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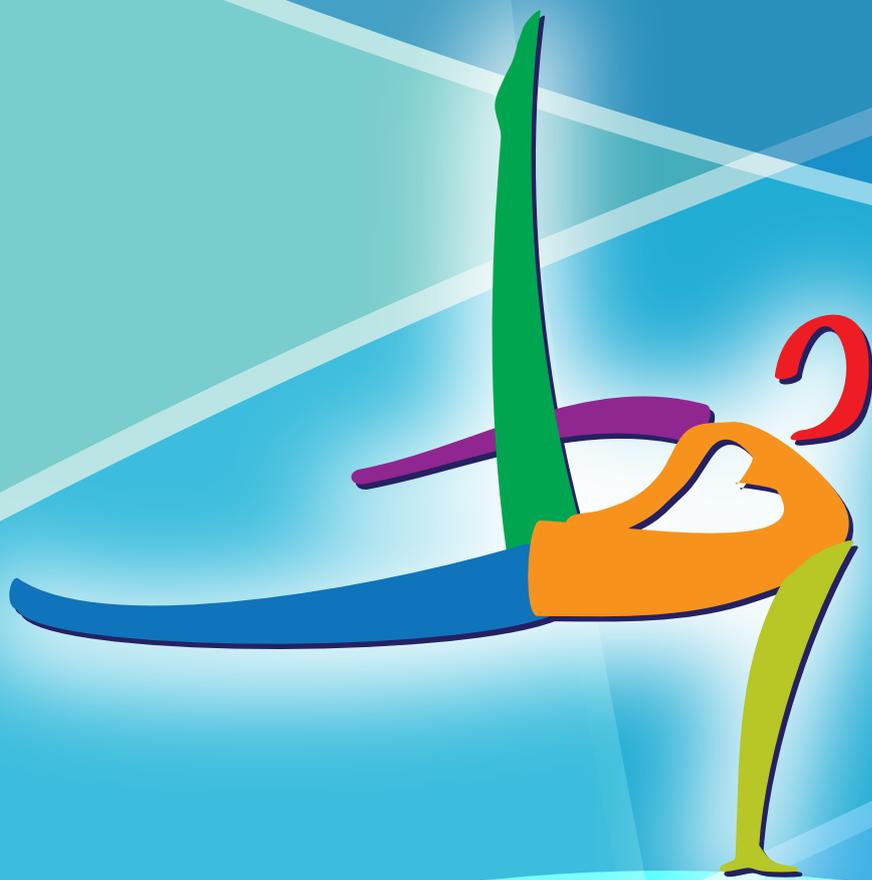
Science of Gymnastics Journal (ScGYM®)

Science of Gymnastics Journal (ScGYM®) 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.

CONTENTS

EDITORIAL

Dear friends,

our activity since the last issue was aimed into adding our journal to international databases. So far we have succeeded to get indexed in OPEN-J GATE, GET CITED, ELECTRONIC JOURNAL INDEX, SCIRUS, NEW JOUR, INDEX COPERNICUS and GOOGLE SCHOLAR. In year 2013 we will be evaluated by Thomson Reuters for entering into science citation index and to calculate journal impact factor, which is one of our important goals. We hope that our articles will be continuously bringing new ideas and knowledge and bring enough impact to be cited in the other articles. The last issue of Journal was visited by more than 6500 visitors, what gives us a true compliment for our endeavor. Recently opened forum for visitors to express their views has not started its true life yet. Perhaps it was set too complicated to join the forum. However we would like very much to get the feedback from you, so you are invited again to send us e-mails to our address scgym@fsp.uni-lj.si. Let us know what you think about this forum and also do not hesitate to send any other comments, suggestions or ideas. We are also preparing a new system for managing articles which should get launched by the end of this year. It is based on the ScholarOne Manuscripts application. With it the authors, reviewers and editors will be able to use the new system with much improvement in the ease of management of articles.

In June (17 - 19th) FIG organizes MAG, WAG and TRAMPOLINE symposium on the Code of Points. We aim to publish the article about what was going on in Zürich (SUI). Also, if you are organizing scientific symposium with gymnastics topics, let us know as we are very much willing to publish the information about your work on the World Wide Web.

The June issue of the Journal starts with the article on thermography. William A Sands, Jenni R McNeal and Michael H Stone from USA restored importance of the thermograhy in diagnosis of the injuries since some other diagnostic means did not show the injuries. It is interesting to see that thermography went through phases of development, with a huge gap in use (and published works) for about twenty years. Therefore in high performance sport thermography can be an important additional tool in detection and defining the causes of pain and injury. The second article from Trevor Dowdell, Australia, is also dealing with medical topics. One of the main questions that often bother us is of course how dangerous gymnastics as a sport is? The FIG's effort to promote safe gymnastics (FIG Academy, FIG Sympossium on safe gymnastics) is well known, however only few articles so far really provided a comparison to other sports. The results reported are favorable for gymnastics, as they clearly show that it is not a more dangerous sport when compared to others, but still we have to be focused on proper methodology and safety issues in gyms. One injury is already too much.

The third article comes from Greece. Olivia Donti, Kalliopi Theodorakou, Spiros Kambiotis and Anstasia Donti studied how some social characteristics from parents determine self esteem in children who are involved in non competitive gymnastics. Mothers are the key factor in child's self esteem and it seems that we should be focusing on mothers when promoting gymnastics.

The last two articles cover Code of Points topics. The fourth one is written by Sunčica Delaš Kalinski, Ana Božanić (both Croatia) and Almir Atiković (Bosnia and Herzegovina) and analyses how dance elements influence balance beam scores. It is found that high difficulty dance elements are a very good predictor of the difficulty value and final score. It looks that a new (old) task for coaches and gymnasts is discovered, if they want to step on award podium. The last article is from Slovene and Australian authors. Maja Bučar Pajek, Warwick Forbes, Jernej Pajek, Bojan Leskošek and myself were determining the reliability and validity of the Real Time Judging System developed by Australian Institute of Sport in collaboration with Faculty of Sport in Ljubljana. The system showed promising results and has already been tested during the European Championship in Berlin in April this year.

I wish you a pleasant reading and a lot of inspiration,

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Ivan Čuk
Editor-in-Chief

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THERMAL IMAGING AND GYMNASTICS INJURIES:
A MEANS OF SCREENING AND INJURY IDENTIFICATION

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Abstract

Gymnasts have a relatively high injury rate and severity with highly qualified gymnasts suffering the most. One of the common injuries in gymnastics is the overuse-type that often remains latent until near the decisive moments of competition when the injury rises to the level of incapacitation. Is there a technology and methodology available to monitor gymnasts during development that can identify latent injuries and thus alert medical personnel to potential performance-limiting problems at the earliest possible time? Imaging consists of the use of a thermal camera to identify inflamed areas and asymmetric temperature patterns. Thermal asymmetries are determined via thermal image and pain is assessed with palpation, history, and subject identification. Video recordings are made of the involved areas and recorded electronically for transfer to physicians, physical therapists, and athletic trainers for further investigation and remediation. This is an ongoing descriptive study of the use of thermal imaging on inflammation and injury in gymnasts. Thermal differentiation of tissue areas is performed by visual inspection and bilateral comparison of the thermal images. Thermal images show bilateral and tissue area thermal differentials by differences in gray scale. This information discriminates injuries, inflammation, and other conditions without invasive procedures. The ability to identify and thus treat injuries while they are minor is a significant improvement over waiting until the injuries become increasingly symptomatic and performance-limiting. Thermal imaging has become a mainstay of our laboratory in assisting young athletes in remaining injury free, making return-to-activity decisions, and collaborating with medical personnel to identify, prevent and treat injuries and other conditions.

Keywords: gymnastics, injuries, thermal imaging.

INTRODUCTION

The history of modern science over the last 200 years has largely been the development of technologies that help people "see better." Microscopes, telescopes, x-ray, magnetic resonance imaging, computerized tomography, positron emission tomography, high-speed film and video, tiny video cameras that can provide the athlete's point of view, radar, electrocardiography, electromyography, and countless others have been responsible for a great deal of the progress of science and medicine. One of the technologies that has been used in a variety of scientific and medical settings, but appears to be relatively unknown in gymnastics, is thermography or thermal imaging. Gymnastics, with its high injury incidence and rate (Steele & White,

1986; Sands, Newman, Harner, Paulos & Shultz, 1987; Caine, Cochrane, Caine & Zemper, 1989; Sands, Shultz & Newman, 1993; De Smet, Claessens, Lefevre & Beunen, 1994; Modlesky, Nichols-Richardson, Massoni, Laing, & Lewis, 2000; Sands, 2000; Chan, Aldridge, Maffulli & Davies, 1991; Hall, 1986) is a ripe area for the application of thermography to detect and characterize inflammation and pain syndromes (Curwin, 1990; Curl, 1990; Hargreaves, 1990; Friedlaender, Jokl & Horowitz, 1990).

Thermal imaging relies on the detection of a small segment of the electromagnetic spectrum below visible light (i.e., infrared). All objects with a temperature above zero degrees Kelvin (absolute zero) emit thermal radiation. Passive thermography consists of using a special camera that is sensitive to the mid (3-5 µm) and long (7-14 µm) infrared bands of the electromagnetic spectrum. These cameras employ an algorithm that converts the invisible infrared light to visible light for display on a viewer, recorded as an image or video, and/or displayed on a computer. Infrared thermography for injury detection relies on the thermal contrast between areas of skin lying above and near the injury and the surrounding tissues. Soft-tissue trauma can easily be detected by thermographic imaging. After a soft-tissue injury, the vascular and metabolic systems change the rate and distribution of heat in the affected areas. This changes the 'normal' surface temperature distribution and makes any tissue thermal differences visible in infrared (Walsh & Helzer-Julin, 1990).

The measurements are highly sensitive to thermal differentials. Healthy people exhibit symmetric thermal patterns (Goodman, Heaslet, Pagliano & Rubin, 1985). Reearch has shown that an assymmetry of 1° C is abnormal (Walsh & Helzer-Julin, 1990). Detecting an already inflamed area may provide substantial additional feedback to medical, scientific, and coaching personnel as to exactly where

the injured area is, and the extent of damaged tissue. From experience, athletes often wait weeks or months before seeing a physician and thereby lengthen the duration of rehabilitation (Goodman et al. 1985). Athletes often cannot pinpoint the location of all injured areas due to a perceptual bias toward the area that hurts the most. If a regular thermal screening of sensitive areas was used, the athlete may be steered to medical remediation sooner than is now typical.

Thermal imaging in the detection and treatment of injury relies on the underlying physiology of temperature differentials. Usually, dermal temperature differentials do not exceed 0.25° C., while differentials in excess of 0.65° C are consistently associated with pathology (BenEliyahu, 1997). Detection of increased or decreased dermal temperature differentials can be indicative of injury. If there is sympathetic or unmyelinated nerve involvement there will be an increase in catecholamines in the area and a vasospastic effect will occur within the local microcirculation resulting in decreased local perfusion and a colder area. Hypersensitization of alpha receptors can also result in a decreased local dermal area temperature due to denervation. Increased dermal temperatures are usually observed with acute injury due to increased vasodilatory effects and increased inflammatory mediators raising metabolism and blood flow (BenEliyahu, 1997; Curl, 1990; Leadbetter, 1990b; Curl, 1990; Leadbetter, 1990a). A French study of 200 ankle sprain patients showed that bilateral isothermia indicated a minor injury that resolved in 1 to 2 weeks. Hyperthermia showed thermal differentials unilaterally of from 1.0° to 4.0° C between the hot "injured" area and surrounding tissues. When thermal asymmetry between the ankle sprain and uninvolved ankle ranged from 1.5° to 2.0° C recovery extended to approximately four weeks (Schmitt & Guillot, 1984). Pochachevsky showed hypothermic asymmetry in ankle injuries that has been termed posttraumatic reflex

sympathetic dystrophy or posttraumatic pain syndrome (Pochaczevsky, 1987). The mechanism underlying this syndromes may be efferent vasoconstriction due to afferent C-nociception from damage to the joint and surrounding structures (Pochaczevsky, 1987).

The purpose of our ongoing investigations and application of thermal imaging is to provide helpful feedback to coaches, athletes, scientists, physicians, physical therapists, and athletic trainers in preventing, assessing, and determining return to activity in athletes and others. We believe that thermography is an essential aspect for athlete screening, injury identification, and monitoring injury recovery. As such, thermography is an underutilized technology that may help gymnasts prevent injury via early recognition and early entrance into the medical system (Holst, 2000).

METHODS

Standard conditions are important for image collection, and areas that show asymmetrical thermal patterns should be palpated to determine if pain is present and a detailed history of the local area and potential injury and/or irritation documented (Holst, 2000). This ongoing study was approved by the Human Subjects Research Committee of Mesa State College under exemption 45 CFR 46, analysis of archived data.

Equipment: The thermal camera is a Raytheon 250D with a 77mm lens (Raytheon Inc. Waltham, MA USA). The camera is an un-cooled ferroelectric-type and sensitive to the infrared spectrum from 7 to 14 µm. The camera provides video output in NTSC format with a resolution of 320 x 240 pixels grayscale, and is mounted on a tripod approximately 5 meters from the subject. The camera is then manually adjusted for focus, gain, and contrast levels to obtain the clearest image of the tissue area of interest.

The room is maintained at a comfortable temperature of approximately 20° C varying less than 1° C throughout the imaging process. Images are captured via digital video recorder and archived for further analysis and comparison. Images are collected for a minimum of 10 s per area of interest. Computer analysis and viewing is performed on the resulting digital video recording.

Procedures: An athlete presents for screening and/or injury evaluation in the imaging area for approximately 15 min prior to imaging. The athletes are dressed in shorts or shorts and sports bra. The 15 min pre-imaging period provides thermal acclimation to surroundings. Pressure on tissue areas of interest is avoided by remaining standing or seated based on whether the soles of the feet are of interest. Following the acclimation period, the athlete is placed in position for imaging and the athlete's area(s) of interest are captured and stored as digital video. Each area that shows a thermal asymmetry is also palpated to determine the presence and extent of pain. In addition, any history of injury or irritation of the tissue area is documented.

Following imaging and recording, a report and a copy of the images are provided to medical personnel and the subject. Areas of pain and inflammation are noted along with ratings of pain.

