

JUMPING ABILITIES IN YOUNG FEMALE GYMNASTS: AGE-GROUP DIFFERENCES

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Abstract

The aim of the study was to give more informations about jumping abilities of young female gymnasts. We examine age-related differences in some variables of counter-movement jump (CMJ) and counter-movement jump with arm swing (CMJA), between two age categories of young female gymnasts (n=47) and also reliability of testing vertical jump in gymnasts. The study was conducted on an international competition. Our research has shown that age-related differences were observed only in height of the jumps, but not in power output of both jumps and displacement of depth of body's center of gravity. Jumping capabilities are crucial in gymnastics in all levels of competitions and in all categories of gymnasts. Testing and periodical monitoring of young athletes' abilities are important for defining the training programmes adapted to the needs of gymnastics and the age of the gymnasts.

Keywords: Artistic gymnastics, explosive leg power, counter-movement jump.

Introduction

It is known that high intensity of exercise and dedication to training in the youngest age group in artistic gymnastics is higher than in most sports for young people (Carrick et al., 2007). In order to reach their goals elite gymnasts have training twice a day, six days a week, so that the average number of hours per week is between 27-33 (Kums, 2008). The uniqueness of gymnastics is reflected in the fact that it closes to the art, not only because of its technology, but also because of the precision of movement, expression and artistry, musicality and choreography (Theodoropolou et al., 2005; Kums, 2008).

As a basic sport, artistic gymnastics affects development of motor skills: strength, coordination, flexibility and balance (Arruda and Farinatti, 2007, Carrick et al., 2007). In terms of coordination, gymnastic elements are the most complex movement. Testing and periodical monitoring of young athletes' abilities is important to define the training programme adapted to

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the needs of gymnastics and the gymnasts' age. In this way we could achieve a harmonious and healthy development of fundamental motor skills in accordance with the physical development of athletes (Ricotti, 2011).

Specifics of the athletes in sports disciplines are the result of selection and on the other side of the specific effects of activities that discipline creates (Čuk et al., 2007). Gymnastics requires explosive sprinting, jumping, pushing and pulling skills, together with balance and artistry. On the vault, balance beam and floor, explosive leg power plays an important role in connecting elements and acrobatic series. Bouncing is one of the most important movements in floor and vault routines and is acquired by gymnasts at a very early age as part of their daily training routines (Marina et al., 2013).

Height of the vaults, jumps and acrobatic elements are one of the most important components of technical requirements for successful execution of gymnastics elements. The ability to develop enhanced levels of muscular power is reflected by the potential to perform more advanced skills and acrobatics (French et al., 2004). Gymnasts' ability to transmit their impulse from their feet to their upper bodies following rebounds is crucial, allowing acrobatic skills such as somersaulting and twisting (Mkaouer et al., 2012).

Countermovement jump contains an eccentric and a concentric phase that constitute a stretch-shortening cycle and they are associated with many dynamic movements, including running, bounding, and tumbling, and depend both on contractile elements and elastic properties of the muscle and connective tissue (Kinser et al., 2007; Bosco et al., 1982). In Women's Artistic Gymnastics, according to the latest updates of Code of points (2013-2016), timing in connections of the two elements is very important for recognition of connection, in order to get points for connection values. At the beginning of Olympic cycle arm swing wasn't allowed between elements (for example, connections of jumps), but FIG recognized that this rule leads to errors in technique and affects performance quality, so they allowed the arms to be used as active components of the whole mechanical chain during movement.

So far in the literature, the authors have described significant differences in jumping abilities between trained and untrained subjects (Kums et al., 2005; Sterkowicz et al., 2011), non-elite and elite athletes, subjects of different ages (Smith et al., 1992; Marina and Torrado, 2013), or cadets, juniors and seniors (Buško et al., 2012). The aim of our study was to access differences in chosen variables of counter-movement jumps without (CMJ) and with arm swing (CMJA), in young female gymnasts.

