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Relation between balance loss in floor exercises by male gymnasts and anthropometric features and balance

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Abstract

This study aims at looking into the relationship between losses of balance in floor exercises performed by male gymnasts at 17th International Bosporus Gymnastics Tournament and some of the anthropomorphic characteristics and the balance tests given under laboratory conditions. 15 male gymnasts volunteered for this research, (aged= 19.93 ± 2.98, training years12.87±3.68). In order to analyze the losses of balance in floor exercises, the floor routines were recorded by video, and each loss of balance following each gymnastic element was evaluated. Also static – dynamic balance, body weight, height, arm span, leg and torso lengths were measured. Pearson Correlation coefficient was used for analyzing the relations between the data findings. It was found that there was no statistical relation between the losses of balance in floor exercises and static-dynamic balance test results ($p>0.05$). Also no correlation was found between floor exercise losses of balance and number of training years, height, body weight, arm span, torso length, and leg length ($p>0.05$). But it was observed that there was a negative correlation between dynamic balance test and body weight ($r=-0.565$ $p<0.05$) and between static balance with closed eyes and age ($r=0.582$ ($p<0.05$). A reasonable explanation for these results are that keeping one's balance after the element in artistic gymnastics is more likely to be a result of the technical mastery.

Keywords: Artistic gymnastics, balance, balance loss, anthropomorphic characteristics.

Erkek cimnastikçilerde yer serisi denge kayıpları ile antropometrik özellikler ve denge ilişkisi

Özet

Bu çalışmanın amacı 17. Uluslararası Boğaziçi artistik cimnastik şampiyonasına katılan erkek cimnastikçilerin yer serisi denge kayıplarıyla laboratuvar ortamındaki denge test sonuçları ve bazı antropometrik özelliklerin ilişkisini incelenmiştir. Bu araştırmaya 15 erkek gönüllü cimnastikci katılmıştır (yaş= 19.93±2,98, antrenman yaşı 12,87±3,68). Yer serisindeki denge kayıplarının analizi için, seriler videoya çekilmiş ve videolar tekrar seyredilerek her cimnastik hareketindeki denge kaybı değerlendirilmiştir. Ayrıca statik – dinamik denge, vücut ağırlığı, boy, kulaç, bacak ve gövde uzunlukları ölçülmüştür. Verilerin analizinde Pearson Korelasyon katsayısı kullanılmıştır. Sonuç olarak, yer serisindeki denge kayıplarıyla static – dinamik denge test sonuçları arasında istatistiksel bir ilişki bulunmamıştır ($p>0,05$). Antrenman yaşı, boy, kilo, kulaç, gövde ve bacak uzunluklarıyla yer hareketleri denge kaybı arasında da bir ilişki bulunmamıştır ($p>0.05$). Ancak dinamik denge test sonucuyla kilo arasında ($r=-0,565$; $p<0,05$), ve statik denge ile yaş arasında negatif bir ilişki bulunmuştur ($r=0,582$; $p<0,05$). Bu sonuçlar, artistik cimnastikte hareket sonrası dengede kalmanın daha çok teknik becerideki ustalıktan kaynaklanmış olabileceği şeklinde açıklanabilir.

Anahtar kelimeler: Artistik cimnastik, denge, denge kaybı, antropometrik özellikler.

INTRODUCTION

Combining coordination with the skills of balance and agility, artistic gymnastics is one of the Olympic sports highly characterized by features of muscular endurance, flexibility and strength (11,20). An elite gymnast is supposed to be equipped with a combination of these motor features (16,23). It is generally believed that it takes at least ten years of extensive preparations to achieve international success in sports like gymnastics (17,27). This period of extensive preparation entails a long process of

training covering special teaching methods to practice the moves with proper technique (27). Good gymnasts must maintain dynamic and static balances in order to successfully perform the acrobatic moves at different levels. Thus, during the special training period, posture control exercises should be particularly emphasized (24).