Analysis: Analysis is based on visual inspection, palpation, and training and/or injury history. The camera is set so that whiter images are warmer than darker images. Areas of thermal asymmetry are palpated, recorded, and documented. This presentation shows four thermographic images of athletes with thermal asymmetries and areas of obvious inflammation.

RESULTS

Figures 1 through 4 show athletes with thermal irregularities. In three of the cases the athletes reported pain on palpation of the

hotter area (Figures 1-3). In the fourth case (Figure 4), the athlete's initial imaging was secondary to complaints of an inability to dorsiflex the foot when fatigued. The imaging then led to surface electromyography showing bilateral asymmetries of peroneal muscle activation and finally to a nerve conduction velocity test that showed a malfunctioning peroneal nerve. The fourth athlete underwent surgery to relieve nerve entrapment and following this returned to full function. In all cases, the athletes were referred to the laboratory for thermal imaging, and then athletes were sent back to their physicians for further follow-up on their conditions.
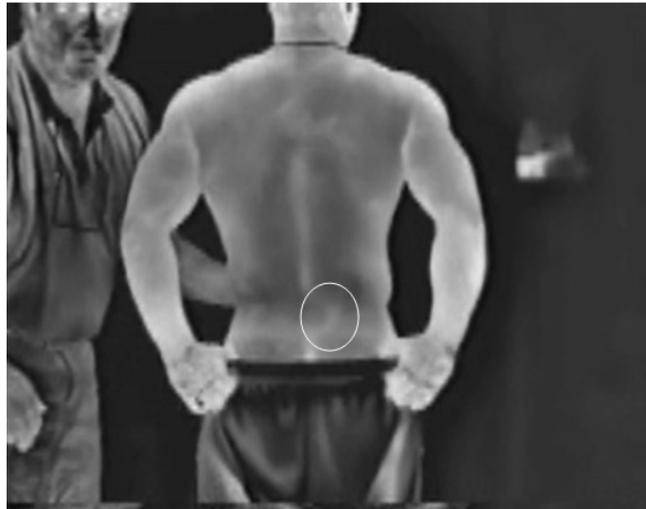
Figure 1. *Male athlete with lower back pain. Note the warmer (lighter) area on the right side of his lumbar spine and sacrum*

Figure 2. *Female athlete with dramatically inflamed areas bilaterally and superior to her sacroiliac joints.*

Figure 3. *Female athlete with an area of knee pain.*
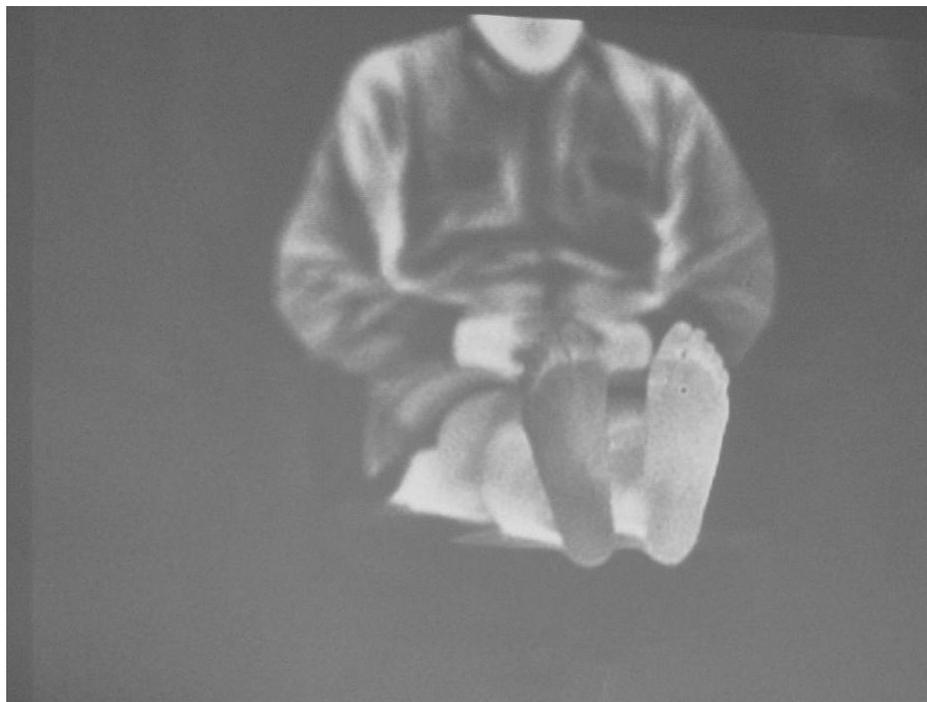
Figure 4. *Athlete showing a cold (darker) right foot. The colder foot was later shown to be caused by a nerve entrapment.*

DICSUSION

In all cases shown above, the athletes suffered for months before seeking medical help. For example, the fourth athlete case suffered from the condition despite typical therapies for over a year prior to being referred to the laboratory for thermography. The thermography check indicated that she was not malingering (Rotella, Ogilvie & Perrin, 1993; Mendelson & Mendelson, 2004) and that the thermal asymmetry was dramatic enough to merit further medical investigation. Previous efforts such as x-ray and magnetic resonance imaging of the foot and lower shank had resulted in no diagnosis.   These diagnostic imaging techniques were concentrating on the athlete's foot and lower shank thereby missing the cyst lying more superior. The

thermography, while not definitive, was the tipping point for further investigations and this ultimately led to resolution of her problem.

Modern literature has continued to reflect a relatively scant use of thermography in the detection and screening of injury in sport, particularly gymnastics, while thermography remains one of the least expensive utterly non-invasive methods of gaining insight into pain (Goodman et al., 1985; Gratt, Sickles & Wexler, 1993; Gratt, Sickles, Ross, Wexler & Gornbein, 1994; Graff-Radford, Ketelaer & Solberg, 1995; Huygen, Niehof, Klein & Zijlstra, 2004; Di Benedetto, Huston, Sharp & Jones, 1996; Friedman, 1994; Park, Hyun & Seo, 2007), reflex sympathetic dystrophy (Ben-Eliyahu, 1992; Friedman, 1994; Aybar, 1993; Jones, Ring & Clark, 1988; Karstetter & Sherman, 1991; Bruehl, Lubenow, Nath & Ivankovich, 1996; Sherman, Karstetter, Damiano & Evans, 1994), and complex regional pain syndromes (Niehof, Huygen, Stronks, Klein & Zilstra, 2007; Niehof, Huygen, van der Weerd, Westra & Zijlstra, 2006; Di Benedetto et al., 1996; Friedman, 1994; Awerbuch, 1991). Themography in sport has continued with studies involving stress fractures (Goodman et al., 1985; Devereaux, Parr, Lachmann, Page-Thomas & Hazleman, 1984)and arthritic and impingement conditions (Paterson et al., 1978; Denoble, Hall, Pieper & Kraus, 2010; Park et al., 2007).

Gymnastics training involves a great deal of exposure to potential injury (Sands, 2000). Moreover, gymnasts are seldom closely involved with a medical facility and very few programs employ certified athletic trainers and/or licensed physical therapists. As such, the use of an early warning system could decrease the severity and duration of injuries simply by alerting medical personnel and coaches to the potential for an injury due to hyper- or hypothermia detected via a thermal camera. Early intervention in medical issues is often cited as one of the primary methods to maintaining health and performance. Moreover, a coach can be more confident in making training load reductions when evidence is available that the athlete is showing early overuse symptoms.

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IS GYMNASTICS A DANGEROUS SPORT IN THE AUSTRALIAN CLUB CONTEXT?

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Original research/review article

Abstract

A common perception is that the gymnastics, especially women's gymnastics, is more dangerous than most other sporting activities. This paper sought local sports injury information to consider the following questions. Is participation in gymnastics dangerous (in this case – more injurious) when compared with other popular Australian sports? Secondly, might reports of comparatively high injury rates in the USA University or Australian High Performance Institute women's gymnastics context translate to the local gymnastics club context? To consider the first question two sources of information about Australian sport injury frequency and injury rates were consulted. The first was the available state injury surveillance reports that present a comparison across sports, including gymnastics and the second source of data is Australian hospital admissions due to sport injury. To consider the second question, a compilation of gymnastics injury rate studies was undertaken. Journal articles pertaining to gymnastic injury rates were located via searches in PubMed and Google Scholar. Secondly, gymnastics injury rates studies over the last three decades are listed and considered in terms of club-based and scholastic based results to shed light on the potential injury rates in the Queensland and Australian gymnastics club context. The mean injury rate (per 1000 hours of participation) in club-level gymnastics is is 2.65 (95% confidence interval 0.87 - 4.43) which is below injury rates for other popular club-level Australian sports. Based on this review, gymnastics does not present the higher hospital emergency department presentations and hospital admission injury numbers, injury rates, and types of injuries found in other Australian sports.

Keywords: artistic gymnastics, injuries, injury rate.

INTRODUCTION

Participation in gymnastics, outside school hours, by children and youth (15 years and younger) is considerable in Australia. Gymnastics was the third highest participatory sport and recreation for females in Australia in 2009 (Australian Bureau of Statistics, 2010). A rise in the participation rate for gymnastics, along with increased skill difficulty practiced at younger ages has led to concerns regarding the risk of injury to young gymnasts (Meeusen & Borms, 1992; Sands, 2003; Singh, Smith, Fields & McKenzie, 2008).

A common perception is that gymnastics, especially women's artistic gymnastics, is more dangerous (i.e. has a higher injury rate) than most sporting activities (Singh et al., 2008). Research interest in injury to gymnasts (club, school and college) has developed along with the growth in this sport's popularity. This was particularly so in the USA scholastic gymnastics programs which had early beginnings dating back to 1825 (USA Gymnastics, 2011). Many reports of injury in gymnastics originate from USA University, school, and club communities (Caine, 2003). Gymnastics

injury rates in the USA scholastic setting, and to some extent in the USA club setting, have been seen as reasons for concern (Caine, 2003; Sands, 2000). For example, the National Collegiate Athletic Association (NCAA) Injury Surveillance System shows women's gymnastics as having the 2ⁿᵈ to 6ᵗʰ highest rates of injury in NCAA college sports (Marshall, Covassin, Dick, Nassar & Agel, 2007). In Australia, investigations of injury to elite gymnasts at State Institutes have reported high injury rates per 100 gymnasts (Dixon & Fricker, 1993; Kolt & Kirkby, 1995, 1999). A retrospective analysis of children and youth gymnastics injury data collected after USA emergency departments visits shows 4.8 injuries per 1000 hours of participation in the USA school and club setting, and this is similar to injury rates reported for other popular sports, such as basketball and soccer (Singh et al., 2008). These gymnastics injury rates in the USA (University, School and Club) and Australia (elites at State Institutes) suggest that gymnasts are as vulnerable to injury as participants in other popular sport such as American football or Rugby football (Kolt & Kirkby, 1996). Insight into the injury rates for Australian youth sports participation may be useful in the discussion of gymnastics injury rates.   In Perth, Western Australia, a retrospective investigation of 1,512 Australian Rules football, field hockey, basketball and netball participants in community-based clubs returned an overall injury rate of 16.7 injuries per 1000 hours of participation. In this study, a sports injury was defined as one that occurred during sports participation and led to one of the following outcomes: a loss of sports activity, the need for advice or treatment, and or adverse economic or social effects. The injury rate was highest for Australian football (20 injuries per 1,000 participation hours), followed by field hockey and basketball (15 and 14 injuries per 1,000 participation hours, respectively) and lowest for netball (12 injuries per 1,000 participation hours) (Stevenson, Finch, Hamer & Elliott, 2003).

However, there has been little, if any, reporting of Australian club level gymnastics injury rates or consideration of comparative Australian sport injury data. University, school or institute gymnastics sporting environments can differ considerably from club based gymnastics settings. Issues of earning and holding scholarships, financially-driven competitions, high training loads and competitive event intensity make the scholastic and elite performance gymnastic sectors different in degree to local gymnastics clubs.

Sporting activity and hazards

All sporting activity presents hazards, and gymnastics has height, flight, rotation and swing that present clear hazards of slipping, tripping, falling and striking. However, nearly all hazards in gymnastics are distributed and can be anticipated and controlled. Gymnastics has a very large variety of movement skills, but involves a set of performances in a "closed" sporting skill environment. This is where the "field of play" is a set, stable and predictable environment allowing advanced organization of skilled movement (Schmidt, 1991). This allows an anticipation of hazardous consequences and the ability to control these hazards. So, while gymnastics is risky, much of the risk can be understood and the hazards controlled.

In games, such as the various footballs (rugby or soccer) hazards are also present throughout the game, but the performance is in an "open" environment which is unpredictable, unstable and prevents predetermined organization of movement (Schmidt, 1991). In most "open" sports, hazard exposure cannot be fully anticipated as these hazards are experienced in a changing game environment. The movement skills in these sport games are mainly fundamental movements and cyclical in nature (running, kicking, throwing), however the playing environment is constantly changing with "moving", colliding opponents and equipment (Bompa, 1983). Contact with

equipment and contact with another player can account for the majority of injuries in team sports (Backx, Beijer, Bol, & Erich, 1991; Radelet, Lephart, Rubinstein & Myers, 2002). This makes these sport hazards difficult to anticipate and control, and increases the variability of injury consequence.

Study Questions

This paper sought local sports injury information to consider the following questions. Is participation in gymnastics dangerous (in this case – more injurious) when compared with other popular Australian sports? Secondly, might reports of comparatively high injury rates in the USA University or High Performance Institute women's gymnastics context translate to the Queensland and Australian gymnastics club context?

METHODS

Gymnastics injury rates

The contexts, subjects, investigative methods, and reporting of information about gymnastics has been varied and confusing (Caine, 2003). What constitutes an injury has ranged from self-reports of soreness to those requiring hospital admission. Differences in injury rates have also lent confusion to the overall record. For example injury rates have been variously described in terms of per 100 gymnasts, per 100 exposures, per 1000 hours of training exposure, per 1000 hours AE (athlete exposure = one gymnast participating in one training session or in one competition.), or simply per year per participant. Many studies of gymnastic injury have used either the number of injuries per 100 exposed gymnasts, or the number of injuries per 1000 training hours per cohort of gymnasts. The former is the rate of injury frequency or the injury rate in a given sample, while the latter is a rate of injury exposure or injury rate in a given time (Bak, Kalms, Olesen, & Jorgensen, 1994; Bruggemann, 1999; Caine, Cochrane, Caine & Zemper, 1989; Caine, Knutzen, Howe, Keeler, Fast, Sheppard &

Henrichs, 2003; Dixon & Fricker, 1993; Dowdell, 2011; Fellander-Tsai & Wredmark, 1995; Garrick & Requa, 1980; Harringe, Renström & Werner, 2007; Hume, 2005; Kolt & Kirkby, 1995; Lindner & Caine, 1990; Marshall et al., 2007; Pettrone & Ricciardelli, 1983; Sands, Shultz & Newman, 1993; Snook, 1979; Weiker, 1985).

