceleration sensor (visible on Figure 2).

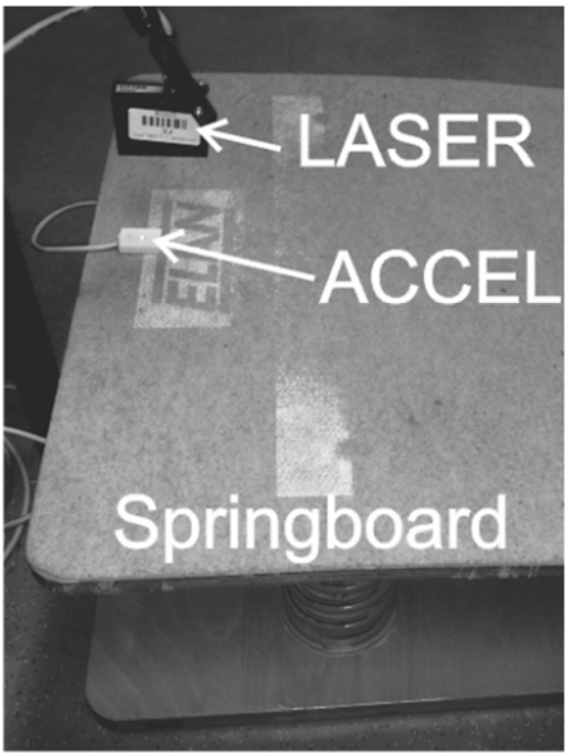


Figure 2. Measurement setup - an optical laser sensor placed directly above the acceleration sensor and pointing a laser beam onto the acceleration sensor.

The measurement setup is presented in Figure 2. The accelerometer chip is assembled on a small PCB plate with some additional elements for proper operation and enclosed in a small box filled and sealed with a two-component epoxy glue. This eliminates any unwanted vibrations of the chip inside the box. Although in practice the acceleration sensor is placed under the top plate of the springboard, in the presented investigation it was placed on top of it (e.g. Figure 2). This enabled exact positioning of the sensor and the laser so that the laser pointed directly onto the middle of the box containing an acceleration sensor, assuring that the accelerometer and the laser measure the same movements and the measurement results can be directly compared. The springboard we used for the experiment is flat from 10 cm before the long wide line and from left to right side to the end. The ideal place for take-off is with feet fingers on the line. As we needed to leave also some space for the take-off of a gymnast the selected accelerometer position shown in Figure 2 was chosen.

43 jumps onto the springboard from one participant (with informed consent; the research was approved by the institutional review board in accordance with Helsinki declaration) were performed in the laboratory conditions. The aim was not to distinguish between different jumps but to identify if the accelerometer can be used to reproduce the lasers's velocity profile of the jump onto the springboard. For this purpose a single participant was sufficient. Participant was 175 cm tall and 83 kg weight. The jumps were designed to be as similar as in the gym pool, with a short runway of 2-3 steps, one leg take-off from the floor, jump onto the springboard and take-off with landing on the floor. Immediately after the jump onto a springboard the SkoCi device (automatically) acquired measured acceleration of the springboard in the vertical direction and simultaneously measured the displacement of the board from the rest position using the laser sensor. The obtained data was gathered from the SkoCi by a personal computer and further processed by Matlab (ver. 7.4; Mathworks, www.mathworks.com). Raw measured data were used for data processing. The acceleration data were scaled and filtered using a Butterworth filter of fourth order and a moving average filter. A cut off frequency of 250 Hz was chosen for the Butterworth filter as it was experimentally determined that it provided the best filtering of the measured signal. An averaging filter is used to eliminate the

so called DC error which is otherwise observed after the integration (needed to obtain the velocity from acceleration) as a linear trend. A window length of one third of the total length of the measured data (per sample) was used for a moving average filter. In order to reduce the phase shift (lag) associated with usage of such a filter a filtfilt Matlab function (filter) was used which enables zero phase filtering by processing the data in both, forward and reverse direction. The data were then numerically integrated to obtain the velocity and once again to obtain the displacement. In a similar way the data from the laser sensor were filtered and then numerically derived to acquire the springboard velocity. During the first phase the top of the springboard moves down accelerating then decelerates toward the maximal bottom position (maximal compression, zero velocity) (Figure 1). After that the springboard goes upward accelerating to a maximal acceleration position and decelerates when the gymnast is off the springboard and continues vibrating after the gymnast's takeoff. Several parameters were extracted from the filtered data. All variables names for laser and accelerometer are same except the first letter, where * is replaced by letter L for laser measurements and letter A for accelerometer measurements: *_t_min_v – time to reach minimum vertical velocity, *_t_0_v_1 –time to maximal vertical negative velocity, *_t_max_v –time to reach maximum velocity, *_t_0_v_2 –time to zero position of the desk, *_min_v – maximum negative velocity, *_max_v – maximum positive velocity, *_max_s – maximum vertical displacement, *_t_max_s – time to maximal desk compression.

Variability, reliability of 2x8=16 variables was analyzed using statistical software package IBM SPSS 22.0. The following tests have been performed: Kolmogorov-Smirnov test, descriptive statistics, koeficient of variation (CV), standard error of measurement (SEM), paired-sample t-test, Pearson correlation, coefficient of determination (R^2) and Cronbach's alpha, and average relative error. Relative error was calculated as absolute difference between laser and accelerometer result and divided with laser result and at the end average relative error was calculated. Bland Altman method of assessing agreement (Bland & Altman, 1986) was calculated with Excel 2010. For calculating Bland Altman figures we subtracted accelerometer values from the values obtained by the laser. All statistics significance for t-test, Pearson correlation and Cronbach's alpha was set to $p<0.05$.

RESULTS

Figure 3 presents a comparison of measured and filtered velocity curves determined from the acceleration measurements using the SkoCi device and laser measurements. Differences were noticed depending on the filtering technique. In general, however, the two sets of results showed good agreement. The parameters obtained from these curves were statistically compared and are presented in Table 1 (Descriptive statistics, Pearson correlation, mean difference, t-test significance). Kolmogor-Smirnov test defined all variables as normal. Coefficients of variation were similar between laser and accelerometer measurements. Standard error of measurements are in general small for both measurement devices, with slightly higher values per specific variables once per laser and once per accelerometer. Person correlations between pairs were significant, high to very high with more than 50% of shared variance. Paired sample t-test significance was observed in most cases; no significant differences in time to reach maximum vertical velocity or maximum trajectory of springboard top, and time to reach minimum velocity, were observed.

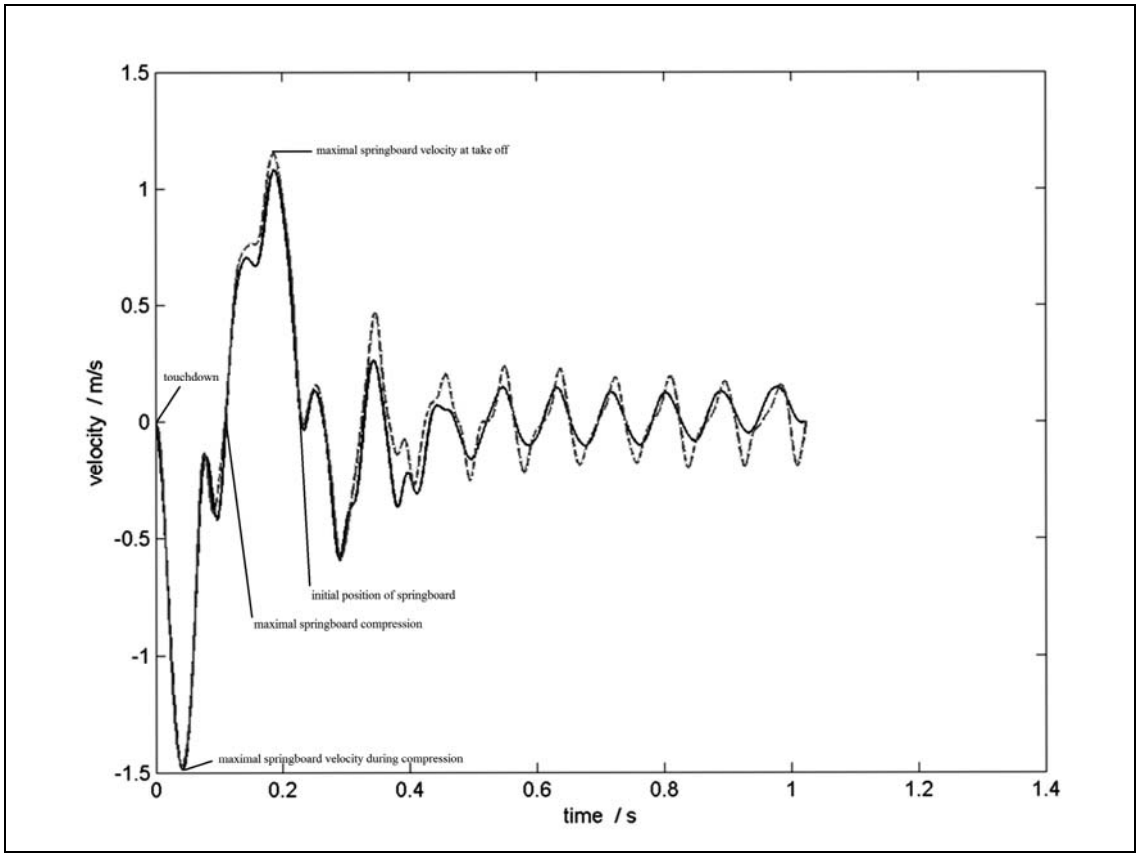
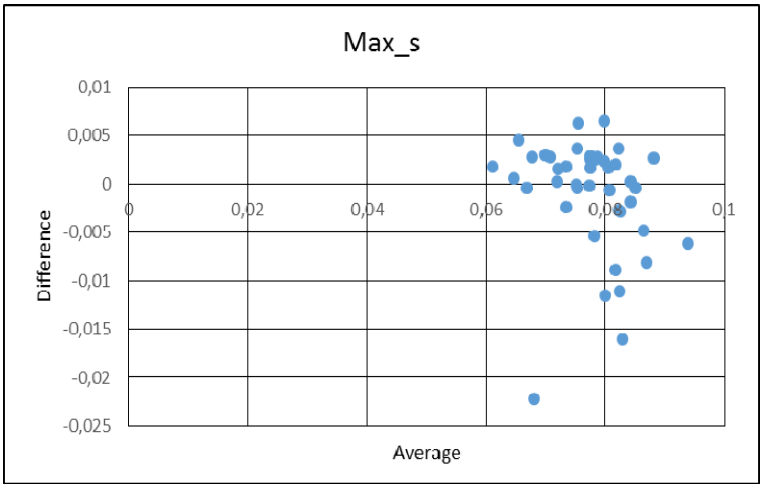
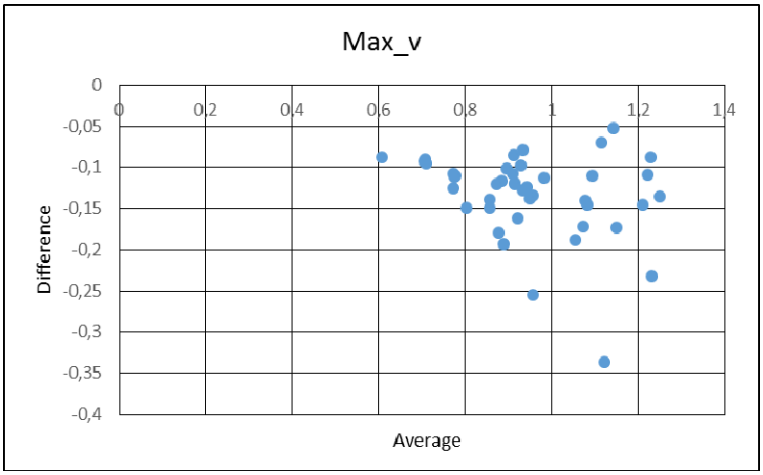


Figure 3. A typical velocity vs. time curve obtained with laser (black line) and accelerometer (grey doted line).

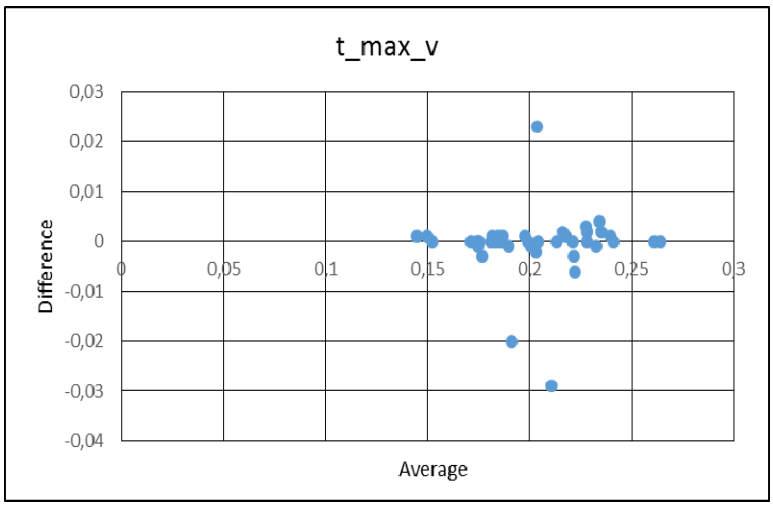
Tables 1 show a large compliance between both measuring devices. A moving average filter which is necessary for balancing the velocity data so that they vibrate around zero velocity has an impact also on the maximal and minimal vertical peak measured by an acceleration sensor. The descriptive statistics shows that the differences between the laser and the SkoCi parameters are small in units. The largest mean difference for time variables is for the time when the springboard gets once more into a normal position and is 0.007 second. Duration of an average take-off in our experiments was 0.258 second for SkoCi which is 3.1% error in comparison with laser results. Time to maximum vertical velocity was 0.201 second and in comparison with average difference from laser this means 0.3% of error. Differences between time variables for laser and SkoCi are small and within the scope of usage in practice. Mean difference in determined minimum velocities for laser and Skoci is 0.05 m/s and is within value of 1.3 m/s which means slightly less than 4% error. Maximum velocity shows more mean difference (0.133 m/s at velocity 1.01 m/s) which results in 13.1% of error for SkoCi (regarding just above mentioned data). For calculating Bland Altman figures (Figure 4) showed high agreement between both methods of measurements.



+1.96 SD=0.012; -1.96 SD = -0.012



+1.96 SD = -0.033; -1.96 SD = -0.239



+1.96 SD = 0.012; -1.96 SD = -0.013

Figure 4. Bland Altman presentation of difference (y axis) and average result (x axis) of maximum length of springboard compression, maximum take off velocity and time from touchdown to maximum velocity.

Table 1.
Descriptive statistics, Standard error of measurement (SEM), Pearson correlation, koeficient of determination (R^2) mean difference, t-test significance, Cronbach's alpha, average relative error.

unit		XA	SD	SE	CV	SEM	Pears. Corr.	R^2	Mean diff.	Sig t-test	Cronbach's alpha	Average relative error
s	L_t_min_v	0,039	0,0157	0,002	40,15	0,004	0,88	0,77	0,002	0,06	0,93	0,049
	A_t_min_v	0,037	0,0139	0,002	37,66	0,014						
s	A_t_0_v_1	0,113	0,0155	0,002	13,71	0,004	0,88	0,78	-0,004	0,00	0,93	0,039
	L_t_0_v_1	0,118	0,0174	0,003	14,74	0,017						
s	L_t_max_v	0,200	0,0284	0,004	14,20	0,003	0,97	0,94	0,000	0,60	0,98	0,012
	A_t_max_v	0,201	0,0283	0,004	14,08	0,028						
s	L_t_0_v_2	0,250	0,0206	0,003	8,24	0,006	0,85	0,73	-0,007	0,00	0,91	0,031
	A_t_0_v_2	0,258	0,0244	0,004	9,45	0,024						
m/s	A_min_v	-1,305	0,337	0,0514	-25,82	0,050	0,97	0,94	-0,053	0,00	0,97	0,046
	L_min_v	-1,252	0,278	0,0424	-22,20	0,278						
m/s	L_max_v	0,886	0,156	0,0237	17,60	0,025	0,95	0,91	-0,133	0,00	0,97	0,153
	A_max_v	1,019	0,169	0,0259	16,58	0,169						
m	A_max_s	0,078	0,008	0,001	10,28	0,003	0,71	0,50	0,000	0,27	0,82	0,053
	L_max_s	0,077	0,007	0,001	9,11	0,007						
s	L_t_max_s	0,116	0,0176	0,003	15,17	0,002	0,98	0,97	0,002	0,00	0,99	0,02
	A_t_max_s	0,114	0,0155	0,002	13,59	0,016						

Letter L for laser measurements and letter A for accelerometer measurements: t_min_v –time to reach minimum vertical velocity, t_0_v_1 –time to maximal vertical negative velocity, t_max_v –time to reach maximum velocity, t_0_v_2 –time to zero position of the desk, min_v –maximum negative velocity, max_v –maximum positive velocity, max_s –maximum vertical displacement, t_max_s – time to maximal desk compression.

DISCUSSION

Calculation of vertical displacement of the top desk of the springboard requires double integration of accelerometer data while for laser we can use raw data directly. The obtained difference was found to be small (less than 1 mm). A series of paired sample t-tests revealed significant differences between laser and SkoCi. However, Pearson correlation coefficients showed in many cases close to linear dependency between laser and SkoCi, what shows high validity of accelerometer. Cronbach's alpha coefficients were all significant and very high showing that rankings are placed correctly and therefore reliability of SkoCi is proper. Reliability calculated with Cronbach' alpha between the laser and the

accelerometer compared used technologies. In this case the number of participants was not important. With a single participant we made variance smaller and therefore made a criteria for reliability significance higher. We were searching for such repeatability that is good for each participant itself and also between the participants (with more participants variance would be larger and reliability would improve).

Bland Altman test showed less than 5 % items (1-2) were not within +-1.96 SD difference between laser and accelerometer, what shows good agreement between both methods. While the difference between laser and accelerometer for maximum length of springboard compression and time from touch down to maximum velocity were deviating around 0 points, the difference between laser and accelerometer for maximum velocity showed systematical deviations around a negative average as accelerometer gave higher values of velocity (similar to results of paired sample t-test). In addition, Pearson correlations between differences and averages for all three variables included in Bland Altman test were not significant, which confirms agreement between laser and accelerometer measurements.

CONCLUSIONS

A metric analysis of the parameters measured by a device developed for analysis of springboard parameters in vaulting has been performed. The device is composed of a processing unit and a separate acceleration sensor that is attached below the top desk of the springboard. The accelerometer measures desk acceleration that is collected by the device for further processing. Due to several sources of noise the obtained acceleration data has been filtered by a moving average filter and a Butterworth filter of the fourth order with a cut off frequency of 250 Hz. The filtered data were integrated to obtain the desk velocity and double integrated to obtain the desk displacement. After the jump onto the springboard the desk is first compressed and then released to vibrate after the gymnast's takeoff. In this short time (lasting typically around 200 ms) several indicative parameters can be extracted from data; in particular from the desk velocity profile. Eight parameters were identified and evaluated: time to reach minimum vertical velocity, time to maximal desk compression, time to reach maximal negative and positive velocity, time to zero position of the desk, maximal positive and negative velocity and maximal springboard vertical displacement. Analysis of 43 single gymnast jumps partly proved the validity and reliability of the extracted parameters. The presented investigation has shown that the measurement technique used in a developed device (SkoCi) using miniature MEMS type accelerometers and the filtration technique is capable of determining several relevant parameters of the springboard usage with an accuracy equal of less than (average relative error) 5,3% for all evaluated parameters except for maximal positive velocity for which an average relative error up to 15,3% has been obtained. Despite of high average relative error for velocity for accelerometer, it is important Person correlation and coefficient of determination with laser are very high, therefore relation is almost linear, while amount of differences is high and can be also related to systematic error. A main advantage of the proposed technique is its ease of use and applicability to a wide variety of situations (different types of springboards, training, gymnast skills, etc), however its use in scientific work is questionable.

REFERENCES

Atiković, A., & Smajlović, N.(2011). Relation between vault difficulty values and biomechanical parameters in Men's artistic Gymnastics. *Science of gymnastics journal*, 3, 91 – 105.

Bland, J.M., & Altman, D.G. (1986). Statistical Methods for assessing agreement between two methods of clinical measurement. *Lancet, 1,* 307- 310.

Cheol-Hwan, K., Byung-Wan, J., & Jin-Taek, J. (2012). Application of Laser Vibrometer to the Measurement and Control of Cable Tensile Forces in Cable-Stayed Bridges. *International Journal of Distributed Sensor Networks*; Article ID 810682. http://dx.doi.org/10.1155/2012/810682.

Cozby, P. (2009). Methods in behavioral research. 10th ed. Boston: McGraw-Hill Higher Education.

Čuk, I., Penič, S., Supej, M., & Križaj, D. (2011). Towards a smart springboard (case study). *Science of gymnastics journal, 3*, 29 – 42.

Čuk, I., & Karacsony, I. (2004). Vault, Methods, Ideas, Curiosities, History. Ljubljana: ŠTD Sangvinčki.

Dolenec, A., Čuk, I., Karacsony, I., Bricelj, A., & Čoh, M. (2006). Runway characteristics of vault in women gymnastics. *Kalokagathia*, *3-4,* 127-136.

Ferkolj, M. (2010) A kinematic analysis of the handspring double salto forward tucked on a new style of vaulting table. *Science of gymnastics journal*, *2*, 35 – 48.

FIG. (2012a). Code of Points Men Artistic Gymnastics. Loussane: FIG.

FIG. (2012b). Code of Points Women Artistic Gymnastics. Loussane: FIG.

Gioffre, M., Gusella, V., Marsili, R., & Rossi G.L. (2000). Comparison between accelerometer and laser vibrometer to measure traffic-excited vibrations on bridges. In: Proc. SPIE 4072, Fourth International Conference on Vibration Measurements by Laser Techniques: Advances and Applications, 230. doi:10.1117/12.386764.

Greenwood, M., & Newton, J.W. (1996). Direct force measurement of the vault take-off in gymnastics. In Abrantes JMCS (ed). *Proceedings XIV International Symposium on Biomechanics in Sports* (pp.332-334). Lisbon: Edicoes FMH Universidade Tecnica de Lisbon.

James, D.A., Davey, N., & Rice, T. (2004). An accelerometer based sensor platform for insitu elite athlete performance analysis. In D. Rocha, P.M. Sarro, & S. Vellkoop (eds). *Proceedings of IEEE Sensors 2004* (pp. 1373–1376). Vienna: Vienna University of Technology.

Kavanagh, J.J., & Menz, H.B. (2008). Accelerometry: A technique for quantifying movement patterns during walking. *Gait & posture*, *1,* 1 – 15.

Keränen, T., Moisio, T., & Linnamo, V. (2008). *Artistic gymnastics vaults vertical take-off velocity measured by electromechanical film*. Retrieved from: www.kihu.jyu.fi

Marinšek, M., Slana, U. (2014). Smart phone as a standing balance assessment device. *Science of gymnastics journal, 3,* 39 – 47.

Pérez, P., Llana, S., & Alcántara, E. (2008). Standard tests ability to measure impact forces reduction on mats. *International journal of sports science and engineering*; *3,* 162–168.

Pober, D.M., Staudenmayer, J., Raphael, C., Freedson, P.S. (2006). Development of novel techniques to classify physical activity mode using accelerometers. *Medicine and science in sports and exercise*, *9*, 1626–1634.

Preece, S.J., Goulermas, J.Y., Kenney, L.P.J., & Howard, D. (2009). A comparison of feature extraction methods for the classification of dynamic activities from accelerometer data. *IEEE transactions on bio-medical engineering*, *3,* 871–879.

Sands, W.A., Smith, S.L., & Piacentini, T. (2010) *Studying Vault Board Behavior: A Preliminary Look.* Retrieved from: http://www.polhemus.com.

Seeley, M.K., & Bressel, E.A. (2005). Comparison of upper-extremity reaction forces between the Yurchenko vault and floor exercise. *Journal of sports science and medicine*, *2*, 85-94.

