

**A comparative study between the players the artistic gymnastics  
and acrobatic in most important of the kinematics to skill back  
handspring on floor exercise**

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دراسة مقارنة بين لاعبي الجمناستك الفني والاكروباتيك في اهم المتغيرات البيوكينماتيكية لمهارة  
قفزة اليدين الخلفية على بساط الحركات الارضية

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الملخص بالعربية

من خلال اطلاع الباحث على مستويات فرق الجمناستك لاحظ وجود قصور في بعض المتغيرات الكينماتيكية وخاصة لدى منتخب الاكروباتيك في شجيجين في بولندا عند اداء قفزة اليدين الخلفية على بساط الحركات الارضية باعتبارها من الحركات التمهيديّة التي يسهم اتقانها الى تكامل الحركات الاكروباتيكية لذا قام الباحث بدراسة الحالة للوقوف على اهم نقاط الضعف عند اداء المهارة من قبل المجموعتين ( منتخب شجيجين للجمناستك ومنتخب شجيجين للاكروباتيك) . تكونت عينة البحث من عشرة لاعبين لكل منتخب خمسة لاعبين اخذت العينة بالطريقة العمدية وتم اجراء الدراسة بواسطة كاميرة نوع سوني سرعتها ٦٠ صورة في الثانية وتمت معالجة البيانات من خلال برامج التحليل الحركي (كينوفا ودرات فيش ولوكريرو) واستخرجت البيانات من خلال الحقيبة الاحصائية (Minitab16) وتم احتساب قيم الدلالة الاحصائية بين المجموعتين وظهرت فروق معنوية ذات دلالة إحصائية بين العينتين في مراحل المهارة. استنتج الباحث ان ارتفاع مركز ثقل الجسم ووقت اقصر ومد مفاصل الجسم وزيادة السرعة الزاوية في مراحل الاداء هي من متطلبات الاداء الجيد في قفزة اليدين الخلفية اما التوصيات فكانت أن تحليل الميكانيكا الحيوية للجمناستك مفيد على حد سواء لتقديم التقارير إلى المدربين وتقديم ملاحظات مفصلة من شأنها أن تؤدي في اكتشاف الأسباب المحتملة لأداء متفوق . البيانات التي تم الحصول عليها تشير إلى أن الاختلافات في الخبرة هي سهلة نسبيا للتحديد من خلال التواصل وصنع التحليل بين المدربين والجمناستك أبسط وأسهل وأكثر كفاءة.

## Abstract

Researchers and from through reconnaissance on the levels of gymnastics teams noticed a deficiency in some kinematics variables and especially with szczecin acrobatic in Poland when performing backward handspring as an of movements Preliminary mastery that an arrow to the integration acrobatic movements so the researcher studying the situation to determine the most important weaknesses in the performance of skill by the two groups (Szczecin acrobatic and Szczecin gymnasts). The research sample consisted of ten players per team five players took a sample way intentional the survey was conducted by camera Sony type speed it 60 frame per second The data was processed through motion analysis software (Kenova, DartFish and Logger Pro) and extracted the data through statistical Package Minitab 16 calculated values the statistical significance between the two groups and appeared significant differences statistically significant .Researchers concluded that the increase in rising in CoM and shorter time and extending the joints of the body and increase the angular velocity phases performance is one of the good Performance in the backward handspring the requirements of either of the recommendations was that the biomechanics analysis of individual gymnasts is helpful both for reporting to coaches and to provide detailed feedback that will lead in discovering potential reasons for superior performance. The data obtained indicate that differences in expertise are relatively easy to quantify through the analysis making communication between coaches and gymnasts simpler, easier and more efficient

## Chapter 1

### 1. Introduction and Significance of research

#### 1.1 Introduction:

Gymnastics is one of the sports that best combine esthetics and technical skills, requiring the execution of highly acrobatic sequences of body movements. The gymnasts are therefore required several hours of technical, strength, and flexibility training to obtain the best results. [6].

