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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.

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Fundacija za šport

J A K

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Photos from the Exhibition in National Gallery 150 years of Južni Sokol

EDITORIAL

Dear friends,

In October 2013 we will celebrate 150 years since the first gymnastics club was established in Slovenia. As the weather in October is already cold and school and sport programs start in September after summer holidays, the main part of celebrations was set for June. A Big Sokol Zlet was held in Ljubljana with over 1000 participants and a few thousand spectators on 17 June 2013. Mr Borut Pahor, the President of the Republic of Slovenia, awarded 'Športni klub Narodni dom' with the Golden Order for Services in the civil field. In addition to the Zlet, an exhibition has opened in the National Gallery which includes several rewards that are available for public viewing for the first time, such as medals of the father of Slovenian gymnastics Dr Viktor Murnik: Legion of Honour from the French president, White Lion from the Czechoslovakian president, Sveti Sava from the king of Yugoslavia, Order for Service from the president of Yugoslavia. To date, the club has organised two world championships (in 1922 and 1970); its member Peter Šumi won the world championship title twice in a row in 1922 and 1926 (his gold medal from Lyon is on display) and the team from Slovenia won the 4th place in Torino in 1911. On display is a cup received as a gift from other teams in 1922; Miroslav Cerar's Olympic medals, Mitja Petkovšek's World and European championships medals, Sašo Bertoncelj's prizes and a laurel wreath from Zlet in 1933. In December, an academic symposium on Sokol's impact on life in Slovenia will be organised.

Big anniversaries are always opportunity to dig into archives. I encourage you to look into your country's history of gymnastics and submit articles on how gymnastics evolved there (e.g., like Abbie Grossfeld and Anton Gajdoš with friends have done already). After all, one of the definitions of learning is transmitting knowledge and experience from one generation to another.

With our Journal we wish to transmit knowledge of our researchers so that it can be applied to practice.

In the June issue we have seven articles. Researchers Roman Farana, Daniel Jandacka and Irwin Gareth united to explore the impact forces on elbows during the round off. The round off can be used on floor, vault, beam; it is used by man and women and the paper provides practical advise on the position for hands. Oya Erkut Atilgan from Turkey submitted the first article in our Journal related to trampolining. I hope it will encourage other trampolinist to participate with their research papers. The third article is from the United Kingdom by Hannah Clowes and Zoe Knowles. They explore the effectiveness of pre-performance routines of elite artistic gymnasts. As British gymnastics were vey successful at OG in London last year the article is well worth reading. The fourth article is from Slovenia: authors Jerneja Fišer Kurnik, Tanja Kajtna, Klemen Bedenik and Marjeta Kovač investigated what advantages parents anticipate to enrol their child in gymnastics. Trevor Dowdell from Australia submitted his paper 'Achievement goals and motivational climate in competitive gymnastics classes' which provides guidelines on how to promote successful climate in a club. George Dallas and Paschalis Kirialanis from Greece wrote an interesting paper on how the vibration method influences flexibility and strength. The last article is from China: Helen Chen provides a case study on diet for high performance gymnastics.

Unfortunately, there is some sad news to impair. A truly good friend (my first lecturer at an international judging course) and a member of our editorial board Mikko Pehkonen has passed away. We thank his friends from Finland for sharing their thoughts about Mikko.

Just to remind you, if you quote the Journal: its abbreviation in 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

Up: prizes on top shelf (from left): IOC reward from 2003, Mitja Petkovšek golden PB 2005, the first cup for Slovenia team at 1911 WC in Torino, golden HB 1988 for Boris Gregorka (coach of Miroslav Cerar), bottom shelf: statues gained from other countries in 1922 WC and 1926 WC
Down: view on Dr. Viktor Murnik – ATA – father of Slovenian gymnastics and sport

INFLUENCE OF DIFFERENT HAND POSITIONS ON IMPACT FORCES AND ELBOW LOADING DURING THE ROUND OFF IN GYMNASTICS: A CASE STUDY

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A case study

Abstract

The round-off is a fundamental gymnastics skill and a key movement in the development of elite female gymnasts. The aim of this study was to determine whether differences in hand position during the round-off may influence the ground reaction forces and elbow joint moments in female artistic gymnastics. One international level active female gymnast from the Czech Republic participated in this study. Two force plates were used to determine ground reaction forces. A motion-capture system consisting of eight infrared cameras were employed to collect the kinematic data. The gymnast performed 10 trials of a round-off from a hurdle step to back handspring with a "parallel" hand position and 10 trials with a "T" shape hand position. Effect size statistics were used to establish differences in means. In conclusion "T" position of the second hand reduces vertical and anterior-posterior ground reaction forces. Differences in joint elbow moments and elbow kinematics indicated that the "T" position may prevent elbow joint complex and reduces potential of elbow injuries.

Keywords: *biomechanics, gymnastics, round-off, upper extremities, prevention*

INTRODUCTION

One of the most serious problems faced by contemporary gymnasts is the occurrence of injury (Sands, 2000). One of the aims of sports biomechanics is to prevent injury (Zatsiorsky, 2000; McGinnis, 2005). Consequently, targeted injury prevention strategies, based on biomechanical analyses, have the potential to help reduce the incidence and severity of gymnastics injuries (Bradshaw & Hume, 2012). Training loads in gymnastics are typically quantified by assessing weekly hours of gymnastics specific training (Burt, Naughton, Higham, & Landeo, 2010). Gymnastics training has been associated with on average more than 100 impacts per one training session on the upper extremities with peak magnitudes of 3.6 body weight (Daly, Rich, Klein, & Bass, 1999). One of the specific training characteristics in female gymnastics is the alternation of support between upper and lower limbs, with the upper extremities often used for weight-bearing therefore, receiving high impacts in both the elbow and wrist (Amaral, Claessens, Ferreirinha, & Santos, 2011). Chronic elbow strain is an injury involving inflammation or fracture which is

caused by repeated bending, stretching or rotating of the elbow over long period of time, or by squeezing from external force (Qu, Liu, & Li, 2000). A previous study by Koh, Grabiner and Weiker (1992) showed that a combination of high reaction forces and corresponding joint valgus moments during back handspring may contribute to the occurrence of lateral compression injuries of the elbow complex.

In the sport of artistic gymnastics the round-off is a fundamental gymnastics skill and a key movement in the development of elite female gymnasts, owing to its association with learning more complex skills (e.g. back handspring with/without multiple somersaults, Tsukahara and/or Yurchenko vaults). Lindner and Caine (1990) identified the floor exercise event as the most hazardous gymnastics event and most injuries happened with moves that were basic or moderately difficult and well-established. McIntosh and Davis (1997) investigated osteochondritis dissecans of the elbow and saw greater injury incidences in the second hand of the round-off. Panzer et al. (1987) stated that during the Tsukahara vault elbow joint reaction forces ranged from 1.7 – 2.2 body weight (BW). Seeley and Bressel (2005) examined reaction forces transmitted to the upper extremities of high level gymnasts during the round-off phase of the Yurchenko vault and round-off on the floor exercise. They stated that vertical and anterior-posterior reaction forces, normalized to body weight, were greater ($p<0.05$) during the round-off phase of the Yurchenko vault (2.38 BW vertical and 0.78 BW anterior-posterior) than during the floor exercise round-off (2.15 BW vertical and 0.60 BW anterior-posterior). Cossens (2012) hypothesis that the "T" shape hand position during round-off hand contact phase may be used to reduce weight bearing load through the elbow. However, this hypothesis is not yet supported by any biomechanical research. Currently, there appears to be no studies in the literature that investigate the mechanism of injury and injury prevention of the elbow joint during round off with two different hand position.

The aim of this study was to determine whether the differences in hand position during round-off may influence the ground reaction forces and elbow joint moments in female artistic gymnastics. The overall purpose being to bring to the training practice information on the issue of injury prevention of the upper extremity in gymnastics, which will be particularly useful for coaches, clinicians and scientist.

METHODS

Participant

One international level active female gymnast from Czech Republic participated in this study. Gymnast age, height and mass were 22 years, 165 cm and 60 kg. The gymnast was a former member of the junior and senior national team of Czech Republic with more than 15 years experience with systematic training and competitive gymnastics. The gymnast was many times winner of national and international competitions and also three times participated on Teamgym European Championship. The gymnast had no previous history of upper extremities injury and at the time of testing was injury-free. The aim of research and all procedures were orally explained to the gymnast and informed consent was obtained in accordance with the guidelines of the University and Human Motion Diagnostics Centre Ethics Committee.

Experimental set-up

Two force plates (Kistler, 9286 AA, Switzerland) embedded into the floor were used to determine ground reaction force data at a sampling rate of 1235 Hz. A motion-capture system (Qualisys Oqus, Sweden) consisting of eight infrared cameras were employed to collect the kinematic data at a sampling rate of 247 Hz and synchronized with force plates. Before the testing session, a right handed global coordinate system were employed and defined using an L-frame with four markers of the known location. A two-marker wand of the known

length was used to calibrate the global coordinate system. The global coordination system was set up so that the z-axis was vertical, y-axis was in anterior-posterior and the x-axis was in the medio-lateral direction. Data from the force plates and the cameras were collected simultaneously. Retroreflective markers (diameter of 19 mm) were attached to the gymnasts' upper limbs and trunk (Figure 1) according to a recommendation of the C-motion Company (C-motion, Rockville, MD, USA).

Figure 1. *Marker placement on gymnast body.*

Markers were placed on each participant at the following body location: left and right acromio-clavicular joints, left and right shoulders, left and right lateral epicondyle of humerus, left and right medial epicondyle of humerus, left and right radius-styloid, left and right ulna-styloid, left and right head of second metacarpal, left and right head of fifth metacarpal, seventh cervical vertebrae, left and right illiac crest tubercle, left and right angulus inferior of scapula, tenth thoracic vertebrae. Two clusters with three markers were placed on left and right upper arm a left and right forearm. Two photocells were used to controlled hurdle step velocity. Based on pilot study the hurdle step velocity was standardized at range of 3.3 – 3.7 m/s.

Protocol

One week prior testing gymnast was asked to practice both techniques as a part of her training session. At each floor training session the gymnast was asked to perform 10 trials of round-offs to back handspring with "parallel" hand position and 10 trials with "T" shape position.

The research was conducted in the biomechanical lab of the Human Motion Diagnostic Centre. The gymnast completed her usual warm up and completed a number of practice round-off trials with different hand position, three trials for both techniques. A thin floor mat was used and taped down at each force plate with double sided tape to replicate the feel of the floor (Figure 2).

Figure 2. *A thin floor mats at each force plate and mat for handspring and landing.*

First technique was defined with "parallel" hand position on the ground (Figure 3). Second technique was defined with "T" shape hand position on the ground. After warm up and practice the gymnast performed 10 trials of a round-off from a hurdle step to back handspring with "parallel" hand position and 10 trials of round-off from a hurdle step to back handspring with "T" shape hand position. Before each trial, the gymnast applied gymnastic chalk to her hands to allow the research a measure of her prescribed hand placement. All trials were performed with a maximal effort from a technical perspective and separated by a one minute rest period.

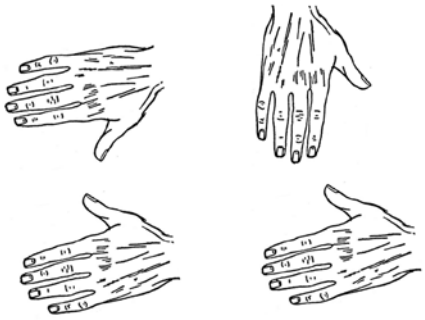


Figure 3. *"Parallel" hand position and "T" shape hand position.*

Data analysis

The marker data were processed using the Visual 3D software (C-motion, Rockville, MD, USA). All upper extremity segments were modelled as frusta of right circular cones and trunk as a cylinder. The local coordinate systems were defined using a standing calibration trial in handstand position (Figure 4).

Figure 4. *Handstand calibration trial and marker placement on gymnast body.*

All analysis focused on the contact phase of the second hand during the round off. Kinematic variables included sagittal, frontal and transverse elbow angles. Kinetic variables included peak vertical, anterior-posterior and medio-lateral ground reaction forces; temporal characteristics of these forces; and elbow joint moments in sagittal, frontal and transversal plane. The net three dimensional joint moments for the upper extremity joints were calculated a using Newton-Euler inverse dynamics technique (Hamill & Selbie, 2004). Net elbow moments are expressed in the local coordinate system of the proximal segment (upper arm). The coordinate data were low-pass filtered using the fourth-order Butterworth filter with a 12 Hz cutoff frequency. All force plate data were low-pass filtered using the fourth-order Butterworth filter with a 50 Hz cutoff frequency.

Statistical analysis

Means and standard deviations ($M \pm SD$) were calculated for all measured variables. Effect size statistics were used to establish differences in means. Effect sizes (*ES*) were calculated and interpreted as <0.2 trivial, 0.2 - 0.6 small, 0.6 - 1.2 moderate, 1.2 - 2.0 large, 2.0 - 4.0 very large and >4.0 nearly perfect (Hopkins, 2002). The effect of >1.2 was considered to be practically significant (Manning, Irwin, Gittoes, & Kerwin, 2011).

RESULTS

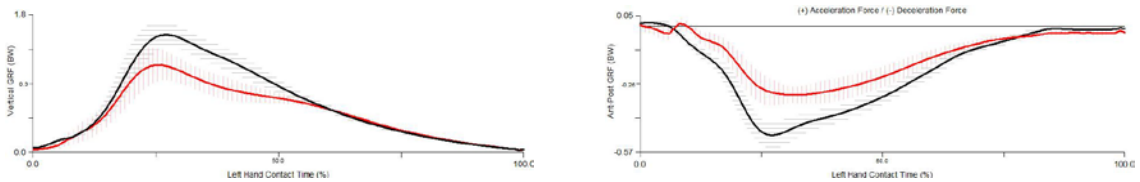
Means and standard deviations for ground reaction forces and temporal characteristics for ground reaction forces for both type of round offs are displayed in Table 1. The results of this case study showed that there are differences in impact characteristics between different hand positions during round off. Effect size statistics showed a *very large* effect size (ES=2.55) for peak vertical ground reaction force with decrease of 0.26 BW in vertical ground reaction force between "T" position in compare with "Parallel" position (Figure 5a). There was also *nearly perfect* effect size (ES=6.00) with decrease of 0.18 BW in peak anterior-posterior ground reaction force in "T" position compared with "Parallel" position (Figure 5b). A *very large* effect size (ES=2.33) was founded in time to peak vertical ground reaction force and in "T" position peak of this force become of 0.007 s earlier than in "Parallel" position (Table 1).

Means and standard deviations for left elbow internal moments for both type of round offs are displayed in Table 2. Effect size statistics showed *nearly perfect* effect size in peak elbow joint moment in

transversal plane (ES=6.32) with increased in "T" position in compare with "Parallel" position (Figure 6a). *Nearly perfect* effect size was found in peak elbow joint moment in frontal plane (ES=6.67) with decrease in "T" position in compare with "Parallel" position (Figure 6b). *Very large* effect size was found in peak elbow joint moment in sagittal plane (ES=2.35) with increase in "T" position in compare with "Parallel" position (Figure 6c).

Table 1. *Ground reaction forces and temporal characteristics of ground reaction forces of second contact hand during round off with two different hand positions.*

Variable	"P" position	"T" position	Effect size	Effect
Peak VGRF (BW)	1.50 ± 0.12	1.24 ± 0.08	**2.55**	**very large**
Peak APGRF (BW)	-0.49 ± 0.03	-0.31 ± 0.03	**6.00**	**nearly perfect**
Peak MLGRF (BW)	-0.12 ± 0.02	-0.10 ± 0.03	0.78	moderate
Time to peak VGRF (s)	0.050 ± 0.003	0.043 ± 0.003	**2.33**	**very large**
Time to peak APGRF (s)	0.050 ± 0.003	0.049 ± 0.004	0.28	small
Time to peak MLGRF (s)	0.081 ± 0.041	0.060 ± 0.039	0.52	small



5a 5b

Figure 5. *Vertical (5a) and anterior-posterior (5b) ground reaction forces of second (left) hand over normalized time (%) during round off. Black curve shows mean and standard deviation of "Parallel" position, red curve shows mean and standard deviation of "T" position.*

Table 2. *Left elbow internal joint moments of second contact hand during round off with two different hand positions.*

Variable	"P" position	"T" position	Effect size	Effect
Peak elbow joint transversal moment (Nm/kg)	-0.10 ± 0.02	-0.20 ± 0.01	**6.32**	**nearly perfect**
Peak elbow joint frontal moment (Nm/kg)	0.79 ± 0.06	0.24 ± 0.10	**6.67**	**nearly perfect**
Peak elbow joint sagittal moment (Nm/kg)	-0.55 ± 0.09	-0.73 ± 0.06	**2.35**	**very large**

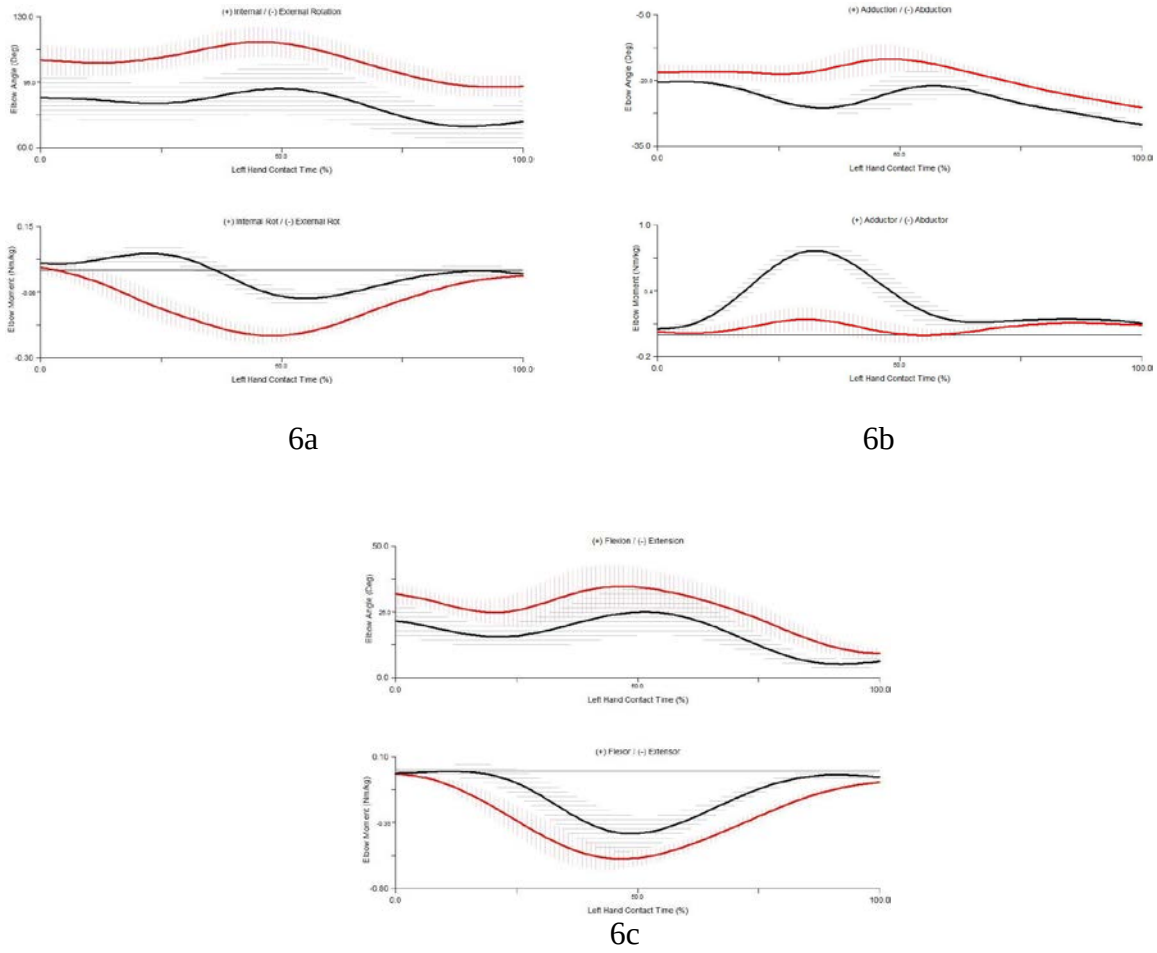


Figure 6. *Left elbow angle and left elbow internal moments over normalized time during round off in transversal (internal/external rotation) (a); frontal (adduction/abduction) (b); and sagittal (flexion/extension) (c) plane. Black curve shows mean and standard deviation of "Parallel" position, red curve shows mean and standard deviation of "T" position.*

DISCUSSION

One of the major challenges in gymnastics is to identify specific techniques, for performing skills that increase the potential for injury. This study aimed to explain whether differences in hand position during round-off influence the ground reaction forces and elbow joint moments in female artistic gymnastics.

The comparison of different round off trials type provided basic insights into how ground reaction forces values are associated with different hand position during ground contact of second hand. In our case study, peak of vertical reaction force of second hand was higher in parallel position (Figure 5a). Also there was higher anterior-posterior reaction force in parallel position (Figure 5b). In "T" position values for vertical and anterior-posterior reaction forces was lower compared to values reported during the Yurchenko vault and floor exercise round-off (Seeley & Bressel, 2005). Koh et al. (1992) states that during back handspring hand producing large compression forces and may contribute to upper-extremity injuries. Based on literature, peak force is the most fundamental element in injury and magnitude of force is a key injury-causing factor (Whiting & Zernicke, 2008). Whereas, in current study the "T" hand position reduced vertical and anterior-posterior ground reaction forces produced

by the second hand and in this point of view provides safety technique of this skill.

In present study the greater peak elbow internal joint moment in transversal plane was found in round off with "T" position in compare with "parallel". This is associated with internal rotation of forearm during round off in "T" position (Figure 6a). Moreover, the greater internal adduction elbow moment (valgus stress) was found in round off with parallel hand position in compare with "T" hand position (Figure 6b). Hume, Reid and Edwards (2006) stated that chronic elbow injuries typically stem from overuse and valgus stress. Repetitive valgus stress placed on the joint can lead to microtraumatic injury and valgus instability (Field & Savoie, 1998). Moreover, Grana (2001) stated that repeated valgus loading can presage medial epicondylitis. Thus, it is possible that this internal adduction moment during the round off in parallel position maybe, for the gymnast from our study, a high risk factor for elbow injury. The study by Sands and McNeal (2006) showed that by turning the hands inward during back handspring the gymnasts, particularly females, can reduce the problem of injuring an elbow (due to the carrying angle) and reduce the risk of damage to the wrist (by reducing wrist hyperextension). Observations from these results concur and found greater peak elbow joint internal moment in sagittal plane which is associated with greater elbow flexion during round off in "T" position (Figure 6c). Chou et al. (2001) stated that during fall with outstretched hand the action of flexion could decrease the maximal axial force of elbow and delay the time of peak, thus it can provide enough time to adjust and avoid the injury. Also, Koh et al. (1992) found that correlations of measures of elbow angle and measures of reaction force showed that elbow flexion during back handspring may protect the elbow joint from large valgus loads.

CONCLUSIONS

This case study brings some new findings about different hand position during fundamental gymnastics skill, the round off. In conclusion "T" position of second hand reduces vertical and anterior-posterior ground reaction forces. Differences in joint elbow moments and elbow kinematics indicated that "T" position may prevent elbow joint complex and reduces potential of elbow injuries. These findings provide a foundation to investigate this area further, with a larger sample and more detailed kinematics and kinetic analysis. Next stage of our research will be focus on understanding of kinetics of elbow joint complex during these two variations of this skill with overall purpose to bring to the training practice the initial findings and information on the issue of injury prevention of the upper extremity in gymnastics. The ecological validity of this study and the fine grained scientific theory provide a useful mechanism that will help coaches, athletes and clinicians potentially reduce the occurrence of injury

REFERENCES

Amaral, L., Claessens, A., Ferreirinha, J., & Santos, P. (2011). Ulnar variance and its related factors in gymnasts: a review. *Science of Gymnastics Journal, 3(3)*, 59-89.

Badia, A., & Stennett, C. (2006). Sports-related injuries of the elbow. *Journal of Hand Therapy, 19*, 206-227.

Bradshaw, E., & Hume, P. (2012). Biomechanical approaches to identify and quantify injury mechanisms and risk factors in women's artistic gymnastics. *Sports Biomechanics, 11(3)*, 324-341.

Burt, L., Naughton, G., Higham, D., & Landeo, R. (2010). Quantifying training load in pre-adolescent artistic gymnastics. *Science of Gymnastics Journal, (3)*, 5-14.

Chou, P.H., Chou, Y.L., Lin, C.J., Su, F.C., Lou, S.Z., Lin, C.F., & Huang, G.F. (2001). Effect of elbow flexion on

upper extremity impact forces during a fall. *Clinical Biomechanics, 16(10),* 888-894.

Cossens, P. (2012). Injury prevention in artistic gymnastics: A guide for coaches and directions for research. In E.J. Bradshaw, A. Burnett, P.A. Hume, (Eds.), *XXX International Symposium of Biomechanics in Sports* (pp. 69-70). Melbourne: Australia.

Daly, R.M., Rich, P.A., Klein, R., & Bass, R. (1999). Effects of high-impact exercise on ultrasonic and biochemical indices of skeletal status: A prospective study in young male gymnasts. *Journal of Bone and Mineral Research, 14(7),* 1222-1230.

Field, L.D., & Savoie, F.H. (1998). Common elbow injuries in sport. *Sports Medicine, 26(3),* 193-205.

Grana, W. (2001). Medial epicondylitis and cubital tunnel syndrome in the throwing athlete. *Clinics in Sport Medicine, 20(3),* 541-548.

Hamill, J., & Selbie, S. (2004). Three-Dimenzional Kinetics. In: G. E. Robertson, G. Caldwell G, J. Hamill, G. Kamen, & S. Whittlesey (Eds). *Research methods in biomechanics* (pp. 145-162). Champaign, IL: Human Kinetics.

Hopkins, W.G. (2002). *New View of Statistics: Effect of magnitudes*. Retrieved 4. 4. 2011 from the World Wide Web: http://www.sportsci.org/resource/stats/effectmag.html

Hume, P.A., Reid, D., & Edwards, T. (2006). Epicondylar injury in sport. *Sport Medicine, 36(2),* 151-170.

Koh, T.J., Grabiner, M.D., & Weiker, G.G. (1992). Technique and ground reaction forces in the back handspring. *The American Journal of Sports Medicine, 20(1),* 61-6.

Lindner, K.J., & Caine, D.J. (1990) Injury patterns of female competitive club gymnasts. *Canadian Journal of Sport Sciences 15(4),* 254-261.

Manning, M.L., Irwin, G., Gittoes, M.J. & Kerwin, D.G. (2011). Influence of longswing technique on the kinematics and key release parameters of the straddle Tkachev on uneven bars. *Sports Biomechanics, 10,* 161-173.

McGinnis, P.M. (2005). *Biomechanics of sport and exercise* (2nd ed.). Champaign, IL: Human Kinetics.

McIntosh, D., & Davis, A. (1997). Osteochondrosis and osteochondritis dissecans in elbows in elite women's artistic gymnasts. *Proceedings of Federation of International Gymnastics medical symposium*, Berlin.

Panzer, V., Bates, B., & McGinnis, P. (1987). A biomechanical analysis of elbow joint forces and technique differences in the Tsukahara vault. *Diagnostics, Treatment and Analysis of Gymnastic Talent*. Montreal: Sports Psyche Editions.

Qu, Y., Liu, P., & Li, G. (2000). Comparison of elbow angles in gymnasts with and without chronic elbow pain in horse vault routine. In Y. Hong, D. Johns, R. Sanders (Eds.), *XVIII International Symposium of biomechanics in sports*. Hong Kong: China.

Sands, W.A. (2000). Injury prevention in women's gymnastics. *Sports Medicine, 30(5),* 359-373.

Sands, W.A., & McNeal, J.R. (2006). Hand position in a back handspring. *Technique, 26(3),* 8-9.

Seeley, M.K., & Bressel, E. (2005). A comparison of upper-extremity reaction forces between the Yurchenko vault and floor exercise. *Journal of Sports Science and Medicine, 4*, 85-94.

Whiting, W.C., & Zernicke, R.F. (2008). *Biomechanics of musculoskeletal injury* (2nd ed.). Champaign, IL: Human Kinetics.

Zatsiorsky, V. (2000). *Biomechanics in Sport: Performance Enhancement and Injury Prevention*. Wiley: Blackwell Science.

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EFFECTS OF TRAMPOLINE TRAINING ON JUMP, LEG STRENGTH, STATIC AND DYNAMIC BALANCE OF BOYS

Oya Erkut Atilgan

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Original research article

Abstract

The purpose of this study is to examine the effects of 12-week trampoline training on static-dynamic balance, vertical jump and leg strength parameters in boys who do not exercise regularly. Twenty-eight 9-to10-year old boys were assigned to the trampoline training group (TG, N=15) and control group (CG, N=13) to examine effects of 12-week trampoline training (TT) on leg strength (LS), vertical jump (VJ), static balance (SB) and dynamic balance (DB). TG was given 12-week training, whereas no sport activities were assigned to CG. According to our results, differences between the pre-test and post-test bipedal SB, VJ, DB in TG are statistically significant ($p<0.05$). No significant difference was observed between the pre and post-test results in terms of unipedal SB, LS. Whereas in the CG, there was no significant difference between pre-test and post-test results based on any of the performance parameters ($p>0.05$). 12-week trampoline training increased bipedal SB-DB and VJ parameters; however, it had no effect on unipedal SB and LS parameters in boys. The trampoline training used in our study may form an example for the sports educators for improving strength and balance in children.

Keywords: *trampoline training, postural balance, children, muscle strength, power.*

INTRODUCTION

The ability of balance is one of the coordinative characteristics, like the reaction speed, and rhythm talent, and is an important attribute in learning sportive skills, and shows differences depending on the characteristics of sports branches (Sirmen et al., 2008). For example; while judo trainings have significant effect on understanding somato-sensorial input, dance trainings contribute to a larger extent to the improvement of balance based on visual input (Perrin et al., 2002). Special postural adaptation which is necessary for balance ability can be improved depending specifically on the nature of each sports branch (Paillard, 2006; Bressel et al., 2007; Asseman et al., 2008; Matsuda et al., 2008; Sirmen et al., 2008). The balance ability increases in parallel to the training experiences in sports. For this reason, it has been reported that, when training athletes and preparing training programs, it is important to evaluate the static-dynamic balance profiles of individuals who are engaged in different branches of sports, and who are not engaged in sports activities (Bergmann et al., 2002; Sirmen et al., 2008; Akan et al., 2009).