Ward, D.S., Evenson, K.R., Vaughn, A., Rodgers, A.B., & Troiano, R.P. (2005). Accelerometer Use in Physical Activity: Best Practices and Research

Recommendations. *Medicine & science in sports & exercise*, *11*, S582–S588.

Žagar, T., & Križaj, D. (2005). Validation of an accelerometer for determination of muscle belly radial displacement. *Medical & biological engineering & computing, 1,* 78–88.

Corresponding author:

Dejan Križaj
Faculty of Electrical Engineering
University of Ljubljana
Tržaška cesta 25
1000 Ljubljana
Slovenia
E-Mail: Dejan.Krizaj@fe.uni-lj.si

ACCURACY IN JUDGMENT THE DIFFICULTY SCORE IN ELITE RHYTHMIC GYMNASTICS INDIVIDUAL ROUTINES

Catarina Leandro [1,2], Lurdes Ávila-Carvalho[2], Elena Sierra-Palmeiro[2], Marta Bobo[2]

[1] Faculty of Psychology, Education and Sport, University Lusófona of Porto, Porto, Portugal
[2] Faculty of Sport Science and Physical Education, University of Coruña, Coruña, Spain

Original article

Abstract

The main goal of this study was to analyse the accuracy in judging the Difficulty score in the Rhythmic Gymnastics Kiev World Championship 2013. The accuracy was determined analysing the judges' agreement on the evaluation of the routines difficulty elements. 1152 difficulty forms concerning 288 individual routines were analysed - 4 forms per routine, 1 per judge. To allow the comparison between gymnasts with different levels the individual routines were clustered into 3 subgroups according to their final ranking competition. Body difficulty elements were organized, according to the composition requirements stated in the RG Code of Points (FIG, 2012). Non-parametric tests - Cochran's Q and Chi-Square Tests were applied to determine whether there were significant differences between groups. As main results we can point out that in general the judges did not agree on difficulty evaluation in 40% of the elements. The level of accuracy was lower in the second part of the ranking, and in the Mastery and DER difficulty elements.

Keywods: *Evaluation, accuracy, judge, rhythmic gymnastics.*

INTRODUCTION

Rhythmic Gymnastics (RG) is characterized by the high level of difficulty of the body elements and apparatus handling, combining esthetical and artistic components. This complexity increases the difficulty of the judgment and its accuracy mainly in high level performances. The requirements are quantitative (amount and variety of body and apparatus movements) and qualitative (degree of difficulty and quality in performance) and they are evaluated by the judges according to the rules and evaluation criteria stated in RG Code of points (Bobo, 2002).

The Body and apparatus movements are grouped according to the type of skills, the level of difficulty and the complexity of the movements (Lebre, 2011). The main groups considered in the routines evaluation are: Jumps, Balances and Rotations, Mixed difficulties, additional criteria for the body movements - waves and pre-acrobatics,

Dance Steps, Mastery (special apparatus handling) and Dynamic Elements with Rotation and throw (DER).

In competition the performance is evaluated by 2 panels of judges: the difficulty (D) jury that judges the routines content and the execution (E) jury to evaluate the quality of the routines. The gymnasts present in each competition a difficulty form with all difficulties listed. Each judge must confirm the difficulty elements performed by the gymnast and cross out those that are not correctly performed or not performed at all (FIG, 2012). The final D score is the average of two intermediate scores. When the score become published on the screens, the judges can compare the final score to their own scores. Therefore, the judges score independently although there's still some feedback (Bucar, Cuk, Pajek, Kovac, & Leskosek, 2013).

In previous studies was noted that judging is not only a matter of identifying the sports performance. There are also various facts, identified in the literature, having an influence on the several stages of processing information in gymnastics judgment (Leandro, 2009).

Findlay and Ste-Marie (2004) found out that the were the judges tend to judge better the gymnast higher qualified in previous competitions, concluding that the reputation of the gymnasts have influence on the judging. The judge's experience has been also described as influencing the quality of judgment. Leandro, Ávila-Carvalho, and Lebre (2010) and Ste-Marie, Valiquette, and Taylor (2001) found that the more experienced judges had better perception and anticipation of the elements and there for, were better evaluators. Other factors, as the memorizing capacity (Ste-Marie, Valiquette, and Taylor, 2001), and the tendency to adapt their scores to those given by the judges of the same panel (Boen, Karen, Yves, Jos, and Tim, 2008) were also described. The observation angle (Plessner and Schallies, 2005) and the judges with experience as gymnasts (Heinen, Vinken & Velentzas, 2012) were also described as factors that can influence in the judges accuracy.

Besides these factors, is also relevant to know whether the factors related to the sport specificity as the structure/organization of the Code of Points, the evaluation criteria defined by the sports authorities has an influence (positive or/and negative) on the judge's performance and consequently on the gymnasts final scores.

Rhythmic gymnastics has been experiencing a constant and outstanding evolution in its' technic for the last few years because of the evolution of the Code of Points (Palomero, 1996). The evaluation of the gymnasts is made by a collective observation of judges that should be objective. However, this evaluation is not yet exact, probably due to huge amount of evaluation criteria defined for each difficulty element. This can be verified by the differences registered between the judges of the same panel when the evaluate the same routine. This fact is wellknown in the sport but not yet studied. The majority of studies available deal with the analysis of the technical content of exercises or with the final scores given at the end of each exercise. We could not find any study dealing with the analysis of the difficulty evaluation, element per element, trying to see if the final score of each judge are the product of the validation of the same difficulty elements.

Under this subject, the most relevant studies we found are Palomero (1996) and Bobo (2002), in which both the authors present a new proposal for the scoring, based in performance indicators. Čuk, Fink, & Leskošek (2012) studied the way the different type of final score calculation can change the gymnasts final ranking. Gambarelli, Laquinta & Piazza (2012) developed a formula to avoid pre-agreements between judges. They proposed that the score from the judge of the same country of the gymnast should not enter in the calculation for the gymnast final score. Furthermore, they consider that this would be a factor of guarantee of higher reliability of the final score.

Some of the studies demonstrate that the structure of the Code of Points itself holds decisive influence in scoring gymnasts. In this way is very important to suggest alternative evaluation tools that respect the principles of evaluation (objectivity, validity, reliability, discriminating power and practical utility) and allow a balanced appreciation of the different dimensions of the sport, in either aspects of quality or quantity in the performance of gymnasts (Bobo, 2002).

On the other side, the permanent changes in the Code of Points may cause a lack of understanding of the rules, which lead to a need of evaluation of judging instrument itself (Kirkpatrick & Hawk, 2006). Mark & Shotland (1987) remarked, any evaluation model has to be based on a group of principles, axioms and postulates that must be feasible. To have a Code of Points with an extremely complex model of evaluation that does not work when it has to be used, must be avoid.

According to Bartolomeis (1999) it is not possible to see everything at the same time. The essential point is that the evaluation instrument evaluates what it is supposed to evaluate. For Tamir (1998) the evaluation criteria used should be tested in both validity (precision) and reliability (internal consistency).

We could not find any study based on the analysis of the judges' activity based on the using of the difficulty forms during the competition, making this study a pioneer in this field.

Thus, before suggesting future changes, it is important to understand how it works in the present, finding out what should be changed and what should be kept. According the pyramidal structure of the evaluation process (Figure 1) we established the goal of the study.

The goal of this study was to analyse the accuracy in judging Difficulty in the Kiev World Championship 2013, trying to learn if the 4 difficulty judges evaluate in the same way the difficulty elements on the D form (agreement between the 4 judges). This accuracy was studied for each element declared in the difficulty form trying to understand if the perception of the validation criteria for each elements is similar for all judges. The final difficulty score given by each judge to the same gymnast were very similar, but, with this study, we will analyse if the judges arrived to the final score validating the same elements or validating different elements.

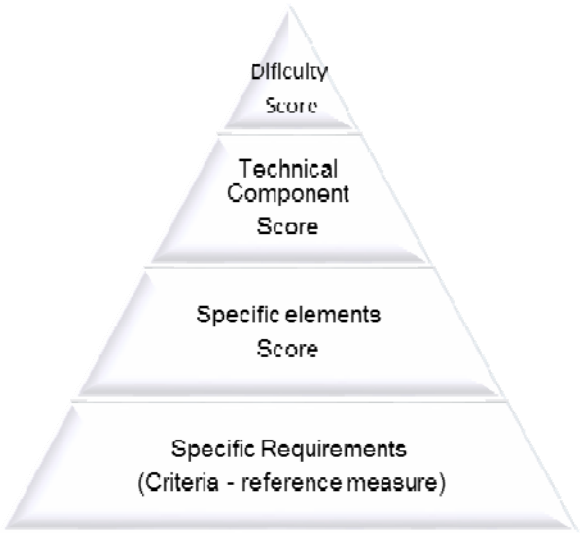


Figure 1. Pyramidal structure for analysis of the evaluation process.

After analysing the date in a global way, we will study the level of agreement between the judges concerning the validation of the difficulty elements according to: (1) the position of the gymnast on the final ranking (1st part, 2nd part and 3rd part), (2) the routine apparatus (hoop, ball, clubs and ribbon), and (3) the type of difficulty element.

METHODS

Subjects and design

1152 difficulty forms concerning 288 individual routines were analysed (4 forms per routine, 1 per judge). The routines were performed by gymnasts from 45 different countries competing at Rhythmic Gymnastics World Championship in Kiev, Ukraine in 2013.

This study was done with the permission of the International Gymnastics Federation. Full blinding of the judges involved was undertaken.

All difficulty elements reported in the difficulty forms provided by the gymnasts at the competition were analysed. Each element was considered validate or not according the notes done by the judge on the form. For each element, we studied the cases of agreement when all 4 judges validate or not the difficulty element and the disagreement when at least one of the judge did not validate and the others consider the element correctly done.

The analyse was done considering the all sample, and the sample clustered into 3 subgroups according to gymnasts final ranking as follows: the first part of the ranking - the top 24 gymnasts, the second part of the ranking - 24 middle gymnasts and third part of the ranking – the 24 lower placed gymnasts on the ranking, to allow the comparison the agreement level of the judges when they evaluate gymnasts with different levels. Then, we studied the sample according to the apparatus used to perform the routine (hoop, ball, clubs and ribbon), and the type of difficulty element performed listed according to the composition requirements of the Code of Points (FIG, 2012), (Figure 2).

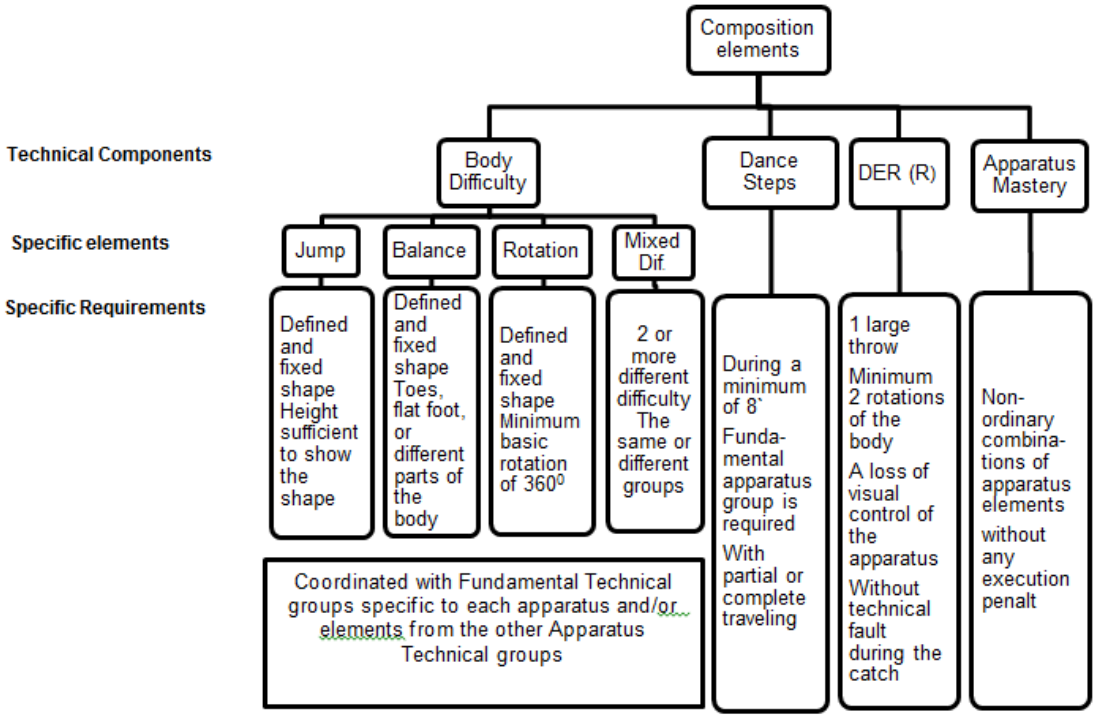


Figure 2. Technical Content of Rhythmic Gymnastics of Individual Gymnasts Routines (COP 2012/2016)

Statistical Analysis

For the statistical analysis we used the Statistical Package for the Social Sciences - Version 21.0 (SPSS 21.0, Chicago, USA) and Microsoft Office Excel 2010.

Non-parametric tests (Cochran's Q and Chi-Square Tests) were applied to determine if there were significant differences between groups. We use the Chi-square Tests for two independent samples to study the differences between two groups for each variable and the Cochran`s Q test to analyse when a set of K differs significantly. Significance level was set at $\alpha = 0.05$ (corresponding to a confidence level of 95%).

RESULTS

The forms were analysed first in a global way. For each difficulty element presented on the forms, the percentage of agreement between the 4 difficulty judges concerning the evaluation of the elements was determined. Then, the level of agreement on the elements evaluation was also calculated with the sample dived in 3 groups according to the final ranking of the gymnasts (Table 1).

The judges agreed on the evaluation of 60.0% of the difficulty elements presented on the difficulty forms. When we observe the results according to ranking of the gymnasts, is visible that higher the gymnast is placed in the ranking, higher is the agreement of the judges on the difficulty elements evaluation: 68.8% on the first part of the ranking, 56.1% on the 2nd part and 54.6% on the 3rd part. According to the results of the Chi-Square test, the differences between the cases of agreement and disagreement on the evaluation of the difficulty elements were statistically significant in all cases.

Table 1.
Level of agreement on the evaluation of the difficulty elements presented on the D Forms for all sample, and for the 3 groups according to the final ranking of the gymnasts.

	All Sample		1st part of the Ranking		2nd part of the Ranking		3rd part of the ranking	
	n	%	n	%	n	%	n	%
Not Agree	4871	40.0	1300	31.2	1836	43.9	1735	45.4
Agree	7294	60.0	2865	68.8	2343	56.1	2086	54.6

Chi-Square Test (Asymp.Sig.(2sided)) .000 * (*P<0.05)

Table 2.
Level of agreement on the evaluation of the difficulty elements presented on the D Forms according to the routine apparatus.

	Hoop		Ball		Ribbon		Clubs	
	n	%	n	%	n	%	n	%
Not Agree	1370	41.2	1129	37.3	1191	41.0	1244	40.6
Agree	1867	58.8	1894	62.7	1715	59.0	1818	59.4

Chi-Square Test (Asymp.Sig. (2sided)) .000 * (*P<0.05)

Table 3.
Results of the Cochran`s Q test comparing the results the agreement level for Hoop, Ball, Clubs and Ribbon routines.

	Hoop	Ball	Clubs	Ribbon
N	3174	3023	3062	2906
Cochran's Q	9.960	6.512	25.174	6.232
Sig.	**.018***	.090	**.000***	.099

(*P<0.05)

Table 4.
Results of the Cochran`s Q (C Q) test comparing the results the agreement level for Hoop, Ball, Clubs and Ribbon routines according to the final ranking of the gymnasts.

	Hoop			Ball			Clubs			Ribbon		
	1st part	2nd part	3rd part	1st part	2nd part	3rd part	1st part	2nd part	3rd part	1st part	2nd part	3rd part
N	1069	1078	1027	1044	1036	943	1050	1061	951	1002	1004	900
C Q	5.167	22.273	2.385	10.793	6.660	6.281	7.482	16.485	4.821	18.351	10.042	5.405
Sig.	.173	**.000***	.499	**.013***	.083	.095	.061	**.001***	.185	**.000***	**.019***	.145

(*P<0.05)

Table 5
Level of agreement on the evaluation of the difficulty elements presented on the D Forms according to the different type of elements.

	Not Agree		Agree	
	N	%	N	%
Mastery	726	62.5	436	37.5
Dance Steps	220	28.7	546	71.3
DER	1871	40.6	2735	59.4
Jumps	270	35.6	489	64.4
Balance	302	43.1	398	56.9
Rotations	1065	32.0	2263	68.0
Mixed Difficulties	93	38.3	150	61.7
Criteria assoc. to diff.	324	53.9	277	46.1

Chi-Square Test (Asymp.Sig.(2sided)) .000 * (*P<0.05)

Table 6
Results of the Cochran`s Q test comparing the results the agreement level for different groups of elements according to the final ranking of the gymnasts.

	1st part			2nd part			3rd part		
	N	Cochran's Q	Sig.	N	Cochran's Q	Sig.	N	Cochran's Q	Sig.
Jumps	257	1.227	.817	244	4.483	.208	258	2.92	.401
Balances	207	1.224	.785	238	5.89	.121	255	6.084	.106
Mastery	361	116.05	**.000***	394	46.744	**.000***	407	32.992	**.000***
DER	1607	62.548	**.000***	1567	8.492	**.036***	1432	17.251	**.001***
Dance Steps	260	8.12	**.047***	244	14.709	**.002***	262	2.121	.551
Rotations	1168	56.937	**.000***	1185	1.625	.652	975	4.288	.224
Mix. Diff.	108	10.553	**.015***	81	10.881	**.012***	54	8.937	**.030***
Criteria	197	12.425	**.005***	226	5.158	.164	178	3.774	.282

(*P<0.05)

Table 7.

Results of the Cochran`s Q test comparing the results the agreement level for different groups of rotations elements according to the final ranking of the gymnasts.

	1st part			2nd part			3rd part		
	N	Cochran's Q	Sig.	N	Cochran's Q	Sig.	N	Cochran's Q	Sig.
RPIV Base	195	2,769	.586	167	2,780	.448	188	7,554	.051
RPIV Rotations	431	37,748	**.000***	346	1,213	.763	333	0,283	.969
RFF Base	99	2,314	.594	96	4,116	.295	65	7,627	**.050***
RFF Rotations	273	11.634	**.008***	198	3,915	.283	106	7,382	.060
RF	206	13,481	**.004***	378	7,774	**.050***	283	2,928	.419

Studying the difficulty forms according to the routine apparatus (Table 2) we observed that the range between the disagreement values for the elements evaluation in the 4 apparatus is not very wide (from 37.3% in ball to 41.2% in hoop). However, when we observed the results of the Chi-Square test we could verify that for all apparatus there were significant differences between the values of the agreement and the disagreement on the evaluation of the difficulty elements.

Comparing the data between apparatus through the Cochran`s Q test (Table 3) we could find that there is a significant difference between the values registered for Hoop and Clubs (p value 0.018 and 0.000 respectively), what showed that there was differences in judges agreement level on the elements evaluation for the different apparatus.

Continuing the analysis in each apparatus, we studied the lack of agreement between judges regarding the final ranking of the gymnasts.

The results of the Cochran`s Q test (Table 4) revealed that in Hoop, and Clubs the judges disagreed significantly only on evaluation the difficulty elements of the gymnasts ranked in the 2nd part of the final ranking; in Ball they disagree significantly on the gymnasts in the 1st part of the final ranking; and finally for Ribbon they disagree significantly on the 1st and 2nd part of the final ranking.

We studied the level of judges agreement on the difficulty elements considering the different group of elements described in the Code of Points (Table 5).

In the most part of the groups of elements the agreement percentage between the judges was higher than the disagreement percentage. Only for the evaluation of the Mastery group and the criteria associated to the difficulties (waves and acrobatic skills) the percentage of disagreement between the judges was higher than the agreement - 62.5% and 53.9% respectively for the agreement against 37.5% and 46.1% for the disagreement. Despite this remark, the results of the Chi-Square test the differences between the cases of agreement and disagreement on the evaluation of the difficulty elements were statistically significant in all cases.

The level of agreement between the judges evaluating the different groups of elements was, then, studied regarding the final ranking of the gymnasts (Table 6).

Observing the results we can see that for Jumps and Balances was not remarked a significant disagreement between judges on the evaluation of the elements performed by the gymnasts independently of their placement in the final ranking. For the Dance Steps, there was only a significant disagreement between the judges for the gymnasts placed in the first and second parts of the ranking. Regarding the Rotations and the Criteria associated to the difficulties the significant disagreement was registered only for the gymnasts placed on the first part of the ranking. When we observe the Table 6, we can see that there

are statistically significant differences for the Mastery elements, the DER elements and Mixed Difficulties in the 3 parts of the ranking, once the p value are null or extremely low, what shows clearly the disagreement between the judges.

For the analysis of the rotations we divided them in 3 sub-groups (RPIV - *relevé* rotations (pivot), RFF - rotations on the flat foot or on other part of the body and RF - *fouetté* rotations), because of their different characteristics that means different evaluation requirements (COP, 2012). In each sub-group of RPIV and RFF rotations, we analysed separately the basis of the rotation and the number of rotations associated to the basis.

The level of agreement of the judges evaluating the different type of rotations elements was, then, studied regarding the final ranking of the gymnasts (Table 7).

On the Table 7 we can see that for the basis of RPIV and RFF, there is no statistically significant difference between the evaluation done by the judges in the first and second parts of the ranking. We can see, also, that the values for significance drop substantially in the third part of the ranking. When we analyse the rotations associated to the basis of RPIV and RFF, we can see that in the first part of the ranking that the p value shows clearly the disagreement between the judges in evaluating such part of the difficulty.

Concerning the *fouetté* rotations, there is no agreement between the judges in the first and second parts of the ranking.

DISCUSSION

The goal of this study was determine the accuracy of the judges on the evaluation of each difficulty element presented in the difficulty forms.

Studying the forms in a global way we found that the percentage of elements where the 4 judges of panel agreed on the elements evaluation was higher than the disagreement cases. Nevertheless, we could observe that the judges agreed only in 60% of the elements, what is not enough for an evaluation that is supposed to be exact and accurate.

When we divided the gymnasts in 3 groups according to their place in the final ranking we found out that the judges showed a higher percentage of agreement for the gymnasts placed in the first part of the ranking and lower when we went down through the ranking. These results may suggest that it is more difficult for the judges to evaluate with precision the average and low level gymnasts. This evidence might be related to some criteria to validate the elements that, probably are not enough specific, what can cause some pliability in the evaluation. To solve this problem Simões (2000) suggests that all evaluation systems should hold precise criteria to allow judging correctly the performance. When the gymnast performs perfectly or almost perfectly the element, as usually happens with the top ranked gymnasts, is easier to the judges to recognize the difficulty, applying the evaluation criteria clearly, and tend to agree on its the evaluation. According to Bartolomeis (1999), the evaluation criteria are defined based on a successful criteria, which can facilitate the agreement of judges when the gymnast perform the elements with success, which is the case for the top ranked gymnasts. For the average and low level gymnasts is clearly more difficult to determine the "drop off" point to validate the difficulty elements because these gymnasts are doing the elements with some technical faults which leads the judges to struggle in applying the evaluation criteria stated in Code of Points (FIG, 2012).

We can also speculate that there could be an influence from what is expected, once the judges might expect better gymnasts to perform the difficulty elements correctly, as Findlay & Ste-Marie (2004) found, in a study with figure skating performances, that the judges gave higher scores to the better known skaters, comparing to the less known ones.

Other point that should be added to this discussion is the fact that the evaluation criteria for some difficulty elements include,

according to the Code of Points (FIG, 2012) some points concerning the quality of execution that may contribute to a higher variability on the validation of the elements. The interference of these execution quality criteria may create some variability in the work of the difficulty judge, creating some "grey zones" in the evaluation of difficulty elements. According to Askew (2002), the evaluator should direct all his attention for a specific profile and ignore the interference of any other information from a different profile.