While knowledge of the rate of injuries in a sample cohort (per/100 persons) can be useful in relation to that cohort, it does not reflect the injury rate in relation to the given time (hours) of participation (exposure). The latter injury rate (injuries/1000 hours of participation) can be a more useful in comparing sports based on hours of participation. For example, two cohorts of basketball and gymnastics athletes may both have an equal frequency rate of 1.38 per 100 athletes, but the gymnast cohort trains 15 hours per week year round, while the basketball group participates 6 hours per week during a semester season. In this case, the use of the injury rate in a given time (1000 hours of participation) would be a more valid and reliable comparative measure of these two sporting group's injury rates.

Data sources and presentation

To consider the first question about participation in gymnastics being dangerous (in this case – more injurious) as compared with other popular Australian sports, two sources of information about Australian sport injury frequency and injury rates were consulted. The first was the available state injury surveillance reports that present a comparison across sports, including gymnastics. These reports contain hospital Emergency Department (ED) presentation data. The sources are the Queensland Injury Surveillance Unit (QISU), the Victorian Injury Surveillance System (VISS) reporting the Victorian Emergency Minimum Dataset (VEMD), and the Australian Sports Medicine Federation (ASMF) Sports Injury survey in the Australian Capital Territory (ACT). The second source of Australian data is Hospital admissions due to sport

injury, which include gymnastics. This was retrieved from the Australian Institute of Health and Welfare reports. The frequency data from these four reports is tabled and sports are weighted for their ranked appearance in at least two studies.

To consider whether reports of comparatively high injury rates in the USA University or Australian Institute women's gymnastics context might relate to the Queensland and Australian gymnastics club context, a compilation of gymnastics injury rate studies was undertaken. Journal articles pertaining to gymnastic injury rates were located via searches in PubMed and Google Scholar. Only those studies that provided injury frequency per sample (injury/100 persons) and, or injury rates per time (injury/1000 hours of participation) are presented in table format. Case reports were excluded as they are not necessarily representative of the gymnastics population. The ranges, means and standard deviations of the injury rates in club based studies and in scholastic-institute based studies are presented.

RESULTS

Hospital sport injury survey findings - Queensland and Australia

The first three sports injury rate reports are ED presentations for the state of Queensland 1998-1999 (Hockey & Knowles, 2000), the Australian Capital Territory 1989 (Sanders, Draper & Fricker, 1989) and the state of Victoria 1999-2001 (Cassell & Clapperton, 2002). The last report is of hospitalized sports injuries in Australia 2002–2003 (Flood & Harrison, 2006).

From a field of approximately thirteen popular sports, gymnastics ranked near last (12th and 11th respectively) in percentage of Queensland hospital ED presentations and in the injury rate per 100 persons. The top ten sports with the most Queensland hospital ED presentations in descending order where Rugby League, Rugby Union, Soccer, Netball, Basketball, Cricket, Australian Rules football, Touch Football,

field Hockey, and Martial Arts. This Queensland report also considered injury rate based on participation and reported an injury "index". This index suggests that during 1989-1990 Rugby League players (injury index = 435) were over four times more likely to be injured than in any other sport (average injury index =100), and that gymnasts (injury index = 7) were 13 times less likely to be injured than other sports.

The 1989 Australian Sports Medicine Federation (ASMF) Sports Injury survey compared the risk factors of the various sport injury rates (per 1000 participation hours) for competitive athletes of all ages in the Australian Capital Territory (ACT). In the ASMF Sports Injury Survey the hours played were estimated from those revealed by sports injured patients while the figures for the number of participants were readily available from the various sporting organizations in the ACT. Gymnastics, with an injury rate of 0.15 per 1000 hours, ranked 10th in the given sports behind Rugby League (2.0), Australian Rules football (1.9), Rugby Union (1.9), Hockey (1.5), Squash (1.3), Basketball (1.1), Indoor Cricket (1.1), Netball (1.1), and Soccer (0.55).

In the 3-year period 1999-2001 there were 40,281 Victorian hospital emergency department presentations identified on the Victorian Emergency Minimum Dataset (VEMD) where sport or active recreation was the identified causal activity (Cassell & Clapperton, 2002). Gymnastics ranked 21st in the frequency (n=273, 0.8 % of all sports) of ED presentations in the state of Victoria for those three years. The five highest ranked sports for ED presentations were Australian football (22.0% of all sports), basketball (8.8%), soccer (6.4%), netball (6.0%), and cricket (4.9%).

Hospitalizations due to sporting injuries throughout Australia (2002-2003) show a similar small admission frequency for gymnastics (Flood & Harrison, 2006). Of the reported twenty sports (some grouped, such as water sports) gymnastics was the 9th most popular activity per 100,000 population but ranked 19th with 400

hospital admissions and 17th in hospital admission rate per 100,000 population (2.0 per 100,000 population compared to all-sports at 231.4 per 100,000 population). However, the gymnastics data included trampolining where many injuries occur in the home setting, rather than a club setting. When trampolining injuries are excluded (by removing falls from trampoline and related activities) the total of hospital admitted gymnastics injuries for 2002-2003 is approximately 225. This report presented hospital admission rates in two ways – per 100,000 population of Australia and per 100,000 participants per sport. When the hospitalization rate per 100,000 participants (in each sport) is considered, the descending order of sports with highest admission rate is: Wheeled motor sports (942.7), Roller sports (738.6), Australian Rules football (734.3), Equestrian (692.7), Rugby League (677.9), Ice & snow sports (546), Rugby Union (317), Gymnastics (excluding trampolining) (261), Soccer (242), Basketball (222), Netball (184) and Cricket (148), Field hockey (126), Combative sports (123) and Water sports (97).

Weighted hospital sport injury frequency findings

A relatively common picture emerges from these surveys of hospital ED presentations and hospital admissions for sports injuries in Australia. Table 1 below shows a frequency comparison of single (ungrouped) sports injury presentations to hospital EDs and hospitals admissions in the four Australian reports. Water sports, ice-snow sports, and combative sports are not included in this discussion as they are inclusive of several (grouped) sports.

After weighting sports for their ranked appearance in at least two studies, a common list of Australian sports with the highest injury presentation frequency presents in descending order. These sports are: Australian Rules football (35), Soccer (35), Rugby League (31), Basketball (31), Netball (30), Rugby Union (25), Cycling (22), Cricket (21), Hockey (16.5), Roller sports (15), wheeled motor sports (11),

Equestrian (9), and Gymnastics (8.5). Above all other sports in injury presentation are the football codes, followed by basketball, netball, cycling and cricket. Gymnastic sports do not present the higher hospital ED and hospital admission injury numbers and injury rates found in many other popular Australian sports.

Competitive gymnastic injury rate study compilation

The compilation of competitive gymnastic injury rate studies (see Table 2) shows a range of 5.3 to 200 injuries per 100 gymnasts and 0.44 to 22.7 injuries per 1000 hours of participation. Some of the studies presented disproportionate injury rates or had inadequate sample sizes. The reported injury rate of 22.7 injury per 1000 hours of participation (Sands et al., 1993) appears to be an "outlier" and may be a result of an injury reporting method that included very minor injuries (Hume, 2005). The reported injury rate of 200 per 100 gymnasts (Dixon & Fricker, 1993) and 198 per 100 gymnasts (Kolt & Kirkby, 1995) also appear to be outliers. These very high rates may be due to these investigations being early surveys of elite gymnasts in sports institute settings. The Hume (2005) study of elite gymnasts injuries in a New Zealand club could be considered a case study due to very low subject numbers (n =15).

Two of the studies might be representative of similar levels of competitive gymnastics club contexts outside of the USA. These are the 1990 Lindner and Caine study that reported Canadian gymnastics club rates as 30 per 100 gymnasts and 0.52 per 1000 hours. Secondly, in a soon to be published prospective study of a mid-sized Queensland gymnastics club, injury rates of 14.8 and 14.1 per 100 gymnast and 0.48 and 0.44 per 1000 hours were found for 2008 and 2009 respectively in a cohort of 85 male and female Level 3-9 gymnasts (Dowdell, 2011).

Table 1. *A frequency comparison of sport injury admissions to EDs, and hospitals in the given Australian reports.*

	ED or Hospital Admissions report – % of total admissions			
Ranked Sport #	ED presentations ACT 1989	ED presentations Queensland 1998-1999	ED presentations Victoria 1999-2001	Hospital admission Australia 2002-2003
1	Rugby Union 18.6%	Rugby League 15.3%	Australian Rules 22%	Australian Rules 8.6%
2	Australian Rules 15.3%	Soccer 14.3%	Cycling 14.7%	Soccer 7.2%
3	Rugby League 14.6%	Netball 9.46%	Basketball 8.8%	Cycling 6.0%
4	Netball 12.6%	Basketball 7.1%	Soccer 6.4%	Rugby League 5.7%
5	Basketball 9.6%	Cricket 6.1%	Netball 6.0%	Roller sports 5%
6	Hockey 8.3%	Rugby Union 4.52%	Roller sports 5.1%	Rugby Union 4.9%
7	Squash 6.0%	Field Hockey 3.0%	Cricket 4.9%	Wheeled motor sports 4.6%
8	Indoor Cricket 5.0%	Martial Arts 2.6%	Wheeled motor sports 4.5%	Equestrian 4%
9	Soccer 7.7%	Gymnastics 1.6%	Equestrian 3.4%	Basketball 2.7%
10	Gymnastics 2.3%	Softball 1.5%	Field Hockey 1.6%	Netball 2.5%
11		Volleyball 1.5%	Swimming 1.6%	Cricket 2.3%
Other			21st Gymnastics 0.8%	19th Gymnastics 0.5%
Other				20th Field Hockey 0.4%

Table 2. *Injury rates reported in competitive gymnastics injury studies*

Study	Year	Country	Gender	Study setting	Number of subjects	Injury rate /100 gymnasts	Injury rate /1000 hours
Lindner & Caine	1990	Canada	Women	Club	178	30	0.52
Bak, Kalms, Olesen, & Jorgensen.	1994	Denmark	Women	Club	46		1.40
Bak et al	1994	Denmark	Men	Club	37		1.00
Fellander-Tsai & Wredmark	1995	Sweden	Women	Club	437	6.25	
Harringe, Renström, Werner	2007	Sweden	Mixed	Club	42		2.20
Hume	2005	New Zealand	Women Male	Elite Club	9 6		0.27
Dixon & Fricker	1993	Australia	Mixed	Elite Sport Institutes	126	200	
Kolt & Kirkby	1995	Australia	Women	Elite Sport Institutes	64	198	3.40
Kolt & Kirkby	1999	Australia	Women	Elite & sub-elite	64		5.45
Dowdell	2011	Australia	Mixed	Club	85	14.1	0.45
Garrick & Requa	1980	USA	Women	School University	98	39.8	
Garrick & Requa	1980	USA	Women	Club		22.2	
Pettrone & Ricciardelli	1983	USA	Women	Club	2558	5.3	
Weiker	1985	USA	Women	Club	766	12.4	
Weiker	1985	USA	Men	Club	107	9.3	
Caine, Cochrane, Caine, & Zemper	1989	USA	Women	Clubs	50		3.66
Sands, Shultz & Newman	1993	USA	Women	University	37		22.7
Bruggemann	1999	USA	Women	Club	79		2.50
Caine, Knutzen, Howe, Keeler, Fast Sheppard,Henrichs	2003	USA	Women	Club University	79		2.50
Marshall, Covassin, Dick, Nassar &Agel	2007	USA	Women	University	1550		6.07 (in practice)
Singh, Smith, Fields, & McKenzie	2008	USA	Women	Children at EDs 1990-2005	425900		4.80

Range of injury rates in the competitive gymnastics injury studies

A direct comparison of injury rates among all the studies, even with larger subject numbers, is problematic as the age of the studies and varying investigative methods present irreconcilable differences. When the studies are considered as two subgroups, one of club-based studies (n =12) and a group of Scholastic-Institute based studies (n =7) then the range of the injury rate findings groups notably as shown in Table 3.

The mean for the injury frequency rate studies (reporting injury per 100 gymnasts) is 53.74. This includes only three scholastics based studies, two of which are "outliers" that have high injury rates at 200 and 198 per100 gymnasts respectively.   No confidence interval for the mean of the injury frequency rate studies is reported. The mean for the injury exposure rates studies (reporting injury per 1000 hours participation), but excluding the 2005 Hume study and the 1993 Sands et al. study,   is 2.65 (95% confidence interval 0.87 - 4.43).

Table 3. *Range of injury rates in the reported competitive gymnastics injury studies*

Injury Rate used in study	Study type		Mean	SD	95% CI Mean
	Range of Club based injury rates n =12	Range of Scholastic Injury rates n = 7			
/100 gymnasts n =10	5.30 - 50.0	39.8 - 200	53.74	77.33	-
/1000 hours Participation n = 11	0.45- 3.66	2.50 – 6.07	2.65	1.87	0.87 - 4.43

DISCUSSION

Limitations associated with sports injury data

The general problems associated with sports injury data have been well documented (Finch, Ozanne-Smith & Williams, 1995). In Australia there is no current available data to compare injury rates across different states, nor is it generally possible to compare injury risk across sports. Furthermore, there is no baseline against which injury prevention gains can be monitored (Australia Department of Health and Ageing, 2004). With regard to study methodology, there is a lack of standardized definitions for injury, a mixed use of injury rates, varied selection of samples, wide-ranging contexts, and a lack of reliable data collection methods. For example, studies deriving information from medical reports are likely to be more consistent and valid than those reliant on injury questionnaires completed by a gymnast. Presentation to a hospital ED or admission to hospital is usually for the more urgent or concerning injuries. However, these reported injuries do not include all injuries suffered by participants in a sporting activity, as many are managed by sports trainers or local medical practitioners. Unfortunately, injuries managed locally are not easily surveyed or reported. Hospital ED presentations and hospital admission injury data can be effectively sourced, and as a source of currently reliable data may provide a possible picture of the more serious injury outcomes of participation in

Australian sports. Nevertheless, it must be acknowledged that generalization of hospital ED presentations to the entire population most likely underestimates the extent of the sports injury data while overstating the severity (Mummery, Schofield & Spence, 2002).