Learning rate and level of technical skills in sports are closely associated with

balance. It is important to keep the whole body in balance and to maintain this balance when learning the movements and changing positions rapidly. Performing complex motor skills, such as those performed by gymnasts or dancers, requires a great sense of balance (Vuillerme et al., 2001). Gymnastics requires a great diversity of movements: transition from dynamic and static elements and vice versa, frequent changes of the body position in space (Paject et al., 2010). Gymnastics offers a great range of locomotive, stability and body control movements which are highly important for the development of children. In certain sports branches like gymnastics that require complex skills, balance is often lost due to the nature of the movements, and this may adversely influence performance (Vuillerme et al., 2001). Trampoline exercises are used during gymnastics trainings, and facilitate learning of the skills.

The modern trampoline was patented by George Nissen in 1936 who championed its use for recreation and competition. During World War II, the trampoline was used to train pilots to improve their spatial orientation and balance, and after the war, it was used in schools and competitively. The recreational use of trampolines and competitive trampolining is widespread and growing rapidly around the world (Esposito & Esposito, 2009). Trampoline is a skill-oriented and difficult to perform for showing beauty sport, the game requires the athlete's feet together to perform a variety of forward and backward somersault with twist or non-twist movement.

As a result the balance ability and control is essential for the trampolinist. Beside, trampoline in training is always changed posture and center of gravity trajectory by high speed jump and transforming movement and their balance control is contributed by visual, vestibular, proprioception and lower extremity muscles, etc. coordination to complete (Song & Qian, 2011). Moreover, jumping on the trampoline is also enjoyable activity which develops motor coordination, aerobic fitness, strength, balance and a sense of rhythm and timing (Heitkamp et al., 2001; Crowther et al., 2007). However, mini-trampoline exercises consist of a multi component approach which are likely to affect many other physical factors other than strength, such as body stability, muscle coordinative responses, joint movement amplitudes and spatial integration (Aragao et al., 2011).

It is noteworthy that no past studies were found regarding the use of trampoline training as a sports activity for children for improving the leg strength, vertical jump and balance. On the other hand, it was reported that the studies more generally focused on relationship between athletes' performance and balance and the injuries of athletes and balance (Hrysomallis, 2011). Because of the lack of research in this area, physical educators and coaches do not realize the effects of trampolining on muscular power, endurance, speed, agility, and coordination.

In light of the above, the purpose of the study is to investigate the effects of 12-week trampoline training on static, dynamic balance, vertical jump and leg strength measurements in boys who do not exercise regularly. It was hypothesized that trampoline training will improve static-dynamic balance, vertical jump and leg strenght.

METHODS

Subjects

Total 28 boys between ages 9-11 who do not exercise regularly voluntarily participated in this study. The parents of children were notified by a letter and asked for their child's participation in the reliability assessment for postural stability using the balance master system and trampoline training. They gave their informed consent to the experimental procedure as required by the Helsinki Declaration. Boys who had no neurological diseases, vestibular visual disorders, lower extremity injuries or orthopaedic problems, and who did not previously join in any sports activities on a regular basis were

included in the experimental group. Non-attendance of the subjects in the trainings for more than twice, injury, or unwillingness to continue was determined as conditions to exclude the subjects from the study. In all of the subjects, right legs were dominant. The study was planned during the fall semester of 2010-2011 academic years of elementary schools and was realised in the gymnasium of the Faculty of Physical Training and Sports and Biomechanics Laboratory of Marmara University. The experiment was approved by the ethics commission of the Marmara University in Istanbul.

Procedures

The subjects were taken to the laboratory twice for pre-tests and post-tests. Prior to testing, subjects were familiarized with the balance device and provided practice sessions on the testing procedures to decrease the change of a learning effect occurring during testing. The tests were conducted at the same times of the day (10.00-13.00) when the body had rested, and measures were taken to prevent distraction due to environmental factors (noise, temperature). First of all, the anthropometric measurements of the subjects were taken, and after warm-up exercises performance tests were conducted (Gelen, 2011). The measurements lasted 20 minutes for each child. The tests of whole group were completed within two days. The group was divided into two homogenous sub-groups by looking at the anthropometric characteristics of the subjects. One of the groups was given TT for 12 weeks, whereas no training was given to CG, and they did not participate in any sports activities. 12 weeks later, the initial measurements were repeated, and the data were statistically interpreted.

Mini-trampoline and trampoline training program

The trampoline training was given a 12-week training program by trainers specialised in the trampoline branch, for 2 days a week, 1.5 hours per day (36 hours in total). During the program, after a 15-minute general warm-up exercises (Gelen, 2011), 15-minute special warm-up exercises specific to gymnastic branch; basic body positions, position of body limbs? Posture, special walking exercises were done. Later, the basic movements of jumping, standing, rotating and landing on mini- trampoline and trampoline were taught in accompany of two trainers (Table 1).

For TT, Trampoline (model 8140) and mini-trampoline (model 5010) were used. All the exercise equipment are FIG (Federation International Gymnast)-approved contest equipment and have protection sliding mats that conform to international standards (model 392) (Spieth Gymnastic GmbH Esslingen/Germany).

Testing procedures

Anthropometric measurements were carried out using anthropometric standardisation references manual (Lohman et al., 1988) by health care professional. The subjects were on naked foot and had light clothing. The heights of the subjects were measured by using portable stadiometer (Holtain Ltd,, Pembrokeshire, UK.), foot length, leg heights and foot width were measured by using anthrop meter (Clas Ohlson, Sweden). Weight measurements were made by using electronic platform scales (nearest 0.1 kg) (Seca 770 Wedderburn, GmbH, Germany). Body mass index was calculated according to the formula weight / height^2 (kg/m^2).

Measurement of Leg Strength: For measuring leg strength (LS), Leg dynamometer (back-leg dynamometer Takai, Tokyo, Japan) was used (LS). After a 5-minute warm-up exercise, the subjects stood on a platform with their feet apart at a comfortable distance of shoulder width for balance. Their hands grasped each end of a bar. The subject was asked to flex at their knees to approximately 135 degrees. The back was kept straight and the hips were positioned direcly over the ankle joints. In this way, the activation of back muscles was eliminated. The chest was kept forward and the head was held in an erect position. The subject took in a large breath and slowly

exhaled as they attempted to extend their knees smoothly and as forcefully as possible. Three attempts were made and a best score was recorded (Saygın & Öztürk, 2011).

Table 1. *Trampoline training exercises.*

Week	Unit	Basic exercises performed mini-trampoline and trampoline	Load
1	1 2	Running and hopping exercise on the mini trampoline-trampoline	5-8 sets for each exercises
2	3 4	Teaching arms, legs, head and body straight position while jumping mini trampoline-trampoline	
3	5 6	High jump and landing exercises on the mini trampoline-trampoline	
4	7 8	Straight jump and landing exercises on the mini trampoline-trampoline	
5	9 10	Tuck jump and landing exercises on the mini trampoline-trampoline	
6	11 12	Straddle jump on the trampoline before landing mini trampoline	
7	13 14	Pike sitting and straight jumping exercises on the trampoline and different jump before landing mini-trampoline	
8	15 16	Pike jump and landing exercises on the mini trampoline-trampoline	
9	17 18	¼ twist on the trampoline, before landing mini-trampoline	
10	19 20	½ twist on the trampoline, before landing mini-trampoline	
11	21 22	1/1 twist on the trampoline, before landing mini-trampoline	
12	23 24	Forward roll on the mat after jumping on the mini-trampoline-trampoline	

Vertical jump (Newtest, Oulu, Finland) measurement was made by using jumping platform through the squat jump (SJ) method. The subjects were asked to make an experimental jump before the test. In SJ, the knee-hip angles of the subjects were measured by using standard goniometer, and the angle was adjusted as 90 degrees. At the beginning of the test, the subjects were asked to jump as high as they could with their hand on their waist. Vertical jump measurements were taken on squat jump double feet (SJB), squat jump right (SJR) and squat jump left foot (SJL). Every child jumped three times and the highest records were used to analyze jumping performance (Agopyan et al., 2011).

Balance; Static and dynamic balance measurements were made by using Prokin 5.0 (Prokin System 5.0 Pk-Manop-05-en-01 Begomo, Italy). After explaining the tests to the subjects, data were entered (height, weight, age) and the device was calibrated. The feet of the subjects were placed on the balance platform nakedly (in a fashion that the distance between feet was 10 centimeters and the projection of the maximum point of the medial arcs was on the x-axis). The subjects were asked to look at the screen in front of them with 10 cm distance between their feet while their arms were at sides, and to keep them fixed at (0) point. After completion of each test, when the device was being re-calibrated, the subject was asked to sit down and rest. At the time of the measurements, no verbal

feedback was given to the subjects other than what was necessary (http://www.tecnobody.it).

Static balance tests were performed for 30 seconds;

a- Bipedal static balance; Eyes open (EO) and eyes closed (EC). The data obtained were evaluated in terms of Eyes open perimeter (EOPE), Eyes Open ellipse area (EOEA), Eyes closed perimeter error (ECPE), Eyes closed ellipse area (ECEA), Romberg test perimeter ratio (RTPR) and Romberg test area ratio (RTAR).

b- Unipedal static balance; static balance was measured respectively on right and left foot, eyes open and the values in terms of Right foot perimeter (RFPE), Right foot ellipse area (RFEA), Left foot perimeter (LFPE) and Left foot ellipse area (LFEA) were taken (Figure 1).

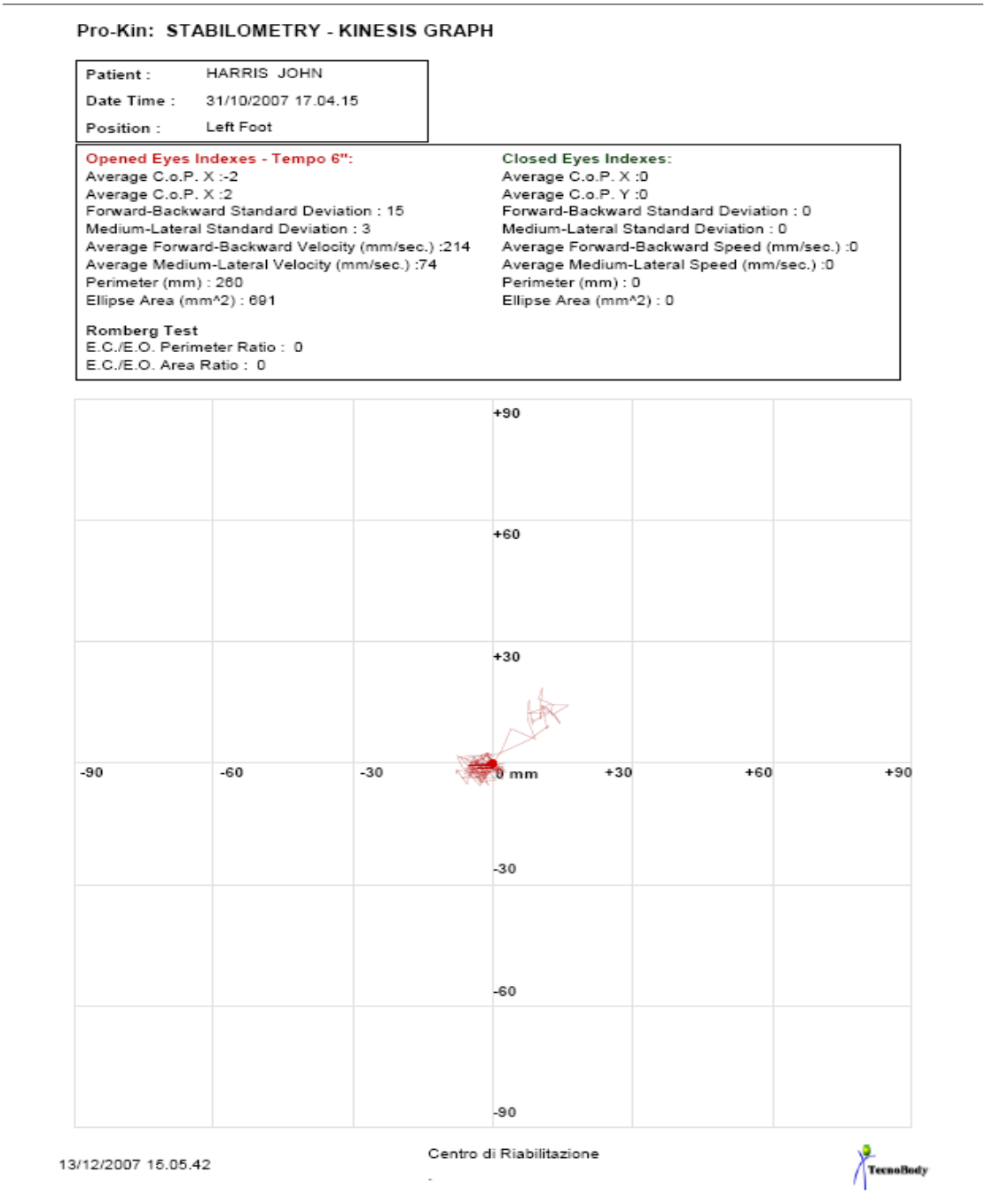

Figure 1. *Static balance tests.*

Dynamic (Equilibrium/ Disequilibrium test); In this test, the subject sees some galleries that come against. The subject's scope is to enter into those galleries and to maintain the tilting board as firm as possible. In this test it's important only one axis, so you have to harden the force absorbers of the other axis. It was performed for 60 seconds and medio-lateral direction. In dynamic equilibrium-disequilibrium test; Front/Right Standard Deviation (DBFRSD), Backward/Left Standard Deviation (DBVLSD) and Distance Medium Error (DBDME) parameters were evaluated (Figure 2).

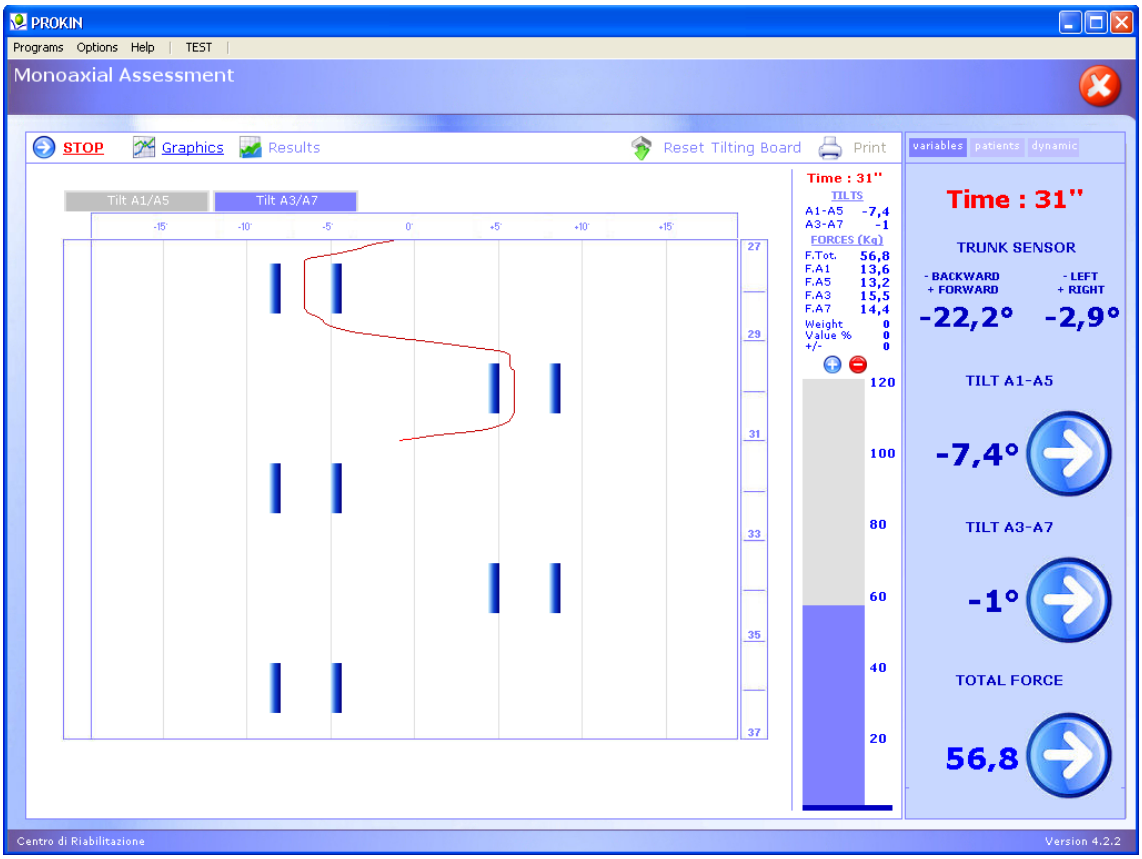

Figure 2. *Dynamic balance tests.*

Statistical analysis

The mean and standard deviation of test results were calculated for pre- and post-tests sessions. The pre- and post-tests data were compared according to the Wilcoxon Signed Rank test within each group for each of the variables. The level of statistical significant was set $p \leq 0,05$. The data analysis was performed with SPSS for Windows 14.0 (SPSS Inc, Ghicago, II,USA).

RESULTS

The demographic characteristics of our experimental group have been shown in Table 2. Age, height, weight, leg height are similar in terms of BMI and CMI statistically.

Table 2. *Demographic characteristics of the groups.*

Variables	Trampoline education group n=15	Control group n=13
Age (year)	9.27±0.94	8.97±0.46
Height (cm)	137.91±7.72	133.94±5.4
Weight (kg)	37.49±10.45	35.26±10.81
Leg Height (cm)	64.58±5.85	62.23±3.27
BMI(kg/m^2)	19.49±4.33	19.42±4.94
Foot Length(cm)	21.92±1.69	21.13±1.57
Foot Width(cm)	7.82±.607	7.53±.48
CMI	53.21±2.81	53.53±1.27

BMI: body mass index
CMI: cormic index

Table 3 shows the pre-test post-test balance values of the experimental and control groups. Static Balance EOEA of children who received TG is not statistically significant. However, EOPE (Z= -2.386; p=0.17) ECEA (Z= -2,101; p=0,036) and RTPR (Z= -1,990; p=0,047) values have been found to be statistically significant. In CG, SB pre-test, post-test values are not statistically significant (p>0.05).

Table 3. *Static balance values of the experimental and control groups.*

	Trampoline education group n=15 Mean±SD			Control group n=13 Mean±SD		
	Pre- test	Post- test	p	Pre- test	Post- test	p
EOEA (mm^2)	619.87±391.84	591.53±211.14	0.78	1449.46±882.550	885.46±634.130	0.065
EOP (mm)	619±69.67	689.33±123.97	0.017*	840.85±362.572	761.38±279.565	0.575
ECEA (mm^2)	921.87±349.653	686.07±245.296	0.036*	1758.92±2065.938	941.08±457.644	0.213
ECP (mm)	806.73±178.301	651.73± 317.2	0.13	1044.46±647.159	790.23±199.55	0.228
RTPR	130.27±25.902	120.60±31.672	0.26	115.54±35.500	109.62±26.738	0.585
RTAR	122.13±58.034	172.60±70.151	0.047*	140.08±86.634	105.92±76.814	0.307

p<0.05* and p<0.01** respectively significant differences between the groups.

In table 4, right and left leg static balance values have been shown. In both groups, the difference between the RFPE, RFEA, LFPE, LFEA static balance pre-test post-test values are not statistically significant (p>0,05).

Table 4. *Right and left leg static balance values of experimental and control groups.*

	Trampoline education group n=15 Mean±SD			Control group n=13 Mean±SD		
	Pre- test	Post- test	p	Pre- test	Post- test	p
RFP (mm)	2004.07±804.97	1798±336.15	0.65	1839.38±394.54	1809±401.51	0.91
RFEA (mm^2)	1801.27±1538.10	1643.87±563.97	0.36	1880±1005.12	2031.46±1085.63	0.70
LFP (mm)	1863.73±515.20	1833.20±316.31	0.91	2013.77±404.83	1729.38±451.07	0.17
LFEA (mm^2)	1633±651.27	1616.8±604.85	1	2242.69±584.42	1921.31±790.64	0.15

p<0.05* and p<0.01** respectively significant differences between the groups.

In table 5, dynamic balance values of TG and CG have been provided. While no statistically significant difference was found between pre-test post-test dynamic balance DBFRSD, DBVLSD of the TG group, DBDME (Z= -1.852; p=0.045) values were found statistically significant. There was no statistically significant difference between CG's DB pre-test post-test values (p>0.05).

Table 5. *Dynamic balance values of experimental and control groups.*

	Trampoline education group n=15 Mean±SD			Control group n=13 Mean±SD		
	Pre- test	Post- test	p	Pre- test	Post- test	p
DBFRSD	1.72± 0.89	1.08± 0.59	0.043*	1.68± 0.97	1.51± .076	0.172
DBVLSD	1.69± 0.65	1.22± 0.52	0.026*	1.75± 0.74	1.56± 0.51	0.208
DBDME	0.68± 0.67	0.25± 0.21	0.016*	0.69± 0.63	0.40± 0.34	0.157

p<0.05* and p<0.01** respectively significant differences between the groups.

In table 6, LS and VJ values of the TG and CG are provided. There was no statistically significant difference between LS pre-test, post-test values of TG and CG groups. However, TG group's SJB (Z= 2.665; p=0.008), SJR (Z= 2.417; p=0.016) and SJL (Z= 2.77; p=0.006) pre-test post-test values were found statistically significant. The difference between pre-test post-values of the Control Group in respect of SJB, SJR, SJL is not statistically significant (p>0.05).

Table 6. *Leg strength and jump values of experimental and control groups.*

	Trampoline education group n=15 Mean±SD		p	Control group n=13 Mean±SD		p
	Pre- test	Post- test		Pre- test	Post- test	
LS (kğ)	62.23±10.81	65.46±12.85	0.43	58.69±10.90	61.19±10.78	0.377
SJB (cm)	20.13±4.38	23±5.68	0.009*	20.54±2.66	20.55±5.3	1
SJR (cm)	9.2± 2.11	10.93± 3.41	0.016*	11.08±3.47	10.46±2.57	0.498
SJL (cm)	9.73±2.28	11.20±3.14	0.042*	10.08±2.87	10.62±2.69	0.490

p<0.05* and p<0.01** respectively significant differences between the groups.

DISCUSSION

The main finding of this study was that there was a significant increase in bipedal SB, DB and VJ values after 12-week TT on 9-year-old boys who do not exercise regularly, and there was no statistically significant difference in terms of their LS and unipedal SB values. In the CG, there was no improvement between the pre-test post-test performance values. These results have shown that inclusion of TT in the training and exercise programs for children has effect on improvement of particularly dynamic balance.

There are limited number of studies made for the purpose of evaluating the sportive postural balance in children (Polishchuc et al., 2007; Kochanowicz et al., 2010; Granacher et al., 2011). In a special branch like trampoline, other than the studies conducted by Aragao (2011) on the elderly, Kidgell (2007) on athletes with functional ankle instability, Song Ya-Wei (2011) on youth trampolinist and the studies

conducted by Heitkamp and Andrea on adolescents, the only literature found was in relation to trampoline injuries. As to our knowledge, this study is the first study in which the effect of TT in 9-year-old boys on SB-DB, VJ and LS are studied. For this reason, we will discuss our results with the other balance training studies.

According to our results, there was improvement in bipedal SB and DB parameters after TT. It is noteworthy that most of the balance studies in literature were not made with children. Mitsiou et al. (2011) found out improvement in static balance after giving trampoline training to children with development coordination disorder. Granacher et al. (2011) conducted 4-week balance trainings for 6-7-year-old children in order to evaluate the effect of balance trainings in children on leg strength and balance parameters, however, found no statistically significant improvements. Aragao et al. (2011) found out that 14-week mini-trampoline exercises prevented sudden front falls in the elderly and improved dynamic balance. Heitkamp et al. (2001) investigated the impact of 6-week balance training program in healthy active adults on variables of static balance and observed that balance training significantly improved unipedal stance. Granacher et al., (2010) found out that 4-week balance training in healthy active youngsters increased SJ and postural control. The results of these studies are in support of our findings.

In our studies, no improvement was observed in unipedal SB parameters. Heitkamp et al. (2001) expressed in this study that mini trampoline exercises improved not only balance but also the coordination between two legs. During exercise trampolinists' muscle relaxation and contraction of the mutual transformation are clearer, and the central control of the muscle of higher muscle co-ordination work more co-ordinately. Standing feet trampolining account balance when proprioceptive control of the dominat role (Song & Qian 2011). It can be thought that, in the trampoline training, the coordination between two legs might have improved with the double feet jumping, and thus, there was no improvement in right and left unipedal SB parameters.

Andrea and Jackie (1997) found out in their study that mini trampoline exercises increased vertical jump. Taube et al. (2007) found out that 6-week balance training in elite athletes' increased jumping height. Kean et al., 2006 and Simek et al., 2007 has been found that their research the addition of a balance training component to the recreationally activities students has resulted in improvement in vertical jump. The findings of these studies are also in parallel to our findings (Andrea & Jackie 1997; Sean et al., 2006; Simek et al., 2007; Taube et al., 2007). Our TT program also included running, bouncing on the trampoline, jumping and landing phase. It can be assumed that the improvement in the jumping abilities in the TT might be due to the mini-trampoline and trampoline making it easier to jump as well as their help in improving the appropriate jumping technique.

Trampoline is characterized by dynamic movement pattern. Trampoline exercises are directed at lower extremities and require particularly kinaesthetic, visual, vestibular perception, balance and movement control. In trampoline exercises, it is important to control the body position in the air at the time of jumps, and to use proper balanced landing and jumping techniques. Also rebounding on a trampoline requires the body to be repetitively in motion, trampolinists' eyes must continually adjust to the different fields of vision. As a result adjusting and reorientation, coordination is greatly improved. It can be thought that the children who receive TT improve bipedal SB-DB because of doing their trainings on the trampoline on bare foot, and on double feet, in order to improve balance and control. Perrin (2002) and Song (2011) expressed in their studies that bare foot trainings of judoists, dancers and trampolinists improved orthostatic balance control by reason of foot position.

As a conclusion, 12-week trampoline training increased bipedal static balance, dynamic balance and vertical jump values in boys who do not exercise regularly. Trampoline training is an effective intervention to improve multifunctional motor features in 9 year-old-boys. Base on this evidence we recommended to use of trampoline training for postural control and explosive power improvement in children to sports trainer and physical education teacher.

REFERENCES

Agopyan, A., Ersöz, A., Topsakal, N. (2011) Effect of Morton's foot on vertical jump, static and dynamic balance performances of modern dancers. *Medicina Dello Sport* 64, 137-150.

Akan, İ., Ramanzanoğlu, N., Uzun, S., Atılgan Erkut, O., Çamlıgüney, F., Küçük, V., Bozkurt, S., Tiryaki, Ç., Sirmen B. (2009) Comparison of Dynamic balance in Adolescents Handball and Football Players. *14th ECSS Congress* 24-27 June Oslo/Norway.

Andrea, L. R., Jackie, L. (1997) Efficacy of a mini-trampoline program for improving the vertical jump Hudson California State University, Chico, CA USA. *Biomechanics in sport* XV, 63-69.

Aragao. A, Karamanidis. K, Vaz, M, Arampatzis, A. (2011) Mini-Trampoline exercise related to mechanisms of dynamic stability improves the ability regain balance in elderly. *Journal of Electromygraphy and Kinesiology* 21, 512-518.

Asseman. B, Caron. O, Cremieux. J. (2008) Are there specific conditions for which expertice in gymnastics could have an postural control and performance. *Gait&Posture* 1, 76-81.

Bergmann, J.H.M, Feltham, M.G, Kortsmit, M, Oosterwerff, F.J. (2002) The Impotance of Visual Information on the Maintanence of Balance in Wakeboarders. *Faculty of Human Movement Sciences* , Vrije Üniversity 9-17.

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

Crowther, R. G., Spinks, W. L., Leicht, A. S., Spinks, C. D. (2007) Kinematic responses to plyometric exercises conducted on compliant and noncompliant surfaces. *J Strength Cond Res*. 21, 460-465.

Esposito, P.W., Esposito L.M. (2009) The Reemergence of the Trampoline as a Recreational Activity and Competitive Sport. *Current Sports Medicine Reports*. 8 (5), 273-277.

Gelen, E. (2011) Acute effects of different warm-up methods on jump performance in children. *Biol Sport* 28 (2), 133-138.

Granacher, U., Gollhofer, A, Kriemler, S.(2010) Effects of balance traning on postural sway, leg extensor strength and jumping height in adolescent. *Research Quarterly for Exercise and Sport* 81(3), 245-251.

Granecher, U., Muehlbauer, T., Maestrini, L., Zahner, L. (2011) Can balance traning promote balance and strength in prepubertal children? *Journal of Strength and Conditioning Research,* 25, 1759-1766.

Heitkamp, H. C., Horstmann, T., Mayer, F., Weller, J., Dickhuth, H. H. (2001) Gain in strength and muscular balance after balance training. *Int J Sports Med.*, 22, 285-290.

Hrysomallis, C. (2011) Balance Ability and Athletic Performance. *Sports Medicine* 41(3), 221-233.

http://www.tecnobody.it (last access date: 27 January 2011).

Kean, C.O., Behm, D.G., Young, W.B. (2006) Fixed foot balance training increases rectus femoris activation during landing and jump height in recreationally active women. *J Sports Sci Med* 5 (1), 138-48.

Kidgel D.J., Horvath D.M., Jackson B.M., Seymour P.J., Effect of six weeks of dura disc and mini-trampoline balance training on postural sway in athletes with funtional ankle instability. *Journal of*

Strength and conditioning Reseach 21(2), 466-469.

Kochanowicz, K., Kucharska, E., (2010) Body Balance İn Children Aged 11-13 Years And The Process Of Physical Training. *Polish Journal of Sports Tourism* 17, 87-96.

Lohman, T.G, Roche, A.F., Martorell, R. (eds) (1988) Anthropometric Standardization Reference Manual. Champaign, IL: Human Kinetics Books.

Matsuda, S., Demura, S., Masaobu, H. (2008) Center of pressure sway characteristics during static one-legged stance of athletes from different sports. *Journal of Sports Sciences* 26(7), 775-779.

Mitsiou, M., Sidiropoulou, M., Giagkazoglou, O., Tsimaras, V. (2011) Effect of Trampoline-based intervention program in static balance of children with developmental coordination disorder. *British Journal of Sport medicine* 45(2), 45-50.

Paillard, T., Noe, F,, Riviere, T., Marion, V., Montoya, R., Philippe, D. (2006) Postural Performance and Strategy. Postural performanceand Strategy in the Unipedal Stance of Soccer Players at Different Levels of Competition. *J. Athl Train.* 41(2), 172-176.

Paject, M.B., Cuk, I., Kocak, M., Jacse, B. (2010) Implemention of the Gymnastics Curriculum In The Third Cycle of Basic School In Slovenia. *Science of Gymnastics Journal* 2(3), 15-17.

Perrin, P., Deviterne, D., Hugel, F., Perrot, C. (2002) Judo, beter than dance, develops Sensorimotor Adaptibilities Involved in Balance Control . *Gait and Posture* 15, 187-194.

