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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.

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

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III INTERNATIONAL SEMINAR ON COMPETITIVE ARTISTIC AND RHYTHMIC GYMNASTICS - SIGARC 2012

FIRST INFORMATION

Dear Gymnastics researchers, athletes, coaches and judges,

We are pleased to invite everyone to participate in the 3rd SIGARC – *INTERNATIONAL COMPETITIVE ARTISTIC AND RHYTHMIC GYMNASTICS,* to be held on October 5 and 6, 2012 in Rio Claro (Sao Paulo – Brazil), at the São Paulo State University (UNESP). The schedule and program, the submission guidelines and other relevant information will be available by February 2012.

Sincerely,

Organizing Committee.

CONTACT
E-mail: sigarc@rc.unesp.br
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EDITORIAL

Dear friends,

We are entering into the fourth year of publishing Science of Gymnastics Journal. Year 2011 was successful as we published 16 articles. Articles were written by authors from Brazilia, Portugal, Serbia, Greece, Unitade States of America, Australia, Croatia, Bosnia and Herzegovina, Germany, Austria, United Kingdom, Belgium and Slovenia, all together from 13 countries.

We were entered into the ProQuest data base, we are still testing SchoolarOne Manuscript Software, and we have a new editorial board member – Koichi Endo from Japan. From last October issue we have to apologize to the authors Luísa Amaral, José Ferreirinha, Paulo Santos and Albrecht Claessens as we did some errors in article design; you can find corrected article on our web pages.

The February issue we start with the article from sport management. Mauricio Santos Oliveira and Marco Antonio Bortoleto analyzed impact of Brazilian State support to results of gymnasts. For gymnastics developing countries the experience of Brazilians can be of a high value as they have excellent gymnasts. It is worth to note between **5th and 6th October 2012** in **Rio Claro** (Sao Paulo State University, Brasilia) will be organized **3rd International Seminar on Artistic and Rhythmic Competitive Gymnastics**. In 2010 the seminar was of a high quality with many international experts including Keith Russell, FIG Scientific Commission president.

The second article is from Lurdes Ávila-Carvalho (Portugal), Panagiota Klentrou (Canada), Maria da Luz Palomero (Spain) and Eunice Lebre (Portugal) and analysis morphologic characteristics of rhytmic gymnast's. International team detected changes in the past few years towards more healty body posture of womens involved in rhytmics.

The third article comes from Greece. Authors Olivia Donti, Kalliopi Theodorakou, Spiros Kambiotis and Anstasia Donti prepared article with title Self-esteem and Trait Anxiety in Girls Practicing Competitive and Recreational Gymnastics Sports, and found important facts for artistic gymnastics coaches to deal with anxiety.

The fourth article is from Croatia, Kamenka Živčić Marković, Ines Čavar and Goran Sporiš were monitoring 5-6 years old girls - gymnasts for nine months how they developed under their gymnastics program. It is worth to look at the figures with development curves as they are non linear and make us to think more about the development pathways.

The fifth article deals with rhythmic gymnastics and motor learning. Greek authors Despoina Tsopani, George Dallas, N. Tasika, A. Tinto write how is more effective learning of rhythmic gymnastics for novice adult physical education students. Worth to read and re-think about our rhythmic and gymnastics programs at Universities.

The sixth and the seventh article are dealing with Code of Points. German authors Thomas Heinen, Pia M. Vinken and Konstantinos Velentzas were exploring how laypeople and expert judges evaluate gymnasts' performance. It seems they can both well evaluate the gymnasts' performance. Perhaps the Code of Points is not too complex? Slovenian - Canadian authors Ivan Čuk, Hardy Fink and Bojan Leskošek analyzed the impact of different ways of calculating final score (difficulty and execution) on ranking. With more weight on execution, ranking would be very changed; different gymnasts would enter into finals, but Code of Points most important statement - the gymnast must include in his exercise only elements that he can perform with complete safety and with a high degree of aesthetic and technical mastery would became effective.

I wish you pleasant reading and a lot of inspiration,

Ivan Čuk
Editor-in-Chief

PUBLIC SPORTS POLICY: THE IMPACT OF THE ATHLETE SCHOLARSHIP PROGRAM ON BRAZILIAN MEN'S ARTISTIC GYMNASTICS

Mauricio Santos Oliveira[1] & Marco Antonio Coelho Bortoleto[2]

[1]Physical Education and Sports School, University of São Paulo, Brazil
[2]Physical Education Faculty, State University of Campinas, Brazil

Original research article

Abstract

The Brazilian government established the Athlete Scholarship Program, by Law n°10.891/2004, aiming to contribute for athletes' economical support, development and permanence in sports and to renew the Brazilian representation in national and international competitive events. This study intends to present the program and to discuss its impact on Brazilian Men's Artistic Gymnastics (MAG) according to the opinion of Brazilian experts. A bibliographic review has been used as methodological procedure, followed by a field survey consisting of semi-structured interviews applied to Brazilian representatives, coaches, judges and world-class gymnasts. The results revealed the important role of the Athlete Scholarship Program on the gymnasts support, however other actions are necessary to solve structural and financial problems that still affect this sport in Brazil. We suggest some changes in the program in order to increase the number of scholarships offered, to minimize the bureaucracy application and to make clearer the enrollment rules, the accountability and the selection process.

Keywords: *sports public funding, sports policy, sports legislation.*

INTRODUCTION

The sport phenomenon became a very important issue for government policies, mainly because of the utilitarian character that it plays as part of both social and educational policies. This fact can be observed in many countries that have several laws and programs designated to raise and support the sport community, as reported by Hoye, Nicholson and Houlihan (2010) and also Ferrando, Otero and Barata (2009).

We can observe, especially since the 70's, an international tendency in increasing governmental support (by the use of the public funding) to sport related aspects, linked to a variety of national and international political goals (Houlihan, 1997). According to Houlihan and White (2002), it was in this period that many governments started projects and public policies to the development and consolidation of sport, particularly for the competitive sport, as part of an overarching policy for the social, educational and cultural areas.

In Brazil, it was in the 80's as reported by Tubino (1993), that the State definitely included sport in the National Constitution, precisely in the *Carta Magna* of 1988 (Federative Republic of Brazil, 1988). From

this moment on, the government's role concerning the sports phenomenon was redefined, consolidating sport funding as a government official commitment (in every level, from national do regional), aiming to promote and maintain sports from the educational bases to the highest level of competition.

Since then, the support of the Brazilian government has significantly increased proportionally to the role that sports acquired in its society. This can also be seen in other countries like Spain, as highlighted by Ferrando, Otero and Barata (2009)[1]. Therefore, "more often the State uses the public resources to invest in sports, providing its development" (Tubino, 1987, p. 65).

Between 2000 and 2010, "there has been an increasing preoccupation of the Brazilian government in order to amplify its participation in the three different scope of the sport: the high level, the scholar and the sport for all" says Ferreira (2007, p. 2).

The development of a specific Ministry for sports in 2003 has signalized, in an even clearer way this time, that there was a Brazilian governmental provision for the sport phenomenon. According to Boudens (2007), the Ministry of Sports became a specific department focusing on the development of the national policies for sports and leisure. In fact, as mentioned by Houlihan (2005), before the 90's just a few countries had a specific budget for sports administration. Even though a bit late, Brazil has followed the tendency of the majority of economical developed countries.

According to the Brazilian governmental strategies, the Ministry of Sports intends, among other attributions, to promote issues related to sports activities as its principle. It is believed that the investment in sports can promote health and benefits for both education and social inclusion (Ministry of Sport, 2010a). In this way, Boudens (2007) points out that the Ministry of Sports might guarantee free access to sports practice helping to improve the citizen's life quality and also human development in general.

According to Bergsgard et al. (2007), national governments started to consider sport as a very important factor for economical and social activities, considering also its contribution to a variety of areas (as educational, health, leisure, etc.), becoming sometimes a panacea for public policies. Coalter (2007) associates these decisions to the fact that sport can be important for the social and economic regeneration, crime and drugs fighting, educational and health improvements. As we may observe, there is a growing fascination among the national governments about the social and economic roles that sports play on communities through the non-sportive results (Hoye, Nicholson, & Houlihan, 2010). In the words of Parish (2008, p. 80),

Sport therefore has a public function and the expansion of its social and economic significance and its growing organizational sophistication and internationalization has attracted increased interest from public policy makers. Sport is used as a tool of nation building (particularly when sporting individuals and teams assume a representative function at European and World Championships), as a provision of a public good, as a tool for health promotion, as a means of combating social exclusion, as a tool for crime prevention, as a vehicle for economic development and as a tool of foreign policy.

Ferreira (2007) affirms that the Brazilian sport policies are now in a development phase, and they have three main characteristics for their execution and regulation. One of them consists in the existence and implementation of laws that recognize sport as a public interest activity and a population right. This strong position became evident when the Brazilian Constitution declared sport as a fundamental activity for the society (Tubino, 1987).

[1]Bortoleto (2004) developed a detailed analysis of the Spanish MAG National Team, highlighting the importance played by the existence of scholarships and other financial help supported by governmental programs, as ADO Scholarship conceded by the Superior Council of Sports (Spain).

Another feature mentioned by Ferreira (2007) is about sport-funding, regulated through legal incentives, patronages and taxes. We would include the benefits offered to the athletes in order to guarantee means for their improvement. At last we may quote the political control to promote cooperation among many sports institutions, in a national, state or county level that also controls the creation and maintenance of the sport's infrastructure available in the country.

The Athlete Scholarship Program may be inserted in those sport policies features above said, since this consists in a group of principles, guidelines and strategic actions developed by the Ministry of Sports through legislation, looking for the promotion and development of the competitive sport culture.

The program's project has been prepared by former Sports Minister Agnelo Queiroz and its legislation has been instituted by the Federal Government Law n^{o} 10.891/2004, sanctioned by the ex-president Luiz Inácio Lula da Silva (Federative Republic of Brazil, 2004).

Through the Athlete Scholarship Program, the Ministry of Sports intends to provide better conditions to the career development of Brazilian athletes by offering financial resources in order to help them dedicate themselves only to the training and competitions.

According to the Ministry of Sports (2008), the program invests with priority in Olympic and Paralympic Sports in order to build, maintain and renew, periodically, the athletes' generation with the potential to compete in high level. Since its implementation in 2005, the Artistic Gymnastics (AG) is one of the sports which are contemplated by these program's resources.

Trying to understand the Athlete Scholarship Program, or more specifically how this subvention has been used in Men's Artistic Gymnastics (MAG), this study descant about the scope of the program and its contribution to the MAG through the opinion of experts involved in this sport at the high level.

Although the sport has been acquiring a greater role in Brazil, and therefore an increase in revenue in this sector may be noted, Veronez (2007) reports that maybe there is no study field so poorly explored as the sport funding area. So, there is the need for researchers to follow and analyze the policies and programs established by the Brazilian government to sports development, trying to constantly assess if these resources are being used correctly and achieving the expected results.

METHODS

At first we developed a bibliographic research alongside a documental one searching for primary information sources which were not treated analytically yet (Gil, 1999).

The field survey consisted of semi-structured interviews that, according to Triviños (1987), valorizes the researcher's presence and offers perspectives to the subjects to achieve the freedom and the spontaneity needed when the interviewed people expose their ideas, which helps to improve the investigation procedures.

About the population for this study, it was composed by nine (09) individuals: two gymnasts (2), three coaches (3), two judges (02) - who have also worked as coaches - and two federation officials (2). Since this is a qualitative research, these subjects were chosen following external criteria such as social stratum, occupation and category, as the focus of the investigation was the variety of issues presented and the argumentative structure applied (Bauer & Aarts, 2003 quoted by Lüdorf, 2004).

For this investigation, the subjects were selected according to their degree of relevance and representation in the competitive Brazilian MAG. The gymnasts and coaches are part of the Brazilian National Team, who have obtained national and international results along the 2005 to 2008 Olympic Cycle. The judges should have the international brevet, minimum

category 3 of FIG, and have participated in at least two international competitions from 2005 to 2008 cycle. About the officials, we opted for those who came from the most developed federations of this sport, that is, the federations who had the highest number of events, courses and gymnasts participating in national competitions.

For the data treatment, we have used the Content Analysis as a technique for the organization and summarization of the information collected. Following the directions pointed out by Bardin (2008), the analysis has followed three steps: pre-analysis, material exploration and inference.

PRESENTATION OF THE ATHLETE SCHOLARSHIP PROGRAM

The national governments and their agencies invest a great amount of money in competitive sports in order to achieve better results, what would enable them to compete equally against other nations (De Bosscher et al. 2006). Intending to contribute to the development and maintenance of the athletes, and also to help Brazil to have better results in the international competitive panorama, the Athlete Scholarship Program has been instituted. This option to help the athletes through financial support, facilitating their sport activity as well as their personal development, represents an attitude of an advanced country which is capable to analyze the sport as an activity with social influences and positive values (Olmeda, 2006).

The program follows the norms instituted by the Law n. 10.891 of July/2004. It was regulated by the Statute n. 5.342 of January/2005, signed by the former Brazilian president Luiz Inácio Lula da Silva and by the author of the project, the former minister of sports Agnelo Queiroz (Federative Republic of Brazil, 2004; 2005).

Five years after its implementation, the program legislation was reviewed and altered by the Provisional Measure n.502, sanctioned by former President Lula in September 20th of 2010. The goal of this measure was to contemplate a larger number of athletes favoring the development of sports in the country, with a focus on the Olympic Games in Rio de Janeiro in 2016, increasing the governmental financial aid for the development of the national athletes. The Ministry of Sports (2010a) affirmed that those changes intend to qualify the program, and offer a better opportunity of development to those athletes who have chances of bringing medals back home.

The Athlete Scholarship Program is managed by the Ministry of Sports, who is responsible for all the procedures of concessions and the distribution of benefits that this law must contemplate in all of its categories. As mentioned before, the emphasis of this program is to provide, by a financial support monthly provided, the minimum conditions to enable training dedication and the participation of athletes in competitive events.

The law instituted that the funding may be oriented, with priority, to high level athletes who compete in Olympic and Paralympic sports. According to the changes made by the Provisional Measure n.502 (Federative Republic of Brazil, 2010), it has been stipulated that all the others sports that do not make part of these two categories would be analyzed and maybe able to also receive the financial aid, since the total amount invested does not exceed 15% of the total program funding. Gymnastics sports, such as aerobics and acrobatics, which are not Olympic sports, may be included in this budget.

The limits on the investments imposed to these non-Olympic sports come to correct the decreased percentage of scholarship conceded to the Olympic and Paralympic sports that should have the priority to receive the scholarships. The Court of Audit (Court of Audit, 2011, p. 26) verified that in the period between 2005 and 2009, there was a reduction of Olympic and Paralympic sports participating in relation to the scholarships conceded. The proportion, in 2005, was 81% (11% were non Olympic or Paralympic). In 2009, it was only 67%

(more than 33% were conceded to other sports).[2]

By looking at these numbers, we were able to note that there is a risk of scholarship losses conceded to the Olympic sports. According to the description of the law, the Olympic sports ought to have the preference to receive these scholarships, since the main goal of this program is to place Brazil in the top 10 medal-winning countries at the Olympic Games (Court of Audit, 2011).

The program divides athletes in different categories according to their results and ranking in national and international competitions. The values conceded and the athletes' categories are listed in Table 1. The Provisional Measure n. 502 added two new categories and increased the importance of the scholarships for 2011. In Figure 1 we can analyze the scholarship distribution according to the athlete's categories from 2005 to 2009.

Each category has some specific demands that must be followed cumulatively (Federative Republic of Brazil, 2010). In the Student Category, the athlete must be between 14 to 19 years old, needs to show an enrollment registration in an educational institution, which may be public or private, and must prove participation in any national sport event recognized by the Ministry of Sports. Moreover, he will only be provided with the benefit if he has reached at least a third place in an individual sport or has been elected among the top six athletes of a team sport.

The auditing, developed in 2010 by the Brazilian Court of Audit, showed that there is a small Student Category participation among the total of scholarships offered by this program. Between 2005 and 2009, this category corresponded only to 8% of the total (Figure 1). According to Court of Audit (2011), it has been identified as a possible causes to the weak participation on the Student Category the following aspects:

a) The minimum age criteria established by the legislation;

b) Scholar Olympic Games as the only competition used as a parameter to select student athletes;

c) Reduced number of sports who integrate the Brazilian Scholar Olympic Games;

d) Low referral of student-athletes to the Athlete Scholarship Program by their enrolled sport association.

In the period before the Provisional Measure n.502, the law established that the minimum age to be able to receive the scholarship was 12 years old. So, children with potential to practice in the high level could not be contemplated with the subvention offered by the Ministry of Sports. We agree with the Court of Audit (2011, p. 28), who said that "this situation is especially compromising for those sports in which the development happen in the early years, as it occurs in Gymnastics".

We may highlight that the absence of many sports in the Brazilian Scholar Olympic Games became a problem, because this was the only sport event used as a selection criteria for the Student Category of the Athlete Scholarship Program. It means that those who didn't participate in this event, due to an injury or because their sport were not in the competition program, were not able to ask for the scholarship. In the existing format until 2009, the category covered only the finalists of one scholar competition, "discarding many potential talents who do not have the opportunity to participate in the national phase of the Scholar Olympic Games" (Court of Audit, 2011: 02). The auditing, developed in 2010 by the Brazilian Court of Audit, showed that there is a small Student Category participation among the total of scholarships offered by this program. Between 2005 and 2009, this category corresponded only to 8% of the total (Figure 1). According to Court of Audit (2011), it has been identified as a possible causes to the weak

[2]Translation made by the authors.

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Table 1. *Categories and Scholarship Importance of the Athlete Scholarship Program.*

Category	Until 2010 (R$)[3]	From 2011 (R$)
Student	300,00	370,00
Base Athlete	-	370,00
National	750,00	925,00
International	1.500,00	1.850,00
Olympic/Paralympic	2.500,00	3.100,00
Podium Athlete	-	Up to 15.000,00

Source: Federative Republic of Brazil (2010).

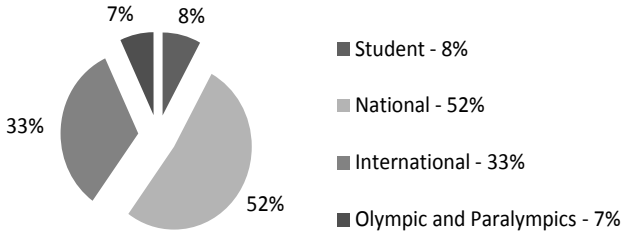

Figure 1. *Athlete Scholarship distribution from 2005 to 2009 (Court of Audit, 2011).*

[3] "REAL" is the Brazilian Currency: R$ 1,00 is approximately equivalent to U$ 0,62 – Rate values based in August 2011.

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The Base Athlete category, created by the Provisional Measure n.502, contemplates the athletes between 14 to 19 years old that excelled in the base category of competitive sports. According to Court of Audit (2011), this category was established trying to meet an existent gap in the Student Category that did not contemplate all the athletes with potential to excel in the Olympic sports, either because the sport was not included in Brazilian Scholar Olympic Games or because the base athlete has missed the right to receive the student scholarship due to age limits.

To prove the athlete excellence to receive the scholarship in the Base Athlete Category, the individual athlete must be among the three first places of an event selected by the national sport entity or be indicated among the top ten athletes of a team sport one year before the scholarship is requested. In the majority of time the competition selected is the national championship because of its scope and importance in the sport area.

As criteria for the National Category, the athletes need to prove their participation in the most important Brazilian competitive event indicated by the national federation or sport association, and they need to place in the podium.

The athletes who make part of the Brazilian national team and who represent the country in an international event (e.g.: South-American Championships, Pan American Games or World Championships) conquering one of the top three positions, may apply for the scholarship in the International Category. The events must be recognized by the Brazilian Olympic or Paralympic Committee or other international entity that manages the sport in case of a non-Olympic sport.

The Olympic and Paralympic Category covers only those athletes who represent Brazil in the Olympic Games and still compete in international events with good results. By the Provisional Measure n.502, the athletes from this category who are ranked internationally in the top twenty

in their sport can apply for the Podium Athlete Category scholarship.

According to the Ministry of Sports (2010a), the subsidy for the Podium Athlete Category may last for four years, in a course of an Olympic cycle, or while the athlete remain in a top position in the international ranking. With the amount received, the athlete can afford their personal expenses, the competitive travels and the sport material.

The Podium Athlete scholarship also allows the athlete to contract a multidisciplinary team to assist him during the training. This positioning of the Ministry of Sports calls our attention to the fact that the athletes only start to have the right of having enough financial resources to attend his needs to achieve the high level in sport when he already reached his excellence, so that the previous stages of his development remains unassisted. We understand, according to Olmeda (2006), the need to highlight that a lower level athlete cannot be seen as less important or with less needs then an elite athlete.

As in the Podium Athlete Category, the Olympic and Paralympic athletes are going to receive the benefits for one Olympic cycle since they prove good results in the international panorama of their sport. In the other categories the benefits are renewed annually.

From the implementation of the Provisional Measure n.502, the athletes have been authorized to make partnerships with sponsors or earn other payments from sports entities (e.g.: sports clubs) as another possibility to support their training and competitions, but they are required to submit the accountability of these incomes in the moment of enrollment. Before the Provisional Measure, athletes were not allowed to receive any funding support alongside the scholarship.

This new approach allows all athletes who will participated in the Olympic and Paralympic Games to have the right to apply for the scholarship, as seeing in the majority of time, and at the same time benefit from any funding provided by sponsors or sport clubs. According to the Ministry of Sports (2010a), the current proposal is to qualify the Athlete Scholarship Program as another funding option to stimulate the athlete.

Another resolution of the current program legislation is related to the approval of the annual athlete training plan, that mentions the goals and targets respecting the criteria and models established by the Ministry of Sports through the 'Administrative Rule' published in the Federal Official Gazette of Brazil. We believe that this proposal comes to correct problems like the non-participation of athletes who own the scholarships in competitions and the lack of good results during the period that the athletes are receiving the financial support (Court of Audit, 2011).

According to the worksheets of the Ministry of Sports (2010b), the Athlete Scholarship Program contemplated 102 artistic gymnasts through the period of 2005-2009, as we may see in Table 2.

Table 2. *Number of Gymnasts Contemplate by the Athlete Scholarship Program.*

Year	WAG	MAG	Number of Gymnasts Contemplate
2005	10	18	28
2006	0	4	4
2007	1	13	14
2008	6	21	27
2009	9	20	29
Total	26	76	102

Source: Ministry of Sports (2010b).

Many gymnasts apply for the scholarship because the benefits from sponsors are restricted in AG. The sponsors are rare in this sport since AG still has a poor visibility in the national media[4]. More over, there are few clubs or teams who have resources to support their gymnasts financially providing payments or scholarships (e.g. transportation, food and accommodation). This reveals the amateurism of this sport in Brazil.

The financial problems, besides making it even more difficult for the athletes to develop themselves, may also force many of them to drop out earlier from the sport practice because of their need to start working and help with their family expenses. Consequently, the gymnasts quit the sport without the opportunity to even reach the maximum of their performance, which usually occurs in MAG at the end of their teenagerhood and in the beginning of their adulthood according to the parameters dictated by Arkaev and Suchilin (2004), and Smoleuskiy and Gaverdouskiy (1996).