Methods

In this study participated 47 young female gymnasts from two age groups, according to the propositions of competition that they participated in. The first group consisted of gymnasts from 8 to 10 years old, ($n=24$; height: 135.98 ± 7.27 cm; body mass: 30.63 ± 4.16 kg) and the second, gymnasts from 11 to 13 years old ($n=23$; height: 150.07 ± 7.99 ; body mass: 40.76 ± 8.12 kg). The age-groups were formed according to the rules of competition and subjects were from seven European countries. The subjects were informed about the scope and protocol of the study, and of the possibility to withdraw from the study at any moment. All parents and coaches submitted their written consent for participating of gymnasts according to Helsinki Declaration. The study was granted approval of the Research Ethics Committee.

The vertical jump tests (counter-movement jump and counter-movement jump with arm swing) were performed on a force plate Kistler Quattro Jump (9290AD), according the protocols described by Bosco (1992) and the criteria for correct trials of jumps were proposed by Acero et al. (2011). Each subject performed six vertical jumps with maximal force on the force plate: three counter-movement jumps (CMJ) and three counter-movement jump with arms swing (CMJA). There were between one and two minute breaks between the jumps. Gymnasts were barefoot in

gymnastics leotards. The jump with the highest elevation of the body center of gravity was chosen for statistical analysis. The investigated parameters were: SVIS – height of the jump without arms swing, DPTT - the depth of displacement of the center of gravity, SNKG – relative power, ZVIS – height of the jump with arms swing, ZPTT - the depth of displacement of the center of gravity in jump with arm swing, ZNKG – relative power of the jump with arm swing.

For statistical analysis of the data, software SPSS version 20 was used. Descriptive statistics and reliability of testing for all variables were calculated. The jump height, relative power and depth of body center of gravity displacement for both protocol were compared between groups by using a one-way analysis of variance (ANOVA). The criterion for establishing statistical significance was $P < 0.05$.

Results

Table 1 and 2 show descriptive statistics, normality of distribution and reliability of testing younger category of gymnasts. Table 3 shows two (groups) x two (sessions) x three (trials) ANOVA of repeated measures.

Table 1. Descriptive statistics, normality of distribution and reliability of countermovement jump

	N	Min.	Max.	Mean	SD	Skew.	Kurt.	Z	Sig.	Cronbach' α	ICC	CV (%)
SVIS	24	26.10	38.10	32.37	3.54	-.126	-1.012	.501	.963	.941	.842	10.94
DPTT	24	11.87	28.67	18.21	4.35	1.090	.786	.965	.309	.841	.573	23.89
SNKG	24	15.93	26.87	22.25	2.52	-.558	.666	.494	.968	.850	.654	11.33
ZVIS	24	30.70	45.23	39.90	3.68	-.726	.231	.654	.786	.929	.814	9.22
ZPTT	24	11.27	28.73	18.72	5.06	.168	-.956	.564	.908	.948	.859	27.03
ZNKG	24	16.47	33.10	23.95	5.27	.115	-1.374	.729	.662	.904	.758	22.00

Table 2. Descriptive statistics, normality of distribution and reliability of countermovement jump

Var.	N	Min.	Max.	Mean	SD	Skew.	Kurt.	Z	Sig.	Cronbach' α	ICC	CV (%)
SVIS	23	29.33	46.63	37.15	4.67	.464	-.460	.579	.891	.958	.883	12.57
DPTT	23	13.87	28.73	20.03	3.62	.474	.041	.588	.880	.766	.521	18.07
SNKG	23	16.50	31.03	23.69	3.72	.315	-.609	.835	.488	.898	.746	15.70
ZVIS	23	35.57	56.57	46.27	5.85	.337	-.965	.705	.703	.953	.870	12.64
ZPTT	23	7.80	28.90	17.74	4.74	.214	.294	.471	.980	.929	.813	26.72
ZNKG	23	13.13	36.47	24.39	6.78	.320	-.964	.702	.707	.918	.788	27.80

Before any analysis we determined variability and normality of distribution. All investigated parameters showed normal distribution (table 1 and 2), but there was a great variability among them. Variability between subjects is shown by the coefficient of variation (CV) and this coefficient was great in both groups of the gymnasts. These results could be consequences of the

differences between gymnasts from different countries. In spite of competing in the same category, their level of performance and quality was different. Jump reliability reported in our study (9-28%) is higher than it was in previous researches. Marina & Torrado (2012) reported reliability from 1.57 to 2.35% in the group of fifty young female gymnasts, 8.84 ± 0.62 years old.