Other factors that could contribute to the discrepancy in the gymnastic injury rates reports include gender differences, event-equipment differences, and safety measures employed at different gymnastics clubs that mitigate injury, the complexity of the competitive skills being performed, the physical fitness of the sample population, and the coach to gymnast ratio (Kolt & Kirkby, 1995).

Hospital sport injury survey findings – Queensland and Australia

It is important to stress again that the injury rankings should not be used to directly compare the level of danger of particular sports as the participation (training and competition) exposure of participants can differ among the various sports. Participation in gymnastics, like all other sport activities, should be considered risky, however, the "closed" nature of the gymnastics "field of play" allows much of the risk to be anticipated and the hazards controlled.

This may account for the difference in bodily location of injury between (say) football codes and gymnastics as described in Australian hospital admissions reports (Flood & Harrison 2006). Falls (49%) and contact with other persons (33%) were the most common single mechanisms of injury in football codes, while in gymnastics (including trampolining) falls (at 76%) was the most common single mechanisms of injury. Hospital admissions were most common for fracture injury in both football codes (over 60%) and in gymnastics (over 70%). In spite of this common mechanism of injury (falls) and common type of injury (fractures), locations such as face, eye, intracranial, internal organ, spine and nervous system injuries were ever present in all the football codes, but limited in gymnastics. For example, in 2002-2003 there were 39 admissions due to nerve and spinal cord injury throughout Australia in the football codes alone (21 in AFL, 11 in Rugby Union, 7 in Rugby League). During this time there were no admissions for nerve and spinal cord injury throughout Australia due to gymnastics (and trampolining) participation. There were 65 sports-related deaths reported after hospital admission in that year from a small number of sports, especially cycling, water sports, equestrian, motor sports, and football, however none in gymnastics.

Of interest is the similarity with regards to the most admitted sports between two hospital admission studies (Australia 2002-2003 and the NSW state report 2010). Over the period 2003-2008, the total number of hospitalisations due to sport injury in New South Wales (NSW) and the distribution of sport activities causing hospital admission had hardly changed from year to year. In that report, gymnastics was grouped under Acrobatic or Aesthetic sports and ranked 11th (1.0 %) behind team ball sports (42%), wheeled non-motor sports (11%), wheeled motor sports (6%), individual water sports (5%), Team batting sports (3.7%), Equestrian (3.3%), Ice and snow sports (3%), Athletics (1.5%), Combative sports (1.3%), and Target sports (1.1%) (Finch, Mitchell & Boufous, 2010). This is similar to the rank order of sport activities causing hospital admission in the 2003 national report. Here the team ball sports of Australian Football, Soccer, Rugby League and Rugby union ranked 1st, 2nd, 4th and 6th in admission frequency. Wheeled non-motor sports, such as cycling and roller sports, ranked 3rd and 5th respectively. Wheeled motor sports ranked 7th, equestrian 8th, batting sports (baseball, softball, cricket 11th) and target sports (basketball and netball) 9th and 10th. Gymnastics was the 19th ranked sport for hospital admissions per 100,000 population.

Injury rates in the competitive gymnastics injury studies

Drawing conclusions about gymnastic injury rates in the Australian club context is problematic because of the mix of the gymnastics injury studies settings and study methods. While there appears to be a difference in the range in injury rates between the club-based studies (lower rates of injury) and the scholastic-institute based studies (higher rates of injury) only an observation of this is possible through this paper. Future investigation in a number of Australian club settings may provide useful, current data. Nevertheless, comment on some issues is possible.

Several studies confirm a significant difference in lower injury rates for non-competitive gymnasts as opposed to competitive gymnasts, or lower injury rates for lower level, lower training hours as opposed to high level, higher training hours gymnasts. The lower injury rates for beginner gymnasts and those at lower competitive levels can be due to less overall exposure, lower skill difficulty, lower exposure to take-offs and landings and lower performance stress (Bruggemann, 1999; Caine & Nassar, 2005; Caine et al., 2003; Lowry & Leveau, 1982; Meeusen & Borms, 1992; Pettrone & Ricciardell, 1987). Differences in injury rate between male and female gymnasts might have been suspected, but only one study (Lanese, Strauss, Leizman & Rotondi, 1990) considered this question directly at an inter-collegiate sports level. These investigators found no evidence for gender differences in matched sports except for gymnastics. Women gymnasts experienced 0.82 injuries per 100 person-hours of exposure as compared to 0.21 injuries for the men. The university age of the subjects, and the technically diverse event apparatus used by female and male gymnasts might explain the observed differences in this study (Lanese et al., 1990).

Lastly, there is a notable difference between the injury rates per time (1000 hours of participation) in the gymnastics studies (mean 2.65/1000 hours, 95% CI 0.87 - 4.43) and the only Australian study reporting popular club-level sports injury rates per 1000 hours participation (Stevenson, Finch, Hamer, & Elliott, 2003). The mean injury rate was 16 per 1000 hours of participation for the reported West Australian sports, and highest for Australian Rules football (20 injuries per 1,000 hours) followed by field hockey and basketball (15 and 14 injuries per 1,000 hours respectively) and then netball (12 injuries per 1,000 hours). Some of this difference may be due to the self-reporting of injury through a telephone interview that can lead to over-reporting of injury, however, reported injury rates in club-level gymnastics appear to be somewhat lower than other reported popular club-level sports in Australia. Further investigation is recommended.

CONCLUSIONS

Gymnastics had a 1998-1999 hospital ED presentation rate of 12th in Queensland sports behind five football codes, netball, basketball, cricket, hockey & martial arts. In hospital ED presentations due to sporting injury in the states of the ACT (1989-1999) and Victoria (1999-2000) gymnastics ranked 10th and 21st respectively in the reported sports injury presentations. While gymnastics was the 9th most popular per 100,000 populations in Australia in 2002-2003, it ranked 19th in the number of hospital admissions and 17th in hospital admission rate per 100,000 populations. Gymnastics is ranked 7th behind Roller sports, Australian Rules Football, Equestrian, Rugby League, Ice & Snow sports, and Rugby Union when the admission rate is considered per 1000 participants in each sport.

A compilation of twenty gymnastics injury rate studies shows a large range of rates being 5.3 to 200 injuries per sample (100 gymnasts) and 0.44 to 22.7 injuries per time (1000 hours of participation). However, when the studies are considered as a group of club-based studies and a group of Scholastic-Institute based studies the range of the injury rate findings clusters

notably. For the club-based studies, the ranges are 5.30-50 per sample (100 gymnasts) and 0.45 – 3.66 per time (1000 hours participation). The scholastic-institute based studies show a range of 39.8 – 200 per sample and 3.40 - 22.7 per time. These potential differences in the range of injury rate in these settings raises questions about the difference in gymnastics training contexts and the many variables therein. Further sports injury investigation in the Australian gymnastic club context is encouraged to uncover and present current data.

Injury can, and does, occur in gymnastic sports but gymnastics does not present the higher hospital ED presentations and hospital admission injury numbers, injury rates, and types of injuries found in many other popular Australian sports. While sprains, strains and fractures predominate in all sports, face, eye, intracranial, internal organ, spine and nervous system injuries that are common in other sports were limited in gymnastics. Because of gymnastic's stable "field of play" and closed skill type the most common gymnastic hazards (i.e. falls) can be anticipated and controlled. In summary, participation in gymnastics in the Australian club context should not be considered more dangerous (injurious) than other popular sports.

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SELF-ESTEEM, TRAIT ANXIETY AND PARENTAL EDUCATIONAL LEVEL OF CHILDREN PRACTICING NON-COMPETITIVE GYMNASTICS SPORTS

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Abstract

The aim of this study was to examine the relation between self-esteem, trait anxiety and parental educational level of 117 children (M age= 10.61 years, SD=O.7), practicing non-competitive gymnastics sports. To measure self-esteem and trait anxiety, the Greek versions of Harter's Self-Perception Profile for Children (1985a) and of the State-Trait Anxiety for Children (STAIC; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973) were used respectively. ANOVA procedure and independent samples t-test were performed in order to examine differences in self-esteem and trait anxiety between the different educational levels of the parents. Results indicated that father's educational level was related only to one subscale of self-esteem (social acceptance) and had no relation with trait anxiety while mother's educational level was related to most of the subscales of self-esteem (school competence, athletic competence, social acceptance and physical appearance) and to trait anxiety. When both parents' educational level was examined simultaneously, results indicated that children with parents of higher educational level scored higher in most of the subscales of self-esteem (school competence, athletic competence, social acceptance and physical appearance) but not in behavioral conduct and global self-esteem, and there was no difference in trait anxiety. Further research is required on the impact of structural features of the family on young athletes' psychological parameters.

Keywords: self-esteem, trait anxiety, gymnasts, parents, education

INTRODUCTION

Most experts in child development and education believe that children's emotional, cognitive and behavioral development is profoundly affected by the way, in which their parents have raised them (Gekas & Schwable, 1986; Harter, 1985b; Rosenberg, 1986). Findings show that young children and adolescents whose parents convey affection, acceptance and support are likely to report higher self-esteem, lower anxiety and depression, greater happiness and scholastic achievement and fewer behavioral problems (Antunes & Fontaine, 1998; Ball, 1992; Gekas & Schwabe, 1986).

Self-esteem is the evaluative element of self-concept (Brown, 1993; Makri-Botsari, 2001b) and can be defined as the degree to which individuals feel positive about themselves (Sonstroem, 1989). According to experts, (Coopersmith, 1981; Rosenberg, 1986) self-esteem reflects the extent to which people believe themselves to be capable, significant, successful, and worthy. Self-esteem is not definitive and may vary from a situation to another, according to problems to be solved or choices to be made (Tap, Tarquinio, & Sordes-Ader, 2002).

To define anxiety, Spielberger (1966), on the basis of previous research, formulated the anxiety theory that suggests possible relationships between state and trait variables. Trait anxiety is a personality disposition that predisposes some young athletes to more often perceive an imbalance between environmental demands and their response capabilities, which in turn causes them to respond with increased state anxiety (Scanlan & Lewthwaite, 1986).

High self-esteem is one of the most important developments in childhood (Barrett & Campos, 1987; Coopersmith, 1981; Makri-Botsari, 2001b) and it is categorized within the emotional/social domain of development (Ball, 1992). Low self-esteem and/or high trait anxiety are associated to risk behaviours, such as substance abuse, suicidal attempts, dieting and other extreme weight control methods (Laure, Binsinger, Ambard, Girault, & Friser, 2005; McGee & Williams, 2000).

The multidimensionality of self-esteem has been well documented (Harter, 1993). Marsh, (1989) demonstrated the organization of the components of self-esteem in a hierarchical structure with global self-esteem at the apex. Achievement related areas like school (cognitive competence), sport (physical competence), and peer relationships (social competence) are supposed to represent important achievement domains. According to Harter (1993), these areas might be seen as independent. For example, children may think they are poor students, good baseball players, homely children, or trustworthy friends.

Empirical research has focused so far on the social framework of self-esteem and in particular on structural features of the family, such as socioeconomic status, parental occupation and education (Johnson, McGue, & Iacono, 2006; Roberts, Bengston, 1993). Socioeconomic status (SES; Pervin, 1993) is traditionally composed of three parts, income, occupation and education. It must be noted that these are not independent concepts; more education typically leads to increased income and to a more prestigious occupation. In short, it reflects an aspect of culture that is commonly considered as environmental variable but there is substantial evidence that the individual personal characteristics contributing to SES are under genetic as well as environmental influence (Bouchard & McGue, 2003).

A frequent finding reported in the literature is that children's self-esteem and anxiety are related to parents' socioeconomic status (SES; Johnson, et al., 2006; Philips & Zigler, 1980; Roberts & Bengston, 1993; Twenge & Campbell, 2002). In addition, parents' level of education and occupational status are associated with children's future educational and occupational aspirations (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001).

It has been reported that during children's school age, feedback and support from significant others (parents, teachers/coaches, and peers) are critical for the development of self-esteem and for coping with mental stress (Cohn, Patterson & Christopoulos, 1991; Gekas, 1972; Harter, 1985b; Kashani, Canfield, Borduin, Soltys & Reid, 1994). In the case of young athletes, parents are typically the individuals who play a key role in children's involvement with sport and future athletic development (Ommundsen & Vaglum, 1991; Scanlan & Lewthwaite, 1986). In most studies of young athletes, it is assumed that parental involvement is the main means of support. Moreover, the stronger is the parental support the child receives, the more positive is the evaluation of the self and lower the level of anxiety or depression that the child feels (Bowlby, 1988; Gotlib & Hammen, 1992). In addition, the possibility of asking from parents for support is very important for adolescents, because they generally have more limited coping resources than adults (Printz, Shermis & Webb, 1999; Van Yperen, 1995).

Gymnastics sports (artistic gymnastics, rhythmic gymnastics, acrobatic, trampoline and gymnastics for all) are popular in young children. Competitive sports are defined as those in which children

compete against others formally for awards. Non-competitive (recreational) sports are operationally defined as those in which children practice regularly but do not compete against others, and do not participate in competitions against other teams for places and awards.

Recently, Amac, Anastasio, Morwick, and Yi (2002), reported that, conversely to what was hypothesised, the self-esteem of young girls (aged 10-13 years) practicing competitive gymnastics was significantly lower than the self-esteem of girls practicing recreational gymnastics. They mentioned several characteristics of the competitive environment that might lead to this result including the amount of pressure created by competition, the highest expectations from coaches and parents, and the urge to find a balance between school life and sport life (Amac et al., 2002). In another study, Kerr and Goss (1997) found that elite female gymnasts aged 11-17 years, reported lower self-esteem scores than the published age- and gender-appropriate norms for children of this age, while the trait anxiety scores did not differ significantly from the norms. For this reason, in order to examine the relation of parental educational level to self-esteem and trait anxiety of children, without the bias of high-level competitive gymnastics, only children from non-competitive gymnastics sports participated in this study.

This study aimed to examine the relationship between parental educational level, and self-esteem and trait anxiety of gymnasts practicing non-competitive gymnastics sports. On the basis of existing evidence of a positive relationship between parental socioeconomic status and children's self-esteem, (Johnson, et al., 2006; Roberts & Bengston, 1993; Twenge & Campbell, 2002) a positive relationship between parental educational level and children's self-esteem, was hypothesized.