The backward handspring is a key skill in gymnastics and is frequently performed in six of the International Gymnastics Federation disciplines, namely: men's and women's artistic gymnastics, tumbling, acrobatic gymnastics, aerobics gymnastics and **general gymnastics**. The backward handspring involves the gymnast performing two connected flight phases, the first from the feet backwards onto the hands and the second from the hands onto the feet The backward handspring can be used as an isolated skill, such as on the beam or in a floor routine, or as an accelerator skill in tumbling or vaulting.

The backward handspring is often the first backward dynamic skill that a gymnast learns and, consequently, the initial learning stages may be accompanied by anxiety. [3] The backward handspring is usually learned from a two-footed standing position, and requires considerable manual assistance from the coach for correct shaping and support. The movement is a closed skill, which is modified on subsequent attempts via feed-forward control on the basis of performance success. [10]. Artistic gymnastics has received considerable attention from biomechanics investigators.[ 4 ] .Kinematic analysis of gymnastics

informs in two ways, scientists learn about the nature of gymnastics movement, and it provides a framework within which coaching and judging analysis can be objectively interpreted. [9].

## 1.2 Significance of the Study:

Contribute to the to identify the technical characteristics of the performance of the motor skill leap background hands with surrounding changes technique and mechanical skill study also demonstrate important aspects of the mechanical aspects of the skill of the study is of great importance in the process of education and the development of study skill is which will reflect positively on the level of performance of the sentences motor on floor exercise as the study is the main skill is the key to group the background of movements on floor exercise.

## 1.3 Research of problem

Researchers and from through reconnaissance on the levels of gymnastics teams noticed a deficiency in some kinematics variables and especially with Szczecin acrobatic in Poland when performing backward handspring as an of movements Preliminary mastery that an arrow to the integration acrobatic movements so the researcher studying the situation to determine the most important weaknesses in the performance of skill.

## 1.4 Hypothesis:

Existence Significant differences between the players acrobatic and artistic gymnastics in the most important kinematics variables to skill back handspring on floor exercise.

## 1.5 Aim :

1. Identify the most important kinematics variables to skill back handspring on floor exercise.
2. To identify the differences between the players acrobatic and artistic gymnastics in the most important kinematics variables to skill back handspring on floor exercise.

## 1.6 the areas of research:

1.6.1 Human field: Ten players 5 artistic gymnastics and 5 acrobatic the ages of 17-24 years.

1.6.2 Temporal field: for the period from 04/06/2014 till 06/24/2014.

1.6.3 Spatial field: training center in hall City Szczecin.

## Chapter 2

### 2- Theoretical studies :

#### 2-1 Technical characteristics of the performance of the back handspring on the ground: (Figure 1)

1- Preliminary stage: Exclusion center of mass from base fulcrum to increase the torque arm by bending the knees and thighs articular by angle (90 degrees) and the tendency.

2- **The main stage is divided into the following: Pushing hands:** The feet when the weight of the body center up at an angle of 45) degrees) and after extended corners of each of the articular thighs and knees where the body acquires rotational movement exploited in the body rotation around the horizontal axis by angle (180 degrees) and other a transitional used to lift the body up the appropriate distance during the flight stage to complete the rotation movement.

**Flight:** After breaking contact between the feet and the ground starts the body in the air in the direction of angle of departure (40-45 degrees) and the body becomes projectile applies projectiles law where the center of mass in the form of a curved parabola At the same time rotating the body about the horizontal axis is transmitted by (90 degrees ) and become in a position to land his hands on the ground and observed during the Flight phase extended all body angle extended plus the body takes the form of the dome in the air until the moment put your hands on the ground.

1- **Pushing hands:** after the arrival of center of mass to place it main handstand by (10 degrees (paid arms ground strongly from the shoulders with extrusion feet to the bottom of the bend articular thighs.

2-**Final stage:** After touching the feet of the land extend the corners of articular thighs and arms up high to get to a standing position due to the muscle contractions of the two legs and the shoulder girdle, back and arms.[10].