The analysis of the results by apparatus revealed that the percentage agreement had not big differences for the routines performed with different apparatus. The results showed that behavior does not change from one apparatus to another; on the contrary we could remark that there was a consistency on the lake of accuracy in the difficulty elements evaluation. This consistency is due to the fact that the difficulty elements used in the different apparatus are basically the same and therefore, the requirements to validate the apparatus are the same (FIG, 2012).

Observing the results obtained for the judgment accuracy when we studied it for each apparatus and according to final ranking of the gymnasts we found out that the lower values of accuracy in the judgment were registered mainly in the gymnasts of the second part of the ranking. Besides what was already discussed about the lack of precision in defining the evaluation requirements, we are still able to speculate about the short amount of time that each judge has to consider a great amount of requirements defined for every single element in the routine composition, which may cause high variability between judges scores (Čuk & Karacsony, 2004). This is a problem for the average gymnasts because in opposite to higher level gymnasts where is easy to identify the difficulty elements correctly done and to lower level gymnast where visible when they do not perform the difficulty elements correctly, the average gymnasts often present an unclear version of the difficulty element making the decision to validate an element even more difficult than usual.

The results obtained when we analysed the level of agreement of the judges according to the type of difficulty element evaluated showed that the judges could not agree on the evaluation of the Mastery elements, and the Criteria (waves and pre-acrobatic elements) associated to the difficulty elements. These two groups showed levels of disagreement higher than the agreements, clearly in opposition to what happened with the other groups. The results suggests that definition of the evaluation requirements may have not an enough clear statement in the Code of Points (FIG, 2012), which can lead the judges in troubles to decide when the elements should be validate or not. According to the technical requirements to validate a Mastery element, it should be "a combination of extraordinary apparatus elements performed without technical faults". The definition of "extraordinary apparatus elements" is too vague to allow the judge to evaluate the elements with accuracy and could be also influenced by the international experience of the judge: after judging a certain number of international competitions the level of expectation for an "extraordinary element" can be raised. Knowing that in the World Championships the judges (one for each country participating) has different background experiences, we can understand that they cannot evaluate this technical requirement with same level of accuracy. In this way we strongly recommend that the Code of Points should include much more precise definitions of the technical requirements, because, according to Simões (2000) the evaluation criteria should be understood in equal manner by the various evaluators, in a way that the effect of the evaluation done may be valid and reliable.

After a more detailed analysis of each group of difficulty elements according to the gymnasts ranking, we could see that for the Jumps and Balances the level of agreement between judges was similar in the 3 parts of the ranking, showing that in these elements

the judges apply the same evaluation criteria. The evaluation criteria are understood and applied in the same way by the evaluators, once they produce the same result. This result allows us to speculate that visual image of the element allows a quicker and more reliable understanding, once the stated difficulties are presented. Boen, Karen, Yves, Jos, and Tim (2008) reach the conclusion that the possibility of feedback creates agreement between gymnastic judges. We know (unpublished study), that jumps and balances are repeated frequently in exercises, by the gymnasts in different apparatus routines, what facilitates the visual experience of the judge and therefore more precision in the application of evaluation criteria. According to Ste-Marie, Valiquette, & Taylor (2001), the visual image that is kept in the memory can influence the judge's performance. The agreement may be higher in the elements that appear often in exercises and because of that the judges have a clearer visual image and therefore a more precise evaluation.

In opposition, we can see that there are statistically significant differences between the 3 parts of the ranking in Mastery elements and DER elements, what clearly reveals the disagreement between the 4 judges on the validation of these difficulties. Besides what was already discussed above about the validation of Mastery elements, it is still relevant underline these elements are not listed and therefore the higher number of possible combination of handling contribute to make the evaluation of these type of elements even more difficult. We understand here that the absence of a list of Mastery elements would bring high improvements in routines creativity, although this could also bring the possibility for mixing originality concepts that should and must be evaluated in the originality item stated in COP (FIG, 2012). According to Balcells, Martín & Anguera (2009) it is possible to evaluate the originality and creativity with validity and reliability defining evaluation criteria that can be seen by the evaluators.

In the case of DER elements, the results lead us to the high number of criteria to bear in mind for the judge during the observation. According the Code of Points (FIG, 2012), the DER has an unlimited value and may contain till 19 different criteria that can be repeated. The judge has to memorize the criteria done to have the possibility to cross out on the difficulty form those what were not performed correctly or not done at all. Ste-Marie and Lee (1991) and Ste-Marie, Valiquette, & Taylor (2001) showed that the objectivity of a judge can be compromised by biases of memory. Also, the high number of criteria performed in such short may be responsible for this lack of agreement between the judges. We can speculate that the small amount of time that the judge has to observe and make all the possible deductions on the Difficulty form could be other source of variability between judges which may cause the evaluation of this group more vulnerable. Bucar, Čuk, Pajek, Kovac, & Leskosek (2013) and Čuk & Karacsony (2004) identified this same problem in the evaluation of the Vault execution in female artistic gymnastics, once this is also done in few seconds with 21 possible deductions.

The data concerning the Dance Steps showed also a significant disagreement of the judges in the validation. Dance Steps has, as criteria to be validate, the duration of at least 8 seconds, which can cause high variability in the evaluation, since this evaluation is done without a stopwatch or other device, but through the sensibility of the judge, and can be serious influenced by the *tempo* of the music.

The evaluation of the Mixed difficulties and Criteria associated to the difficulty elements (acrobatic elements and waves) reveals a significant disagreement between the judges, which could be due to the statement on the Code of Points concerning the link between the wave or acrobatic element and difficulty element itself. According to COP (FIG, 2012) the link must be immediately before or after but it is not clearly specified if it should be in continuity of the difficulty element or if it

could be a composition of two elements. According to Plessner (2005), the non-stated rules which can be considered as social norms, may influence the judge's decisions. It's important that they have great knowledge of the rules, to avoid wrong decisions.

Concerning the rotations, we can see that when evaluated the base of RPIV and RFF, there's no significant difference in the evaluation, in the first and second parts of the ranking. However, we can see that the values of a significant decrease in the third part of the ranking. Normally it is on the third part of the ranking where we find the lower level gymnasts and therefore with poor execution technique straight from the base of the rotation. According to the COP, the judge has to see the form, the degrees (360º) of the first turn and the technical faults that cancel the difficulty. The junction of all this factors (which are more present in the lower level gymnasts) belonging to two different profiles (difficulty and execution), may be explain the results of variability between judges found in the evaluation of this part of the difficulty.

Concerning the number of rotations associated to the base of RPIV and RFF, we can see that in the first part of the ranking there is clearly disagreement between the judges in evaluating these difficulty elements. About *fouetté* rotations, we found that in the first and second parts of the ranking there is no agreement between the four judges.

It is in the first and second parts of the ranking that the rotations performed done have a higher number of turns. By the evaluation criteria stated in COP, the judge has to count the number of full turns performed that is sustained fixed, without technical faults. Then, the difficulty in counting a high number of turns performed (that can go upper than 10 turns, mainly in *fouettés*) at high speed in few seconds, identifying the technical faults that implies the cancellation of the difficulty, may be in the origin of this variability for this kind of elements, in the first part of the ranking. Once again, we highlight here the interference of some criteria concerning execution, when judges are judging difficulty. According to Plessner (2005), positive and negative effects of prior knowledge on referee decisions and observation of a high amount of demand in such a short amount of time, may cause the loss of important information.

CONCLUSIONS

The four judges of difficulty panel did not agree in their evaluation in 40% of the difficulty elements presented in the difficulty forms. Regarding the final ranking of the gymnasts the agreement level is higher in the high and low level gymnasts. The level of accuracy was lower in the second part of the ranking, and in the difficulty elements which validation criteria depends not only from difficulty criteria but also from execution criteria.

The analysis by type of difficulty elements showed that for the Jumps and Balances the judges agreed on the evaluation of the elements which means an acceptable accuracy of judgement, but for the other types of elements the level of disagreement between the judges was significantly high to be an accurate judgement, where we highlight the Mastery and DER difficulty elements. This study provides updated information about the precision of difficulty judging in rhythmic gymnastics, to be considered in the possible alteration of the present code of points, in particular in the definition of the evaluation criteria of the elements where we see the highest disagreement between judges.

REFERENCES

Askew, S. (2002). Feedback for learning. *Journal of eduction for teaching*, *28*, 83-90.

Balcells, M., Martín, C., & Anguera, M. (2009). Instrumentos de observación ad hoc para el análisis de las acciones motrices en Danza Contemporánea, Expresión Corporal y Danza Contact-Improvisatio. Apunts educación física y deportes.

Ciencias aplicadas a la actividad física y el deporte, 14-23.

Bartolomeis, F. (1999). *Avaliação e Orientação: Objectivos, instrumentos e métodos.* Lisboa: Livros Horizonte.

Bobo, M. (2002). *El juicio deportivo en Gimnasia Rítmica. Una propuesta de evaluación basada en indicadores de rendimiento. (PHD Thesis*), Universidad da Coruña, Instituto Nacional de Educación Física de Galicia, Coruña.

Boen, F. B., Karen, H., Yves, V. A., Jos, F., & Tim, S. (2008). Open feedback in gymnastic judging causes conformity bias based on informational influencing. *Journal of Sports Sciences*, *26*(6), 621–628.

Bucar, P. M., Cuk, I., Pajek, J., Kovac, M., & Leskosek, B. (2013). Is the Quality of Judging in Women Artistic Gymnastics Equvalent at Major Competitions of Different Levels? *Journal of Human Kinetics*, *37*, 173-181.

Čuk, I., Fink, H., & Leskošek, B. (2012). Modeling The final score in Artistic Gymnastics by different weights of difficulty and execution. *Science of Gymnastics Journal*, *4*, 73 – 82.

Čuk, I., & Karacsony. (2004). *Vault: methods, ideas, curiosities, history*. Ljubljana: STD. Sangvinck.

FIG. (2012). *Code of Points for Rhythmic Gymnastics Competitions.* Available at: http://www.fig-gymnastics.com/site/page/view?id=472

FIG. (2013). *Gymnastics Results*. Available at: http/www.gymnasticsresults.com

Findlay, C., & Ste-Marie, M. (2004). A Reputation Bias in Figure Skating Judging. *Journal of Sport & Exercise Psychology*, 26 (1), 154-166.

Gambarelli, G., Laquinta, G., & Piazza, M. (2012). Anti-collusion indices and averages for the evaluation of performances and judges. *Journal of Sports Sciences*, *30*(4), 411-417.

Heinen, T., Vinken, P., & Velentzas, K. (2012). Judging Performance In Gymnastics: A Matter Of Motor Or Visual Experience? . *Science of Gymnastics Journal, 4,* 63 – 72.

Kirkpatrick, J., & Hawk, L. (2006). *Curricula and evaluation: Maximizing results.* Measuring and Evaluating. Available from EBSCO .

Leandro, C. (2009). *Avaliação de Juízes de Ginástica Rítmica.* (Master Thesis), Porto University, Porto.

Leandro, C., Ávila-Carvalho, L., & Lebre, E. (2010). The avaluation of the performance of Rhythmic Gymnastics` Judges. Palestrica of the *Third Millennium Civilization & Sport, 11*(3), 202-206.

Lebre, E. (2011). *Technical principles for the new framework.* Crossroads to the Future [Press release].

Mark, M., & Shotland, R. (1987). *Multi Methods in Program Evaluation. New Directions For Program Evaluation* (Vol. 35). Londres: Jossey – Bass Inc.

Palomero, M. L. (1996). *Hacia una objetivación del Código*. Barcelona: Internacional de Gimnasia Ritmica Deportiva.

Plessner, H. (2005). Positive and negative effects of prior knowledge on referee decisions in sports. In T. Betsch, Haberstroh,S (Ed.) *The routines of decision making* (pp. 311–324).

Plessner, H., & Schallies, E. (2005). Judging the Cross on Rings: A Matter of Achieving Shape Constancy. *Applied Cognitive Psychology*, *19,* 1145-1145.

Simões, G. (2000). *A avaliação do desempenho Docente.* Lisboa: Texto Editora.

Ste-Marie, D., & Lee, T. D. (1991). Prior processing effect on gymnastic judging. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 126-136.

Ste-Marie, D. M., Valiquette, S. M., & Taylor, G. (2001). Memory Influenced Biases in Gymnastic Judging Occur Across Different Prior Processing Conditions. *Research Quarterly for Exercise and Sport*, *72*(4), 420-426.

Tamir, P. (1998). Assessment and Evaluation in Science Education . Opportunities to Learn and Outcomes *International Hand book of science*

Education (pp. 761-789): Dordrecht: Kluwer Academic Publishers.

Corresponding author:

Catarina Leandro
University Lusófona of Porto
Faculty of Psychology, Education and Sport
Rua Augusto Rosa, nº 24 (à Pç. da Batalha)
Porto 4000-098
Portugal
E-Mail: catarinaleandro@sapo.pt

ELEMENTS DEVELOPMENT ON HORIZONTAL BAR IN MEN'S ARTISTIC GYMNASTICS IN JAPAN LITERATURE

Moriatsu Nakasone

Biwako Seikei Sports College, Kitahara, Japan

Original article

Abstract

More recently a total of 800 elements have been recorded in the Gymnastics Code of Points. However few of theses elements made gymnastics history. As such we wonder by whom, when or where these various elements are performed. The purpose of this study was to collate data elements on the Horizontal Bar (HB) in men's artistic gymnastics and to suggest new elements in the future. The method of study was undertaken by bibliographic analysis. This article refers mainly to journals that were published by the Japan Gymnastic Association, and a list that was made regarding the occurrence of new elements on HB in Men's artistic gymnastics. From the analysis, the author gatherd data regarding various elememts that were performed. For example, Swing forward and vault backward straddle to hang (Tkatchev) was performed by Tkatchev A. in the 1979 World cup. A Tkatchev stretch was performed by Liukin V. and Nishikawa D. in the 1988 Seoul Olympics. In conclusion, developments of HB elements are greatly influenced by the improvement of apparatus, rules of the era. In the near future, directions of new occurring elements on the HB may add twists to the existing elements.

Keywods: *men, artistic gymnastics, history.*

INTRODUCTION

The first gymnastics world championship was held in Antwerp in Belgium in 1903, however artistic gymnastics was already at Olympic Games in Athens 1896. As gymnasts took part at international level at the very beginning of competition era, at national level wer competitions organized even earlier. Rules how to evaluate changed since very beginning, and the last major change was in 2006 when single ten-point systems was changed into score of difficulty (open ended) and performance (still 10 points maximum score). New elements may have been presented by gymnasts at the competition. For example, the salto forward with three turns and the salto backward with 4 turns on floor exercise were performed by 17-year-old Sirai. K. (Fédération Internationale de Gymnastique (FIG), 2014).

Recently 800 elements is in the Code of Points (CoP), more than 100 on horizontal bar (FIG, 2013). In the past there were already attempts to provide historical information (Atiković, 2014; Abie, 2010,

2014) and historical information about elements development on horizontal bar (Anton, 1997; Kinoshita, 2001; Kurihara, 1982). However per each element is not known by whom, when or where these various elements are performed. If we must summarize development of the elements in the past, there is possibility to predict new elements in the future. The purpose of this study was to collate data elements on the horizontal bar (HB) in men's artistic gymnastics.

METHODS

Elements are described with CoP (FIG, 2013). The method of study was undertaken by bibliographic analysis. This article refers mainly to journals that were published by the Japan Gymnastic Association (JGA), and a list that was made regarding the occurrence of new elements on HB in Men's artistic gymnastics. Additionally, we handle video of different World Championship.

Today we can obtain information of new elements by FIG Newsletters (FIG, 2006, 2008, 2010, 2011, 2012, 2013, 2014, 2015). New elements are named after the gymnasts that was first performed by (FIG, 2013). The new element must be performed successfully in order to be recognized as a new element in FIG regular competition as Olympic Games, World Championship, World Cup, etc (FIG, 2013).

RESULTS

HB Elements in CoP 2013 (FIG, 2013) have been classified into five groups:

1. Long hang swings and turns
2. Flight elements
3. Elements near the bar ("in-bar" elements)
4. El-grip and dorsal hang elements
5. Dismounts

Long hang swings and turns

Various types of one arm giant swing were characterized by the 1970s and 1980s. For example, the one arm giant swing backward (360°) that was performed by Tong Fei in the 1979 (JGA, 1995) and the giant swing forward with one arm in under grip (360°) was performed by unknown Soviet gymnast in Soviet Cup in the 1978 (Kurihara, 1982). The one arm giant swing forward with 1/1 turn to el-grip and 1/1 turn to undergrip was performed by Zou Li Min in the 1985 World Championship. At that time, various types of the one arm giant swing had a major impact in combination with flight elements. In recent years, new elements performed in this group are the giant swing backward with hop 3/2 turns to double el-grip or the flying giant swing backward with 2/1 turns (JGA. dep. S, 2004). The giant swing backward. with hop 3/2 turns to double el-grip was performed by Rybalko (KAZ) in the 1993 World Championships. The flying giant swing backward with 2/1 turns was performed by Mizutori (JPN) in the 2004 japan national NHK Cup. And I earned information that Filip Yanev (BLU) applied this element in the 2004 Olympics. But I can't be made confirmation that did he perform. The flying giant swing backward with 1/1 turn that many gymnasts perform was first performed by Thomas (USA) in the 1979 world cup (Kurihara, 1982).

Flight elements

Recent years, this group was most promoted in men's artistic gymnastics. Dynamic flight elements had captivated not only gymnastics officials but also the audience. The back uprise and piked vault with 1/2 turn to hang or the back uprise and rear vault with 1/4 turn to hang were the mainstream until the 1970, but Jäger (DDR) performed the swing backward and salto forward straddled to hang in the 1974 World Championships (Kurihara, 1982). In response to this event, new flight elements were performed one after another by improvement of the protector and apparatus, and development of skills. In 1977, Markelov (URS) performed the back uprise and straddled hecht with 1/2 turn to hang (Kurihara, 1982), Tkachev (URS) performed the swing forward and vault

backward straddled hang (Kurihara, 1982) and Deltchev (BLG) performed the swing forward and salto backward straddled with 1/2 turn to hang (Kurihara, 1982). The double salto backward tucked over the bar was performed by Kovacs (HUN) in the 1979 further (Kurihara, 1982). In 1980, Yamawaki (JPN) performed the Markelov with legs together in Japan national NHK Cup, Gaylord (USA) performed the salto forward over the bar in the USA Inter College Competition (Kurihara, 1982). Also the czech giant and vault backward straddled to hang were perfprmed by Jonson (USA) (Kurihara, 1982).

Development of flight elements were accelerating 1980s. Deff (FRA) performed the Gienger 1/1 turn in the 1981 World Championships (Endo, 2000) and Winkler (DKP) performed the salto forward stretched with 1/1 turn (JGA, 1995). Pogorelov (URS) performed the salto forward stretched with 1/1 turn from el grip in the 1982 (Japan Gymnastics Association of department of study (JGA. dep. S.), 1982b), Gaylord (USA) and Balabanov (URS) perfprmed new elements in the 1984 each other (JGA, 1995; JGA. dep. S. 1985). Pineda (MEX) performed the Gienger with 1/2 turn over the bar in the 1985 World Championships and Xiao Ruizhi (CHN) performed the swing forward and counter salto forward straddled to hang in the 1986 World Cup (Tumura and Mori, 1986). Also in the 1988, the Tkatchev stretched and the Tkatchev stretched with 1/1 turn performed by Liukin (URS). Li Chunyang (CHN) performed the salto forward stretched from el-grip in the 1989 World Championship (JGA. dep. S. 1990b), Ambros (DDR) performed the Kovacs stretched (Goto, 1990) and Li Jing (CHN) performed the Gaylord piked in the 1989 Chunichi cup (JGA. dep. S. 1989c).

Many new flight elements were performed 1990s and 2000s. Kolman (SLO) performed the Kovacs with 1/1 turn in the 1992 European Championships (Shiraishi and Takaoka, 1992), Pegan (SLO) performed the Gaylord with 1/2 turn in the 1994 European Championships (JGA. dep. S. 1994). The stoop circle forward to straddle cut with 1/2 turn and the Stalder 1/2 turn to rear vault with 1/4 turn to hang were performed by Carballo (ESP) (JGA, 1998). Cassina (ITA) performed Kovacs stretched with 1/1 turn in 2001. Now, for top gymnasts have become essential in order to win that learn the high difficulty flight elements the Cassina. In 2010, Kulesza (POL) performed the Tkatchev stretched with 1/2 turn to double el-grip (FIG, 2011), Munoz (ESP) performed the Yamawaki 1/2 turn streched to mixed grip into back uprise to handstand in the 2011 World Championships (FIG, 2012).

Elements near the bar ("in-bar" elements)

This group has developed around the free circle backward straddled together through handstand that was first performed Stalder in the 1952 Olympic (Kurihara, 1982) and the free circle forward straddled together through handstand that was first performed Endo (JPN) in the 1964 Olympic (Kurihara, 1982). Homma (JPN) performed the Stalder with 1/2 turn through handstand in 1973 (JGA. dep. S., 1974), and Mizushima (JPN) performed the Stalder with hop 1/1 turn through handstand in 1990 Japan national individual events competition (JGA. dep. S. 1990a). The main trend this group to combination of group 1 to the Stalder and the Endo. For example, there are elements such as the Endo with 1/1 turn through handstand in el-grip, another example there is the Stalder with hop 3/2 turn through handstand in el-grip (FIG, 2013).

El-grip and dorsal hang elements

Group 4 has been most developed in the 1960s. Steineman (SUI) performed the from dorsal hang, uprise forward to suppport rearward in 1933 (Kaneko and Kishino, 1970). Ono (JPN) performed the from dorsal hang, uprise with 1/2 turn to support in 1960 (Kurihara, 1982), Kerdemildi (URS) performed the giant swing rearways forward (Russian giant) in the 1960 Olympic (Kurihara, 1982).

Skoumal (ČSSR) performed the giant swing backward with inlocation during swing in the 1966 (Kurihara, 1982). Elements of group 4 have almost completed the 1980s. The stoop in shoot and 1/1 turn through handstand in Mixed grip was performed by Li Ning (CHN) in the 1985 World Championships (JGA. dep. S. 1986). This element has been often performed at present, because the rule that gymnast get the additional point in combination with elements of more Zhan D values and Flight elements of more than D value. Recently, Likhovitskiy (BLR) performed the Koste 1/2 turn to elgrip in 2013 European Championships (FIG, 2014).

Dismounts

Schwarzman (GER) performed the Hecht straddled in the 1952 Olympics (Kurihara, 1982), Endo (JPN) performed the Hecht with 1/1 turn in 1964 Tokyo Olympics (Kurihara, 1982). Soshin (URS) performed the double salto backward pike in 1965, and Lisitsky (URS) performed the salto backward stretched with 2/1 turns in 1967. This group of elements developed rapidly since the 1960s. Straumann (SUI) performed the double salto backward tucked over the bar in 1970, Tsukahara (JPN) performed the double salto backward tucked with a 1/1 turn in the 1972 Olympics, and Andrianov (URS) performed the triple salto backward tucked in the 1974 World Championships.

In 1980, more high-value elements emerged. Watanabe (JPN) performed the double salto backward stretched with 2/1 turns in 1983 World Championships, Hoffmann (DDR) performed the triple salto backward tucked over the bar in 1984 Moscow and Riga Competition. Elements of forward somersault dismounts were also developed during time. Rumbutis performed the triple salto forward tucked in the 1986 Chunichi Cup. Bell (DDR) performed the triple salto backward tucked with a 1/1 turn in the 1987 European Championship. Moreover, Fedorchenko (KAZ) performed the double salto backward stretched with 3/1 turns in 1995 World Championship. All competitors performed the Watanabe in the event finals of the 2012 Olympic Games. Fardan (DEN) performed the triple salto backward piked in the 1996 European Championship.