Authors such as Du and Tsai (2007) related the lack of financial support and the desire to improve their economic status as factors that influence the retirement of many athletes. The difficulty of the athletes in devoting themselves fully to training and competitions is also evidenced by Green and Houlihan (2005).

Approximately 74.5% of all the scholarships designated to AG have been conceded to MAG. We may infer that the major visibility and consequently the greatest investment designated to the WAG in Brazil may explain the minority of scholarships conceded to women gymnasts. Since the WAG team dispose of an official sponsor since 2004 has also contributed for this fewer number of female gymnasts contemplated, in that period it was not allowed to accumulate scholarships along with the sponsors funding.

In 2006 there has been a decrease in the number of AG beneficiary athletes. We believe that the entrance of a new official sponsor for the Brazilian Gymnastics Federation, which contemplated both men's and women's AG, may have influenced the decrease in the number of gymnasts who had the scholarship that year (Oliveira, 2010). In Table 3 we present a summary of the program in the period of 2005 and 2010.

Table 3. *Number of athletes and amount of investment for Athlete Scholarship Program*.

Year	Amount (R$)	Nº of Athletes benefit
2005	12.692.400,00	924
2006	13.220.400,00	846
2007	25.736.400,00	2.160
2008	40.181.400,00	3.370
2009	40.400.000,00	2.954
2010	40.000.000,00	3.009
Accumulated	172.230.600,00	10.254

Source: Ministry of Sports (2011a, 2011b).

Analyzing this data, the Court of Audit (2011) affirmed that the Athlete Scholarship Program consists in an action of major financial investment for the competitive sport sector made by the Ministry of Sports. Track & Field and swimming were the sports that most received scholarships during this period. We emphasize that the number presented in Table 3 also includes athletes with special needs.

The increasing number of scholarships given by the program shows the struggle, not only presented by the gymnasts, but from all sports when trying to find financial support from sponsors, clubs and sports associations. From 2005 to 2009 only the athletes with no income were able to apply for this support.

Next we are going to elucidate the impact of Athlete Scholarship Program in the daily routine of Brazilian MAG by asking some experts who make part of this reality daily.

[4] In the last years the SPORTV channel has been broadcasting regularly the main international events, and some of them by the main Brazilian TV channel. At the same time, the Brazilian Gymnastic Federation has been sponsored by important enterprises, which has enormously contributed for better conditions of this sport practice and a greater visibility in the mass media (Bortoleto, Ferreira, Rodrigues, 2011).

THE IMPACT OF THE ATHLETE SCHOLARSHIP PROGRAM IN BRAZILIAN MAG BY THE EXPERTS PERSPECTIVE

The Brazilian MAG has passed through significant changes in the last decades. According to Oliveira and Bortoleto (2009) this sport came from an completely amateur organization during the 80's and early 90's, becoming later a more professional organization nowadays. We have also observed an expressive qualitative improvement in international competitions results (Table 4 and 5). The individual results, as the two gold medals won in World Championships by Diego Hypólito in floor exercise (2005 and 2007), and recently medals in 2011 (a bronze medal in floor exercise by Diego Hypólito, and a silver medal in Rings by Arthur Zanetti), confirm this trend.

Table 4. *Number of medals at the Pan-American Games (1991-2011).*

Year	1991	1995	1999	2003	2007	2011
Gold	0	0	0	0	3	3
Silver	0	0	0	3	1	1
Bronze	0	0	0	3	1	0
Total	0	0	0	6	5	4

Table 5. *Team results at World Championships (1991-2011).*

Year	1991	1994	1995	1997	1999	2001	2003	2006	2007	2010	2011
Result	25th	*	*	*	*	23th	19th	18th	17th	19th	13th

* Brazil didn't participate with a full team.

This improvement of Brazilian's MAG results was partially supported by better economic condition provided by sponsors and mainly by public agencies. The governmental investment has offered better training conditions, regular opportunities for international exchanges, increase of Brazilian gymnasts in international competitions, and finally stronger financial support for new scholarships and equipments and facilities improvement (Oliveira, 2010). The opinion of Judge 2 (J2) reinforce this situation: "today's economic reality is one million times better than it was 20 years ago, today we have gymnasts who make living by practicing gymnasts. His profession is the gymnastics".

When we asked to Gymnast 1 (G1) about the Athlete Scholarship Program, he quoted to be contemplated with the benefit and affirmed that the program is effective and helps in the process of the athlete development. G1 also explained that more than the financial provision, the program has become an aspect of motivation for the gymnastic practice:

It works, because today I see other gymnasts dying to win a medal in the Brazilian Championship and trying even harder to win an international medal, because, as I said: those with no results, nowadays, have difficulties to earn anything from their town or club compared to the amount provided by the International Category of the Athlete Scholarship Program, for example, it is difficult. (G1).[5]

In consonance with G1, the Gymnast 2 (G2) says that the program works and many athletes are looking for this option not only to pay the materials and supplies needed for training, but for their personal expenses, for living: "It works, man, I know many athletes, even from the Brazilian national team, and they use this option as a

[5]All the testimonials has been translated by the authors of this investigation.

way of living, not only to buy the supplies, grips that they need to practice gymnastics, but for their personal life" (G2).

The G2 mentioned that the amount paid by the Athlete Scholarship Program surpass, in the majority of time, the payment given by the club or even the income paid by the Brazilian Gymnastics Federation: "Some clubs, almost in the majority of times, do not offer this amount for the gymnast and by the Federation it wouldn't be worth it either, so they keep the scholarship".

The fact of the gymnasts who belong to the Brazilian Team refer to this program shows that even those in the high level have difficult to earn money from sponsors or from the sports institutions in which they are involved. This demonstrates the fragility of this sport regarding the economic aspects to sustain the athletes.

G2 affirms that the amount provided by the Student Category, in the previous period of the Provisional Measure n.502, is the same amount he earned when he first participated in the World Championship in the mid-90's:

Three hundred bucks (R$ 300,00) I got when I used to go to the World Championship. My first World Championship I got this. The gymnastic reality is completely different (today). [...] the younger gymnasts who are getting into the Brazilian Team will find this structure, maybe they do not recognize all the problems we have had before. (G2).

Despite the compliments, the Official 2 (O2) manifested that the Athlete Scholarship Program is a gain, but there are still problems to be solved:

It is a very good project that came to help the clubs a lot. Sometimes I think there are some distortions. There are sports, I work in a club, there are sports that the guy practice three times a day and go to a World Championship, second division, and he gets fifteen hundred *reais* monthly, you know? It is our sport reality. In gymnastics, for you to get the International Scholarship you have to win a competition abroad. South American, Pan- American is really hard. (O2).

When analyzing the program's law, we verified that there is no specification or requirement established for the quality of results reached or for the competitive level of the event. It would be pertinent that the results were compared to international parameters, as records or scientific protocols. According to the Court of Audit (2011), this act would contribute so that the scholarship would be designated to those athletes with real chances of reaching the high level practice. A complex decision, but consistent with a limited budget program that can't contemplate all the athletes.

Other problems have been listed by Coach 3 (C3), despite his support to the Athlete Scholarship Program:

The Athlete Scholarship Program, yes. It works. Like this, it works with many problems of course. They delay a lot the payments to the athletes, when the contract expires they take five months to restart the payment and you can't get back what you have lost. (C3).

Addressing C3's critics about the funding provision, the Court of Audit (2011) verified that the average time between the request for the scholarship at the Ministry of Sports and the first payment was around 417 days. This long wait also occurs between the scholarship's and its renewing process. These procedures need to be enhanced so the athletes become able to have the same support during the process analysis for the next benefit concession.

This issue was improved after the Provisional Measure n. 502 for the athletes who make part of the Olympic/Paralympic and Podium Athlete categories, because they will start to have an automatic renovation of their scholarship during the Olympic cycle, only if they are able to prove good results in competitions. We could verify that the delay on the publication of the contemplated athletes by the scholarship and the beginning of their payments, continue to be a problem and need to be solved by the managing agency.

We agree with the Court of Audit (2011, p. 29) about those athletes who use the scholarship to finance food and transportation expenses: "this delay may contribute for the drop out of the sport and the search of new working opportunities elsewhere, which contributes for the athletic career renounce due to the lack of perspective to continue practicing."

Guimarães (2009) quoted that there have been just a few athletes who received the scholarship for three or four years between 2005 and 2008. This discontinuity can be related to the fact that the achievement of good results also helped some athletes to conquer better projection in the media, and, consequently, they received the support of sponsors and had to abandon the scholarship benefit because, in that period, they couldn't have both incomes. Another aspect that might have contributed for this discontinuity concerns to the absence of satisfactory results or even the lack of participation in competitive events (Court of Audits, 2011).

We also found that the values paid in the previous period of Provisional Measure n. 502 did not attend all the athletes' needs. Coach 1 (C1) affirmed that the athlete scholarship helped them to practice longer but the program didn't assure the necessary conditions for an adult gymnast with the responsibility to raise a family. We believe that with the increase of the value of scholarships, and the possibility of adding other income sources can minimize this problem.

Beside the changes on the Provisional Measure n.502, some of them predicted by Guimarães (2009) as the funding limits imposed to the non-Olympic sports, the creation of the Base Athlete Category and other aspects still need to be discussed.

One aspect deserving attention is related to athletes who have good competitive history, but who are injured and for this reason aren't able to demonstrate good results and ended up being cut off from the program. It makes their regress to competitions much more difficult. This requires attention in order to improve the program and its success. Another consideration is about the scholarship concession to those low-ranked athletes when other better positioned athletes do not request the benefit. These are some of the alternatives that could be included in the Law aiming to improve the Athlete Scholarship Program, but unfortunately they are still not in the program legislation and barely make part of the academic debate about the public funding designated to the competitive sport in Brazil.

CONCLUSIONS

We agree with De Bosscher et al. (2009), when they affirm that the success of an athlete, professional or amateur, depends greatly on the governmental support and its efficiency to apply the funding for the sport. The financial aspect plays a determinant role, since the countries who invest in sports end up generating greater possibilities for their athletes to practice and to dedicate themselves under ideal circumstances.

The athletes' need to dedicate themselves completely since sport practice became a priority nowadays in order to achieve the sports elite (Verjoshansky, 1990). Therefore, as Houlihan and Green (2008) mentioned, without the whole dedication, the athlete is going to have enormous difficulties to be successful in the contemporaneous sports. The Athlete Scholarship Program created in 2005, after four years of discussion between the House of Representatives and the Senate in the Brazilian politic arena, has shown a great effort from the Brazilian government to offer real possibilities for a full-time regime of dedication of the athletes to their training and competitions. Between 2005 and 2009, a total of 102 scholarships were conceded to AG, 76 of these to the men's category.

We recognize that a great parcel of Brazilian Olympic athletes train in a non-professional system (amateur) using their own expenses, motivated by their pure dilettantism (Court of Audit, 2011). In MAG this is not much different, there are only a few gymnasts who are able to count

on the investment of sponsors or any other financial support provided by a sport entity that enrolls them (Oliveira, 2010). This situation may explain why, at least partially, the increasing on the number of AG athletes applying for the Athlete Scholarship Program.

We verified by what has been said by the subjects interviewed, that this program plays an important role supporting the MAG in Brazil, although some adjustments are still needed in order to improve its coverage with more scholarships granted, bureaucracy minimization and the transparency of procedures and accountability.

In general, we corroborate with Guimarães (2009) who says that all the investments applied to national sport is relevant, but in particular, revenues derived from the public source should be managed according to the principles established by the Constitution of 1988, among them: legality, impersonality, morality, transparency and efficiency (Federal Republic of Brazil, 1988). According to the Ministry of Sports (2008), Brazil needs to implement a permanent process of assessment aiming the efficiency guidance of the resources available.

We reiterate the need of a continuous diagnosis about the Athlete Scholarship Program impact on the development of MAG and also other sports. This kind of investigation would help the program to improve, aiming to help the development of the future generations of athletes in Brazil. We still highlight that researchers and the public and also private administrators should be aware of the existence of uncertainties regarding the relationship between public policies, the amount invested and the subsequent success in the high level sport due to the multidimensional aspects that interfere in the sport success.

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Coresponding author:
Marco Antonio Coelho Bortoleto,
Campinas State University,
Sao Paolo,
bortoleto@fef.unicamp.br

BODY COMPOSITION PROFILE OF ELITE GROUP RHYTHMIC GYMNASTS

Lurdes Ávila-Carvalho[1], Panagiota Klentrou[2], Maria da Luz Palomero[3], Eunice Lebre[1]

[1]Department of Gymnastics, Faculty of Sports, Porto University, Portugal
[2]Department of Kinesiology, Brock University, Ontario, Canada
[3]Barcelona University, INEF, Spain

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Abstract

The aim of this study was to analyze the anthropometric characteristics, training experience, body composition and biological maturity of Elite group gymnasts. 84 RG group gymnasts from the 2009 and 2010 World Cup were evaluated. Body Mass Index (BMI) was calculated using standard procedures. Relative body fat (%BF), fat mass and lean body mass were estimated from skinfold thickness, and waist/hip circumferences were measured. Biological maturity was determined by the age at menarche.
An increase on the age of the gymnasts participating in high level competitions seems to affect the new body appearance profile. Gymnasts are taller and with higher body mass than in the past. BMI were at the normal range whatever the success in competition. The more successful gymnasts had lower values of %BF but still higher than what have been reported in RG studies. A relation between the body composition data and the results has been not found. The higher level gymnasts had begun activity in RG earlier, and had more years of practice, and higher training volume. All gymnasts had a late menarche. We think that the initial selection of gymnasts who had late maturate can influence their body appearance when they become adults.

Keywords: *rhythmic gymnastics groups, body composition, profile, ranking.*

INTRODUCTION

Aesthetic requirements in sports performance evaluation are usually the cause of the body composition importance. Gymnastics, ice skating and synchronized swimming can be included in this group (Lebre, 1993). On the other hand, athlete development is the result of organized physical and technical training, methodical, rigorous, and based on the sports demands and the participants morphological profile (Freitas, 2007). According to Lebre (1993) since Seoul Olympic Games in 1988, with the first place occupied by a Soviet Union gymnast and with physical characteristics very different from the Bulgarian School, the body composition and the body appearance with very low body fat became less important. Although the International Federation of Gymnastics (FIG) Rhythmic Gymnastics (RG) Code of Points (2009) does not include deductions related to the gymnasts' body composition profile, it requires that all group gymnasts should have similar body appearance. However, very few authors studied the physical characteristics and body composition of International level RG gymnasts (Berlutti et al., 2010; Colombo, 1997; Douda, Toubekis, Avloniti, & Tokmakidis, 2008; Georgopoulos et al., 1999; Georgopoulos et al., 2002; Georgopoulos et al., 2001; Klentrou & Plyley, 2003; Pineau, 1994;

Theodoropoulou et al., 2005) and most of all with no specific reference to group gymnasts.

The aim of this study was to analyse the anthropometric characteristics, training experience, body composition and biological maturity of Elite group gymnasts.

METHODS

A total of 84 group gymnasts (18.59±2.44 years of age) from 14 countries were invited and gave consent to participate in the study. Data were collected during the 2009 and 2010 RG World Cups in Portimão, Portugal. This study also had the Scientific Committee of the FIG, team coaches and heads of national delegations consent.

The sample was divided in two groups: the gymnasts from the groups that performed routines with similar apparatus (5 hoops) and those who performed with mixed apparatus (3 ropes and 2 ribbons). After inside each group we organized them in two sub-groups according to their position in the competition ranking (first and second half of the ranking).

Body mass and height were measured using the protocol of Gordon, Chumlea and Roche (Gordon, Chumlea, & Roche, 1988). Thorax (TC), hip (HC), arm (AC), thigh (ThC), waist (WC), and calf (CC) circumferences were measured, and the waist/hip ratio was then calculated. Relative body fat (%BF) was calculated using sex and age-specific equations from 4 skinfold thickness (mm): suprailiac, triceps, thigh and calf. For the gymnasts with less than 18 years, we used the equation of Slaughter et al. (1988) using triceps and calf skinfold thickness. For gymnasts over 18 years old, body density was calculated using the equation developed by Jackson, Pollock & Ward (1980) for females, using triceps, thigh and calf skinfold thickness and then, %BF was calculated using the equation developed by Siri (1961). The fat mass (FM Kg) was calculated using %BF. Body mass index (BMI) was calculated from body mass and height (kg/m²). Absolute lean body mass (LBMkg) and relative lean body mass (%LBM) were calculated using the equation developed by Poortmans, Boisseau, Moraine, Moreno-Reyes, & Goldman (2005) using adjusted circumference of arm, thigh and calf (cm). Biological maturity was determined by the age at menarche; training experience in years was estimated using the initiation age in RG; training volume was defined as hours/week. All does last data were got using a questionnaire answered by the gymnasts.

For the statistical analysis we used the Statistical Package for the Social Sciences - Version 17.0 (SPSS 17.0, Chicago, USA) and Microsoft Office Excel 2007. Descriptive statistics were calculated using the mean values as a measure of central tendency, standard deviation as measures of dispersion and minimum and maximum values as range extent. We analyzed the normality by Kolmogorov-Smirnov and found that the variable distribution in all sample groups followed the normal distribution. Thus, Parametric Test was applied – S*tudent's* t-test for two independent samples, to determine the significant differences between groups.

RESULTS AND DISCUSSION

The results and discussion of our sample was divided in: anthropometric characteristics, body composition variables, training level and age at menarche sections:

Anthropometric characteristics

Gymnast's anthropometric characteristics participants are presented in Table 1. In table 2, we present the chronological age, body mass and height, reported in Rhythmic Gymnastics studies from literature.

There were significant differences in chronological age between the gymnasts of the first half and the second half of ranking in routines with 3 ropes & 2 ribbons. The gymnasts more successful in competition were older (table 1). In Pineau (1994) study, the national level French gymnasts were

14.95±9.4 years old, much lower than our sample. Our study data are closed to other studies with high level RG gymnasts (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2002) (Table 2). Nowadays, the increase on gymnast's age in high level competition means an increase of the RG gymnasts' longevity career that can affect the high-level gymnasts new body appearance model. Our sample data for height and weight (table 1) were in accordance with the references values by World Health Organization [WHO] (1995) (163.7cm and 56.6Kg, respectively). We pointed a significant difference between the gymnasts' height when we compared the ranking first and second half for both type of routines. The more successful gymnasts were the taller in both types of routines. Those data were in accordance to similar studies (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2002) presented in table 2. Berlutti, et al. (2010) analysed RG gymnasts body composition, biological maturity, dietary habits and anthropometric characteristics during the European Championships of 1986 (Florence) and 2008 (Turin). The group gymnasts included in the sample from Turin had similar height as our sample. But at the 1986 European Championship the authors reporter for group gymnasts lower height (Table 2). Those data means that the high-level gymnasts are now taller than in the past.

As shown in Table 2, Berlutti, at al. (2010) reported a body mass value very close to our data, in 2008 group gymnasts, while for the 1986 group gymnasts they reported a lower value. This can be related to the fact that those gymnasts were younger (approx. less 2 yrs.). The biggest difference found in body mass values between our sample and those in RG studies was in Douda et al. (2008) and Pineau (1994). We believe that those differences were related to the lower age and level of the gymnasts in those two studies. Our results were closer to those from the other studies with group gymnasts and/or with similar age (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Quintero, Martín, & Henríquez, 2011). Apparently, in the past, RG groups were composed by younger and thinner gymnasts than today. Berlutti et al. (2010) reported that the typical thin body profile of RG gymnasts from the past, is not anymore observed nowadays.

We found (table 1) significant differences between circumferences data from the gymnasts of the first and the second half of ranking in 3 ropes & 2 ribbons routines only in arm circumferences. The only available explanation for this difference could be the physical characteristics of those apparatus (deformable) and therefore a constant movement of the arms is needed for a proper apparatus execution. Douda et al. (2008) noted significant lower values of arm circumferences in elite RG gymnasts vs non-elite RG gymnasts. Douda, Laparidis, & Savvas (2002) noted lower values of arm circumferences in RG gymnasts when compared with Artistic gymnasts, but authors in both studies didn't pointed out any reasons for those differences.

Table 1. *Gymnasts Anthropometric characteristics for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons).*

				5 Hoops		3ropes & 2 ribbons	
	All Sample / Ranking (n=84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min	max	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Chronological age (years)	18.59 (2.44)	15.27	25.04	18.90 (2.54)	18.28 (2.32)	19.33 (2.35)*	17.86 (2.32)*
Body mass (Kg)	53.05 (4.66)	41.10	63.10	53.97 (4.23)	52.12 (4.93)	53.35 (4.51)	52.75 (4.85)
Height (cm)	168.13(4.95)	156	180	170.24 (5.74)*	166.02(5.15)*	169.71(4.59)*	166.55(4.84)*
Thoracic circumference (cm)	83.14 (3.19)	75.20	90.05	83.30 (3.07)	83.97 (3.34)	83.16 (3.53)	83.12 (2.86)
Hip circumference (cm)	88.07 (3.94)	76.50	98.10	88.06 (3.60)	88.07 (4.30)	87.91 (3.40)	88.22 (4.45)
Arm circumference (cm)	23.51 (1.68)	20.20	27.50	23.31 (1.62)	23.75 (1.73)	23.13 (1.48)*	23.93 (1.80)*
Thigh circumference (cm)	52.22 (2.79)	45.30	57.50	52.11 (2.62)	52.32 (2.97)	52.08 (2.54)	52.35 (3.04)
Waist circumference (cm)	67.05 (3.22)	58.50	74.10	66.36 (2.71)	67.73 (3.56)	67.50 (2.79)	66.59 (3.57)
Calf circumference (cm)	34.03 (1.61)	30.90	37.00	34.32 (1.61)	33.75 (1.56)	34.01 (1.61)	34.05 (1.62)

*Significant differences for $p<0.05$ (T-test analysis).

Table 2. *Age, body mass and height (Mean ± standard deviation) previously reported in rhythmic gymnasts.*

Variables/ Authors	Sample (n)	Level of performance	Chronological age (years)	Body Mass (Kg)	Height (cm)	Height percentile	Weight percentile
Pineau (1994)		National (France)	14.95±9.4	40.8±3.3	162±4.5		
		International (Germany)	16±1	49.4±2.2	164.7±4.6		
		International (Italy)	16.4±0.5	46.6±3.1	159±2.2		
Georgopoulos et al. (1999)	255	EC 1997	14.73 ±2.12 (11 a 23)	42±7.37	160.4±7.4	> 50	< 50
	16	EC 1997	18.43±2.09 (15 a 23)	52.4±5.1	168.2±5.2		
Georgopoulos et al. (2001)	104	EC and WC 1997-2000	16.0±1.7 (12-23)	45.3±6.6	163.6±5.6	> 50	
Georgopoulos et al. (2002)	129	WC 1999	17.1±1.4	47.3±4.8	166.3±4.6	> 50	< 50
Douda et al. (2002)	9	National (Greece)	(15-17)	44.07±3.61	160.40±4.83		
Theodoropoulou et al. (2005)	423	WC and EC 1997 to 2004	15.90±2.40			> 50	< 50
Douda et al. (2008)	15	International Greece and Cyprus	13.41±1.62	35.60±5.46	151.06±9.50		
Amigo et al. (2009)	151	National International (Spain)	18.2±0.18	53.7±3.28	170.8±2.86	90	25
Berlutti et al. (2010)	139	EC Groups 2008	18.8±2.2	52.4±4.5	168.9±5.6		
		EC Groups 1986	16.4±2.1	49.5±5.5	164.8		
Quintero et al. (2011)	15	Canary club championship 2008	(15-19)	51.3±5.6	162.95±6.1		

Legend: EC = European Championship; WC = World Championship.