Previous research reflected a negative relationship between family socioeconomic status and children's trait anxiety (Bradley & Corwyn, 2002; Cohen & Wills, 1985; Gallo & Matthews, 2003); consequently, a negative relation between parental educational level and children's trait anxiety was expected. The relations between parental educational level and the subscales of self-esteem within the present research will enable further understanding of whether the level of education of the parents is also affecting the way that parents can support their children, deal with their problems, and provide information when it is needed. Different relationships between the educational level of the mother and the educational level of the father to children's self-esteem and trait anxiety were predicted, in line with the existing literature about the different role of the parents in children's emotional, cognitive and behavioral development (Bell, 1970; Georgas, 1998).

METHODS

Participants

One hundred seventeen children (101 girls and 16 boys) aged 10-12 years old (M=10.61, SD=0.71), practising non-competitive gymnastics sports, participated in this study. Gymnasts were representing four gymnastics sports (artistic gymnastics: 55 children, rhythmic gymnastics: 15 girls, trampoline: 17 children, and gymnastics for all: 30 children). This study was nationwide; subjects were drawn from 15 different clubs affiliated with the Hellenic Gymnastic Federation, set up at several locations throughout Athens and Thessaloniki

The gymnasts were practising for 2-5 years (3.84±0.70 years), and training 2-3 times a week, for "45-60 minutes" every time. They were practising in a training stream, which excluded taking part in any competition and moving up to the competitive program was not possible as well.

Instruments

The Greek version (Theodorakou, 1997) of Harter's Self-Perception Profile for Children (1985a) was used to measure the self-esteem of each participant. Self-Perception Profile for Children (Harter, 1985a) is widely used for assessing self-esteem in youths and was created for

children aged 8-14 years old. The scale measures the children's perception of themselves across various domains of their life. It consists of six separate subscales reflecting five specific domains (*scholastic competence, social acceptance, athletic competence, physical appearance, behavioural conduct*) as well as *global self-esteem*. Each of the six subscales contains six items, resulting to a total of 36 items.

The Greek version of the instrument consists of 38 items. Two items from the subscale of physical appearance ("Some kids are happy with their height and weight" and "Some kids wish something about their face or hair looked different") were divided in two items each, resulting to 4 independent items (regarding height and weight, face and hair respectively). This division was done as, during the pilot studies these items showed inadequate validity because there were many children that answered that they were happy with their height but not with their weight or happy with their hair but not face. Participants answered on a four-point scale, where a score of 1 indicates low perceived competence and a score of 4 reflects high perceived competence. Cronbach's α values for Greek population, ranged from 0.67 to 0.74 (Makri-Botsari, 2001a; Theodorakou, 1997). On the first page of the inventory, children completed the data about their parents' level of education and occupation, separately for their father and their mother. According to their educational level, parents were divided in two categories: 1) *Lower level* of education (parents that had elementary and/or secondary education) and 2) *Higher level* of education (parents that had postsecondary education, - University, College and/or higher degree of studies).

To measure anxiety, the Greek version (Psychountaki, Zervas, Karteroliotis, & Spielberger, 2003) of the State-Trait Anxiety Inventory for Children (STAIC; Spielberger, Edwards, Lushene, Montuori & Platzek, 1973) was used. This scale is frequently used to measure anxiety in children 9 to 12 years old. It is a "how-I-feel" questionnaire that consists of two

forms (State and Trait anxiety) of 20 items each, that ask the children how they feel generally, when they respond to the T-Anxiety (Trait anxiety) scale and how they feel at a particular moment when they respond to the S-Anxiety (State anxiety) scale (Spielberger, 1983). For the purpose of this study, only the T-Anxiety scale was used. The STAIC T-Anxiety scores are 3, 2 or 1 for all items. Participants were asked to respond to each item by indicating the frequency of occurrence of the behaviour described by it. The scoring weights are assigned to very often, sometimes, and hardly ever. Cronbach's α value for Greek athletic population was found to be 0.80 in previous research (Psychountaki et al., 2003).

Procedure

For the young gymnasts who participated in this study written parental consent was provided. With the permission of the coaches and club administrators, investigators visited a training session and distributed questionnaires which were completed before the training. Instructions to the participants included a reminder to respond to all items and a statement that there were no correct or incorrect answers. Cover letters were also given to the parents and coaches in which were mentioned the importance of participation, purpose of this study, confidentiality and anonymity.

RESULTS

Measures of skewness and kurtosis found the data to be normally distributed therefore, the use of parametric statistics was deemed appropriate. Internal consistency of the trait anxiety and self-esteem scales was checked with Cronbach's α values. Results from reliability analysis provided adequate evidence for the internal consistency of the State-Trait Anxiety Inventory for Children (STAIC; Spielberger et al., 1973); Cronbach' s α value for trait anxiety was 0.83. For the subscales of Harter's Self-Perception Profile for Children (SPPC; Harter, 1985a) Cronbach' s α values

ranged from 0.69 to 0.73 and were considered acceptable except for the subscale of *behavioral conduct* which demonstrated poor internal consistency (0.52). In particular, Cronbach' s *α* values for the rest of the subscales of self-esteem were as follows: *scholastic competence*, 0.72, *social acceptance,* 0.71, *athletic competence,* 0.70, *physical appearance,* 0.71, and *global self-esteem,* 0.69), thus being in agreement with previous research in Greek population of this age (Makri-Botsari, 2001a).

     Mean differences of children's trait anxiety and the subscales of self-esteem between the two groups of educational level of the parents were initially examined separately for the father and the mother. Comparisons between the two groups were performed with the independent samples t-test. Means and standard deviations of trait anxiety and self-esteem subscales between the two different educational levels of the fathers are presented in Table 1. As can be seen, children whose fathers had higher educational level, scored higher in one subscale of self-esteem (*social acceptance),* and there was no difference in trait anxiety.

Table 1. *Mean values of self-esteem subscales and trait anxiety between the different educational levels of the fathers.*

	Fathers with lower level of education (N=54)	Fathers with higher level of education (N=63)	p
	M/SD	*M/SD*	
Scholastic competence	3.03±0.73	3.26±0.66	0.06
Social acceptance	2.75±0.66	3.19±0.55	0.00*
Athletic competence	2.77±0.62	2.97±0.60	0.08
Physical appearance	2.88±0.73	3.06±0.74	0.19
Behavioral conduct	3.10±0.71	3.08±0.73	0.83
Global self-worth	3.12±0.58	3.20±0.57	0.43
Trait anxiety	31.24±6.00	30.00±5.80	0.26

  * p<0.05

     Mean values and standard deviations of trait anxiety and self-esteem subscales between the two different educational levels of the mothers are presented in Table 2. Children with mothers of higher educational level scored higher in most of the subscales of self-esteem and lower in trait anxiety than children with mothers of lower educational level. In order to examine the relation of both parents' educational level to children's anxiety and self-esteem, children were divided in 4 groups including a first group with children whose both parents had lower level of education (42 children), a second group with children whose father had higher level of education and mother lower level (22 children), a third group with children whose father had lower level of education and mother had higher level (10 children) and a fourth group with children whose both parents had higher level of education (42 children). The small number of couples with different educational level shows that people with similar SES tend to cluster together (Jeynes, 2002).

     Dependent variables (trait anxiety and self-esteem) were examined with ANOVA procedure, having as independent factor the level of education of the parents. When ANOVA procedure, revealed significant differences between the four groups of children, followed post-hoc comparisons, with corrections for multiple comparisons, using Dunnett multiple comparisons test

(Howell, 1987). In this method, all groups were compared with the first group (lower educational level for both parents) which was considered as control group. The aim of this analysis was to examine the possible changes in the groups when one parent or both parents had higher level of education. Mean differences of trait anxiety and the subscales of self-esteem between the four children groups that were created from the examination of both parents' educational level, are presented In Table 3. Post-hoc comparisons, with Dunnett multiple comparisons test, indicated that children from the second group - father with higher level of education and mother with lower level - scored higher than the children of the first group - both parents with lower level of education - only in one subscale of self-esteem, the *social acceptance* (p<0.01). Children from the third group - mother with higher educational level and father with lower educational level - had higher values than children of the first group in the subscales of self-esteem, *school competence, athletic competence* and *physical appearance*. The fourth group of children - both parents with higher educational level - scored higher than the first group in the subscales of self-esteem, *school competence, athletic competence, physical appearance* and *social acceptance*.

DICSUSION

The aim of this research was to examine the relation between self-esteem, trait anxiety and parental educational level of children (10-12 years old) practicing non-competitive gymnastics sports. Results indicated that father's educational level was related only to one subscale of self-esteem (*social acceptance*) and had no relation with trait anxiety, while mother's educational level was related to most of the subscales of self-esteem (*school competence, athletic competence, social acceptance* and *physical appearance*) and to trait anxiety. When both

parents' educational level was examined at the same time, it was shown that children with parents of higher educational level scored higher in most of the subscales of self-esteem (*school competence, athletic competence, social acceptance* and *physical appearance)*; however there was no difference in trait anxiety.

The educational level of the father, examined separately from the educational level of the mother, was related to only one subscale of children's self-esteem, the *social acceptance.* Harter (1985a) clarifies that the subscale of *social acceptance,* mainly expresses the degree to which the child feels popular or accepted from his peers. It seems that the educational level of the father, which is affecting the socioeconomic level of the family, is consequently influencing the way that the child feels accepted by his peers and friends. Many researchers report that the two parents differ not only to the degree of support that they offer to their children, but also in the relation of this support to different aspects of the self (Georgas, 1998; Makri-Botsari, 2000).

On the other hand, the educational level of the mother was related to most of the subscales of self-esteem (*scholastic competence, athletic competence, social acceptance, physical appearance*) and to trait anxiety. Mother is the main "reference" person in the life of the child (Bell, 1970). According to Bowlby (1988), mother is most of the times the person from which the child asks for affection and support, consequently the link between the mother and the child is more critical for the child's social and emotional development than the link with the father. In addition, because of the father's longer absence from home, mother is emotionally closer to her children and is dealing more systematically with their problems (Georgas, 1998). Later, when children get older, their relation with their father becomes more important (Cohn, Patterson & Christopoulos, 1991).

Table 2. *Mean values of self-esteem subscales and trait anxiety between the different educational levels of the mothers.*

	Mothers with lower level of education (N=66) M/SD	Mothers with higher level of education (N=51) M/SD	p
Scholastic competence	2.99±0.69	3.37±0.66	0.00*
Social acceptance	2.85±0.64	3.15±0.61	0.01*
Athletic competence	2.69±0.57	3.12±0.59	0.00*
Physical appearance	2.82±0.71	3.17±0.73	0.01*
Behavioral conduct	3.00±0.70	3.20±0.72	0.14
Global self-worth	3.12±0.57	3.23±0.57	0.29
Trait anxiety	31.62±5.80	29.43±6.00	0.05*

* p<0.05

Table 3. *Mean values and standard deviations of trait anxiety and self-esteem subscales for the four children groups.*

	Father and mother with lower level of education (n=42)	Father with higher and mother with lower level of education (n=22)	Father with lower and mother with higher level of education (n=10)	Father and mother with higher level of education (n=42)	$F_{3,111}$
Scholastic competence	2.92±0.69	3.14±0.70	3.50±0.76*	3.34±0.63*	3.57*
Social acceptance	2.69±0.64	3.21±0.48**	3.09±0.71	3.17±0.59**	5.83**
Athletic competence	2.66±0.60	2.74±0.55	3.24±0.56*	3.09±0.60**	5.37**
Physical appearance	2.76±0.71	2.97±0.72	3.44±0.57*	3.10±0.75	3.08*
Behavioral conduct	3.08±0.69	2.90±0.73	3.33±0.78	3.17±0.72	1.06
Global self-worth	3.09±0.56	3.18±0.56	3.28±0.6	3.22±0.57	0.52
Trait anxiety	32.21±6.00	30.83±5.40	28.24±6.40	29.63±6.00	1.93

* p<0.05   ** p<0.01

Interestingly, the subscales of *behavioral conduct* and *global self-esteem* did not have any significant difference because of the father's or the mother's higher educational level. Probably, the behavior of a child does not depend so much on the education of the parents, but on the family values, behavior, and culture. It is also possible that warmth and unconditioned acceptance - total acceptance of the child with his experiences and behavior without any critical evaluation, (Rogers, 1961) - from the parents are more important for a child's *global self-esteem* than the level of parental education. Many researchers report that the child that feels affection, respect and trust can think of himself as someone who deserves affection, respect, and trust (Gecas, 1972, Hattie, 1992, Rosenberg, 1986).

The results of this study also indicated that children whose mothers had higher educational level, scored lower in trait anxiety. Probably, children with mothers of higher educational level, at least *felt* that their mothers could handle better problems at school or in the gym or problems concerning their relations with peers, their physical appearance etc.

Further, the educational level of both parents simultaneously was examined in order to examine its relation to children's self-esteem and trait anxiety. This study highlights an interesting finding: it was expected that young athletes with both parents of higher educational level would score higher in self-esteem and lower in trait anxiety. This expectation was confirmed for most of the subscales of self-esteem but not for *global self-esteem* and *behavioral conduct*. Harter (1985a) clarifies that *global self-esteem* constitutes a global judgment of one's worth as a person, rather than domain-specific competence or adequacy. The results of this study indicated that parental educational level is important to the process of children's cognitive and emotional development in many domains, - like *scholastic competence, athletic competence, social acceptance,* and *physical appearance* - but it did not affect the extent to which the

children liked themselves as persons, and were generally happy with the way they are.

Unexpectedly, no difference was found in young gymnasts' trait anxiety between the different educational levels of the parents. One possible explanation of this result could be that parents' high educational level affects the educational expectations they have from their children (DeRidder, 1990; Kaplan, Liu & Kaplan, 2001; Penick & Jepsen, 1992). These expectations tend to be based on parents' financial situation, their own experiences with educational attainment and their own aspirations regarding education (Kaplan, et al., 2001; Penick & Jepsen, 1992). Namely, the environment that both these parents create will affect the children, as they tend to expect from their children higher marks at school or to choose a certain career, thus influencing the level of trait anxiety of the children. The participants of this study were not high-level athletes. They practiced regularly and they kept improving their skills in gymnastics sports but there were no specific goals other than to do better for their own self-confidence and to have fun with friends, peers, etc. However, school performance was a demand that they were also asked to fulfil.