Polishchuk, T., Mosakowska, M. (2007) The balance and jumping ability of artistic gymnastics competitors of different ages. *Reseach Yearbook Medsportpress* 1, 100-103.

Saygın, Ö., Öztürk, A.Ö. (2011) The effect of twelve week aerobic exercise programme on health related physical fitness components and blood lipids in obese girls. *African Journal of Pharmacy and Pharmacology* 5(12), 1441-1445.

Song, Y.W., Qian J.G. (2011) The Static Balance Stability's Biomechanics Research on Youth Trampolinists. *2011 International Conference on Future Computer Science and Education, China*.

Simek, S., Milanovic, D., Jukic, I. (2007) The effects of proprioceptive training on jumping and agility performance. *Kinesiol.* 39 (2), 131-41.

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

Taube, W., Kullmann. N., Leukel, C., Kurz, O., Amtage, F., Gollhofer, A. (2007) Differantial reflex adaptaations following sensorimotor and strenth traning in young elite athletes. *Int Journal of Sport Medicine* 28, 999-1005.

Vuillerme, N., Teasdale, N., Nougier, V. (2001) The Effect of Expertise in Gymnastics. *Nouroscience Letters* 311(2), 83-86.

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EXPLORING THE EFFECTIVENESS OF PRE-PERFORMANCE ROUTINES IN ELITE ARTISTIC GYMNASTS: A MIXED METHOD INVESTIGATION.

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Abstract

Competitive sport at the highest level demands consistency and precision in the transfer of skill across various environments, on multiple occasions, in order to produce optimal performance (Singer, 2002). Pre-performance routines (PPR) are sequences of motor, emotional, and cognitive behaviours performed immediately in advance of the execution of self-paced tasks (Cohn, 1990). The purpose of this study was to explore both content and variation of pre-performance routines (PPR) between the four apparatus within Women's Artistic Gymnastics. Participants were purposely selected from former Great Britain international, female elite artistic gymnasts (n=9). This study employed a mixed-method, phased design. All participants completed the Test of Performance Strategies (TOPS; Thomas et al., 1999) in phase one. A purposeful sampling mechanism using descriptive statistics from questionnaire results generated five profiles for further qualitative exploration as to the application and effectiveness of PPR's via semi structured interviews. Pen-profiling was used to compare and contrast common themes amongst the preparations for the apparatus. Results indicated differences between vault and beam exercise with regard to pre-performance state and preparation strategies linked to arousal/activation control and cognitive rehearsal. Gymnasts reported prior use of individualised and highly refined routines dominated by imagery and arousal/activation control. Specific PPR strategies were reported for each apparatus with some robust, consistent psychological skills training (PST) components within them. The results from this study demonstrate that each apparatus requires unique preparation strategies with regards to the achievement of an optimal psychological state for performance.

Keywords: *elite gymnasts, imagery, females*

INTRODUCTION

Women's Artistic Gymnastics is a closed-skill, multi-discipline sport, composed of four individual apparatus (Vault, Asymmetric-bars, Beam exercise, and Floor exercise). Psychologically, gymnasts are required to cope with the

expectation of a technically perfect performance of their routines, alongside a consistently high risk of serious injury (Post, 2010). With respect for such sport-specific pressures, a consideration for the range of potentially beneficial psychological skills that can be incorporated into the procedures of preparation for training drills and competition performance is valuable, as a means to inform selected rehearsal mechanisms to achieve optimal preparatory states for actual performance.

Pre-performance routines (PPR's) are a combination of cognitive, motor and emotional behaviours performed immediately in advance of self-paced task execution (Cohn, 1990; Lidor & Singer, 2000). PPR's allow for an athlete to intentionally self-regulate arousal (Crews & Boutcher, 1986; Gould & Udry, 1994); divert attention away from task-irrelevant cues (Czech et al., 2004); facilitate the maintenance of the 'prepared' state by preserving psychological and physiological readiness (Schmidt, 1988) and achieve a sustained optimal emotional, confident and focused state immediately prior to and during performance (Singer, 2002). PPR's can also be utilised as training aids to assist with achieving consistent optimal practice performances and to encourage rehearsal of such techniques prior to the pressurised environment of the performance arena. In order for a PPR to be most effective, it should be sport specific, self-styled, individualised to match the athlete's skill level and individual pre-performance preferences, and influenced by the nature of the required task (Singer, 2002; Wrisberg & Pein, 1992).

Previous research has focused on how PPR's have both *influenced* and *improved* performance in sport. A popular method of assessing the effect PPR's have on performance has been the comparison between performances of an experimental group (following a PPR intervention strategy) and a control group (e.g., Hall & Erffmeyer, 1983; Lobmeyer & Wasserman, 1986; Marlow et al., 1998) Although across these studies a clear connection between PPR use and improved performance is evident, there is a sense that exploring the different aspects of PPR's deemed more functional in supporting different aspects of performance would be useful. Previous literature has also focused on the *duration* of PPR's (e.g., Crews & Boutcher, 1986; Jackson, 2003; Southard & Miracle, 1993). Although the literature suggests there may seem to be some association, the increased duration of psychological preparation has shown no direct link with performance improvement. However, this absence of a direct relationship between duration and performance improvement may be attributed to the content and consistency of the PPR rather than the length of time to complete it.

Generally, the focus of PPR research has been amongst closed skill sports such as golf (e.g., Cotterill et al., 2010) basketball (e.g., Lonsdale & Tam, 2007), volleyball and tennis service (e.g., Lidor & Mayan, 2005), and bowling (e.g., Kirschenbaum et al., 1982). Closed skill events are self-paced in nature, allowing for adequate pre-skill preparation time where environmental conditions are stable and predictable (Singer, 2002). The self-paced nature of gymnastics requires movements that are initiated and controlled by the performer with time for psychological preparation immediately prior to each event. This preparation varies between individuals and events as different internal states and cognitive preparation strategies are required for optimal readiness and performance (Cohn, 1990).

This study will fundamentally explore how former female, elite, artistic gymnasts retrospectively implemented different psychological preparation techniques into their PPR's in training and competition, across the four different apparatus (Vault, Asymmetric-bars, Beam exercise and Floor exercise) with the intention of adding to the information already existent in the relevant literature.

The majority of research within the PPR area of study has taken a quantitative approach, with questionnaires being the primary measurement tool (e.g., Lidor &

Mayan, 2005; Mesagno & Mullane-Grant, 2010). Questionnaires alone can be limiting in scope to explore participant's experiences, true feelings, thoughts, opinions and additional information on the topic in question (Patton, 1990). Qualitative measures allow for detailed accounts of the athlete's personal views and experiences, as research can be based on description, be context specific and allow for in-depth analysis. The present study will follow a mixed methodology of questionnaires in phase one and interviews in phase two. On conclusion the study will offer recommendations for the coach and/or sport psychology consultant as to the understanding of PPR complexity and relevant strategies and techniques to use with elite female artistic gymnasts.

METHOD

Participants

Data were gathered from nine former elite level female gymnasts (*M* = 20.55 years, *SD = 1.81*) who were all previous members of the Great Britain Women's Artistic Gymnastics team. Gymnasts had an average training age of 13.2 (*SD = 1.96*) years, first competed nationally at the average age of 9.2 (*SD = 1.32*) years old, and retired at 18.22 (*SD = 1.56*) years. Gymnasts were purposely selected (Berg, 2009) as they were information-rich and corresponded with specific selection criteria namely being previous members of the GB National squad for a minimum of 18 months during their career, one or more international representation honours ('friendly' or competitive tournament) and retirement from gymnastics within the most recent Olympic cycle. Five gymnasts had competed at World Championships with the remainder at more than one of European Championships, Commonwealth and Commonwealth Youth Games, and at Australian or European Youth Olympic Festivals.

Procedure

Phase 1 – Questionnaire

Prior to participant recruitment, full ethical approval was gained from a University Research Ethics Committee. Participants were recruited via email containing an information letter to explain the purpose of the study and request participation. On receipt of consent participants each completed the Test of Performance Strategies (TOPS) and returned these to the researcher via email within two weeks along with a small number of demographic questions relating to age, participation in gymnastics, retirement age and top three significant competitions. Participants were instructed to reflect on their psychological skill usage from a defined period between when they reached national level and gained International representative honours, until retirement.

Phase 2: Interview

The qualitative approach in essence respects the expert knowledge of the participant and allows for the provision of insights into each participant's personal and unique experiences (Kesby, 2007). As qualitative inquiry typically focuses in-depth on a relatively small sample selected purposefully (Patton, 2002), this was an appropriate approach for this study. Following data consideration and analysis from the questionnaires, 5 participants were selected to take part in one-to-one interviews. These participants demonstrated particularly interesting results (i.e. results worthy of further exploration within the qualitative phase) which indicated very high and low pre-performance strategy usage, including an average scorer to obtain a diverse range of profiles which were than explored in-depth in the interview.

The semi structured interviews were carried out on separate dates within one month of the completion of the questionnaires and following analysis of the results. The interview focused on the TOPS results, with interest towards the prominent subscales from each participant's earlier questionnaire results. Throughout the

interview, participants were asked to discuss psychological techniques used in both training and competition contexts and, where possible, give specific examples of their use. A full interview schedule is available upon request from the author. Each interview was carried out over an average duration of approximately 25 minutes dependent on the detail of the participants' responses. Interviews were audio recorded using a Dictaphone (OLYMPUS, WS-450S, China), and were later transcribed verbatim by the primary researcher into 41¼ pages of size 12 double spaced text.

Within this study credibility and transferability (the qualitative equivalent of internal and external validity, respectively) were demonstrated through verbatim transcription of data and triangulation with an experienced qualitative researcher. Dependability (the qualitative equivalent of reliability) was demonstrated through the comparison of pen profiles with verbatim citations and triangular consensus methods.

Instruments

The TOPS questionnaire was completed to retrospectively assess the participant's use of a range of psychological skills, strategies and techniques in practice and competition contexts. The self-report instrument consisted of a 64-item questionnaire, measured on a 5-point Likert scale (1 = *never* to 5 = *always*) to rate the *frequency* of usage of each psychological skill dimension. Items were split into 16 subscales to target the eight most significant dimensions of psychological skill that produce successful athletic performance; activation, relaxation, imagery, goal-setting, self-talk, automaticity, emotional control and attentional control in competition and practice settings. The subscale "attentional control" was found to be an inappropriate solution within the competition context (Thomas et al., 1999) and was thus replaced by "negative thinking". The maximum score for each subscale of TOPS was 20. High scores indicated greater usage of that mental skill. The internal consistency of the TOPS subscales were reported to range between 0.66 and 0.81, and reliability coefficients for this test have been reported to range from 0.86 to 0.93 (Thomas et al., 1999).

Data Analysis

Descriptive statistics were calculated for participant's individual overall usage of psychological performance strategies (TOPS results). These acted as a purposeful sampling mechanism for participant selection in phase two. Overall total and mean scores were the focus for selection of each participant to initially identify them for phase two interviews. In order to obtain a variable spread of data, two high scoring, two low scoring and one moderate scoring participant were selected for interview. Raw scores from subscales of the questionnaire were then considered to assist with the selection of specific areas for deeper exploration in the phase two interviews.. For the TOPS questionnaire, this refers to the combined practice and competition score for each subscale. Other subscale scores were selected based on the indication of the greatest difference between practice and competition scores.

Interview data was represented via a pen profile technique. The pen profile method has been used to represent analysis of data sets in the exercise domain originating from young participants, including those from write and draw (Knowles et al., 2013), focus group (Ridgers et al., 2012) and interviews (Mackintosh et al., 2011). The pen profiles were constructed from the transcripts using verbatim quotations taken directly from the interviews (figures 1-5). This process allowed for the efficient emergence of key themes and dimensions within the data.

Data in the pen profiles refers to verbatim quotes that are both specific to the individual apparatus and also to some of the general information relating to PPR strategies that appeared relevant and significant for the discussion of use within the sport of artistic gymnastics.

RESULTS

Phase 1: Questionnaire

Descriptive statistics acquired from the TOPS questionnaire indicated profiles for participants 1, 2, 4, 6, 7 and 8 demonstrated results worthy of further exploration. However, at the time of the second phase, P7 was not contactable due to unforeseen circumstances. As a result, despite the high scoring nature of their results and incidentally their initial consideration for interview, they were withdrawn from the study, hence the selection and inclusion of other participants (Table 1).

Table 1. *Individual subscale, mean, standard deviation, range and total score of participants for the TOPS questionnaire*

	Activation		Relaxation		Imagery		G-Setting		Self-Talk		Auto.		E. Control		Att. / Neg.					
Participant	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	Mean	SD	Range	Total
1	10	8	**5**	**12**	12	17	11	15	14	10	9	14	**13**	**16**	**14**	**6**	11.63	3.46	12	**186**
2	**10**	**17**	8	13	**17**	**20**	**10**	**17**	14	16	14	14	**11**	**14**	11	9	13.44	3.41	12	**215**
3	14	18	8	8	11	18	15	20	16	14	16	12	10	10	14	12	13.5	3.60	12	216
4	14	18	**6**	**12**	**20**	**20**	**14**	**19**	**19**	**18**	12	10	**4**	**12**	13	8	13.69	5.04	16	**219**
5	11	14	12	11	12	17	15	15	15	15	12	10	12	13	12	10	12.88	2.06	7	206
6	**13**	**20**	13	15	**16**	**20**	**16**	**20**	**17**	**20**	**13**	**10**	10	13	14	5	14.69	4.25	15	**235**
7	10	17	10	17	18	18	14	13	16	19	9	4	12	20	14	10	13.81	4.42	16	221
8	**9**	**15**	**5**	**11**	10	12	10	12	11	11	**11**	**13**	10	12	**11**	**11**	10.88	2.09	10	**174**
9	9	15	9	12	14	17	15	13	13	15	15	13	12	14	13	7	12.88	2.63	10	206
Total	100	142	76	111	130	159	120	144	135	138	111	100	94	124	116	78				

Note. Total values shown in boldface represent the participants selected for phase two interviews. Individual subscale values selected for exploration are also shown in boldface. P = Practice; C = Competition.

The results reveal high scores for P4 and P6, low scores for P1 and P8, and average scores for P2 as shown in table 1. The remaining participants (P3, P5 and P9) were not considered for further investigation in the interview phase due to their moderate results. All those classified as moderate scoring were contacted for interview as a means to obtain a variable account of PPR strategy usage, however, only one (P2) was available within the timescale of the study.

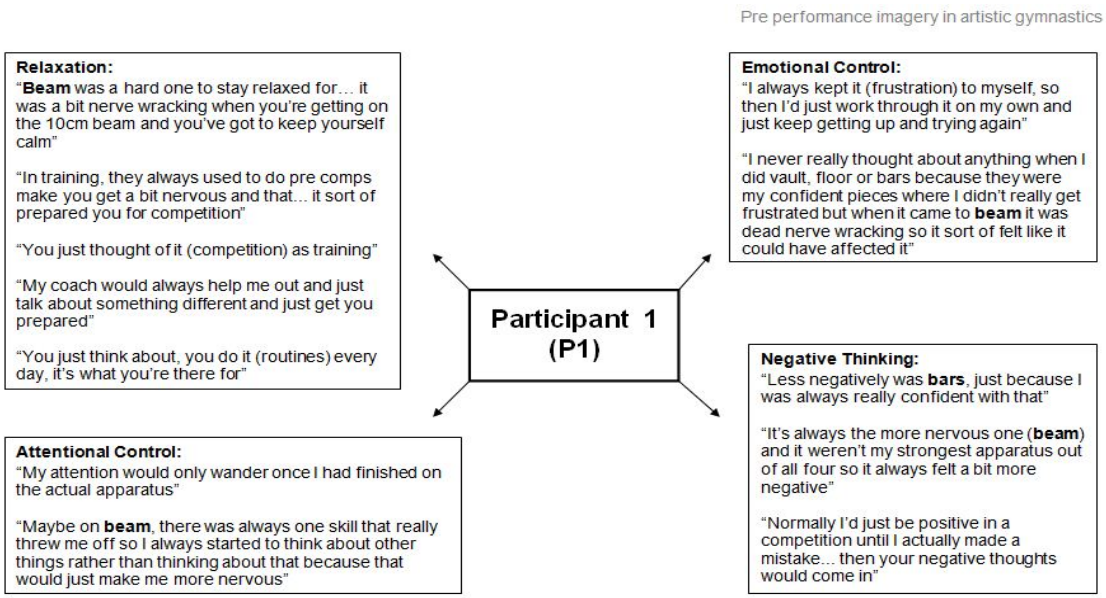

Figure 1. Pen Profile for participant 1.

Figure 1. *Pen profile for participant 1 showing verbatim quotations for relaxation, emotional control, attentional control and negative thinking PPR strategies.*

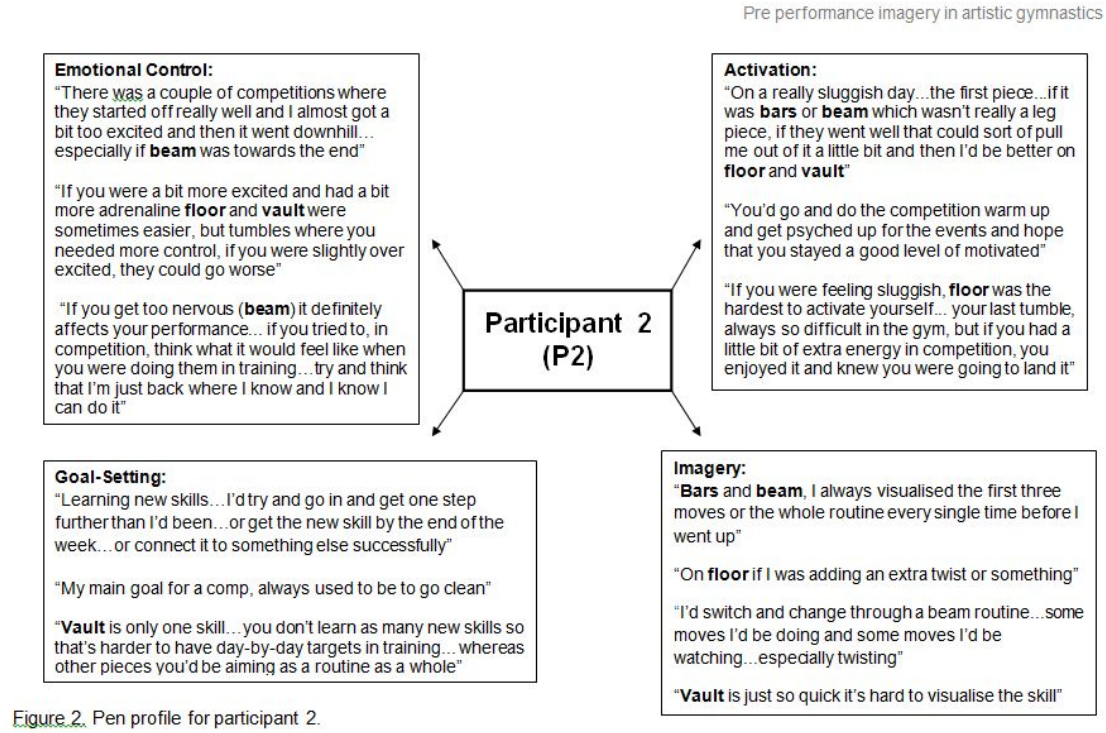

Figure 2. Pen profile for participant 2.

Figure 2. *Pen profile for participant 2 showing verbatim quotations for emotional control, activation, imagery and goal-setting PPR strategies.*

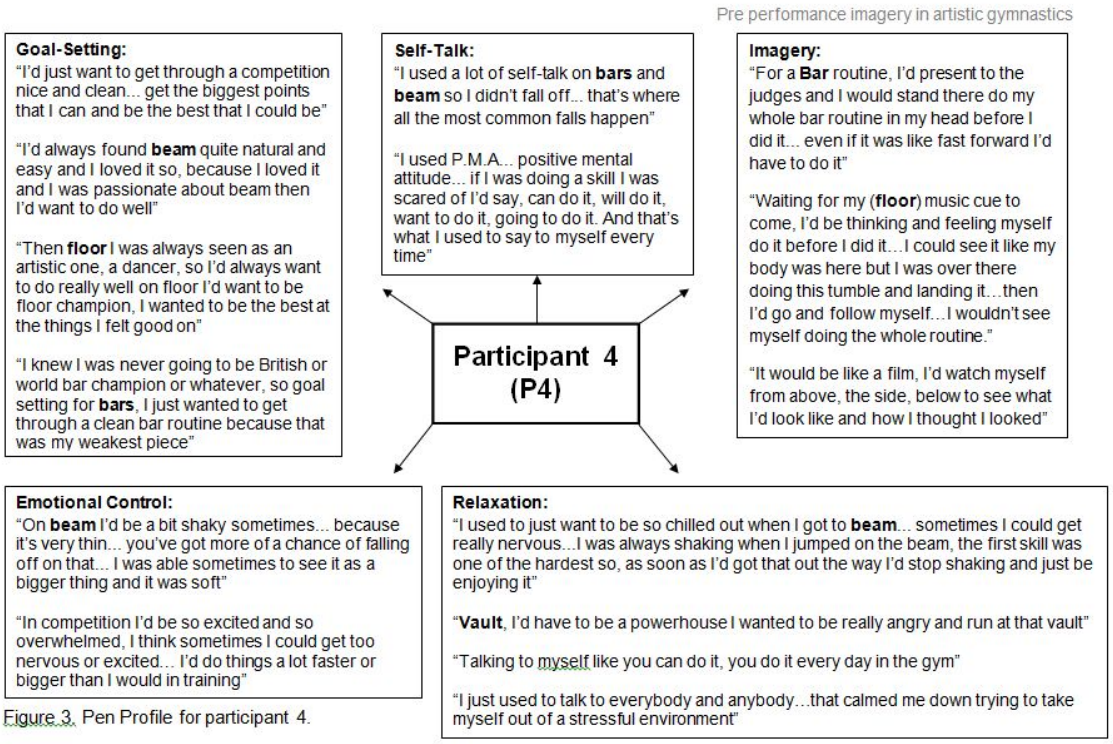

Figure 3. Pen Profile for participant 4.

Figure 3. *Pen profile for participant 4 showing verbatim quotations for goal-setting, self-talk, imagery, relaxation and emotional control PPR strategies.*

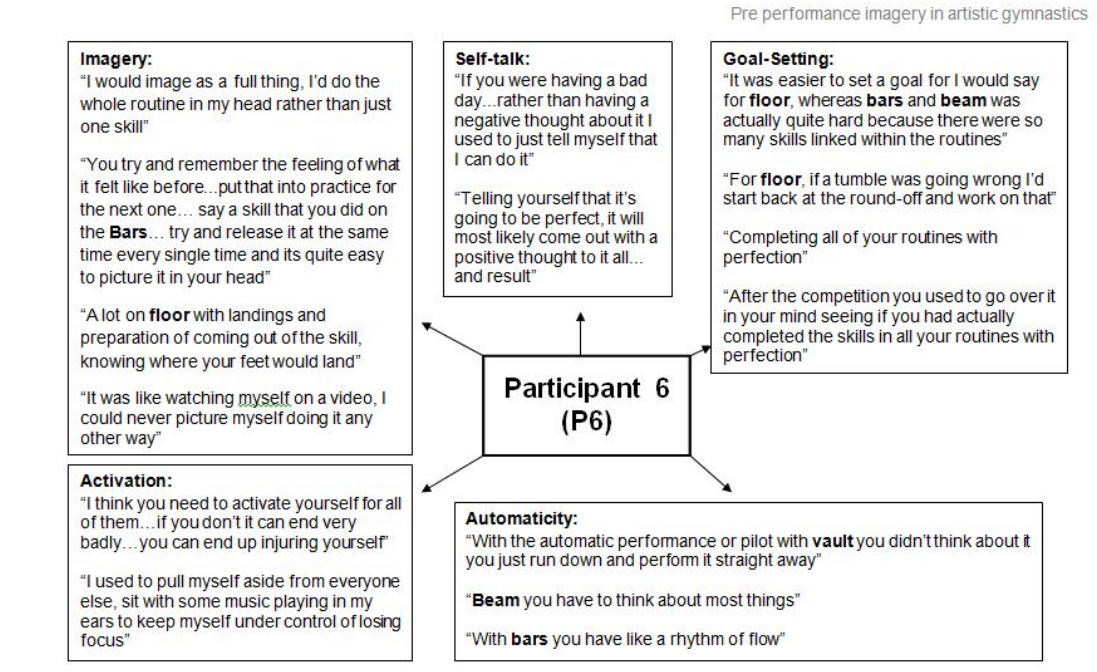

Figure 4. Pen Profile for participant 6.

Figure 4. *Pen profile for participant 6 showing verbatim quotations for imagery, self-talk, goal-setting, automaticity and activation PPR strategies.*

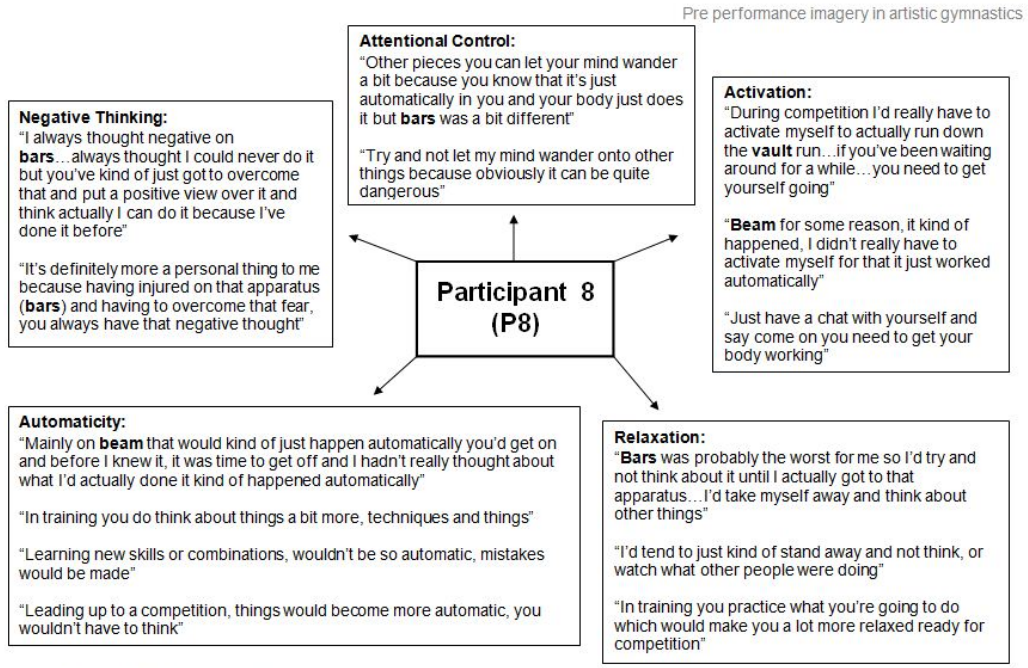

Figure 5. Pen profile for participant 8.

Figure 5. *Pen profile for participant 8 showing verbatim quotations for negative thinking, attentional control, activation, relaxation, automaticity.*

DISCUSSION

This study aimed to explore the unique variation in pre-performance preparation strategies employed across the four individual apparatus within Women's Artistic gymnastics. Analysis revealed a number of frequently occurring strategies implemented by participants with respect to psychological preparation for the vault and beam exercise. Arousal/activation was noted by the participants as a method for achieving the appropriate performance state for vault while, contrastingly, relaxation appeared principal in obtaining prime pre-performance status for beam exercise. Participants consistently reported the importance of executing a powerful and energetic pre-vaulting approach. Description of a process known as "psyching-up" was mentioned, which has previously been suggested to operate as that of a cognitive stimuli for enhancement of the aroused state, and to be of use for activities requiring power (Weinberg et al., 1985). Within the psyching-up process, participants reported use of positive self-talk and related imagery mechanisms which have previously been reported as effective stimulatory techniques for dynamic tasks (e.g., Tod et al., 2003). White and Hardy (1998) reported the presence of an aggressive imagery approach in slalom canoeists linked to mood enhancement but, in contrast, gymnasts did not use imagery in this same way. The present study, however, contradicts those suggestions, as the participants described similar tendencies to the canoeists to achieve an 'angry' mind-set prior to vaulting (figure 3).

The data also highlighted the somewhat contrasting pre-performance state required for the beam exercise. Participants consistently associated the width of the apparatus with their own perceptions of anxiety and nerves (figures 1 & 3). Participants perceived that the beam exercise required a particular 'focus' and that inappropriate focus was the most common cause of falls and mistakes and in effect more dangerous than other apparatus. This data highlights the importance of

achieving a state of relaxation both prior to and during beam performance. Imagery has previously been employed as a strategy to calm nerves (Hall et al., 1998) and was among the techniques reported by participants in this study to achieve and maintain relaxation required for the beam exercise. During competition, one participant described imagining themselves in their training environment (figure 2). This simulation of a 'safe' atmosphere seems to have been used effectively to reduce the pressure associated with competition. Mental rehearsal of an environment has previously been reported by other multi event sports such as heptathletes (e.g., Gregg et al., 2007) and more recently gymnasts (Post, 2010). The participants in the present study simulated performance environments in training, in order to familiarise themselves with the competition scenario (figures 1 & 8).

The use or absence of cognitive rehearsal was another contrasting technique applied for the vault and beam. Due to being fast paced and of a short duration, a common response among the participants related to the difficulty experienced with imaging for vault, due to it being a short, dynamic movement (figures 2 & 4). This concurs with research by Post (2010) who also reported difficulties by gymnasts in imaging their vault sequences due to the high velocity of the skill. Participants in Post's work employed a method of imaging the element at a slower pace in order to capture the details of the movement. The participants in the present study appeared to deliberately avoid the use of cognitive imagery, and referred to just allowing the skill to happen with a sense of automaticity, despite the complex nature of vaulting elements, and the potential performance benefit that could be gained from mental rehearsal.

In contrast to this, participants conveyed the need for explicit cognitive control and rehearsal for the beam exercise. Several participants described the visualisation of blocks of skills, or full routines, immediately prior to their completion in competition (figures 2; 3; 4). This level of cognitive specific imagery has been found previously to be the most frequent type of imagery used by gymnasts as a resource for them to rehearse difficult moves and skill combinations (White & Hardy, 1998).