Table 3. *Body composition variables for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3ropes & 2 ribbons	
	All Sample / Ranking (n= 84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
BMI (Kg/m^2)	18.75 (1.30)	16.14	21.75	18.61 (1.14)	18.90 (1.44)	18.50 (1.09)	19.01 (1.45)
BF (%)	16.74 (2.87)	10.28	23.81	16.60 (3.23)	16.88 (2.50)	15.96 (2.74)*	17.53 (2.81)*
FM (Kg)	8.92 (1.89)	5.48	13.83	9.02 (2.13)	8.82 (1.63)	8.56 (1.91)	9.27 (1.82)
LBM (Kg)	26.31 (2.78)	20.31	32.23	26.57 (2.61)	26.05 (2.95)	26.50 (2.60)	26.12 (2.96)
LBM (%)	49.56 (2.39)	44.66	57.36	49.19 (2.34)	49.94 (2.40)	49.65 (2.16)	49.48 (2.61)
Waist/Hip circumference (cm)	0.76 (0.03)	0.68	0.85	0.75 (0.03)	0.77 (0.04)	0.77 (0.03)	0.76 (0.04)

Legend: BMI = Body Mass Index; BF = Body Fat; FM = Fat Mass; LBM = Lean Body Mass
*Significant differences for $p<0.05$ (T-test analysis) max and min

Table 4. *Body composition data (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Variables/ Authors	Sample (n)	Sample (RG gymnasts)	Age (years)	BMI (Kg/m^2)	BF (%)	LBM (Kg)	LBM (%)	FFM (Kg)	Waist/Hip circumference (cm)
Pineau (1994)		National (France)	14.95±9.4	15.5±0.5	13.2±0.4				
		International (Germany)	16±1	18.2±0.6	16.8±1.6				
		International (Italy)	16.4±0.5	18.4±0.8	15.5±1.8				
Georgopoulos et al. (1999)	255	EC 1997	14.73 ±2.12 (11 a 23)	16.26±1.82	16.1±4.07				
	16	EC 1997	18.43±2.09 (15 a 23)	18.52					
Georgopoulos et al. (2001)	104	EC and WC 1997-2000	16.0±1.7 (12-23)	16.8±1.8	15.9±4.9				
Georgopoulos et al. (2002)	129	WC Osaka 1999	17.1±1.4	17.1±2.1	13.1±4.9				
Douda et al. (2002)	9	National (Greece)	(15-17)		14.33±2.80				
Theodoropoulou et al. (2005)	423	WC and EC 1997 to 2004	15.90±2.40	16.9±1.80	15.5±4.60				
Douda et al. (2008)	15	International Greece and Cyprus	13.41±1.62		13.97±2.18	29.84± 1.81			
Amigo et al. (2009)	10	National International (Spain)	18.2±0.18		11.3±1.43		47.7±1 .69	47.6±3 .23	
Berlutti et al. (2010)	139	EC Groups 2008	18.8±2.2	18.3±1.3	17.6±3				0.75±0.03
		EC Groups 1986	16.4±2.1	18.1±1.5	14.4±3.8				
Quintero et al. (2011)	15	Canary club championship 2008	(15-19)		11.99±1.5		49.89 ±1.1		

Legend: EC = European Championship; WC = World Championship; BF (%) = Body Fat; BMI = Body Mass Index; LBM = Lean Body Mass; FFM = Fat Free Mass.

Body composition

Body composition variables are presented in Table 3. Body composition data from literature are resumed in table 4.

According to Amigo et al. (2009), the most used parameters of body composition in sports are BF and LBM. However, in RG studies, the BF and BMI were the most frequently used parameters. The BMI values in our sample (table 3) were close to lower limit of the normal range by the WHO (2000) (18.50 to 24.99 kg/m^2). In table 4 we can see that older gymnasts from other studies (Berlutti et al., 2010; Georgopoulos et al., 1999) had higher BMI than the younger ones (Pineau, 1994; Theodoropoulou et al., 2005). Some authors (Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2001; Pineau, 1994; Theodoropoulou et al., 2005) reported %BF values closed to ours, studding gymnasts with similar and lower age than our sample. However, we found also some authors that reported lower values of %BF than our study (Amigo et al., 2009; Douda et al., 2002; Douda et al., 2008; Georgopoulos et al., 2002; Pineau, 1994; Quintero et al., 2011) maybe because the gymnasts in these studies were mostly younger than ours, and not so high level gymnast than our sample (table 4). All gymnasts from these studies competed in individual competition, which may have influenced the results. In individual competition the subjective aesthetic evaluation from judges is more focused on the gymnast profile while in group competition is more focused on the group work design (Vitrichenko et al., 2011).

In our study, the first half ranking gymnasts had lower values of %BF than the second half ranking gymnasts. Even for both kind of apparatus differences were found, only in 3 ropes & 2 ribbons routines the differences were significant. The %BF that Amigo et al. (2009) recorded in Spanish gymnasts was much lower than reported in other studies (including our study) and also lower than the reference values of the Spanish population. The author pointed out that the gymnasts in the different studies had different training requirements, were assessed at different times of the season, and had different diets, that can had influence on the results difference. Quintero et al. (2011) had also %BF much lower than what we and other studies have shown (table 4), according the author the %BF, FM (Kg), LBM (Kg and %) had no effect the good results in their sample. Analysing our results and those from the literature we could observe that as the sample level is lower the %BF is also lower. So we could see that lower %BF is not a measure of success in rhythmic gymnastics nowadays.

The LBM (Kg) values of our study were close to those reported by Douda et al. (2008) in international RG gymnasts from Greece and Cyprus (Table 4). According to Amigo et al. (2009) the LBM (%) measured in Spanish gymnasts (national and international level) with a mean age of 18.2 years was significantly higher than the reference value for the Spanish population. In addition, they reported that the LBM of the 15 to 18 years old gymnasts did not differ significantly with age. In our sample we did not remark differences on the LBM (Kg or %) for the different sample groups. The gymnasts from our sample were composed by the best group gymnasts in the world, if even they were placed in the second half of ranking on the world cup competition, and all gymnasts were submitted to a high intensity level training. According Lisitskaya (1995) LBM (%) in GR Elite gymnasts must be around 47-50%. The results for our sample are in according to this requirement.

Berlutti et al. (2010) observed that the group gymnasts had a waist/hip ratio less than 0.78 cm, what, for authors defines a gynoid biotype. The results for all sample in our study were 0.76 cm witch was very close to that appointed by these authors.

Training level

Training data for all gymnasts in the sample are presented in Table 5. In Table 6 are resumed the data from the studies in RG that analysed training data.

In Table 5 we can see that the gymnasts from our sample began the RG practice at 6.46 years of age although, the lower limit was 4 years old and higher 10 years old. According to Berlutti, et al. (2010), the gymnasts who participated in the 2008 European championship began the practice of RG at 6.2 years old but the gymnasts who participated in the 1986 European Championship had started at 7.8 years of age suggesting that the beginning in RG is becoming earlier. All other studies (Table 6) have reported beginning age in RG between 6.8 years old (Georgopoulos et al., 1999) and 7.7 years old (Georgopoulos et al., 2002). When we compare the gymnasts from ranking first half with the ranking second half in both types of routines, we observed significant differences between groups, being the ranking first half gymnasts who began earlier the activity in RG.

In our study the gymnasts have been in RG for 12 years. The range was between 7 and 20 years of practice. When we compared the groups according to their position on the ranking, in both type of routines, we observed significant differences between groups, being the gymnasts from the more successful groups those who had more years of RG practice.

The gymnasts from our study trained 6.8 hours daily, but we could see a range from 4.5 hours/day to 8.5 hours/day. This difference is clearly reflected in the weekly training volume. The groups participating in World Cup of Portimão trained 40.5 hours/week (mean value for all sample). Only Berlutti, et al. (2010) refers to the daily training of RG gymnasts, so we can see in Table 6 that the gymnasts who participated in the 2008 European championship trained 6 hours daily, however the authors noted trained range between 3 hours to 10 hours per day. In the same study (Berlutti et al., 2010) reported 3.8 hours of daily training for the gymnasts who participated in the 1986 European Championship. In our study, when we compared the ranking first half with the ranking second half gymnasts, for both type of routines, we observed significant differences between groups on training duration (hours/day). The ranking first half gymnasts trained more hours/day and more hours/week than the others.

Table 5. *Training data for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3 ropes & 2 ribbons	
	All Sample / Ranking (n=84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Age of initiation in RG (years)	6.46 (1.54)	4	10	6.12 (1.17)*	6.81 (1.78)*	6.10 (1.12)*	6.83 (1.81)*
Practice (years)	11.99 (2.61)	7	20	12.69 (2.88)*	11.29 (2.12)*	13.14 (2.78)*	10.83 (1.82)*
Training duration (hours/day)	6.82 (1.12)	4.5	8.5	7.21 (0.93)*	6.43 (1.16)*	7.07 (0.87)*	6.57 (1.28)*
Training Volume (hours/week)	40.50 (6.43)	27	51	42.43 (5.24)*	38.57 (6.97)*	41.57 (4.71)	39.43 (7.69)

*Significant differences for $p<0.05$ (T-test analysis).

Table 6. *Training data (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Authors/ Variables	Georgopoulos et al. (1999)		Georgopoulos et al. (2001)	Georgopoulos et al. (2002)	Theodoropoulou et al. (2005)	Berlutti et al. (2010)	
Sample (n)	255	16	104	129	423	139	
Sample (RG gymnasts)	EC 1997	EC 1997	EC and WC 1997-2000	WC 1999	WC and EC 1997 to 2004	EC Groups 2008	EC Groups 1986
Age (years)	14.73 ±2.12 (11 a 23)	18.43±2.09 (15 a 23)	16.0±1.7(12-23)	17.1±1.4	15.90±2.40	18.8±2.2	16.4±2.1
Onset RG (years of age)	6.82±1.92		7.3±2.3	7.7±2.2	7.4±2.3	6.2±1.9	7.8±2.8
Training/day (hours)						6±1.8	3.8±1.6
Training/week (hours)	29.14±15.35		32.5±13.5	31.2±9.6	27.1±10.40	36	21.66

Legend: EC = European Championship; WC = World Championship

Table 7. *Age at menarche data for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3 ropes & 2 ribbons	
	All Sample / Ranking (n=52)			First half (n= 22)	Second half (n=30)	First half (n= 22)	Second half (n=30)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Menarche (age)	15.92 (1.40)	13	18	16,05 (1,53)	15,83 (1,32)	15,86 (1,46)	15,97 (1,38)

Table 8. *Age at menarche (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Authors/ Variables	Georgopoulos et al. (1999)		Georgopoulos et al. (2002)	Theodoropoulou et al. (2005)	Berlutti et al. (2010)	
Sample (n)	255	16	129	423		139
Sample (RG gymnasts)	EC 1997	EC 1997	WC 1999	WC and EC 1997 to 2004	EC Groups 1986	EC Groups 2008
Age (years)	14.73 ±2.12 (11 a 23)	18.43±2.09 (15 a 23)	17.1±1.4	15.90±2.40	16.4±2.1	18.8±2.2
Menarche (age)	14.3±1.46		15.2±1.4	14.6±1.50	14±1.3	15.9±1.3

Legend: EC = European Championship; WC = World Championship

Age at menarche

From the 52 gymnasts who answered about the menarche age (table 7), 86.7% said that they had already menarche and 13.3% were not menstruating (these gymnasts were between 15 and 16 years old).

The mean age at menarche reported in our sample was 15.92±1.40 years. Georgopoulos, et al. (2002) reported that 28.65% of the gymnasts in their study (which participated in 1999 Osaka World Championships) had not reached menarche. Also Theodoropoulou, et al. (2005) reported, in Elite gymnasts in 1997 to 2004 World Cup and European Championship, that 16.8% had no menarche. As shown in Table 8 Berlutti, et al. (2010) also reported a mean age at menarche of 15.9 years old, similar to our sample. Those values were higher than the described to normal population (Berlutti et al., 2010). The authors noted, that the 1986 Florence European Championship, the age at menarche was lower (14 years old) than that observed today. Theodoropoulou, et al. (2005) described also an later age of menarche in RG gymnasts (14,6 years old). Beunen et al. (1994) relates the precocious onset of menarche with a high %BF and the delayed onset of menarche with low rates of %BF. The %BF noted in our study and in the other in RG studies was not measured gymnasts at the moment of the menarche onset and, so, we cannot discuss if the %BF was the main reason for the delayed menarche in these gymnasts.

Wilmore & Costill (1999) noted that the menarche onset was later in highly trained elite athletes (such as in gymnastics) but made it clear the fact that there is still no evidence supporting the idea that the intensive training delayed menarche. Also Cumming, et al. (2011) said that there were some evidence in the inverse relationship between maturational status and physical activity. In addition, considering that the Elite gymnasts trained 30 to 40 hours/week we may say that the biggest difference between the gymnasts in the older studies and the gymnasts in most recent studies is the weekly training volume that has increased over the years.

Two studies reported significant differences between age at menarche of gymnasts, and the menarche age of their mothers and non-gymnast sisters suggesting the delayed menarche may not have a genetic origin (Georgopoulos et al., 1999; Theodoropoulou et al., 2005).

In our study we observed a similar age for menarche onset than those described in recent literature (Berlutti et al., 2010; Georgopoulos et al., 2002; Theodoropoulou et al., 2005).

The data collected cannot give enough information to point that the late onset of menarche in elite gymnasts is due to the low %BF, or genetic factors or the training intensity. However, we think that maybe also are unconscious selection of the gymnasts who had late maturate profile because the RG typical body appearance.

CONCLUSIONS

Analysing the results discussions we could conclude that the high-level gymnasts are, nowadays, older and higher than in the past; and also the more successful gymnasts were older, higher and with more body mass.

The Elite group RG gymnasts had BMI, high and body mass values at the normal range whatever the success in competition. The more success group gymnasts had lower %BF values but still higher than what have been reported in RG studies in the past. We could see that lower %BF is not a measure of success in rhythmic gymnastics nowadays. LBM (Kg or %) values were in accordance to reference values for Elite RG and had no effect on the results.

The more successful gymnasts began earlier the RG, had more years of practice, train more hours a day and had more weekly training volume. The Elite group RG gymnasts had a later onset of menarche than normal population. We think that also are unconscious selection of the gymnasts who

were late maturate in initial selection of the gymnasts in this sports because them body appearance.

We believe that this study is a strong contribution to update the knowledge about the success elite RG gymnasts. The increase on gymnasts age in high level competition could mean an increase of the RG gymnasts longevity, that affect the new body appearance model of high-level gymnasts. In groups competition we think that Elite RG body composition had no direct effects on the results because the subjective aesthetic evaluation that judges do in groups competition is more focused on the design of the group work.

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Coresponding author:
Lurdes Ávila-Carvalho,
Faculty of Sports,
Porto University,
Portugal
Lurdesavila4@hotmail.com

SELF-ESTEEM AND TRAIT ANXIETY IN GIRLS PRACTICING COMPETITIVE AND RECREATIONAL GYMNASTICS

Olivia Donti[1], Kalliopi Theodorakou[1], Spiros Kambiotis[1] and Anastasia Donti[2]

[1] Athens Kapodistrian University, Greece
[2] Hellenic Gymnastics Federation, Athens, Greece

Original research article

Abstract

The purpose of this study was to examine self-esteem and trait anxiety in 161 girls, 10-12 years old, practising competitive and recreational 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. A MANOVA and an independent samples t-test were performed in order to examine differences in self-esteem and trait anxiety between the two groups of gymnasts respectively. Results indicated that there was no significant difference between competitive and recreational gymnasts in self-esteem except for the subscales of scholastic competence, and social acceptance, which had lower values for the competitive girls. However, girls participating in competitive gymnastics sports had significantly higher values of trait anxiety compared to girls practising recreational gymnastics sports. Further research is required on the impact of competitive sport effect on gymnasts' psychological parameters.

Keywords*: trait anxiety; self-esteem; gymnastics, girls*

INTRODUCTION

It has been reported in sports and exercise literature that the practice of a regular physical activity has potential benefit for children, psychologically, and physically (De Marco & Sidney, 1989; Sonstroem, 1984). In particular, physical training was related to increased self-esteem (Hõs, 2005; Jackson & Marsh, 1986; Taylor, 1995) and to reduced anxiety level (Landers & Petruzello, 1994).

Self-esteem is the evaluative element of self-concept (Brown, 1993; Makri-Botsari, 2001) and can be defined as the degree to which individuals feel positive about themselves (Sonstroem, 1989). According to experts, (Coopersmith, 1984; 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).

The theoretical basis of the relationship between physical activity and self-esteem or anxiety, is initially found in other areas than sport psychology (Boyd & Hrycaiko, 1997). For instance, the theoretical models and measurement scales of these two variables were developed in education, psychology and mental health (Harter, 1982; Rosenberg, 1986). However, the applicability of these scales to other domains, like sports, has been widely tested, (Boyd & Hrycaiko, 1997).

To achieve higher self-esteem and/or lower anxiety, physical activity is often presented as an effective tool (Ekeland, Heian, & Hagen, 2005), apparently because compared to their peers, young athletes show higher self-esteem (Bissinger, Laure, & Ambard, 2006; Calfas & Taylor, 1994; Percy, Dziuban, & Martin, 1981) and lower trait anxiety, depression and stress (Tomson, Pangrazi, Friedman, & Hutchison, 2003; Trew, Scully, Kremer, & Ogle, 1999) even if the underlying mechanisms, which result this fact, remain unclear, (Duda, 1993). Indeed, in high-level, competitive sport it is reported that elite athletes when compared to non-elite, have higher level of self-confidence, mental toughness, ability to focus and block-out distractions, ability to set and achieve goals, (Crust & Azadi, 2010; Gould, Dieffenbach, & Moffat, 2002; Williams & Krane, 2001) superior anxiety control and locus of control (Mahoney, Gabriel, & Perkins, 1987). Findings from previous research in gymnastics, indicated that elite young gymnasts, show higher self-confidence (Spink, 1990), self-concept, locus of control (Porat, Lufi, & Tenenbaum, 1989), and persistence (Lufi & Tenenbaum, 1991), than non-elite.

Gymnastics sports (artistic gymnastics, rhythmic gymnastics, acrobatic, trampoline and gymnastics for all) are popular in young girls. Competitive sports are defined as those in which children compete against others formally for awards. Non-competitive (recreational) sports are 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 (Amac, Anastasio, Morwick, & Yi, 2002).

Competitive gymnastics sports have experienced rapid growth and development. The evolution of competitive gymnastics sports demands performance of elements of high difficulty, faultless technical execution, and original composition (Rhythmic Gymnastics, Code of Points 2009-12; F.I.G; Trampoline, Code of Points, 2009-12; Women's Artistic Gymnastics, Code of Points, 2009-12). The current approach of young gymnasts' evaluation during competition, is to break a new "world record", since the traditional "10" is no longer existing and the score that a gymnast can get has no upper limit. Consequently, training is starting from a very young age (5-6 years old), and is scheduled on a daily basis (20-25 hours a week) for approximately 250-300 days a year (Smolefski & Gaverdofski, 1999). By the age of 12, young gymnasts have already been competing and training for years. During this critical stage of development as children experience rapid physiological, neurologic, and psychological growth, participation in competitive gymnastics may place excessive physical and psychological load on them (Tofler, Stryer, Micheli, & Herman, 1996).

Recently, Amac, et al., (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. In their research, Tofler, Stryer, Micheli and Herman (1996), reported that elite gymnasts might be at risk for nutritional, endocrine and psychiatric disorders.

In addition, in competitive gymnastics sports there is constant pressure - particularly from adults- for the young gymnasts to be thin because small size and low weight are associated with speed and agility, it is easier for gymnasts to perform flight skills, and it is more appealing to the eye (Sample, 2000). Moreover, in competitive gymnastics, young athletes are required to execute movements on all apparatuses that defy gravity and can arouse emotions such as fear, worry, and anxiety, often related to the risk of physical injury (Cartoni, Minganti, & Zelli, 2005) Fear of failing in competition and feelings of inadequacy are also affecting young girls. These factors can create high levels of stress and less sport enjoyment (Feltz & Ewing, 1987).

Apparently, there are also family background factors affecting gymnasts' self-esteem and trait anxiety, because of the interaction within the members of the family and also of the experience that young gymnasts are acquiring from the environment (Fox, 1992; Harter, 1993). In school age, children consider as important persons in their life their parents, teachers/coaches, peers and friends (Printz, Shermis, & Webb, 1999). In the case of young athletes parents are typically the individuals who are supposed to give unconditional support to their children when a need exists, such as in a stressful situation like a competition (Roberts & Bengston, 1993; Ommundsen & Vaglum, 1991). However, in competitive sport, it is often reported that rather than supporting their child, parents are more inclined to put pressure on their talented child to spend hours of training and to perform well (Van Yperen, 1995). The role of coaches is also critical, sometimes even as a mother or as a father figure, particularly for young athletes (Balague, 1999). High-level coaches often have exceptional knowledge and experience but are also vulnerable to the stresses of their positions. Sometimes pressure is enormous and can lead to inadequate and inappropriate coaching practices (Balague, 1999).

Numerous previous studies in the area of youth sports (Calfas & Taylor, 1994; Ekeland, Heian, & Hagen, 2005; Tomson, Pangrazi, Friedman, & Hutchison, 2003), examined the psychological characteristics of young athletes compared to non-athletes or elite athletes to non-elite. There has been little research in the area of competitive versus non-competitive (recreational) sports though it seems possible that the competitive environment in some sports may lead to less positive mental profiles among young competitive athletes when compared to their non-competitive peers. In particular, in sports like artistic gymnastics and rhythmic gymnastics, where the age of peak performance internationally is very young (16-18 years) and the training load (psychologically and physically) is extremely high, starting from a very young age and continuing for a long period, questions arise on the impact of competitive demands to young girls' psychological parameters.

Therefore, the present study was designed to examine possible differences in self-esteem and trait anxiety between female gymnasts (aged 10-12 years old), practising competitive and recreational gymnastics sports. On the basis of previous research examining youth sport competitors' trait anxiety (Gould, Wilson, Tuffey, & Lochbaum, 1993; Feltz & Ewing, 1987), it was expected that gymnasts practicing competitive gymnastics, would score higher in trait anxiety than their non-competitive peers. Because of the conflicting results concerning young gymnasts' self-esteem, no a priori hypotheses were formed, concerning *global self-esteem* (Amac et al., 2002; Gould et al., 2002; Kerr & Goss, 1997; Williams & Krane, 2001).

METHODS

One hundred sixty one (161) female gymnasts, aged 10-12 years old, (mean age value 10.7, sd=0.81) practising competitive and non competitive gymnastics sports, participated in this study. Gymnasts represented five gymnastics sports, (artistic gymnastics: 76 girls; rhythmic gymnastics: 32 girls; trampoline: 12 girls; gymnastics for all: 27 girls; and acrobatic: 14 girls).

This study was nationwide, subjects were drawn from two high performance training centres and 22 clubs affiliated with the Hellenic Gymnastics Federation.