While performing acrobatic moves, gymnasts have to constantly transfer their bodies from one position to another (1). Therefore, gymnasts practice special training methods by using their own body weights. These exercises consist of the move itself or similar but modified moves (10). In the process of learning a move, repetitions over a long period of time also serve as special strength exercises, which help to increase the gymnast's strength and stamina (11). Practicing different training techniques improves the gymnast's ability to control his body position in the air during somersault moves and ability to stand in landing. As the number of somersaults increases, the angular momentum in the longitudinal axis will also increase and make it harder for the gymnast to keep his balance in landing (22).

Competitions in artistic gymnastics last about 3 hours, and the gymnast`s total effort lasts for 12-15 minutes including warm-ups. The gymnast has to perform his skills in such a short time by applying maximum strength and agility (10,11). In the evaluation of the performances by the judges during the competition, the gymnast is expected to fulfill special requirements for each apparatus. In this complex structure, the male gymnasts are expected to perform a series of moves in all 5 apparatuses except for the vaulting table. These series of moves consist of simple and complex skills following one another consecutively (3,6). A floor routine requires an anaerobic energy system, made up of acrobatic moves of short duration and high intensity. Thus, a floor routine has to be completed in 70 seconds (3). Judges evaluate the quality of the performance of gymnastic elements with reference to mastery in technical skills (3), comparison of different techniques (7,26) and flaws in execution (6,18). Each acrobatic move in floor exercises must end in a perfect standing position (6). Deviances from the correct position are considered as mistakes and the necessary deductions are made by the judges accordingly. In landing from the twisting and somersault moves consisting of acrobatic skills, the primary purpose is to be able to stop the linear and circular movement effectively at the moment of contacting the floor. A good gymnast can display the control in landing well, but mistakes in technical execution and insufficient height can affect the balance in landing negatively (15).

General balance ability is crucial for both acquiring and controlling the motor skills. Even if this skill may be a genetic characteristic of the person, it is said that it can be improved by training (20). The speed and the level of learning the technical skills in sports are closely associated with balance ability. Static and dynamic balance ability are more advanced in athletes than people who are not involved in sports, and the balance ability improve in tandem with the number of years spent in sports (19). In addition to this, posture control is thought to be related to the kind of activity undertaken (1). Literature indicates that gymnastic exercises enhance the balance ability (13,25). However, there are very few studies comparing losses of balance in floor apparatus with balancing skills (16,27).

Starting from this fact, the purpose of this study is to compare the correlation between the losses of balance in the floor exercises of the male gymnasts who participated in the 17th Bosporus Gymnastics Tournament, and balance tests given under laboratory conditions. Furthermore, balance test results of the gymnasts and their balance performances in floor routines were compared with some anthropomorphic and motor features to establish a correlation between them.

MATERIAL & METHOD

This study was conducted with 15 voluntary male gymnasts competing in 17th Bosporus Gymnastics Tournament (aged 19.93±2.98, training years 12.87±3.68). Heights, body weights, arm span, leg and torso lengths of the gymnasts were measured by the experts on the day before the competition. The leg dominance of each subject was established during a one – on – one interview. During the competition, starting and resulting scores, and deductions made by the jury for the floor exercise performances of the gymnasts were recorded. Floor exercise routines were also recorded by a camera in order to analyze the losses in balance. The performances of the recorded gymnasts were watched and evaluated once again by four International Brevet Judges for losses of balance.

Measurement of heights, body weights, arm span, leg and torso lengths: Height of the gymnasts were measured by Holtain brand stadiometer sensitive to ±0,1mm (4,8). Body weight was measured in kilograms by Seca brand electronic scale sensitive to ±0,2 kilograms. Arm span, leg and torso lengths were measured with a steel tape (±0,1mm). All measurements were taken according to Lohman standardized protocol (14).

Measurement of the static balance: It was assessed with Flamingo test, whose reliability factor is 0.87 (12). The gymnast was asked to stand on his dominant leg with his hands on his hips by pulling the tip of the other foot`s toes up to the dominant leg`s knee. Afterwards, the gymnasts were given one trial. After the command "go," the subject raised the heel of his dominant leg and tried to keep his balance on his toes. The test was stopped when the subject`s heel touched the ground or the hands were taken off the hips. Time in balance position was measured in seconds. Flamingo static test was applied twice; once with open (EOSB) and once with closed (ECSB) eyes, and the best time in both measurements was taken into account.