Table 3. Two (groups) x two (sessions) x three (trials) ANOVA of repeated measures

Var.	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
SVIS	25.690	1.872	13.723	5.184	.009	.103
DPTT	191.103	1.923	99.368	9.273	.000	.171
SNKG	4.589	1.964	2.336	.651	.521	.014
SNTS	.104	1.934	.054	.784	.456	.017
ZVIS	9.897	1.658	5.970	1.285	.279	.028
ZPTT	2.489	1.933	1.288	.284	.746	.006
ZNKG	38.525	1.927	19.997	1.995	.144	.042

The results of our study showed that the height of the jump without and with arms swing was significantly different in Category I and II ($p < .05$), but not in other parameters of the vertical jumps (table 3). These results suggest that while doing the analysis we can't take in to consideration only one parameter. Better results in older gymnasts are consequence of training experience and also larger fund of acrobatic elements. Age-related differences were not found in other parameters. The results of the study are different than those the two studies where the authors didn't find differences in jump height between three groups of athletes (Buško et al., 2012; Gerodimos et al., 2008). The differences could be result of the sport disciplines. Bencke et al. (2002) found that gymnasts had most explosive muscular performance of all participants in their study (handball players, tennis players and swimmers). The elite gymnasts (advanced level, mean age 11.8 years) were more explosive than the non-elite gymnasts (intermediate level) indicating that jumping capabilities are crucial for gymnastics performance.

Further, French et al. (2004) suggested that the ability to develop improved levels of muscular power was reflected by the potential to perform more advanced elements and acrobatics. Powers & Howley (2007) reported an estimation of the used energy systems in gymnastics. Gymnasts seem to have a predominant anaerobic energy system.

Discussion and conclusion

Vertical jumps are used in plenty of sports. Their primary goal is usually to reach the greatest possible height (Psycharakis, 2006). Other goals could also include rotation in acrobatic somersaulting. Gymnasts' jumping ability is often linked to successful performance (especially in floor routines, balance beam and vault) and is sometimes considered an overall indicator of gymnast's proficiency. Gymnastics' performance is largely defined by the ability to successfully perform complex forward and backward rotating skills (Mkaouer et al., 2012). If a gymnast is not successful doing an acrobatic jump, the problem could be either related to jumping capacity, the specific technique and coordination of the movement, or both (Marina & Torrado, 2013).

Kums et al. (2005) concluded that young elite female rhythmic gymnasts demonstrated a markedly greater ability to use the potentiating effect of stretch-shortening cycle to vertical jumping performance compare to the control subjects during drop jumps, but not during counter-movement jump. The rhythmic gymnasts produced greater mechanical power during repetitive maximal jumping exercise, but fatigued faster than controls. Temfemo et al. (2009) compared vertical jumping performances in boys and girls during growth. The maximum heights was attained in a counter-movement jump (CMJ) and squat jump (SJ). Height, LMV, and body mass

values were larger in boys than girls aged 14 years. Both groups had a similar body mass index independently of age. The CMJ-SJ decreased with increasing age in both groups without significant differences. Authors concluded that jumping performance increases during growth, with gender differences manifesting from the age of 14 onwards due to much greater increase in leg length and LMV in boys than in girls.

Jumping capabilities are crucial in gymnastics in all levels of competitions and in all categories of gymnasts. There is a lack of investigations in the categories of the young gymnasts that are already competing on the international level. These gymnasts are already selected as talented in their countries and can be seen as future representatives of their countries at major competitions. Monitoring and periodically testing is very important in order to achieve good results, especially in young categories which are considered to be the period of the investment for results in senior category.

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