Competitive group of gymnasts: 60 girls, (mean age value 10.8, sd=0.8 years) participated in this study. The gymnasts were training for 3-5 years (4.0±0.8 years), in competitive gymnastics sports, (artistic gymnastics, rhythmic gymnastics, acrobatic, and trampoline), on a daily basis (5 to 6 days per week), between 20-25 hours a week (21±2.6 hours). They were participating in competitions 2-4 times a year (according to the calendar of the gymnastics sport that they were practising) in the official national competitions of the Hellenic Gymnastic Federation. The gymnasts were training in 10 different clubs and 2 high performance-training centres.

Recreational group of gymnasts: 101 girls, (mean age value 10.6, sd=O.7) that were practising for 2-5 years (3.8±0.7 years) recreational gymnastics sports, (artistic gymnastics, rhythmic gymnastics, trampoline and gymnastics for all), participated in this study. The gymnasts were 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. These gymnasts were practising in 12 different clubs affiliated with the Hellenic Gymnastic Federation.

One important factor that might affect young athletes' trait anxiety and self-esteem was parental educational and socioeconomic level (Johnson, McGue, Iacono, 2006; Roberts, Bekgston, 1993). 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). The gymnasts in the two groups (competitive and recreational) had homogenous distributions concerning their parents' educational and socioeconomic level (chi-square=0.852, df=3, p=0.837).

The Greek version (Theodorakou, 1997) of Harter's Self-Perception Profile for Children (1985) was used to measure the self-esteem of each participant. Self-Perception Profile for Children (Harter, 1985) 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, 2001; 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.

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).

For the young gymnasts who participated in this study written parental consent was provided. With the permission of the coaches and club administrators, researchers 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.

Data screening was used to ensure all dependent variables met the assumptions necessary for the use of parametric statistics prior to data analysis. Internal consistency of the trait anxiety and self-esteem scales was checked with Cronbach's α values. In order to examine the effect of participation in competition on gymnasts' self-esteem and trait anxiety, a multivariate analysis of variance (MANOVA) was performed. Each subscale of the Self Perception Profile for Children acted as a dependent variable, with the participation in competitive and non competitive gymnastics as independent factors. In addition, an independent *t*-test was used to test the differences in trait anxiety between gymnasts practicing competitive gymnastics sports and gymnasts practicing non-competitive gymnastics sports.

RESULTS

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, 1985) Cronbach' s α values ranged from 0.69 to 0.73 and were considered acceptable except for the subscale of *behavioral conduct* which demonstrated inadequate 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, 2001).

With regards to the Self-Perception Profile for Children (SPPC; Harter, 1985) inventory, the MANOVA procedure showed significant differences between competitive and recreational gymnasts (Wilk's Lamda=0.935, $F_{6,154}$=2.98, $p<0.05$). Results from the follow-up univariate ANOVAs indicated that the recreational group of gymnasts had significant higher mean values than the competitive group of gymnasts in two subscales of self-esteem, *scholastic competence* and *social acceptance* ($p<0.05$) and are presented in Table 1. The effect size of trait anxiety was

10.3%. All remaining values were considered small and were less than 10%, therefore the meaningfulness of these differences should be viewed with caution.

An independent *t*-test found significant differences in trait anxiety between competitive and recreational gymnasts (*t*=4.07, df=159, p‹ 0.001). Gymnasts from the competitive group were found to report significantly higher levels of trait anxiety than gymnasts from the recreational group. The means and standard deviations of the trait anxiety scale between the two groups of gymnasts are presented in Table 2.

Table 1. *Mean values, F-values and significance of the subscales of self-esteem and trait anxiety in between groups differences produced by MANOVA.*

Dependent Variables	Competitive group of gymnasts(N=101)	Recreational group of gymnasts (N=60)	$F_{1,159}$-value	p	Partial eta squared
Scholastic competence	3.17±0.70	2.88±0.67	7.00	0.009*	4.2%
Social acceptance	3.03±0.62	2.80±0.67	4.97	0.027*	3.0%
Athletic competence	2.89±0.61	2.84±0.61	0.27	0.610	0.2%
Physical appearance	2.98±0.75	2.85±0.64	1.17	0.281	0.7%
Behavioral conduct	3.11±0.70	2.90±0.70	3.39	0.067	2.1%
Global self-esteem	3.13±0.58	2.95±0.69	3.25	0.073	2.0%

* p<0.05 * *p<0.001

Table 2. *Differences in trait anxiety between girls practicing competitive and non-competitive gymnastics sports.*

	M (SD)	T	df
Trait anxiety of gymnasts practicing competitive gymnastics sports	35.00(6.30)	4.07**	159
Trait anxiety of gymnasts practicing non-competitive gymnastics sports	30.63(6.27)		

* *p<0.001

DISCUSSION

The aim of this study was to examine self-esteem and trait anxiety in young female gymnasts (10-12 years old), practising competitive and recreational gymnastics sports. Results indicate that between the group of gymnasts participating in competitive and the group participating in recreational gymnastics sports, there was no difference in most of the subscales of self-esteem (*athletic competence, physical appearance, behavioural conduct,* and *global self-esteem*), except for the subscales of *scholastic competence,* and *social acceptance*, which had lower values for the competitive girls. However, the two groups of young gymnasts differ significantly in trait anxiety, with gymnasts from competitive gymnastics sports scoring significantly higher than gymnasts from recreational gymnastics sports.

This study highlights an interesting finding: young gymnasts from competitive gymnastics (some girls were Greek champions of their age category) did not score higher in the subscale of *global self-esteem*, than gymnasts from recreational gymnastics, although in previous studies in youth sports, it was often reported that elite athletes had higher levels of self-esteem than non-elite (Fox, 1992; Porat, Luffi & Tenenbaum, 1989) and athletes had higher self-esteem than non-athletes (Calfas & Taylor, 1994; Ekeland, Heian, & Hagen, 2005). At school age, children engage in social comparisons with peers as well as with the standards set by adults. Therefore, judgements of self become heavily influenced by these comparisons, (Antunes & Fontaine, 1998). In particular, the meaning attributed by children to their perceived ability and achievement determines whether self-esteem is enhanced or diminished (Antunes & Fontaine, 1998). It is possible that the extreme demands of competitive environment for absolute skill standards and perfection, are negatively affecting young girls' *global self-esteem* as also suggested from previous research in competitive gymnasts of this age (Amac et al., 2002; Kerr & Goss, 1997). Nevertheless, the values of *global self-esteem* found in this research for girls practising competitive and recreational gymnastics sports is consistent with previous research in Greek female non-athletic population of this age (3.13±0.58 and 2.95±0.69 versus 3.14±0.62 respectively), (Makri-Botsari, 2001).

Despite their high level of physical capacities and their thin and trained bodies, girls practicing competitive gymnastics sports did not score higher in the subscale of *physical appearance*, than girls practicing recreational gymnastics. It is reported that participation in "aesthetic" sports like artistic gymnastics, rhythmic gymnastics, figure skating, etc, that promote leanness, is associated with factors related to eating disorders including body dissatisfaction, elevated weight concerns, desire for extreme thinness, and excessive dieting (Anshell, 2004; Zucker, Womble, Williamson, & Perrin, 1999). It is also possible that negative comments about the athlete's bodies, are merely expressions of parental and coaches' perceptions, demands, or ambitions rather than the true perception of the young gymnasts themselves (Pruett, Sataloff, Brandfonbrener, & Ledermann, 1991).

In addition, in two subscales of self-esteem, *scholastic competence* and *social acceptance*, gymnasts from competitive gymnastics sports scored lower than gymnasts from recreational gymnastics. Young gymnasts, practicing competitive gymnastics sports, have to train for 3-4 hours on a daily basis for 6 days a week. Consequently, they do not have enough time to study and prepare adequately for school and to spend with friends and peers. Indeed, some researchers underline the importance of missed educational experiences for young competitors (Toffler & Stryer, 1996). Furthermore, Harter (1985) clarifies that the subscale of *social acceptance,* mainly expresses the degree to which the child feels popular or accepted by his peers. Girls from gymnastic sports, have a certain body type, usually shorter and thinner than their peers, looking younger from their chronological age (Peltenburg, Erich, Zonderland, Bernick, & Huisveld, 1984). This is possibly one more reason why they *report* not feeling so popular among their peers. At 12 years old, some girls in their class are fully mature and dress like adult women, while young gymnasts are usually looking much younger. Research has demonstrated that an individual's physical attractiveness does affect others' reactions to him/her and especially heterosexual attraction and first impressions of peers (Dion & Bersceid, 1974).

Consistent with prior work in this area, (Balague, 1999; Nieman, 2002) young gymnasts from the competitive group, scored significantly higher in trait anxiety than gymnasts from the recreational group. The setting of high competitive standards is an integral part of elite sports, and often beneficial for the athlete's performance. However, individuals striving for attainment

of ideal standards, have been shown prone to experience heightened levels of anxiety, due to discrepancies between ideal and current self (Koivula, Hassmen, & Fallby, 2000).

There is an international concern about the physical and psychological well-being of competitive gymnasts, possibly because women's gymnastics provides a useful framework for viewing worrisome trends in other competitive youth sports (Tofler et al., 1996). Research has not been driven far enough to answer all the relative questions. It is not known whether competitive gymnasts' future well-being is affected by significant differences in their psychological parameters when compared to their non-competitive peers. Therefore, further adequately-controlled, longitudinal research is needed to examine the relation between competitive and training demands to the young gymnasts' self-esteem, to identify the sources of anxiety in every stage of the young gymnasts' development and the relative influence of significant others (parents, coaches, peers) in that development. Research in the area of youth competitive gymnastics sports can provide information to the elite gymnastics community in monitoring the future evolution of the sport, changing the judging criteria to diminish possible psychological pressures for absolute performance and thinness -especially in young age.

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 (Bissinger at al., 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 only girls. Probably, if data were collected from male gymnasts, results would have been different, especially in what concerns trait anxiety since it is known that girls have higher trait anxiety than boys (Spielberger , 1966; Psychountaki et al., 2003). A final point about the present study is that with the current study design a link of causality between participation in competitive sports and gymnasts' trait anxiety and self-esteem cannot be established.

Despite its limitations, the strength of this study is the examination of same age gymnasts' self-esteem and trait anxiety in different athletic levels and thus could be considered as a new contribution in the area of youth sports. Moreover, it is providing useful information for coaches and specialists in charge of competitive gymnasts. Implementing workshops for beginner and advanced coaches could help protect the young gymnasts from potential excessive psychological pressure.

Apparently, the type, duration and intensity of physical activity that is necessary to achieve optimal, positive emotional and mental benefits are until now poorly defined (Bissinger, Laure, & Ambard, 2006). Examining differences between athletes performing at a range of levels, and especially in the area of youth sports will help to promote understanding of the psychological parameters underlying elite performance.

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Coresponding author:
Olyvia Donti
Department of Physical Education and Sport
Section of Gymnastics and Dance
odonti@phed.uoa.gr

CHANGES IN GYMNASTS MOTOR ABILITIES DURING THE NINE MONTH TRAINING PROCESS OF FEMALE GYMNASTS 5-6 YEARS OF AGE

Kamenka Živčić Marković, Ines Čavar & Goran Sporiš

Faculty of Kinesiology University of Zagreb, Croatia

Original research article

Abstract

This study was aimed to determine changes in the development of some motor abilities of female gymnasts aged 5-6 years during the nine-month training process. Six gymnasts, members of gymnasts club „Novi Zagreb"from Zagreb aged from 5 - 6 years, volunteered in this study. They were involved in the training process, which was consistent of the elements of "B" (higher level) program for girls, for nine months. Changes in motor variables were recorded in the 7 time points for each subject. One way ANOVA for repeated measures determined if changes in measured motor abilities would appear through nine month training process. The primarily finding of this study supported our research hypothesis, with statistically significant improvement in all of measured motor abilities (power and flexibility), except in explosive power.

Keywords*: power, flexibility, training, development*

INTRODUCTION

Artistic gymnastic is one of the components of competitive gymnastics and is divided in men's and women's artistic gymnastics. There are four events in the women's artistic gymnastics: vault, uneven bars, balance beam and the floor. On the each of apparatus, except on vault, where is performed only one jump, gymnasts do links between the series of gymnastic elements which merge into one ententity (routine) of 30 to 90 seconds duration.

Each of gymnastic events imposes special requirements while performing some movements. Those movements are consisted of a numerous different simple and complex, static and dynamic elements with precisely defined techniques. Artistic gymnastic is characterized by a lot of random hand and leg supports while the body is in the flight phase. Namely, the majority of gymnastic elements are acrobatic. Ability to move body through the space, random activation of needed muscles, increased joint range of motion (ROM) while maintaining a high level of power and optimal level of precision of the body position and position of some parts of the body is needed while performing them. Considering that, in order to achieve quality, routine and safety while executing some of the elements. So, responsibility is primarily focused on gymnasts conditioning preparation in the training process.

In Artistic gymnastics gymnasts must have an incredible fitness, what is primarily seen in conducting training process, not on competitions, as in many other sports. High level of fitness enables basic prerequisites for successful learning and performing

gymnastic elements. The gymnasts differ from each other in motor abilities which are reflected in the performing quality of gymnastic movements, or accuracy of the techniques, levels of the elements, compositional possibilities of the realization of gymnastic exercises.

Gymnasts have incredible neuromuscular connections and they are also characterized by very high levels of strength, power, flexibility, and muscular endurance, combined with speed and coordination (Jemni et al, 2006).

The success of each gymnast is directly dependent on the level of her motor abilities, in particular strength. Strength occupies the highest place within the hierarchy in relation to other motor abilities, in all three basic forms (explosive, repetitive and static). Inconsistent strength training can explain the decline in performance, or at least the stagnation, of a number of athletes who had promising performances during the preparatory season. Most important for gymnastics is the insight that maximal strength can also be increased without increasing muscle mass (Bührle and Werner, 1984; Poliquin, 1991; Verchoshanskij, 1985 according to Major, 1996). It also has been noticed for some time that the very best gymnasts in the world have great strength with little muscle mass (Schwermann, 1986 according to Sands & McNeal 2000).

Strength training in artistic gymnastic is closely linked to the gymnastic skills, so we can talk about the development of specific strength that is comparable to other sports. When we look at children's artistic gymnastic, considering definitions of strength and power, we can not talk about strength, we can, only, talk about power, especially explosive.

Many authors have reported that modern Artistic gymnastics requires greater strength and power because of the ever-increasing technical difficulty required through revision of the Code of Points (FIG, 2005, according to Jemni et al, 2006), which changes every Olympiad (Brooks, 2003; French et al, Richards et al, 1999 according Jemni et al, 2006).

One of the most important problem in training process in Artistic gymnastic is that training process starts in young childhood (about 5 to 6 year). Therefore, it is very important to pay extraordinary attention to the conditioning process. Each training, and thus the training process, has to be precisely planned and focused on achieving the main goal, which is primarily the adoption of proper techniques of gymnastic elements. Continuous systematic tracking of each gymnast receives a constant review of its level and progress in basic and specific motor abilities.

According to everything we have mentioned before, and as well respecting the principle of specify in gymnastic training process, we hypothesized that our training program will increase an entire space of motor abilities important for Artistic gymnastics.

To our knowledge there is a lack of studies about effects of gymnast´s training programs on developing motor abilities. Therefore, the aim of this study is to determine changes in the development of some motor abilities of female gymnasts aged 5-6 years during the nine-month training process.

METHODS

Six gymnasts, members of gymnasts club „Novi Zagreb"from Zagreb, aged 5 to 6 years volunteered in this study. All subjects had been involved in gymnastic training process for the last two years. Trained six times a week with the length of training for 3 hours. Performing in the category "girl" in competition "C-program (CGF, 2006). Gymnasts were in preparation for a higher qualitative level, or "B-program competition during the transitive (control) measurements. Self–reported medical histories were received from all subject's parents, and any subject who reported any orthopaedic problem and/or taking any medicamentations on regular basis in the last year was not accepted into the study.

Before testing one of subject's parent signed informed consent. All procedures were approved by the Ethics Committee of the Faculty of Kinesiology University of Zagreb.

The training process lasted nine months from the 1st of August 2008 till the 1st of July 2009. They were measured 7 times during that period, on the first of each month except on December and January. All testing and training procedures were conducted by a trainer of Gymnastics club «Novi Zagreb». The trainer trained the same girls for two years.

Gymnasts were measured indoor, each time before training, after standard gymnasts warm up (5 minutes of running, and 10 minutes of dynamic stretching). They were measured on each test using a standard protocol of Croatian Gymnasts Federation.

The gymnasts were trained six times a week per three hours (from 5 till 8 pm). Their training processes were consistent of the elements of "B" program for girls. The introductory part of training lasted for 45 minutes. It was compounded of warm up (dynamic flexibility elements lasting 25 minutes) and specific gymnastics power exercises (hollow rock, hollow hold, hollow holding position) lasting for 20 minutes. In the main part of the training (lasting about 2 hours) they trained acrobatics (summersaults) in function of flashover. On the floor and balance beam they performed basic elements (bridges, hand stands) and rhythmic elements. Subjects trained uneven bars the most (50% of the training they trained uneven bars, 25% floor and 25% balance beam). The final part of training was lasting about 20 minutes. And it was compounded of specific power exercises (lasting about 15 minutes) and flexibility exercises in static form lasting for 5 minutes. The introductory and the final part of training were the same for all the gymnasts, but the main part was individualized in the intensity and extensity of the elements according to their capabilities and actual placement.

Gymnasts were measured at seven time points, by 12 different standard gymnast's motor tests during nine-month training process. Motility tests were selected to cover the field power of arms and shoulders, legs and trunk, and the flexibility of the hip joint. Two tests measured power of arms and shoulders, three tests for the power of trunk, three for the power of lower limbs, one test for the power of the entire body and three for the hip flexibility.

Table 1. *Names of motor tests, names of variables, measures, and motor abilities for each used test.*

Name of motor test	***Name of the variable***	***Measurement unit****	***Motor ability***
Legs lift from picked position	LLPP	number	Power (low abs and gauds)
Chin-up in 30 seconds	CU30	number	Power (arms and shoulder belt)
Legs lift in 30 sec	LL30	sec	Power (low abs and quads)
Rope climbing using legs/feet	RCL	sec	Explosive Power (arms and shoulder belt)
Tuck up trunk and leg flexion	TUTLF	sec	Power
Single leg squats (right)	SLSRL	number	Power (lower limbs)
Single leg squats (left)	SLSLL	number	Power(lower limbs)
Horizontal jump	HJ	cm	Explosive power
Split (right leg)	SRL	cm	Flexibility (hip and pelvic)
Split (left leg)	SLL	cm	Flexibility (hip and pelvic)
Canter split	CS	cm	Flexibility (hip and pelvic)
Press handstand	PH	number	Power of the entire body

*in figures are units in y axis

Statistic for Windows version 9.0 was used. The Kolmogorov-Smirnov (KS) test of Normality and Descriptive statistics were performed on all variables. All data were normally distributed according to KS-test. Hence the data were analyzed using One way ANOVA for repeated measures. Significance was considered to be achieved at $p<0.05$.

RESULTS

Table 1. *Results of One way ANOVA for repeated measures of motor tests.*

POWER MOTOR TESTS							
	LLPP	CU30	LL30	TUTLF	SLSRL	SLSLL	PH
F-value	12,39773	7,09830	8,1330	20,256	7,8068	7,0974	11,622
p-value	0,000001	0,000090	0,00003	0,0000	0,000041	0,00009	0,00000
EXPLOSIVE MOTOR TESTS							
	RCL			HJ			
F-value	0,91013			17,613			
p-value	0,53013			0,00000			
FLEXIBILITY MOTOR TESTS							
	SRL		SLL		SC		
F-value	5,5583		7,3038		6,8395		
p-value	0,00057		0,00007		0,00012		

Motor tests for assessing power

The results of motor tests (LLPP, CU30, LL30, TUTLF, SLSRL, SLSLL, PH) for assessing power presented in table 1., showed significant increase (F_{LLPP} = 12,396, F_{CU30} = 7, 0983, F_{LL30} = 8,1330, F_{TUTLF} = 20,256, F_{SLSRL} = 7,8068, F_{SLSLL} = 7,0974, F_{PTH} = 11,622; $p < 0,05$). Figure1 shows the dynamics of results measured on LLPP test. There is an increase between first and second time points, after that there is a plateau. The highest increase happened between fifth and sixth time points.

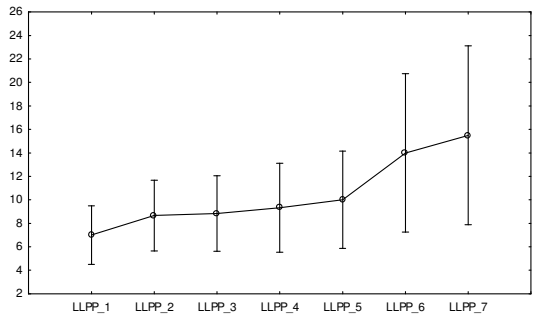

Figure 1. *Result's changes of LLPP test between each time point.*

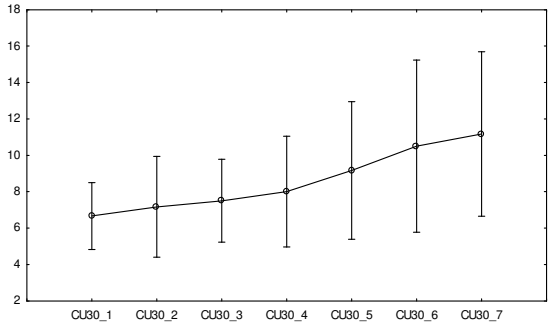

Figure 2. *Result's changes of CU30 test between each time point.*

Figure 2. shows a plateau between first and second time point, followed by notable increase of the results of CU30 test between second and sixth time points. It is seen a low increase, almost plateau between sixth and seventh points.

Results of LL30 show plateau between first and second, and sixth and seventh point, and significant increase between second and sixth time point, figure 3.

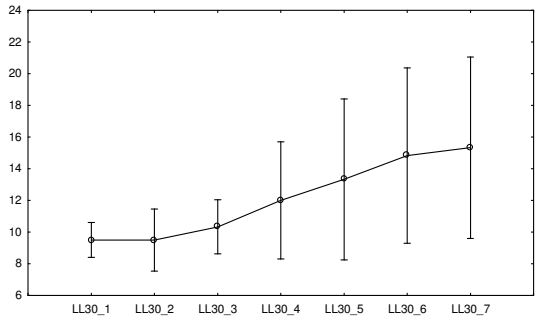

Figure 3. *Result's changes of LL30 test between each time point.*

There is a significant decrease between initial and final measuring of TUTLF test. We can see plateau until forth point. Afterwards there is a high increase until sixth time point, followed by lower increase, figure 4.

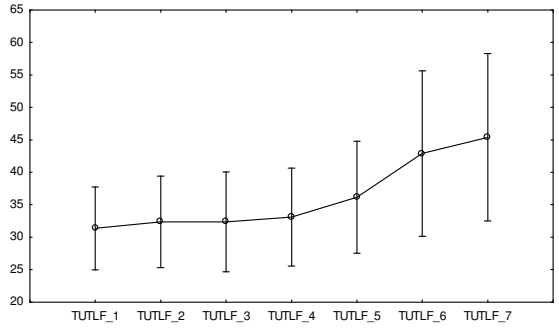

Figure 5. *Result's changes of TUTLF test between each time point.*

Results of single leg squats (SLSRL, SLSLL) shows almost identical dynamics through time. Strong increase between third and fourth, and fifth and sixth time point. There is a plateau between last two points on the dominant leg, and low decrease on non-dominant leg. There are one more plateau for non-dominant leg between fourth and fifth time points, figure 6 and 7.