Measurement of the dynamic balance: It was measured by using Stability Platform (16020 Stabilometer, Lafayette Ins. Co. USA). The instrument has high reliability (r=0.99) for measuring balance ability of individual (2). The stabilometer platform was placed 16.5 cm from the frame and 21.6 cm from the floor. In order to make the task more difficult, the sensitivity of the stabilometer was set ±10 degree of a horizontal position. The gymnasts were given information about the equipment, and then they were given a trial with the equipment. The subjects were asked to stand in a way to keep the balance position with an assistant support and then the stopwatch was started when the subject assumed the balance position without assistant support for 30 second. Dynamic balance test was given twice with open (EODB) and closed (ECDB) eyes, and the best time was recorded in seconds

Evaluation of the floor exercises: Start value (SV) and final score (FS) for each gymnast's floor routine was determined by the jury of judges of the competition. In line with the purpose of the study, a jury of four International Brevet Judges was formed to detect the losses of balance (LB) in floor routines. Keeping in mind the deductions made by the judges and score given by the head judge during the competition, these judges watched the recorded routines once again. In conformity with the international code of points, losses of balance was penalized as small (0.10), medium (0.30), and major (0.50) faults. Mistakes in landing due to poor technique in the execution of a skill were not taken into account.

Statistical analysis: The relationship between, static and dynamic balance start value, final score, loss of balance and age, training years, height, body weight arm span, torso, leg lengths were investigate by using multiple correlations. The level of statistical significance was set to $p \leq 0.05$. Statistical analyses were done by using Statistical Package for Social Sciences (SPSS version 15.0).

RESULTS

The descriptive arithmetic means and the standard deviations (SD) of the male gymnasts participating in the study and are shown in table 1.

All collected data were analyzed using Pearson Correlation Coefficient and shown in table 2. It was observed that there was a negative correlation between dynamic balance test and body weight ($r=-0.565$; $p<0.05$) and between static balance with closed eyes and age ($r=0.582$; $p<0.05$). There was not found any statistically significant correlation between Static Balance Test with open and closed eyes and other parameters ($p>0.05$). No correlation was found between floor exercise losses of balance and number of training years, height, body weight, arm span, torso length, and leg length ($p>0.05$).

Table 1. Features of the gymnasts participating in the study.

Features (n=15)	Mean	Sd
Age (years)	19.93	2.98
Training history (years)	12.87	3.68
Height (cm)	166.44	4.17
Weight (kg)	62.46	7.18
Arm span (cm)	173.66	7.81
Torso length (cm)	86.64	2.75
Leg length (cm)	79.79	3.14
Stabiliometre (Eyes open) (sn)	19.75	4.41
Stabiliometre (Eyes closed) (sn)	15.16	2.69
Flamingo Balance (Eyes open) (sn)	10.43	6.39
Flamingo Balance (Eyes closed) (sn)	2.25	0.85
Start value (points)	8.90	0.78
Final score (points)	8.11	0.87
Losses of balance (points)	0.29	0.18

Table 2. Correlation between balance and score values and some anthropomorphic features.

Variables (N=15)	Age	Years trained	Height	Body Weight	Arm span	Torso length	Leg length
Dynamic Balance (EO)(sn)	-.048	-.178	-.284	-0.565*	-0.360	-0.051	-0.331
Dynamic Balance (EC) (sn)	-0.065	-0.144	-0.307	-0.024	0.308	-0.259	-0.181
Static Balance (EO) (sn)	-0.403	-0.278	-0.243	-0.151	-0.296	-0.510	0.125
Static Balance (EC) (sn)	-0.582*	-0.439	-0.216	-0.197	0.080	-0.396	-0.060
Start Value (SV)	0.297	0.379	-0.035	-0.014	0.181	-0.154	0.089
Final Score (FS)	0.349	0.427	0.029	-0.027	0.195	-0.162	0.181
Loss of Balance (LB)	-0,221	-0,302	-0,127	0,036	0,309	-0,386	0,172

*p≤0.05

Table 3. Pearson correlation matrix for deductions and balance loss in floor exercise and balance parameters.