It should be recognized that this study has its limitations. First, data were collected by using inventories and though this is a common method, investigators do not have the possibility to check the answers (Bisinger, Laure & Ambard, 2006). On the other hand, this technique does not seem to disrupt excessively the validity of results (Pate, 1993). Another limitation comes from the fact that participants of this study were mostly girls. This was due to the fact that in Greece there are few boys participating in non-competitive gymnastics sports. Probably, if data were collected from another sport, like football, and if there were more boys participating in this study, results would be different, especially in what concerns the relationship with the father. Nevertheless, these results are in agreement with previous studies in Greece (Makri-Botsari, 2000) where it is reported that the

subscales of self-esteem in children correlate higher with the support from the mother than from the father. A final point about the present study is that with the current study design a link of causality between parental educational level and gymnasts' trait anxiety and self-esteem cannot be established.

Despite its limitations, the strength of this study is the examination of the relation of only one of the components of S.E.S - parental educational level - to young gymnasts' psychological parameters and as such can be considered as a new contribution in the area of youth sports. Further longitudinal research, adequately controlled, should examine the relation of structural features of the family to young gymnasts' anxiety and self-esteem separately for boys and girls. Some of the results that were found in the present study appear to warrant further investigation as it seems possible that all the components of the S.E.S of a family (income, occupation, and education) can have different relation to children's psychological characteristics. With the noted differences in self-esteem and trait anxiety of gymnasts with parents of different educational levels, it seems plausible that the results of this study reflect that parental educational level has an important relation to gymnasts' self-esteem but not to trait anxiety.

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INFLUENCE OF DANCE ELEMENTS ON BALANCE BEAM RESULTS

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Abstract

According to the Code of Points (FIG, 2009) the balance beam difficulty value is determined by the sum of maximum 8 most difficult elements (including the dismount), fulfilling 5 composition requirements and by the values that exceed from the connections between the acrobatic elements, turns and acro-rhythmic elements. The aim of this study was to determine the frequency of performed dance elements on the balance beam and their influence on: difficulty value, execution value and final score. The sample consisted of 109 women top junior athletes, who participated in qualifications on the European Championships in Birmingham in 2010. The results obtained showed that the gymnasts in average perform 4.28 dance elements in their balance beam routines. The highest frequency was determined to a C difficulty jump ″switch leap″ (N=101), to two A difficulty jumps: "wolf hop or jump from cross or side position" (N=83) and to ″Sissone″ (leg separation 180°) take off from both legs (N=61); and to A difficulty turn: "1/1 turn (360°) on one leg – free leg optional below horizontal" (N=66). Regression analysis revealed a statistically significant influence of some dance elements on the difficulty value of the exercise (p <0.05) and on the final score. Statistically significant influence of different dance elements on the execution value was not found.

Keywords: women artistic gymnastics, juniors, difficulty, execution, code of points.

INTRODUCTION

From the publishing of the latest Code of Points (2009) many studies have been conducted over the gymnasts' final score. Some studies analyzed judges through their validity and reliability (Leskošek et al., 2010; Sands, 2010) while some analyzed equality between disciplines (Čuk & Atiković, 2009, Čuk & Forbes, 2010). Despite quite a number of studies, it is important to note that all results were carried out on male gymnasts' results, while the studies over results of the female gymnasts have not been found.

In artistic gymnastics women compete on four apparatus: vault, uneven bars,

balance beam and floor. For every apparatus, specific rules (Composition Requirements and Connection Value) and tables of elements and their Difficulty Values are in the Code of Points (2009).

As it is mentioned before, balance beam is one of the four apparatus in Women Artistic Gymnastics (WAG) on which gymnasts perform elements from different groups during a routine, in a time that may not exceed 1.30 minutes (90 seconds). Every routine begins with a mount (taken-off from the board or the mat). During the routine on the balance beam, gymnasts perform gymnastic leaps, jumps and hops,

gymnastic turns, holds and acrobatic elements with or without flight phase and hand support. The evaluation of the routine begins with a mount and finishes with a landing of the dismount. After finishing the routine, whether with a dismount or with a fall that lasted more than 10 seconds, judges give two scores: difficulty value (DV) score and execution value (EV) score. DV score is calculated based on the sum of maximum 8 highest difficulties including the dismount (maximum 5 acrobatic and minimum 3 dance elements), fulfilling prescribed composition requirements (one connection of at least 2 different dance elements, 1 being a leap, jump or hop with 180° split (cross position only); 360° turn; one acrobatic series, minimum of 2 flight elements one being a salto; acrobatic elements in different directions (forward/sideways and backward); appropriate value of dismount and from values that gymnasts get for directly connecting acrobatic elements, turns and/or acrobatic-dance elements. EV score is given for the quality of the skills performed (Fédération Internationale de Gymnastique - FIG, 2009) and has an initial value of 10.00 points if the gymnast performs at least 7 elements. From the value of 10.00 points judges deduct errors that occur during the performance of a routine. Final score (FS) is calculated as the sum of DV and EV minus neutral deductions. According to Cuk et al. (2010) we can predict 84% of all-round final score with DV scores only.

All around world gymnastics competitions are held for the gymnasts of different ages, due to which different requirements apply for different categories. Competition requirements for younger gymnasts mostly differ in composition requirements and, sometimes, in required number of elements for scoring 10.00 points for EV. Competitions for juniors and seniors are held under the FIG organization. The only difference between these groups is a requirement for C dismount in junior category in relation to requirement for D dismount in senior category.

Although DV estimation is done by the sum of maximum 8 elements with the highest difficulty value (including dismount), the gymnasts usually perform much more than 8 elements during their balance beam routine. The question is how many elements gymnasts usually perform in order to achieve the highest possible DV. Also, it is not clear what type of dance elements do the gymnast choose or can perform in the balance beam routine, especially the juniors.

Do they choose to perform elements with higher difficulty value, in which case performance is usually followed by an increased chance of falling and scoring deductions, or they perform elements with lower difficulty values which are usually performed with better technique? Does the huge number of elements from the Code of Points (2009) increase diversity among gymnasts' routines or they mostly choose to perform the same elements?

The main idea for the current research was based on the performance of dance elements on the balance beam and finding creativity and variety in performance of dance connections, as it can be found in the floor exercises (Johnson, 2011). In accordance with the above, the aim of the research was to determine the influence of performed dance elements on: (1) difficulty score (DV); (2) execution score (EV); and (3) final score (FS) in top junior artistic gymnasts.

METHODS

A total sample of 109 top junior gymnasts, competing at the qualifications of the European Championships in Birmingham in 2010 was investigated. From the official balance beam results 5 variables were extracted: difficulty value (DV), execution value (EV), final score (FS), total number of dance elements (DE) and total number of balance beam elements (TBE).

Data were analyzed using the Statistica for Windows 7.0 package. Statistical significance was set at $p < 0.05$. Graphic presentation was used to

demonstrate the prevalence of certain dance elements on the balance beam. Basic descriptive statistics were calculated for all variables: mean values (Mean), standard deviations (SD), minimum (Min) and maximum (Max) results, skewness (Skew) and kurtosis (Kurt). The Kolmogorov-Smirnov test (K-S) was used to confirm the normality of distributions. Finally, three multiple regression analyses investigated relationships between unique dance elements and (1) DV, (2) EV and (3) FS.

RESULTS

Basic descriptive statistics (Table 1) revealed a DV mean value of 4.82 while the EV mean value was 7.08. The mean final score was 11.90 points. According to K-S test and values of skewness and kurtosis, those variables had normal distributions. Among the total number of balance beam elements (mean 11.67), the gymnasts performed in average 4.28 dance elements. According to Kolmogorov-Smirnov test, in the number of DE differences were found between the observed and expected distributions ($p<0.05$), since the boundary for the DE was 0.21. Values of skewness and kurtosis coefficients revealed minor leptokurtic distributions.

Table 1. *Basic descriptive statistics for all variables; the results of the Kolmogorov- Smirnov test for normality of distributions (d value for K-S test (N=109) is 0.15 with p<0.05)*

	Mean	Minimum	Maximum	SD	Skewness	Kurtosis	K-S (d)
DV	4.82	3.50	6.30	0.52	0.06	0.29	0.10
EV	7.09	4.55	8.83	0.87	-0.64	0.16	0.08
FS	11.91	8.65	14.75	1.18	-0.11	0.10	0.04
DE	4.28	1.00	8.00	1.02	0.26	1.57	0.21
TBE	11.61	7.00	16.00	1.66	0.36	0.46	0.14
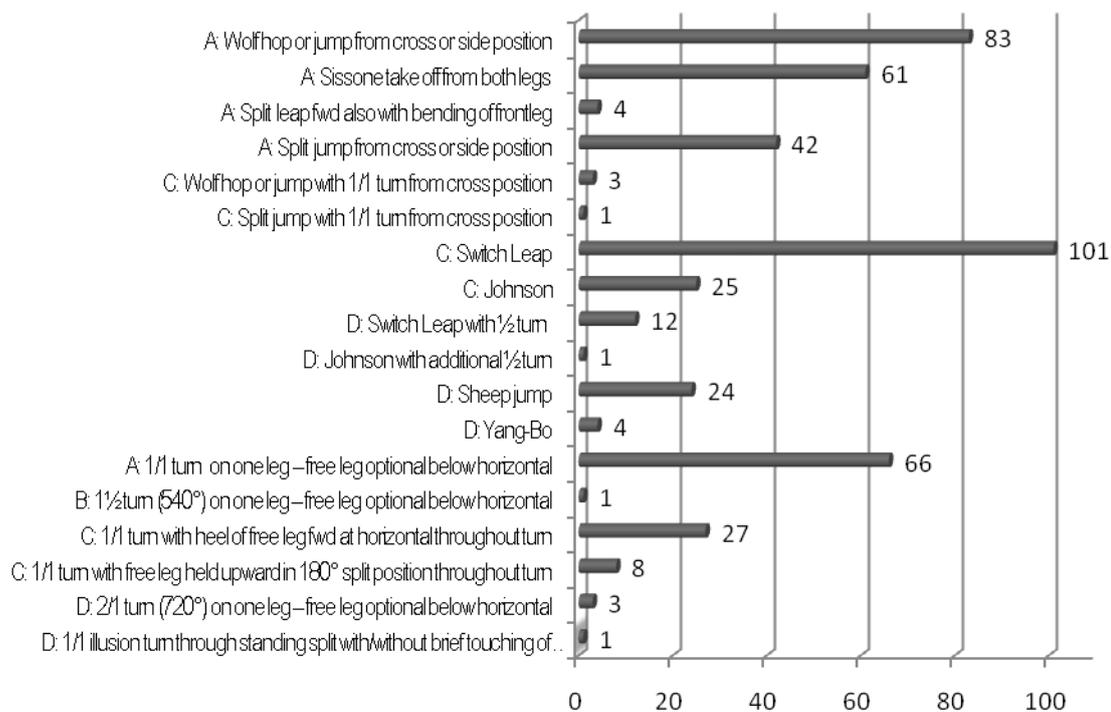
Figure 1. *The prevalence of certain dance elements on the balance balance beam*

Table 2. *Regression analysis of difficulty value; execution value; final score and types of dance balance beam elements (difficulty from A to D)*

	DV		EV		FS	
	Beta	p	Beta	p	Beta	p
A:*Wolf hop or jump from cross or side position*	-0.02	0.79	-0.02	0.84	-0.03	0.79
A: *Sissone (leg separation 180°) take off from both legs*	-0.07	0.47	-0.12	0.33	-0.12	0.29
A: *Split leap fwd (leg separation 180°)*	-0.05	0.55	-0.07	0.58	-0.07	0.51
A:*Split jump (leg separation 180°) from cross or side position*	0.00	0.99	0.00	0.99	0.00	0.99
C:*Wolf hop or jump with 1/1 turn (360°) from cross position*	-0.04	0.58	0.04	0.70	0.01	0.91
C:*Split jump with 1/1 turn (360°) from cross position*	-0.13	0.07	0.04	0.69	-0.03	0.73
C:*Switch Leap*	0.00	0.99	0.08	0.45	0.06	0.54
C:*Johnson*	0.20*	0.01*	-0.02	0.87	0.07	0.42
D:*Switch Leap with ½ turn (180°)*	0.32*	0.00*	0.07	0.47	0.19*	0.04*
D:*Johnson with additional ½ turn (180°)*	0.26*	0.00*	0.14	0.17	0.21*	0.02*
D:*Sheep jump*	0.32*	0.00*	0.12	0.24	0.23*	0.02*
D:*Yang-Bo*	0.15*	0.05*	0.18	0.08	0.20*	0.03*
A:*1/1 turn (360°) on one leg – free leg optional below horizontal*	0.03	0.82	0.01	0.94	0.02	0.89
B:*1 ½ turn (540°) on one leg – free leg optional below horizontal*	0.11	0.23	-0.18	0.13	-0.09	0.43
C:*1/1 turn (360°) with heel of free leg fwd at horizontal throughout turn*	0.22	0.09	-0.01	0.96	0.09	0.55
C:*1/1 turn (360°) with free leg held upward in 180° split position*	0.23*	0.02*	0.00	0.98	0.10	0.38
D:*2/1 turn (720°) on one leg – free leg optional below horizontal*	0.14	0.08	0.05	0.63	0.10	0.30
D:*1/1 illusion turn (360°) through standing split with/without brief*	0.23*	0.00*	0.18	0.06	0.24*	0.01*
R	0.72		0.44		0.57	
R²	0.53		0.20		0.32	
p	0.00*		0.25		0.00*	

* p<0.05

The highest prevalence of dance elements was observed in the C difficulty ″Swich leap″ jump (N=101), in the A difficulty ″Wolf hop or jump from cross or side position″ (N=83) and in the A difficulty "1/1 turn (360°) on one leg – free leg optional below horizontal" (Figure 1).

Finally, for the three multiple regression analyses with different types of dance elements as the predictors, the criterions were DV in the first analysis, EV in the second and FS in the third. The first analysis showed high value of the multiple correlation coefficient (0.72) which indicates strong linear connections between the predictor variables and the criterion variable. Also, predictor variables explain 53% of the total variance. All statistically

significant predictors (dance elements) have a positive influence on the criterion. The second regression analysis revealed that the dance elements are not good predictors of EV, while the third analysis showed medium linear connections between the predictor variables and the criterion variable (R=0.57) and the predictors explain 32% of the total variance.