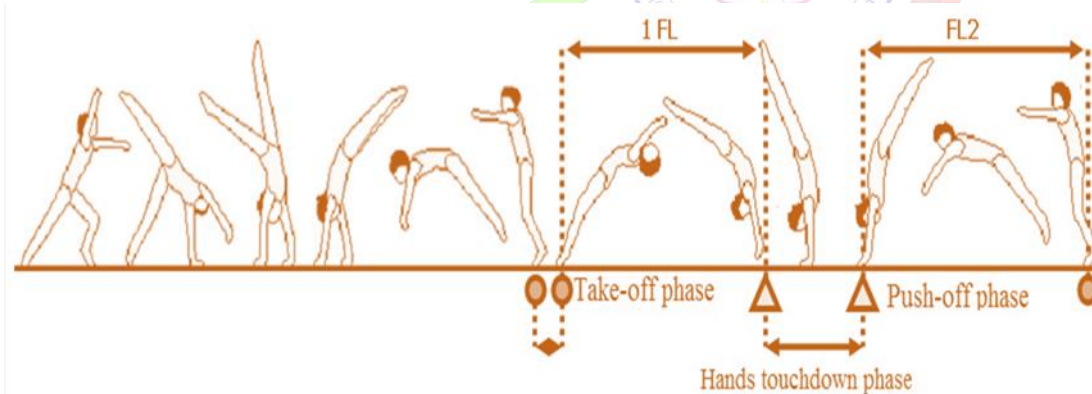


Figure 1: shows the performance of Phases backward handspring.

### 2-3 Mechanical aspects influencing the performance:

1. Proper angle of the knee moment preparedness and pushing and this will lead to the integration of payment knees to achieve the best height for the center body mass moment of pushing.[1].
2. Events arched the spine for the purpose of raising center body mass to as high as possible and to increase the angular velocity moment of inertia by law and achieve Aviation appropriate path allows the player to achieve the correct the track to the center of mass.[11].
3. The swing arms and speed of fundamental importance first of balance and the second product of the kinetic energy and angular momentum must exploit this energy and angular momentum and their employment in the service skill by converting to the trunk.[12].
4. The angular velocity (is the amount of angular displacement at the time) correlate with angular momentum. And on this basis working angular velocity of the trunk in the Leadership

section to increase the angular momentum of the two legs no angular momentum and thus works to increase the effectiveness of performance and reach the correct technique.[15].

5. The increasing extend in the ankle, knee and hip angle lead to higher high body mass center and from can the player through which to invest the movement of his body during a performance of skill.[16].

### Chapter 3

#### 3- Methodology research and procedures :

##### 3.1 Research Methodology:

The researchers used the descriptive approach to the appropriateness of the nature of research.

##### 3.2 Subjects:

Was chosen study subjects by intentional way represented players of Szczecin team and Szczecin Acrobatic. Ten male ages 17-24 years, volunteered to participate in this study 5 players of Szczecin team and 5 players of Szczecin Acrobatic. All subjects were informed of the experimental procedures and gave their consent before participating. Age and anthropometric characteristic in the table 1.

Table 1.show Age and anthropometric characteristic for subjects:

Variables	Artistic gymnastics ( N=5)			Acrobatic ( N=5)		
	Mean	SD	Skewness	Mean	SD	Skewness
Age	22,5	1,1	1,4	19,6	1,6	0,16
Tall	167,9	5,2	1,02	169,5	3,3	0,4
Mass	62,7	2,5	-1,1	73,7	3,70	-0,9

SD (standard deviation)

##### 3.2 Research tools:

1. Foreign sources.
2. Observation and analysis.
3. Video camera the type Sony HDR-PJ10 speed 60 frames per second.
4. A computer (laptop type Samsung).
- 5- Software (Kinovea and Dartfish 5.5 teampro , Logger Pro 3.8.6.1)
5. Floor exercise.

##### 3.3 Pilot experiment:

The pilot experiment been conducted on 4-06-2014 at four in the afternoon in the training center hall of Szczecin gymnasts, and was the main objective of the pilot experiment was to determine on the most important procedures to be taken in the main experiment as

well as the better knowledge of the positions for the camera in order to obtain clear images for analysis variables skills under study.

### 3.4 Main experiment:

The main experiment was carried out on 08-06-2014 in the hall for gymnastics training using video camera type and a speed of 60 images / s, and the research sample player's performance skill under consideration for the purpose of later analysis.