Improvement of equipment and hand guards

The advancement of horizontal bar techniques in gymnastics closely corresponds to the development of equipment and hand guards. The horizontal bar of the Olympic Games in 1924 had a diameter of 32mm, a height of 230cm, a width of 220cm; but by the end of 1980, the bar improved with a diameter of 28mm, a height of 255cm, a width of 240cm (Ichiba, 2005, pp.171-172). These changes were made possible by more advanced mechanisms for changing the height of the horizontal bar; therefore flight duration became longer. In addition, the wire supporting the horizontal bar changed to a double wire from a single wire to ensure resilience and stability. Today, the bar is highly elasticity, durable, thinner, and easier to grip all of which make it easier to execute more movement-rich swings.

The role of improved hand guards in the advancement of horizontal bar technique should not be dismissed. Changes in hand guards in the late 1970 have been confirmed to have played an important role in the development of horizontal bar technique, along with the official changes in equipment standards for the rings and horizontal bar in particular (Ichiba, 2005, pp.96-97). According to Ichiba " hand guards were originally used so as to protect performers' palms. At that time, they were still small and used on their palms adherently. They were shifted from the stage of passive and protective function to the next stage that provided the supportive function against oscillation by making a cuff near the finger hole (This cuff sometimes includes padding). Hand guards became larger as well as longer to create folded, but also more robust protection in the belted portion of the wrist. The larger hand guards not only provided passive protection but also served

to support swing by strengthening swings and swing support while supporting the wrist and strengthening the grip by creating a core, a folder and a robust belt section. In other words, technological development of equipment and hand guards is directly related to the development of more challenging elements.

We aren't supposed to forget Pits. Pits are the facilities where a chip of urethane and a sponge was filled in one serving in the hole opened in a landing part. Even if these facilities fall from the beginning, the impact is absorbed sufficiently. Safety started to be secured. Fear to a fall was taken by development in a pit, and a change had occurred to practice method. A challenge to new elements which weren't considered up to now became possible. Besides, development of Landing mat were changed to more soft more thicker to make absorbing an impact landed.

The trend toward more difficult moves

Future trends in horizontal bar elements should consider the perspective of the transition to the CoP. The CoP in gymnastics is the competition scoring system and is intended to guarantee fair competition through objective rules.

According to Kaneko (Kaneko, 2005a, p.248), Trends in the development of elements fall roughly into two types. One is to make conventional technique more complicated, and the other is to create quite a new technique that is completely original in its form.

A development of a more complex structure, for example, was the addition of 1/1 or 2/1 turns to a double somersault. Shirai (JPN) performed the salto backward with 4/1 turns in Floor Exercise (FX), and the round off, handspring backward and salto backward 3/1 turn in Vaulting Table (VT) to add difficulty to existing elements.

Examples of original forms are the flair in side support performed by Thomas in Pommel Horse (PH) in the 1970s and the round off, handspring backward and salto backward performed by Yurchenko in VT in the 1980s.

When new elements in recent years will be see, A almost elements are added to elements of existence or combined elements of existence and elements of existence. Its tendency was omened from 30 years ago.

An incident in 1984 reflects this trend toward new elements Because of Los Angeles Olympic Games, TV and Olympic became now strongly linked and globalization was realized in gymnastics. According to Watanabe (Watanabe, 2005, p.7) ”Rule to understand that everyone in gymnastics globalized, score anyone to convince”. An example of such globalization is the impact of scoring system, which handles only elements described in the CoP. That is to say, judge activity was inclining toward the quantitative way that everyone knows.

In 1993, the added point for by proficiency and originality were eliminated (Japan Gymnastics Association, 1993) and were replaced by added point to the combination or elements of difficulty D, E. According to Watanabe (Watanabe, 2005, p.5), “The difficulty of judging “what motion is worth bonus” had been pointed out since then. As judges in charge of evaluation in international competitions have their own physical culture from their backgrounds and moreover their judgments in these scoring areas would be reflected on the results of performers directly, there were probably many judges who insisted their opinions and wouldn’t withdraw them” Additional points that are difficult to conceptually justify were also eliminated. In other words, the scoring system for competitions handles the elements described in the CoP, but some have noted that growing trend increasing the rotational speed of the elements has gained social gymnastics of the “civil rights” (Watanabe, 2005, p.5-6). Simultaneously, quantitative scoring criteria involved angle, deduction, and execution of the elements. Ishida (Ishida,1995, p.16) said that evaluation of gymnastic performance that was observed with the point of view centered on its quality, some of which only specialists could appreciate, has had the remarkable

tendency to judge a performance by replacing it with physical quantity that anybody can understand.

In 1997, compulsory routines were abolished (JGA, 1997). Kaneko noted, "Attracted by commercialism of the media, significant compulsory performances were thoughtlessly abolished … Since the contents in the compulsory performance are identified to every performer, it is the only way to develop a new technique that has never seen and approach the limit of the same technique in order to win. Then there is no way but developing the technique of a performer who has ability to practice such a new technique, therefore creation of a new technique is regard as a subject at any cost" (Kaneko, 2005a, p.248). Some have argued that appearance of new elements would diminish after compulsory routines were abolished, and primary means of innovation will be adding complexity to the existing elements.

Furthermore, in 2006, the 10-point system was abolished. Under the current rules, in order for the top gymnasts to earn high scores, they must perform 10 elements of as high difficulty as possible in five events without the VT. Therefore competitors and coaches consider it preferable to learn the skills common to all events, rather than the skills specific to each event. For example, the double salto backward tucked with a 1/1 turn can be used on the horizontal bar and the double salto backward tucked with a 1/1 turn can be used on the Ring, "Tkachev" can be used on the horizontal bar and the swing forward, straddle cut backward, and regrasp with straight body at horizontal can be used on the Parallel Bars. Hence, there is common tendency to train for skills transferable to other events, which is considered one of the reasons for the tendency for existing elements with added complexity to be performed. For these reasons, the creation of completely new forms is unlikely to occur.

This is reflected in elimination of the added point for originality in 1993, the elimination of compulsory routines in 1997, and the establishment of new scoring rules since 2006. When such process is surveyed, future trends for new elements in the future are likely to involve adding extra complexity to existing elements rather than creating original ones up to now.

Table 1
Group 1 - Long hang swings and turns

Elements	Performer	Year	Competition	Reference
Swing backward and pirouette to hang	Unknown	1889	Paris	Kinoshita, 2001
Swing backward and pirouette to support	Boiko (URS)	1971	Japan VS Soviet Union	JGA. dep. S., 1972
Giant swing forward. with one arm in under grip (360°)	Unkown (URS)	1978	Soviet Cup	JGA. dep. S., 1978
One arm giant swing backward (360°)	Tong Fei (CHN)	1979	Unknown	JGA, 1995
Flying giant swing backward with 1/1 turn	Thomas(USA)	1979	World Cup	JGA. dep. S., 1979
On 1 arm, giant swing forward with 1/1 turn to el-grip and 1/1 turn to under grip	Zou Li Min (CHN)	1985	World Championships	video
Giant swing backward with hop 3/2 turns to double el- grip	Rybalko (KAZ)	1993	World Championships	video
Back uprise to handstand with 1/1 turn also to mixt	Karbanenko (RUS)	1993	World Championships	JGA. dep., S. 1993
Flying giant swing bwd. with 2/1 turns	Mizutori (JAP)	2004	Japan National NHK Cup	JGA. dep., S.2004

Table 2
Group 2 - Flight elements

Elements	Performer	Year	Competition	Reference
Back uprise and piked vault with 1/2 turn to hang	Voronin (URS)	1965	Unknown	JGA, 1995
Swing backward. and salto forward straddled to hang	Jäger (DDR)	1974	World Championship	JGA. dep. S., 1975
Back uprise and straddled. hecht with 1/2 turn to hang	Markelov (URS)	1977	Moscow News Cup	JGA. dep. S., 1977a
Swing forward and vault backward. straddled to hang	Tkatchev (URS)	1977	World Cup	JGA. dep. S., 1977a
Swing forwd. and salto backward. straddled with 1/2 turn to hang	Deltchev(BLG)	1977	Riga Competition	JGA. dep. S., 1977a
Swing forward and salto backward piked with 1/2 turn to hang (Piked Deltchev)	Gienger (DKP)	1977	World Cup	JGA. dep. S., 1977a
Swing backward and salto forward to hang also from el-grip	Krysin (URS)	1978	World Cup	JGA. dep. S., 1978
Double salto backward tucked over the bar	Kovacs (HUN)	1979	European Championships	JGA. dep. S., 1979
Stoop circle backward to Tkatchev straddled	Yogo (JPN)	1979	Japan national Competition	JGA. dep. S., 1980
Markelov with legs together	Yamawaki (JPN)	1980	Japan national Competition	video
Salto forward over the bar	Gaylord (USA)	1980	USA Inter College Competition	JGA. dep. S., 1981
Czech giant and vault backward straddled to hang	Jonson (USA)	1980	USA Inter College Competition	JGA. dep. S., 1981
Swing forward and salto backward with 3/2 turn to hang	Deff (FRA)	1981	World Championship	Endo, 2000
Salto forward stretched with 1/1 turn	Winkler (DKP)	1981	Unknown	JGA, 1995
Salto forward stretched with 1/1 turn from el grip	Pogorolev (URS)	1982	International Invitation Cup	JGA. dep. S., 1982b
Gienger stretched over the bar	Gaylord (USA)	1984	Unknown	JGA, 1995
Salto forward stretched	Balabanov (URS)	1984	Chunichi Cup	JGA. dep. S., 1985
Gienger with 1/2 turn over the bar	Pineda (MEX)	1985	World Championships	video
Swing forward and counter salto forward straddled to hang	Xiao Ruizhi (CHN)	1986	World Cup	Tumura and Mori, (1986)
Tkatchev stretched	Liukin (URS)	1988	Olympic Game	Kinoshita, 2001
Tkatchev stretched	Nishikawa (JPN)	1988	Olympic Game	Kinoshita, 2001
Tkatchev stretched with 1/1 turn	Liukin (URS)	1988	Moscow News Cup	Kinoshita, 2001
Kovacs stretched	Ambros (DDR)	1989	World Championships	Goto, 1990
Gaylord piked	Li Jing (CHN)	1989	Chunichi Cup	JGA. dep. S., 1989c
Kovacs with 1/1 turn	Kolman (SLO)	1992	European Championships	Shiraishi and Takaoka, 1992
Tkatchev straddled with 1/2 turn to mix el-grip intoback upraise to handstand	Lynch (USA)	1992	'92 Phar-Mor U.S. Gymnastics Championships	www.youtube.com
Gaylord with 1/2 turn	Pegan (SLO)	1994	European Championships	JGA. dep. S., 1994
Stoop circle forward to straddle cut with 1/2 turn	Carballo (SPA)	1996	Olympic Game	video
Gienger from Czech Giant Swing	Sapronenko (LAT)	1997	World Championships	FIG, 2014
Stalder 1/2 turn to rear vault with 1/4 turn to hang	Carballo (SPA)	1998	European Championships	JGA. dep. S., 1998
Kovacs stretched with 1/1 turn	Cassina (ITA)	2001	World Championships	JGA. dep. S., 2002
Carballo with 1/2 turn to mixed el-grip	Quintero(COL)	2002	World Championships	JGA. dep. S., 2003
Quintero to el-grip	Quintero(COL)	2002	European Championships	JGA. dep. S., 2003
Pegan Pike	Maras (GRE)	2006	European Championships	FIG, 2014

Tkatchev stretched with 1/2 turn to mix el-grip into back upraise to handstand	Moznik (CRO)	2007	World Championships	FIG, 2008
Piatti stretched with 1⁄2 turn to mixed el-grip and back uprise to handstand	Kierzkovski (POL)	2009	World Championships	FIG, 2015
Tkatchev stretched with 1/2 turn to double el-grip	Kulesza (POL)	2010	World Championships	FIG, 2011
Gaylord from el-grip	Maras (GRE)	2011	World Championships	FIG, 2012
Yamawaki 1/2 turn streched to mixed grip into back uprise to handstand	Munoz (SPA)	2011	World Championships	FIG, 2012
Kovacs with 2/1 turns	Bretschneider (GER)	2014	DTB Team Challenge	FIG, 2015

Table 3
Group 3 - Elements near the bar ("in-bar" elements)

Elements	Performer	Year	Competition	Reference
Free circle backward. straddle through handstand	Stalder (SUI)	1952	Olympic Game	Kaneko, 1976
Free circle forward. straddled together through handstand	Endo (JPN)	1964	Olympic Game	JGA. dep. S., 1965
Stalder with 1/2 turn through handstand	(William Bill)	-1958	(Intercollege competition)	(Abie Grossfeld, 2010)
	Honma (JPN)	1973	International Invitational Competition	JGA. dep. S., 1974
Endo in el-grip through handstand	Gienger (DKP)	1974	World Championship	JGA. dep. S., 1975
Stalder with hop 1/1 turn through handstand	Mizushima (JPN)	1990	Japan national individual Events Competition	JGA. dep. S., 1990a

Table 4
Group 4 - El-grip and dorsal hang elements

Elements	Performer	Year	Competition	Reference
From dorsal hang, uprise forward to suppport rearward	Steineman (SUI)	1933	Gymnastics Festival in Stuttgart	Kaneko and Kishino, 1970
Giant swing rearways forward (Russian giant)	Kerdemildi (URS)	1960	Olympic Game	Kaneko, 1976
Steineman uprise with 1/2 turn to support	Ono (JPN)	1960	Olympic Game	Kaneko, 1976
Giant swing backward with inlocation during swing	Skoumal (CEZ)	1966	World Championships	JGA. dep. S., 1967a
Endo in el-grip through handstand	Gienger (DKP)	1974	World Championships	Kurihara, 1982
Stoop in shoot and 1/1 turn through handstand in mixt grip.	Li Ning (CHN)	1985	World Championships	JGA. dep. S., 1986
Stoop in shoot and hop 1/1 turn through handstand to mixed el-grip or Adler hop with 1/1 turn to mixed el-grip	Baldauf (AUT)	2012	Cottbus World Challenge Cup	FIG, 2015
Koste 1/2 turn to el-grip	Likhovitskiy (BLR)	2013	European Championships	FIG, 2014

Table 5
Group 5 - Dismounts

Elements	Performer	Year	Competition	Reference
Hecht straddled hecht	Schwarzman (GER)	1952	Olympic Game	Kaneko, 1976
Hecht with 1/2 turn	Ono (JPN)	1956	Olympic Game	Kaneko, 1976
Hecht with 1/1 turn	Endo (JPN)	1964	Olympic Game	JGA. dep. S., 1965
Salto backward piked with 1/1 turn	Watanabe (JPN)	1965	Japan VS Soviet Union	JGA. dep. S., 1966
Double salto backward piked	Soshin (URS)	1965	Japan VS Soviet Union	JGA. dep. S., 1966
Salto backward stretched with 2/1 turn	Lisitsky (URS)	1967	European Championships	JGA. dep. S., 1967b
Salto forward. piked with 1/2 turn	Hayata (JPN)	1968	Japan National NHK Cup	JGA. dep. S., 1969
Double salto backward tucked over the bar	Straumann (SUI)	1970	Universiade	JGA. dep. S., 1970
Double salto backward tucked with 1/1 turn	Tsukahara (JPN)	1972	Olympic Game	JGA. dep. S., 1972
Double salto forward tucked	Schubert（DDR）	1973	International Berlin Cup	JGA. dep. S., 1973b
Triple salto backward tucked	Andrianov (URS)	1974	World Championships	JGA. dep. S., 1975
	(Mark Davis)	1971	(NAAU Championships)	(Abie Grossfeld, 2010)
Double salto backward stretched	Roschukin（URS）	1974	Chunichi Cup	JGA. dep. S., 1975
Double salto backward tucked with 2/1 turn	Kajiyama (JPN)	1976	Olympic Game	JGA. dep. S., 1976b
Salto backward stretched with 3/1 turn	Morisue (JPN)	1976	Japan National Competition	JGA. dep. S., 1976a
Double salto backward tucked with 1/1 turn over the bar	Kitagawa (JPN)	1978	International Shanghai Cup	JGA. dep. S., 1978
Double salto forward. tucked with 1/2 turn	Shimizu (JPN)	1978	International Strasbourg Cup	Kurihara, 1982
Double salto backward stretched with 1/1 turn	Unknown (CUB)	1979	World Championships	JGA. dep. S., 1980
Double salto backward stretched with 2/1 turn	Watanabe (JPN)	1983	World Championships	JGA, 2007
Triple salto backward tucked over the bar	Hoffmann (DDR)	1984	Moscow and Riga Competition	JGA. dep. S., 1985
Triple salto forward tucked	Rumbutis (URS)	1986	Chunichi Cup	JGA. dep. S., 1987a
Triple salto backward tucked with 1/1 turn	Belle (DDR)	1987	European Championships	JGA. dep. S., 1987b
Double salto backward stretched with 1/1 turn over the bar	Hayden (USA)	1988	American Cup	Video
Double salto backward stretched with 3/1 turn	Fedorchenko (KAZ)	1995	World Championships	JGA. dep. S., 1996
Triple salto backward piked	Fardan (DEN)	1996	European Championships	Takeda, 1996

CONCLUSIONS

This paper was to collate data elements on the horizontal bar (HB) in men's artistic gymnastics and summarized the history of their occurrence, which has not been done in recent years. I think that new elements of chronological table in HB should be corrected by a formal document many times. We have to carry gymnastics history in the next generation.

REFERENCE

Atiković, A. (2014). Development and Analysis Code of Points (CoP) in Men's Artistic Gymnastics (MAG) from the 1964 to 2013 year. In M. Bučar Pajek et al (eds.). *Final program, invited proceedings, book of abstracts and book of proceedings*. Ljubljana: Slovenian Gymnastics Federation, 2014, str. 22-35. http://issuu.com/revija.gimnastika/docs/2014_zbornik_tehnicni

Eckhard. H. (2011). *Bernd Jäger: A gymnastics innovator turns 60!*. Retrieved May 6, 2015, from GYMmedia. com web site: http://www.gymmedia.com/artistic-gymnastics/Bernd-Jaeger-gymnastics-innovator-turns-60

Endo, Y. & Ono, Kiyoko. (1982). *Taisoukyougi wo mirutameno Honn [Book to watch in Artistic Gymnastics]*. Tokyo: Douwashoinn.

Endo, K. (2000). Taiso Daijitenn 147 kai [Dictionary of Gymnastics 147th]. *Gekkann sports eye,* 60-61.

Endo, K. (2001) Taiso Daijitenn 154 kai [Dictionary of Gymnastics 154th]. *Gekkann sports eye*, 60-61.

Endo, K. (2001) Taiso Daijitenn 155 kai [Dictionary of Gymnastics 155th]. *Gekkann sports eye*, 60-62.

FIG. (2006). *Code of points Men' s Artistic Gymnastics*. Lausanne: Fédération Internationale de Gymnastique.

FIG. (2008). The MTC *Newsletter No. 22*, July 2008.

FIG. (2009). *Code of points Men' s Artistic Gymnastics*. Lausanne: Fédération Internationale de Gymnastique.

FIG. (2011). The MTC *Newsletter No. 25*, January 2011.

FIG. (2012). The MTC *Newsletter No. 26*, January 2012.

FIG. (2013). *Code of points Men' s Artistic Gymnastics*. Lausanne: Fédération Internationale de Gymnastique.

FIG. (2014). The MTC *Newsletter No. 27*, March 2014.

FIG. (2015). The MTC *Newsletter No. 28*, February 2015.

Gajdoš, A. (1997). *Artistic Gymnastics: A History of Development and Olimpic Competition*, Leicestershire: Loughborough University

Grossfeld, A. (2010). A history of United States artistics gymnastics. *Science of Gymnastics Journal*, *2*(2), 5-28.

Grossfeld, A. (2014). Changes during the 110 years of the world artistic gymnastics championships. *Science of Gymnastics Journal, 6*(2), 5-27.

Goto, Y. (1990). Dannshi Testubo Jiyuu Enngi no Hikaku [Comparison to Horizontal bar in Men free exercise]. *Kennkyu Buho*, *64*, 77-81.

Hayashi, M., & Endo, K. (1987). 87 Yôroppa Sennshukenntaikai Houkoku [Report of European Championships Championship in 1987]. *KennkyuBu jyoho*, 2, 38-40.

Ishida, Y. (1995). Kunnstturnen und seine Bewertung (in Japanese). *Journal of Gymnastics Research*, *3,* 9-10.

Jair Lynch (1992). *US Olympic Trials High Bar.* (n.d). Retrieved May 6, 2015, from

https://www.youtube.com/watch?v=u_Sj-fOyBZ8

JGA. (1975). *Code of Points Men Artistic Gymnastics 1975 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1979). *Code of Points Men Artistic Gymnastics 1979 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1985). *Code of Points Men Artistic Gymnastics 1985 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1989). *Code of Points Men Artistic Gymnastics 1989 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1993). *Code of Points Men Artistic Gymnastics 1993 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1997). *Code of Points Men Artistic Gymnastics 1997 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

JGA. (1995). *sixty years history of Japan Gymnastics Association*. Tokyo: Japan Gymnastics Association, 181-187.

JGA. (2001). *Code of Points Men Artistic Gymnastics 2001 years edition* (in Japanese). Tokyo: Japan Gymnastics Association.

Japan Gymnastics Associatio. (2007). *Taiso Kyougi Shashinn Taikan* [Pictures of Encyclopedia in Artistic Gymnastics]. Tokyo: I-O-M.

Japan Gymnastics Association of department of study. (1974). *Kennkyu Buho*, *34*, 6-7.

Japan Gymnastics Association of department of study. (1982a). *Kennkyu Buho*, *51*, 14-15.

Japan Gymnastics Association of department of study. (1982b). *Kennkyu Buho, 52*, 10.

Japan Gymnastics Association of department of study. (1985). *Kennkyu Buho*, *54*.

Japan Gymnastics Association of department of study. (1986). *Kennkyu Buho*, *56*, 8-9.

Japan Gymnastics Association of department of study. (1987a). *Kennkyu Buho*, *58*, 17-18.

Japan Gymnastics Association of department of study. (1987b). *KennkyuBu jyoho, 2*, 6.

Japan Gymnastics Association of department of study. (1989a). *Kennkyu Buho*, *63,* 8.

Japan Gymnastics Association of department of study. (1989b). *Kennkyu Buho, 64*, 20.

Japan Gymnastics Association of department of study. (1989c). *KennkyuBu jyoho, 4,* 8.

Japan Gymnastics Association of department of study. (1989d). *KennkyuBu jyoho*, *4,* 18.

Japan Gymnastics Association of department of study. (1990). *Kennkyu Buho, 65,* 11-12.

Japan Gymnastics Association of department of study. (1990). *Kennkyu Buho*, *65*, 20.

Japan Gymnastics Association of department of study. (1993). *KennkyuBu jyoho, 8,* 6.

Japan Gymnastics Association of department of study. (1994). *KennkyuBu jyoho,* 9, 21.

Japan Gymnastics Association of department of study. (1996). *KennkyuBu jyoho*, *10*, 65-66.

Japan Gymnastics Association of department of study. (1998). *Kennkyu Buho*, *81*, 5.

Japan Gymnastics Association of department of study. (2003). *Kennkyu Buho*, *90*, 39-40.

Japan Gymnastics Association of department of study. (2004). *Kennkyu Buho*, *93*, 3.

Japan Gymnastics Association of department of study. (2006). *Kennkyu Buho*, *97*, 15-16.

Kaneko, A. and Kishino, Y. (1970). *Tetsubou Unndou no Coach [Coaching of Horizontal Bar]*. Tokyo: Taishuukan.

Kaneko, A. (1974). *Taiso Kyougi no Coaching [Coaching of Artistic Gymnastics]*. Tokyo: Taishuukan.

Kaneko, A. (2005a). *Shintaichi no Keisei Jyo [Mold of bodily knowledge the 1st volume]*. Tokyo: Meiwashuppann.

Kaneko, A. (2005b). *Shintaichi no Keisei Ge [Mold of bodily knowledge the 2nd volume]*. Tokyo: Meiwashuppann.

Kaneko, A. (2007). *Shintaichi no Kozou [Structure of bodily knowledge]*. Tokyo: Meiwashuppann.