Variable	EODB	ECDB	EOSB	ECSB	SV	FS	LB
EODB	1	.143	-.341	.003	.011	-.067	-.162
ECDB		1	-.007	.006	.109	.092	.248
EOSB			1	.394	-.404	-.337	.296
ECSB				1	-.368	-.344	.030
SV					1	.977*	.076
FS						1	-.005
LB							1

* p≤0.01

Correlation between floor exercise evaluations and balance parameters was assessed with Pearson Correlation coefficient, shown as correlation matrix in table 3. A highly significant positive correlation was found between the start value and final score ($r=0.977$ $p<0.01$). No significant correlation ($p>0.05$) was found between static and dynamic balance parameters (open and closed eyes) and start value-final score and losses in balance.

DISCUSSION

Our study found a negative correlation between dynamic balance (open eyes) and body weight. No significant correlation was found between dynamic balance (eyes open) and static balance (eyes open and closed) and body weight. Measuring dynamic balance in high level athletes Davlin (5), found negative correlation between dynamic balance performance and height and weight. Our research found greater balance control in static and dynamic balance tests done with open eyes, which is a common feature with the studies done by Robertson et al. (21) and Golomer et al. (9). Our study, however, found no correlation between the length of body parts and losses in balance during floor routines of the elite male gymnasts.

Among the population of the competing gymnasts, physical performance special to gymnastics, general motor coordination and high-level skills are the most important values in determining the profile of the talented gymnast (22). When the gymnast lowers the center of gravity, he can overcome the resistance applied by his feet to the floor and reaction resistance of the floor more easily by muscle strength and coordination (41). McNitt's study (15) indicated that only 1 gymnast out of 20 did not make any mistake in dismount moves in parallel bar and horizontal bar routines in 1996 Olympics. In performing acrobatic elements, a gymnast can make mistakes at any phase of the move. These phases are interrelated, and it is stated that a mistake in the first stage of the move can affect the final stage and thus the balance in landing (22,27).

In gymnastics competitions, landing after the acrobatic elements is very important for determining the final score of the gymnast. In artistic gymnastics, on the other hand, the force applied to the floor is very high during the moment of first flight and landing. It is pointed out that force applied to the floor during landing is 3.9 to 14.4 times greater than the gymnast's body weight (15,17). The goal in landing is to absorb on the floor the energy produced by the body during the flight period in the air. The gymnast has to figure out during the flight period how to orient the direction and the amount of energy in his landing. The direction of the kinetic energy can be diverted as the gymnast contacts the floor in landing or the kinetic energy can be reduced by slowing down the move during the flight in the air (16). The gymnast's control of his standing against the reaction force of the floor during the

landing depends upon variables like the gymnast's muscle coordination, body weight, and ability to overcome the impact at the moment of contacting the floor (15,16).

Our study found a significant correlation between the start value of the floor routine and the final score. The start value of a routine is the highest score a gymnast can get if he executes the routine without any mistakes and with maximum difficulty. On the other hand, the final score is found by deducting for the mistakes in the gymnast's execution of the routine. Therefore, mistakes in keeping one's balance are an important factor in determining the final score. However, our study did not find a significant correlation exclusively between mistakes in balancing and the final score. The height of the somersault is crucial for a good landing. If a somersault is high at the start, there will be more time for the gymnast to prepare himself for the landing, and the probability of making mistakes in landing will decrease (16). Our study did not consider the losses in balance due to problems related to poor technique. Therefore, the low number of losses in balance and lack of correlation to balance tests can lead one to surmise that technical execution might be the determining feature for floor apparatus.

In conclusion, in sports like artistic gymnastics which require aesthetic, technical, and complex skills by their nature, losses of balance are an important problem and they can negatively affect one's performance (25). Our study found no correlation between static-dynamic balance parameters and losses in balance in floor exercises. A reasonable explanation for this situation is that keeping one's balance after the move in artistic gymnastics is more likely to be a result of the technical mastery. Furthermore, instead of the balance test batteries that we used in evaluating the competition performance, development of test batteries that are more sensitive to the technical characteristics specific to gymnastics can yield more effective results in the evaluation of balance performance.

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