The asymmetric-bars presented psychological demands that are somewhat distinct to that of of the other apparatus. Participants described the need to employ cognitive rehearsal in a similar process as that of the beam exercise. Participants expressed the need to visualise opening sections or whole routines in advance of mounting the asymmetric-bars in competition, even if their images were faster than the real time skills (figures 2 & 3). This illustrates that the participants were able to *control* the speed of their images akin to the findings of Post (2010). Results from the present study contradict in part to that of Post, where it was reported participants' images were slowed down to gain a beneficial effect of individual skill component practice. Participants in the present study, however, reported an increased image speed. Being able to control the speed of an image may be favourable to the gymnast as it would allow for mental practice even when time is limited. This was highlighted by White and Hardy (1998) who noted that rehearsal based strategies proved problematic for gymnasts during the warm up phase of the competition, as they felt pressured to use this short amount of valuable time for physical practice. Therefore, the ability to alter the speed of imagery in view of available time for this technique to be employed effectively may prove advantageous for the gymnast. Frequent use of kinaesthetic imagery has been reported by athletes in sports where proprioceptive cues and timing are crucial (Hall et al., 1990). Participants in this study referred to the use of mental rehearsal to assess and compare the *feel* and *timing* of some of the movements in practice on bars (figure 4). This technique was used as an attempt to automate the sensitive timings of release

skills and allow for the mechanics of skills to develop consistency. This finding illustrates that imagery is multi-sensory and, perhaps, by incorporating more than just an image within their PPR, gymnasts could increase the power of their cognitive rehearsal, especially for the technical nature of bar skills.

Participants reported the lowest use and range of PPR strategies in respect to the floor exercise despite the demands for a wide range of skill types, arousal states and mind-frames. Participants PPR strategies for the floor exercise were akin to those techniques of cognitive rehearsal utilised on bars. One participant discussed a thorough usage of imagery prior to their floor routine (figure 3). As they awaited the music cue they described a powerful 'out of body' experience. Through first visualising and *feeling* the tumble run successfully, subsequently they would 'follow' their body to successfully execute the skill that they had already seen themselves complete. Again, this reiterates the potential benefit of kinaesthetic imagery for the complex skills involved in the majority of a gymnast's performance. It is important to note that the participants only discussed using this cognitive rehearsal technique for the tumble run and skilled movements within their floor routine (figures 2 & 4), they did not seem to apply the same method of practice to their choreography. Gymnasts have also previously reported primarily imaging the skilled parts of their floor routine, with little attention to their dance (Post, 2010). This suggests that imagery of technical elements is prioritised over the more simplistic yet required elements.

Results clearly demonstrated that each participant utilised an individual combination of techniques in a way that was unique and deemed most effective for them. As such this reinforces the findings of Cotterill et al. (2010) and Gregg et al. (2007) with respect to the notion of individual differences in the selection and use of psychological skills and imagery use.

An interesting strategy that emerged as a mechanism for relaxation during the pre-performance period in competition was that of self imposed isolation and distraction. Frequent references were made relating to how the participants intentionally removed themselves from competitive surroundings and isolated themselves from other competitors as part of their preparation (figures 4 & 5). In contrast to this, other distractive relaxation techniques employed by the participants involved the engagement in seemingly irrelevant (to the task) conversation with their coach or others, in order to distract from the stressful environment (figures 1 & 3). Cotterill et al. (2010) witnessed similar use of deliberate distraction techniques in their study with international golfers. It seems that athletes utilise strategies such as these to avoid the occurrence of any non-constructive or perhaps detrimental thought processes in the period directly prior to performance.

In the present study, imagery was identified as a particularly effective and important skill reported by the participants, which supports the notion from Hall et al. (1990) that imagery usage prior to performance is a crucial skill to develop. With respect to imagery, it is perhaps of use to consider the preferred perspective adopted by the participants. Some gymnasts reported using only internal or external imagery (figures 3 & 4), whereas, others described how they would utilise both approaches interchangeably (figure 2) and is such consistent with findings by Post (2010). As each apparatus requires different pre-performance states it appears gymnasts need to be able to adapt their imagery in relation to the apparatus, as both internal and external perspectives have value for tasks that require the execution of correct form (White & Hardy, 1995). Further reference was made, by the participants, as to the need to experience the kinaesthetic feel for their images which again stresses the importance and skill development required for this technique.

A key limitation within the study relates to the retrospective nature of the research. The sample of participants consisted of retired elite gymnasts, who

were required to reflect upon their experiences prior to retirement, make generalisations and contextualise their answers. Therefore, the research was based on responses reliant on memory recall; something which inevitably decays over time and may have therefore provided imprecise answers. Every effort was made to counteract this with an appropriate 'time-frame setting' and ensuring that examples given were checked as being from the defined time period. Another potential limitation of the study was related to the size and limited sample of participants. The selection criteria was employed to ensure the standard of the sample, however, the number of gymnasts that had attained the appropriate competitive level and also retired within a reasonable time-frame was limited, especially in the UK. It is also important to note that four of the five participants selected for interview in phase two, did in fact train at the same club. Whilst it should be noted that being exposed to the same club environments may be influential to training and thus the strategies employed by the gymnasts, given the individual nature of coaching it is said with some certainty that participants in this club were divided between several principle coaches. It is, also interesting to consider that both P4 (who demonstrated generally high scores) and P8 (low scores) were members of the same club under supervision of the same coach, yet clearly utilised very different PPR strategies in competition and training

Participants involved in this study reported use of PPR strategies which were beneficial to them within both their training and performance. The general age of participants within this research is positively higher than the average gymnast currently competing at national level. Previous research has been conflicting when exploring e effectiveness of of cognitive strategies with young athletes. Lidor and Mayan (2005) reported no benefit from the use of cognitive PPR's with young athletes in volleyball. This result may be due to the fact that the sample of participants had no previous experience in the sport. It has, however, also been found that young athletes are able to learn and use cognitive techniques to enhance their performance (Lidor & Singer, 2000) and they are particularly motivated by opportunities that promote skill development (Wrisberg & Anshel, 1989).

PPR use and development is often related to experience, which usually equates to the chronological age of the athlete. With consideration for the nature of gymnastics and its associated high training age at a low chronological age, it seems appropriate perhaps to suggest that young gymnasts do need to be develop psychological skills to cope with the demands of the sport, particularly for those times in event and pre performance. Findings from this study have shown PPR's to be useful in this quest; however it is recommended that they be developed in conjunction with the gymnast's preferences of PPR strategies and sympathetic to their present level of skills which may change over time as skills or competition demands increase. Further research, perhaps with *current* elite level senior gymnasts would allow the use of strategies employed 'within career' to be examined, thus eliminating the potential of recall bias when using a retired population. It may also be beneficial to explore these findings with gymnasts from other countries in view of influences from different training environments/techniques and regimes.

CONCLUSION

The results from this study demonstrate that each of the apparatus within Women's Artistic Gymnastics requires unique preparation strategies with regards to the achievement of an optimal psychological state for performance. Generally, preparation for the vault was characterised by increased arousal and activation, and although results displayed a lack of cognitive rehearsal, it may be suggested that gymnasts would benefit from the use of imagery for vaulting due to its complex nature and short duration of

performance. Beam preparation was defined by arousal control and relaxation mechanisms, with clear usage of cognitive imagery as a method to manage anxiety and nerves. Similarly, preparation for the asymmetric-bars and floor exercise was characterised by cognitive rehearsal with specific reference to kinaesthetic imagery; a technique which emerged as being particularly important across all aspects of gymnastics. Findings from the present study reiterate the importance of individual differences when developing PPR strategies and imagery use in gymnasts. Results of the study could therefore be used to inform psychological training programmes for gymnasts as they progress through development structures towards that of the senior elite/International competitive environments.

REFERENCES

Berg, B.L. (2009). *Qualitative Research Methods for the Social Sciences*. London: Allyn & Bacon.

Cohn, P. J. (1990). Preperformance Routines in Sport: Theoretical Support and Practical Applications. *The Sport Psychologist, 4,* 301-312.

Cotterill, S. (2010). Pre-performance Routines in Sport: Current Understanding and Future Directions. *International Review of Sport and Exercise Psychology, 3,* 132-153.

Cotterill, S., Sanders, R., & Collins, D. (2010). Developing Effective Pre-performance Routines in Golf: Why Don't We Ask the Golfer? *Journal of Applied Sport Psychology, 22,* 51-64.

Crews, D.J., & Boutcher, S.H. (1986). An Exploratory Observational Behaviour Analysis of Professional Golfers during Competition. *Journal of Sport Behaviour, 9,* 51-58.

Czech, D.R., Ploszay, A.J., & Burke, K.L. (2004). An Examination of the Maintenance of Preshot Routines in Basketball Free Throw Shooting. *Journal of Sport Behaviour, 27,* 323-329.

Gould, D., & Udry, E. (1994). Psychological Skills for Enhancing Performance: Arousal Regulation Strategies. *Medicine and Science in Sport and Exercise, 26,* 478-485.

Gregg, M., Hall, C., & Hanton, S. (2007). Perceived Effectiveness of Heptathletes' Mental Imagery. *Journal of Sport Behaviour, 30 (4),* 398-414.

Hall, C., Mack, D., Paivio, A., & Hausenblas, H. (1998). Imagery Use by Athletes: Development of the Sport Imagery Questionnaire. *International Journal of Sport Psychology, 29,* 73-89.

Hall, C. R., Rodgers, W. M., & Barr, K. A. (1990). The Use of Imagery by Athletes in Selected Sports. *The Sport Psychologist, 4,* 1-10.

Hall, E.G., & Erffmeyer, E.S. (1983). The Effect of Visuo-motor Behaviour Rehearsal with Videotaped Modelling on Free Throw Accuracy of Intercollegiate Female Basketball Players. *Journal of Sport Psychology, 5,* 343-346.

Jackson, R.C. (2003). Pre-performance Routine Consistency: Temporal Analysis of Goal Kicking in the Rugby Union World Cup. *Journal of Sports Sciences, 21,* 803-814.

Kesby, M. (2007). Methodological Insights On and From Children's Geographies. *Children's Geographies, 5 (3),* 193–205.

Kirschenbaum, D.S., Ordman, A.M., Tomarken, A.J.., & Holtzbauer, R. (1982). Effects of Differential Self-Monitoring and Level of Mastery on Sports Performance: Brain Power Bowling. *Cognitive Therapy and Research, 6 (3),* 335-342.

Knowles, Z., Parnell, D., Ridgers, N., & Stratton, G. (2013). Learning from the Experts: Exploring Playground Experience and Activities Using a Write and Draw Technique. *Journal of Physical Activity & Health*. In Press.

Lidor, R., & Mayan, Z. (2005). Can Beginning Learners Benefit From Pre-performance Routines When Serving in Volleyball? *The Sport Psychologist, 19,* 343-363.

Lidor, R., & Singer, R. N. (2000). Teaching Pre-performance Routines to Beginners (Health & Fitness). *The Journal of Physical Education, Recreation & Dance, 71*(7), 34.

Lobmeyer, D.L., & Wasserman, E.A. (1986). Preliminaries to Free Throw Shooting: Superstitious Behaviour? *Journal of Sports Behaviour, 9,* 70-78.

Lonsdale, C., & Tam, J.T.M. (2007). On the Temporal and Behavioural Consistency of Pre-performance Routines: An Intra-individual Analysis of Elite Basketball Players' Free Throw Shooting Accuracy. *Journal of Sports Sciences, 26,* 259-266.

Mackintosh, K., Knowles, Z., Ridgers, N., & Fairclough, S. (2011). Using Formative Research to Develop Physical Activity. CHANGE!: A Curriculum-based Health-education Intervention. *BMC Public Health, 11,* 831.

Marlow, C., Bull, S., Heath, B., & Shambrook, C. (1998). The Use of a Single Case Design to Investigate the Effect of a Pre-performance Routine on the Water Polo Penalty Shot. *Journal of Science and Medicine in Sport, 1,* 143-155.

Mesagno, C., & Mullane-Grant, T. (2010). A Comparison of Different Pre-Performance Routines as Possible Choking Interventions. *Journal of Applied Sport Psychology, 22,* 343-360.

Patton, M.Q. (1990). *Qualitative Evaluation Methods* (2nd Ed.). Beverly Hills, CA: Sage.

Patton, M.Q. (2002). *Qualitative Evaluation and Research Methods.* Newbury Park, CA: Sage.

Post, P.G. (2010). A Phenomenological Investigation of Gymnasts' Lived Experience of Imagery. Unpublished PhD Dissertation, University of Tennessee.

Ridgers, N., Knowles, Z., & Sayers, J. (2012). Encouraging Play in the Natural Environment: A Child-Focused Case-study of Forest School. *Children's Geographies, 10 (1),* 55-71.

Schmidt, R.A. (1988). *Motor Control & Learning: A Behavioural Emphasis* (2nd Ed.). Champaign, IL: Human Kinetics.

Singer, R. N. (2002). Preperformance State, Routines, and Automaticity: What does it take to Realize Expertise in Self-Paced Events? *Journal of Sport and Exercise Psychology, 24,* 359-375.

Southard, D.L., & Miracle, A. (1993). Rhythmicity, Ritual and Motor Performance: A Study of Free-throw shooting in Basketball. *Research Quarterly for Exercise and Sport, 64,* 287-290.

Thomas, P. R., Murphy, S. M., & Hardy, L. (1999). Test of Performance Strategies: Development and Preliminary Validation of Comprehensive Measure of Athletes' Psychological Skills. *Journal of Sports Sciences, 17,* 697-711.

Tod, D., Iredale, F., & Gill, N. (2003). Psyching-up and Muscular Force Production. *Sports Medicine, 33 (1),* 47-58.

Weinberg, R. S., Jackson, A., & Seabourne, T. (1985). The Effects of Specific Vs. Nonspecific Mental Preparation Strategies on Strength and Endurance Performance. *Journal of Sport Behaviour, 8,* 175-180.

White, A., & Hardy, L. (1995). Use of Different Imagery Perspectives on the Learning and Performance of Different Motor Skills. *British Journal of Psychology, 86,* 169-180.

White, A., & Hardy, L. (1998). An In-depth Analysis of the Uses of Imagery by High-level Slalom Canoeists and Artistic Gymnasts. *The Sport Psychologist, 12,* 387-403.

Wrisberg, C.A., & Anshel, M.H. (1989). The Effect of Cognitive Strategies on the Free Throw Shooting Performance of Young Athletes. *The Sport Psychologist, 3,* 95-104.

Wrisberg, C.A., & Pein, R.C. (1992). The Pre-shot Interval and Free Throw Shooting Accuracy: An Exploratory Investigation. *The Sport Psychologist, 6,* 14-23.

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WHY PARENTS ENROL THEIR CHILDREN IN RECREATIONAL GYMNASTICS PROGRAMMES AT THE BEGINNING OF THEIR EDUCATION

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Abstract

The purpose of this study was to examine the motives of parents who enrolled their children in recreational gymnastics programmes at six primary schools and their auxiliary branches in the north-east part of Slovenia in the 2007/2008 academic year. The study included 386 parents who (after the programme ended) answered a questionnaire specifically designed for this study. Basic statistical parameters were calculated, and a one-way analysis of variance has been carried out in order to observe the differences in the motives of parents, according to their gender, age, educational level and gender of their child. The results of the study revealed that the most significant motive stated by the parents as a reason for enrolling children in a course was "because sport benefits the health of my child". This indicates the awareness of parents about the usefulness of sport for the development and health of children. According to gender of parents, there were minor differences found, although differences in the structure of motives were revealed according to the age of parents, their level of education and gender of their child. The prevailing motives of parents indicate that the organisers of gymnastics courses should emphasise such organisation in schools, which will emphasise the effects of exercising on the health of children along with enjoyment and useful spending of free time.

Keywords: *extracurricular programmes, recreational gymnastics, first three-year period, motives, parents*

INTRODUCTION

Physical activity has been proved beneficial for health and the positive physical, intellectual, and emotional development of children and adolescents (Bratina et al., 2011; Fredricks & Eccles, 2006; Malina, 1996; Malina & Bouchard, 1991; Pate et al., 1995). Regular physical activity may contribute to the prevention of the main chronic degenerative diseases (Froberg & Andersen, 2010) and enables children and adolescents to successfully control their aggression (Fredricks & Eccles, 2006). A better organisation and structure of their free time prevents negative

behavioural patterns (Fredricks & Eccles, 2006). The psychological outcomes of extracurricular physical activities, such as higher self-esteem and self-confidence and lower rates of depression, have been also documented (Barber, Eccles, & Stone, 2001; Eccles & Barber, 1999; Mahoney, Schweder, & Stattin, 2002), as well as better academic outcomes and educational aspirations of children and youth (Cooper, Valentine, Nye, & Lindsay, 1999; Eccles & Barber, 1999; Marsh & Kleitman, 2002).

Parents play the most prominent role when enrolling children in free time activities; by doing so, they introduce them to regular sports activities from an early age (Freedson & Everson, 1991; Howard & Madrigal 1990; Jago, Fox, Page, Brockman, & Thompson, 2010; Moore et al., 1991). Educational institutions and sports clubs also play a significant influence with their extracurricular sport programmes (Eccles, Barber, Stone & Hunt, 2003; Eccles & Templeton, 2002; Golja, Šterlinko, Stubelj Ars, & Besednjak-Kocijančič, 2009).

Gymnastics is a compulsory part of all PE curriculum and each child practice gymnastics during regular PE classes (Živčić Marković, Sporiš, & Čavar, 2011). Gymnastics plays one of the most important parts in development of children as it offers a wide range of locomotive, stability and body control movements, which are extremely beneficial for children's development. Gymnastics requires a considerable diversity of movements: transitions from dynamic to static elements and vice versa, and frequent changes of the body position in space. The successful performance of each element requires accurate muscular activity of a specific intensity, through space and at the right moment (Bučar, 2003; Bučar Pajek, Čuk, Kovač, & Turšič, 2010; Kovač, 2006; Novak, Kovač, & Čuk, 2008; Živčić Marković et al., 2011).

Slovenian adults participate in sports activity for various reasons: to feel better and to be healthy, to acquire motor and working abilities, for fun, socialising and relaxation as well as enjoyment, competition and satisfaction (Petkovšek & Ambrožič, 1999; Sila, 2007). Adults who are physically active and are aware of the importance of exercising for health and well-being can be a good example also for their own children (Moore et al., 1991). Particularly salient is the role of parents in younger children; specifically, the enrolment of pre-school children and children in the early year period of primary school into extracurricular activities is decided mostly by parents (Biddle & Goudas, 1996; Brustad, 1996; Kunješić, 2012).

The influence of parents and social environment is highly complex. Parents can influence their children's physical activity involvement in direct and indirect manners (Taylor, Baranowski, & Sallis, 1994), either with role modelling of physical activity (Bandura, 1996) or with their beliefs about the competence of their children (Eccles, Wigfield, & Schiefele, 1998). Brustad (1996) found that encouragement and support from parents and their beliefs in 4-6th grade children are stronger than other social factors. The influence of fathers and mothers may be manifested in different ways; furthermore, father and mother could influence their child's physical activity also by different processes (Bois, Sarrazin, Brustad, Trouilloud, & Cury, 2005). Brustad (1993, 1996) conducted a series of studies on the influence of parental attitudes and behaviours on children's physical competence perceptions and affective responses to physical activity. The findings varied by gender: parents with lower socioeconomic status from a large urban area gave more encouragement to their sons than daughters, and girls reported lower perceived physical competence and positive affect toward physical activity than did boys. The aim of this study was to examine the motives that led parents to make a decision about enrolling children into recreational gymnastics programmes. The study also observed differences in the motives according to gender, age, educational level and the gender of their child.

Understanding the motives that led parents to enrol their children into gymnastics programmes will help the organisers of programmes to be more focused when presenting them to parents, and to adapt the programme goals, thus persuading more parents to enrol their children into regular sports activity.

METHODS

Programme

All schools in Slovenia offer different extra-curricular sport programmes for children, which are organised and implemented by schools or sport associations. The Gymnastic Association of Slovenia (GAS) has developed an extracurricular programme called "Gymnastics in primary schools" (Fišer, 2008) in order to promote gymnastics among children in the regions where previously there were no gymnastics traditions. The programme is non-competitive, intended for recreation of children aged 7 to 9 who do not want to commit to long hours in the gym or take part in competitions. Classes develop co-ordination, strength and flexibility while building confidence in body movement and at the same time teaching children the fundamentals required for all sports.

Schools involved in the study had good sport facilities and equipment and offer children of that age various extra-curricular sport programmes. The participation of children is free of charge as the coaches are paid by the GAS. Children practice twice per week (each class lasting 60 minutes) at the afternoon after the regular compulsory educational programme. After first year of implementation GAS evaluated the efficiency of the programme by measuring motor abilities of children and examining the motives of parents who enrolled their children in recreational gymnastics programmes.

Sample of participants

The sample included 386 parents who had enrolled their children into the programme "Gymnastics in primary schools" at six primary schools and their auxiliary branches in the north-east region of Slovenia in the 2007/2008 academic year. The sample included 185 fathers and 201 mothers whose children (aged 7 to 9) were pupils in the first three-year period of primary school and who voluntarily enrolled with their parents' consent into an extracurricular gymnastics programme. The average age of parents was 36.55 years. When compared to the Slovenian population, parents were less active than the average Slovene (Sila, 2007). A comparison between genders revealed a larger proportion of inactive mothers and a larger number of regularly active fathers. Similar results about the level of sports activities in this part of Slovenia were also found by Karnet (2012).

Sample of variables

A questionnaire was specially designed for the purposes of this study (Fišer, Kajtna & Kovač, 2008, in Fišer, 2008), consisting mostly of closed questions with some additional open questions. The questionnaires were addressed separately to mothers and fathers, thus acquiring data on the gender of the subjects. The first part of the questionnaire collected basic information: age, level of education and the type of residence as well as data about their sports activity (how often they participate in sport, which sports they participate in, the level of awareness about the importance of sport for health they acquired during their education, etc.). The second part of the questionnaire consisted of 30 statements about motives (see Table 1) with a ranking scale from 1 to 5, which were later used for analysis and interpretation as dependable variables. "1" represented an unimportant motive, whereas "5" represented a very important motive.

Table 1. *List of all motives and their abbreviations.*

Abbreviation	Motive
M1	Sport benefits the health of my child.
M2	My child will be in better physical condition.
M3	My child will spend free time in a useful way.
M4	My child will have fun at sport.
M5	My child likes to compete.
M6	Sport will serve as relaxation.
M7	My child will be fitter.
M8	My child enjoys sport.
M9	My child will make good friends when exercising.
M10	My child likes to play.
M11	Sport follows certain rules.
M12	My child needs exercise after school.
M13	Sport increases self-confidence.
M14	Sport will help him/her in future life.
M15	My child will look better.
M16	My child will acquire competitive experience.
M17	My child wished to participate in a course.
M18	His/her friends also participate in a course.
M19	It will give me more free time.
M20	My child will be more confident.
M21	My child will acquire certain working habits.
M22	My child will burn off excess energy.
M23	I would like my child to learn new skills.
M24	My child likes to exercise.
M25	Gymnastics will develop his/her abilities.
M26	His/her friends practice gymnastics.
M27	Gymnastics is interesting and attractive.
M28	I would like my child to later train gymnastics.
M29	By doing gymnastics, he/she will acquire basic motor skills, important for all sports.
M30	Because I used to do gymnastics.

Data collection and analysis

The questionnaire for fathers and mothers was distributed to 282 children in May and June 2008; the children returned 386 questionnaires in gymnastics lessons, by the end of the academic year. The rate of questionnaire return was 68%. Data acquired with questionnaires has been analysed with the use of SPSS programme (Statistical Package for the Social Science). Descriptive statistics and one-way analysis of variance have been calculated.

RESULTS AND DISCUSSION

Parental beliefs associated with sport are predominantly positive and mostly related to the positive impact of sport on health and abilities of their children (Kunješić, 2012; Townsend & Murphy, 2001). The results of our study have revealed that "sport benefits the health of my child" was the most important motive for parents enrolling their children into the gymnastic programme. Motor activity is crucial for the motor and physical development of children (Gallahue & Ozmun, 1998) and consequently also has a significant effect for their health (Froberg & Andersen, 2010; Pate et al., 1995). It seems that parents are aware that the health of children is endangered due to the various negative influences of current lifestyles as inactivity leads to excess weight at the youngest age, obesity, diabetes type II and high blood pressure (Froberg & Andersen,

2010). Recognising the benefits of gymnastics for development and health of children results in the desire of parents to enrol their children into additional sports activities (Kunješić, 2012).

Some other leading motives found were "my child wished to participate in a course" and "gymnastics will develop his/her abilities" (see Figure 1). The former motive indicates that parents listen to their children and their wishes when choosing sports activities for them. Furthermore, it shows that physical activity is a primary need of children from an early age (Gallahue & Ozmun, 1998); they feel the lack of it and wish to participate in sports activities. The latter motive is also related to the benefit of physical activity for children. It is apparent that the tradition of gymnastics in Slovenia (Kovač, Starc, & Doupona 2005) and the traces of gymnastics in the common consciousness of Slovenian people describe gymnastics as a sport with an important effect on the health and motor abilities of people.

Among the top ten motives are mainly those supporting the effects of sports participation on health, well-being, fun, enjoyment, useful spending of free time and development of abilities and skills, which is in line with the findings in some other studies (Anderson, Funk, Elliott, & Smith, 2003; Čebokli, 2006; Kunješić, 2012; Weiss, 1993).

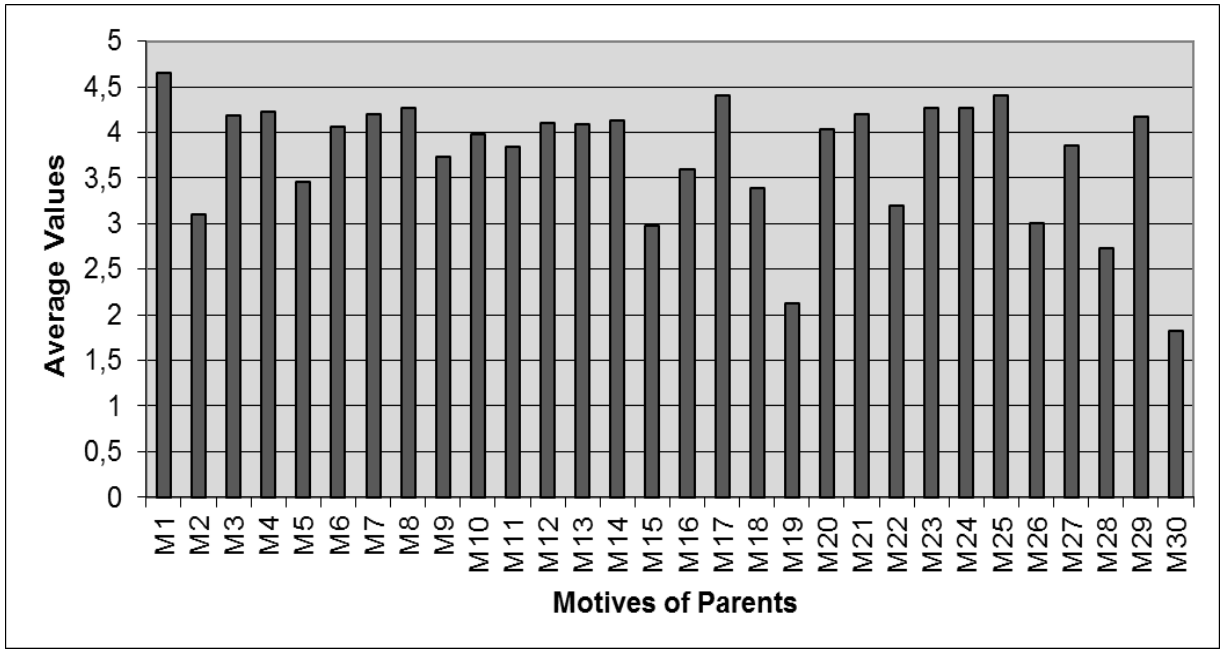

Figure 1. *Motives of parents for enrolling children in a programme "Gymnastics in primary schools".*

Some of the less prominent motives found were "because I used to do gymnastics" and "it will give me more free time". The reasons could be that parents did not previously participate in gymnastics, which does not have a substantial tradition in this part of Slovenia (Kovač et al., 2005); as such, this motive is not a significant decision-making factor due to lack of experience with gymnastics. In addition, as the programme was organised in the afternoon hours, when parents are at work, the enrolment in gymnastics does not represent a "way-out" for parents but could only be understood as provision of various possibilities for physical activities of children.

One of the aims of the study was to determine whether there are differences in the structure of motives according to gender. Bois and colleagues (2005) found that the influence of fathers and mothers on child's physical activity may be manifested in different ways and by different processes. The results of present study indicated that on the average gender of parents did not

represent any important significant differences. Some minor differences were observed only with the motives "my child enjoys sport" (p=.02), "my child needs exercise after school work" (p=.02) and "my child likes to exercise" (p=.04). All the above motives were listed as more important by mothers (Table 2). These findings seem to indicate that mothers are salient socialisation agents for children of these ages. Results of other studies also show that mothers in Slovenia generally have a larger role than fathers in making decisions about the free time activities of their children (Karnet, 2012; Kovač, Doupona Topič & Strel, 2004).

Table 2. *Motives of parents according to their gender.*

	mothers		**fathers**			
Motive	**M**	**SD**	**M**	**SD**	**F**	**Sig (F)**
My child enjoys sport.	4.37	0.78	4.17	0.87	5.40	**.02**
My child needs exercise after school.	4.20	0.90	3.98	1.01	5.37	**.02**
My child likes to exercise.	4.34	0.82	4.17	0.87	4.18	**.04**

For the purpose of the study, parents were divided according to their age into two groups. The first group consisted of parents aged 35 years or less (N=168) and the second group of parents aged 36 years or more (N=210). According to the age of parents, statistically significant differences were revealed in nine motives (Table 3). It can be concluded that younger parents attribute greater importance to competitions and rules as they assume that their children like to compete. Parents want their children to acquire competitive experiences and later also to take part in gymnastics; at the same time, they feel that the sport follows certain rules. Parents think that children could benefit from this in future life. All of the above reflects a prevailing stereotype of young people who equate the sport with competitions.

Table 3. *Motives of parents according to their age.*

	<35yrs.		**36+ yrs.**			
Dimension	**M**	**SD**	**M**	**SD**	**F**	**Sig (F)**
My child will spend free time in a useful way.	4.29	0.81	4.10	0.91	4.51	**.03**
My child likes to compete.	3.66	1.14	3.29	1.06	10.91	**.00**
Sport follows certain rules.	4.00	0.99	3.73	1.07	6.44	**.01**
Sport will help him/her in future life.	4.24	0.77	4.06	0.94	4.34	**.04**
My child will acquire competitive experience.	3.75	1.07	3.46	1.11	6.41	**.01**
My child wished to participate in a course.	4.52	0.77	4.33	0.82	5.34	**.02**
His/her friends also participate in a course.	3.53	1.22	3.26	1.19	4.61	**.03**
Gymnastics is interesting and attractive.	3.98	0.79	3.75	0.97	5.84	**.02**
I would like my child to later train gymnastics.	2.87	1.14	2.62	1.05	4.73	**.03**

Level of education is one of the factors influencing the opinions of parents about sports activity, their own participation (Kovač et al., 2004; Sila, 2007) and the participation of their children in sport (Raudsepp, 2006). Higher education most often also results in better financial status; therefore, parents can offer their children various types of sports activities and motivate them for sport. Better educated parents are also more aware of the positive influence of physical activity for health (Kovač et al., 2007); thus it can be concluded that their motives for enrolling children into sport are also different from other less educated parents.