Kato, S. (1996). Der größte Beschluß von Vollversammlung der F.I.G. im Jahre 1994 und seine Einfluß auf die

Trainingsgegenwart des Turnens (in Betreff der Abschaffung von Pflichtwettkampf), *Ibaraki Journal of Health and Sport Sciences*, *14*, 1-8.

Kinoshita, H. (2001). Zur Entwicklungstendenz der Flugelemnte am Reck (in Japanese). *Journal of Gymnastics Research*, *9*,21-34.

Kondo, A. (1985). Moscow Riga Taikai Hokoku [Reports of Moscow and Riga competition]. *Kennkyu Buho*, *54*, 1-5.

Kondo, A. and Tsumura, J. (1988). Dai 24 kai Taisokyogi Sekaisennshukenn Taikai Hokoku [Reports of 24th World championship]. *Kennkyu Buho*, *60*, 1-21.

Kondo, A. and Hayashi, M. (1995). 95 nenn Yôroppa Sennshukenntaikai Houkoku [Report of European Championships Championship in 1995]. *Kennkyu Buho*, *75*, 1-17.

Kurihara, H. (1982). Tetsubo ni okeru Shingi no Shutsugenn to sono Hennsenn [Transition and Appearance for new elements of Horizontal Bar in Men Artistic Gymnastics]. *Kennkyu Buho*, *50*, 95-106.

Marijo Možnik (2015) (n.d). Retrieved May 6, from http://hr.wikipedia.org/wiki/Marijo_Možnik

Marijo Možnik (2015): *Ako se nešto ne pokrene bojim se da nećemo imati nasljednike.* (n.d). Retrieved May 6, from http://www.zg-sport.com/marijo-moznik-ako-se-nesto-ne-pokrene-bojim-se-da-necemo-imati-nasljednike/

Sato, T., Taguchi, H. Brüggemann, P., & Zilmaz, A. (1995). Eine Betrachtung über die Beschleunigungstechnik im Vorschwung beim gestreckten Doppelsalto rückwärts am Reck :Vergleoch zwischen dem chinesisichen und japanischen Typ (in Japanese). *Journal of Gymnastics Research*, *3*, 37-47.

Shiraishi, Y. & Takaoka, O. (1992). Dai 20 kai Yôroppa Danshi Taisoukyogi Sennshukenntaikai Houkoku [Reports of 20th European championship in Men Artistic Gymnastics] (in Japanese). *KennkyuBu jyoho*, *7*, 38-43.

Takeda, Y. (1996). 1996 nenn Danshi Yôroppa Sennshukenntaikai Houkoku [Reports of European championship in Men Artistic Gymnastics in 1996] (in Japanese). *Kennkyu Buho*, 77, 1-11.

Tsuchiya, J. Katase, F., & Akaba, A. (2002). 2001 Sekai Taiso Senshuken Ghent Taikai Hokoku・Kyogi bunnseki [2001 Analyses and Reports in World championship in Ghent]. *Kennkyu Buho*, *88*, 8-21.

Tumura, J., & Mori, A. (1986). 86 World cup Pekinn Taikai Hokoku [Report of world cup in Beijing in 1986]. *Kennkyu Buho, 57*, 1-16.

Watanabe, N. (1994). Morphologische Betrachtung des Stilwandels der Turnkunst (in Japanese). *Journal of Gymnastics Research*, *2*, 47-58.

Watanabe, N. (2005). Zum Stilwandel der Turnkunst (in Japanese). *Journal of Gymnastics Research*, *13*, 1-9.

.

Corresponding author:

Moriatsu Nakasone
Biwako Seikei Sports College
1204 Kitahira,
Otsu-shi, Shiga
Japan 520-0026
Phone : +81-77-596-8458
Fax : +81-77-596-8419
Email : nakasone@bss.ac.jp

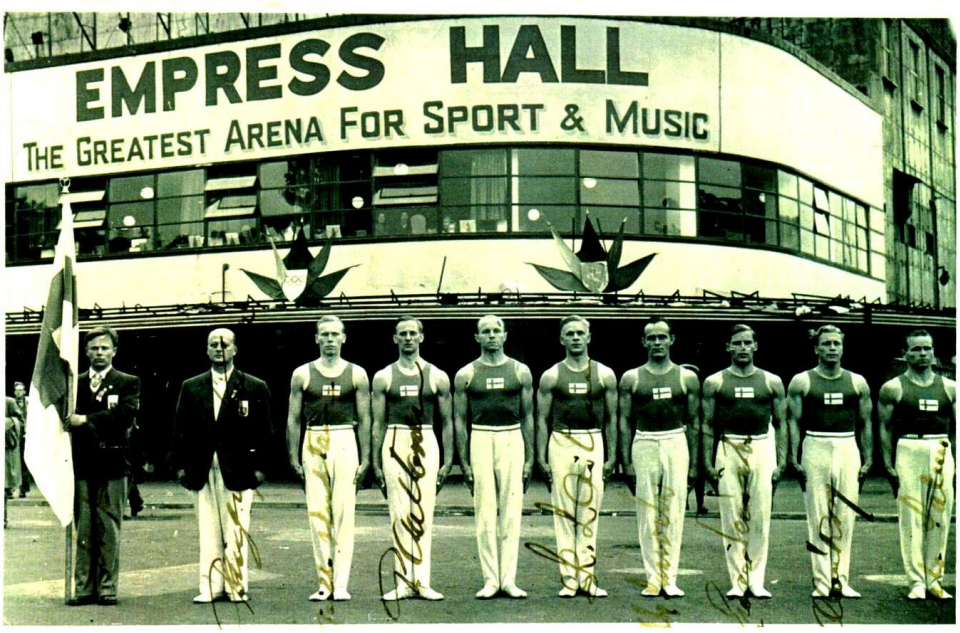
SHORT HISTORICAL NOTES IV

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.

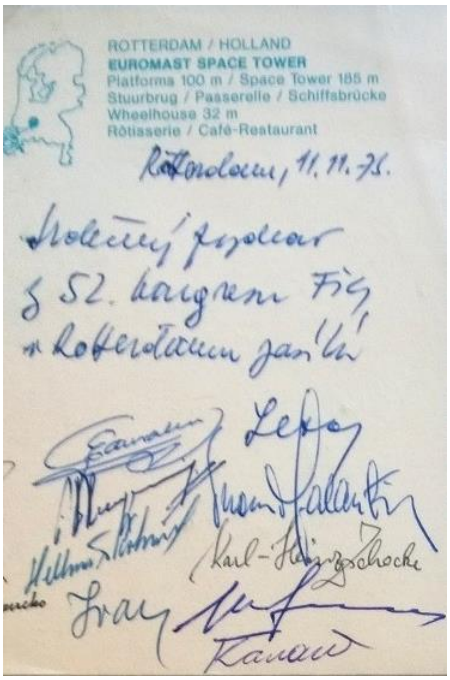
FINLAND MEN TEAM AT OG 1948

The first Olympic Games after the WWII were in London (GBR) in 1948. At the competition, dominated countries, which were not severely demolished during the war. On the top after 2 consecutive 3rd places at 1932 Los Angeles (USA) and 1936 Berlin (GER), Finland steped to the top. Team consisted of Veikko Huhtanen (also won all around), Paavao Aaltonen (in all around he placed 3rd), Kalevi Laitinen, Olavi Rove, Einari Teräsvirta and Heikki Savolainen. Finland won gold in front Switzerland for a small margin with result 1358.30 to 1356.70. Finland team was also very successful on apparatus. Veikko Huhtanen was 3rd on horizontal bar, 2nd on parallel bars. Paavao Aaltonen won vault, while Olavi Rove wqas 2nd. On pommel horse all thre medals went to Finland – 1st Paavao Aaltonen, 2nd Veikko Huhtanen and 3rd Heikki Savolainen. Finland only on floor exercise and rings did not received a medal. For Finland this team is the most succesfull team ever. On photo below Esa Seeste – the flagman, competed at OG 1936 in Berlin.



ESA SEESTE, BIRGER STENMAN (Trener), VEIKKO HUHTANEN, PAAVO AALTONEN, HEIKKI SAVOLAINEN, KALEVI LAITINEN, ALE SAARVALA, EINARI TERÄSVIRTA, OLAVI ROVE, SULO SALMI.

AKITOMO KANEKO (Japan)



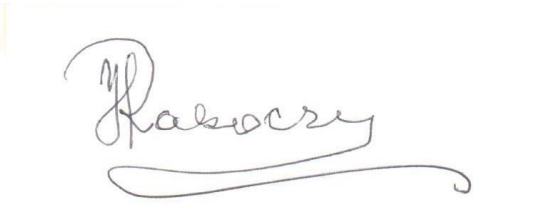
Despite Professor Akitomo Kaneko as a gymnast, was not often decorated with medals, he was the most important person in making Japanese gymnastics the best in sixties and seventies of twentieth century. As a gymnast, he was part of Japonese team at OG 1952 in Helsinki (FIN), where team ranked 5th and Akitomo 21st in all around. Even better result was for Japan 2 years later at WC 1954 in Rome (ITA), where team ranked 2nd and Akitomo 19th in all around. His knowledge of biomechanics, gymnastics technique, methods made Japan gymnasts the best in the world. He served also as FIG MTC member for a long time.

On the left regards from MTC, Kaneko's signature on the bottom, included signs from Aleksander Lylo (Lexa)(CZE, former TCH), Tuomo Jalantien (FIN), Karl Heinz Zchocke (GER, former DDR), Boris Sachlin (UKR, former URS)

Japan team at WC 1954 in Rome, from left Kubota, Kono, Takemoto, Nabeya, Ono and Kaneko.

HELENA RAKOCZY (Poland)

Born (23.December 1921) and died (2. September 2014) in Krakow (Poland). She competed at two Olympic Games in Helsinki (FIN) 1952 and Melbourne (AUS) 1956. At Helsinki OG she made a mistake and she was 43rd in all around and with team 8th. In Melbourne she did much better, 8th in all around and 5th on uneven bars, while team was 4th. Her most glorious moment was in Basel, at World championship in 1950 , where she won all around, vault, beam and floor exercise, on uneven bars she took silver. At WC in Rome (ITA) in 1954 she was 3rd in all around and also 3rd on uneven bars.



Slovenski izvlečki / Slovene Abstracts

Luiz Henrique Duarte, Myrian Nunomura, Michele Viviene Carbinato

ORODNA TELOVADBA IN STRAH: VZROKI ZA STRAH

Na področju psihologije športa je skoraj enotno mnenje med strokovnjaki, da pozitivna in negativna čustva neposredno vplivajo na športno uspešnost. Pri orodni telovadbi ni nič nenavadnega, da se telovadci soočijo s posebnim, značilnim čustvom strahu. V študiji smo analizirali strah, ki ga telovadci čutijo pri vadbi, da bi odkrili subjektivne zaznave o vzrokih strahu in strategij, uporabljenih za njegovo obvladovanje. S šestnajstimi telovadci, ki tekmujejo v kategoriji dečkov (9 - 10 let) na državnem prvenstvu Sao Paula so bili opravljeni pogovori. Analiza vsebine pogovorov je zaznala štiri vzroke za strah: strah pred poškodbo, strah pred napako, strah pred orodjem in strah pred trenerjem. Za obvladovanje strahu smo odkrili sedem načinov: socialna podpora (prijatelji in družina), podpora z dodatnim informiranjem, povečana pozornost in koncentracija, pozitivno mišljenje in samozavest, duševne prakse in tehnike sproščanja. Na splošno lahko vaditelji močno vplivajo na izkazovanje strahu, kot tudi pri njegovi kontroli. Med možnimi pedagoškimi ravnanji, lahko izpostavimo prilagoditve okolja vadbe in učnih postopkih, ki zagotavljajo uspešen proces učenja, zlasti v zvezi z čustvom varnosti.

Ključne besede: telovadci, čustva, strah, varnost, psihološki pristop, kvalitativne raziskave.

Evdoxia Kosmidou, Miltiadis Proios, Evgenia Giannitsopoulou, Theofanis Siatras, George Doganis, Michalis Proios, Helen Douda, Anna Fachantidou-Tsiligiroglou

VPLIV POSEBNEGA PROGRAMA NA OCENJEVANJE LASTNEGA TELESA, PREHRANJEVALNE NAVADE IN PRITISKA DA SI SUH PRI RITMIČARKAH

Cilj raziskave je bil ugotovit, kako vpliva poseben 3 mesečni program na mišljenje ritmičark o njihovi telesni samopodobi, odnosu do prehrane in pritisku, da si suh. Vzorec je sestavljalo 49 grških ritmičark (29 v poskusni in 20 v kontrolni skupini). Obe skupini sta izpolnili vprašalnik na začetku in koncu raziskovanega obdobja. Rezultati so pokazali, da je imela poskusna skupina ob koncu višje vrednosti telesne samopodobe, znižale so odnos do prehrane (pomembnost prehrane, zmanjšanja telesne teže, odnos do bulimie) in zmanjšal se je pritisk, da bi morale biti suhe pri starših in vaditeljih. Pri kontrolni skupini so bili rezultati ravno nasprotni. Poskusna skupina je tudi ocenila program kot izjemno primeren za ritmičarke z različnih vidikov.

Ključne besede: ritmika, odnos do lastnega telesa, prehrana.

Yoshie Motoshima, Junichi Kitagawa, Akira Maeda

POVEZANOST MED MEHANSKIMI SPREMENLJIVKAMI PRI ODRIVU NA PRESKOKU IN ODRIVU PO GLOBINSKEM SKOKU

Na preskoku je odriv z odrivne deske izjemno pomemben za uspešen preskok in za izvajanje vedno težjih preskokov. Ob poznanih kinematičnih značilnostih posameznega skoka, pa smo ugotovili, da bi bilo pomembneje poznati dinamične lastnosti odriva. Zato smo želeli ugotoviti povezanost med odrivom na odrivni deski in odrivom po globinskem skoku v laboratoriju s poudarkom na indeks RDJ (razmerje med časom trajanja odriva in časom leta). Sedem telovadcev je izvedlo Kasamacu preskok in izmerjeni so bili s 3D kinematičnim sistemom MAC3D. Ob tem so izvedli globinski skok z višine 0,4 metra brez pomoči zamah rok z odrivne deske in brez odrivne deske. Kasamacu RDJ indeks je bil povezan s RDJ indeksom globinskega skoka samo na odrivno desko, ne pa tudi brez odrivne deske. Meritve sposobnosti odrivne moči v laboratoriju bi bilo smiselno prilagoditi dejavnosti v živo.

Ključne besede: preskok, navpični impulz sile, globinski skok, RDJ indeks.

Helmut Geiblinger, Tony Dowden

RAZMIŠLJANJA O KONTROLIRANEM DOSKOKU NA TEKMOVANJU V ORODNI TELOVADBI: POGLED STROKOVNJAKOV

Seskoki z orodja so sestavljeni iz večkratnega vrtenja okoli različnih osi, izvajajo jih vrhunsko pripravljeni telovadci, seskoki zahtevajo veliko poguma in virtuoznost se izkazuje v natančno organiziranem gibanju in spretnostih. Seskok in doskok zapuščajo končno sliko sestave in so pogosto ključ do uspešne ocene pri sodnikih. Doskoki zahtevajo natančno kontrolo delovanja telesa in spretno spreminjanje gibanja delov telesa. Cilj raziskave je bil ugotoviti kako doskoke vrhunskih telovadcev vidijo oči strokovnjakov. 21 strokovnjakov – vrhunskih vaditeljev, vrhunskih telovadcev in mednarodnih sodnikov je sodelovalo pri raziskavi. Strokovnjaki so izpostavili kar nekaj pomebnih dejavnikov, ki jih ni zaznati v strokovni literaturi. Strokovnjaki so poudarili pomembnost varnosti in pomembnost nadzorovanja in spreminjanja mednarodnih pravil ocenjevanja, ki bi lahko izboljšala naš šport.

Ključne besede: tehnika doskoka, strategije doskoka, najboljša skladnost delovanja telesa.

Klaus Hübner, Christoph Schärer

ODNOS MED RAZOVKO V RAZPORI, RAZOVKO V OPORI IN RAZPORO NA KROGIH IN NJIHOVIMI PRIPRAVLJALNIMI VAJAMI MOČI

Na krogih so prvine moči odločujoče. Za razvoj moči se na vadbi izvajajo različne pripravljane vaje. Vendar odnos med pripravljalnimi vajami in prvinami moči do sedaj ni bil dobro raziskan. Cilj raziskave je bil ugotoviti povezanost med močjo pri sedmih pripravljalnih vajah in izvedbo treh pomembnih prvin moči razovke v razpori, razovke v opori in razpore. Deset telovadcev švicarske državne ekipe je izvedla test 1RM (maksimalni dvig bremene, ki ga lahko izvedeš samo enkrat) in trajanjem drže pri prvinah moči. Značilna povezanost je bila le med razovko v razpori in predvajo razovke v razpori v leži na hrbtu (r: 0.71, p: 0.031) in iztegi rok v leži na hrbtu "Bench press" (r: 0.71, p: 0.046); razovko v opori in predvajo razovke v razpori v leži na hrbtu (r: 0.69, p: 0.039). Razpora je bila povezana s razporo na pasu in škripcu (r: 0.66, p: 0.051) in iztegi rok v leži na hrbtu (r: 0.67, p: 0.069). Ugotovili smo da je potrebno najmanj 1RM od 73.4% telesne mase za uspešno izvedbo razovke v razpori v leži na hrbtu za izvedbo razovke v razpori. Za izvedbo razovke v opori je potrebno 1RM od 67.4% telesne mase pri razovki v razpori v leži na hrbtu.

Ključne besede: telovadba, RM, razovka v razpori, razovka v opori, razpora.

Dejan Križaj, Ivan Čuk

ALI LAHKO UPORABLJAMO MINIATURNI POSPEŠKOMETER PRITRJEN NA ODRIVNO DESKO ZA ANALIZO ODRIVA?

V članku raziskujemo metrične značilnosti Mikro-Elektro-Mehaničnega (MEMS) pospeškometra pritrjenega na odrivno desko. Iz izmerjenega pospeška smo izračunali hitrost odrivne deske in pot odrivne deske. Izmerjenih je bilo 43 odrivov. Vse dobljene rezultate smo filtrirali z Butterworthovim filtrom četrtega reda in frekvenco loma 250 Hz. Izračunane so bile naslednje spremenljivke: čas do najnižje točke odrivne deske, največja pozitivna in negativna hitrost, čas za dosego teh hitrosti. Dobljeni rezultati so bili primerjani z referenčnim visoko natančnim laserskim merilcem razdalje. Pospeškometer ima zadovoljivo zanesljivost in veljavnost, napaka v primerjavi z laserskim merjenjem je povsod manjša od 5,3%, razen pri oceni največje pozitivne hitrosti, kjer je napaka 15, 3%, zato menimo, da je naprava primerna za analizo skokov.

Ključne besede: metrične značilnosti, zanesljivost, veljavnost, preskok.

Catarina Leandro, Lurdes Ávila-Carvalho, Elena Sierra-Palmeiro, Marta Bobo

NATANČNOST OCENJEVANJA TEŽAVNOSTI SESTAV POZAMEZNIC PRI RITMIČARKAH

Cilj študije je bil preveriti natančnost sojenja težavnosti na svetovnem prvenstvu v ritmiki v Kievu leta 2013. Natančnost je bila ocenjena gleda na skladnost sodnikov pri vrednotenju težavnosti prvin. Vrednoteno je bilo 1152 obrazcev težavnosti pri 288 sestavah posameznic - 4 obrazci težavnosti na sestavo, 1 na sodnico. Da bi lahko primerjali ritmičarke različnih kvalitetnih razredov, so bile razdeljene v tri skupine, glede na končno razvrstitev na tekmovanju. Težavnosti prvin so bile opredeljene, kot jih opredeljuje pravilnik FIG za ocenjevanje iz leta 2012. Neparametrijska testa Cochran's Q in hi kvadrat test sta bila uporabljena za oceno razlik med kvalitetnimi skupinami. Najpomembnejša ugotovitev je, da se sodnice kar pri 40% težavnosti med seboj niso strinjale. Tako je natančnost ocenjevanja težavnosti nizka, prav tako v »Master« in »DER« skupini težavnosti prvin.

Ključne besede: ocenjevanje, natančnost, sojenje, ritmika.

Moriatsu Nakasone

RAZVOJ PRVIN NA DROGU GLEDE NA JAPONSKE VIRE

V današnjem pravilniku FIG za ocenjevanje v moški orodni telovadbi je okoli 800 prvin. Za malo teh prvin se natančno ve, kdaj so bile prvič izvedene, kdo jih je prvič izvedel in kje jih je izvedel. Namen članka je bil raziskati pojavnost prvin na drogu z namenom predvideti nove prvine. Uporabljena je bila bibliografska metoda. V članku so predvsem uporabljeni japonski viri, izdani s strani Japonske telovadne zveze in narejen je bil seznam glede na čas pojavitve posamezne nove prvine. Upoštevane so bile različne izvedbe posameznih prvin, npr. Tkačev je izvedel iz predkoleba skok nazaj raznožno v ponovni prijem leta 1979 na svetovnem pokala. Prvič sta stegnjenega Tkačeva izvedla Ljukin in Nišikava na olimpijskih igrah leta 1988 v Seulu. Napredek na drogu so omogočili predvsem razvoj orodja in razvoj prvin. V prihodnosti lahko predvsem pričakujemo prvine z dodanimi obrati.

Ključne besede: moški, orodna telovadba, zgodovina.

Maria Raquel Gonçalves e Silva

Alimentação na Ginástica: de Pais para Filhos

FGP

Título: Alimentação na Ginástica: de Pais para Filhos
Autor: Maria Raquel Gonçalves e Silva
Edição: Federação de Ginástica de Portugal
Criação e composição gráfica: Nuno Almeida
Capa: Nuno Almeida
Revisão: Paulo Barata
Impressão e acabamento: SILTIPO - Artes Gráficas
Tiragem: 500 exemplares
Editado em: Janeiro, 2015

ISBN: 978-989-8650-53-5
Depósito Legal n.º 387948/15

A autora ainda não aderiu ao Novo Acordo Ortográfico.

Estrada da Luz, 30 A ::: 1600 - 159 Lisboa
T. +351 218 141 145 ::: F. +351 218 142 950
https://www.facebook.com/ginasticaportugal?fref=ts
www.fgp-ginastica.pt

Índice


Maria Raquel Gonçalves e Silva
Teresa Paiva
Sono, Nutrição,
Ritmo Circadiano,
Jet Lag e Desempenho
Desportivo
FGP

E-mail: gympor@gympor.com

Título: Sono, Nutrição, Ritmo Circadiano, Jet Lag e Desempenho Desportivo
Autores: Maria Raquel Gonçalves e Silva & Teresa Paiva
Edição: Federação de Ginástica de Portugal
Criação e composição gráfica: Nuno Almeida
Capa: Nuno Almeida
Revisão: Paulo Barata
Impressão e acabamento: SILTIPO - Artes Gráficas
Tiragem: 500 exemplares
Editado em: Janeiro, 2015

ISBN: 978-989-8650-54-2
Depósito Legal n.º 387950/15

As autoras ainda não aderiram ao Novo Acordo Ortográfico.

Estrada da Luz, 30 A ::: 1600 - 159 Lisboa
T. +351 218 141 145 ::: F. +351 218 142 950
https://www.facebook.com/ginasticaportugal?fref=ts
www.fgp-ginastica.pt

Índice

István Karácsony, Ivan Čuk

Horizontal Bar

(Methods, Ideas, Curiosities, History)

2015

Authors : István Karácsony, Ivan Čuk

Title: Horizontal bar (methods, ideas, curiosities, history)

Published by Ivan Čuk s.p., Podpeška 51, Brezovica pri Ljubljani

Photo: Enes Hodžić Lederer, Simon Trček

Illustraded: Attila Rácz

Reviewers: Ph. D. Bojan Jošt, Ph.D. Milan Čoh

Printed by Demago d.o.o.,Slovenia

Printed: 50 pieces

Price: 15 euros

Authors are grateful to the Slovenian Ministry of Education, Science and Sport, Slovenia Research Agency, The Slovenian Foundation of Sport and the Hungarian Gymnastics Federation for their support in the realization of specific chapters of this book.