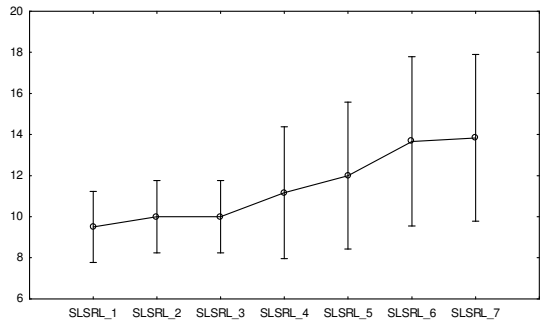

Figure 6. *Result's changes of SLSRL test between each time point.*

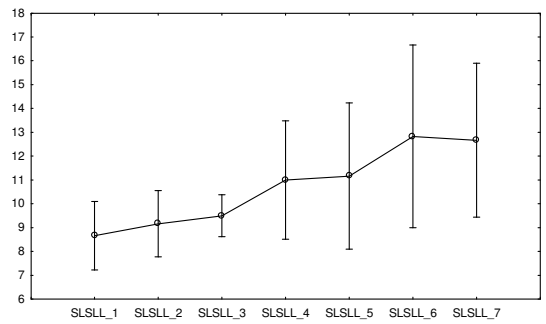

Figure 7. *Result's changes of SLSLL test between each time point.*

Results of PH test indicates minimal augment in the first two points, followed by significant increase until sixth time point, and notable decrease between last two points, figure 8.

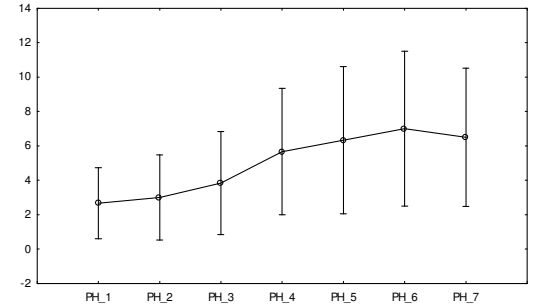

Figure 8. *Result's changes of PH test between each time point.*

Motor tests for assessing explosive power

We used two unspecific motor tests to assess explosive power, rope climbing and horizontal jump (RCL and HJ). The results of these tests are presented in table 2.

Rope climbing test indicates no significant changes between initial and final testing ((F_{RCL} = 0,91013, p= 0.53013), while distance jump shows minimal significant increase (F_{HJ} = 17,613, p < 0.05). There is a significant increase only between third and fourth time points, and plateau from first till third and between fourth and seventh points.

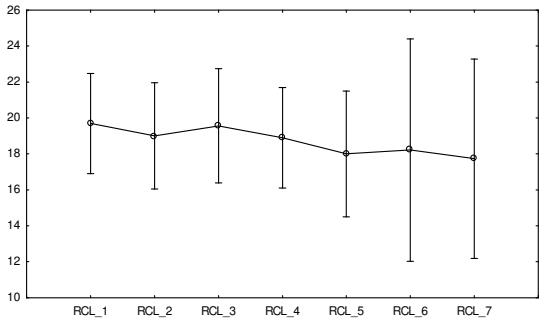

Figure 9. *Result's changes of RCL test between each time point.*

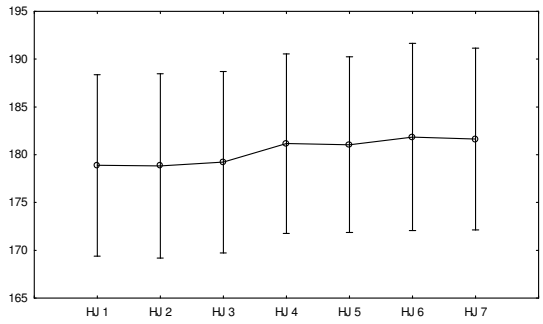

Figure 9. *Result's changes of HJ test between each time point.*

Motor tests for assessing flexibility

To assess flexibility we used three tests, respectively three types of splits, right, left and central split. Which results are presented in table 1. These variables are inversely scaled. All tests indicate significant increase in flexibility (F_{SRL} = 5,5583, F_{SLL} = 7,3038, F_{SC} = 6,8395, p < 0.05).

Figure 10 shows strong increase between first and second point, followed by short plateau. After that we can see high increase of results, followed by low decrease, and at the end, again, low increase. There is almost the same dynamics of results of SPLIT test, figure 11.

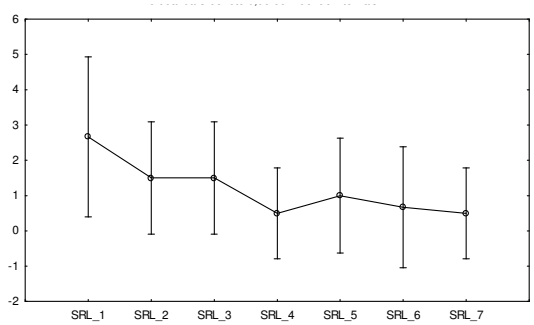

Figure 10. *Result's changes of SRL test between each time point.*

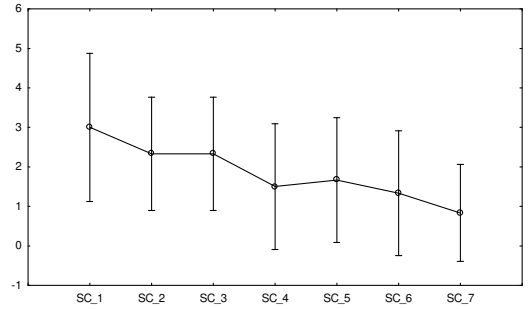

Figure 11. *Result's changes of SC test between each time point.*

Results of left split indicate almost linear increase through the time, except in last time point where is seen a plateau, figure 12.

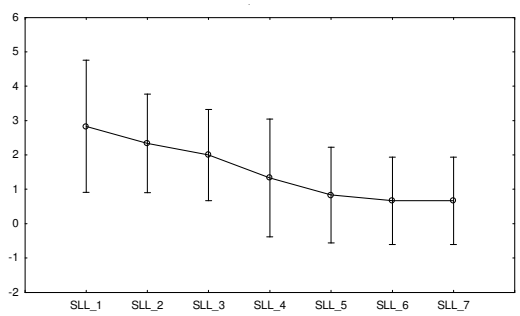

Figure 12. *Result's changes of SLL test between each time point.*

DISCUSION

The primarily finding of this study supported our research hypothesis, with statistically significant improvement in all of measured motor abilities, except in explosive strength (rope climbing, and minimal increase in horizontal jump). The explanation can be found in the knowledge of many previous studies.

It is well known that one of the most important principles of conditioning is – specificity. The principle of specificity means that conditioning should involve similar movements as those commonly found in gymnastics skills. However, specificity is sometimes "over-interpreted" to mean that the athlete should perform conditioning exercises exactly the same as seen in the actual movements, usually with added resistance. Of course, the only way to do a movement exactly the same is to do the movement itself. Adding resistance to sport movements may be appropriate at some times, but adding resistance to a skilled movement is usually not a good idea. Conditioning for particular gymnastics movements is specific to the ROM of the limbs, the speed of the movement, the type of movement, the duration of movement, the tension type and so forth. This further amplifies the importance of movement similarity between conditioning and performance movements (Siff, 2000).

Accordingly, gymnasts at this age mostly train acrobatics, basic elements on uneven bars (hanging and support position), and rhythmic elements (jumps, bounding, pirouettes and holding positions) on the balance beam and floor. That was also a content of our training program, fully respecting the principle of specificity. As we noted before our gymnasts trained elements from B program for girls, while they competed in C program for girls (National Award Regulations, 2005). However, in the last two measurements time points (May and July) started to compete in B program for girls. B program, as we mentioned before, is higher level than C program. B program means heavier elements on each apparatus, but the number of training hours remains the same. There is an increase in the number of repetitions of specific preparatory exercises (increase in intensity) for learning vault, acrobatic elements and new elements on uneven bars. The plateau or slight decreases in the last two time point of measuring in almost all motor abilities we can prescribe only to entry into the competition period. Accordingly, the gymnasts have already been adapted to training loading and were not showed progression any more. Many authors have already emphasized that once athletes started to compete, their results did not live up (Bührle and Werner, 1984 according to Major, 1996). Gymnastics experts have also warned, many times, against decreasing strength training during the competition season (Borrmann, 1978; Hartig and Buchmann, 1988; Plotkin, Rubin and Arkaev, 1983; Ukran, 1969 according to Major, 1996).

Contents of each of the gymnastic events are specificity in the way of exercising, and the type of elements and exercises. So this type of training results in specific developing of motor abilities.

The high rate of increasing results in our study we prescribe to the fact that they started to train elements of B program for girls which contains elements which require much higher level of power and explosive strength. Until then they trained in the beginner's C program for girls. There were highlights on basic power exercises, on the flexibility and acrobatic elements in the training process before that. Largest

increase was recorded in the results of LL30 test and LLPP test which is quite understandable considering that the most practicing elements are of the uneven bars.

It is known, the most important motor ability for gymnasts is strength and power, certainly, more precisely strength and power coupled with flexibility (Major, 1996). Importance of strength and power in artistic gymnastics is still debatable between the experts who have been explored that problem. So, some of them emphasize that the demonstration of the power of the muscles, being one of the most important skills in artistic gymnastics (Gaverdovskij et al, 1979; Kochanovicz, 1998; Savczyn, 2007 according to Koperski et al 2007). According to the definition of power, strength (force) is one of the components on account of which we can improve power (Markovic, 2008). As we mentioned before, when we talk about children's artistic gymnastic we can only talk about power, because they are too young for strength training with high loads. This insight is consistent with the results of our study, which show significant increase in all of six motor tests to assess the power, and also in each of two tests to assess flexibility. And also in consistent with our training principals, gymnasts trained power the most. Many authors studied importance and developing of strength/power in Artistic gymnastic (Major 1996; Sands et al, 2000; Sands et al 2005; McNeal et al, 2006). Many of them emphasize that special strength for gymnastics training must answer the demands of gymnastics (Shiff, 2000). The principle of specificity implies that the exercises used in training should be similar to the exercises that must be performed in the competition routine. Thus, our training program was composed of the elements of an official B program for girls (National award regulations, 2005). Therefore, many coaches and gymnastics experts imagine that the best training for gymnastics would be more gymnastics. However, long ago this was proven not to be the case (Borrmann, 1978; Oppel, 1967; Plotkin, Rubin, and Arkaev, 1983, according to Major, 1996). Special training is necessary to develop the strength and power in the athlete sufficient for correct technical performance of skills (Hartig and Buchmann, 1988; Oppel, 1967 according to Major, 1996), but there is also a need for conventional strength and power training.

Results of One way ANOVA for repeated measures shows minimal increase in the values of horizontal jump, and slight decrease in rope climbing. These results we can prescribe to the fact that horizontal jump is one of the tests which is used in the selection process. Thus, our gymnasts had a higher average value of the results from their counterparts (girls in the first class x_{HJ}= 120 cm) (Findak et al, 1992; Findak 2002), and even higher values from the results of the girls in the fourth class (x_{MSDM}= 145 cm) (Findak et al, 1992) who are not active athletes, at the onset of the training process. Rope climbing is a kind of specific gymnastics power exercises. They do rope climbing on each training, so they probably reached maximum of powerful capabilities for their age. But B program contains much demanding elements on uneven bars, and heavier acrobatic elements on the floor requiring higher lever of explosive power of arms and shoulder belt. So, there is a need for improving these capabilities in this age, already.

There is a need for improvement the explosive power of arms and shoulder belt, because as we already said, power and strength, while maintaining optimal ROM, are the most important motor abilities in gymnasts. We are inclined to say that the power is more expressed than strength, but the strength can be considered as a basis for developing power. Results of the study of Jamni and colleagues showed the high peak power values, placing the gymnasts near the top levels of power athletes (Jemni et al, 2006). An increase in maximal strength "is always connected with an improvement of relative strength and therefore with improvement of power abilities" (Schmidtbleicher, 1992 according to Sands et al 2000).

Each of two tests for accessing flexibility showed significant increase in the ROM. Making significant increases in flexibility will bring marked improvement in performance. Larger ROMs will allow for longer periods of applied force, improvement in technique, increases in biomechanical advantages and reduction in joint strain. Flexibility which promotes optimal ROM in the joints of the athlete, it is essential to both produce the most efficient movement, as well as protecting the athlete to a degree from the rigorous of the sport, particularly the repetitive nature of both training and competition. Most gymnastic coaches would agree that flexibility is an essential aspect of gymnastic training and performance (Sands and McNeal, 1999). In our training program gymnasts did flexibility exercises at the beginning, during warm up of the training (dynamic flexibility) and at the end of the training (static flexibility). But they trained much less flexibility compared to power. Which is in consistent with a numerous previous studies which showed that the main key to gaining flexibility is dedication and consistency (Sands, McNeal, 2000). No matter what method you use, if you do not stretch regularly, you will not gain flexibility. They didn't do much flexibility but they did it regularly. It is known that in the selection process for Artistic gymnasts we choose those who are flexible. So, our gymnasts were baseline more flexible than their counterparts. Namely, all of subjects were able to do all splits before they started to train gymnasts. Flexibility is frequently included in talent identification and screening measures for gymnasts, diver and dancers (Brodie et al, 1998; Hubley, 1982 according to Sands and McNeal, 2000).

Nowadays, the issue of flexibility is datable. No that much between gymnast´s coaches as well as between coaches of other sports. As scientists regularly investigating elite performance at the Olympic level (top eight in the world), we find that high-level coaches are beginning to question the role of stretching in performance, and no longer simply accept stretching as an integral part of an athlete preparation (McNeal et al 2006). Gymnastic coaches have found that athletes with extraordinarily large ROMs in static conditions are not able to show this range of motion in a dynamic setting (static split vs a split leap), and by adding resistance training in extreme positions the dynamic range of motion was improved (Jemni et al, 2006). Although documentation of the negative effect of stretching on acute maximal strength and power performance accumulates, the mechanisms by which this effect is produced are not clear (McNeal et al, 2006).

There is a lack of investigations about the effects of different training programs on motor abilities. So, there is a huge room for improvement and making gymnasts better even more.

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Coresponding author:
Kamenka Živčič Marković
Faculty of Kinesiology
University of Zagreb, Croatia
kamneka@kif.hr

THE EFFECT OF DIFFERENT TEACHING SYSTEMS IN LEARNING RHYTHMIC GYMNASTICS APPARATUS MOTOR SKILLS

Despoina Tsopani[1], George Dallas[1], Niki Tasika[1] & Amalia Tinto[2]

[1] Athens Kapodistrian University, Greece
[2] Interfaculty University School of Motor Science, Turin, Italy

Original research article

Abstract

The purpose of this study was to examine which of the two teaching systems, the Current Teaching System (CTS) and the Serial Organization System (SOS), is more effective in the learning rhythmic gymnastics skills in this novice (basic) level of students. The sample that consisted of 84 novices female students of physical education of Athens, aged 18-20 years old (19.02±0.77) who volunteered to participate in this study separated in two groups (n_1=39, n_2=43). At first, a pre test wad done to ascertain the initial level of performance and a post test after the end of practice in order to assess the effectiveness of these two teaching methods. All the experimental skills were evaluated by two teachers of University who were also official judges in the sport of Rhythmic Gymnastics. All participants took place in a nine weeks intervention program, 2 times per week for 90 minutes in each session (teaching unit). According to the results, although there was not a group effect in the pre test in each apparatus ($p>.05$), in the post test there was significant group effect in the total number of examined skills ($p<.05$). Further, there was a significant group effect between the two measurements in the total number of skills in each apparatus of ribbon ($p<.05$), rope and clubs ($p<.001$). Furthermore, it has to be stressed that the SOS had higher scores in the majority of examined skills in post test. Conclusively, SOS is more effective than CTS in case of learning Rhythmic Gymnastics skills according to the position of body and apparatus, especially in these cases where the parameters of implementation of exercise are not altered.

Keywords: *Rhythmic Gymnastics- motor skills- learning.*

INTRODUCTION

Rhythmic Gymnastics (RG) is a sport that requires increased coordination of body movements and apparatus. In this particular sport gymnasts during training period must execute a great number of motor skills in order to structure their competitive routines, and this is the reason that they perform rhythmic skills, which are characterized by a change of body position and/or locomotion of apparatus (Aparo and her colleagues, 1999). This condition was verified by Karpenko and her colleagues that proposed the utilization of two apparatus for the improvement of performance in a weekly training schedule (Karpenko et al, 2005). On the contrary, other studies support the utilization of even four apparatus in the main part of an instructive-training course (Gaverdovskij et al, 1984; Lisitskaja et al, 1985). However, in RG as a main unit of our educational program, educators pursue the teaching of

more than one of these skills during a session, taking into consideration various factors, as the level and the number of participators, and the duration and the distribution of time of practice. Based on these factors, it is obvious that the method that is used in teaching (total - partial) depends mainly on the type of skills (Wightman & Lintern, 1985) while the type of exercise (selected - random) depends mainly on the characteristics of the skill, the characteristics of the practitioner and the evaluation of learning (Magill & Hall, 1990). A number of studies reported in the planning of practising motor skills, with participants repeating a number of repetitions of the same movement in one session or between several sessions support the superiority of random versus grouped practice (Lee & Magill, 1983; Shea & Kohl, 1990; 1991; Shea, Kohl, & Indermill, 1990). In addition, the way of organizing one practice unit (session) is related to the contextual interference that constitutes the number of various skills that are practiced in the session. Many studies report that the increase of elements that are practiced simultaneously and thus complicating the conditions during one session, results in the better recall of information on the instructing skill after a great amount of time (Bating 1972; Bating 1979; Goode & Magill, 1986). Related literature, according to the contextual interference effect, is referred mainly to laboratory conditions (Del Ray, 1982; 1989; Gabriel, Hall and Lee, 1989; Lee and Magill, 1983; Shea & Morgan, 1979; Wulf & Lee, 1993). Further, there is evidence that random practice surpasses considerably the method of grouped practice in the retention of motor skills (French, Rink and Werner, 1990; Goode, & Magill, 1986; Hall, Domingues and Cavazos, 1994; Wrisberg and Liu, 1991). Goode and Magill (1986) used three different types of service in badminton revealed that group followed random practice and serial practice achieved higher levels of maintenance and transfer of learning contrary to the group that followed grouped practice. This is also well documented by Bortoli and his colleagues that apply a similar method during practice in volley ball skills (Bortoli et al, 1992). Similar results are reported also by Wrisberg and Liu (1991) who examined in real teaching conditions students who learned two types of service (grouped practice: completion of total number of trials of each skill) and alternative practice: alternation of service types in predetermined order), with the group that followed alternative method of teaching to achieve higher levels of transfer and retention of these skills.

From motor control perspective, learning is directly linked to the memory that is reported as an internal data or representation of some fact or experience that preceded (Gordon, 1989). According to Anderson (1987) declarative memory is responsible of the process of learning, in cases where a performer who knows what to do to perform a motor skill. Also, the ability to recall information is influenced by the time interval that intervenes from the end of exercise up to the examination of the skill according to the closed loop theory (Adams, 1971). In this case the mnemonic trace, which is responsible for the choice and start of a certain plan of movement, becomes weaker because of the time interval and the intervention of other information before the skill or after this, and this constitutes one of the causes for the disability of the performer to utilize the essential information from the memory. Schmidt, (1991) with regard to the transfer of learning, supports that the movement-criterion, according to that the application of learning, concerns the attribution of another movement that was acquired by a different movement or situation. Moreover, according to Schmidt and Young (1987) learning of one skill influences the learning of another skill and, in this case transfer of learning leads to the creation of more complete knowledge for the utilization of various teaching strategies.

According to the Current Teaching System (CTS) in RG in our Faculty, the practice of a new skill in one apparatus

begins after the completion of the number of repetitions of the previous one and is continued until all skills are completed in each apparatus. For this reason a new system of teaching is proposed (Serial Organization System: SOS), where students practise different skills in different apparatus in random order in the same session, and it is expected that this method contributes to a positive effect on learning these skills. The purpose of this study was to investigate the effect of two different teaching systems (CTS - SOS) in learning Rhythmic Gymnastic skills that are performed in normal conditions during the course of RG in the practice hall.

METHODS

Eighty-four female gymnasts of Faculty of Physical Education and Sport of Athens University aged 18-20 years (19.02±0.77) volunteered to participate in this study and for this reason signed a consent form. No significant difference was found in chronological age between these groups (19.05±0.76 and 19.00±0.79 respectively). All participants were novices with no previous experience in rhythmic gymnastics motor skills. Students that were gymnasts on the past in any competitive level were excluded from this study.

The initial level of performance was assessed with a pre test that includes all the examined skills. After this initial evaluation participants were separated in two groups. The first group (n_1=39) that followed massed practice was in accordance with CTS that means, participants of this group complete all the trials of first skill in 1st apparatus and then practised the 2nd skill in the same (first) apparatus. The second group (n_2=43) that followed SOS (successive practice), based on the proposed teaching system, completed trials of the 1st skill in each apparatus and then practised the 2nd skill in each apparatus, and so on. This means that participants of 2nd group have an experience, successively, in all apparatus, before they begin the 2nd skill in each apparatus. This differentiation exists in regard to the choice of apparatus and skills so that in each session new skills are taught in different apparatus in random order. The insertion of participants into two aforementioned groups was based to the definition of groups according to the time schedule of study program of this department. The time period of nine weeks that correspond to the time schedule of teaching RG in our Faculty, constitutes the macrocycle in the RG course in the periodical circle of studies for these participants. Teaching these skills was done in constant conditions for two groups. Participants practised these skills according to the study's program of the department, for 90 minutes per session, two times per week for nine weeks (one semester) for all teaching and examined skills.

All participants independently form the assigned group, performed the same skill in each apparatus in random order, according to structural groups and groups of handling of apparatus as the planning of teaching matter reports. They were simple or complex discrete skills that required coordination of body and apparatus and in other cases coordination of apparatus and body concerning the space, e.g. throwing of apparatus and catching after the flight phase (table 1). Throughout the practice sessions, participants received verbal instructions, which determined the basic technical characteristics of these skills (Kim et al, 1998; Wright, 1991). One day after the end of the interventionist program, a post test was performed to evaluate the learning of these skills. Two educators with many years of international judging experience in RG evaluated each skill separately according to the code of points (FIG, 2006). During the post test each participant did not observe performances of other participants, in order to exclude observational learning effect (Bandura, 1977; Keele, 1968) and for this reason they remained in a special formative space waiting for their call.

The apparatus that were used were the five Olympic portable apparatus (ball, hoop, rope, ribbon and clubs) according to the code of points that is in valid (FIG, 2009).

On the three factors of evaluation in the RG: execution, artistry (artistic value) and difficulties (technical value), the present research focused only in the evaluation of execution, which is done in a 0-10 points scale, and the score is calculated by deducting tenths of points depending on the degree of the mistake. The apparatus and the skills are presented in table I.