DICSUSION

Code of Points (COP) defines that DV value is composed from top 8 high scoring elements (maximum 5 acrobatic and minimum 3 dance elements). Results of the study determined that the junior gymnasts in average performed 4.28 dance elements in their balance beam routines. The results of skewness values revealed the existence of a larger group of gymnasts performing less than 4 dance elements what, very likely, indicates a current trend in exercising on the balance beam, in order to achieve good performance and better final score.

According to COP the first composition requirement on the balance beam is one direct connection of at least 2 different dance elements, 1 being a leap, jump or hop with 180° split (cross position only). Based on determined frequencies of jumps, performed on the balance beam by juniors (Figure1), it is possible to conclude that gymnasts often use dance elements of lower difficulty value to meet this requirement. Confirmation of this can be seen in frequency of the three A difficulty value jumps: *Sissone take off from both legs (N=61), Split jump from cross or side position (N=42)* and *Wolf hop or jump from cross or side position* (N=83). Obtained result for these jumps also indicates tactic of some gymnast when composing a routine, which is the usage of these jumps in fulfilling first composition requirement. Because of their high frequency and their A value difficulty, statistically significant impact of these jumps on DV, EV and FS was not determined.

When performing a dance element on the balance beam, in order to recognize their DV, specific Technical expectations, prescribed in article 7 of Code of Points, are required. For dance elements on the balance beam they imply (1) completing turns exactly, (2) split requirement when performing Leaps, Jumps, Hops and Turns and (3) some special requirements for some selected dance elements. If these requirements are not fulfilled performance of dance elements is considered as bad and leads to deductions or to devaluation of DV to dance element. This possibility is perhaps one of reasons why gymnasts mostly choose to perform dance element with lower DV.

Statistically significant influence on DV and FS was determined in the jumps of C and D difficulty (C difficulty value: *Johnson* (N=25); D difficulty value: *Switch Leap with ½ turn* (N=12), *Johnson with additional ½ turn* (N=1), *Sheep jump* (N=24) and *Yang-Bo* (N=4)), whose frequencies were much smaller than the A difficulty jumps. Unlike values of the A difficulty jumps, difficulty values of these jumps were part of the initial DV, according to E judge sheets (where devaluation of dance elements wasn't marked), while the performance of these jumps was confirmed as statistically significant on DV. Concurrently with the above mentioned, because the smaller group of gymnast performed jumps with higher difficulty values, it was expected that the same will make statistically significant distinction between the gymnasts in the FS. Statistically significant influence of jumps with higher difficulty value on EV was not determined, probably as a result of "tactic" in the balance beam exercise composing, that is, using only technically correct and safe jumps. With the all previously mentioned results and facts, it is important to point out that gymnasts, probably, performed the higher difficulty value jumps separately, in order to perform them as best as they can.

C difficulty value *Switch Leap jump* was found in almost every junior balance beam exercise (N=101). Statistically significant influence of this jump was not determined on DV, EV or FS. However,

importance of learning this jump on the highest possible level is inevitable for more reasons. The first reason can be seen through the high frequency of this jump in juniors' exercise, on what basis it can be concluded that this jump probably is not very hard to learn or to perform. Another reason lies in difficulty value of this jump (C difficulty value) and its contribution to a total DV value. The third reason is its structure of performance, or 180° leg split, because of what this jump can fulfill the composition requirement (connection of 2 dance elements). The fourth reason is the fact that the jump can be used in connection of dance and acrobatic elements in order to get 0,10 point bonus award. It is known that DV is not possible to increase with difficulty value of more than 8 most difficult elements. In that case, getting bonus awards presents a very important part of the total DV score, primarily because of the fact that they are unlimited. Bonuses on the balance beam are given if connections are performed between acrobatic elements (C/D+D (or more), C+C, B+E, B+B+D, C+B+C for 0,10 point; C with rebounding effect/D+D (or more), B+F, B+B+E, C+C+C, B+C+D for 0,20 point), turns (A+C or more turn (or reverse) for 0,10 point) and between acrobatic and dance elements (mix: C+C or more and D – salto to 1 foot + A- scale for 0,10 point).

The second composition requirement on the balance beam (COP, 2009) is performing turn from Group 3. Accordingly, it was expected that turns could be performed in various forms and rotation degrees. The *1/1 turn on one leg – free leg optional below horizontal (N=66)* had the highest prevalence, but statistically significant influence of this turn on DV, EV and FS was not determined. From the group of turns statistically significant influence on the DV was determined for the *1/1 turn with heel of free leg fwd at horizontal throughout turn (C difficulty value; N=27)* and for the *1/1 illusion turn through standing split with/without brief touching of balance beam (D difficulty value; N=1).* With respect to the difficulty value of this turns it is possible

to assume that they had a part in determining the total DV of exercise and because of what their influence on DV and FS was determined as statistically significant. If we observe the possibility of bonus award for connecting turns (A+C) through the number of all turns (N=106) in relation to the number of gymnasts (N=109) it can be assumed that (1) there were no gymnasts that performed more than a single turn, so there were no connections between the turns or (2) that the D judges devaluated the turns or (3) didn't recognize them occurring the fall. The absence of significant influence of all types of turns on the EV is probably the result of the accurate technique for performed turns which led to fewer deductions.

Summarizing the results, it is obvious that, although COP consists of a huge number of dance elements, junior gymnasts mostly performed the same elements. This result is consistent with Minusa (2000) and his opinion that performances in gymnastics have become increasingly similar and that virtuosity in performing isn't priority to most gymnast. The highest prevalence was determined to one C difficulty value dance element (*Switch Leap jump*) what is explained through its simplicity of performance and usability in fulfilling first composition requirement, in getting bonus for "mix" and in determination of total DV. Beside *Switch Leap jump*, very high prevalence was determined to four A difficulty value dance elements: *Sissone take off from both legs, Split jump from cross or side position, Wolf hop or jump from cross or side position* and *360° turn.* Although these elements have the lowest difficulty value, it is possible that they were a part of total DV scores of most routines. This especially counts for *360°turn* which is minimum turn, but inevitable part for fulfilling second composition requirement. Because most of the gymnasts chose to perform only this turn in exercise, expectedly, its statistically significant influence on DV, EV and FS wasn't determined.

Although COP defines minimum, but not maximum of dance elements in balance beam routine, only a few gymnasts choose to perform greater number of dance elements in their routines to achieve higher DV and accordingly higher FS. One of the reasons of this result probably lies in the article 7 which explains devaluation of dance elements if their performance is bad.

For routines with greater number of dance elements it can be assumed that they were composed from the elements with lower difficulty value, which fulfill composition requirements and from the elements with higher difficulty value (performed correctly) whose aim was to increase total DV. This assumption was confirmed with statistically significant influence of a dance elements with lower prevalence but higher DV score (*Johnson*, *Switch Leap with ½ turn*, *Johnson with additional ½ turn*, *Sheep jump* and *Yang-Bo*) on total DV and ultimately on a better FS.

Based on this result it can be concluded that, although implementing high difficulty dance elements on the balance beam is very risky, it is clear that the highest scoring dance elements are the best predictors of success in junior gymnastics competition. Nevertheless, this result needs to be perceived through the fact that information from this study came from E judge sheet, where devaluation of these jumps has not been marked. If the D judge sheets were used, it is possible that the results of this study would have been slightly different.

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RELIABILITY OF REAL TIME JUDGING SYSTEM

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Original research article

Abstract

The aim of our research was to analyse the implementation of a Real Time Judging System (RTJS) . In this research, 6 volunteer international level judges evaluated male parallel bars routines from Šalamun's memorial 2009 (World cup series B artistic gymnastics competition). The computer assisted system with a keyboard interface was used to record and display deductions from individual judges in real time. For validity assessment, the mean absolute and rank deviations of judges' execution scores, Kendall's W and ANOVA statistics were calculated. For consistency and reliability assessment, item-total correlations, Cronbach's alpha coefficient, intra-class correlations and Armor's theta were calculated. The overall results in terms of consistency (Cronbach's alpha mostly above 0.96) and reliability (Armor's theta 0.95, intra-class correlation for single and average measures 0.77 and 0.95, respectively) were satisfactory. As compared to results of judging analysis from a previous high level competition at Universiade 2009 higher indices of individual judge bias were found. In conclusion, RTJS shows promise as an efficient system to increase the transparency and informative value of judging while maintaining the same level of reliability.

Keywords: artistic gymnastics; information technology; panel judging; bias.

INTRODUCTION

Transparent and precise judging in artistic gymnastics is of paramount importance. Currently there are 6 judges (or 4 judges for competitions at levels lower than Olympic Games or World Cup) evaluating exercise execution. This results in the E (execution) score. In addition, 2 judges evaluate exercise content and they provide the D (difficulty) score (FIG, 2009). E scores range from 10 points down in decrements of 0.1 and D scores go from 0 points rising in increments of 0.1. Since the D score is a joint (consensus) score of both judges who evaluate exercise content, it is impossible to calculate reliability and validity, while for the E score – which is an average score of

the middle four (or two) judges – this calculation is possible.

It must be stressed that currently only the sum of deductions is presented in the individual judge's score and it is not known at what time-points which deduction took place and what was its magnitude. It would be of great value if E score judges could also be evaluated according to what deduction was taken and when it was taken during the rated exercise. The differences between judges of different expertise in this regard do exist (Dallas & Kirialanis, 2010). Computerised systems to allow for such an analysis of judging are available (Čuk & Forbes, 2006) and they should be tested as a

means to reduce significant differences in judge's scores and to improve the overall quality of judging.

This work is aimed to present for the first time the results of judging with the RTJS, which enables to record the deductions of individual judges in real time. The reliability and validity indices as defined previously (Bučar Pajek, Čuk, Pajek, Karacsony & Leskošek, 2011) were examined. The results were compared to recent contemporary results of judging on parallel bars under the same FIG Code of Points regulations from 2009 (Leskošek, Čuk, Karacsony, Pajek & Bučar, 2010).

METHODS

This study was performed at the Faculty of Sport, University of Ljubljana in March, 2011. Six international judges of breve (levels) 1-4 who volunteered to participate in this study were rating the videotaped routines. The routines were chosen from the international competition Šalamun's memorial, which is a world cup competition series B and was held at Maribor, Slovenia in 2009. As for the first study, only routines on men parallel bars were selected for evaluation.

The RTJS was used to serve as an application for entry of judges' deductions, their recording and display.   It was developed in Australian Institute of Sport (Warwick Forbes, Colin Mackintosh) and with collaboration of Faculty of Sport, University of Ljubljana (Ivan Čuk) . It enables the entry of judge deductions in real time during the routine execution. It is composed of a special keyboard with 4 keys (Figure 1), a computer, USB manifold, video camera, manifold of video signal, symbol generator, TV, video-recorder and video-player. System is regulated by a special software developed specifically for this application by Colin Mackintosh (Figure 2).

Figure 1. *A special keyboard for the entry of deductions (4 keys only, for deductions of 0,1; 0,3; 0,5 and 1 points, respectively).*

Figure 2. *The outlook of the special software developed specifically for this application (computer screen reporting deductions. Note the timeline on x-axis and the deductions by specific judges on the y-axis)*


Figure 3. *The video-screen showing routine and the deductions in real-time.*

Main system features and advantages are:

- E judges cannot change deductions during the routine;

- The judges must react to each mistake during the routine with a press on the appropriate key;

- System records the time the deduction was taken and the value of deduction taken (Figure 2);
- System could be compatible with ICROS Longines® system;

Through recording of selected routine and displaying the deductions on the video of that routine at the exact time when deductions were entered it gives the competitors and coaches an invaluable feedback about the judges' evaluation (Figure 3).

After the rating of all the parallel bar routines we calculated descriptive statistics for deductions, item (individual judge) and scale (all judges together) scores. Distributional statistics (mean and standard deviation) were calculated for individual judge's deductions and for signed and absolute deviation from final E score of competitors. These two forms of deviation are measures of bias (under- or over-estimation). For each individual judge, mean rank (R_{mean}) and its deviation (dR_{mean}) from expected (unbiased) rank were also calculated. These measures of systematic deviation of E scores were used to evaluate the validity of judging (specifically, the aspect of validity which refers to the presence and extent of bias). Expected rank was calculated as (m+1)/2, where m is the number of judges (with 6 judges the expected mean rank is always 3,5). The corrected item-total correlation (r_{corr}) was also calculated (the correlation between individual judge's scores and total scores).

Cronbach's alpha coefficient as a measure of internal consistency was used to test for consistency of individual judges. For each judge the *Cronbach's alpha if item deleted* was also calculated. This is the estimated value of alpha if the given judge was removed from the model.

Armor's reliability coefficient, theta (θ), is based on the calculation of the first and largest eigenvalue (λ_1) from the principal component analysis (Armor, 1974). While the ratio of λ_1 and the number of items (in our case judges) may be interpreted as the percent of total variance in the score due to the variation in the principal component, the Armor's θ is interpreted as a measure of reliability; that is how much of the total variance is represented by the between-subject variance. The closer the value is to 1, the lower is the impact of the raters' errors.

ICC coefficients were calculated under one-way random effects model, where judges were conceived as representing a random selection of possible judges, who rated all competitors of interest. The ICC may be thought of as the ratio of variance explained by the independent variable divided by total variance, where total variance is the explained variance plus variance due to the raters plus residual variance (Shrout & Fleiss, 1979). ICC equals 1 only when there is no variance due to raters and no residual variance. There are two types of reliability analysed with ICC: the single measure reliability and the average measures reliability; both were calculated.

We also performed two analyses of between-judges differences: Kendall's coefficient of concordance W and repeated measures ANOVA. Note that in the context of this research, high (statistically significant) values of Kendall's W indicated systematic bias (under- or over-estimation) with at least one of the judges.

All data were analysed with SPSS Statistics v. 17.0 software (SPSS Inc., Chicago, IL, USA) whenever possible, otherwise with Microsoft Excel v. 11.0 (Microsoft Corporation, USA).

RESULTS

There were 28 parallel bars routines evaluated by the experimental 6-judge panel. The median E score was 8,26 (range 5,68 – 9,5) and the mean±SD was 8,07±0,92. Representation of individual deductions of judges is shown in Figure 4.