Parents were divided into two groups according to the level of education: first group consisted of parents with lower levels of education (unfinished primary school, finished primary school and finished vocational school (N=179)) and the second group of parents with higher levels of education (finished four-year high-school, college, university degree or more (N=204)). Statistically significant differences were shown in thirteen motives (Table 4). Parents with lower levels of education considered motives related to competitions and rules in sport to be more beneficial. Less educated parents were also driven by the motives "his/her friend practice gymnastics" (p=.00) and "his/her friends also participate in a course" (p=.01), considering the social relations to be more beneficial than the more educated parents. The motives related with health, spending free time in a useful way and increasing self-confidence by sport seem to be more beneficial for higher educated parents.

Table 4. *Motives of parents according to the level of education*

	Lower education		**Higher education**			
Motive	**M**	**SD**	**M**	**SD**	**F**	**Sig (F)**
Sport benefits the health of my child.	4.57	0.64	4.73	0.53	6.85	0.01
My child will be in better physical condition.	3.24	1.22	2.96	1.10	5.51	0.02
My child will spend free time in a useful way.	4.06	0.93	4.29	0.80	7.27	0.01
My child likes to compete.	3.72	1.08	3.22	1.11	20.29	0.00
My child needs exercise after school.	3.97	1.02	4.19	0.90	5.01	0.03
Sport increases self-confidence.	3.93	0.98	4.23	0.86	10.04	0.00
My child will look better.	3.13	1.22	2.83	1.13	6.03	0.01
My child will acquire competitive experience.	3.74	1.10	3.44	1.07	7.24	0.01
His/her friends also participate in a course.	3.55	1.23	3.22	1.16	7.14	0.01
It will give me more free time.	2.34	1.30	1.88	1.09	14.05	0.00
His/her friends practice gymnastics.	3.24	1.17	2.76	1.12	16.51	0.00
I would like my child to later train gymnastics.	2.89	1.17	2.55	0.99	9.51	0.00
Because I used to do gymnastics.	198	1.22	1.70	1.09	5.92	0.02

Despite the fact that the gender of parents stereotyped perceptions about physical competence of their children were already documented in some studies (Bois et al., 2005; Jacobs & Eccles, 1992), present study examined whether there were differences in the structure of parents' motives according to the child's gender. Parents were divided according to the gender of their child into two groups. The first group consisted of boys' parents (N=195) and the second group of girls' parents (N=191).

Table 5. *Motives of parents according to the child's gender.*

	Girls' parents		**Boys' parents**			
Motive	**M**	**SD**	**M**	**SD**	**F**	**Sig (F)**
My child likes to compete.	3.33	1.20	3.58	1.02	5.04	0.03
Sport follows certain rules.	3.62	1.10	4.05	0.95	17.12	0.00
My child will acquire competitive experience.	3.47	1.14	3.72	1.05	4.85	0.03
My child will burn off excess energy.	3.03	1.18	3.35	1.19	6.93	0.01
I would like my child to learn new skills.	4.19	0.81	4.35	0.71	4.57	0.03

The results demonstrated that parents' motives for enrolling their child in recreational gymnastics programme vary more with the gender of their child than the gender of parents. All five motives were listed as more important by boys' parents (Table 5) and represented gender stereotyped perceptions of parents. Three of the motives were related to competition ("my child likes to compete"; "my child will acquire competitive experience"; "sport follows certain rules"). The fundamental perception that sport is a 'male' activity in which success is measured in what has been seen as 'male' characteristics such as competition, dominance and aggression is still predominant (Anderson et al., 2003). It seems that boys' parents still labelled these abilities and behaviours as masculine as a result of social and cultural expectations. On the other hand reasons could also be top sports results in men's artistic gymnastics in Slovenia, such as Mitja Petkovšek and Aljaž Pegan, who are European and World Champions. Both top athletes are idols for young boys.

CONCLUSIONS

The role of parents is particularly beneficial for the participation of the youngest children in extracurricular sport activities (Bois et al., 2005; Freedson & Everson, 1991; Gustafson & Rhodes, 2006; Howard & Madrigal 1990; Jago et al., 2010; Kunješić, 2012; Moore et al., 1991). As such, it is necessary for providers of sports activities to understand the motives that drive parents as only then they will be able to upgrade and improve the programmes they offer and thus encourage parents to enrol children into additional sports activities. The results of the study indicate that the providers of sports programmes should pay particular attention to the selection of contents and the organisational approach, which should emphasise the importance of gymnastics for the healthy development of children as this is a crucial motive for parents enrolling their children into the programme. For this purpose, it is suggested that the organisers of the programme prepare a leaflet to be distributed to the parents at the beginning of the academic year, which should emphasise the role of gymnastics for the healthy development of children along with enjoyment and useful spending of free time. Regular measurements of some key health indicators (body weight and the amount of skin fat) and motor competency (particularly the coordination of movement, strength, balance and flexibility) could demonstrate the importance of regular and expertly organised exercise to parents in the best possible way.

It has frequently been suggested that parental modelling of activity behaviour is likely to be central in promoting physical activity among children (Freedson & Everson, 1991; Gustafson & Rhodes, 2006; Moore et al., 1991). As the parents of the participating children were less active in sports than the average Slovenian person (Sila, 2007), it would also be wise to consider organising parallel sports activities for parents, particularly mothers. Specifically, more active parents more frequently enrol their children in sports activities (Bois et al., 2005; Gustafson & Rhodes, 2006). In addition, engagement in recreational activities could provide social integration opportunities for family members (Wells, Widmer, & McCoy, 2004).

REFERENCES

Anderson, J. C., Funk, J. B., Elliott, R., & Smith, P. H. (2003). Parental support and pressure and children's extracurricular activities: relationships with amount of involvement and affective experience of participation. *Journal of Applied Developmental Psychology*, *24*(2), 241–257.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Barber, B. L., Eccles, J. S., & Stone, M. R. (2001). Whatever happened to the jock, the brain, and the princess? Young adult pathways linked to adolescent activity

involvement and social identity. *Journal of Adolescent Research, 16,* 429–455.

Biddle, S. & Goudas, M. (1996). Analysis of children's physical activity and its association with adult encouragement and social cognitive values. *Journal of School Health, 66*(2), 75–78.

Bois, J. E., Sarrazin, P. G., Brustad, R. J., Trouilloud, D. O., & Cury, F. (2005). Elementary schoolchildren's perceived competence and physical activity involvement: the influence of parents' role modelling behaviours and perceptions of their child's competence. *Psychology of Sport and Exercise*, 6, 381–397.

Bratina, N., Hadžić, V., Battelino, T., Pistotnik, B., Pori, M., Šajber, D., Žvan, M., Škof, B., Jurak, G., Kovač, M., & Dervišević, E. (2011). Slovenske smernice za telesno udejstvovanje otrok in mladostnikov v starostni skupini od 2 do 18 let [Slovenian guidelines for physical activity in children and adolescents in the age group 2–18 years]. *Zdravstveni Vestnik, 80*(12), 885–896.

Brustad, R. J. (1993). Who will go out and play? Parental and psychological influences on children's attraction to physical activity. *Pediatric Exercise Science, 5,* 210–223.

Brustad, R. J. (1996). Attraction to physical activity in urban schoolchildren: Parental socialization and gender influences. *Research Quarterly for Exercise and Sport, 67*(3), 316–323.

Bučar Pajek M., Čuk I., Kovač M., & Turšič B. (2010). Implementation of the gymnastics curriculum in the third cycle of basic school in Slovenia. *Science of Gymnastics Journal, 2*(3), 15–27.

Cooper, H., Valentine, J. C., Nye, B., & Lindsay, J. J. (1999). Relationships between five after-school activities and academic achievement. *Journal of Educational Psychology, 91*(2), 369–378.

Čebokli, N. (2006). *Razlogi za vključevanje otrok v športno vadbo.* [Reasons for enrolling children in sports activities] Diplomsko delo [BSc Dissertation], Ljubljana: Univerza v Ljubljani, Fakulteta za šport.

Eccles, J. S. & Barber, B. L. (1999). Student council, volunteering, basketball, or marching band: What kind of extracurricular involvement matters? *Journal of Adolescent Research, 14,* 10–43.

Eccles, J. S., Barber, B. L., Stone, M., & Hunt, J. (2003). Extracurricular activities and adolescent development. *Journal of Social Issues, 59,* 865–889.

Eccles, J. S. & Templeton, J. (2002). Extracurricular and other after-school activities for youth. *Review of Research in Education, 26,* 113–180.

Eccles J. S., Wigfield, A., & Schiefele, U., (1998). Motivation to succeed. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology* (p. 1017–1094). New York: Wiley.

Fišer, J. (2008). Motivi staršev za vključitev otrok v program Gimnastične zveze Slovenije "Gimnastika v osnovni šoli". [Motives of parents for enrolling children into a Slovenian Gymnastics Association programme "Gymnastics in primary schools"] Diplomsko delo. [BSc Dissertation] Ljubljana: Fakulteta za šport.

Freedson, P. S. & Evenson, S. (1991). Familial aggregation in physical activity. *Research Quarterly for Exercise and Sport, 62*(4), 384–389.

Fredricks, J. A. & Eccles, J. S. (2006). Is extracurricular participation associated with beneficial outcomes? Concurrent and longitudinal relations. *Developmental Psychology, 42,* 698–713.

Freedson, P. S. & Evenson, S. (1991). Familial aggregation in physical activity. *Research Quarterly for Exercise and Sport, 62*(4), 384–389.

Froberg, K. & Andersen. L. B. (2010). The importance of physical activity for childhood health. In M. Kovač, G. Jurak, & G. Starc (eds.), *Proceedings of the Fifth International Congress Youth Sport 2010* (p. 41–46). Retrieved January 21, 2011, from: http://www.youthsport2010.si/images/stories/SM2010/proceedings1.pdf

Gallahue, D. L. & Ozmun, J. (1998). *Understanding Motor Development: Infants, Children, Adolescents, Adults*. Boston, McGraw-Hill.

Golja, P., Šterlinko, H., Stubelj Ars, M., & Besednjak-Kocijančič, L. (2009. Physical activity of children and adolescents, who do or do not participate in sports clubs. [Telesna dejavnost otrok in mladostnikov, ki so oz. niso vključeni v športne klube]. *Zdravstveni Vestnik, 78*(5), 225–230.

Gustafson, S. L. & Rhodes, R. E. (2006). Parental correlates of physical activity in children and early adolescents. *Sports Medicine, 36*(1), 79–97.

Howard, D. & Madrigal, R. (1990). Who makes the decision: The parent or child? *Journal of Leisure Research, 22*, 244-258.

Jacobs, J. E., & Eccles, J. S. (1992). The impact of mothers gender role stereotypic beliefs on mothers and children's ability perceptions. *Journal of Personality and Social Psychology*, 63, 932–944.

Jago, R., Fox, K. R., Page, A. S., Brockman, R., & Thompson, J. L. (2010). Parent and child physical activity and sedentary time: Do active parents foster active children? *BMC Public Health.* 10, 194. Published online 2010 April 15. doi: 10.1186/1471-2458-10-194

Karnet, K. (2012). Motivi staršev za vključevanje otrok v športne dejavnosti v Pomurju. [Motives of parents for enrolling children into sports activity in Pomurje region] Diplomsko delo, [BSc Dissertation] Ljubljana: Fakulteta za šport.

Kovač, M. (2006). Gimnastično znanje učencev v slovenskih osnovnih šolah ter njegovo preverjanje in ocenjevanje [Gymnastic knowledge of pupils in Slovenian primary schools and assessing and grading it]. *Šport, 54*(2), 11–18.

Kovač, M., Doupona Topič, M., & Strel, J. (2004). Izjemna naklonjenost staršev za vključevanje otrok v športne dejavnosti. [Extreme desire of parents for enrolling children into sports activities] *Šport mladih, 12*(99), 30–31.

Kovač, M., Jurak, G., & Strel, J. (2007). Šolsko okolje in družina kot oblikovalca življenjskega sloga mladih. [School environment and family in formation of young people's lifestyle] In M. Kovač & G. Starc (eds.), *Šport in življenjski slogi slovenskih otrok in mladine* (p. 155–163). Ljubljana: Univerza v Ljubljani, Fakulteta za šport, Inštitut za kineziologijo, Zveza društev športnih pedagogov Slovenije.

Kovač, M., Starc, G., & Doupona Topič, M. (2005). *Šport in nacionalna identifikacija Slovencev.* [Sport and national identification of Slovenian people] Ljubljana: Fakulteta za šport, Inštitut za kineziologijo.

Kunješić, M. (2012). Parent's expectations towards children's artistic gymnastics exercise. *Science of Gymnastics Journal, 4*(2), 65–73.

Mahoney, J. L., Schweder, A. E., & Stattin, H. (2002). Structured afterschool activities as a moderator of depressed mood for adolescents with detached relations to their parents. *Journal of Community Psychology, 30*, 69–86.

Malina, R. M. (1996). Tracking of physical activity and physical fitness across the lifespan. *Research Quarterly for Exercise and Sport, 67*(3), 48–57.

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

Marsh, H. W. & Kleitman, S. (2002). Extracurricular school activities: The good, the bad, and the non-linear. *Harvard Educational Review, 72*, 464–514.

Moore, L. L., Lombardi, D. A., White, M. J., Campbell, J. L., Olshan, A. F., & Ellison, R. C. (1991). Influence of parents physical activity levels on activity levels of young children. *Pediatrics, 118*(2), 215–219.

Novak, D., Kovač, M., & Čuk, I. (2008). *Gimnastična abeceda*. [ABC of gymnastics] Ljubljana: Fakulteta za šport.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C. et al. (1995). Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association, 272*, 402–407.

Petkovšek, M. & Ambrožič, F. (1999). Motivation of adult Slovenes for sports activity. In *Proceedings of the 6th Sport*

Kinetics Conference (p. 269–272). Ljubljana: Univerza v Ljubljani, Fakulteta za šport.

Raudsepp, L. (2006). The relationship between socio-economic status, parental support and adolescent physical activity. *Acta Paediatrica*, *95*(1), 93–98.

Sila, B. (2007). Leto 2006 in 16. študija o športnorekreativni dejavnosti Slovencev: Pogostost športne aktivnosti in delež športno aktivnega prebivalstva. [Year 2006 and 16th study about sports-recreational activity of Slovenian people: Frequency of sports activity and the proportion of sportingly active people.] *Šport*, 55(3)/priloga, 3–11.

Taylor, W. C. Baranowski, T. & Sallis, J. F. (1994). Family determinants pf childhood physical activity: A social-cognitive model. In R. K. Dishman (ed.), *Advances in Exercise Adherence* (p. 319–342). Champaign, IL: Human Kinetics.

Townsend, M. & Murphy, G. (2001). "Roll up and spend your last dime" The merry-go-round of children's extra-curricular activities in modern society. *The ACHPER Healthy Lifestyles Journal*, 48 (3–4): 10–13.

Weiss, M. R. (1993). Children's participation in physical activity: Are we having fun yet? *Pediatric Exercise Science, 5*, 205–209.

Wells, M. S., Widmer M. A., & McCoy, J. K. (2004). Grubs and grasshoppers: Challenge-based recreation and the collective efficacy of families with at-risk youth. *Family Relations, 53,* 326–333.

Živčić Marković, K., Sporiš, G., & Čavar, I. (2011). Initial state of motor skills in sports gymnastics among students at Faculty of Kinesiology. *Acta Kinesiologica 5*(1), 67–72.

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ACHIEVEMENT GOALS AND MOTIVATIONAL CLIMATE IN COMPETITIVE GYMNASTICS CLASSES

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Original research article

Abstract

This paper is a preliminary investigation into the motivational climate of competitive gymnastics classes. Motivational climate can be described as the gymnast's relatively persistent collective perceptions of the achievement goal structure of their class. Twenty-eight male and 180 female competitive gymnasts from six metropolitan and four regional competitive gymnastics clubs in Queensland, Australia were surveyed with a draft of the Sports Class Environment Scale (SCES). Using the revised SCES subscales as dependent variables, multivariate analyses of variance were conducted to compare club type, gender, and competitive level. The low training hours and the high training hours classes were significantly different in their perceptions of the Ego Involvement of their motivational climate ($p<0.01$). Male gymnasts were significantly different to female gymnasts in perceptions of Ego Involvement ($p<0.01$), Affiliation ($p<0.01$) and Effort, Order & Organization ($p<0.01$) aspects of their class climates. This study demonstrates the potential value of creating class motivational climates high in both task mastery (Task Involvement) and comparative competence (Ego Involvement) for competitive gymnastics clubs. Because motivational climate is easier to manipulate than individual achievement goal dispositions, it is an important variable that should be better understood, described, developed, and manipulated by gymnastic coaches.

Keywords: *achievement goals, motivational climate, competitive gymnastics*

INTRODUCTION

Competitive gymnastic class standards have risen dramatically over the last 30 years. A "user-pays" proviso for participation is a pervasive development requiring positive results for clients. Both participants and parents have expectations of effective and motivational gymnastic classes. Understanding and enhancing motivation is a central concern in the sports context (Roberts, 2001). The coach is often in a position to influence the creation and maintenance of the sports class motivational climate.

Benefits of this study for practice

If the motivational investment of participants in sport settings is to be understood, then motivational climate is a factor to consider. Particular motivational climates may influence the effort,

persistence, and emotions of participants in their sports context (Roberts, 1992). Sporting organizations appreciate participants and coaches with adaptive behaviours such as exerting appropriate effort, valuing, persisting with, and enjoying the task at hand. Such sports participants may be more likely to have a life-long love of sport and physical activity that has personal (including health) benefits for them and for society at large.

In spite of the current growth in motivational climate research in sport and the development of the underlying research methodology, only one study (Goudas & Biddle, 1994) has attempted to consolidate the field of classroom learning climate research and physical education motivational climate studies. This current investigation was embedded in the development and initial validation of the Sports Class Environment Scale (SCES). The SCES has provided the missing framework for integration of class learning climate measures and class motivational climate instruments.

Sports class motivational climate

Sports class motivational climate has been defined as the environment created by coaches that affects participant's behaviour and achievement strategies (Boixad'os, Cruz, Torregrosa, & Valiente, 2004), or the perceived situational achievement goal structure (Ames, 1988, 1992, 1995).

The study of motivational climate in physical education and sports settings has its foundation in the social-cognitive concepts of achievement goal theory (Roberts, 1992, 2001). Achievement goal theories are social-cognitive perspectives since they examine how individuals cognitively and affectively process and develop their views about achievement in various social settings and under a variety of influences (Ntoumanis & Biddle, 1999). Achievement goal theory can be said to apply to persons who have a personal or socially constructed goal in an achievement context, such as a sports class. This theory attempts to explain why a person strives in their particular achievement context, and argues that the overarching reason is to demonstrate competence (Roberts, 2001).

According to achievement goal theory, self-perceptions of achievement (perceived competence) are influenced by personal goal dispositions and perceived social climate factors in that particular achievement goal setting (Ntoumanis & Biddle, 1999). The primary goal in achievement contexts, such as sports training and competition, is the demonstration of competence (Nicholls, 1984). Two primary conceptions of competence and, therefore, two types of achievement goals are suggested by Nicholls. When a participant aims to learn, improve, or perfect a skill, then the participant is using a task oriented conception of competence to achieve task mastery. In the second conception of competence, the participant performs skills in a direct social comparison with others, or judges their skill capacity solely relative to others. When the focus of attention is on the self compared to others, the participant is using an ego or performance oriented conception of competence to achieve ego involved goals. A proposed addition to the classic achievement goal theory approach is to apply an approach-avoidance construct to distinguish the dichotomous achievement goals (Elliot, 1999). A valence (approach-avoidance) has been added to the basic mastery-performance dichotomy. The 2x2 achievement goal model comprises mastery-approach, mastery-avoidance, performance-approach and performance-avoidance goals. (Elliot, 1999; Elliot & McGregor, 2001). The value of this more comprehensive model has been recognized (Conroy, Elliot & Hofer, 2003) but the case for these additional constructs has not been fully supported in the sports setting (Duda, 2007).

Coaches, who have the key leadership role in class settings, play a major part in the creation of the motivational climate and, in turn, are affected by it (Fraser, 1994). The coaches in the participant's achievement setting (e.g. gymnastics class) create task involved or

ego involved goal structures by their choice of either task oriented or ego oriented conceptions of competence. In this way, the created goal structures can produce a motivational climate that makes one or the other conceptions of competence conspicuous. The participant recognizes that their competency is thus assessed in a task involved or ego involved manner and they develop context-specific goals of achievement consistent with the achievement goal structure created in that setting (Treasure, 2001; Treasure & Roberts, 2001).

Task-involved individuals who hold the conception that competence is an acquirable skill tend to express greater confidence even when starting with lower perceived competence than individuals who perform the same task in an ego-involving condition (i.e., under the conception that competence is inherent capacity) (Chi, 1993; Hall, 1990). Research has shown that perceived competence does not moderate the positive relationship between task involvement and perceptions of success in physical education classes (Vlachopoulas & Biddle, 1997). Ego-involved basketball players with low perceived competence had lower success expectations than ego-involved players with higher perceived competence, or task-involved players regardless of their perceived competence (Cury, Biddle, Sarrazin & Famose, 1997). Using task involved conceptions of achievement to judge personal competence in physical activity settings can strengthen the resilience of the individuals' perceived competence (Roberts, 2001).

When participants hold ego oriented goal dispositions, they view achievement striving as a means to an end; that end being the demonstration of superior competence (Roberts, 2001). For task oriented participants, task mastery is an end in itself. This contrast is especially true when the two goal perspectives are compared as sources of satisfaction. A consistent pattern of this effect has been demonstrated in research with children and adolescents (Nyheim, Kavussanu, Roberts & Treasure, 1996; Treasure & Roberts, 1994) and elite athletes (Roberts & Ommundsen, 1996). Ego oriented participants mainly gain satisfaction when they demonstrate success in a normative comparison with their peers, or please their coach and parents. On the other hand, task oriented participants' find skill learning, task mastery and improvement as signs of accomplishment, and sources of satisfaction.

Studies of the relationship between achievement goal orientations, perceived competence and the attendant achievement behaviours (adaptive or maladaptive) provide meaningful findings for coaches and their conduct of classes (Dweck & Leggett, 1988; Kavussanu & Roberts, 1996; Roberts, Treasure, & Kavussanu, 1997). Adaptive behaviours such as choosing moderately challenging tasks, exerting effort, persistence in the face of obstacles or failure seem to result when a participant is task oriented or when the participant is ego oriented and has a high perception of their competence. However, an ego orientation coupled with a perception of low competence is associated with maladaptive behaviours such as choosing easy or very difficult tasks, and lack of effort in the face of difficulty. In a study of the link between achievement goal orientation and task choice among university athletes, those high in task orientation reported that they were more likely to choose activities that offer the opportunity to learn, but that were also somewhat challenging (Kavussanu & Roberts, 1996). Variations in the effort young people exert in physical activity and sport can be attributed in part to the individual differences in achievement goal orientations (Cury, et al., 1997; Duda, Chi, Newton, Walling & Catley, 1995; Kavussanu & Roberts, 1996; Sarrazin, Roberts, Cury, Biddle & Famose, 2002). Research has shown a significant positive relationship between task orientation and reported exerted effort, and a non-significant relationship between ego orientation and exerted effort (Duda, et al., 1995; Sarrazin et al., 2002).

Whether these adaptive behaviours occur because task involved participants adopt adaptive behaviour or because task goal orientations directly lead to these more positive behaviours is unclear. Being task involved in the sport and physical activity setting seems to lead to more appropriate achievement strategies by the participants, irrespective of the participant's achievement goal orientation. Individuals who are ego-involved and have high-perceived competence can show adaptive achievement behaviours as well, but are vulnerable to decreasing motivation when they perceive their competence deteriorating (Dweck & Leggett, 1988).

Competitive gymnastics has been the subject of study in the field of motivational climate. A survey of 93 gymnasts and 15 coaches examined the relationships between gymnast's perceptions of their class motivational climate and their goal orientations (Lattimore, 2000). Task orientation and perceptions of a task involved climate were associated with adaptive motivational responses such as preference to be challenged, having fun and trying hard. The same responses of preferring challenging tasks, having fun and trying hard were not as evident with ego orientations. Results suggested that both goal orientations and perceptions of motivational climate play important roles in the adaptive motivational responses of gymnasts.

A further study (Halliburton & Weiss, 2002) of the motivational climate in gymnastics investigated gymnasts by competitive level. This investigation surveyed 103 adolescent Level 5-10 female gymnasts and considered whether perceptions of motivational climate vary by skill level, if sources of competence information vary by skill level, and whether sources of competence information and motivational climate are related. The study found that perceptions of motivational climate did not differ across lower to higher competitive levels; however, gymnasts at lower levels used their perceptions of effort rather than perceived competence to judge their achievement. Significant relationships emerged between sources of competence and motivational climate. Perceptions of task involved climate were associated with use of self-referenced sources of information. Use of practice performance information as a source of competence was positively related to a task involved climate. Learning and improving skills were also positively related to a performance (ego involved) climate.

METHOD

Participants

A club cohort of convenience, with at least two clubs from each of the eight gymnastics regions of Queensland, was invited to participate in the draft SCES survey. This group of clubs included 11 metropolitan clubs and 18 regional clubs. Thirteen clubs formally agreed to participate representing a potential cohort of 238 female gymnasts and 62 male gymnasts. Of the 13 clubs, eleven clubs were in the top twelve competitive club rankings in the State of Queensland. The clubs in the study cohort were grouped under one of two types, "low training hours" or "high training hours", based on their weekly number of training hours in comparison with the average number of training hours for all clubs. Clubs designated "low training hours" had weekly training hours lower than the "All Clubs" mean training hours, while clubs in the "high training hours" group had weekly training hours that exceeded the "All clubs" training hours mean.

Instrument and Data Analysis

This study of achievement goals and motivational climate in competitive gymnastics classers progressed during the development and validation of a new learning climate scale - the Sports Class Environment Scale (SCES). Participant's initial class climate perceptions were gathered using a draft SCES scale. The returned draft SCES surveys were coded for each participant, their gender, their gymnastic level, their club membership, and

their club type. Participants' responses to each item were scored 1 ('Not at all like my class'), 2 ('Not much like my class'), 3 ('A bit like my class') or 4 ('Very much like my class') with 4 being the 'highest' score and 1 being "lowest". Each participant's results were entered for each item under a subscale, and a total and average for the set of subscale items were computed.

The survey data from the revised SCES subscales were used as dependant variables using multivariate analysis of variance (MANOVA) to compare the effect of the two clubs types (low training hours and high training hours), gender and competitive level. This process was achieved in two steps, because the first club type (high training hours) consisted of one gender only – female gymnasts. The first MANOVA examined the effect of club type on the revised SCES subscales, while the second MANOVA tested the effect of gender and gymnastics level of the "low training hours" clubs.

RESULTS

Participants

Thirteen competitive gymnastics clubs returned completed SCES surveys, however, two of these clubs have a competitive class in common and were considered as one club for the purposes of the data analysis. Of the twelve clubs with reportable data, two clubs returned a very small number of completed surveys (n = 4 and 7 respectively) most of which were by non-competitive Level 2 gymnasts. Consequently, their club results were removed from the study. The final cohort consisted of 208 gymnasts (180 females and 28 males competing in National Levels 3 - 10) from ten clubs. Nine of the remaining 10 clubs were ranked in the top ten competitive clubs in the state, however, clubs in this group differed in the amount of gymnastics training participated in per week and in the gender of their gymnasts. A description of the gymnasts by gender, competitive level and training hours per week (ranges and means) for all clubs and club types (low and high training hours) is shown in Table 1.

Table 1. *Description of cohort by gender, competitive level and training hours.*

Cohort Description		All clubs n = 10	Low training hours Clubs n = 7	High training hours clubs n = 3
Male Gymnasts		28	28	0
Female Gymnasts		180	130	50
Level 3-5 (Junior gymnasts)		150	121	29
Level 6-10 (Senior gymnasts)		58	37	21
Training Hours /wk Level 3-5	Range	9 – 18	9 - 12	14 - 18
	Mean	12.6	11.7	14.7
Training Hours /wk Level 6-10	Range	12 – 21.5	12 - 18	20 – 21.5
	Mean	17.7	16.1	21.2

Results of the SCES survey

Descriptive statistics for subscale scores are shown in Table 2. Subscale mean scores are above 19 (out of a possible 24) for all subscales with the exception of Ego Orientation. The mean scores for the Task Oriented and Ego Orientation subscales are 22.4 and 12.1 respectively. These are the

highest and lowest of the subscale mean scores, however, the largest range of scores is for the Ego Orientation subscale, 6.0 - 22.5 and this range of mean scores is further reflected in the largest standard deviation (*SD* = 3.5) of all the subscale mean scores.

Table 2. *Descriptive statistics of draft SCES survey sub-scale scores.*

Sub-scale item	Mean score	Standard Deviation	Minimum score	Maximum score
Involvement	19.6	2.6	9	24
Affiliation	21.9	2.3	14	24
Coach Support	19.6	2.3	11	24
Task Orientation	22.4	1.7	17	24
Ego Orientation	12.1	3.5	6	22.5
Rule Clarity, Order and Organization	20	2.6	12	24

Club type, competitive level and learning climate

MANOVA was used to test the effect of club type (Low and High training hours) and competitive level on motivational climate as measured by the revised SCES. The summary results (see Table 3) show only a significant main effect at the .01 level for club type $F(5,200) = 6,62$, $p = .00$. Effect size is in the moderate to high range ($d = 0.72$).

Tests of between subject effects are summarised in Table 4 and indicate that there was a significant difference at the .01 level between club types only on the Ego Involvement subscale.

The subscale means for each club type and all clubs (shown in Table 5) indicate the direction of these effects. The SCES subscale climate dimension of Ego Involvement identified and separated competitive gymnastics club types. The clubs with high training hours had a higher overall mean Ego Involvement score (*M* = 2.22, *SD* = 0.51) than the low training hour clubs (*M* = 1.68, *SD* = 0.17). Club 3, club 8, club 9, club 7 and club 2 had the highest Ego Involvement scores respectively.