CIP - Kataložni zapis o publikaciji, Narodna in univerzitetna knjižnica, Ljubljana

796.41

KARACSONY, Istvan

Horizontal bar : (methods, ideas, curiosities, history) / István Karácsony, Ivan Čuk ; [photo Enes Hodžić Lederer, Simon Trček ; illustraded Attila Rácz]. - Brezovica pri Ljubljani : I. Čuk, 2015

ISBN 978-961-285-012-8

1. Čuk, Ivan, 1961-

281695744

Orders: ivan.cuk@fsp.uni-lj.si

1

International Scientific Conference
Sport Health & Education
Complementary Approach to Gymnastics

Visegrad Fund

LECTURES AND BOOK OF ABSTRACTS

18-20th of June 2015

Organizers:

Gdansk University of Physical Education and Sport

In cooperation with the:
Matei Bel University in Banská Bystrica, Slovakia
University of Debrecen , Hungary
Charles University in Prague, Czech Republic
University of Ljubljana, Slovenia
Kazimierz Wielki University, Poland
National University of Physical Education and Sport of Ukraine in Kiev

THE HONORABLE PATRONAGE:

Prezydent Miasta Gdańska Paweł Adamowicz

Sopot

Marszałek Województwa Pomorskiego Mieczysław Struk

Polski Związek Gimnastyczny

MEDIA PATRONAGE:

SCIENCE OF GYMNASTICS JOURNAL

Radio Gdańsk

HONORARY COMMITTEE

Waldemar Moska

Magnificence Rector of *Gdansk University of Physical Education and Sport,*

Pavol Bartík

Vice-Dean for International Cooperation of Faculty of Arts Matei Bel University in Banská Bystrica,

László Csernoch

Vice Rector for Science, *University of Debrecen,*

Eva Kohlíková

Dean of Faculty of Physical Education and Sport *of Charles University in Prague,*

Ivan Svetlik

Magnificence Rector of *University of Ljubljana,*

Sławomir Kaczmarek

Vice Rector for Science and International Relations *, Kazimierz Wielki University in Bydgoszcz,*

Dutchak Miroslav

Vice Rector for Science and Research, *National University of Physical Education and Sport of Ukraine,*

Leszek Blanik

Member of Parliament of The Poland Republic,

Jarosław Wałęsa

Member of European Parliament.

SCIENTIFIC COMMITTEE

ORGANIZING COMMITTEE

Andrzej Kochanowicz – *chairman*

Jan Mieszkowski – *vice-chairman*

Bartłomiej Niespodziński – *secretary*

Aleksander Drobnik

Mirosława Szark-Eckardt

Adam Szulc

Monika Żmudzka-Brodnicka

Hanna Żukowska

Wiesława Pilewska

INVITED SPEAKERS

Almir Atiković (BIH) Faculty of Physical Education and Sport, University of Tuzla.

Pavol Bartík (SVK) Department of Physical Education and Sports, Matei Bel University in Banská Bystrica.

Elena Bendíková, (SVK) Department of Physical Education and Sports, Matei Bel University in Banská Bystrica.

Maja Bučar Pajek, (SVN) Gymnastics and Kinesiology Department, University of Ljubljana.

László Csernoch, (HUN) Department of Physiology, Department of Otorhinolaryngology and Head and Neck Surgery, Medical and Health Science Centre, University of Debrecen.

Ivan Čuk, (SVN) Head of Gymnastics and Kinesiology Department, University of Ljubljana.

Miroslav Dutchak (UKR) National University of Physical Education and Sport of Ukraine.

Roman Farana, (CZE) Human Motion Diagnostics Centre, Department of Human Movement Studies, University of Ostrava.

Soňa Formánková (CZE) Department of Sport, Palacky University in Olomouc.

Karol Görner (SVK) Department of Physical Education and Sports, Matei Bel University in Banská Bystrica.

Thomas Heinen, (GER) Institute of Sports Science, University of Hildesheim.

Eva Kohlíková, (CZE) Department of Physiology and Biochemistry, Charles University.

Juraj Kremnický, (SVK) Department of Physical Education and Sports, Matei Bel University in Banská Bystrica.

Soňa Kremnická , (SVK) Department of Physical Education and Sports, Matei Bel University in Banská Bystrica.

Elena Lusenko (UKR) Department of theory and methodology of sports training and backup capabilities athletes, National University of Physical Education and Sport of Ukraine**.**

Michel Marina Evrard, (ESP) National Institute of Physical Education (INEFC), University of Barcelona**.**

Falk Naundorf, (Germany) Institute for Applied Training Science, Department Strength-Technique, Leipzig.

Dymytriy Nikonorov (UKR) National University of Physical Education and Sport of Ukraine.

Oksana Shinkaruk (UKR) Research Institute of the National University of Physical Education and Sport of Ukraine.

Pia M Vinken, (GER) Institute of Sport Sciences, Georg-August-Universität Göttingen.

INVITED SPEAKERS

HANDGRIP IN ARTISTIC GYMNASTICS, Ivan Čuk

Faculty of Sport, University of Ljubljana, Slovenia

In artistic gymnastics, (AG) contact with apparatus can be on different body parts. On uneven bars, parallel bars, rings, pommel horse and horizontal bar the most important contact with apparatus is with handgrip, while on floor, beam and vault most used contact is with feet, and hand contact is the second most used contact. Two main documents define handgrip in artistic gymnastics prepared by International Gymnastics Federation (FIG), Code of Points (for Men AG and Women AG) and Apparatus Norms. Besides both documents, next decisive factors are anatomy of hand and biomechanics of element. Code of points with its definition of element difficulty is mostly consistent with anatomy, however it sometimes requires extreme flexibility, and while Apparatus Norms have its lacks as morphologic characteristic of gymnasts are changing, while norms persist constant. Element's biomechanics have impact on handgrip (in some cases were recorded loads on hands over 13G), which can be performed only with use of safeguards. As apparatus are made of different materials (e.g. wood, metal) use of magnesium carbonate on some apparatus is required to minimize moisture, however it raises friction (what is in sometimes in gymnasts' favor and sometimes not). While in contact with apparatus palm skin temperature rise or lower according to all above factors. There are some acute and chronic injuries directly related to handgrip e.g. blisters. Also new apparatus can be developed with better handgrip adjustment.

THE ROLE OF VISUAL PERCEPTION IN THE CONTROL AND ACQUISITION OF GYMNASTICS SKILLS, Thomas Heinen

Institute of Sport Science, University of Hildesheim, Germany

Expert gymnasts are able to perform complex skills, such as a double somersault with double twist with ease. On first sight, such skills are complex and it seems unclear how they are regulated. The theoretical position of perception-action coupling holds the view that when an actor (a gymnast) moves in a particular, yet dynamic environment, he/she grabs up information from the environment, which in turn is used to regulate action in order to achieve a particular movement goal. The coupling between perception and action is influenced by task demands and mental representations an actor possesses. The most dominant information source in perception-action coupling is visual information and it is argued that skilled gymnasts optimize their visual information pickup to best serve the task demands in complex skills. Therefore, gymnasts optimize their gaze behavior as well as the information that is extracted from the environment. Gymnasts seem to regulate complex skills, on the basis of visually perceived environmental cues, whereas different cues may guide different aspects of a particular skill. For gymnastics training this perspective could imply different strategies, such as directing gaze when

performing a particular skill, and/or highlighting specific informational sources from the environment during skill acquisition processes. Theoretical perspectives, empirical evidences and practical implications concerning the idea of perception-action coupling in complex gymnastics skills will be discussed and critically evaluated.

THE POSSIBLE IMPACT AND SIGNIFICANCE OF ASYMMETRIES IN ARTISTIC GYMNASTICS, Maja Bučar Pajek

Faculty of Sport, University of Ljubljana, Slovenia

Gymnastic exercises demand coordination in three space dimensions and time so they are crucially exposed to the possible influence of asymmetry in motor action initiation, performance and finalisation. The symmetry of body may be recognised as a cosmetic component as well as a component of physical abilities. In the Sokol gymnastic organization (one of the main middle Europe's gymnastic societies in the first half of 20th century) special emphasis was laid on equal involvement of musculoskeletal apparatus through distributed employment of exercises for various body parts. There are two critical aspects of possible asymmetric influence: impact on injury risk and impact on results. So far this issue has been understudied.

Does practicing gymnastics promote symmetry in movement and body structure?An important issue regarding the impact of asymmetry in load can be seen from the example of the general structure of balance beam routines as defined by the FIG Code Of Points [2]. Elements are divided into following groups (added number of elements with difficulty, take offs and landing are counted for each figure within difficulty box):

- Mounts – 45 elements – take off with one leg 7, landing with one leg 6;
- Gymnastics leaps, jumps and hops – 35 elements, take off with one leg 17, landing with one leg 22;
- Gymnastics turns – 22 elements, take off (start of turn) with one leg 22, landing (end of turn) with one leg 22;
- Holds and acrobatic non –flight – 18 elements, take off with one leg 18, landing with one leg 12;
- Acrobatic flight - 34 elements, take off with one leg 15, landing with one leg 14;
- Dismounts - 29 elements, take off with one leg 16, landing with one leg 0;

We can see that a big number of elements are defined as one leg take off or one leg landing. At any level of competition in gymnastics the symmetry of exercises is not sufficiently emphasized neither in children, nor in adults. Furthermore, in COP there is no rule or statement on the symmetrical load. So it is evident that current COP and rules do not favour or acknowledge the symmetry of load.

Preferential use of one of the limbs leads to adaptations at morphological, structural and functional levels. The influence of long-term training on anthropometric parametersof rhythmic sports and artistic gymnasts was investigated by Douda et al. [3]and they found significant differences in circumferences between the right and left legs, but surprisingly only in rhythmic gymnasts, not in artistic gymnasts. Another studyassessed theposition of theanterior and posterioriliacspinae. Gymnasts as a group were found to have asymmetrically positioned innominate bones as opposed to non-gymnasts representing thecontrol group. By repeatingasymmetricalphysical activities bilateraldifferencesbetween extremities and bones are expected to enlarge with time.

We have performed a research to study how many elements which asymmetrically load lower extremities are included in balance beam routines of professional female gymnasts.We video-recorded all exercises of qualification round on balance beam at an international competition B World Cup in Ljubljana 2014. We analysed take-offs and landings to define the actions done by left leg, both legs simultaneously, or right leg. A delay of at least 0.01 second in recruitment of one of the lower limbs defined the action as being from a single leg.In the routines of 19 included gymnasts we found significant asymmetry of load: right leg initiated 42.87% of actions (on average 12.47±3.32 per routine), while left leg and both legs initiated 29.08 and 28.05 % of actions (on average 8.58±2.97 and 8.21±3.07 per routine, respectively). The load on right leg was significantly larger compared to left leg and both legs (p=0.002 and 0.003). Only 4 gymnasts (20.8%) loaded left leg more than right leg. It is clear from our results that there is significant asymmetry of the usage of lower limbs at balance beam routines in elite gymnasts.From our results a critical question arises whether asymmetrical load of such a magnitude is acceptable not only for adults, but also children and youngsters. This asymmetrical load may have significant anthropometric, structural and safety impact.

What is the possible impact of asymmetry on the injury risk potential? Niu, Wang, He, Fan and Zhao [5] analysed biomechanical asymmetry between the dominant and non-dominant limb during double-leg landing. They concluded that the non-dominant ankle has a more effective protective mechanism regarding excessive joint motion and that the dominant ankle joint is at a greater injury risk during drop landing. In athletes, the non-dominant leg showed greater cortical bone mineral density than the dominant leg which is used for mobility or manipulation whereas the non-dominant leg lends support during the actions of the dominant leg. It is generally well known that greater bone mineral density is protective against fracture risk.The lateral differences in body structure are not only limited to bone but also ligaments may show side differences. Bohm et al [9] measured mechanical and morphological Achille's tendon properties of the non-dominant and dominant leg by means of ultrasound, magnetic resonance imaging and dynamometry. The Achille's tendon of the dominant leg featured a significant higher Young's modulus and length but a tendency toward lower maximum strain compared with the non-dominant leg. The tendon cross-sectional area and stiffness were not significantly different between sides.

Concerning injury causes Lund and Myklebust found that 84 % of the injuries occurred in the landing phase of the gymnastic skills and most frequently the ankle was injured. The majority of competition injuries (approximately 70 %) resulted also from either landings or dismounts. Some above-mentioned authors reported the same causes without percentages. Most injuries occurred on floor exercise (32.1 %), beam (20.7 %), and bars (17 %). These studies do not, however, evaluate which side of body was affected, whether it was an injury that occurred during performing symmetrical or asymmetrical elements and whether the dominant or non-dominant limb was injured.

What is the possible impact of asymmetry on results? Čuk and Marinšek highlighted the asymmetric activity of the lower limbs when the jump element execution was not technically perfect. In such cases landing on both legs was associated with uneven load distribution. Even elements which are supposed to be performed with both legs simultaneously can have a significant asymmetrical load on lower limbs. This often happens in elements with turns. In general, not many data on this topic is present in the scientific literature and further work should be done to reveal the possible impact of asymmetry on the performance and success in artistic gymnastics.

From the above considerations it is evident that the problem of asymmetry is understudied in artistic gymnastics. We are mainly concerned with the impact on injury risk and the impact on results. There is significant body of evidence showing that the Code of Points predisposes to the asymmetry of load and the current artistic gymnastic practice executes it abundantly. Concerning the injury risk we propose that further research should incorporate laterality data and associate this data with the asymmetry of load. Concerning the general performance and success in element performance a thorough biomechanical and epidemiological studies for separate elements and routines may reveal the possible benefit of increasing symmetry in improving the results. We propose that the problem of asymmetry should not be neglected in the future scientific work in artistic gymnastics, a practice turn from the current situation which could benefit the future developments in this sport.

THE IMPORTANCE OF FUNCTIONAL DIAGNOSTICS IN PREVENTING AND REHABILITATING GYMNAST INJURIES WITH THE ASSISTANCE OF THE TENSIOMYOGRAPHY (TMG) METHOD: A CASE STUDY, Almir Atiković[1], Mitija Samardžija Pavletić[2], Muhamed Tabaković[3]

[1]University of Tuzla, Faculty of Physical Education and Sport, Tuzla, Bosnia and Herzegovina

[2]University of Primorska, Applied Kinesiology, Koper, Slovenia

[3]University of Sarajevo, Faculty of Sport and Physical Education, Sarajevo, Bosnia and Herzegovina

The tensiomiography assessment offers information, in the time domain, regarding the following parameters: maximal radial deformation or displacement of the muscle belly (Dm), contraction time (Tc), reaction time (Td), sustain time (Ts) and relaxation time (Tr).

Four muscles were chosen on both lateral sides regarding the artistic gymnastics the participant are involved in: Biceps Femoris (BF), Erector Spinae (ES), Gluteus Maximus (GM), Rectus Femoris (RM). The testing sample in this survey was taken from Croatian Republic's senior representative, who won third place in the floor routine at the ECh for juniors in 2012 and eight place for seniors three years later 2015.

The testing and measuring took place after he injured the lumbar region of the spinal cord and after a four month long prevention exercise program. After the first two stages of measuring the differences can be found in: BF:-7%; ES:+17%; GM:-8%; RF:+11%. Generally speaking, an dependent t-test did not found significant differences in between in first and second measurment point ($t=1.941$, $df=39$, $P<0.059$).

This approach can be used to investigate high level athletes who are in the process of training for muscle recovery, as a result of skeletal muscle injury.

PERFORMANCE-ENHANCING METHODS IN GYMNASTICS TRAINING, COMPETITION AND RECOVERY – A SPECIAL EMPHASIS ON ELASTIC TAPING, Pia M. Vinken

Georg-August-University Göttingen, Germany

Several methods and techniques such as active and passive warm-up and cool-down-techniques, massage, water immersion, myofascial release as well as taping and bracing are commonly applied to support athletic performance, recovery and. Whereas the implementation

of these methods and techniques is widely common and accepted in gymnastics training and competition, their effectiveness and verification should be outlined in this presentation.

Thereby, a special emphasis is given to the effectiveness of elastic taping: Whether elastic taping is supposed to support muscle and joint. However, when it comes to task- and application-specific effects of elastic taping on athletic performance of healthy, active athletes, elastic taping may have on the one hand a comforting and load-tolerating performance supporting effect, whereas on the other hand some elastic tape applications may have a performance decreasing effect on other parameters of athletic performance.

One superior effect of elastic taping seems to be a differentiated sensory perception of the taped body area, which may function as a supporting and/or prophylactic tool when an athlete believes in its postulated effects, however, this effect could mask performance-decreasing and/or -unchangeable effects may impact overall athletic performance.

EFFECT OF TECHNIQUE SELECTION ON ELBOW LOADING AND MOVEMENT VARIABILITY DURING THE ROUND-OFF IN GYMNASTICS, Roman Farana

Department of Human Movement Studies, Pedagogical Faculty, University of Ostrava, Czech Republic

Chronic elbow injuries from tumbling in female gymnastics present a serious problem for performers. This research examined (a) how the biomechanical characteristics of impact loading and elbow kinematics and kinetics, change as a function of technique selection; and (b) based on a within-gymnast analyses this study aimed to examine of the variability in elbow joint kinematics and kinetics of expert gymnasts in the execution of the round-off with different hand position. Seven international level female gymnasts performed 10 trials of the round-off from a hurdle step to flic-flac with “parallel” and “T-shape” hand position. Synchronized kinematic (3D automated motion analysis system, 247 Hz) and kinetic (two force plates, 1235 Hz) data were collected for each trial. Wilcoxon non-parametric test and effect size statistics determined differences between the hand positions examined in this study. Within gymnast variability was calculated using biological coefficient of variation (BCV) discretely for ground reaction force, kinematic and kinetic measures. Variability of the continuous data was quantified using coefficient of multiple correlations (CMC). Group BCV and CMC were calculated and T-test with effect size statistics determined differences between the variability of the two techniques examined in this study. In conclusion, the T-shape hand position reduces vertical, anterior-posterior and resultant contact forces and a decreased loading rate indicating a safer technique for the round-off. Significant differences observed in joint elbow moments highlighted that the T-shape position may prevent overloading of the joint complex and consequently reduce the potential for elbow injury. Moreover, expert gymnasts displayed higher movement variability in the elbow joint peak abduction angle and adduction moment during the T-shaped hand position compared with parallel hand position whilst performing the fundamental RO skill. This may potentially lead to reducing abduction load and consequently protect the elbow joint from overload and biological failure due to repetitions of the same motor tasks.

COORDINATIVE TRAINING IN GYMNASTICS ON THE STAGES OF COMPREHENSIVE AND DIRECTED SKILLS IMPROVING, Vladimir Lyakh

University of Physical Education in Krakow, Poland

The question of the importance of coordination training (directed development of coordinated motor abilities – CMA) in Gymnastics on the different stages of sports improving is not in doubt among neither theoreticians nor practitioners. At the same time, this important section of gymnasts' training remains one of the least explored.

Consideration of gymnasts' CMA development questions in theory and practice.

Analyses of literature resources, method of expert evaluations, surveys of specialists in CMA development problems and gymnastics coaches (n>20).

On the basis of the conducted research the following aspects of the problem will be covered:

- The aim and goals of the coordinative training in Gymnastics;
- Concepts of the coordinative training in sport;
- The place of general and special coordinative training in the sportsmen' training system;
- The leading CMA determining success in gymnastic exercises training;
- The main provisions of sports training in Gymnastics.

JUMPING PROFILE IN COMPETITION ARTISTIC GYMNASTICS, Michel Marina Evrard

National Institute of Physical Education, University of Barcelona, Spain

To propose a precise jumping performance profile of elite gymnasts, we compared the factors influencing jumping performance between 76 well-trained gymnasts and 91 moderately active subjects. The jumping tests performed on a contact mat were: squat jump (SJ) with progressive loads of 0, 25, 50, 75 and 100% of body mass, counter-movement jump (CMJ), counter-movement jump with arm swing (CMJA), and drop jumps (DJ) performed from 20, 40, 60, 80 and 100 cm heights. The parameters used to assess the jumping performance were flight time (FT, ms), contact time (CT), flight-contact ratio (FC), FT normalized to body mass (FTbm, ms/kg), Bosco expression (BE), estimated elastic component (EC) and arm participation (AP). When using FT to estimate the F-v curve through SJ with overloads, similar results were observed among males. Nevertheless, when FT was normalized to body mass (FTbm), the F-v curve showed the advantage of female gymnasts in particular over their control group when overloads were above 50%. Larger differences between gymnasts and their control groups were observed in CMJ and CMJA, with FTbm instead of FT.EC and AP can be considered as suitable complementary parameters of jumping performance in gymnasts. In DJ male gymnasts scored similar FT to their controls, whereas female gymnasts had significantly longer FT compared to their peers. The gymnasts obtained significantly shorter CT than their control groups, whereas their FC ratios were significantly higher and increased when the height of the drops was close to 60 cm. FT is the less discriminating factor distinguishing gymnasts' DJ performances. Considering CT, FC and BE results all together could better profile the gymnasts' plyometric performance rather than taken separately.

THE USE OF HYPEROXIA TO ACCELERATE RECOVERY AFTER SPECIFIC LOAD IN ARTISTIC GYMNASTICS, Juraj Kremnický, Soňa Kremnická

Department of physical education and sport, Matej Bel University, Banská Bystrica, Slovakia

The research was realized by the form of case study. The research deals with the use of inhalation of concentrated oxygen in the regeneration interval during anaerobic load in Artistic Gymnastics. The aim of research´s realization was to diagnose the impact of inhalation of concentrated oxygen (hyperoxia) on the recovery´s duration on reaction of heart rate and the level of the lactate in capillary blood during intensive specific load of elite gymnasts.

The experiment was realized on three professional gymnasts (members of nation team of Slovakia) during training sessions. The specific load consisted of floor exercises and pommel horse exercise (max repeat double leg circles). During the experiment´s realization, the heart rate of gymnasts was continuously monitored. One minute after each specific load and also after 3,7,15 and 23 minute recovery, we applied measuring of the lactate levels in capillary blood. The experimental factor was anonymous inhalation of concentrated oxygen respectively air (in form of placebo) during the rest. Gymnasts regenerated after each specific load by the form of inhalation of concentrated oxygen or placebo.

Diagnostics´ results after specific load of all professional gymnasts suggest on decrease of anaerobic cover after oxygen´s inhalation and faster lactate´s remetabolisation when comparing with placebo´s inhalation. It was also exhibited the decrease of heart rate with oxygen´s inhalation when comparing with placebo´s inhalation. It was confirmed during the recovery after the floor exercises and also after participating max repeat double leg circles on pommel horse.

According to these information we can consider that that the inhalation of hyperoxic mixture was an appropriate method to accelerate the recovery after specific load of elite gymnasts.

RESEARCH FOR NATIONAL TEAM SUPPORT IN ELITE ARTISTIC GYMNASTICS, Falk Naundorf, Stefan Brehmer, Thomas Lehmann, Ilka Seidel

Institute for Applied Training Science, Leipzig, Germany

The lecture is focused on different parts of scientific support of the German national teams in artistic gymnastics. Foundation of all research questions is the analysis of international competitions (especially Olympic Games and world championships) in gymnastics. Based on the results of analysis of current performances of the best gymnasts in the world and the success or deficit of German national team research tasks were agreed between the German gymnastics federation and the Institute for Applied Training Science. Most of the tasks were applied for junior and senior national team.

- Biomechanical Analysis of difficult elements to compare parameters between international top gymnast and national gymnasts (especially on vault, horizontal bar, uneven bars)
- Development of Measurement and Information Systems (Feedback Systems: Instrumented horizontal bar, uneven bars and vault table to measure forces and synchronized video recording)
- Applying the Measurement and Information Systems in national training camps (give athletes feedback on their current technique to learn new elements or make the performance of elements better)
- Diagnostic of strength and other basic requirements for successful gymnastics

- Measuring of run up velocity on vault
- Analysis of training loads
- Preparation of illustrative material (continuous pictures, video, animations) to support motor learning
- Transfer of knowledge to coaches (presentations in coaches education workshops)

The presentation reflects not only the way of working in Artistic Gymnastics but shows the basic approach of the Institute for Applied Training Science in different kind of sports.