### 3.5 Experimental filming protocol:

Videography was employed for the biomechanical kinematics analysis of backward handspring on floor. The camera that was used for this study was a standard Sony HDR- PJ10. The video camera was mounted on the tripod stand at the height of 1.37 mts. from the floor arena. The video camera was placed perpendicularly at center in the line of inner bar and parallel to the sagittal plane at a distance of 10 meters (figure 2). The frequency of the camera was 60 frames/ second with HD quality of video. The subjects performed the skill three times and the best trail was used for the analysis.

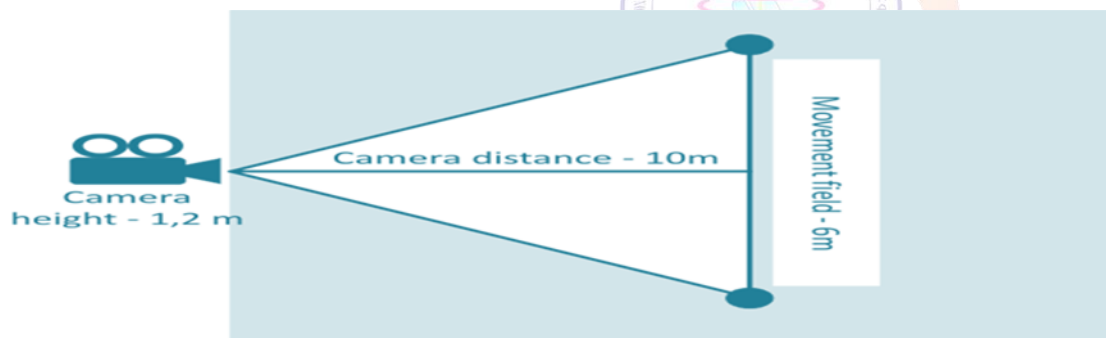


Figure 2. Camera position within filming.

### 3.6 Procedure of data collection:

Data were gathered in the standard testing procedure under the controlled condition. All testing was carried out in training Center hall in the city of Szczecin. Ideography technique was employed in order to register the performance of backward handspring for the study.

Selected kinematics variables (table 2,3,4,5,6,7,8 and 9) and three selected phases of whole skill i.e. take off phase, flight phase and landing phase were analysed. The most appropriate position from selected phases was taken out from the video by using snipping tool software. The digitization of the photographic sequence of selected phases was done with the help of kinovea and Dartfish 5.5, Logger Pro 3.8.6.1 software and the selected angular kinematic and liner variables were obtained at take off phase, flight phase and landing phase. The centre of mass of required phases was located by using segmentation method [8]. The angles of selected joints were measured degree; time variable in seconds and linear kinematics variable were measured in meters

### 3.7 Statistical methods:

The use of statistical package Minitab version 16 to extract the following: Mean standard deviation and 2-t-test sample.

## Chapter 4

### 4. Result and discussion:

There were several significant kinematic differences between two groups in back handspring in phases.

Table 2: Time of back handspring unit: s

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Total time	1,89	0,010	1,94	0,034	-2,99	0,017*
Eccentric phase	1,17	0,15	1,15	0,19	0,12	0,905
Concentric phase	0,29	0,07	0,26	0,073	0,86	0,415
First flight phase	0,26	0,015	0,23	0,019	2,90	0,020*
Push-off phase	0,35	0,07	0,32	0,01	3,03	0,016*
Second flight phase	0,12	0,019	0,13	0,014	-1,06	0,319
Height of CoM(m)	88,97	1,77	84,52	2,52	3,24	0,012*

( $P \leq 0.05$ ) at the degree of freedom of 8 See table 2. CoM (center of mass)

There are significant differences on total time and first flight phase and push-off phase and height of CoM between Szczecin gymnasts and Szczecin Acrobatic (Table 2). They have Szczecin gymnasts a shorter total time a longer first flight time and a shorter push-off phase and body CoM height than the Szczecin Acrobatic. The Szczecin gymnasts have a longer first flight phase indicated the Szczecin gymnasts using both feet forceful push-off ground which results a longer CoM height than the Szczecin Acrobatic. The greater CoM height after takeoff helped the Szczecin team perform the turn and execute the back handspring. The Szczecin gymnasts also has a shorter push-off phase suggest the hands quickly push-off floor which helps body swing and landing.