Table 1. *The apparatus and skills of Rhythmic Gymnastics according to international code of points.*

	Ball	Hoop	Rope	Ribbon	Clubs
1	Swing	Swing	Swing	Swing	Swing
2	Rotation	Rotation	Rotation	Rotation	Rotation
3	Throw & catch	Throw & catch	Throw & catch	Throw & catch	Throw & catch
4	Rhythmical bounces	Rotation standing on the palm	Skips/Hops	Tosses	Small Circles
5	Roll on the floor	Roll on the floor	Small Circles / Rotations	Spirals	Mills
6	Roll over the body	Roll over the body	Skips or Hops into the rope	Snakes	Asymmetric movements

RESULTS

Student's test for independent samples was used to examine the differences between two groups. The level of significance was set at $p < 0.05$. There was not a group effect in the pre test in each apparatus ($p>.05$) On the contrary, in the post test there was significant group effect in the total number of examined skills (5 apparatus - 6 skills) (4.79±3.02, 5.43±2.66, 1st and 2nd group respectively). There was significant group effect between the two measurements in the total of skills in each apparatus of ribbon ($p<.05$), rope and clubs ($p<.001$). The means and standard deviations of two groups in two evaluation measurements are presented in table 2.

Table 2. *Means and standard deviations (in parentheses) on the scores in evaluations apparatus into two experimental conditions in two groups.*

	Pre test		Post test		
	Group1	Group2	Group1	Group2	P
Ribbon	2.04 (2.15)	2.23 (2.09)	5.02 (2.93)	5.39 (2.65)	*
Rope	2.02 (1.91)	2.38 (2.13)	4.59 (2.99)	5.53 (2.44)	***
Ball	3.45 (1.92)	3.61 (2.11)	5.84 (2.35)	6.08 (2.11)	
Clubs	1.80 (2.19)	2.44 (2.19)	3.31 (3.36)	4.82 (3.05)	***
Hoop	2.47 (2.02)	2.58 (2.26)	5.19 (2.83)	5.27 (2.82)	

* P < 0. 05, *** P < 0. 001

Table 3. *Means, standard deviations on the scores in evaluations skills in every apparatus in the post test in the two groups, as well as the level of significance between two measurements.*

Apparatus	Skill	Post test		level of significance
		1st group	2nd group	
	1	5.66 (2.55)	5.79 (2.41)	
	2	4.65 (3.47)	6.74 (1.71)	**
	3	5.87 (1.52)	5.79 (1.71)	
Ribbon	4	2.87 (3.06)	2.87 (3.17)	
	5	5.33 (2.88)	5.62 (2.42)	
	6	5.69 (2.76)	5.53 (2.77)	
	1	5.10 (2.88)	5.88 (2.21)	
	2	3.79 (3.63)	5.71 (2.29)	**
	3	4.97 (2.24)	5.95 (1.78)	*
Rope	4	6.42 (1.60)	6.31 (1.44)	
	5	3.10 (2.97)	4.59 (3.05)	*
	6	4.18 (3.19)	4.70 (3.09)	
	1	5.77 (2.24)	5.74 (2.85)	
	2	4.00 (3.62)	5.14 (3.14)	
	3	6.41 (1.16)	6.52 (1.27)	
Ball	4	6 .68 (0.93)	6.76 (1.11)	
	5	6.12 (1.69)	6.40 (1.34)	
	6	6.00 (2.42)	6.19 (1.42)	
	1	5.38 (2.85)	6.30 (2.12)	
	2	3.79 (3.83)	5.55 (2.94)	*
	3	4.92 (2.44)	5.83 (2.41)	
Clubs	4	4.28 (3.22)	5.70 (2.23)	*
	5	0.92 (2.39)	1.46 (2.38)	
	6	2.94 (3.34)	2.69 (3.13)	
	1	5.97 (1.72)	6.11 (2.17)	
	2	3.44 (3.56)	4.88 (3.22)	
	3	6.51 (1.21)	6.37 (1.29)	
Hoop	4	5.23 (2.89)	4.86 (3.46)	
	5	6.05 (1.76)	5.93 (1.86)	
	6	3.94 (3.56)	3.49 (3.25)	

p < ,05* p< ,01 **

Further, t-test for independent samples revealed significant differences of individual skills between two groups, but not in all cases. It is mentioned that in a total number of 30 skills, the 2nd group had a better performance in relation to 1st group in a 20% (6 from 30) of total skills, which characterized the superiority of this group (table III). The means and standard deviations as well the level of significance between two systems in each skill in each apparatus in the post test is presented in table 3.

According to the results of table 3 in ribbon apparatus, an unclear picture appeared regarding the comparison of two teaching systems in the allocated skills. However, it has to be stressed that the SOS had higher scores in the majority of examined skills in post test. The superiority of SOS is very clear in rope and it has to be stressed that there was a significant differences in the half of the examined skills (2nd, 3rd and 5th skill). In ball SOS showed clear superiority as well, but without any significant difference in the examined skills. The superiority of SOS is obvious in five of all six examined skills, showing significant differences in the second and fourth skill. In hoop, both teaching systems are equally efficient with some minor differences but with no statistical significance in the examined allocated skills.

DISCUSSION

All practitioners, independent from the teaching system they followed, improved considerably ($p<001$) the initial level of performance. Maybe the level of physical conditioning of participants had a positive effect on learning rhythmic gymnastics skills as physical education student's posses an efficient level of performance. This verify previous data of Miletic and his colleagues which support that factors as coordination and strength of lower limbs contributed mainly to the jumping ability performance (Miletic, Sekulic and Jasenka, 2004), and those of Miletic et al which revealed that factors as flexibility and explosive strength contribute to successful performance in rhythmic gymnastics basic body elements (Miletic, Katic, and Males, 2004).

Whoever, the effectiveness of the proposed method is based to the fact that a great percentage of the examined skills scored higher in relation to the CTS. Serial Organization System is superior according to grades in the 20 from the total 30 examined skills. In addition, the statistical difference in six (6) skills that was appeared indicates the superiority of 2nd group in relation to the 1st group. The second group that practised simultaneously in different skills and apparatus, at the duration of each instructive hour achieved higher levels of learning concerning the team that completed the learning of skills in one apparatus and then was trained in the skills of the next apparatus. It should be reported that individual skills in RG that vary in the degree of difficulty require co-ordination of movements between body and apparatus. In this case, according to Kioumourtzoglou and his colleagues (1997), the previous experience in general motor abilities e.g. dynamic and static balance, sense of kinesthesis as well as perceptual abilities e.g. whole-body reaction time, and eye-hand movement, may affect positively the performance of rhythmic gymnastics skills in these physical education female students that participate in our study. In addition, observation of performances by other participants may influence positively performance in these experimental skills in our sample. This situation is in accordance with finding of Magill and Schoenfelder-Zohdi (1996) who using a rhythmic gymnastics rope manipulation skill, revealed that participants who observed the model made fewer errors pertaining to the coordination patterns of their body and limbs than did those participants that had not observed the model.

Further, the results of the present study are in agreement with other data (Aparo et al, 1999; Bortoli et al, 1992; French et al, 1990; Hall et al, 1994; Karpenko et al, 2005; Lisitskaja et al, 1985) which support that the application of successive method is more effective than the grouped practice when teaching motor skills.

More concretely, in skills where does not exist a change of body position but only the locomotion of apparatus in the space, the two systems are equally effective. This fact is in agreement with other studies which state that the characteristics of skills are basic factors for the existence of not statistically important differences between the grouped and successive practice, specifically in the cases where emphases is given in the precision of orbit of movement despite the correct implementation of movement (Bortoli et al, 1992; French et al, 1990). In skills where the schema-posture of body and the level of movement in the space in frontal plane are not altered, as in rotation, e.g. 4th skills in hook, SOS surpasses considerably the CTS method in the overwhelming majority of apparatus (four from the five apparatus: rope, hoop, ball, clubs, ribbon), while a mixed picture is observed in other skills independent from existing or not of transfer of learning from previous motor experiences as it happens to girls that in their childhood are engaged in motor games where they used the ball (bounces, throws and caches, rolls), the rope (rope turning forward / backward, throws and caches , rotations) or the hoop (rolls, rotations) etc. In these cases it appears that

both systems of teaching are equal effective. On the whole, according to the results a) learning with both systems of teaching was effective, b) SOS is more effective in these skills where that are not altered the parameters of implementation (form, level). Further, both systems are equally effective in those gymnastic skills that exists transform of learning from previous motor situations or in the skills that do not exist change of body position but only change of apparatus.

Another interesting point is to emphasize the effectiveness of teaching period in our Faculty. The macrocycle devided in periods, should aim, among others, in the assimilation of a new and perfection of already known curriculum. (Karpenko et al, 2005). Conclusively, the Serial Organization System (SOS) is more effective than Current Teaching System (CTS) in learning rhythmic gymnastics' skills in contrast to the selected exercise, specifically in cases where increased co-ordination of movements of body and apparatus is required.

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Coresponding author:
Despoina Tsopani
National and Kapodistrian University of Athens,
Faculty of Physical Education and Sport Science
gdallas@phed.uoa.gr

JUDGING PERFORMANCE IN GYMNASTICS: A MATTER OF MOTOR OR VISUAL EXPERIENCE?

Thomas Heinen[1], Pia M. Vinken[2] & Konstantinos Velentzas[3]

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

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Abstract

We addressed the question if laypeople with motor experience in gymnastics evaluate gymnastic performance similar to judges with only visual experience in the same domain. In addition we sought to explore the (biomechanical) sources of information that may account for the evaluation of gymnastics skills. We predict that laypeople rate handsprings on vault similar as expert judges and that gymnastics judges' scores are related to time-discrete kinematic characteristics whereas laypeople's scores are related to the form-aspect of the skill. 23 gymnastics judges and 23 laypeople rated handsprings on vault. Laypeoples' scores were in average lower than gymnastics judges' scores when judging handsprings. Laypeoples' scores were predicted well by time-continuous kinematic parameters whereas judges' scores were predicted well by time-discrete characteristics of the handsprings. We conclude, that judging in gymnastics can be facilitated by either own motor experience or specific visual experience.

Keywords: *handspring, kinematic analysis, judges, laypeople.*

INTRODUCTION

Perceiving the actions of other people is one important skill for judges, coaches and athletes in the sports domain and especially in gymnastics. Gymnastic judges have to correctly estimate the movement quality with regard to official international or national guidelines (Dallas & Kirialanis, 2010). Research has shown that both, visual and motor experience, may account for correctly estimating the movement quality of other people (Loula, Prasad, Harber & Shiffrar, 2005; Blake & Shiffrar, 2007). However, two questions remain open: The first one is, on which informational source(s) this estimation is predominantly based on. The second one deals with changes in informational source(s) as a function of the amount of visual or motor experience the observer exhibits. In the present study we therefore addressed the question if laypeople with motor experience in gymnastics evaluate gymnastic performance similar to judges, which have only visual experience in the same domain. In addition we sought to explore the (biomechanical) sources of information that may account for the evaluation of gymnastics skills.

Empirical evidence suggests that judges outperform laypeople in judgment tasks, mainly because they differ in the organization and activation of their

knowledge representations for the judged skills (Ste-Marie, 2003). Judges are better at anticipating upcoming gymnastic elements from previous information (Ste-Marie, 1999) and they know which information is relevant when judging a specific movement in their domain (Bard, Fleury, Carrière, & Hallé, 1980). Following this, expert judges are better in detecting movement errors or determining deviations from movement templates than laypeople (Plessner & Schallies, 2005; Ste-Marie & Lee, 1991) and they exhibit significantly greater depth and breadth in their declarative knowledge base (Ste-Marie, 2000). This is mainly because they have accumulated a large amount of visual experience over time. However, when we observe someone performing a motor skill, corresponding representations in our action system are automatically activated, depending not only on the amount of experience we have accumulated over time in imagining and observing, but also in planning and executing an action, suggesting that both, motor and visual experience, define visual sensitivity to human action (Blake & Shiffrar, 2007; Loula et al., 2005).

Loula et al. (2005) investigated how well observers are able to recognize themselves, friends or strangers from point-light displays of various actions (Experiment 1 & 2 of Loula et al, 2005). In order to generate point-light display, the authors attached reflective white markers to participants' major joints and head. The participants were also dressed in black clothes. When being filmed, only the reflective markers remained visible (cf., Johansson, 1973). If motor and visual experience determines visual sensitivity to human movement, then observers should be most sensitive to their own actions and more sensitive to actions of their friends than to actions of strangers. Participants viewed displays of point-light sequences of actions of themselves, their friends and strangers performing various actions. In actor identification and discrimination tasks, sensitivity to one's own actions was highest. Visual sensitivity to friends' was higher than to stranger's actions. The authors concluded that both, motor and visual experience define visual sensitivity to human action.

Knoblich and Flach (2001) had participants predicting the landing position of dart throws at a target board after watching video clips of displaying either themselves or somebody else throwing the dart. They found out that the predictions were more accurate when participants watched themselves acting. The results confirmed the assumption that observers are more sensitive to actions most familiar to them and less sensitive to actions unfamiliar to them. This effect also occurs when people learn new movements. Casile and Giese (2006) could show that motor learning influences later perceptual performance. The authors had blindfolded participants learn novel arm synchronization patterns. Relative to a pre-testing session all participants showed improved post-learning visual recognition. It was concluded that motor learning had a direct influence on action recognition that is not mediated by visual learning.

From this point of view, not only visual but also motor experience defines people's sensitivity to human action recognition. However, the observation of the same action may rely on different (biomechanical) informational sources, depending on the amount of visual or motor experience the observer has accumulated over time (Blake & Shiffrar, 2007). As a consequence, two questions arise: The first one is: On which informational source is this estimation is predominantly based on? The second one is: Does the estimation and/or the informational source change as a function of the amount of visual or motor experience the observer exhibits?

Given that for instance expert judges' scores should by definition reflect the quality of the performed skill, one could assume relationships between judges' scores and kinematic parameters (e.g. Atiković & Smajlović, 2011; Takei, 1998, 2007; Takei, Blucker, Nohara, & Yamashita, 2000). In several studies, kinematic variables of

several skills performed on the gymnastic's vault were analyzed and related to the judge's scores by correlation- and regression-techniques. A common finding is that about 50 to 60% of the variation of the judges' scores can in general be explained by the variation of a few kinematic parameters. One major shortcoming of the mentioned studies is that the form-aspect of the movements to be judged is neglected, because only time-discrete parameter values were analyzed, without paying attention to their time-course. However, there is compelling empirical evidence, that time-discrete kinematic parameters do only in part capture the form-aspect of movements (Jaitner, Mendoza, & Schöllhorn, 2001), and a more holistic impression of a movement could be of high relevance when judging a skill in gymnastics (Arkaev & Suchilin, 2004).

In the current study, we compared gymnastics judges to laypeople. Gymnastic judges exhibited specific visual experience due to their education, but no motor experience. Laypeople were able to execute the skill they should judge in our experiment but had neither gymnastics judging experience nor specific knowledge of the judging guidelines of the International Gymnastics Federation (FIG, 2009), and thus they had no specific visual experience of the skill.

We evaluated the judgments of handsprings on vault in gymnastics. Our first assumption was that gymnastics judges with specific visual experience do not differ from laypeople with specific motor experience when judging handsprings on vault, because both, motor and visual experience may account for a precise judgment. Our second assumption was that judge's scores are related to time-discrete characteristics of the handspring vaults because expert judges know better which information is relevant when they are to judge a specific movement in their domain, whereas laypeople's scores are related to the form-aspect of the movement pattern, mainly because they might rely their estimations more on a holistic impression of a skill, rather than on specific parameters (Jaitner et al., 2001; Takei, 1998).

METHODS

N = 23 gymnastics judges (experts; age: median = 35 years , range = 34, quartile range = 20) and N = 23 students of Sport Sciences (laypeople; age: median = 27 years, range = 25, quartile range) were recruited to participate in this experiment. We derived the number of participants from a power analysis when expecting a medium effect (Cohen's $f > 0.25$) with type I error probability of 5%, and type II error probability of 20%. All laypeople had specific motor experience in gymnastics due to their successful participation in gymnastics courses at the German Sport University Cologne. More specifically all laypeople were able to perform the handspring on vault by themselves without any guidance technique. They had neither gymnastics judging experience nor specific knowledge of the judging guidelines of the International Gymnastics Federation (FIG, 2009). All expert judges had an average experience of judging gymnastics skills of 8 ± 1 years and a valid judging license of the German Gymnastics Federation. All judges had some basic motor experience in gymnastics, which is typical for gymnastics judges, but none of them reported to ever be able to perform the handspring on the vault. All participants were asked to participate in an experiment on perceptual processes in the evaluation of gymnastic performances. They were informed about the procedure of the study and gave their written consent prior to the experiment, which was carried out according to the ethical guidelines and with the approval of the University's Ethical Committee. After the experiment they were debriefed and received a chocolate bar as a reward for their participation.

Preparation of video sequences. Video sequences of N = 30 female gymnasts (age: 18 ± 5 years) performing handsprings on vault were used in the experiment. All female gymnasts had at least seven years of experience with a minimum of six hours

training per week. The video sequences were recorded during training sessions. All 30 gymnasts were asked to perform the handspring three times and were advised to perform the formal process like they would do in competition, hence, announcing to the judge prior to the performance and give notice of completion after landing. Their performance was videotaped with two digital video cameras (50 Hz) which were placed at a distance of 15 m from the vaulting table. One camera recorded the gymnasts with a pan shot, simulating the judge's perspective. We wanted to simulate the natural perspective of the judges to control for possible influences of the observation angle on their judgments (Plessner & Schallies, 2005). The second camera was stationary and videotaped the performance orthogonal to the movement direction which was used for two dimensional movement analyses.

We used two validation steps in the preparation of the video sequences. First, two gymnastics coaches with national experience were independently asked to serialize the three performances of each gymnast in terms of their movement quality. They could use a laptop computer to play back the video sequences in slow motion whenever needed. There were no differences in their choice for the best handspring performance of each gymnast so that in each case the handspring with the highest quality could be picked out for further preparation of the experiment.

In the second step of the validation procedure, three judges with an international license and a judging experience of at least ten years who were not part of the study sample, rated the $N = 30$ video sequences in a random manner to ensure that they represent a typical sample one encounters in a regional gymnastics competition. The videos were shown in a randomized order on a laptop computer. The judges were independently asked to rate the performances on a 7-point scale ranging from 1 = *not representative* to 7 = *representative* for a regional competition in gymnastics. This procedure ensured that all gymnasts had a comparable performance level. Inter-observer reliability was calculated at $r = .82$ ($p < .05$) using the coefficient of intra-class correlation over all rated performances. From the judges' ratings, $n = 10$ video sequences had to be removed from the experiment, because they were rated less representative for a typical sample one encounters in a regional gymnastics competition.

Kinematic Analysis. The video sequences from the second camera that videotaped the performance orthogonal to the movement direction were used for kinematic analysis. The horizontal and vertical coordinates of eight points (body landmarks) defining a 7-segment model (Figure 1) of the human body were recorded for each frame using the movement analysis software *WinAnalyze 3D* (Mikromak, 2008).

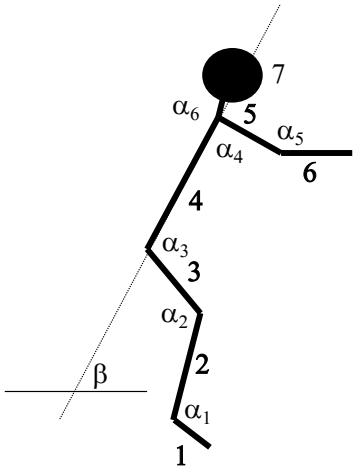

Figure 1. *Free body diagram of the 7-segment model used to calculate kinematic parameters of the handsprings. The numbers from 1 to 7 correspond to the body-segments.* α_1 *to* α_6 *describe the analyzed joint-angles and* β *symbolizes the orientation angle of the trunk.*

We have chosen the model outline similar to previous research (King & Yeadon, 2004). Because a single handspring on vault contains only regulatory movements of low frequency, a frame rate of 50 Hz was seen as sufficient for kinematic analysis of the handspring performances by an independent biomechanist. We applied a digital filter

(cut off frequency = 6 Hz) for data smoothing and calculated a mean temporal error of ± .02 s and a mean spatial error of ± .006 m from our data. Body-segment parameters were calculated on the basis of the individual anthropometric properties of each gymnast (Zatsiorsky, Seluyanov & Chugunova, 1990).

The kinematic analysis was performed in two steps. In a first step, we calculated time-discrete kinematic parameters for the handspring. With the help of a biomechanist who developed a deterministic model of the handspring and a top-level gymnastics coach, we chose nine kinematic parameters from our movement analysis data, that represent the most relevant judgment criteria from a biomechanical point of view in the three phases of the handsprings on vault, namely the first flight phase, repulsion phase and second flight phase (DTB, 2001). The distinct phases, the kinematic parameters as well as the corresponding criteria of the judging guidelines are presented in Table 1.

Table 1. *Distinct phases of the handsprings on vault and time-discrete kinematic parameters that were deviated from the judging guidelines of the German Gymnastics Federation (DTB, 2001; CM = centre of mass).*

Phase	Parameter	Judging criteria
First Flight Phase	Horizontal take-off velocity (CM)	Insufficient flight due to the technique of the handspring (too high or too low)
	Vertical take-off velocity (CM)	
	Moment of inertia at take-off	Insufficient body posture at take-off
Repulsion Phase	Moment of inertia at initial support	Insufficient body posture at initial support
	Contact angle of body and support surface	Insufficient contact angle
	Duration of repulsion phase	Effusive duration of repulsion phase
Second Flight Phase	Horizontal take-off velocity (CM)	Insufficient height and width of after-flight
	Vertical take-off velocity (CM)	
	Moment of inertia a touch-down	Insufficient body posture

In a subsequent step, time courses of angles and angular velocities of six joints (α_1 to α_6) of our 7-segment model as well as the orientation angle of the trunk (β) and its corresponding velocity were calculated for further process oriented data analysis (Jaitner et al., 2001). The use of the joint angles and angular velocities together with the orientation and its time dependent change of the trunk angle assured that the movements' description was physically complete. Each movement pattern of the n = 20 handsprings (including angles and angular velocities) consisted of 14 variables that were normalized by time and then compared to a reference handspring on vault. The data for the reference handspring performance was provided from an international licensed judge, used in judges' education programs in Germany.

A *similarity value* with arbitrary units was calculated by comparing each individual handspring pattern with the reference handspring (cp., Jaitner et al., 2001). While there were 14 variables per trial, a total of 280 comparisons were calculated. A similarity value of zero represented an identical movement pattern compared to the reference handspring. The

larger the value, the more dissimilar the two movement patterns were. With the calculation of the similarity values we could objectively quantify the form-aspect of the handsprings from a biomechanical point of view.

Performance rating. The judges scored the quality of each handspring on vault with regard to the judging guidelines of the German Gymnastics Federation (DTB, 2001) on a 9-point scale. A handspring could be scored with a maximum of eight points (perfect mastery of the handspring) and a minimum of zero points (major movement errors and/or aborting of performance). The laypeople also scored the quality of each handspring attempt on a 9-point scale comparable to the judges' scale, ranging from zero points for performing the movement with major movement errors or when aborting the performance and eight points for perfect mastery of the handspring.