WHAT IS THE FUTURE OF GYMNASTICS IN PHYSICAL EDUCATION – EXPERIENCES FROM EDUCATIONAL INSTITUTIONS IN DENMARK, Finn Berggren

Gerlev Physical Education & Sports Academy, Denmark

The gymnastic history in Denmark is unusual as gymnastic already became compulsory in the schools from 1814.

Even gymnastics have kept a strong position in the physical education curriculum during 200 years then the last 20 years have changed the picture.

The traditional gymnastics have changed dramatically from Olympic style gymnastics to Team Gymnastics and the present and the future will maybe be influenced by the grassroot movement PARKOUR.The development and future will be influenced by following aspects:

A new pedagogical approach to gymnastics
A new style of motivating equipment
A playful approach
A strong influence by Parkour and new kind of activities
A Health Perspective instead of educational and personal development

PHYSICAL ACTIVITY IN RELATION TO SELECTED DETERMINANTS OF ADOLESCENTS' HEALTH, Elena Bendíková, Pavol Bartík

Department of Physical Education and Sports, Faculty of Arts, Matej Bel University, Banská Bystrica, Slovakia

As a result of the insufficient physical activity, the number of secondary school students with major or minor health issues is increasing. This paper presents a pilot observation of a selected health determinant relating to the body weight of students, in particular the physical activities of their exercise regime. The observed group consisted of 96 third- and fourth-year female students of secondary schools from the city of Liptovský Mikuláš. Diagnostics of the primary indicators of the somatic nature as well as other determinants were implemented in 2014, with the help of primary care physicians, based on standardized medical and pedagogical diagnosis, and personal medical history. The results demonstrate that already at such a young age, these students have minor health problems occurring of various combinations, as well as increased body weight (27.84 %) and obesity (5.76 %), which probably resulted from their sedentary lifestyle combined with other risk factors.

INSTRUMENTALITY AND VALUES INAESTHETIC SPORTS, Irena P. Martínková

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

This paper discusses the theme of instrumentality in aesthetic sports(such as, for example, gymnastics and figure skating) and its impact on values that these sports yield for athletes who practise them.

Firstly, instrumentality within sport is identified (i.e. various kinds of relationships of means and ends), which leads to the distinction between purposive and aesthetic sports. While it is claimed that aesthetic sports are less instrumental than purposive ones, it is still possible to find various instrumental relationships in them. I shall present these instrumental features in aesthetic sports and then I shall discuss their consequences for values that arise for athletes in these sports before presenting their ethical implications.

SPORT IS NOT ART (INCLUDING AESTHETIC SPORTS, SUCH AS GYMNASTICS), Jim Parry

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

Firstly I offer an account of the aesthetic as an attitude – as a way of perceiving an object that is value-neutral, non-purposive, and can be taken towards any object whatsoever.

I then define ‘art’ in terms of the aesthetic – art objects are aesthetic artefacts that embody meanings.

Next, I distinguish between purposive sports and aesthetic sports. Purposive sports are clearly not art, even though they can be the subject of art. And neither are aesthetic sports since, although they are aesthetic artefacts, they do not allow for the expression of a view on life issues – on human meanings. So: sport is not art.

HOW THE AGE OF OLYMPIC MEDALIST HAS CHANGED IN THE PAST FIFTY YEARS. A GENDER BASED STUDY, László Csernoch, Nikoletta Kith, Ildikó Balatoni

Department of Physiology, Faculty of Medicine, University of Debrecen, Hungary

Legal endurance training methods, sport outfits, sport instruments, and how the different sport centers are equipped have undergone dramatic changes in the past half century. During our investigation we were aiming to see whether all these advances influenced, if yes, in which direction, the age of the Olympic medalists. These are of special interest since professional teams readily use physiological, mechanical, psychological, and nutritional training when preparing the participants in recent Olympics.

From the Olympic sports those individual events were selected into the analysis which do not require any specific technical instrument that could influence the outcome of the competition significantly, and, furthermore, where a better physical and psychological fitness is likely to be behind the better result. An internet-based database was used for data assembly and a statistical software for analysis.

From 4 sport categories– swimming, fencing, athletics, and pentathlon – 34events were included into the study. The age of all female and male Olympic medalists of these events at the

time of the competition was compared including all fourteen Olympics since 1960 (Rome). Our results show statistically significant changes in the age of the Olympic medalists in certain events. While this tendency is usually and increasing one, a decreasing tendency has also been observed.

There are differences between the different sport events and between the genders within an event in respect how the age of the Olympic medalists has changed in the past half century. Due to these differences in the overall tendency in age it is likely that sport-event specific factors underlie the observations, the study of which requires further investigation. Nevertheless, the average age seems to converge to a defined value in all events tested.

HOSTILITY SYNDROM AS A DISTINCTIVE PROFILE OF THE SPECTATORS OF SPORTS EVENTS, Karol Görner[1], Janusz Zielinski[2], Adam Jurczak[3]

[1]*Faculty of Arts, Matej Bel University, Banska Bystrica, Slovakia*
[2]*Pedagogical department, Institute of Physical Education, University of Rzeszow, Poland*
[3]*Institute of Social Sciences, Academy of Physical Education In Krakow, Poland*

The purpose of the research is an attempt to state the difference In the increase of hostility In two groups of football matches spectators: football fans and hooligans. The study covered 120 respondents, where 50% were the hools, currently known as pseudo fans – the basic group – acting under the banner of Rzeszowian football clubs and the same number of Rzeszow University students who admit to be football fans – the sample group. The respondents were studied with the Scale of Interpersonal Relations (SUI), which allowed us to diagnose the style of functioning in a society and discriminate the personality disorder. Significant for this research, it was possible to define the level of hostility syndrome along with its components among the representatives of these groups. A set of behavioral features typical for this syndrome varies in specific study groups. Socially it exposes, depending on its intensity, among the participants of sports events in the form of specific behaviors. Some of them can be classified as those violating the personal sphere of other spectators, while others fall into the group which, according to the generally accepted standards, manifests the sports successes or defeats of their "beloved" club. Calculating the significance level p for the pairs created in the profiles of the basic and sample groups confirmed the existence of significant differences in their scales of interpersonal relations.

SPORT SESSION

THE IMPACT OF LENGTH, WIDTH AND FLAT FOOT ON BALANCE, Ana Kašček, Ivan Čuk, Suzana Pustivšek, Vedran Hadžić, Maja Bučar Pajek

Faculty of sport, University of Ljubljana, Slovenia

The aim of this study was to find out if the foot morphologic characteristics impact on maintenance of balance position by athletes. Morphologic characteristics of the foot are

described with length, width and flat of the foot. 122 sport students registered in the first class in study year 2011/2012 at Faculty of Sport in Ljubljana were participating in this study. The flat foot was defined with Clark‘s method. The balance was measured with Biodex stability system (BSS) (Biodex Medical Systems Inc, Shirley, NY) under conditions: the hardness of the supporting surface = 4, we made 3 recurrence and 20 second balance maintained. We have calculated the correlation coefficients (Pearson, Kendall's tau b and Spearman's rho) and regression analysis for dependence stability indexes (Overall stability index (Osi), Anterior/Posteriorstability (A/Psi), Medial/Lateralstability (M/Lsi)). Results for the right leg, within the error of 5%, are pointing on the influence of the foot’s length on all three of the stability indexes (Osi: p = 0,001, A/Psi: p = 0,001, M/Lsi: p = 0,006). Results for the left leg are also showing on the influence of foots length on Osi (p = 0,035) in A/Psi (p= 0,027), while M/Lsi (p= 0,073) there is none. Flat foot has no influence over stability indexes.

INTER-RATER RELIABILITY IN EVALUATING MEN'S TRAMPOLINE ROUTINES AT EUROPEAN CHAMPIONSHIPS 2014, Bojan Leskošek[1], Ivan Čuk[1], Cesar J.D. Peixioto[2]

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

Inter-rater reliability of judging of men's trampoline routine at European Championships (EC) 2014 in Guimarães, Portugal were analyzed. 66 men, of whom 4 and 15 does not complete all 10 jumps in their exercise with special requirements and voluntary routines, competed in qualification round. Old, classic format of scoring, where the execution score is sum of the scores of individual judges (discarding lowest and highest score) was compared with new format, where only the median scores of each jump are summed for the final score. Intra-class correlation (ICC) coefficients for both absolute agreement (ICC(A)) and consistency (ICC(C)) model and Kendall's coefficient of concordance W were computed. For the classic scoring format, extremely high reliability was found with all ICC coefficients above .99 and Kendall's W above .97 in both exercise with special requirements and voluntary routines. In new scoring format reliability of individual jumps was much lower with ICC coefficients around .90 and W coefficients around .70. Although Pearsonian correlation coefficients between old and new format scores were high (r=.965 and r=.997 for exercise with special requirements and voluntary routines, respectively), there were some important differences in rankings of competitors between old and new scoring format (Spearman rank correlation rho=.94 and rho=.96 for exercise with special requirements and voluntary routines, respectively). The results suggest high reliability of judging trampoline routines. However, any changes to scoring format should be implemented with caution.

GROUP ACROBATIC ROUTINES – »TEAMGYM«, Karmen Šibanc

Faculty of Sport, Universityof Ljubljana, Slovenia

TeamGym is a sport discipline which originates from Scandinavia. It dates back to the past,but the first official European Championship was organized in 1996. The sport began to spread quite quickly and today it is well known all over the world. Compared to Artistic Gymnastics, TeamGym is based on the teams overall performance and is known only as a team

sport. The competition consists of three apparatus – Floor, Trampet and Tumbling. On each apparatus the team performs a routine to music. It is about the performance of the whole team, which is marked on the gymnastic routine and series of acrobatic elements. This will give the team a total score. The competition is for Men, Women and Mixed Teams which consist of 8 to 12 members. On the Trampet and Tumbling the team performs three different rounds of acrobatic elements. Each round is performed by 6 members of the team. The Floor Program consists of a choreographed routine that is based on different gymnastic elements where the whole body is engaged and must fulfil different requirements. TeamGym should be represented to Gymnastics Teachers, Coaches, Gymnasts, and also to people of other sports. Development of TeamGym in Slovenia started 20 years ago with good success at international competitions, but then the activity in TeamGym almost completely TeamGym is a team sport that follows trends and global development. The way the group works, way of its actions, progress and its appearance is based on a fact that all team members work as one. It is about the fact that this sport follows the world trends of encouraging teamwork.disappeared.

REACTION TIME AND MOVEMENTS FREQUENCY ABILITIES OF RHYTHMIC AND ARTISTIC GYMNASTS, Tatiana Poliszczuk[1], Dmytro Poliszczuk[2], Daria Broda-Falkowska[1], Ewa Jankowska[1]

[1]*Department of Gymnastics and Sports for All, Josef Pilsudski University of Physical Education, Warsaw, Poland*

[2]*Department of Physiology, Josef Pilsudski University of Physical Education, Warsaw, Poland*

Gymnastic exercises are characterized by complex movement structure, performance usually takes place in a very short period of time but with the large muscular effort. Frequent changes of body segments position require gymnasts quick reaction and precision movements at high frequency.

The aim of the study was to compare reaction time and movements frequency abilities of Rhythmic (RG) and Artistic Gymnasts (AG), (aged 14-19 years) taking into account the age category and the specificity of sport discipline.

The study was performed among 41 highly trained athletes aged 14-19 years. Contestants were divided into two groups - according to sport discipline: 24 rhythmic gymnastics and 17 artistic gymnastics, - due to the age category: juniors, seniors. Training experience of the study participants ranged between 6 and 13 years. The study used two Vienna Test System (VTS): RT Reaction Time (S1) and MLS Motor Performance Series (Subtest Tapping).

RG group achieved better results in motor time test compared with AG ($p < 0,05$). At the master level AG are characterized by higher movement frequency than RG ($p < 0,001$). Similar results were found in reaction time test, motor time test and movements frequency test among the two groups of juniors.

In gymnastics in the case of the movements frequency and motor time the high level of one ability determines increasing the level of the second ability. The study found that tested abilities have improved with age and training experience among all study participants.

The study was supported by MNiSW Grant No. AWF – DS-175.

THE IMPORTANCE OF MORPHOLOGICAL FEATURES AT THE STAGE OF INITIAL AND TARGETED SPORTS TRAINING IN FEMALE SPORTING GYMNASTICS, Wiesława Pilewska, Robert Pilewski, Agnieszka Barczewska

Institute of Physical Culture, Kazimierz Wielki University in Bydgoszcz, Poland

The aim of the study was to answer the following questions: What are the characteristics of female gymnasts' somatic build at the stage of the initial and targeted training? Does somatic build, at different stages of sports training, determine the achievement of sporting success and do the possible determinants change collaterally with the stages of sports training?

The study involved 18 girls at the age of 8–20, practicing sporting gymnastics at Bydgoski Klub Sportów Gimnastycznych "Zawisza".

Anthropometric measurements of somatic characteristics – width, length, perimeter and weight – were conducted. The obtained results were subject to anthropology-specific classifications and a statistical analysis.

In the majority of cases, girls practicing sporting gymnastics presented parameters of weight, body height and BMI index characteristic for younger age groups. 94.4% of gymnasts were characterized by proper body weight. Among the researched group: 94.4% had a short torso, wide shoulders (88.8%), narrow pelvis (94.4 %), short upper limbs (77.8%) and short lower limbs (94.4%), stocky shoulders (61.1%) slender lower arms (100%), slender thighs (72.2%) and shanks (100%). 94.4% of girls were characterized by leptosomatic body build. Somatic build was related to the sports level that changed collaterally with the stages of sports training. The values and indicators of selected morphological features have shown that the level of sport performance has changed collaterally with particular stages of sports training.

AEROBIC AND ANAEROBIC METABOLISM IN YOUNG MALE GYMNASTS, Piotr Sawicki

Faculty of Physical Education, Gdańsk University of Physical Education and Sport, Poland

One of the aim of the study was to describe physiological factors in young boys participating in the artistic gymnastic training process and to evaluate differences between the levels of aerobic and anaerobic efficiency in this group as compared to the control group.

In the present study took part young male gymnasts (G) participating in the training process since 6 years (n=12, 11-12 y.o.) and control group (n=12) boys participating in the physical education classes (K). Aerobic efficiency was evaluated using Wingate test (30 sec) for upper arms. The test was executed on hand ergometer (Monark). Adjusted load was defined on the level of 50g/kg of body mass. Aerobic efficiency was defined using gradual effort to exhaustion for lower limbs on the pedaling ergometer with simultaneous breathing gases analysis (Oxycon Pro). Statistical analysis was done using t-Student test (S-10).

In the examination of anaerobic efficiency for upper arms parameters: work, mean power and peak power were higher in the G group as compared to the K group, while power decline (%) appeared to be lower. The test to exhaustion showed that G group achieved lower results comparing to K group , the values were respectively: 48.32ml $\cdot$ $kg^{-1.}$ min^{-1} and 56ml $\cdot$ $kg^{-1.}$ min^{-1} ($p \leq 0.05$).

The present study demonstrated that aerobic metabolism predominate in the control group compared to gymnasts. Early specialization in young male gymnasts showed advantage of anaerobic metabolism with simulations decreasing the “proper” aerobic metabolism

development. Executing Wingate test using upper arms in gymnasts group was more convenient and precise according to anaerobic efficiency.

METHODOLOGICAL REFLECTIONS OF PUBLISHED ARTICLES IF FIELD OF RHYTHMIC GYMNASTICS, Ruzena Popovic

Faculty of Sport and Physical Education, University of Nis, Serbia

Former Yugoslavia is a country from which many studies on Rhythmic Sports Gymnastics (RSG) have originated. Between 1950th and 1991st at least 150 papers were published in official Serbo-Croatian language. Examined papers were subdivided in two periods (1950-1975, and 1976-1991). The published papers from the third period (1992-2015) are mostly examined in this study, which contain about 30 manuscripts. In the first period, many of published papers studied aspects of the harmonious development of the body achieved through participation in some kind of rhythmical activities. In the second period, a significant percentage of published papers examined the relationship between some segments of anthropological status of female athletes and their subsequent success. The main goal of this study was to systematically analyze and synthesize the published papers in the area of Rhythmic Gymnastics, from the aspect of applied methodology. There were reflected several methodological problems, evident from this analysis. Those most problematic contained issues of gender, social role, the heterogeneous nature of the athletes, the varying definitions of women in sport and the state of psychometric prognosis and measures instruments, available in the field of study, as well as the applied statistical procedures. In conclusion the differences and problems of individual approaches to the solving of research problems in the field of study (RG) are examined and interpreted from a comparative perspective.

COMPARISON OF NEUROMUSCULAR CHARACTERISTICS OF YOUNG AND OLDER GYMNASTS DURING HANDSTAND, Bartłomiej Niespodziński[1], Andrzej Kochanowicz[2], Jan Mieszkowski[1]

[1]*Institute of Physical Culture, Kazimierz Wielki University, Bydgoszcz, Poland*
[2]*Faculty of Physical Education, Gdansk University of Physical Education and Sport, Poland*

Gymnasts can perform handstand in early ages of their training carrier but mastering it takes time and it is essential skill to many other gymnastic exercises. Such training changes in handstand expertise should manifest in neuromuscular coordination expressed as specific muscle activation.

To evaluate and compare muscle activity during handstand position of young and elite adult gymnasts and to compare agonist/antagonist torque ratio between them.

15 young prospective male gymnasts (13.9±0.7 yrs) and 12 elite adult male gymnasts (23±3 yrs) have undergone assessment of muscle activity using Noraxon TeleMyo DTS surface electromyograph during 10 second handstand on the AMTI force platform. Muscle activity was expressed as peak and mean percent values of maximal isometric voluntary contraction (%MVIC) obtained on Biodex System 4 isokinetic dynamometer.

As it was predicted normalized torque for each joint, was higher in older gymnasts, however, with age and training experience ratio of glenohumeral joint significantly increase for the advance of extensors. For elbow joint and wrist joint such relation do not differ.

In case of muscle activity, adults showed less % activity than younger ones. For mean values it was 0.17±0.07 compare to 0.32±0.19 %MVIC and 0.04±0.02 compare to 0.10±0.05 for triceps and biceps brachii muscles, respectively. Regarding the peak values, significantly higher values for young gymnasts was also seen for trapezius descendens, deltoideus medius and anterior, which was 34, 39 and 53 percentage points, respectively. Only latissimus dorsi muscle showed the opposite: 34 percentage points higher values for adult gymnasts in peak %MVIC.

Intermuscle torque relations in glenohumeral joint differs from young to adult gymnasts, but in elbow and wrist not. Muscle activity of adult gymnast during handstand is lower in compare to young ones, but opposite in case of latissumus dorsi. During handstand carpal flexors are the most active muscle group among young and adult gymnasts.

.

EDUCATION SESSION

ANALYSIS OF TEACHERS-PUPILS INTERACTION DURING GYMNASTICS WARMING-UP IN PROCESS OF PE TEACHERS' EDUCATION - CASE STUDY, Jan Chrudimský, Iveta Holá, Viléma Novotná

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

Warming-up is an integral part of every lesson of physical education and in teacher's preparation. Knowledge of developing, organizing and leading warming-up are considered as basic didactic competences of PE teachers. In spite of different movement content of warming-up according to focus on following part of PE lesson (gymnastics athletics, swimming or sports game) we are able to find a common pattern of teacher´s behaviour during warming-up leading. By our paper we are concerned with analysis of teacher´s and pupil´s behaviour during warming-up during lessons with gymnastics movement content.

Evaluation of didactic interaction of teacher (teaching student) – pupils ware realized through modified method of Analysis of didactic interaction – MADI. Intentional sample of synchronized sounds and video records of warming-up of students of physical education were analysed.

The results reflect that the most frequent forms of teacher behaviour during leading worming-up and also with musical accompaniment is instruction and correction. From list of teacher´s communication is it verbal communication and verbal communication linked with movements.

Records reflect usability of MADI like as instrument for evaluation of learning outcomes future PE teachers, as well as instrument for feedback providing about quality and content of student didactic performance.

GYMNASTIC LITERACY COMPONENTS VERIFIED THROUGH REPERTORY GRID TECHNIQUE – CASE STUDY, Iveta Holá, Jan Chrudimský, Viléma Novotná

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

The purpose of cultivating physical literacy is to acquire fundamentals movements creating suitable "movement pattern" from the aspect of the quality of movement expression and physical education. Basic preparation in rhythmic gymnastics (RG) aims gradual development of motor abilities and sports skills on the principle of comprehensive foundation based on theory and professional practice. Acquired competence can be used to transfer them to specific gymnastic skills in the acquisition of gymnastic literacy.

The correspondence between the published scientific theory of training and experience of coaching was verified using Repertory grid technique (Repertory grid interview). Along the semi-structured interviews with selected rhythmic gymnastics experts was achieved large number of same personal constructs (opinions), which documented the topic.

The experts, in view of the gymnastic literacy agreed on the fact that its largest foundation in RG practice has a set of exercises for body posture, a set of exercises without apparatus and a set of exercises to develop manipulation skills. The smallest significance has (by experts) set of exercise for physical fitness and set of exercise for orientation in space.

The stage of gymnasts´ development should emphasize the positive experience of motion over the importance of competition results and emphasize the cultivation of physical and gymnastic literacy over senseless drill and countless repetition of movements.

EVALUATION OF TEACHERS' ACTIVITIES BY THE METHOD ADI, Kristýna Hubená, Irena Čechovská, Jan Chrudimský

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

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

Tutorial of physical education is subject of investigation a long time. The most often are researches focused upon physical loading of pupils during lesson and time utilization for pupils' active movements. Today is already essential area of investigation also forms of interaction among teacher and pupils.

Determination of interactive pattern of teachers and pupils behaviour is contribution for description and analysis of appearances during lessons of physical education. Obtained finding contribute not only to education of future teachers, but they may be background for increasing effectiveness of one´s own didactic process. The first attempts for analysis of didactic interactions are discovering in 60s of last century. During 80s happen to fundamental forming of method of Analysis of Didactic Interaction (ADI). Method was successfully used in different learning subjects, including physical education. Today is ADI utilized continually with modification for PE e.g. Modified Analysis of Didactic Interaction – MADI.

Contribution of ADI/MADI is connected with possibilities to quantified teacher's and pupils' activities and behaviour during PE lessons and also for build up analysis of their bilateral interaction. Results are the amount of objectification education reality through categories which represent teachers and pupils activities. Methods is for processer very elaborate, time-

consuming, drilling of evaluator is demanded and also in light of uniform approach by encoding observed behaviour is difficult.

FUNDAMENTALS OF MUSIC-MOVEMENT COMPOSITIONS (GROUP PERFORMANCES) FOR WORLD GYMNAESTRADA, Viléma Novotná, Iveta Holá, Jan Chrudimský

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

World Gymnaestrada is opportunity for international confrontation of various concepts of Gymnastics for all and approaches to creating music-movement compositions. Sport for All presents the group performances that affect the lifestyle of large amounts of athletes. In our creative work, we pay attention to the theoretical aspects of the creation and effectiveness of the created physical education program.

Motivation of athletes to participate in World Gymnaestrada and subjective assessment of the group performance were repeatedly collected through a questionnaire. The severity of exercises during group performances was measured through monitoring of heart rate in relation to the theoretical value. Criteria of creating performance quality were writing over the years defined analysis and observation of our and foreign performances.

The biggest motivation for gymnasts is their participation in the World event with a unique atmosphere, wishes to practice in a team and feel the performances together. The values of heart rate during the performances showed a higher level of physical fitness of gymnasts compared with the general population. For creative work in group composition were defined principles: unity, gradation, contrast, repetition, variety and phrase.

For further development and improvement of the performances we identified two basic assumptions: implementation of the principles in the creating of composition and sport concept and contents of Gymnastics for all.