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Table 3.*Multivariate tests of club type and gymnastics level.*

Effect	Hypothesis df	Error df	F	Sig	Effect Size
Club type (Low training hours - High training hours)	5.000	200.000	6.62	.00**	0.72
Competitive Level	5.000	200.000	1.82	.11	
Club type . Level	5.000	200.000	1.7	.14	

* p<.05 ** p<.01

Table 4.*Tests of between-subjects effects club type and competitive level*

Source	Scale Mean	df	Mean Square	F	Significance
Club type -Low training hours -High training hours	Task Involvement	1	.007	.051	.82
	Ego Involvement	1	6.257	17.573	.00**
	Communication	1	.011	.031	.86
	Effort, Order & Org	1	.088	.315	.56
	Affiliation	1	.332	1.972	.16
Competitive Level -Level 3-5 -Level 6-10	Task Involvement	1	.134	.973	.33
	Ego Involvement	1	1.137	3.192	.08
	Communication	1	.513	1.465	.23
	Effort, Order & Org	1	.001	.005	.94
	Affiliation	1	.058	.347	.56
Club type . Level	Task Involvement	1	.099	.715	.40
	Ego Involvement	1	.867	2.436	.12
	Communication	1	.323	.921	.34
	Effort, Order & Org	1	.720	2.583	.11
	Affiliation	1	.007	.041	.84

* p<.05 ** p<.01

Table 5. *Ego and Task Involvement subscale mean scores for club types and all clubs.*

Club Type	Club	Ego Involvement score	Ego Involvement- all clubs mean score
High Training hours	Club 3	2.76	2.22
	Club 8	2.13	
	Club 10	1.76	
Low Training hours	Club 1	1.44	1.68
	Club 2	1.80	
	Club 4	1.65	
	Club 5	1.44	
	Club 6	1.73	
	Club 7	1.81	
	Club 9	1.89	

Gender, competitive level and learning climate

The second MANOVA tested the effect of gender and competitive levels in the low training hour clubs which include male and female gymnasts. The summarized results (Table 6) show a significant main effect at the .01 level for gender F(5, 198) = 8.18, p = .00.

Table 6. *Multivariate tests of gender and competitive level.*

Effect	F	Hypothesis df	Error df	Sig.
Gender	8.18	5.000	198.000	.00**
Competitive Level	1.52	5.000	198.000	.18
Gender . Level	2.12	5.000	198.000	.06

(* p<.05) (** p<.01)

Tests of between subject effects for gender are summarised in Table 7 and indicate that there are significant effects for gender at the .01 level on Task Involvement, Ego Involvement, Effort, Order and Organization, and Affiliation.

Table 7. *Tests of between-subjects effects of gender.*

Source	Dependent Variable Means	df	Mean Square	F	Sig.
Gender	Task Involvement	1	1.821	14.051	.00**
	Ego Involvement	1	4.516	13.394	.00**
	Communication	1	.150	.426	.52
	Effort, Order & Org	1	7.161	29.199	.00**
	Affiliation	1	2.942	18.989	.00**

(* p<.05) (** p<.01)

The SCES subscale means for gender indicate the directionality of these effects. The SCES subscale means scores for gender in the low training hour cohort are displayed in Table 8. The means for males were lower than for females on Task Involvement, Effort, Order and Organization, and Affiliation, but higher on Ego Involvement.

Table 8. *SCES subscale means scores for club type (low hour clubs) and gender.*

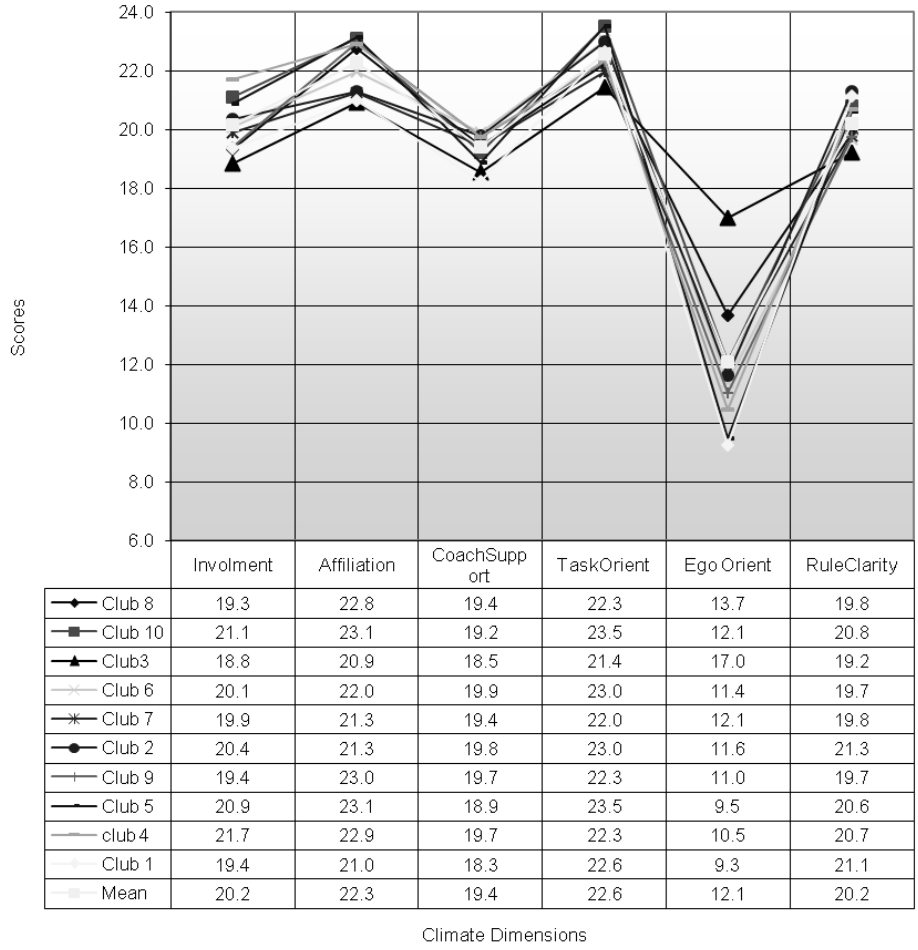
	SCES subscale				
Source	Task Involvement	Ego Involvement	Coach-athlete communicate	Effort, Order Organization	Affiliation
Male gymnasts	3.34	2.15	3.26	2.61	3.30
Female gymnasts	3.64	1.92	3.33	3.20	3.72

DISCUSSION

Class motivational climate profiles

Differences in class motivational climate were found across different clubs. Figure 1 shows the average class climate subscale score, as measured by the draft SCES for classes in each of the 10 clubs. The results are illustrative only for the purpose of visually displaying motivational class climate across all the competitive classes in the clubs in this study. This graphical approach can be a valuable tool for coaches, and can give the target class and their coach timely information about the motivational climate of their class as perceived by participants in that class.

*Club type and motivational climate*The differences between SCES responses on the subscales of Ego Orientation are related to club type. In this study, the revised SCES identified significant differences between perceptions of class climate in the competitive gymnastics high training hours versus low training hours clubs. The high training hour clubs had a combination of a high task involved climate score (M = 3.61) and a moderate to high ego involved climate score (M = 2.22) at the same time. Four clubs from the lower training hour group also demonstrated this characteristic. This may be due to the fact that these clubs, like the high training hours clubs, employ professional teachers and/or tertiary educated coach practitioners.



	Involment	Affiliation	CoachSupport	TaskOrient	Ego Orient	RuleClarity
Club 8	19.3	22.8	19.4	22.3	13.7	19.8
Club 10	21.1	23.1	19.2	23.5	12.1	20.8
Club3	18.8	20.9	18.5	21.4	17.0	19.2
Club 6	20.1	22.0	19.9	23.0	11.4	19.7
Club 7	19.9	21.3	19.4	22.0	12.1	19.8
Club 2	20.4	21.3	19.8	23.0	11.6	21.3
Club 9	19.4	23.0	19.7	22.3	11.0	19.7
Club 5	20.9	23.1	18.9	23.5	9.5	20.6
club 4	21.7	22.9	19.7	22.3	10.5	20.7
Club 1	19.4	21.0	18.3	22.6	9.3	21.1
Mean	20.2	22.3	19.4	22.6	12.1	20.2

Figure 1. *Graphical presentation of Club Motivational Climate Scores.*

There is some evidence that elite level athletes seem to function better when a high task mastery orientation or a high ego goal orientation is tempered with a high task involved class climate (Pensgaard & Roberts, 2000). It may be that highly competent athletes with either a high task mastery orientation or a high ego goal orientation are motivated in any perceived class climate, but when in a situation that threatens their perceived competence, they perform better in a task involved sports class climate (Duda, 2001). Researchers in physical activity and sport suggest that when one is learning physical skills, being more task involved (as opposed to ego involved) is motivationally conducive to learning (Ommundsen, 2001; Roberts, 2001; Standage, Treasure, Hooper, & Kuczka, 2007; Xiang, Bruene, & McBride, 2004). This may result in greater intrinsic motivation for the participant, discourage non-adaptive behaviours such as self-handicapping and encourage adaptive behaviours, such as persistence in the face of difficulty by the participant while in their sports class (Ommundsen, 2001; Roberts, 2001; Standage, Treasure, Hooper, & Kuczka, 2007; Xiang, Bruene, & McBride, 2004).

Gymnast competitive level and motivational climate

Perceptions of gymnastic class motivational climate did not differ between the junior competitive levels (Levels 3-5) and the senior competitive levels (Levels 6-10) in the gymnastics clubs surveyed. This finding is consistent with Halliburton and Weiss (2002), who found that the

perceptions of class motivational climate did not differ across the U.S.A. competitive gymnastic levels.

Gymnast gender and motivational climate

This study indicated that the perceptions of the motivational climate in gymnastics classes as measured by Task Mastery, Ego Orientation, Effort, Order and Organization, and Affiliation scales are gender-related. Competitive artistic gymnastics is primarily based on learning complex skills that are then performed sequentially in an individual routine to achieve a competitive result. It might be expected that all gymnasts, irrespective of gender, would perceive their training class climates as more task (skill) involved and less ego involved. In this study, this was not the case. Moreover, there was a result approaching significance at the .05 level for gender and competitive level. While not of significance here, further investigation into motivational climate in gymnastics classes needs to consider competition level as well as gender. The finding that male gymnasts perceived their class climate to be less task involved and more ego involved than did female gymnasts agrees with the findings of sport climate surveys with University-aged tennis players (Kavussanu & Roberts, 1996) and with a mixed group of adolescent-aged athletes (White, Duda, & Hart, 1992). The gender differences in perceptions of task involved and ego involved climate found in these gymnastics classes may reflect a gender-biased view of effort and outcome. A gender biased result has been found in a study of the relationship of achievement motivation and anxiety in elite handball players (Abrahamsen, Roberts, Pensgaard & Ronglan, 2008). These authors found a positive relationship between a perceived ego-oriented performance climate and anxiety, but only for females.

CONCLUSION

Class motivational climate can be easier to manipulate than individual achievement goal dispositions (Whitehead, Andree, & Lee, 1997). Because of this, motivational climate is an important variable that should be understood, described and manipulated by gymnastics coaches.

In this investigation, perceptions of class motivational climate did not differ between the junior competitive levels (Levels 3-5) and the senior competitive levels (Levels 6-10), however, the study identified significant differences between perceptions of class climate in the competitive gymnastics club types (high training hours versus low training hours). The high training hour clubs had, at the same time, a combination of a high task involved climate score and a moderate to high ego involved climate score.

This study indicated that the perceptions of the motivational climate in gymnastics classes as measured by Task Mastery, Ego Orientation, Effort, Order and Organization, and Affiliation are gender-related. Male gymnasts perceived their class climate to be less task involved and more ego involved than did female gymnasts. Further tests of the SCES along with measures of personal goal dispositions, such as the Task and Ego Orientation in Sport Questionnaire (TEOSQ) (Duda, 1989), used on much larger numbers of male versus female gymnasts, may shed light on gender differences in perceptions of gymnastics class motivational climate.

REFERENCES

Abrahamsen, F. E., Roberts, G. C., Pensgaard, A. M., & Ronglan, L. T. (2008). Perceived ability and social support as mediators of achievement motivation and performance anxiety. *Scandinavian Journal of Medicine & Science in Sports, 18*(6), 810-821.

Ames, C. (1988). Achievement goals in the classroom: Student's learning strategies and motivational processes. *Journal of Educational Psychology. 80*(3), 260-267.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84,* 261-271.

Ames, C. (1995). Achievement goals, motivational climate and motivational processes. In G. C. Roberts (Ed.), *Motivation in sport and exercise* (pp.161-176), Champaign, IL: Human Kinetics.

Boixad´os, M., Cruz, J., Torregrosa, M., & Valiente, L. (2004). Relationships among
motivational climate, satisfaction, perceived ability, and fair play attitudes in young soccer players. *Journal of Applied Sport Psychology, 16,* 301–317.

Chi, L. (1993). *Predication of achievement-related cognition and behaviours in the physical Domain: A test of the theories of goal perspectives and self-efficacy.* Unpublished doctoral dissertation, Purdue University.

Conroy, D. E.; Elliot, A.J. & Hofer, S. M. (2003). A 2 x 2 Achievement Goals Questionnaire for Sport: Evidence for Factorial Invariance, Temporal Stability, and External Validity. Journal of Sport & Exercise Psychology, Vol 25(4), 456-476.

Cury, F., Biddle, S. H.,Sarrazin, P., & Famose, J. P. (1997). Achievement goals and perceived ability predict investment in learning a sport task. *British Journal of Educational Psychology, 67*(3*),* 293-309.

Duda, J. L. (1989). The relationship between task and ego orientation and the perceived purpose of sport among male and female high school athletes. *Journal of Sport and Exercise Psychology, 11,* 318-335.

Duda, J. L. (2001). Achievement goal research in sport: Pushing the boundaries and clarifying some misunderstandings. In G. C. Roberts (Ed.), *Advances in Motivation in Sport and Exercise* (pp.129-182). Champaign, ILL: Human Kinetics.

Duda, J.L. (2007). Motivation in sport – the relevance of competence and achievement goals. In A.J. Elliot & C.S. Dweck, (Eds.). *Handbook of competence and motivation*. (pp. 318-335). New York: Guilford Press.

Duda, J. L., Chi, L., Newton, M. L., Walling, M. D., & Catley, D. (1995). Task and ego orientation and intrinsic motivation in sport. *International Journal of Sport Psychology. 26,* 40-63.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*. *95,* 256-273.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational psychologist. 34*(3), 169-189.

Elliot A.J. & McGregor, H.A. (2001). A 2 X 2 achievement goal framework. *Journal of Personal Social Psychology. 80(3),* 501-19.

Fraser, B. (1994). Research on classroom climate. In D. L. Gabel (Ed*.), Handbook on science teaching and learning* (pp.493—541). New York: Macmillan.

Goudas, M., & Biddle, S. (1994). Perceived motivational climate and intrinsic motivation in school physical education classes. *European Journal of Psychology of Education, 9,* 241-250.

Hall, H. K. (1990). *A social-cognitive approach to goal setting: The mediating effects of achievement goals and perceived ability.* Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Halliburton, A. L., & Weiss, M. R. (2002). Sources of competence information and perceived motivational climate among adolescent female gymnasts varying in skill level. *Journal of Sport & Exercise Psychology. 24*(4), 396-419.

Kavussanu, M., & Roberts, G. C. (1996). Motivation in physical activity contexts: The relationship of perceived motivational climate to intrinsic motivation and self-efficacy. *Journal of Sport and Exercise Psychology, 18,* 264-281.

Lattimore, D. L. (2000). Motivational perspectives of female gymnasts and their coaches. *Microform Publications Bulletin: Health, Physical Education and Recreation, Exercise and Sport Sciences, 13(1),* University of Memphis.

Nicholls, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice and performance. *Psychological Review, 91*, 328-346.

Ntoumanis, N., & Biddle, S. (1999). A review of motivational climate in physical activity. *Journal of Sports Science, 17*, 643-665.

Nyheim, M., Kavussanu, M., Roberts, G. C., & Treasure, D. C. (1996, June). *Goal orientations, beliefs about success, and satisfaction in summer sports camp participation.* Paper presented at the annual conference of the North American society for the Psychology of Sport and Physical Exercise, Ontario, Canada.

Ommundsen, Y. (2001). Self-handicapping strategies in physical education classes: The influence of implicit theories of the nature of ability and achievement goal orientations. *Psychology of Sport and Exercise, 2*(3), 139-156.

Pensgaard, A. M., & Roberts, G. C. (2000). The relationship between motivational climate, perceived ability and sources of distress among elite athletes. *Journal of Sport Sciences, 18*(3),191-200.

Roberts, G. C. (1992). Motivation in sport and exercise: Conceptual constraints and convergence. In G. C. Roberts (Ed.), *Motivation in Sport and Exercise* (pp. 161-176). Champaign, ILL: Human Kinetics.

Roberts, G. C. (2001). Understanding the dynamics of motivation in physical activity: The influence of achievement goals and motivational processes. In G. C. Roberts (Ed.), *Advances in Motivation in Sport and Exercise* (pp.1-49). Champaign, ILL: Human Kinetics.

Roberts, G. C., & Ommundsen, Y. (1996). Effect of goal orientations on achievement beliefs, cognition, and strategies in team sport. *Scandinavian Journal of Medicine an Science in Sport, 6*, 46-56.

Roberts, G. C., Treasure, D. C., & Kavussanu, M. (1997). Motivation in physical activity contexts: An achievement goal perspective. In P. Pintrich & M. Maehr (Eds.), *Advances in motivation and achievement* (Vol.10, pp.413-447). Stamford, CT: JAI Press.

Sarrazin, P., Roberts, G. C., Cury, F., Biddle, S. & Famose J. P. (2002). Exerted effort and performance in climbing among boys: The influence of achievement goals, perceived ability, and task difficulty. *Research Quarterly for Exercise and Sport, 73*(4), 425-36.

Standage, M., Treasure, D.C., Hooper, K. & Kuczka, K. (2007). Self-Handicapping in School Physical Education: the Influence of the Motivational Climate. *British Journal of Educational Psychology, 77(1),*81-99.

Treasure, D. C. (2001). Enhancing young people's motivation in physical activity. In G. C. Roberts (Ed.) Advances in motivation in sport and exercise (pp.79-100). Champaign, IL: Human Kinetics

Treasure, D. C., & Roberts, G. C. (1994). Cognitive and affective concomitants of task and ego goal orientations during the middle school years. *Journal of Sport and Exercise Psychology, 16*(1), 15-28.

Treasure, D.C. & Roberts, G.C. (2001). Students' perceptions of the motivational climate, achievement beliefs, and satisfaction in physical education. *Research Quarterly for Exercise and Sport., 72(2*), 165-176.

Vlachopoulas, S., & Biddle, S. J. (1997). Modelling the relation of goal orientation to achievement-related affect in physical education: Does perceived ability matter? *Journal of Sport and Exercise Psychology, 19*(2), 169-187.

White, S. A., Duda, J. L., & Hart, S. (1992). An exploratory examination of the parent-initiated motivational climate questionnaire. *Perceptual and Motor Skills, 75*, 870-880.

Whitehead, J., Andree, K. V., & Lee, M. J. (1997). Longitudinal interactions between dispositional and situational goals, perceived ability and intrinsic motivation. In R. Lidor & M. Bar-Eli (Eds.), *Innovations in sport psychology: linking theory and practice. Proceedings of the IX World Congress in Sport Psychology: Part*

II (pp. 750–752). Netanya, Israel: Ministry of Education, Culture and Sport.

Xiang, P. Bruene A. & Mcbride, R. E. (2004). Using Achievement Goal Theory to assess an elementary physical education running program, *Journal of School Health, 74(6),* 220-225.

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THE EFFECT OF TWO DIFFERENT CONDITIONS OF WHOLE-BODY VIBRATION ON FLEXIBILITY AND JUMPING PERFORMANCE ON ARTISTIC GYMNASTS

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Original research article

Abstract

*The purpose of this study was to examine the effect of different conditions of Whole Bode Vibration (WBV) on flexibility and jumping performance on artistic gymnasts. Twelve well trained gymnasts volunteered to participate in this study. They were performed under two different condition protocols. The first was examined as WBV combined with static stretching condition (WBVSS) and the second was examined as WBV. Flexibility and explosive strength tests were performed initially (Pre), immediately after the intervention (Post 1), 15 minutes (Post 15) and 30 minutes after the end of the intervention program (Post 30). A two-way ANOVA (condition * trials) with repeated measures on both factors was used. The level of significance was set at $p < 0.05$. Univariate analyses with Bonferroni adjustments (0.05/6) were selected as post hoc tests. The results revealed no significant interaction between conditions and trials in all examined variables ($p>0.05$). However, significant difference was found with respect to Sit&Reach test between pre and post 1 measurement ($p=0.002$). Further, the percentage improvement of WBV was greater in SJ and CMJ variables compared to WBVSS condition. Conclusively, both conditions (WBVSS and WBV) were effective on flexibility and jumping performance on artistic gymnasts and that each of them has a specific effect on the examined variables.*

Keywords: *vibration, flexibility, muscle strength, stretching, gymnastics.*

INTRODUCTION

The ability of the neuromuscular system to produce maximal power output is of critical importance in artistic gymnastics (AG). This ability requires optimal combinations of muscle strength, balance and flexibility to maximize gymnastics performance. Two of the six apparatus in artistic gymnastics, floor exercises and vaulting, are based, mainly, on muscular strength and flexibility of lower limbs to perform successfully the corresponding requirements in these events. Several methods have been used to improve flexibility (Abdulrahim et al, 2012; Bacurau et al, 2009; Bradley et al, 2007; Behm & Chaouachi, 2011; Christensen & Nordstrom, 2008; Covert et al, 2010; Davis et al, 2005; Hindle et al, 2012; Samuel et al, 2008), and explosive strength of lower limbs (Bacurau et al, 2009; Bazett-Jones et al, 2008; Behm, et al, 2006; Behm, Kibele, 2007; Delecluse et al, 2003). Further,

previous findings showed that stretching has been used to improve gymnasts' split leap leg positions (Sands & McNeal, 2000; Sands, McNeal, Stone, Russell, & Jemni, 2006), whereas associated with an acute loss of maximal strength and power (McNeal & Sands, 2003; Sands, 2002). In addition, other studies support that gymnasts improved their split range of motion after vibration exposure (Sands et al, 2008). On the contrary, simultaneous vibration and stretching may improve flexibility while not altering explosive strength (Kinser et al, 2008).

Artistic Gymnastics relies on the gymnast's ability to produce a large amount of muscular force and to achieve limb positions that are beyond the norm. This sport uses a large range of motion (ROM) to achieve certain techniques and to increase score based on special body positions. According to Sands (2002) flexibility has been defined as the ROM in a joint or a related series of joints. Previous findings support that acute stretching as part of a warm-up, particularly slow and static stretching (SS) can cause a loss of maximum strength, rate of force development, power and explosive performance (McNeal & Sands, 2003; Stone et al 2006). Moreover, according to Di Cagno (2008) SS before physical activity is detrimental when performance requires subsequent maximal force and power production (Di Cagno, 2008). As Kinser and her colleagues stated, the potential stretching-induced decrease in explosiveness could reduce performance capabilities. Thus, a warm-up method that could allow ROM enhancement while enhancing or maintaining explosiveness would be quite applicable (Kinser et al, 2008).

Whole Body Vibration (WBV) is a neuromuscular method that uses a low-to moderate-vibration stimulus to enhance flexibility (Cochrane & Stannard, 2005; Fagnani et al, 2006; Jacobs & Burns, 2009), muscular strength and power (Bosco et al, 2000; Torvinen et al, 2002) and may produce benefits which can be useful in training and has been reported to be an effective method to enhance athletic performance (Cardinale & Wakeling, 2005; Rittweger et al, 2000). In addition, WBV training can be artificially produced when a person stands upon vibration platform that generates side to side alternating vertical sinusoidal mechanical vibration at a frequency between 30-50Hz. This may produce benefits which can be useful in training and has been reported to be an effective method to enhance athletic performance (Cardinale & Wakeling, 2005; Rittweger et al, 2000). The main argument for using vibration for muscle training has been based on the assumption that strength improvements can be easily achieved during a short duration vibration exposure (Cardinale and Bosco, 2003).

A lot of studies showed that WBV training resulted in improved muscle strength or muscle performance (Bosco et al, 2000; Delecluse et al, 2003; Gerodimos et al, 2010; Roelants et al, 2004), increase explosive strength of lower limbs (Cochrane & Stannard, 2005; Cormie et al, 2006), flexibility with or without stretching (Dallas et al, 2012; Jacobs & Burns, 2009; Kinser et al, 2008; Sands et al, 2006; 2008). In addition, studies that are referred to gymnastics sports have examined mainly the vibration effect on flexibility in high level gymnasts (Kinser et al, 2008; Sands et al, 2006; Sands et al, 2008) or elite female synchronized swimmers (Sands et al, 2008). However, few studies involved stretching during vibration (Issurin et al, 1994; Sands et al, 2006; Sands et al, 2008). Further, other studies had examined the acute effect of a WBV program on muscle performance of female athletes (Bullock et al, 2008; Cochrane & Stannard, 2005; Fagnani et al, 2006; Kinser et al, 2008). Previous data support that vibration may enhance measures of explosiveness (Ronnestand, 2004), and that vibration is most effective in muscles with increased length or tension (Rohmert et al, 1989). In this sense, a combination of vibration and stretching as part of the warm-up enhanced ROM and caused no loss (Kinser et al, 2008; Stone et

al, 2006). Although, a great number of studies referred on flexibility and explosive strength enhancement with vibration on young artistic gymnasts, there is no scientific evidence on the efficacy on well trained artistic gymnasts that possess a high level of flexibility and explosive strength after many years of training. Therefore, the purpose of this study was to examine whether a single bout of Whole-Body-Vibration condition (WBV) or WBV combined with static Stretching (WBVSS) can be use as a warm-up activity that leads to short-term changes.

METHODS

Experimental Approach to the Problem

This investigation was designed to assess the possible beneficial effects of WBV or the WBVSS on well trained artistic gymnasts. Flexibility test (sit and reach test (S & R), and Explosive strength of lower limbs [Squat jump (SJ)], and counter movement jump (CMJ) were examined.

Subjects

Twelve well trained artistic gymnasts (Age: M = 21.88, SD = 1.05 years; Body Mass: M = 65.76, SD = 7.33 kg; Body Height: 170.53, SD = 6.76 cm; and percent body fat; M = 16.62, SD =1.864) volunteered to participate in the present study. All subjects had 8 to 10 years of experience in training, at least four days per week, three hours per day, with no previous experience in WBV. Further, they had experience in competing, both nationally and internationally, from six to eight years. Three days before the study, they had a familiarization training session and reproduced experimental procedures regarding the flexibility and explosive strength testing, and measurements of anthropometric characteristics (age, body mass, body height, percent body fat) were performed, as well. The study was approved by the local institutional Review Board and all procedures were in accordance with the Helsinki declaration of 1975 as revised in 1996. The vibration protocol consisted of a single bout WBV condition with and without stretching, which will be discussed in detail herein. The subjects were informed extensively about the experiment procedures and the possible risks or benefits of the project, and a written consent was obtained and they were instructed to refrain from any other activity during experimental procedure of this study.

Procedures

WBV Treatment

Subjects on both conditions were trained on a WBV platform (Power Plate®) that produced vertical sinusoidal oscillations. The frequency and the amplitude used in this study were 30-Hz and 2mm, respectively. The duration of the total stimuli was 75 seconds, which consisted of one set of 15 seconds for each one of five different exercises. The rest interval between each exercise for both groups was defined at 15 seconds. Subjects had to report to the lab on two separate days. On each testing condition, subjects performed a five-minute warm-up on a cycle ergometer without resistance at a self-selected moderate pace speed ranging from 4.0 to 5.0 km x h^{-1}). Immediately after the warm-up, the subjects completed a series of measurements for: flexibility (sit & reach test: SR) and legs' explosive strength (Squat Jump: SJ and Counter Movement Jump: CMJ) in a randomized order. A battery of tests was performed at baseline (pre), immediately after the end of the trial (post1) and 15 minutes after the end of the trial (Post15). The participants were informed about the test procedures and were asked to perform all tests at maximum intensity. All testing sessions were conducted at the same time of day (13:00 to 16:00). Verbal encouragement was given throughout testing trials.

On first day in WBV condition, during the first and second exercises, subjects from upright position flexed their knees to a squat position, to contract knee extensors. During the third exercise, subjects from supine position on the floor,

put their flexed leg at the knee on the platform and simultaneously push downward against to contract their hamstrings (photo 1). During the fourth and fifth exercises, subjects from upright position, they were supported on their toes to contract plantar flexors (calf muscles) (photo 2).

On second day in WBVSS condition, during the first and second exercises, subjects put their free leg on the floor, while the other leg was supported on the platform to stretch the knee extensors muscles (photo 3). The third exercise had the subjects flex their torsos forward over the working leg on the platform such that the position stretched the hamstring muscles (photo 4). During the fourth and fifth exercises, subjects put their free leg on the platform that was turn off, while the other leg was supported with foot on the platform that was turn on, trying to press downward the hell to stretch calf muscles (photo 5).

The 15 sec exercise is used to hopefully improve the performance enhancement found by Cormie et al (2006). During the vibration-training session, the participants wore the same gymnastics shoes to avoid bruises and standardize the damping of the vibration caused by foot wear. As there are no scientifically-based WBV programs the training program in the present study was based on similar protocols that resulted in significant changes in muscle performance (Delecluse et al., 2003; Torvinen et al., 2002). The rest intervals between exercises, for both conditions, were 15 seconds.

1 2 3

4 5

Photos.

Flexibility test (Sit & Reach)

Flexibility was assessed using the sit and reach test using a Flex-Tester box (Cranlea, UK). Participants were instructed to remove their shoes and sit with their legs extended in front of them against the box. The subjects then placed one hand over the other and stretched forward slowly a far as possible along the top of the box until they could stretch no further, holding this position for 2 seconds (Fagnani et al, 2006) (photo 6). The test was repeated twice with a rest period of 10 seconds (Cochrane and Stannard, 2005) and the best trial of the two allowed was recorded to the nearest 1.0cm for further analysis.

Photo 6.

Explosive strength

Explosive strength of lower limbs was assessed by SJ, and CMJ using a switch mat (Bosco, Luhtanen, & Komi 1983) connected to a digital timer (accuracy±0.001s, Ergojump, Psion XP, MA.GI.CA. Rome, Italy), which recorded the flight time (t_f) of each single jump. In order to avoid upper body work and to minimize horizontal and lateral displacements the hands were kept on the hips through the tests (photo 7). The subjects were jumping from a semi-squatting position without counter movement (SJ). Two trials were performed, the best score was considered for statistical analysis.

Photo 7.

Statistical analysis

A two-way ANOVA (condition * trials) with repeated measures on both factors was used. The level of significance was set at $p<0.05$. Univariate analyses with Bonferroni adjustments (.05/6) were selected as post hoc tests. The significant level for the tests was set at $p< 0.05$ and the data was presented as mean ±SD. Further, percent changes in all examined variables from base-line following WBV exercise were calculated. All analyses were executed using the statistical package PASW 18.

RESULTS

The interaction effect between condition * trials was not significant with respect to S&R test (F= 1.351, p= .319, n^2=.310). Further, the condition main effect was not significant as well (F= 2.482, p= .143, n^2=.184). The trial main effect however was significant (F= 11.074, p= .002, n^2=.787) and the post hoc analysis with Bonferroni adjustment (.05/6) revealed significant differences between: a) pre vs post 1 (F= 38.833, p= .000). Inspection of mean scores revealed that the means S & R score at post1 was significantly higher compared to mean scores at pre test (table 1).