A trained research assistant introduced the experimental task to each individually tested participant. The participant was shown n = 3 handsprings, differing in movement quality. This was done for orientation and calibration purposes. The research assistant provided the participant with the information that the first of the three handsprings is typically scored about four points, the second is scored about seven points, and the third is scored about one point in a regional competition. After the introduction, the participant was asked to rate each individual performance of the n = 20 handsprings. Therefore, each of the video sequences of the handsprings on vault was presented in real-time with a data projector on a silver screen with a diagonal of 2.50 meters. The participant was seated at a distance of 3.00 meters from the silver screen. After the handspring on vault was shown, the participant rated the performance of the gymnast just presented by typing the score into a laptop computer. The participant was given the chance to make notes after watching each handspring on vault, prior to giving a final score for each handspring performance. The test order of the trials was randomized for the participants to control for sequence effects. The experimental task took approximately 25 minutes to complete. After the experiment, inter-observer reliability was calculated for both, the judge's and the laypeople's group at r = .78 and r = .82 (p < .05) respectively using the coefficient of intra-class correlation over all trials.

A significance criterion of α = 5% was established for all results reported. In order to assess differences in the performance ratings between the both groups, a Mann-Whitney U-Test was calculated, including participants' performance rating scores of the handspring on vault as dependent variable. In addition, Spearmans' rho between the ranking lists of the laypeoples' and the gymnastic judges' scores was calculated as an criterion to which degree both groups judge the handspring in a similar fashion.

In order to assess relationships between movement kinematics and judge's and laypeople's scores, in a first step, we used multiple linear regression analysis to predict the laypeoples' and judges' scores for the handsprings on vault from the nine analyzed kinematic parameters. Therefore, the scores for each trial were averaged in the groups to give a final performance score. In the second step, we used correlation analysis to relate laypeople's and judges' scores to the *similarity values* of the handsprings on vault. A similarity value of zero represented an identical movement pattern compared to a reference handspring. The larger the value, the more dissimilar the two movement patterns were (see Kinematic Analysis section).

RESULTS

Performance Rating

Our first assumption was that gymnastics judges with specific visual experience do not differ from laypeople with specific motor experience when judging handsprings on vault. The Mann-Whitney U-Test revealed a significant difference between the two groups, U = 59,

Z = -3.82, p < .01. In average, laypeople tended to rate all performances about one point lower compared to the gymnastics judges (Figure 2). In addition it was found that the laypeople's ranking list for the video sequences was correlated at r_S = .87 (p < .05) with the judge's ranking list. The overall pattern of results provides an indication that the ratings of the laypeople were similar to the ratings of the judges.

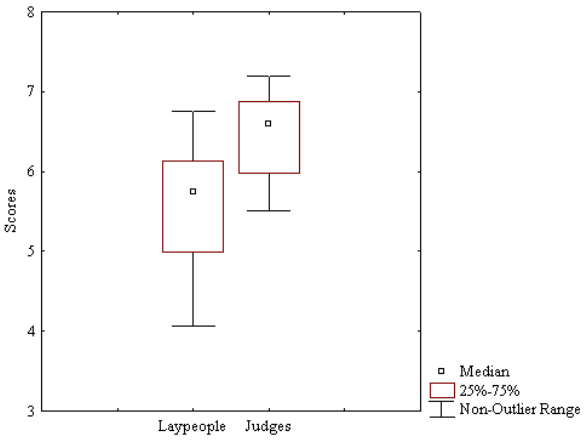

Figure 2. *Box plot of the judgments of the handspring vaults of the laypeople and the gymnastic judges.*

Kinematic Parameters and Participants' Scores

Our second assumption was that the judges' scores are related to the kinematic characteristics of the handspring vaults, whereas the laypeoples' scores are related to the form aspect of the movement pattern. We found that judges' scores could be predicted well by the time-discrete kinematic parameters whereas laypeople's scores could be predicted better by the similarity value of the process analysis (form-aspect of the handsprings on vault).

In detail, the variation of laypeoples' scores for the digital video sequences could be explained by an adjusted R^2 = .41. However, the overall F-test of the relationship between the laypeople's scores and the kinematic parameters was not significant, $F(9, 10)$ = 2.39, p = .09, Cohen's f = 0.69. The adjusted coefficient of determination of the judges' scores for the digital video sequences could be calculated at R^2 = .68 with the kinematic parameters as predictors. The F-test for the regression model was significant, $F(9, 10)$ = 5.49, p < .05, Cohen's f = 2.12

The results of the correlation analysis showed negative significant product-moment correlation coefficients for the laypeople's scores of the video sequences and the similarity values of the kinematic analysis, r = -.59 (p < .05). A negative correlation coefficient indicates higher scores associated with smaller similarity values and vice versa. The product-moment correlation coefficients for the judges' scores of the digital video sequences and the similarity values were not significant, r = -.37 (p = .10).

DISCUSSION

The aim of this study was twofold: At first, we sought to evaluate the judgments of laypeople with motor experience, and of gymnastics judges with visual experience when observing handsprings on vault. In addition we sought to explore the (biomechanical) sources of information that may account for the evaluation of gymnastics skills. Our first assumption was that gymnastics judges with specific visual experience do not differ from laypeople with specific motor experience when judging handspring vaults. Our second assumption was that the judges' scores are related to the kinematic characteristics of the handspring vaults, whereas laypeople's scores are related to the form aspect of the movement pattern. Therefore, judges and laypeople were asked to judge gymnastics handspring vaults. Kinematic parameters were statistically related to the scores of both groups.

A surprising result was, that laypeople rated all performances significantly lower compared to the gymnastics judges, whereas, laypeople rated the handspring performances by ranking similar to the judges. When relating kinematic data and participants scores, judges' scores could be predicted well by time-discrete kinematic

parameters whereas the laypeoples' scores could be predicted better by the similarity value of the process analysis, capturing the form-aspect of the handsprings.

Differences or similarities in judging gymnastics skills can be explained by people's organization of memory representations (Bless, Fiedler & Strack, 2004) and their corresponding activation through perceptual stimuli (Wolfe, 1994). The categorization and encoding of a current stimulus relies on the structure and content of these representations. Judges have movement templates in their mind that cover "good", "bad", and "average" performances, so that they can in principle generate appropriate evaluations. Laypeople may not have specific movement templates, especially if they have no or only marginal visual experience with the skill to be judged.

Giving judgments in an experimental scenario, which was the case in our study, may also be influenced by particular calibration effects (e.g., Lackner & DiZio, 2000). One may speculate that either laypeople or judges systematically misjudged the movement quality. This could stem from the fact, that judges had specific movement templates in their mind which differed from the scores which the judges were normally used to judge for the three baseline-handsprings at the beginning of the experiment. Since laypeople were not familiar with the baseline-handsprings, they could potentially be more strongly influenced by the anchoring procedure of the baseline-handsprings.

A specific memory representation (i.e., movement template) could furthermore lead to the fact, that judges may allocate their attention to specific parts or phases of the handsprings, because these parts and phases are made explicit in the judging guidelines. For instance in vaulting, attention has to be allocated to the angle between the body and the support phase in the repulsion phase, because this is a criterion to be judged. Due to their intensive training, they already have acquired processing strategies together with substantial visual experience (Ste-Marie, 2003), so that they may extract the same specific information related to specific kinematic parameters.

Because judge's scores could be predicted well by time-discrete kinematic parameters, we claim, that specific visual experience is closely connected to the perception of time-discrete parameters, rather than to a more global impression of the handsprings. Focusing on time-discrete kinematic parameters of the handsprings could be in relation with the visual-pivot strategy, that some authors found in expert judges compared to novice judges (Bard et al., 1980). Fixating distinct areas for longer periods and using lesser saccades could help to focus visual attention on specific parts of the movement (e.g. pre-flight or repulsion), and therefore extracting time-discrete information. However, motor experience with the handspring on vault could also lead to a better perception of the handspring and motor experience seems to be stronger connected to the perception of the form-aspect of the movements to be judged. Already Kozlowski and Cutting (1978) pointed out, that judgments depend on some overall bodily features, and recently it could be shown, that different brain areas are activated due to the instruction given to the observers even if he or she looked at exactly the same stimulus material (Zentgraf et al., 2005).

We are aware of some critical issues within our design that need to be taken into account in further experiments and want to highlight three specific aspects. First, we contrasted judges with visual experience to laypeople with motor experience, but we did not integrate participants with neither visual nor motor experience in our design. Most of the existing studies show that experts in general outperform novices and laypeople in judging gymnastics skills (e.g., Ste-Marie, 1999). However, a replication of our study could integrate a third group consisting of judges with specific motor experience in gymnastics to extend our findings, especially with regard to the correlations between kinematic parameters and participants' judgments. Second, we did not

assess information rich areas for neither the laypeople nor the judges in terms of measuring participants' gaze behavior when watching the experimental stimuli. Therefore, we cannot be sure if judges' and laypeople's gaze behavior differs with regard to their spatial distribution or temporal dynamics. Measuring gaze behavior could be integrated in a replication of our study. Third, we used multiple linear regression analysis to predict laypeoples' and judges' scores for the handsprings on vault from the nine analyzed kinematic parameters. We acknowledge that different kinds of statistical analyses (e.g., neural network modelling, PCS-models) may potentially better predict judges' and laypeoples' scores from kinematic parameters. However, there may also be a trade-off between the degree of specificity and the amount of generalizability of such models (see for instance Glöckner, Heinen, Johnson & Raab, in press). As a consequence one of the next steps should be to analyze the *structure* of the relationships between kinematic variables and judges' or laypeoples' scores, assuming, that not all relationships maybe linear.

There are some practical consequences and implications of this study so far. First, we state, that own motor experience is as effective as visual experience when judging handspring vaults in gymnastics. Even laypeople with motor experience but no specific visual experience are able to give appropriate judgments of handsprings on vault in gymnastics. However, we furthermore conclude, that integrating specific tasks in judges' education courses, in which people gain experiences with simple mechanical relationships that govern complex gymnastics skills (like for instance the relationship between moment of inertia, angular momentum and angular velocity when performing somersaults) could potentially optimize the education process. In addition, it could be fruitful to analyze judges' visual and motor experience prior to competition in order to estimate the reliability of the final judgments.

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Coresponding author:
Thomas Heinen
University of Hildesheim
Institute of Sport Science
thomas.heinen@uni-hildesheim.de

MODELING THE FINAL SCORE IN ARTISTIC GYMNASTICS BY DIFFERENT WEIGHTS OF DIFFICULTY AND EXECUTION

Ivan Čuk[1], Hardy Fink[2] & Bojan Leskošek[1]

[1] Faculty of Sport, University of Ljubljana, Slovenia
[2] FIG Academy, Canada

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Abstract

The aim of this research is to investigate how different calculations of the final score may change the ranking orders among gymnasts. Fourteen different calculations were taken into consideration and then compared with official results from the 2011 Men's European Championships in Berlin. The proportion between difficulty and execution scores, according to different formulas, can range from 17% to 67%. With the different proportions in the final score calculations the number of changes in rankings is high: in C1 81%, in CII 61% and in CIII 35%. The formula D score + Sum (Middle four E scores) and formula D score + Sum (Middle three E scores) have the highest impact on the changes of qualifiers towards competitions CII and CIII. The above mentioned two formulas also specifically support the Men's Code of Points (articles 15 and 20) which state that gymnast is expected to include in his exercise only elements that he can perform with complete safety and with a high degree of aesthetic and technical mastery.

Keywords: *ranking, gymnasts, finals, qualifiers.*

INTRODUCTION

The International Gymnastics Federation (FIG) symposium in Zürich 2011 brought into awareness the problem of the final score in Artistic Gymnastics and its proportion between difficulty and execution scores. For better understanding, some history of how the final score is calculated in gymnastics is needed. While for the competitions before World War I it is difficult to know the judging rules, we can extrapolate some of them from the published results. According to Wallechinsky (2004), in the Olympic Games (OG) 1896 only rankings are known, in the OG 1900 the all around (AA) winner scored 302 points (from 11 events, including long jump and weightlifting) and concerning other results from the early OG we cannot extrapolate the calculation system of scores.

Štukelj (1989) wrote his biography, which includes some very valuable data on how the judging was conducted between the World Championships (WC) 1922 in Ljubljana and the OG 1936 in Berlin. In the WC in 1922, gymnasts were evaluated by two judges per apparatus with a maximum score of 10 points and he scored the maximum of 20 points on parallel bars (compulsory and optional exercises). In the OG 1924, the maximum score was 11 points for exercises and the maximum scores were given to Zamporini (ITA) for his optional exercise on parallel bars, also to the optional

exercise from Štukelj (YUG) on rings and to Segiun (FRA) on compulsory vault. In the WC 1922, the jury was composed of three judges and the formula for the final score was the sum of all three scores divided by 2 plus up to one point for deportment. The maximum score of 16 points was achieved by Štukelj on his optional exercise of rings. In the OG 1928, the final score was calculated as the sum of all three judges and Mack (SUI) obtained the maximum score of 30 points on vault over pommel horse (the apparatus from that time). For the final score calculation in the WC 1930 it was again the sum of three judges divided by two plus up to 1 point for deportment and the maximum score of 16 points was achieved by Pele (HUN) for compulsory and optional exercises on high bar. Other maximum scores were obtained by Peter (HUN) and Štukelj (YUG) both on their optional exercise on high bar, also by Loeffler (TCH) for compulsory and optional exercises on rings and Primožič (YUG) on his compulsory exercise of pommel horse. In the OG 1936 the jury was comprised of four judges on each apparatus and the final score was established as 10 points. Based on the results it is hard to presume how the final score was calculated.

With the increasing number of judges involved in judging, the researchers began looking to the bias, reliability and validity of judging. It can be stated that judging is very reliable and valid (Bučar et.al. 2011, Leskošek et.al.2010).

In the OG 1948, the maximum score was 20 points per apparatus and from the OG 1952 until the OG 2004, the maximum score established was 10 points (Wallechinsky, 2004). From the OG 1936 up to OG 1988 four judges per apparatus were used (final score was the average of the middle two) and from OG 1992 up to OG 2004 six judges were used to evaluate the gymnasts' performances (final score was the average of middle four). From 2006 (FIG 2006) the difficulty (D score) has been evaluated by two judges and the exercise presentation (E score) by 6 judges (final score is the D score plus the average of middle four E scores), and with the new rules from 2011 (FIG 2011), in the WC and OG there are two judges for difficulty, five judges for exercise presentation and two reference judges. The final score is the sum of the D score with the average of the middle three E scores.

It is interesting to analyze the calculation system of the results from different sports. The results from fights and combative sports (e.g. judo) are expressed only in Bolean value win-lose (IJF, 2003), the same for some team games e.g. basketball (FIBA, 2010), while others e.g. soccer (FIFA, 2011) have also the possibility of a third value (win-draw-lose). Swimming (FINA, 2011) and track and field (IAAF, 2010) have competitions where all the athletes start together (marathon), or compete in subgroups and the best ones continue to the next level of competition (if they achieve the required result, or win in its subgroup).

From a historical overview many different ways of calculating the final score were used to evaluate gymnastics. In the past (Fink (1986, 1991a, 1991b, 1992) Bučar, (1995)) suggested multiplying exercise presentation by D score, but it was never implemented in the official FIG competitions. This solution was used successfully at some 200 competitions in Canada between 1993 and 1996 and tested with »shadow« panels of judges in the major international competitions in Japan, Hungary and the WC 1993. The solution continues to be of interest but for wide-spread use would require the D score to be significantly lower than the computed E score – which is not the case in the current Code of Points - otherwise it is too tempting for gymnasts to increase difficulty at the expense of execution if judges evaluate both factors leniently. In any case, the political will for such a drastic change did not exist at the time.

Since OG 1936 and up to the so-called "open ended" COP (FIG, 2006), the proportion of the evaluation parameters related to the exercise content (difficulty and execution) was approximately 50:50.

With the COP (FIG, 2006), the proportion changed in favor of execution, also in accordance with the philosophy of the new COP (FIG, 2009c), which states in its article 15 and 20 that the gymnast is expected to include in his exercise only elements that he can perform with complete safety and with a high degree of aesthetic and technical mastery. Very poorly performed elements are not recognized by the D-jury and are penalized by the E-jury. According the article 20 of the COP (FIG, 2009c), the responsibility for the gymnast's safety rests entirely with him and it is required of the E jury to deduct very rigorously for any aesthetic, execution, composition and technical errors. The gymnast must never attempt to increase the difficulty or "D" score at the expense of aesthetic and technical execution.

It is worth noting the many concerns for the gymnast's health such as the increased risk that high difficulty brings if not well performed. Some sports have different proportions between content and execution (table 1) and can be from 4% (diving) up to 50% (synchronized swimming), while in AG is between 61% and 72%. According to the results of WC 2010 in Rotterdam, the proportions of the difficulty for the final score were between 36.7% and 51.4% (Table 2) .

Table 1. *Percentage of difficulty components of final scores for selected artistic sports.*

Sport	Content Components (Difficulty (D), Requirements), high level score		Performance Components (Execution (E), Artistry (A), etc), high level score		High Level Final Sc.	Difficulty % of Final Score	Final Score Calculation
Rhythmic	(Delements+Dapparatus)/2 = (10+10)/2 =10	9.5	E+A = 10+10 = 20	18	27.5	33% (50% for group)	D+2E
Acrobatic	D→10+	9.5	E+A = 10+10 = 20	18	27.5	33%	D+2E
Aerobic	D/1.9 or D/2.0→4.5+ (women 4.0+)	4.0	E+A = 10+10 = 20	18	22men, 20women	16-20%	D/2+2E
Men Artistic Gymnastics	D→7.0+	6.5	E = 10	9	15.5	42%	D+E
Women Artistic Gymnastics	WAG D →6.0+	5.5	E = 10	9	14.5	37%	D+E
Trampoline Routine 2 with Time of Flight (TF)	Dmen→16+, Dwomen→1.5+	15	E+E+E+TF =10+10+10+17≈ 47	44	60men 55women	25%	D+3E+TF Routine 1 has much lower D (≈3.0) and higher E (= 47) → D = 6%
Double Mini Trampoline	Dmen→9+,		E+E+E = 10+10+10 = 30	27	38men	20-25%	D+3E
	Dwomen→6.5+		E+E+E = 10+10+10 = 30		35 women	15-20%	D+3E
Tumbling	Dmen→11+, Dwomen→7.0+		E+E+E = 10+10+10 = 30	26	38 men 34women	20%	D+3E
Diving	D→3.5+	3.0	5of7X3/5=E+E+E = 30	25	75	4%	Equivalent to Dx3E Note multiplication
Synchronized Swimming	Technical Merit = 5x10	45	Artistic = 5Ex10 = 50	45	90	50%	D+E
Aerial ski	D→4.5+	4	3of5 Air=7+Land= 3x3=3E=30	25	100	5%	Equivalent to Dx3E Note multiplication

Table 2. *Proportion between difficulty and final score (proportion = difficulty/final score) (CI) at WC Rotterdam 2010.*

MAG	WorldChampion	Range of Difficulty %
Floor	42.0%	40.1% - 46.3%
P. Horse	42.3%	41.1% - 44.5%
Rings	42.8%	41.8% - 43.9%
Vault	42.6%	41.3% - 43.4%
P. Bars	42.0%	39.5% - 45.4%
H. Bar	46.4%	44.5% - 51.4%
WAG		
Vault	39.8%	36.7% - 41.5%
U. Bars	43.2%	40.9% - 48.6%
B. Beam	42.3%	40.5% - 45.1%
Floor	39.8%	37.7% - 45.7%

The aim of our work is to investigate how different final score calculations may change the ranking orders among gymnasts and to identify the most effective variations.

METHODS

Our sample was comprised by gymnast's scores from the European Championships 2011, both men and women, during the qualification round (CI), all around finals (CII) and during event finals (CIII) on all men's apparatus (deductions from judges chair were not evaluated) . On each apparatus the jury was composed by 2 D judges and 6 E judges.

We used the following formulas for calculating the final score:

1. A1 - D score + Average ((Middle four (E judge1:E judge6))(Escore < 10)
2. A2 - D score + Average (Middle two E judge1:E judge6) (Escore < 10)
3. A3 - D score + Sum (Middle two E judge1:E judge6) (Escore < 20)
4. A4 - D score + Sum (Middle four E judge1:E judge6) (Escore < 40)
5. A5 - D score + 2 x Average ((Middle four (E judge1:E judge6)) (Escore < 20)
6. A6 - D score + 3 x Average ((Middle four (E judge1:E judge6)) (Escore < 30)
7. A7 - D score x Average (Middle four (E judge1:E judge6)) (Escore < 10)

To simulate the current official size of the jury's panel for OG and WC which is composed of 2 D judges and 5 E judges we removed all the scores from the judge number 6 and the final score was calculated according the following formulas:

8. B1 - D score + Average ((Middle three (E judge1:E judge5)) (Escore < 10)
9. B2 - D score + Average ((E judge1:E judge5)) (Escore < 10)
10. B3 - D score + Middle score (E judge1:E judge5) (Escore < 10)
11. B4 - D score + Sum (Middle three score (E judge1:E judge5)) (Escore < 30)
12. B5 - D score + 2 x Average ((Middle three score (E judge1:E judge5)) (Escore < 20)
13. B6 - D score + 3 x Average Middle three score (E judge1:E judge5)) (Escore < 30)
14. B7 - D score x Average Middle three score (E judge1:E judge5)) (Escore < 10)

We established the rankings of each gymnast based on their final score according to different formulas and analyzed the

number of changes compared to the ranking based on the official method for calculating the final score. In the C1 we also separately observed the number of changes in rankings among the top 8 (qualification for apparatus final) and top 24 gymnasts (qualification all around final), and determined the Kendall Tau b rank correlations between all new versions of the final score. Between the number of changed qualifiers for CII and CIII and the average proportion between difficulty and execution the Pearson correlation was calculated. All the results were calculated in MS Excel.

RESULTS

The analysis showed that the differences between all apparatus, in most cases the proportion between difficulty and execution is similar regardless of the formula we used to calculate the final score; it changes significantly when we use formulas with more weight on execution. The lowest proportion observed was with formula A4= D score + Sum (Middle four E judge1: E judge6), where the proportions ranged between 0.16 (parallel bars) and 0.18 (pommel horse), followed by A6 and B4 with proportions between 0.21 (parallel bars) and 0.24 (pommel horse) and A3 and B5 with proportions between 0.32 (parallel bars) and 0.35 (pommel horse).