PLACE AND CONTENT OF GYMNASTICS LESSON UNITS CLASSES IN SCHOOLS WITH GENERAL EDUCATION IN RUSSIAN FEDERATION, Vladimir Lyakh1 Larisa Glinchikova2

[1]*University of Physical Education in Krakow, Poland*
[2]*Immanuel Kant Baltic Federal University, Russian Federation*

In physical education programs for pupils of all classes in former USSR and currently in Russian Federation a significant place have Gymnastics lessons with elements of Acrobatics.

Within 73 hours for mastering the core material throughout the academic year, there are 18 hours allotted for Gymnastics lessons from 1 to 11 classes. In addition, Gymnastics material can be developed and improved during variative part of program (by choice of teacher, pupils, school).

The report attempts to:

1) consideration of place and content of Gymnastics lesson units classes with elements of Acrobatics, recommended in programs for schools with general education in Russian Federation for pupils of primary (1 – 4 classes), basic (5 – 9 classes) and secondary (10 - 11 classes) school;

2) discussion of real situation with gymnastics lessons conduction in schools of Kaliningrad region of Russian Federation.

THE INFLUENCE OF GYMNASTICS PROGRAM ON ANTHROPOLOGICAL CHARACTERISTICS OF FIRST-GRADE STUDENTS, Sunčica Delaš Kalinski, Mirjana Milić, Ana Kezić

Faculty of Kinesiology, University of Split, Croatia

The aim of this research was to identify the influence of the kinesiological treatment, enriched with artistic gymnastics skills, on different anthropological characteristics of first grade students. One hundred and two first-graders were involved in the study, with chronological age of 7±0.5. They were divided in two groups: experimental (76) and (26) control. Both groups attended physical education class 3 times a week for 45 minutes during 6 months but according to different program. Both groups attended current curriculum program but experimental group also did some gymnastics skills (selected due to the material conditions of the school). Level of motor abilities and anthropometric characteristics have been measured in the beginning, after three, after six months of applied treatment and 7 weeks after finishing the treatment.

Through this period of time, there was an increase of numerical parameters of morphological variables, however, not significant. Statistically significant differences between the groups were found in different motor variables in different measurement points. Identified differences suggest that the influence of the applied gymnastics treatment in the earlier stages is only visible in the variables that, given the inborn coefficient, have the greatest ability to change (variables that hypothetical estimate flexibility). Upon cessation of the treatment differences in these variables between samples have not been established. The variables that have a higher coefficient of innateness, differences between samples were determined in subsequent measurement points.

Given the well-known positive effects of similar treatments, it can be concluded that the time of implementation of the experimental gymnastics program was too short to determine significant differences in a number of variables between groups.

HEALTH SESSION

RISK FACTORS FOR EATING DISORDERS IN GYMNASTS: PILOT STUDY, Aleksandra Aleksić-Veljković[1], Dejan Madić[1], Dušanka Đurović[2], Kamenka Živčić Marković[3], Katarina Herodek[4]

[1]*Faculty of Sport and Physical education, University of Novi Sad, Serbia*
[2]*State University of Novi Pazar, Serbia*
[3]*Faculty of Kinesiology, University of Zagreb, Serbia*
[4]*Faculty of Sport and Physical education, University of Niš, Serbia*

Numerous studies in recent years suggest that in athletes from the aesthetic sports there is a high risk of developing eating disorders. Because of the seriousness of the consequences of these disorders, early detection is essential in order to prevent progression. The aim of this study

is to determine whether there are risks of eating disorders development in active and former gymnasts, and compare them to the control group of non-athletes.

The study involved 19 gymnasts (mean age 17.6±2.5 years, BMI 20.5±2.7), 32 former gymnasts (mean age 28.5±7.6 years, BMI 22.7±3.5) and 32 females (mean age 31.7±6.6 years, BMI 24.1±3.5). All respondents completed the Eating Attitudes Test (EAT-26).

The results of ANOVA analysis showed that there were no statistically significant differences between groups ($p > .005$) in total results in the EAT-26. However, the maximal value in each group exceeded 20 points, and for the questions about the behavior that indicates disorders, 5 to 10% of respondents gave answers that indicate problem in behavior related to nutrition and necessary consultations with a specialist. There were statistically significant differences between groups in Oral control subscale ($p=.024$). The active gymnasts had higher prevalence of behavior that can cause higher risk of developing eating patterns.

Based on the results of this transversal study and previous researches in this area, we will start monitoring programs and strategies for maintaining or losing weight in active and former gymnasts, and provide them necessary informations about proper nutrition, as well as other preventive treatments.

ANTHROPOMETRIC PROFILE OF GIRLS AGED 9-13, PRACTISING AESTHETIC SPORTS, Daria Broda-Falkowska, Tatiana Poliszczuk

Josef Pilsudski University of Physical Education, Warsaw, Poland

Besides performance technique judges' evaluation is also influenced by aesthetic values in aesthetic sports. In most sports disciplines proper body build dictates not only general but also special physical effectiveness and additionally aesthetic look during a presentation in competitions.

The goal was to characterize and compare somatic build of contestants in chosen aesthetic disciplines.

The research covered 103 girls aged 9-13 who haven't achieved age at menarche yet. The research was divided into five groups: rhythmic gymnasts [RG] (n=21), acrobatic gymnasts [AG] (n=21), figure skaters [FS] (n=21), sports dancers training modern dance [SD] (n=21) and control group [CG] (n=21).

The Health-Carter body build and BMI indicator evaluation methods were employed.

AG were much shorter and possessed smaller index of mesomorphy rating ($p<0.001$) than the rest of the girls. RG characterized by the lowest body mass and the lowest influence of endomorphy ($p<0.05$) and BMI indicator, which value was located in the lower limit of normal. The comparison of average results of body mass and height proved similarity between the groups SD, FS and CG. FS characterized by bigger massiveness than contestants of the rest of aesthetic disciplines. SD somatic profile indicates their similarity in body build to girls who did not train. Dancers characterized by the biggest endomorphy in comparison to the rest of tested contestants of other disciplines.

Aesthetic disciplines contestants body build is conditioned by the selection for the specific sport. Despite preferring slim body build, tested girls grow up correctly.

The study was supported by MNiSWGrant No. AWF – DM-42.

SUBJECTIVE ASSESSMENT OF KINESIOTHERAPY AS AN ELEMENT OF COMPREHENSIVE REHABILITATION PROCESS OF SUBJECTS WITH LOWER SPINE PAIN, Wioletta Łubkowska[1], Mirosława Szark-Eckardt[2], Żukowska Hanna[2], Justyna Połeć

[1]*Department of Physical Education and Health Promotion, University of Szczecin, Poland*
[2]*Kazimierz Wielki University in Bydgoszcz, Poland*

Spinal pain has triggered interest in many fields of medicine, such as orthopedics, neurology, rheumatology, and rehabilitation. Despite ongoing development of surgery techniques, a major role is played by fitness improvement treatments, which need to be promoted.

The aim of the research was a subjective assessment of kinesiotherapy as an element of comprehensive rehabilitation process of subjects with lower spine pain.

This paper has an empirical character. The research was conducted amongst a randomly selected group of 60 patients of Independent Public Health Care Unit in Choszczno, Poland (rehabilitation at an outpatients' clinic), aged 20-51. All of them were subjected to a series of 10 kinesiotherapy treatments. The research used diagnostic polling method and the following techniques:survey and implicit interview.

The research proved that after completion of 10 treatments, the subjects noticed a significant improvement of their health. Kinesiotherapy helped return to an active professional life for those who were forced to resign or suspend their work. Subjects reported that 10 kinesiotherapy treatments were enough to notice their effectiveness in lumbar spine pain reduction. Kinesiotherapy treatments resulted in a reduced usage of painkillers.

.There is evidence of positive impact of physical exercise on treatment results and beneficial effects in patients with spinal pain. Proper education aimed at changing bad habits and advising how to care for spine may be a powerful way to fight for health.

VOCATIONAL QUALIFICATIONS OF THE EXERCISE SPECIALISTS FOR PRE- AND POSTNATAL PHYSICAL ACTIVITY – A RESEARCH PROJECT CONCEPT, Aneta Worska, Anna Szumilewicz

Faculty of Physical Education, Gdansk University of Physical Education and Sport, Poland

Research over the past 30 years have shown that regular physical activity during pregnancy has a multidirectional positive impact on the health of pregnant women and their babies. Nevertheless, the authors from different countries observe insufficient level of prenatal physical activity. As the reasons for this phenomenon they list among other things: lack of information among women on the exercises during pregnancy and lack of social support. Exercise specialists are supposed to play the most important role in providing information and professional support in the design of physical activity programmes for different populations. However, our pilot study has demonstrated that they are not prepared to conduct exercise sessions with pregnant clients.

Our aim is to present the concept of a research project focused on the analysis of the exercise specialist's qualifications to implement exercises in pregnancy. Presented will be the research methodology and expected results in the context of the European Qualifications Framework and the international educational standards of the Europe Active (former European Health and Fitness Association).

THE INCIDENCE OF THE RECTUS DIASTASISAMONG PREGNANT WOMEN PARTICIPATING IN TWO DIFFERENT EXERCISE PROGRAMMES – A RESEARCH PROJECT CONCEPT, Natalia Rajkowska, Anna Szumilewicz, Stanisław Sawczyn

Gdansk University of Physical Education and Sport, Poland

The abdominal muscles are essential to keep the abdominal viscera, good posture, stabilize the pelvis and are involved in the movements of the trunk. During pregnancy, women should pay special attention to exercising abdominal muscles. Due to inter alia the growing uterus, changes in the curvature of the spine and the effect of pregnancy hormones they are heavily stretched. An adverse effect of this can be the separation of the rectus muscles, so called the rectus diastasis. The ethiology of this condition is unknown. The imbalance in the abdominal wall in the medium and long term may cause low back pain and lower the quality of life.

The popularity of this topic is very low. Reviewing the international guidelines on exercise in pregnancy we didn't find any information on how to perform specific exercises for the prevention or treatment of the rectus diastasis.

We aim to present the research project concept on the incidence of the rectus diastasis among pregnant women participating in two different exercise programmes. The first programme is based on the standard set of strengthening exercises recommended for pregnancy. In the second one we include the abdominal exercises that might prevent the appearance of the separationin the abdominal wall, based on their biomechanical analyses. We will present the research methodology and expected results of the project to be used in preparing new international guidelines for prenatal exercise programmes design.

COMPARISON OF THE EFFECT OF RELAXATION CAUSED BY SENSORY DEPRIVATION TECHNIQUE AND THE TECHNIQUE OF BREATHING CONTROL ON CHANGES IN BODY TEMPERATURE CAUSED BY THE VISUALISATION PROCESS, Monika Naczk[1], Zasada Mariusz[1], Zdzisław Sybilski[2]

[1]*Institute of Physical Education, Kazimierz Wielki University, Bydgoszcz, Poland*
[2]*Chair of Clinical Psychology, Faculty of Pedagogy and Psychology, Kazimierz Wielki University, Bydgoszcz, Poland*

Visualization is the process of using the imagination to achieve what we intend. The visualization training as a relaxation technique is a creative activity aimed at forming habits. In contrast to dreams it is a conscious action, which distinguishes it from a vision or hallucination. The session in the deprivation chamber introduces a person in the state of equilibrium between the left and right hemisphere of the brain, stimulating the alpha state. According to H. Kampf the visualisation is the most effective in the alpha state, because a human has the ability to focus a greater amount of attention (predominant frequency waves are from 8 to 13 Hz, which, being present in the stand-by state, give a deeper state of consciousness).

To determine the effectiveness of the visualization process to increase body temperature in the left upper limb of subjects after a relaxing session in the deprivation chamber and subjects undergoing relaxation techniques using breathing control.

The study monitored a group of 34 people aged from 17 to 27 years. They were people actively involved in sport who have not been previously subjected to a process of visualization. The subjects were divided into two groups: the experimental group (the subjects did a session in the deprivation chamber) and the control group (the subjects underwent the relaxation process

using breathing control technique). The study was conducted in the laboratory conditions, in an enclosed, separated from any disturbing external factors. The temperature measurement in the left upper limb lasted 10 minutes.

The studies have shown a very significant relation between the susceptibility to suggestion and the ability to control body temperature among people who have previously been in the deprivation chamber. The individuals who were subjected to relaxation by the technique of controlled breathing, did not reveal any changes in the ability to regulate the body temperature.

The change in body temperature as a result of visualization and the intensification of changes due to the relaxation method, proves the effectiveness of the relaxation method caused by deprivation in sport training aimed at forming the habits connected not only with the technical training.

THE EFFECTIVENESS OF THE GYMNASTICS AND DANCE IN FORMING THE PHYSICAL EFFICIENCY OF THE MEDICAL STUDIES FEMALE STUDENTS,

Agnieszka Perzyńska, Tomasz Zegarski

Nicolaus Copernicus University Ludwik Rydygier Collegium Medicum Bydgoszcz, Poland

Gymnastics and dance is now one of the most modern forms of physical activity. In recent years we observe rapid development of modern aerobics, the most important of is the growing interest of women in all ages. Making this type of physical activity and exercise-aerobic is one of the many forms of movement forcing people to exercise.

Evaluation of the effectiveness of individual exercises gymnastics and dance in the level of physical fitness and an analysis of the reasons that medical school students take this form of physical education classes. The specific objectives are to know the definition of gymnastics and her subdisciplines, as well as the definition of dance and its types; determine which gymnastics exercises and dance are the most useful for physical education classes, and also to evaluate the level of physical activity of students and evaluation of physical and mental well-being before and after school facility.

The study involved 50 students of the first year of medical studies at the Medical College of L. Rydygier Nicolaus in Bydgoszcz by Copernicus University in Torun. The research tool was an original questionnaire, conducted in 25-29.05.2015. The survey include twelve questions about gymnastic and dance exercises.

The survey involved respondents attend on fitness classes as part of physical education at the university. More than half of the surveyed students chose the fitness classes because their priority was to improve the physical fitness for simple schemes of gymnastics and dance. The students are aware of how the gymnastics and dance exercises effect on their physical and mental health - the main motive for taking this type of physical exercise was to improve the well-being and the struggle for slim body.

The obtained results prove that the forms of gymnastics and dance as part of physical education are positively received by the students. Classes are conducted in a theoretical and practical manner, and hence the girls understand basic commands to perform the choreography and they are able to give a satisfactory repeat the steps to the music. During the academic year the most useful and most liked exercises were speed- endurance exercise in the form of aerobics. The most effective turned out to be endurance- speed exercises, and the least stretching exercises.

VARIA

ASSESSMENT OF THE RELATIONSHIP BETWEEN MAXIMUM FORCE AND FORCE SENSE IN LOWER EXTREMITIES

Dariusz Harmaciński[1], Tadeusz Stefaniak[1], Anna Burdukiewicz[2], Jadwiga Pietraszewska[2], Aleksandra Stachoń[2], Justyna Andrzejewska[2], Krystyna Chromik[2], Kazimierz Witkowski[3], Jarosław Maśliński[3], Małgorzata Kałwa[4]

[1]*Department of Individual Sports, University School of Physical Education, Wrocław, Poland*

[2]*Department of Physical Anthropology, University School of Physical Education, Wrocław, Poland*

[3]*Department of Combat Sports, University School of Physical Education, Wrocław, Poland*

[4]*Department of Theory of Sport Training, University School of Physical Education, Wrocław, Poland*

Adequate level of muscle strength determines correct posture, fitness and good sports results. Strength exercises have been used for a long time for the purpose of correcting and rehabilitating the motor system at different stages of human development. A drop in muscle strength triggers adverse changes in the body significantly reducing physical fitness. Due to on-going civilisational, technological and information development of the human environment, man's motor abilities must be rationally stimulated and improved especially as regards their coordination rather than just fitness. Each motor task requires a certain amount of "force input". Most human activities need not only maximum but also optimal force, i.e. the kind of force which is necessary to carry out a motor task efficiently and accurately. Consequently, the authors of the present study decided to analyse how much the level of maximum force in lower extremities is related to the sense of the amount of force used (so-called force sense).

The study was carried out on 54 students of the University School of Physical Education in Wrocław. Maximum force (Fmax) and force sense of lower extremities were established with the use of a specialist device called "extremity muscle force characterograph". The study started with the subject generating maximum force with the left and right lower extremities one after the other which was followed by a single trial (with vision analysis) carried out to determine 50% of maximum force (50%Fmax as the so-called model). Subsequently, the subject was to recreate 50%Fmax from memory in five trials (without vision analysis) for the left and right lower extremities separately. The data gathered were analysed with commonly used statistical tools. Basic calculated parameters were the following – arithmetical mean, standard deviation, coefficients of variation as well as minimum and maximum values.

The results are presented in relative values of the parameters assessed. Mean value of force sense obtained by subjects with the left lower extremity amounted to 43.28 N, the same figure for the right extremity being 58.33 N. Mean value of maximum force (Fmax) obtained with right lower extremity was higher (897.17N) compared to the same value for the left extremity (769.94N), but the difference is not statistically significant (P=0,8). The highest value of maximum force obtained was 1308N for the left lower extremity and 1530N for the right one. The lowest values of maximum force generated by subjects were 294N and 216N for the right and left lower extremities respectively. The strength of correlation between variables of maximum force and force sense in the left lower extremity amounted to 0.38. Correlation for the right lower extremity stood at the same level – 0.37. Obtained results are not statistically significant (p>0,05).

It can be concluded that an increase in maximum force generated with the left and right lower extremities will cause an increase in force sense in both extremities. The results obtained in the study are a great inspiration for the authors motivating them to keep on reflecting on the problem and carry out a long-term experiment employing different methods of strength training.

*Research project N RSA1 001551 Development of muscle strength in persons practicing combat and strength sports in the context of their changing morphological structure

POSTURAL STABILITY LEVEL IN JUDO PRACTITIONERS, Jarosław Maśliński, Kazimierz Witkowski, Wojciech Cieśliński, Tomasz Śliz

University School of Physical Education in Wrocław, Poland

One of the aims of judo is to gain advantage over the opponent by taking him/her down to the mat. In order to create the best possible mechanical conditions to do the throw, the contestant tries at all costs to cause the opponent to lose balance. In consequence, the opponent will be unbalanced (*kuzushi*) and his/her defence against the throw will be less efficient. An unbalanced opponent is not, however, a 'dead' opponent. His/her task is to defend him/herself against the unbalancing. The balance maintenance also depends on, among other things, the morphological features of the contestant, including: the body mass, the body height, the thelion height (i.e. nipple height) and the area where the contestant is grappled during the throw. The grapple height influences the lever-arm used to induce the unbalancing, and the lever-arm, in turn, influences the torque.

The study was made on 84 active judo practitioners aged 15–42 years from Wrocław-based judo clubs. Two tests were used to measure the balance. The dynamic balance was measured during a march on a purposefully designed truss. The static balance was measured using the Flamingo Balance Test.

The study results show that the level of dynamic balance increases in the studied subjects along with their age and their experience as sports practitioners. The level of static balance does not show that correlation with the calendar age.

The study results strongly suggest that dynamic balance increases in direct relation to the age and practice experience of athletes. The relation is reversed in case of the static balance, which may be a consequence of changes in body proportions of the group of juniors under the study caused by their growth. Considering the balance improvement related to the practice experience of athletes, the utilitarian values of judo practice should be emphasised as they may have a considerable impact on our daily life.

THE APPLICATION OF AUGMENTED REALITY (AR) TECHNOLOGY TO IMPROVE THE TECHNIQUES OF JUDO, Wojciech B. Cieśliński[1], Kazimierz Witkowski[1], Jarosław Maśliński[1], Roman Kalina[2] Sławomir Kownacki[3]

[1]*The University School of Physical Education in Wroclaw, Poland*

[2]*Faculty of Physical Education, Gdańsk University of Physical Education and Sport, Poland*

[3]*Polish Judo Association*

This article describes the role and meaning of AR technology in teaching and developing judo techniques.

The aim of this research is an elaboration of a AR implementation model in judo teaching techniques – perspective of biomechanics of movement, psychology and sports pedagogics.

The subject of this research is the process of judo techniques teaching and the AR system functionality.

The objects of research are children learning judo and adults improving themselves individually (master level).

It is assumed hypothetically that "illustrating reality" with the use of AR increases learning attractiveness, deepens the effect of mental and imagination training.

Augmented reality – is an information technology that allows connection of real and computer world.

The given article is financed from Grant nr 0011/RS3/2015/53 by Ministry of Science and Higher Education from the "Development of Academic Sports" program in 2015-2017.

CHANGES IN SPECIAL FITNESS EFFICIENCY OF TEN-YEAR-OLD TENNIS PLAYERS IN THE ANNUAL TRAINING CYCLE, Tomasz Waldziński, Ewa Waldzińska

III Liceum Ogólnokształcące im. Żołnierzy Obwodu Łomżyńskiego AK w Łomży, Poland

Dynamic development in tennis involves great progress in methods of management of tennis training process. In the field of theory and practice of sport training the way of showing physical fitness was distinguished, that is general and special physical efficiency. It is believed that the general efficiency constitutes a base to form special efficiency, and their mutual proportions are different in other sport disciplines.

The test was conducted on a group of thirty competitors at the age of ten practising tennis in the podlaskie province. Participants of the examinations were divided into two groups according to sex. Changes in special efficiency were noticed in both groups under influence of training in the annual training cycle.

In the group of tennis players dynamic progress in abilities in steering the ball and strength of tennis blows was noticed.

CORRELATION BETWEEN BODY ESTEEM AND MOTIVATION IN GROUP OF PROFESSIONAL SWIMMERS AND ATHLETES, Aleksandra Budzisz. Monika Nawrocka

Faculty of Physical Education, The Jerzy Kukuczka Academy of Physical Educationin Katowice, Poland

The aim of the research was to determine the correlation between the motivation scale and the body esteem scale. Researched group consisted of people who are highly trained in swimming and track & field (both females and males). The research was conducted on a group (N=77) of athletes (N=42) and swimmers (N=35) selected during training camp of the Polish sports association team.

Body Esteem Scale (BES), which was created by S.L. Franzoi, S.A. Shields, 1984, and translated into Polish by M. Lipowska, M. Lipowski, was applied for the research. This method

makes it possible to determine subjective esteem of one's own body. The scale consists of 35 items in 3 subscales, different for females and males.

Motivation was measured with Sport Orientation Questionnaire, which was created by D.L. Gill and T.E. Deeter, 1988. The scale is made of 2 subscales - goal and win, each one consists of 6 items designed to measure goal motivation, and win motivation.

Research showed that from the perspective of Items and discipline, which was not divided by gender resulted in statistically significant low correlations (R=0,30-0,50) among athletes and swimmers. After narrowing the figures to gender, the statistically significant correlation became stronger (R=0,50-0,70).

The demonstration of the research tool assumes the possibility of investigation of mutual dependency in the terms of gender-dedicated subscales. This method indicated significant correlation between female swimmers in subscale of sexual attractiveness, and the goal orientation, as well as the win orientation (R=0,61-0,73).

WHAT CAN COGNITIVE SCIENCE BRING TO GYMNASTICS? WHAT CAN SPORT BRING TO COGNITIVE SCIENCE?, Sławomir Kujawski

Faculty of Humanities, Nicolaus Copernicus University In Toruń, Poland

Neuroscience develops various theories considering move pattern acquisition, changes in neural system due to physical training. Information from this field can help with scientific description of most effective forms of physical training. Knowledge about neural system functioning contributed to create new forms of rehabilitation. Moreover, some researchers investigated cognitive profiles of sportsmen. Scientists wanted to prove differences between sportsmen on various level of performance in tasks such as reaction time and cognitive inhibition. As a result, to maximize sportsman performance, cognitive training for sportsmen could be developed. Noteworthy, embodied cognition and the extended mind theory can be used as useful tool to describe sportsmen cognition.

On the other hand, sports has own role in developing new techniques in clinical neuroscience.

Shift of perspective on human from a mind - body dichotomy to embodied mind with its close relationships with body and environment resulted in new field of researches in neuroscience.

Effects of physical activity on increasing cognitive functioning in elderly people is well established. Moreover, gymnastics seems to be valuable tool to bring help to elderly who are in fall group risk.