Table 1. *Means and SDs (M ± SD) in various tests across condition and trials with respect to the measurements used.*

	WBV			WBVSS		
	S & R (cm)	SJ (cm)	CMJ (cm)	S & R (cm)	SJ (cm)	CMJ (cm)
Pre	38.83±3.54	30.72±6.46	32.44±6.40	37.75 ±3.84	30.61 ±7.44	32.35±6.84
Post 1	39.92±3.23*	31.32±6.85	33.13±6.94	39.58±4.01*	30.76±6.69	32.52±7.22
Post 15	40.58±2.64*	31.08±6.51	32.57±6.81	39.75±3.69*	30.62±7.19	31.80±6.61
Post 30	41.08±2.39*	30.70±6.66	32.53±7.01	39.92±3.50*	30.69±6.67	32.29±6.52

No significant interaction effect between condition and trials was found with respect to SJ (F= 0.339, p= .798, n^2=.102). Further, main effect were no significant for condition (F=.618, p= .449, n^2=.053) and trials (F= 1.158, p= .378, n^2=.279) and therefore no post hoc analyses was conducted (table 1). No significant interaction effect between condition and trials was found with respect to CMJ (F= 1.212, p= .360, n^2=.288). Further, main effect were no significant for condition (F=.980, p= .343, n^2=.082) and trials (F= 3.103, p= .082, n^2=.508) and therefore no post hoc analyses was conducted. Separate improvement for WBVSS and WBV may be found in table 2. Further, Confidence Intervals (95% CI) are presented in table 3.

Table 2. *Percentage improvements (%) in S&R, SJ, and CMJ of gymnasts exposed to WBV and WBVSS, across time.*

	S&R		SJ		CMJ	
	WBV	WBVS S	WBV	WBVSS	WBV	WBVSS
Pre vs Post 1	2.81%	4.84%	1.72%	0.49%	2.13%	0.52%
Pre vs Post 15	4.51%	5.29%	1.96%	0.03%	0.40%	-1.70%
Pre vs Post 30	5.79%	5.75%	0.00%	0.26%	0.27%	-0.18%
Post 1 vs Post 15	1.65%	0.43%	0.24%	-0.45%	-1.69%	-2.21%
Post 1 vs Post 30	2.90%	0.86%	-1.69%	-0.23%	-1.81%	-0.71%
Post 15 vs Post 30	1.23%	0.43%	-1.93%	0.23%	-0.12%	1.54%

Table 3. *95% Confidence Intervals in various tests across trials*.

Trials	95% CI (S & R)	95% CI (SJ)	95% CI (CMJ)
Pre	36.02 – 40.55	26.85 – 35.05	28.24 – 36.55
Post 1	37.53 – 41.97	26.78 – 35.30	28.37 – 37.29
Post 15	28.28 – 42.05	26.54 – 35.16	27.97 – 36.39
Post 30	37.73 – 42.26	26.50- 34.88	28.14 – 36.68

DISCUSSION

The selection of well trained artistic gymnasts was based on the desire to determine whether vibration training and Static Stretching on the vibration platform could enhance range of motion and explosive strength of lower limbs in these athletes who were accustomed to intense flexibility training and had participated in static stretching and strength training for periods ranging from months to years before the investigation. According to the results the only significant difference was observed in S & R test that means both conditions were equally effective to improve flexibility in this particular group of gymnasts. However, the percentage improvement was greater in WBVSS condition compared to WBV condition in Post1 and Post15 but in Post30 WBV condition showed higher improvement compared to WBVSS condition (figure 1).

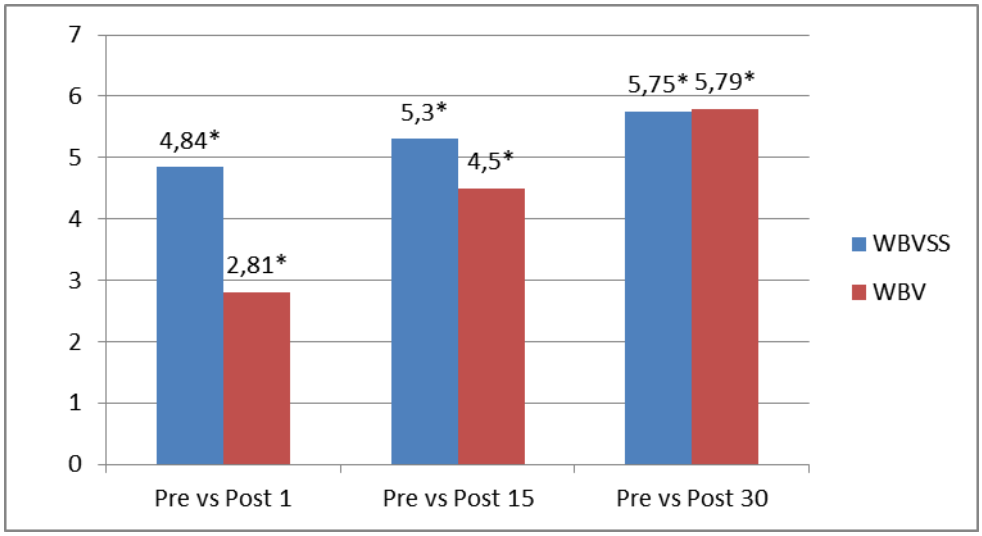

Figure 1. *Percentage (%) improvements in S & R test by two different conditions.*

These results are in congruence with those of Cochrane & Stannard (2005) and Jacobs & Burns (2009) which state that an acute bout of WBV have shown to improve flexibility and may be a more efficient warm-up method. Further, our results reinforce previous data of Sands and his colleagues (2006) that revealed an increase in ROM in forward split flexibility in high trained male gymnasts and those of Sands et al, which found that vibration combined with stretching had significant influence on passive forward split flexibility in elite female synchronized swimmers (Sands et al, 2008). In addition, beneficial effects of WBV on flexibility were maintained for at least 30 min, a finding that supports previous data of Gerodimos et al (2010). According to Issurin (2005) a possible explanation for the enhanced flexibility after a single bout of WBV involves circulatory, thermoregulatory, and neural mechanisms.

Previous data support that vibration enhances the stretch reflex loop through the activation of the primary endings of the muscle spindle, which influences agonist muscle contraction while antagonists are simultaneously inhibited (Rothmuller & Cafarelli, 1995). Further, according to Cardinale & Bosco (2003), the acute enhancement of neuromuscular performance after vibration is probably related to an increase in the sensitivity of the stretch reflex. Furthermore, vibration appears to inhibit activation of antagonist muscles through Ia-inhibitory neurons, thus altering the intramuscular coordination patterns leading to a decreased braking force around the joints stimulated by vibration.

Although no significant differences was found in jumping performance in gymnasts that exposed in WBVSS and WBV condition the percentage improvement of WBV was greater in SJ and CMJ variables compared to WBVSS condition (figure 2). The WBVSS revealed a slight improvement by 0.49% and 0.52% in SJ and CMJ, respectively a finding that opposed those of Kinser et al (2008) which found that vibration stretching group showed a decrease by -0.9% and -0.6% in SJ and CMJ, respectively in young female gymnasts.

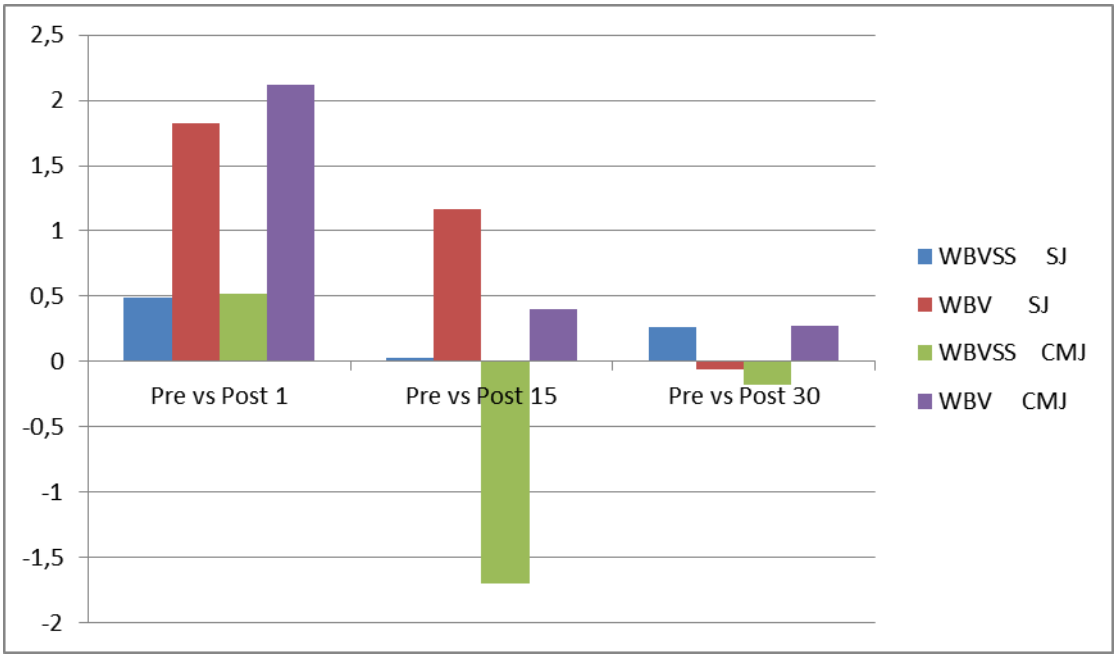

Figure 2. *Percentage improvements in SJ and CMJ test by two different conditions.*

Moreover, the no significant difference in explosive strength of lower limbs between pre and post measurements in WBV condition verify previous finding of Kinser et al (2008) that found an improvement by 0.4% in CMJ but a decrease by -0.9% in SJ. The corresponding improvement in our study was 1.82% and 2.12% respectively, for the SJ and CMJ measurements. In addition, our findings support results of previous studies (Armstrong et al, 2010; Cormie et al, 2006) that found a slight increase in CMJ after a 30- until 60-second vibration treatment, and those of Wyon et al, 2010, which suggest that WBV training has a beneficial effect on vertical jump height. Moreover, it is mentioned that negative effects of vibration is reported only after 2-8 hours daily use, whereas studies that have shown evidence for an elevated risk of health are referred to long term exposure to WBV and not on those that examine the acute effect of WBV on different kinds of subjects.

CONCLUSIONS

In conclusion, this study demonstrates that both conditions (WBVSS and WBV) can enhance flexibility, while at the same time their jumping performance not only was detrimental but maintained for at least 15 minutes. Additionally, the lack of any detrimental WBVSS effect of this method in jumping performance, suggests that this approach seems to be effective and can be applied from gymnasts in pre event activities & in sport performance. Further, the fact that WBV enhance flexibility may be useful in some settings as a neuromuscular warm-up in preparation for explosive sport events.

REFERENCES

Abdulrahim, Z. Ganeswara, R., and Buragadda, M.S. (2012). Efficacy of PNF Stratching Tecniques on hamstring tightness in young male adult population. *World Journal of Medical Sciences*, 7(1): 23-26.

Armstrong, W.J., Grinnell, D.C., and Warren G.S. (2010). The acute effect of whole-body vibration on the vertical jump height. *Journal of Strength and Condition Research*, 24(10): 2835-2839.

Bacurau, R.F., Monteiro, G.A., Ugrinowitsch, C., Tricoli, V., Cabral, L.F., Aoki, M.S. (2009). Acute effect of a ballistic and a static stretching exercise bout on flexibility and maximal strength. *Journal of Strength and Conditioning Research*, 23: 304-308.

Bazett-Jones, D.M., Finch, H.W., and Dugan, E.L. (2008). Comparing the effects of various whole-body vibration accelerations on counter-movement jump performance, *Journal of Sports Science and Medicine*, 7, 144-150.

Behm, D.G., Bradbury, E.E., Haynes, A.T., Hodder, J.N., Leonard, A.M., Paddock, N.R. (2006). Flexibility is not related to stretch-induced deficits in force or power, *Journal of Sports in Science and Medicine*, 5: 33-42.

Behm, D.G., & Chaouachi, A. (2011). A revies of the acute effects of static and dynamic stretching on performance. *European Journal of Applied Physiology*, 111: 2633-2651.

Behm, D.G., Kibele, A. (2007). Effects of different intensities of static stretching on jump performance, *European Journal of Applied Physiology*, 101: 587-594.

Bosco, C, Iacovelli, M, Tsarpela, O. (2000). Hormonal responses to whole body vibration in man. *European Journal of Applied Physiology*, 81: 449-454.

Bradley, P.S., Olsen, P.D., and Portas, M.D. (2007). The effect of static, ballistic, and proprioceptive neuromuscular facilitation stretching on vertical jump performance. *Journal of Strength and Conditioning Research*, 21(1): 223-226.

Bullock, N, Martin, D.T, Ross, A, Rosemond, C.D, Jordan, M.J, Marino, F.E. (2008). Acute effect of whole-body vibration on sprint and jumping performance in elite skeleton. *Journal of Strength and Conditioning Research*, 22: 1371-1374.

Cardinale, M, and Wakeling, J. (2005). Whole-body vibration exercise: are vibrations good for you? *British Journal of Sports Medicine*, 39: 585-589.

Cardinale, M, and Bosco, C. (2003). The use of vibration as an exercise intervention. *Exercise and Sport Science Review*, 31: 3-7.

Christensen, B.K., and Nordstrom, B.J. (2008). The effects of proprioceptive neuromuscular facilitation and dynamic stretching on techniques on vertical jump performance. *Journal of Strength and Conditioning Research*, 22: 1826-1831.

Cochrane, D.J, Stannard, S.R. (2005). Acute whole body vibration training increases vertical jump and flexibility performance in elite female field hockey players. *Briritsh Journal of Sports Medicine*, 39:860–865.

Cormie, P., Deane, R.S., Triplett, N.T, and McBride, J.M. (2006). Acute effects of whole-body vibration on muscle activity, strength, and power. *Journal of Strength and Conditioning Research*, 20: 257-261.

Covert, C.A., Alexander, M.P., Petronis, J.J., and Davis, S.D. (2010). Comparison of ballistic and static stretching on hamstring muscle length using an equal stretching dose. *Journal of Strength and Conditioning Research*, 24(11): 3008-3014.

Dallas, G., Kaimakamis, V., Mellos, V., Paradisis, G. (2012). Acute effect of Whole-Body Vibration combined with stretching on bridge performance in artistic gymnasts. *Biology of Exercise*, 8,2, 5-15.

Davis, D.S., Ashby, P.E., McCale, K.L., McQuain, J.A., and Wine, J.M. (2005). The effectiveness of 3 stretching techniques on hamstring flexibility using consistent stretching parameters. *Journal of Strength and Conditioning Research*, 19: 27-32.

Delecluse, C., Roelants, M., and Verschueren, S. (2003). Strength increase after whole-body vibration compared with resistance training. *Medicine in Science and Sports Exercise*, 35: 1033-1041.

Di Cagno, A., Baldari, C., Battaglia, C., Gallotta, M.C., Videira, M., Piazza, M., Guidetti, L.J. (2010). Preexercise static stretching effect on leaping performance in elite rhythmic gymnasts. *Journal of Strength and Conditioning Research*, 24:1995-2000.

Fagnani, F., Giombini, A., Di Cesare, A., Pigozzi, F., Di Salvo, V. (2006). The effects of a whole-body vibration program on muscle performance and flexibility in female athletes. *American Journal of Physical Medicine and Rehabilitation* 85: 956-962.

Gerodimos, V., Zafeiridis, A., Karatrantou, K., Vasilopoulou, Th., Chanou, K., Pispirikou E. (2010). The acute effects of different whole-body vibration amplitudes and frequencies on flexibility and vertical jumping performance. *Journal of Science and Medicine in Sport* 13: 438-443.

Hindle, B.K., Whitcomb, J.T., Briggs, O.W., Hing, J. (2012). Proprioceptive neuromuscular facilitation (PNF): Its mechanisms and effects on range of motion and muscular function. *Journal of Human Kinetics*, 31: 105-113.

Issurin, V.B., Liebermann, D.G., Tenenbaum, G. (1994). Effect of vibratory stimulation on maximal force and flexibility. *Journal of Sport Science*, 12: 561-566.

Issurin, V.B. (2005). Vibration and their applications in sport: a review. *Journal of Sports Medicine and Physical Fitness*, 45(3): 324-336.

Kinser, A.M, Ramsay, M.W, O'Bryant, H.S, Ayres, C.A. (2008). Vibration and stretching effects on flexibility and explosive strength in young gymnasts. *Medicine and Science in Sports and Exercise*, 40: 133-140.

Jacobs, P.L, Burns, P. (2009). Acute enhancement of lower-extremity dynamic strength and flexibility with whole-body vibration. *Journal of Strength and Conditioning Research*, 23:51–57.

McNeal, J.R., & Sands, W.A. (2003). Acute static stretching reduces lower extremity power in trained children. *Pediatric Exercise Science*, 15: 139-145.

Rittweger, J., Beller, G., and Felsenberg, D. (2000). Acute physiological effects of exhaustive whole-body vibration exercise in man. *Clinical Physiology* 20: 134-142.

Roelants, M., Delecluse, C., Coris, M., and Verschueren, S. (2004). Effects of 24 weeks of whole body vibration training on body composition and muscle strength in untrained females. *International Journal of Sports Medicine*, 25: 1-5.

Rohmert, W., Wos, H., Norlander, S., Helbig, R. (1989). Effects of vibration on arm and shoulder muscles in three body postures. *European Journal of Applied Physiology and Occupation Physiology*, 59: 243-248.

Ronnestand, B.R. (2004). Comparing the performance-enhancing effects of squats on a vibration platform with conventional squats in recreationally-trained men. *Journal of strength and Conditioning Research*, 18: 839-845.

Rothmuller, C., and Cafarelli, E. (1995). Effect of vibration on antagonist muscle coactivation during progressive fatigue in humans. *Journal of Physiology*, 485: 857-864.

Samuel, M.N., Holcomb, W.R., Guadagnoli, M.A., Rubley, M.D., and Wallmann, H. (2008). Acute effects of static and ballistic stretching on measures of strength and power. *Journal of strength and Conditioning Research*, 22(5): 1422-1428.

Sands, W.A., & McNeal, J.R. (2000). Enhancing flexibility in gymnastics. *Technique*, 20(5): 6-9.

Sands, W.A. (2002). Physiology. In: Sands W.A, Caine DJ, Borms G, (Eds.), *Scientific Aspects of Women's Gymnastics.* Basel, Switzerland: Karger.

Sands, W.A, McNeal, J.R, Stone, M.H, Russell, E.M, Jemni, M. (2006). Flexibility enhancement wit vibration: Acute and long–term. *Medicine and Science in Sports and Exercise*, 38: 720-725.

Sands. W.A., McNeal, J.R., Stone, M.H., Haff, G.G., and Kinser, A.M. (2008). Effect of vibration on forward split flexibility and pain perception in young male gymnasts. *International Journal of Sports Physiology and Performance*, 3: 469-481.

Sands, W.A., McNeal, J.R., Stone, M.H., Kimmel, W.L., Haff, G.G, Jemni, M. (2008). The effect of vibration on active and passive range of motion in elite female synchronized swimmers. *European Journal of Sport Science*, 8: 217-223.

Stone, M.H., Ramsey, M.W., Kinser, A.M., O'Bryant, H.S., Ayres, C., Sands, W.A. (2006). Stretching: acute and chronic? The potential consequences. *Strength Condition Journal*, 28: 66-74.

Torvinen, S., Kannus. P., Sievanen. H., Jarvine, T.A.H., Pasanen, M., Kontulainen, S., Jarvinen, T.L.N., Jarvinen, M., Oja, P., & Vuori, I. (2002). Effect of a vibration exposure on muscular performance and body balance. Randomized cross-over study. *Clinical Physiology and Functional Imaging*, 22: 145-52.

Wyon, M., Guinan, D., and Hawkey, A. (2010). Whole-body vibration training increases vertical jump height in a dance population. *Journal of Strength and Conditioning Research*, 24(3): 866-870.

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A CASE STUDY OF THE BODY WEIGHT MANAGEMENT OF AN ELITE GYMNAST DURING THE PREPARING PERIOD FOR 2012 OLYMAPIC

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A case study

Abstract

On the very first Science of Gymnastics Journal® in 2009, the authors have reported a successful weight-loss program in China National Gymnastics Team for preparing for 2008 Olympic Game, ever for an elite female gymnastic athlete (Chen, H., 2009).
So far as we know, to reduce body weight effectively is not an easy theme for everyone on the earth, even for elite gymnastics at the top level in the world, especially in the rush hour during the process of preparing for Olympic Games. Whenever these athletes need to lose a small amount (couple of pounds) of body weight, some issues are brought up. During the process in increased and decreased of body weight, how could the athlete keep their competition level and physical fitness stand at an optimal and high level? How to control the amount of daily training which should improve their skill and performance successfully?
Based on the needs of higher and higher competition level day by day in the world, more and more details gained from training practice should contribute more evidence to the development of gymnastic. This report would like to present another successful weight-loss case from a male elite athlete in China National Gymnastics Team who struggled with injury while prepared for 2012 Olympic Game.

Keywords: *body weight management, Olympic Games, elite gymnastics.*

INTRODUCTION

Male gymnasts usually have a longer competition life span than that of the females. Some top level male gymnasts can extend their competition span into their 30's. At this age, however, a number of negative physical and psychological problems might happen to them due to the incredibly stressful experience in preparation of a large number of games (Pensgard, 1997; Wegner, 2000), which include no motivation for training, less confidence for winning championship, and depression (Ardila, 2006). One possible cause of such problems is so-called overuse injury, which results

from many years' professional training. In such case, any weight gain during this period may significantly interfere with the rehabilitation of injury, as well as the competition level, which apparently reduce the competition life span.

Theoretically, the balance of energy input (food intake) and energy output (physical activity, and so on) was considered a key point of body weight management (D'Alessandro, C., et al. 2007; Filaire E., Lac G., 2002). Thus, alteration of the ingredient of food intake should be necessary and some fashionable snack, such as high density snack made from high fat and high-sodium, full flavor, rare moisture content and the light quantity that trigger too much body-weight change was forbidden from the menu (Chen, H., et al, 2009). Besides milk (Michopoulou, E. et al, 2011; Kawano, Y., et al, 2002), zero energy soda, as substitute for most of the beverage, should be added into the menu. Together with change of the ingredient of food intake, improvement of the gymnasts' motivation significantly contribute to an effective weight control. Such comprehensive program always puts equal emphasis on physiological aspect and psychological aspect (Anderson CM 2011; Nora Klinkowski, et al. 2008; Rushall, 1989).

In the present study, the subject, a 28-year-old male gymnast of Chinese national gymnastic team, experienced such situations several months before the 2012 Olympic Game. We considered the management of body weight a crucial measure at that time and effort was put on the development of a personalized program for losing weight, balancing the targeted body weight and the optimal competition level, and rebuilding his confidence and self-belief in achieving world class results. Four months later, the subject lost 4000 gram body weight including 2330 gram fat. Consequently, he achieved world class results in 2012 Olympic Games.

METHODS

Time: January 30 – June 01, 2012.

Program: In the beginning of the study, the subject suffered from injury. Based on his actual physiological and psychological condition, an intervention program composed of several aspects was designed as shown in Table 1.

Table 1 *Seven aspects of intervention program.*

Aspect	
1.	Cooperation with coach
2.	Diet regulation
3.	Adjust physical activity besides daily training
4.	Use "true" body weight indicator to record the gymnast's courage and encourage the gymnast
5.	Combat the gymnast's depressive condition
6.	Assessments and evaluations used as monitor to prevent the gymnast from "overtraining"
7.	Injury rehabilitation

Description of intervention program

1. Cooperation with coach

A very close communication was established between the program designers and the coach group following the method described by Anthanasios and colleagues (Anthanasios, 2005). They met couple of times a day to ensure the program designers had detailed information about the amount of daily training and daily activities, as well as the performance of the gymnast in order to calculate the daily energy consumption precisely (Cote, & Salmela, 1996; Carta et al, 1998; Chen, H., et al, 2009).

2. Diet plan adjustment (table 2)

To make a precise energy intake plan, a Personal Health Status Questionnaire* and a Daily Nutrient Intake Record * * were used (Bajerska, Jeszka, & Kostrzewa, 2003; Ziegler, P. J., 2005; Chen, H., et al, 2009; Antonio Paoli, et al, 2012).

Based on the actual needs for training and recovery, his consumption of 70% or even more food energy was from carbohydrate during the 4-month study period, the intake of carbohydrate referred from Foster-Powell and Brand-Miller(Foster-Powell, K. & Brand-Miller, J., 1955). The gymnast took low GI (Glycemic Index) food every 2-3 hours to keep an optimal body and mental condition. Following this way, the subject did not feel tired and hungry during the training class, and good recovery was made before the next day's training.

By comparison, his daily diet plan before the study period included 2 or 3 meals, which were rich in salt and fat, and about 70% of the food energy was consumed after the last training class in the late afternoon, which made him feel tired and hungry. As a result, it was hard for him to get a good recovery before the next day's training, which always put him in a bad mood.

3. Adjustment of non-training physical activities

To help him in weight loss, a number of physical activities such as pilates, yoga, dancing, and meditation, and meditation were added to the training program, as done by others ("Finally in control: 'as I became slimmer, my self-confidence grew, and I tried new activities like dancing, yoga, weight training and Pilates.'", 2003; La Forge, 2009). As suggested by a number of studies, such physical activities could consume calories additionally and effectively in support of weight control, improve the mood, and build self-confidence (Berger, Pargman, & Weinberg, 2002; Gallagher, Jakicic, Napolitano, & Marcus, 2006).

Table 2. *Difference in food and beverage intake between the original and interventional diet plans.*

	Original diet plan	*Interventional diet plan*
Carbohydrate intake (the percentage of total energy intake)	30%	70%
Protein intake (the percentage of total energy intake)	20%	20-23%
Fat intake (the percentage of total energy intake)	50%	10%
Beverage intake (ml)	1300-1700	3000-3500

4. Use "true" body weight indicator to record the gymnast's courage and encourage the athlete

It was found that there were so many athletes who did not fully understand the difference between body weight and body fat (P Klentrou, M Plyley, 2003; Weier, 1997), which also happened to the subject in the present study. For example, he was very stressed out when there was a change in his body weight. Therefore, the "true" body weight indicator was applied in the present study for recording athlete's courage and encourage the athlete, as we did previously (Chen, H., et al, 2009; Weier, 1997). With the aid of a dual-energy X-ray absorptiometry (DXA) (GE Lunar Prodigy DF+301772, GE Healthcare), the subject was able to understand the real meaning of body weight and body composition.

5. Solution to the gymnast's depressive condition

A desire for the championship, perfect body weight control, or successful rehabilitation means nothing but stress to the athlete (Chen, H., et al, 2009; Neoklis A. 2011). At the beginning of the study, the subject expressed his need for help in relieving stress caused by his depression and disappointment to his competition level.

Besides the non-training physical activities described above, the athlete underwent music therapy several times a week, since music therapy might soften depression symptoms (Saalfield, 2008). As suggested by Silverman and colleagues

(Coaches need to 'Walk the Talk.', 2009; Silverman, 2009), communicational psychological technique was also applied in this study to make the relationship between the coaches and the gymnast more friendly, both of them understood each other much more, and the atmosphere in the daily training was much more harmony.

6. *Assessments and evaluations used in preventing the gymnast from overtraining*

Quantitative analysis of EEG and statistical mapping technique were used in the system to show the central effects of a new compound concluded in his body-weight control system (response relationships or time/efficacy potential, brain bioavailability, effects on vigilance, etc.), as described by us and others (Chen, H., et al, 2009; Zhou, W., Chen, H., et al, 2010).

In addition to Encephalofluctuograph Technology (ET), other assessments and evaluations were used to prevent the athlete from ”over-trained” following the methods described by Berglund and Safstrom (1994). Since the training intensity is always very high and over-training might be triggered during the preparation for world level sports and competitive events (Halson, & Jeukendrup, 2004), such assessments and evaluations about his body and mental condition were necessary.

7. *Rehabilitation of injury*

Had been taking part in gymnastic training for more than 20 years, the subject suffered from meniscus strain and achilles tendinitis at the beginning of this study.

The rehabilitation protocols was designed based on the authors’ experience in injury rehabilitation (Chen, H., et al, 2009; Chen, H., et al, 2010; Chen, H., et al, 2011), as well as in training the top gymnasts in the world (Li, J., Chen, H., 2010). However, to admire the will of the Chinese Olympic Committee and Chinese national gymnastics Association, the rehabilitation protocol of the subject, who is still an active member of Chinese national gymnastics team, will be reported separately.

RESULTS

Table 3. *Body weight changes in following the program in these 4 months.*

	Jan. 30, 2012	June 01, 2012	Difference in the 4 months	Relative Change in %
Body weight (kg)	62.20	58.20	4.00	-6.87%
Body fat (gram)	5845	3515	2330	-66.3%

In 4 months this male athlete lost 4000 gram of body weight, among them 2330 gram was fat (Table.3). He achieved the optimal balance between body fitness and body weight for his intense training. He gained an optimal mental condition for the champion. His rehabilitation program would be carried out successfully in these 4 months. He achieved world class results in 2012 Olympic Games.

DISCUSSION

The Olympic Games are held every four years, it is impossible to have a group of Olympic medalists as the subjects in a study; therefore, any case report of Olympic medalist is valuable beyond all question. As we know, it is very important for the top level athletes to maintain ideal body weight and body composition. Such athletes, especially those who undergo rehabilitation of injury during the preparation period for the Olympic Games, always possess unique physical and psychological aspects. Accordingly, personalized program are designed for each individual elite athlete, which also make it impossible to conduct group study.

This case study reports a successful management of body weight of a 2012 Olympic medalist of male gymnastics, who suffered from injury and underwent rehabilitation during the preparation for the

2012 Olympic Games. As we know the gymnastic performance of the elite gymnasts is generally influenced by a number of physical factors such as body condition, body weight, and body composition, as well as many psychological factors such as self-confidence and motivation (Stark, & In, 1991), Apparently, a comprehensive program for body weight management is of significant importance in helping the gymnast to achieve optimal condition in the preparation for the games. Therefore, the following aspects should be included into such program.

1. *Lose fat as many as possible before the gymnastic competition in the Olympic Games.*

Weight loss means a life-term process for the world's top level gymnasts (P. Klentrou, M. Plyley, 2003). To lose fat as more as possible is very important to the elite gymnasts since even a couple of pounds of fat loss could be of help in improving their relative strength, speed and flexibility. There is an optimal point or named balance–point for each individual especially for the elite gymnasts, which is important for them to trace and keep. For example, if the bodyweight of a gymnast increases, the balance between his/her feelings for the instrument and his/her action, power, speed, agility, and flexibility, almost everything concerning performance, could be damaged (Ackland, Elliott, & Richards, 2003). By contrast, if the body weight is too low, the athlete might not have enough muscle to produce muscular strength for required power, speed, agility, flexibility and balance. Although such optimal situation is not easy to reach and maintain, many gymnasts are able to maintain this balance point through many years of practice. For example, the balance point for the subject in the present study is about 57 kilogram of the body weight with 6% of total body fat. Diet management (Schuit, 2006) is one key factor for reaching and maintaining the balance point, which is always influenced by character of the games, as well as the gymnasts' personal traits and individual life habits. Therefore, it is necessary for the gymnasts to have the basic knowledge in nutrition, which helps them to find out a proper way in balancing the body weight, injury prevention, enforcement of training program, and performance.