The descriptive measures of performance of individual judges are shown in the Table 1. It can be seen that there were two judges with highest excursions from the expected rank (judges 2 and 4).
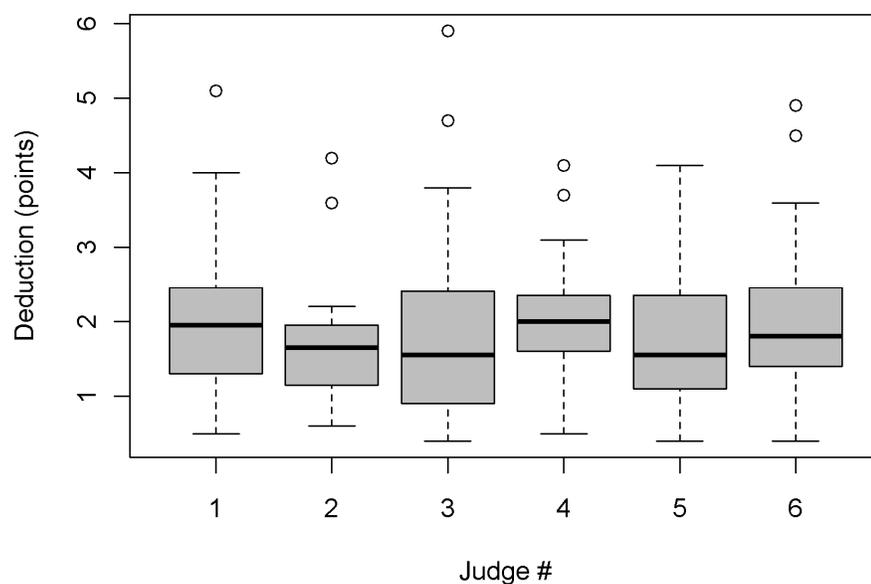
Figure 4. *The box-plots of individual judge deductions.*

Table 1. *The descriptive measures of individual judge performance. Abbreviations: rcorr - corrected item-total correlation; alpha del - value of Cronbach's alpha coefficient if judge deleted; Mean rank - mean rank of judge's E score; devRmean - mean deviation from the expected rank (expected rank always 3,5).*

Judge		Judge 1	Judge 2	Judge 3	Judge 4	Judge 5	Judge 6
Judge's deductions	Mean	2,00	1,65	1,89	2,14	1,78	2,06
	SD	0,95	0,80	1,32	0,82	0,97	1,05
Deviation from E							
score	Mean	0,07	-0,28	-0,04	0,21	-0,14	0,13
	SD	0,50	0,45	0,49	0,38	0,37	0,35
Absolute deviation	Mean	0,36	0,37	0,36	0,31	0,29	0,29
	SD	0,35	0,37	0,32	0,30	0,27	0,23
rcorr		0,82	0,83	0,95	0,89	0,88	0,91
alpha del		0,95	0,95	0,94	0,95	0,95	0,94
Mean rank		4,04	2,50	2,86	4,45	3,07	4,09
devRmean		1,43	1,57	1,71	1,45	1,32	1,38

Table 2. The correlation matrix for between individual judges' scores. The values shown are Pearson correlation coefficients.

Judge	2	3	4	5	6
1	0,69	0,83	0,80	0,70	0,78
2		0,83	0,72	0,79	0,80
3			0,87	0,89	0,88
4				0,80	0,86
5					0,86

The correlations between individual judges are shown in the Table 2. Overall high correlations were found between any two individual judges.

Chrombch alpha was 0.96. The intraclass correlation for single judge scores was 0,765 and the intra-class correlation for average values was 0,951. Kendall's coefficient of concordance was 0,18 (p<0,001). Armor's theta coefficient was 0,96. The F value of ANOVA for between judge differences was 4.37 (p=0,002).

DISCUSSION

In this first report of the results of judging using the RTJS we have found overall satisfactory indices of reliability. When we compare the values to the report of judging analysis on the Universiade 2009 (Leskošek et al, 2010) we can see that the values of reliability are quite comparable, see Table 4.

Table 4. *The comparison of this study and judging analysis of universiade 2009 in indices of reliability (objectivity)*

Study	Leskosek et al 2010 (Universiade 2009)	This study
Rcorr (median and range)	0.93 (0.77 – 0.96)	0.88 (0.82-0.95)
Cronbach's alpha (median and range)	0.98; 0.93; 0.96	0.96
ICC (single measures) †	0.91; 0.77; 0.81	0.77
ICC (average measures) †	0.98; 0.93; 0.96	0.95
Armors theta †	0.98; 0.94; 0.97	0.96

† The three values for Universiade 2009 denote are derived from the qualifications, all around finals and apparatus finals sessions, respectively.

When the indices of validity (concerning systematic bias) are regarded, there is a trend towards higher maximal deviations from E score at individual judge level with RTJS. Also, when compared to all around finals and apparatus finals at Universiade 2009 it can be seen, that RTJS yielded higher and statistically significant indices of bias (systematic deviation).

To put the observed differences from Table 5 in proper perspective two notions about the current judging process must be

made. First, currently there is a possibility for judges to correct their E-scores when they inspect the final sum of their deductions at the end of routine. Second, during the competition (going from routine to routine) it is possible for judges to correct their judging according to the final e-scores from previous routines. These two possibilities were prevented in our experiment. The judges had to make their deductions during the routine without the possibility for further corrections once the deduction was perceived by computer system (i.e. after the click on the keyboard). This important difference reduced the regression towards the mean and accentuated the differences between judges.

When we regard the possible use of RTJS in future it is more than obvious that such system would be of great value for the training of judges. It would enable a faster and more efficient inspection the judging output during the routine. Additionally, with this application the feedback to coaches and competitors would be much more informative giving them as much detail as possible about when and where the deductions were taken within their routine. Finally, we believe that this system should be tested also at gymnastics competitions to compare it with the current one and to see if it would enable us to further improve the judging performance in terms of reliability and validity and transparency of judging.

Table 5. *The comparison of this study and judging analysis of universiade 2009 in indices of validity (systematic bias of judges).*

Study	Leskosek et al 2010 (Universiade 2009)	This study
Maximal mean deviation from E score	0.07; 0.08; -0.18	-0.28
Maximal mean absolute deviation from E score†	0.17; 0.19; 0.26	0.37
Kendall's W†	0.03 (p<0.05); 0,08; 0.12	0.18 (p<0.001)
ANOVA F value for between judge differences (p)†	5.7 (p<0.05); 1.87; 0.89	4.37 (p=0.002)

† The three values for Universiade 2009 denote are derived from the qualifications, all around finals and apparatus finals sessions, respectively.

To conclude, we have reported for the first time the performance of RTJS. The system was able to record the deductions of individual judges in real time during the execution of routines. The results of the judging panel composed of 6 international level judges evaluating male parallel bars routines were comparable to the highest level competition (Universiade 2009) in the terms of reliability indices. Higher values of bias indices were found RTJS probably as a consequence of reducing the process of self stimulated regression towards the mean. This system shows great promise as a computerised application to provide more transparent, informative and reliable judging performance in the future.

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Slovenski izvlečki / Slovene Abstracts

William A. Sands, Jenni R. McNeal, Michael H. Stone

TERMOGRAFIJA IN TELOVADNE POŠKODBE: NAČINI UGOTAVLJANJA IN DOLOČANJA POŠKODB

Telovadci imajo relativno veliko poškodb, in najbolj težke poškodbe prizadenejo najboljše. Precej pogoste so poškodbe preobremenitve, ki mnogokrat ostajajo v ozadju do trenutka tekmovanja, ko pridejo na plan in onemogočijo telovadca. Ob tem se sprašujemo ali obstaja tehnologija, ki omogoča določanje teh nevidnih poškodb in možnost pravočasnega opozorila za medicinsko ukrepanje? Slikanje s termo kamero omogoča ugotavljanje vnetih delov telesa in simetričnih temperaturnih stanj. Asimetrična temperaturna stanja so določena s termo kamero, bolečina pa je ocenjena s tipanjem, anamnezo in pogovorom. Video posnetki bolečih mest se spravijo v elektronsko digitalno obliko ter pošljejo zdravniku, fizioterapevtu in trenerju za nadaljnjo analizo in ocenjevanje. Temperaturne razlike posameznih tkiv se ocenjujejo z razlikami v spektru sivine na sliki in primerjavo leve in desne strani telesa. Tako pridobljena informacija razlikuje poškodbe, vnetja in ostale dejavnike, brez motečih postopkov. Sposobnost določanja in zdravljenja poškodb, dokler so še nemoteče je zelo pomemben napredek pri onemogočanju poškodb, ki onemogočajo športno dejavnost. Termografija je postala zelo pomemben dejavnik pri pomoči mladim športnikom, pri ohranjanju njihovega zdravja , lažjem določanju o vrnitvi na športne terene ter sodelovanju med zdravstvenim in športnem osebju.

Trewor Dowdell

ALI SODI GIMNASTIKA MED NEVARNE ŠPORTE V AVSTRALSKIH ŠPORTNIH DRUŠTVIH

Splošni mnenje je, da je gimnastika, še prav posebej ženska športna gimnastika bolj nevaren šport, kot večina drugih. V članku ugotavljam: ali je sodelovanje v gimnastiki bolj nevarno (če je, bi morali imeti več poškodb) kot sodelovanje v drugih športih; ter ali je delovanje v lokalnih gimnastičnih klubih bolj nevarno kakor sodelovanje v programih gimnastike na univerzah v ZDA ali Avstralskih inštitutih za šport. Analiza je narejena na osnovi poročil avstralskih zdravstvenih organizacij ter člankov v revijah, ki so dostopni v zbirkah PubMed in Google Učenjaku. Povprečno število poškodb (na 1000 ur telovadbe) v gimnastičnih društvih je 2.65 (95% območje zaupanja 0.87 - 4.43), kar je močno pod številom poškodb za ostale priljubljene avstralske športe. Gimnastika ne predstavlja povečane verjetnosti za poškodovanje, v primerjavi z drugimi športi..

Olivia Donti, Kalliopi Theodorakou, Spiros Kambiotis in Anstasia Donti

SAMOPODOBA, STRAH IN IZOBRAŽENOST STARŠEV OTROK, KI SO SODELUJEJO V TELOVADNIH NETEKMOVALNIH PROGRAMIH

Cilj raziskave je bil ugotoviti povezanost med samopodobo, strhom in izobraženostjo staršev 117 otrok (povprečna starost 10.61 let, SD= 0.7), ki sodelujejo v netekmovalnih programih gimnastike. Uporabljena sta bila vprašalnika prilagojeni grški Harter's Self-Perception Profile for Children (1985a) in State-Trait Anxiety for Children (STAIC; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973). Izračunana je bila ANOVA in t-testi za neodvisne vzorce. Rezultati kažejo, da je očetova izobrazba vplivala le na en del sampodobe (socialno vključenost) in ni bila povezana s strahom, medtem ko materina izobrazba vpliva na vse dejavnike samopodobe (šolsko uspešnost, športno uspešnost, socialno vključenost in telesno podobo) in strah. Izobrazbena raven obeh staršev hkrati pomeni, da otrok višje in visoko izobraženih staršev ima deloma boljšo samopodobo (šolsko uspešnost, športno uspešnost, socialno vključenost in telesno podobo), ne pa tudi obnašanje in celotno samopodobo, pri strahu pa se ne razlikujejo od vrstnikov.

Ključne besede: samopodoba, strah, telovadci, starši, izobrazba.

Sunčica Delaš Kalinski, Ana Božanić in Almir Atiković

VPLIV RITIMIČNIH PRVIN NA REZULTATE NA GREDI

Po Pravilih FIG za ocenjevanje (FIG, 2009) je težavnost sestave določena z vsoto osmih najtežjih prvin v sestavi (vključno s seskokom) ob upoštevanju vseh petih posebnih zahtev ter dodatnih točk za povezanost akrobatskih ter ritmičnih prvin. Cilj članka je ugotoviti pojavnost ritmičnih prvin na gredi in njihov vpliv na težavnost sestave, izvedbo sestave in končno oceno. Vzorec je sestavljalo 109 telovadk, ki so nastopile na mladinskem evropskem prvenstvu leta 2010 v Birminghamu. Telovadke so v povprečju pokazale 4.28 ritmične prvine. Največkrat so telovadke izvedle ritmično prvino skok prednožno zanožno strižno – C težavnostne stopnje (N=101), povezano v dva skoka A težavnostne stopnje in sicer v skok prednožno upognjeno z eno nogo (N=83) in skok prednožno zanožno (kot med nogami več kot 180°) s sonožnim odrivom (N=61); oziroma v obrat na eni nogi (prav tako A težavnostne stopnje) (N=66). Regresijska analiza je bila značilna in rtimične prvine imajo pomemben vpliv na težavnost sestave.in na končno oceno. Težavnost ritmičnih prvin nima vpliva na oceno izvedbe sestave.

Ključne besede: ženska športna gimnastika, mladinke, težavnost, izvedba, pravila.

Maja Bučar Pajek, Warwick Forbes, Jernej Pajek, Bojan Leskošek in Ivan Čuk

ZANESLJIVOST SISTEMA ZA SOJENJE V REALNEM ČASU

Cilj je bil ugotoviti uporabnost sistema za sojenje v relanem času (RTJS). Pri raziskavi je prostovoljno sodelovalo šest mednarodnih sodnikov, ki so ocenjvali sestave na moški bradlji s Šalamunovega memorial iz leta 2009 (tekma svetovnega pokala B kategorije). Računalniško podprt system sestoji iz posebne tipkovnice, vmesnika računalnika in posebej narejenega program za spremljanje in hranjenje odbitkov posameznega sodnika v realnem času. Za veljavnost smo uporabili naslednje mere: povprečni absolutni odbitek, rang odbitka, razpršenost odbitkov, Kendall W in ANOVA. Za doslednost in zanesljivost smo izračunali korelacije med sodniki, Cronbach alpha koeficient, intra-class korelacije in Armor's theta koeficient. Rezultati kažejo visoko doslednost (Cronbach alpha večinoma preko 0.96) in zanesljivost (Armor theta 0.95, intra-class korelacije za posamezne in povprečne meritve so od 0.77 do 0.95). Primerjava z rezultati sojenja na drugih velikih tekmovanjih (Univerziada 2009) kažejo na nekoliko povečano nedoslednost posameznih sodnikov. RTJS bi lahko bil uspešen system za povečanje jasnosti sojenja ob primerni zanesljivosti sojenja.

Ključne besede: športna gimnastik, informacijska tehnologija, sodniki, zanesljivost