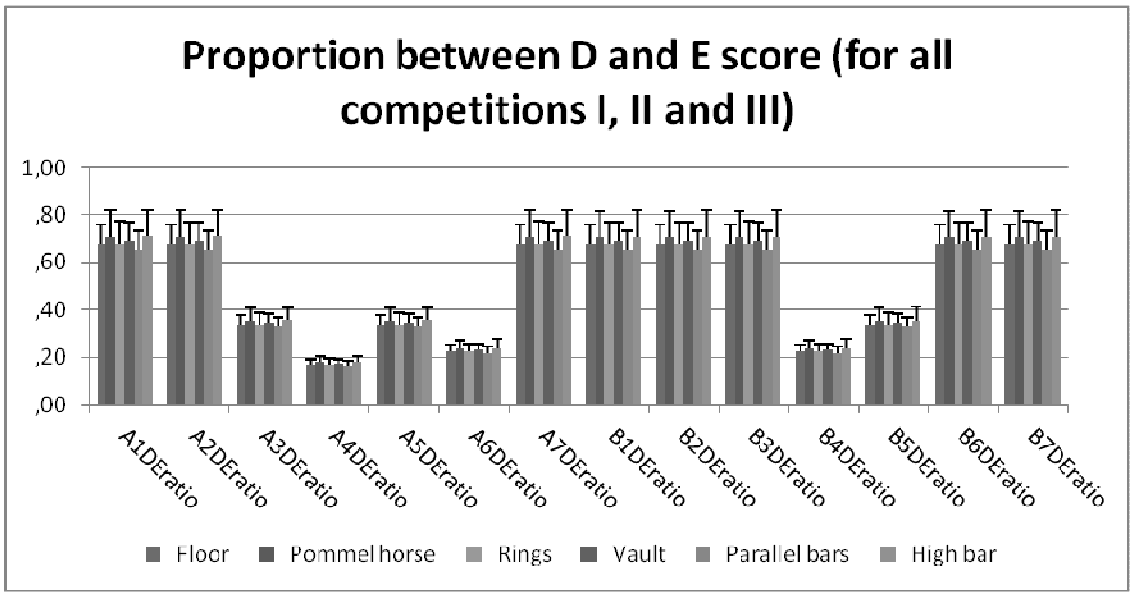

Figure 1. *Proportion between D and E score (results from all competitions I, II and III).*

With these observed changes in the proportions, there appeared also a significant change in the rankings of all apparatus in all competitions (Table 3). In general most of altered rankings would occur in CI, then in CII and at last in CIII. The most stable rankings would be in CIII, but still with notably changes.

Table 3. *Percentage of changes in rankings compared to the official results.*

Comp.	apparatus	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	B7	XA
	Floor	63%	94%	89%	90%	84%	83%	63%	76%	82%	93%	91%	88%	85%	83%
	Pommel horse	46%	90%	99%	94%	99%	78%	62%	63%	77%	94%	87%	82%	80%	81%
	Rings	51%	89%	95%	85%	89%	78%	67%	68%	76%	94%	90%	83%	85%	81%
CI	Vault	56%	95%	94%	94%	95%	78%	53%	63%	77%	96%	94%	91%	87%	82%
	Parallel bars	47%	90%	96%	92%	91%	90%	60%	64%	70%	92%	91%	87%	90%	82%
	High bar	56%	96%	92%	94%	91%	80%	55%	56%	66%	92%	93%	84%	83%	80%
	Total	53%	92%	94%	92%	92%	81%	60%	65%	75%	93%	91%	86%	85%	81%
	Floor	33%	83%	88%	96%	88%	33%	38%	33%	42%	75%	79%	50%	71%	62%
	Pommel horse	29%	79%	83%	71%	88%	38%	25%	54%	42%	83%	79%	50%	54%	60%
	Rings	50%	71%	92%	63%	83%	63%	42%	50%	63%	88%	79%	46%	58%	65%
CII	Vault	29%	63%	75%	71%	58%	29%	33%	46%	50%	83%	71%	50%	63%	55%
	Parallel bars	29%	67%	88%	71%	71%	46%	33%	29%	54%	75%	67%	46%	54%	56%
	High bar	25%	79%	88%	83%	88%	63%	50%	46%	46%	83%	83%	75%	75%	68%
	Total	33%	74%	85%	76%	79%	45%	37%	43%	49%	81%	76%	53%	63%	61%
	Floor	25%	63%	88%	75%	100%	38%	50%	50%	50%	75%	75%	13%	38%	57%
	Pommel horse	0%	0%	0%	0%	0%	25%	13%	0%	25%	13%	13%	38%	38%	13%
	Rings	13%	38%	50%	50%	50%	0%	13%	0%	38%	50%	38%	0%	38%	29%
CIII	Vault	19%	44%	31%	31%	31%	0%	31%	19%	38%	56%	56%	25%	31%	32%
	Parallel bars	0%	38%	63%	38%	63%	25%	13%	0%	25%	63%	50%	25%	38%	34%
	High bar	25%	50%	75%	50%	75%	25%	25%	25%	38%	75%	88%	25%	50%	48%
	Total	14%	39%	48%	39%	50%	16%	25%	16%	36%	55%	54%	21%	38%	35%
	Floor	55%	90%	89%	90%	86%	71%	57%	66%	72%	88%	88%	76%	79%	77%
	Pommel horse	40%	83%	90%	83%	90%	67%	52%	57%	67%	87%	81%	73%	72%	72%
	Rings	48%	82%	91%	78%	86%	70%	58%	60%	71%	90%	85%	70%	77%	74%
Total	Vault	48%	84%	84%	84%	82%	62%	48%	56%	69%	90%	86%	78%	77%	73%
	Parallel bars	40%	82%	92%	85%	85%	77%	52%	53%	64%	87%	84%	75%	80%	74%
	High bar	48%	89%	90%	89%	89%	73%	52%	52%	60%	89%	91%	79%	79%	75%
	Total	46%	85%	89%	85%	86%	70%	53%	57%	67%	88%	86%	75%	77%	74%

Table 4. *Number of different gymnasts qualified for C II and C III.*

	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	B7
All around	0	2	4	2	4	1	1	1	1	3	2	1	1
Floor		2	4	2	3			1		3	2		
Pommel horse	1	3	3		3	1	1	1	1	2	2	1	1
Rings		2	2	1	2		1	1		2	2	1	1
Vault	1	1	5	4	4			1		3	3		
Parallel bars	1	1	2	1	2	1	1	1		1	1	1	2
High bar		3	4	1	3	1	1	1	1	3	3	1	1
Total	3	12	20	9	17	3	4	6	2	14	13	4	5
Difficulty/ Execution)	.69	.35	.17	.35	.23	.69	.69	.69	.69	.23	.35	.69	.69

$r_{total/(difficulty/execution)}$= -0.95; p<0.01

Table 5. *Kendall tau b correlation coefficient (τ_b or τ_c) for the official scores (A1) with all other calculated scores (all apparatus and competitions).*

Comp.	apparatus	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	B7
CI	Floor	.984	.86	.76	.86	.79	.92	.98	.97	.96	.79	.85	.91	.91
	Pommel horse	.990	.90	.82	.90	.85	.95	.98	.98	.97	.84	.89	.94	.94
	Rings	.987	.89	.79	.89	.82	.94	.98	.98	.97	.83	.89	.94	.93
	Vault	.988	.85	.71	.85	.76	.94	.986	.98	.97	.76	.84	.93	.92
	Parallel bars	.986	.83	.69	.84	.75	.91	.983	.98	.96	.75	.84	.91	.90
	High bar	.985	.81	.65	.81	.71	.91	.984	.97	.97	.71	.81	.91	.90
CII	Floor	.97	.83	.71	.86	.76	.95	.97	.98	.94	.75	.85	.92	.88
	Pommel horse	.97	.86	.68	.86	.74	.92	.982	.94	.95	.71	.81	.91	.89
	Rings	.96	.83	.63	.82	.67	.91	.96	.96	.96	.67	.77	.93	.93
	Vault	.98	.86	.74	.90	.81	.96	.981	.96	.97	.80	.88	.96	.93
	Parallel bars	.984	.86	.77	.86	.81	.93	.95	.97	.94	.80	.83	.91	.87
	High bar	.983	.82	.56	.80	.67	.91	.95	.96	.96	.63	.74	.92	.92
CIII	Floor	.96	.38	.22	.37	.25	.91	.74	.70	.68	.33	.37	.982	.91
	Pommel horse	1	1	1	1	1	.93	.982	1	.96	.982	.982	.91	.91
	Rings	.982	.91	.86	.86	.86	1	.982	1	.93	.86	.91	1	.91
	Vault	.987	.94	.95	.95	.95	1	.97	.98	.97	.92	.92	.97	.97
	Parallel bars	1	.91	.79	.91	.79	.93	.982	1	.94	.84	.86	.93	.91
	High bar	.93	.47	.29	.40	.29	.93	.93	.93	.74	.33	.50	.93	.86

Table 6. *Kendall tau b correlation coefficient for all scores (all apparatus and competitions, N=775) (all correlations are significant, p<0.01).*

	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	B7
A1	1	0.98	0.88	0.79	0.89	0.83	0.95	0.98	0.98	0.96	0.82	0.88	0.94	0.94
A2		1	0.89	0.78	0.88	0.82	0.94	0.97	0.97	0.97	0.82	0.88	0.94	0.94
A3			1	0.90	0.97	0.93	0.83	0.88	0.88	0.88	0.93	0.96	0.83	0.83
A4				1	0.90	0.96	0.74	0.79	0.79	0.78	0.94	0.89	0.73	0.73
A5					1	0.94	0.83	0.88	0.88	0.88	0.93	0.97	0.83	0.83
A6						1	0.78	0.83	0.83	0.82	0.96	0.93	0.77	0.77
A7							1	0.94	0.94	0.93	0.77	0.83	0.98	0.97
B1								1	.983	0.97	0.83	0.89	0.95	0.94
B2									1	0.97	0.83	0.89	0.94	0.94
B3										1	0.83	0.88	0.94	0.95
B4											1	0.94	0.78	0.77
B5												1	0.83	0.83
B6													1	0.98
B7														1

The changes in rankings from CI are most important due to the qualification of gymnasts to the CII and CIII finals. While for the CII finals few changes were observed (Table 4) with a maximum of 4 different qualified gymnasts (which represents only 16 %), concerning the qualifiers for CIII the picture is quite different where we found an apparatus with 5 different finalists of a total of 8 (62.5%).

The Kendall tau b correlations of the official scores with other (simulated) scores (Table 5) are progressively lower from CI to CII to CIII. In this sense, it can be supposed that pommel horse already has very high demands on execution, while floor and high bar tend to have a higher disproportion between execution and difficulty.

From Table 5 it can be stated that the A4 formula differs most from the others as it has the lowest correlations.

DISCUSSION

Defining the final score in gymnastics is a matter for the Technical Committees to decide and is therefore a political question. In the Code of Points it is emphasized that the exercise presentation is the most important part and it should never be compromised for difficulty. In the practice of competitions we often see exactly the opposite philosophy from gymnasts and their coaches. At this moment, the proportion between difficulty and execution is, on some apparatus, already above 70% (pommel horse, high bar)(Figure 1). If we look at other sports it is clear that the most risky sports (diving, aerial skiing) have very low contributions from difficulty towards the final score while the most aesthetic sports (synchronized swimming, rhythmic gymnastics) have a more balanced proportion between difficulty and execution. As artistic gymnastics is more similar to risky sports due to the difficult acrobatic elements performed (e.g. triple saltos) it is probably only for historical reasons (Bučar, 1998) that the difficulty and execution are balanced since in the past the difficulty elements were much less risky than today. The Technical Committees were always aware of the importance of risk and difficulty as they expanded the original range of elements from A to C, to include first CR, bonus points for risky elements (FIG, 1979), later introduced the D value and ever further so that at the moment the range goes to G elements (FIG, 2009). With this expanded range of difficulty the proportion between execution and difficulty remained at 50:50 until the COP 2006 with a new formula for the final score calculation. Despite lowering the proportion of difficulty, the coaches continued the drive towards more difficult exercises while execution remained one step behind. Even from the latest World Championships (2011) it is hard to tell which strategy is better. Whereas on floor exercise it is definitely better to perform exercises with minimum errors (1. KOSMIDIS Eleftherios, GRE, 6.600/9.100; 2. UCHIMURA Kohei, JPN, 6.500/9.033; 3. PURVIS Daniel, GBR, 6.500/8.866), on the high bar it seems that difficulty matters more (1. ZHANG Chenglong, CHN, 7.500/8.666; 2. ZONDERLAND Epke, NED, 7.300/8.733; 3. HAMBUECHEN Fabian, GER, 7.100/8.866) (Longines, 2010).

If the gymnastics did not have such a limited number of places in the finals and would just declare the best gymnasts after the qualification round, the method of calculating the final score would not be so important. With the finals by apparatus and all around it matters much more and the ranking in the top 8 or 24 is essential. All the others are out of the competition. For the gymnast ranked in 50th place on high bar a possible change on the ranking is not very frustrating compared to the gymnasts who classified 9th or 10th. The number of changed positions to enter in the apparatus finals is correlated with the proportion between difficulty and execution (table 5), the correlation is very high and negative, which means that a lower proportion between difficulty and execution would often place different gymnasts in the finals. In reality, with a different calculation of the final score, the articles 15 and 20 from COP

(FIG, 2009c) would really have effect. Similar but with fewer changes is the effect on the AA qualifiers.

When comparing the level of competitions, the percentage of rankings which have changed from competition CI (81%), CII (61%) and CIII (35%) decreased. In the apparatus finals, the most stable rankings are those from the apparatus without bonus points for connection (pommel horse, rings, vault, and parallel bars); while in the CI and CII the rankings are similar for all apparatus.

It is important to note that A4 and B4 versions of the final score calculation presented the lowest correlation with others, which shows a really different kind of final score calculation.

CONCLUSIONS

The ideal or preferred system for final score calculation is a matter of political decisions. We compared 14 different models for calculating the final scores, whose characteristics are:

- The proportion between difficulty and execution ranged between 17% and 67%.
- With different final score calculations, the rankings changed severely in C1 (81%), CII (61%), CIII (35%) depending on the calculation method chosen.
- Floor exercise and high bar (CIII) were the apparatus with more changes in the rankings (apparatus where connection bonus points are awarded), It is worth noting that these two apparatus are the most risky ones (it would be important to monitor similar modeling at other competitions to prove if this effect is only because of the connection bonus rules).
- Kendall tau b correlations between different ways of final score calculation are significant and range from low (A4) to very high ones (A3).
- The most different calculation models are A4 - D score + Sum (Middle four E scores) and B4 - D score + Sum (Middle three score)
- The number of changes in the rankings was more severe with formulas A4 and B4 which have the lowest proportion between difficulty and execution,
- With A4 and B4 more changes would also occur in CII and CIII qualifiers.
- With formulas A4 and B4, the expectations stated in articles 15 and 20 from COP (FIG, 2009c) could be more closely observed.

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Coresponding author:
Ivan Čuk
University of Ljubljana
Faculty of Sport
ivan.cuk@fsp.uni-lj.si

Slovenski izvlečki / Slovene Abstracts

Mauricio Santos Oliveira in Marco Antonio Coelho Bortoleto

POLITIKA V ŠPORTU: VPLIV ŠPORTNIH ŠTIPENDIJ NA RAZVOJ MOŠKE ŠPORTNE GIMNASTIKE V BRAZILIJI

Brazilska vlada je z zakonom 10.891/2004 ustanovila Program športnih štipendij, ki naj bi omogočal razvoj športnikov pri doseganju večje brazilske zastopanosti v nacionalnih in mednarodnih tekmovanjih. Cilja raziskave sta predstaviti program in ugotoviti njegov vpliv na rezultate brazilske moške gimnastike, glede na mnenje brazilskih strokovnjakov v polstrukturirnih intervjujih s trenerji, sodniki in telovadci svetovnega razreda. Rezultati so pokazali pomembno vlogo Programa športnih štipendij za podporo telovadcem, vendar so potrebni še drugi ukrepi za reševanje strukturnih in finančnih težave, ki še vedno vplivajo na ta šport v Braziliji. Predlagamo nekaj sprememb v programu, da bi povečali število ponujenih štipendij, zmanjšali vlogo birokracije in naredili jasnejša pravila za izbor športnikov, ki prejemajo štipendijo.

Ključne besede: šport javnih sredstev, športna politika, šport zakonodaja

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Lurdes Ávila-Carvalho, Panagiota Klentrou, Maria da Luz Palomero, Eunice Lebre

BODY COMPOSITION PROFILE OF ELITE GROUP RHYTHMIC GYMNASTS

Cilji raziskave so bili ugotoviti telesne značilnosti, sestavo telesa in biološko zrelost vrhunskih ritmičark v skupinskih sestavah Vzorec merjenk je obsegal 84 ritmičark, ki so leta 2009 in 2010 sodelovale na tekmovanju za svetovni pokal. Izmerjene so bile naslednje pomembne spremenljivke: indeks telesne mase (ITM), relativna telesne maščobe (% BF), maščobna masa, mišična masa, ter biološka zrelost (s starostjo nastopa mentruacije). S povečanjem starosti ritmičark na najpomembnejših tekmovanj so se spremenile tudi telesne značilnosti. Ritmičarke so višje in z višjo telesno maso kot v preteklosti. ITM je pri vseh ne glede na kvaliteto na normalnih vrednostih. Bolj uspešne imajo nižje vrednosti BF, vendar še vedno višji od tistega, kar so poročale pretekle študije.Telesne značilnosti nimajo vpliva na tekmovalni rezultrat. Boljše ritmičarke so se pričele ukvarjati z ritmično gimnastiko bolj zgodaj, imajo daljši staž, ter večji obseg vadbe. Vse ritmičarke so pozno dobile prvo menstruacijo. Možno je, da pozna dozorelost lahko vpliva na telesne značilnosti v dobi odraslosti.

Ključne besede: ritmična gimnastika, skupine, telesne značilnosti, razvrstitev.

Olivia Donti, Kalliopi Theodorakou, Spiros Kambiotis in Anastasia Donti

SAMOPODOBA IN TESNOBA PRI VRHUNSKIH IN REKREATIVNIH TELOVADKAH

Namen študije je bil preučiti sampodobo in tesnobo pri 161 telovadkah, starih 10-12 let, ki so tekmovale v vrhunskem in rekreativnem programu. Za merjenje samopodobe in tesnobe sta bila uporabljena vprašalnika Profil Self-Perception Harter za otroke (1985a) in STAIC (Spielberger, Edwards, Lushene, Montuori, in Platzek, 1973), Narejena je bila MANOVA za neodvisne vzorce ter t-testi. Rezultati so pokazali, da ni bilo bistvene razlike med vrhunskimi in rekreativnimi telovadkami v samopodobi razen na ravni šolske uspešnosti in družbene sprejemljivosti, kateri sta nižji pri vrhunskih telovadkah. Dekleta, ki sodelujejo v vrhunskem programu imajo precej višje vrednosti tesnobe. Nadaljnje raziskave so potrebne o vplivu vrhunskega športa na psihološke značilnosti telovadk.

Ključne besede: tesnoba, samopodoba, gimnastika, dekleta

Kamenka Živčić Marković, Ines Čavar, Goran Sporiš

SPREMEMBE V GIBALNIH SPOSOBNOSTIH DEKLIC STARIH 5-6 LET V DEVETIH MESECIH VADBE GIMNASTIKE

Cilj raziskave je bil ugotoviti vpliv devetmesečnega programa gimnastike na razvoj nekaterih gibalnih sposobnosti telovadk starih 5-6 let. Šest telovadk, članici kluba "Novi Zagreb" je bilo s privoljenjem staršev vključenih v proces vadbe, ki je bila skladna s programom vadbe "B" (višja stopnja), ki jo predpisuje Hrvaška gimnastična zveza. Spremembe v gibalnih sposobnostih so bile merjene v sedmih zaporednih časovnih točkah. Z ANOVA so bile ugotovljene pomembne spremembe gibalnih sposobnosti. Statistično značilno izboljšanje je bilo na vseh področjih moči, razen v eksplozivni moči, ter gibljivosti.

Ključne besede: moč, gibljivost, vadba, razvoj, telovadke, 5-6 let.

Despoina Tsopani, George Dallas, Niki Tasika in Amalia Tinto

VPLIV RAZLIČNIH NAČINOV POUČEVANJA PRVIN RITMIČNE GIMNASTIKE

Namen te študije je bil preučiti, kateri od načinov poučevanja – obstoječi (kjer se najprej opravi z nalogo ena s prvim orodjem, potem nalogo 2 s prvim orodjem itd.) in zaporedni (najprej se opravi naloga ena s prvim orodjem, potem naloga ena z drugim orodjem itd.) – je bolj uspešen pri poučevanju prvi ritmične gimnastike. Vzorec je sestavljalo 84 študentk športne vzgoje v Atenah, starih 18-20 let (19,02 ± 0,77), ki se prostovoljno odločili za sodelovanje v tej študiji ločeni v dve skupini (n1 = 39, n2 = 43). Najprej je bilo izmerjen znanje prvin sledilo je poučevanje in ob koncu je bilo izmerjeno znanje prvin. Poučevanje in vadba je trajala devet tednov, 2-krat na teden po 90 minut. Analiza je pokazala da je zaporedni način bistveno bolj uspešen v vseh nalogah in vseh drobnih orodjih (trak, kolebnica, kiji).

Ključne besede: ritmična gimnastika, učenje gibanja, prvine, metoda poučevanja.

Thomas Heinen, Pia M. Vinken in Konstantinos Velentzas

SOJENJE V GIMNASTIKI: STVAR GIBALNEGA ALI VIDNEGA DOŽIVETJA?

Cilj raziskave je bil ugotoviti ali lahko laiki z gibalnimi izkušnjami v gimnastiki enako ocenijo izvedbo kot sodniki samo z vidno zaznavo. Ob tem smo poskušali spoznati biomehanične značilnosti informacij, ki so pomembne za ocenjevanje v gimnastiki. Ugotovili smo, da laiki enako ocenjujejo premet na preskoku kot sodniki, ki ocenjujejo predvsem spremembe kinematičnih značilnosti gibanja v času, medtem ko laiki predvsem ocenjujejo držo telesa. Na splošno so bile ocene laikov nižje od sodnikov. Ocene laikov so bile dobro napovedane s sočasnimi kinematičnimi spremenljivkami, medtem ko so ocene sodnikov bile dobro napovedane s časovnim sosledjem premeta. Zaključimo lahko, da je lahko sojenje pogojeno ali z lastno izkušnjo ali pa z vidnimi zaznavami.

Ključne besede: premet naprej, sojenje, kinematična analiza, sodniki, laiki

Ivan Čuk, Hardy Fink in Bojan Leskošek

MODELIRANJE KONČNEGA REZULTATA V GIMNASTIKI Z RAZLIČNIMI UTEŽMI TEŽAVNOSTI IN IZVEDBE

Cilj raziskave je bil raziskati, kako lahko različni načini izračuna končnega rezultata spreminjajo uvrstitev telovadcev. Štirinajst različnih modelov je bilo upoštevanih in nato smo uvrstitve primerjali z uradnimi rezultati moškega evropskega prvenstva v Berlinu 2011. Razmerje med težavnostjo in izvedbo se glede na različne formule gibljejo od 17% do 67%. Z različnimi formulami je števila sprememb v uvrstitvi v C1 81%, 61% v CII in CIII v 35%. Formula D + vsota srednjih štirih ocen (v primeru šestih sodnikov) in formula D + vsota srednjih treh ocen (v primeru petih sodnikov) imata največji vpliv na spremembe v uvrstitvah, ki vodijo v finale mnogoboja in na posameznem orodju. Zgoraj omenjeni formuli najbolj podpirata člena 15 in 20 pravil moške gimnastike, ki navajata, da se od telovadca pričakuje, da vključi v svojo sestavo samo prvine, ki jih lahko opravlja popolnoma varno in z visoko stopnjo estetskega in tehničnega mojstrstva.

Ključne besede: sojenje, modeli, končna ocena, razvrstitev.