2. *Help the athlete to understand the real meaning of body weight and body composition.*

Many methods have been used to measure body weight and body composition (McCardle, Katch, & Katch, 1994). Weight scale can only measure the body weight without telling the body composition, and body mass index (BMI) may only provide information about body composition without determining the percent body fat (Houtkooper, Mullins, Going, Brown, & Lohman, 2001). As discussed early, the weight of body fat is critical to elite gymnast's performance, which is associated with the achievement and performance.

Previously the authors applied the bioelectric-impedance analysis for obtaining fat-free mass and body-cellular mass with a low-cost portable device. However, data measured by this device were not suitable for continuous analysis and comparison.

By contrast, dual-energy X-ray absorptiometry (DXA) is helpful in providing a "true" and "clear" indicator of body weight (Hetland, Haarbo, & Christiansen, 1998). Such indicator is easy for the athlete to understand the real meaning of body weight and body composition, it may help the athlete to trace in the training.

3. *Does "eating less" or "training more" or the combination of "eating less and training more" affect the body weight effectively?*

For a long time, the elite gymnasts have seriously expected the answers to such questions (Laquale, 2007), and dropping off excessive body fat is always their lofty goal (Paul J. A., et al, 2006). Unfortunately, so far the affirmative answers have not come into being. In fact, the optimal body weight for the competition is very personalized (Griffin,

1989), and it turns out that the combination of "eating less" and "training more" might be an effective strategy in the weight control (Bogdanis, & Tsetsoni, 1999).

4. Content of food.

The content of food is very important in building up the body (Rowlands, Thorp, Rossler, Graham, & Rockell, 2007). It provides energy for daily training and the maintenance of an ideal body weight. Michopoulou (2011) and Kawano (2002) suggested that the ingredient of food intake of the athletes could be varied before the Olympic Games, and Howarth and colleagues questioned if the protein content of food could be reduced (Howarth, Moreau, Phillips, & Gibala, 2009).

In our previous case study of a female gymnast (Chen, H., et al 2009), we recommended her not to take milk as well as food that is rich in milk protein. Consequently she lost several grams of muscle as result without influencing her performance in the competition. In the present study, we added zero energy soda in the menu as substitute for beverage that is rich in sugar. He also changed his diet habit during the study period and ate more rice and needle than before. Therefore, the switch of calorie source from beverage to rice and needle significantly contributed to a stable blood glucose level and a stable mood, which were beneficial to his performance in daily training. In the meanwhile, the new diet plan for the subject increased the intake of protein, which is of help in building up his body and injury rehabilitation.

5. When they eat less, what should be cut in the diet?

Michopoulou et al (2011) and Soric et al (2008) found that gymnasts were accustomed to higher carbohydrate intake; however, Paoli (2012) suggested that very low carbohydrate ketogenic diets (VLCKD) for a relatively short time period (i.e. 30 days) could decrease body weight and body fat without negative effects on strength performance in high level athletes. In fact, a suitable diet plan that matches the character of the training program would be a common choice for long term weight control (Gleeson, & Bishop, 2000). The method suggested by Stroescu and colleagues (Stroescu, Dragan, Simionescu, & Stroescu, 2001) was followed in the present study, and the subject increased his daily protein intake by drinking milk beverage and taking protein-rich foods. As result, he lost several pounds of fat (relative change: 66.3%) and was satisfied with the program and his achievement.

There remains significant concern about the influence of long term weight control in gymnast's condition and performance. Such influence was suggested to be associated with the contents of training. Results from the present study as well as our previous study demonstrated that long term weight control might not influence the condition and performance of the gymnasts since both of them achieved top class results in the Olympic Games.

Another concern is how to maintain muscle mass in the event of reducing calories (Guest, 2005). Although some reports about sedentary people are available, it remains a puzzle if the conditions of the sedentary people are similar to those of the gymnasts.

Perhaps cutting calories is more effective than increasing the amount of exercise in losing the excessive body fat (*200 best muscle building foods*, 2008).

CONCLUSION

In conclusion, results of the present study suggest that body weight control is an important issue for the elite gymnasts. Adjustment of food intake and energy balance is equally influenced by energy consumed. The balance between body condition and mental condition contribute to the optimal body weight and performance. Beyond body weight control, significant attention should be paid on the other factors which influence the performance of the gymnasts. The "true" indicator for the body weight control plays an important role in directing the gymnasts to understand the

optimal body weight and to reach the balance between body condition and body weight. Further study is needed to help the top gymnasts to better achieve their career goals.

REFERENCES

Ackland, T., Elliott, B., & Richards, J. (2003). Growth in body size affects rotational performance in women's gymnastics. *Sports Biomechanics*, 2(2), 163-176.

Anderson CM, Petrie TA, Neumann CS. (2011). Psychosocial correlates of bulimic symptoms among NCAA division-I female collegiate gymnasts and swimmers/divers. *J Sport Exerc Psychol.* 2011 Aug;33(4):483-505.

Anthanasios, L. (2005). Communicational problems in professional sports: the case of Greece. *Crawford, Scott, Applied Research in Coaching & Athletics*, 20, 154-163.

Antonio Paoli, Keith Grimaldi, Dominic D'Agostino, Lorenzo Cenci, Tatiana Moro, Antonino Bianco and Antonio Palma. (2012). Ketogenic diet does not affect strength performance in elite artistic gymnasts. *Journal of the International Society of Sports Nutrition*. 2012, 9:34.

Ardila, R. (2006). The experimental synthesis of behaviour. *International Journal of Psychology*, 41(6), 462.

Bajerska, J. J., Jeszka, J., & Kostrzewa, T. A. (2003). The evaluation of nutritional habits, nutritional status, energy expenditure connected with training load and energy balance of young football players. *Medycyna Sportowa*, 19(1), 16-21.

Barnes, K. J., Vogel, K. A., Beck, A. J., Schoenfeld, H. B., & Owen, S. V. (2008). Self-regulation strategies of children with emotional disturbance. *Physical & Occupational Therapy in Pediatrics*, 28(4), 369.

Berger, B. G., Pargman, D., & Weinberg, R. S. (2002). Exercise as a stress management technique: psychological and physiological effects. *Fitness Information Technology*, 123-135.

Berglund, B., & Safstrom, H. (1994). Psychological monitoring and modulation of training load of world-class canoeists. *Medicine & Science in Sports & Exercise*, 26(8), 1036-1040.

Bogdanis, G. C., & Tsetsoni, N. V. (1999). The role of nutrition and exercise in the control of body weight. *Exercise & Society Journal of Sport Science*, 21, 9-24.

Carta, I., Porru, A., Zucca, A. M., Corongiu, P., Padalino, G., & Piras, M. B. (1998). Some methods to evaluate the energy balance on physical activity. *Medicina dello Sport*, 51(3), 291-297.

Chen, H., et al (2009). A Case Study Of a Body Weight Control Programme for Elite Chinese Female Gymnasts in Preparation for the 2008 Olympic Games, *Science of Gymnastics Journal*, Vol.1, Issue 1: 15-20.

Chen, H., et al (2010). Research on therapy and training program of epiphysitis of ischial tuberosity of elite gymnastics, *Chinese Journal of Sports Medicine*, 2010, Vol. 29, No.6,710-713.

Chen, H., et al (2010). "Pronator teres Syndrome and Adaptation in Training : Conservative therapy in two high competitive athletes", *Medicina dello Sport*, Vol. 58, Issue 4:1-2.

Chen, H., et al (2011). "Navicular stress fracture and adaptation in Training: A case report concerning high competitive gymnastics", *Gazzetta Medica Italiana*, Vol. 170-N.2,141-146.

Coaches need to 'Walk the Talk.'. (2009, Mar). *International Gymnast*, 13.

Cote, J., & Salmela, J. H. (1996). The organizational tasks of high-performance gymnastic coaches. *Sport Psychologist*, 10(3), 247-260.

Cupisti A, D'Alessandro C, Castrogiovanni S, Barale A, Morelli E. (2000) Nutrition survey in elite rhythmic gymnasts. *J Sports Med Phys Fitness.* 2000 Dec; 40(4):350-5.

D'Alessandro C, Morelli E, Evangelisti I, Galetta F, Franzoni F, Lazzeri D, Piazza M, Cupisti A. (2007). Profiling the diet and body composition of subelite

adolescent rhythmic gymnasts. *Pediatr Exerc Sci*. 2007 May;19(2):215-27.

Dueck, C. A., Manore, M. M., & Matt, K. S. (1996). Role of energy balance in athletic menstrual dysfunction. *Int. J.Sport Nutr*, 6, 165-190.

Family: gymnasts will learn faster and better if coaches can create an environment of unconditional acceptance. (2009, Jun). *International Gymnast*, 13.

Filaire, E., Ferrand, C., Jouanel, P., Colombier, M., Begue, R. J., & Lac, G. (2002). Biological, hormonal, nutritional and psychological status of elite female gymnasts. *Science & Sports*, 17(1), 1-7.

Filaire E, Lac G. Nutritional status and body composition of juvenile elite female gymnasts. *J Sports Med Phys Fitness*. 2002 Mar;42(1):65-70.

Finally in control: "as I became slimmer, my self-confidence grew, and I tried new activities like dancing, yoga, weight training and Pilates.". (2003, Oct). *Shape*, 126.

Foster-Powell, K. & Brand-Miller, J. (1955). International tables of glycemic index. American Journal of Clinical Nutrition 62 (Suppl.), 871S-893S.

Gallagher, K. I., Jakicic, J. M., Napolitano, M. A., & Marcus, B. H. (2006). Psychosocial factors related to physical activity and weight loss in overweight women. *Medicine & Science in Sports & Exercise*, 38(5), 971-980.

Griffin, J. (1989). The weight: am I carrying too much, or too little? If I lose pounds, will I gain success? This is the magnificent obsession that pursues the athlete throughout his career. *Running Magazine (UK)*, (104), 52-54.

Guest, N. S. (2005). Gain muscle with hard work and mode total calories. *Fitness Business Canada*, 6(3), 44-45.

Gleeson, M., & Bishop, N. C. (2000). Elite athlete immunology: importance of nutrition. *International Journal of Sports Medicine*, 21(4), 44-50.

Halson, S. L., & Jeukendrup, A. E. (2004). Does overtraining exist? An analysis of overreaching and overtraining research. *Sports Medicine*, 34(14), 967-981.

Hetland, M. L., Haarbo, J., & Christiansen, C. (1998). Regional body composition determined by dual-energy x-ray absorptiometry: relation to training, sex hormones, and serum lipids in male long-distance runners. *Scandinavian Journal of Medicine & Science in Sports*, 8(2), 102-108.

Horswill, C.A., Hickner, R.C., Scott, J.R., Costill, D.L., & Gould, D. (1990). Weight loss, dietary carbohydrate modifications, and high intensity, physical performance. *Medicine & Science*, 22(4), 470-476.

Houtkooper, L.B., Mullins, V. A., Going, S. B., Brown, C. H., & Lohman, T. G. (2001). Body composition profiles of elite American heptathletes. *International Journal of Sport Nutrition & Exercise Metabolism*, 11(2), 162-173.

Howarth, K. R., Moreau, N. A., Phillips, S. M., & Gibala, M. J. (2009). Coingestion of protein with carbohydrate during recovery from endurance exercise stimulates skeletal muscle protein synthesis in humans. *Journal of Applied Physiology*, 106(4), 1394.

Jonnalagadda SS, Benardot D, Dill MN. (2000). Assessment of under-reporting of energy intake by elite female gymnast. *Int J Sport Nutr Exerc Metab.* 2000 Sep;10(3):315-25.

Kawano Y, Ishizaki S, Sasamoto S, Katoh Y, Kobayashi S. (2002). Effect of meals with milk on body iron stores and improvement of dietary habit during weight loss in female rhythmic gymnasts. *J Nutr Sci Vitaminol (Tokyo).* 2002 Oct;48(5):395-400.

La Forge, R. (2009). Mind-body research update. *IDEA Fitness Journal*, 6(6), 48.

Laquale, K. M. (2007). Energy in-energy out: a balanced equation? *Athletic Therapy Today*, 12(5), 34.

LI, J, Chen, H. (2010). The design and training on the highest difficulty routine of world champion in 2008 gymnastics world cup pommel horse final. *China Sport Science and Technology*, Vol. 46, No. 3, 87-90.

McCardle, W., Katch, F., & Katch, V. (1994). The composition of the human body. *In Essentials of Exercise Physiology*.

Michopoulou E, Avloniti A, Kambas A, Leontsini D, Michalopoulou M, Tournis S, Fatouros IG. (2011). Elite premenarcheal rhythmic gymnasts demonstrate energy and dietary intake deficiencies during periods of intense training. *Pediatr Exerc Sci.*, 2011, Nov;23(4):560-72.

Music therapy might soften depression symptoms. (2008, Mar). *Journal on Active Aging*, 22.

Neoklis A., et al. (2011). Abolished circadian rhythm of salivary cortisol in elite artistic gymnasts. Steroids. 76 (2011) 353–357.

Nora Klinkowski, Alexander Korte, Ernst Pfeiffer, Ulrike Lehmkuhl, Harriet Salbach-Andrae. (2008). Psychopathology in elite rhythmic gymnasts and anorexia nervosa patients. *Eur Child Adolesc Psychiatry*. (2008). 17:108–113.

Paul J. A., Christopher L. G., Roger M-P, Michael, J. O., Meghan E., Lauren Z., et al. (2006). Increased dietary protein and combined high intensity aerobic and resistance exercise improves body fat distribution and cardiovascular risk factors. *International Journal of Sport Nutrition & Exercise Metabolism*, 16(4), 373-392.

Pensgard, A. M. (1997). Motivation and coping with stress in Olympic and Paralympic athletes. *Oslo, Norway: Norges idrettshogskole*.

P. Klentrou, M. Plyley (2003). Onset of puberty, menstrual frequency, and body fat in elite rhythmic gymnasts compared with normal controls. *Br J Sports Med*. 2003; 37:490–494.

Rowlands, D. S., Thorp, R. M., Rossler, K., Graham, D. F., & Rockell, M. J. (2007). Effect of protein-rich feeding on recovery after intense exercise. *International Journal of Sport Nutrition & Exercise Metabolism*, 17(6), 521.

Rushall, B. S. (1989). Sport psychology: the key to sporting excellence. *International Journal of Sport Psychology*, 20(3), 165-190.

Saalfield, A. G. (2008). Finding rhythm in rehabilitation. *Athletic Therapy Today*, 13(6), 13.

Schuit, A. J. (2006). Physical activity, body composition and healthy aging. *Science & Sports*, 21(4), 209-213.

Silverman, R. J. A. (2009). Competitive gymnasts: 10 ways to keep the peace between friends in competition. *Technique*, 29(1), 6.

Soric M, Misigoj-Durakovic M, Pedisic Z. (2008). Dietary intake and body composition of prepubescent female aesthetic athletes. *Int J Sport Nutr Exerc Metab*. 2008 Jun;18(3):343-54.

Stark, C., & In, T. G. (1991). Development of physical characteristics as a precondition for achieving high sports results in gymnastics (apparatus). *Coach education: proceedings of the Maccabiah-Wingate International Congress, (Netanya), The Emmanuel Gill Publishing House: Wingate Institute for Physical Education and Sport*, 155-157.

Stover, E. A., Petrie, H. J., Passe, D., Horswill, C. A., Murray, B., & Wildman, R. (2006). Urine specific gravity in exercisers prior to physical training. *Applied Physiology, Nutrition & Metabolism*, 31(3), 320-327.

Stroescu, V., Dragan, I., Simionescu, L., & Stroescu, O.V. (2001). Hormonal and metabolic response in elite female gymnasts undergoing strenuous training and supplementation with SUPRO brand isolated soy protein. *Journal of Sports Medicine & Physical Fitness*, 41(1), 89-94.

200 best muscle building foods. (2008, Apr.). *Joe Weider's Muscle & Fitne*ss, 116-119.

Wegner, M. (2000). Psychologie, sport and behinderung: theorien-konzepte-erfahrungen. *Psychologie and Sport*, 7(4), 124-140.

Weier, K. L. (1997). The relationship between perceived body image and percent body fat among female college students. *Eugene, Ore:Microform Publications, Int'l Inst for Sport & Human Performance, University of Oregon*.

Zhou, W, Chen, H., et al (2010). Research on the EEG of elite shooting athletes, *Chinese Journal of Sports Medicine*, 2010, Vol. 29, No.2, 197-203.

Ziegler, P. J., Nelson, J. A., Tay, C., Bruemmer, B., & Drewnowski, A. (2005). A comparison of three methods of determination of energy density of elite figure skaters. *International Journal of Sport Nutrition & Exercise Metabolism*, 15(5), 537.

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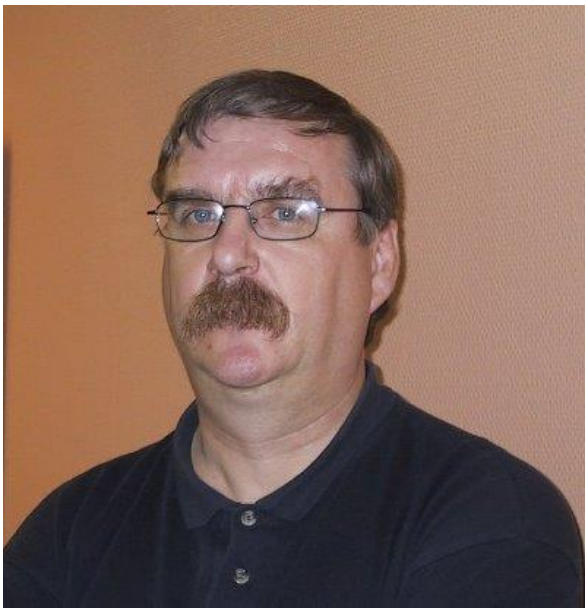
In Memory of Mikko Pehkonen



Doctor of Physical Education Mikko Timo Ensio Pehkonen passed away on 26 January 2013 in the age of 60 years and 16 days, having suffered from a difficult illness. As numerous friends of Mikko said many times at the memorial service, he was a humane, humorous, wise, and sensitive person. As one of his British colleagues wrote: *Mikko was a lovely friend and amazing teacher*.

For most of his career, Dr. Pehkonen worked as a Senior Lecturer in Physical Education at the University of Lapland, Rovaniemi, Finland. He has been described by his colleagues as a thought-evoking character, who worked tactfully with students and had a great respect for nature. Mikko enjoyed the great outdoors of Lapland by canoeing, skiing, and hiking together with his family, students, and friends. Toward the end of his university career, he focused more and more on nature sports from the viewpoint of accessibility as well as nature tourism. In addition to his responsibilities as a Lecturer in Physical Education, Mikko took care of numerous tasks in the Faculty of Education and the University of Lapland. He was e.g. a reliable member of the University Board and the Faculty Council.

Artistic gymnastics was especially important for Mikko. He was known as a top-level gymnast, who developed the pedagogy of gymnastics, inspired the young, coached with enthusiasm, and was one of the founding members of the gymnastics club Taipumattomat in Rovaniemi. For years, Mikko gave a dedicated contribution to Finnish gymnastics organisations. Furthermore, he worked as an international gymnastics assessor since 1981 and was a member in the Editorial and Scientific Board of the Science of Gymnastics Journal.

After obtaining his Bachelor's degree in Physical Education in 1976, Mikko continued his studies and earned his Master’s degree in Physical Education in 1977 and his Licentiate degree in 1982. He obtained his Doctoral degree in Education in 1981. In 2000, he became a Doctor of Physical Education at the University of Jyväskylä; the topic of his Doctoral thesis is *Learning and teaching motoric skills: gymnastics and physical education in comprehensive schools*. Thereafter, Mikko participated in many extensive cross-sectional and longitudinal studies on Physical Education in Finland. The latest study that he participated in began in the 1980s, and it discussed the effects of Physical Education in schools. As a researcher, Mikko collected data independently and with care, wrote scientific articles on gymnastics and served as a peer reviewer of scientific articles as well. Mikko supervised dozens of Master’s theses and took part in supervising Licentiate and Doctoral theses.

Mikko, who humbly did not very much bring out his other interests, wrote poetry, and was also interested in profound thinking and photography. Mikko, a valued pedagogue, a great humanist, and a distinguished promoter of gymnastics will be missed by his numerous friends in Finland and other countries.

Heimo Nupponen and Seppo Penttinen
Colleagues and fellow researchers of Mikko Pehkonen

Slovenski izvlečki / Slovene Abstracts

Roman Farana, Daniel Jandacka in Irwin Gareth

VPLIV RAZLIČNIH POLOŽAJEV DLANI NA IMPULZ SILE IN OBREMENITEV KOMOLCA PRI PREMETU VSTRAN Z OBRATOM NAZAJ: ŠTUDIJ PRIMERA

Premet vstran z obratom nazaj je osnovna telovadna prvina in ključna prvina v razvoju vrhunske ženske telovadbe. Cilj raziskave je bil ugotoviti ali različne postavitve dlani različno vplivajo na silo podlage in navore v komolcu pri ženskah. Ena telovadka mednarodnega nivoja iz Češke republike je sodelovala pri raziskavi. Dve pritisni plošči sta bili uporabljeni za določitev sile na podlago. Osem infrardečih kamer je bilo uporabljenih za pridobitev kinematičnih podatkov. Telovadka je izvedla 10 poskusov premeta vstran z obratom nazaj z vzporedno postavitvijo dlani in 10 poskusov s pravokotno postavitvijo dlani. Statistična analiza je pokazala da je pri pravokotna postavitvi dlani pri drugi roki manjša navpična in vodoravna sila na podlago. Razlike v navorih v komolcu in v kinematičnih značilnostih kažejo, da morda lahko pravokotna postavitev dlani varuje komolec in zmanjšuje možnost poškodovanja.

Ključne besede: biomehanika, telovadba, premet vstran z obratom nazaj, roka, preventive.

Oya Erkut Atilgan

VPLIV VADBE NA VELIKI PROŽNI PONJAVI NA SKOČNO MOČ TER STATIČNO IN DINAMIČNO RAVNOTEŽJE DEČKOV

Namen študije je bil ugotoviti vpliv 12-tedenske vadbe na veliki prožni ponjavi (VPP) na skočno moč in statično in dinamično ravnotežje pri dečkih, ki niso v procesu treninga. Od 28 dečkov starih 9-10 let je bilo 15 dečkov v poskusni skupini in 13 v kontrolni skupini. Kontrolna skupina je imela 12 tedenski program vadbe, medtem ko kontrolna skupina ni imela nobene športne vadbe. Rezultati so pokazali razlike med pred in po programu v sonožnem statičnem ravnotežju, navpičnem odrivu, dinamičnem ravnotežju pri poskusni skupini, medtem ko se enonožno statično ravnotežje in moč nog nista spremenili. Pri kontrolni skupini med pred in po poskusu ni bilo nobenih sprememb. Vadba na prožni ponjavi je odlično sredstvo za razvoj gibalnih sposobnosti.

Ključne besede: velika prožna ponjava, ravnotežje, mišična sila in moč, dečki.

Hannah Clowes, Zoe Knowles

RAZISKOVANJE USPEŠNOSTI PREDTEKMOVALNIH POSTOPKOV PRI VRHUNSKIH TELOVADKAH: MEŠANA METODA RAZISKOVANJA

Tekmovalni šport na najvišji ravni zahteva doslednost, natančnost in prenos spretnosti v različnih okoljih v večkratnih ponovitvah s ciljem vedno izvesti optimalni nastop (Singer, 2002). Predtekmovalni postopki (PPR) so zaporedje gibalnih, čustvenih in razumskih oblik vedenja izvedenih tik pred tekmovalnim nastopom (Cohn, 1990). Namen študije je bil ugotoviti vsebino in obseg PPR med različnimi orodji ženske športne gimnastike. Vzorec telovadk je bil namensko izbran iz bivših vrhunskih telovadk Velike Britanije (n=9). Uporabljena je bila mešana fazna metoda. Vse telovadke so v prvi fazi izpolnile vprašalnik Nastopnih strategij (TOPS; Thomas et al., 1999). Iz opisne statistike vprašalnika je bilo določenih pet profilov za nadaljnjo kvalitativno obdelavo in uporabo uspešnosti PPR preko polstrukturiranih intervjujev. Primerjani so bili načini priprave na posamezno orodje. Rezultati kažejo na različne PPR priprave na preskok in gred glede na kontrolo vzburjenosti/aktivacije in razumsko vadbo. Telovadke so poročale o posebnih in natančno določenih postopkih, ki vsebujejo predvsem podobe izvedbe in kontrolo vzburjenosti in aktivacije. Posebne PPR strategije so potrebne za vsako orodje, v skladu s trenutno pripravljenostjo.

Ključne besede: vrhunske telovadke, predstave, psihološka priprava.

Jerneja Fišer Kurnik, Tanja Kajtna, Klemen Bedenik, Marjeta Kovač

ZAKAJ STARŠI VPISUJEJO OTROKE K TELOVADBI OB PRIČETKU ŠOLANJA

Namen raziskave je bil ugotoviti motive staršev, ki vpisujejo otroke v rekreativno telovadbo v osnovni šoli ob vstopu v šolo v šolskem letu 2007/2008. V raziskavo je bilo vključenih 386 staršev, ki so odgovarjali na vprašalnik pripravljen prav za to raziskavo. Izračunana je bila opisna statistika in ugotavljanje razlike v motive staršev glede na spol, starost, izobrazbeno strukturo in spol otroka. Najpomembnejši razlog je "šport vpliva na zdravje mojega otroka". Glede na spol staršev so razlike majhne, struktura motivov pa je različna glede na starost staršev, njihovo izobrazbo in spol otroka. Najpomembnejše motive za telovadbo bi morali upoštevati organizatorji telovadbe v šolskem okolju, se pravi poudariti zdravje otroka ob upoštevanju veselja do pametno uporabljenega prostega časa.

Ključne besede: zunaj kurikularni program, rekreativna telovadba, prvo triletje, motive starši.

Trevor Dowdell

CILJI IN MOTIVACIJSKA KLIMA V OKOLJU TEKMOVALNE TELOVADBE

Raziskava je del preliminarnega raziskovanja motivacijske klime v tekmovalnih telovadnih društvih. Motivacijska klima je določena kot relativno trajajoča skupinska zaznava strukture ciljev. Osemindvajset dečkov in sto osemdeset deklic tekmovalne telovadbe iz šestih mestnih društev in štirih regijskih v Queenslandu, Australia je bilo izprašanih z vprašalnikom Lestvica športne klime v društvu (SCES). Analiza variance je bila uporabljena, da bi ugotovili ali se razlikujejo po vrsti kluba, spolu in tekmovalnem nivoju. Nizko število ur vadbe in visoko število ur vadbe značilno določata oceno lastne vključenosti v motivacijsko klimo ($p<0.01$); pri tem se moški razlikujejo od žensk ($p<0.01$) še pripadnosti ($p<0.01$), naporu, in organiziranosti ($p<0.01$). Ta študija kaže na pomembnost motivacijske klime v smislu doseganja nalog in primerjalnih pristojnosti za tekmovalna društva. Motivacijsko klimo je lažje upravljati kot posameznikove lastne cilje, zato jo morajo trenerji poznati, opisovati, razvijati in upravljati.

Ključne besede: cilji, motivacijska klima, tekmovalna telovadba.

George Dallas, Paschalis Kirialanis

VPLIV DVEH VRST VIBRACIJ CELEGA TELESA NA GIBLJIVOST IN SKOČNOST PRI VRHUNSKIH TELOVADCIH

Namen študije je bil preučiti vpliv različnih načino vibriranja celega telesa (WBV) na gibljivost in odrivno moč telovadcev. Sodelovalo je dvanajst vrhunskih telovadcev. Pri poskusu sta bila uporabljena dva postopka in sicer WBV s statičnim raztezanjem (WBVSS) ter samo WBV. Meritve gibljivosti in skočne moči so bile izvedene pred (Pre), takoj po vibriranju (Post 1), 15 minut po (Post 15) in 30 minut po vibriranju (Post 30). Za analizo podatkov je bila uporabljena dvosmerna ANOVA (pogoji * poskusi) za ponavljajoče poskuse na obeh dejavnikih. s ponavljajočimi ukrepov na obeh dejavnikov je bila uporabljena.Stopnja pomembnosti je bila določena na $p <0,05$. Za Post hoc test je bila izbrana metoda Bonferonija (0,05 / 6). Rezultati so pokazali, da ni interakcije med pogoji in preskušanji v vseh obravnavanih spremenljivk ($p> 0,05$). Vendar pa je bila pomembna razlika, ugotovljena pri gibljivosti med pred in po 1. meritve ($p = 0,002$). Po samo WBV je bil odstotek izboljšanja večji pri spremenljivkah moči kot pri WBVSS. Obe vrsti vibriranja (WBVSS in WBV) imata učinek na merjene gibalne sposobnosti.

Ključne besede: vibracije, gibljivost, mišična moč, raztezanje, gimnastika

Haitao CHEN, Shu LIU, Mei. WANG, Yubin HUANG, Shuqing CUI, Weiai ZHOU

ŠTUDIJ PRIMERA: URAVNAVANJE TELESNE TEŽE PRI VRHUNSKEM TELOVADCU

V prvi številki revije Science of Gymnastics Journal leta 2009 so avtorji poročali o uspešnem programu zmanjšanja telesne teže pri vrhunski telovadki v sklopu priprav na OI v Pekingu leta 2008. Kot je doslej znano, je uspešno zmanjševati telesno težo zelo težko sleherniku, prav tako pa tudi vrhunskim športnikom, še posebej v zaključnih pripravah na olimpijske igre. Kadarkoli mora vrhunski športnik izgubiti nekaj telesne teže, se pojavijo določeni problemi. V procesu pridobivanja in izgubljanja telesne teže je osnovni problem, kako naj športnik ohrani svojo tekmovalno in telesno pripravljenost na optimalnem nivoju. Kako naj nadzira obseg in intenzivnost dnevne vadbe, saj je to predpogoj za izboljšanje njihovih spretnosti in uspešne izvedbe prvin. Na osnovi zahtev višjega nivoja tekmovalne pripravljenosti za uspešen nastop v svetovnem vrhu ,je potrebno raziskati vedno več podrobnosti vadbe in jih tudi analizirati in zapisati. To poročilo je narejeno kot primer uspešnega dietetičnega program za vrhunskega kitajskega telovadca na OI 2012 v Londonu, ki se je boril tudi s poškodbami pred samimi igrami.

Ključne besede: upravljanje telesne teže, olimpijske igre, vrhunska gimnastika, moški