Tumbling can be considered a particular `form of locomotion` that involves both hands and feet, not simply feet. If we think of tumbling as something similar to an `acrobatic- run` then the goals of the backward handspring should be clear and similar to a running stride. In the case of the backward handspring, alternate feet contacts are replaced with simultaneous hands and feet contacts. Run speed is controlled by stride length and stride frequency [11]. No difference was found on Eccentric phase and concentric phase, Second flight phase variables between two groups.

**Table 3: Horizontal and vertical CoM velocities at take-off and push-off unit: m/s**

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Horizontal CoM velocity take-off	1, 75	0,215	1, 37	0, 22	3, 86	0,005*
Vertical CM velocity take-off	0, 82	0, 06	0, 44	0,046	11, 12	0,000 *
Horizontal CoM velocity hand push-off	1, 62	0, 16	1, 27	0, 03	5, 35	0,001*
Vertical CoM velocity hand push-off	0,035	0, 29	-0,003	0,593	0, 13	0,902

*(P ≤.05) at the degree of freedom of 8 See table3. CoM (center of mass)*

Show table 3 that The Szczecin gymnasts has the greater horizontal and vertical body CoM velocities than the Szczecin Acrobatic at feet takeoff which also indicated the Szczecin team has greater resultant body CoM velocity at take-off. The greater body CoM velocity at takeoff for Szczecin gymnasts result the greater CoM jumping height which gives a longer time for performing back handspring. The Szczecin gymnasts also have greater horizontal body CoM velocity at hand push-off which help the body for the landing. The smaller values of body CoM velocities at take-off and hands push-off results the poor back handspring performance of the Szczecin Acrobatic. There is an optimal combination of both distance and speed in a running stride and in a backward handspring. A gymnast who performs a back handspring with high speed while sacrificing distance of travel will not achieve overall effectiveness in tumbling [9].

**Table 4: Joint angle of back handspring at take-off unit: degree:**

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Shoulder	166, 96	5, 00	164, 51	3, 77	0, 87	0,407*
Hip	206, 6	42, 1	218, 81	6, 43	-0, 64	0,540 *
Knee	138, 2	3, 86	126, 7	4, 82	4, 15	0,003 *
Ankle	143, 40	5, 11	140, 70	1, 82	1, 11	0,299

*(P ≤.05) at the degree of freedom of 8 See table 4*

**Table 5: Joint angular velocity of back handspring at take-off unit: deg/s:**

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Shoulder	766,2	40,4	381 ,4	185 ,3	4,56	0,002*
Hip	776,1	33,4	6781,0	27,0	5,10	0,001 *
Knee	493,2	69,8	332,4	66,2	3,74	0,006 *
Ankle	458	155	370,0	106	1,05	0,323

*(P ≤.05) at the degree of freedom of 8 See table 5.*

Show table 4 and 5 that Joint angles and velocities of shoulder, hip, knee, and ankle of both groups at takeoff the Szczecin gymnasts have greater in Shoulder and hip and knee and ankle angle and angular velocities than the Szczecin Acrobatic at feet take-off. The greater knee extension and faster hip and knee angular velocities at take-off are the important variables for indentify good and average back handspring performance. All of this assists with providing the transfer of momentum required to perform this skill at a high quality. The purpose of a back handspring is to increase horizontal momentum of the body in the overall tumbling pass and to convert some of the horizontal momentum to vertical during the take-off from the feet [9]

**Table 6: Joint angles of back handspring at hands touchdown unit: degree:**

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Average maximum wrist hyperextension	88,6	3,7	83,5	2,9	2,41	0,047*
Shoulder	176,19	8,62	187,51	6,24	-2,38	0,045*
Hip	244,65	3,36	247,2	11,1	-0,48	0,643
Knee	137,01	9,10	109,7	14,1	3,65	0,007*
Ankle	145,35	4,44	145,47	4,51	-0,04	0,967

*(P ≤ .05) at the degree of freedom of 8 See table 6.*

**Table 7: Angular velocities of back handspring at hands touchdown unit: deg/s**

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Shoulder	-240,0	112,0	-223,3	76,3	-0,27	0,793
Hip	-232,0	89,5	-143,0	115,0	-1,36	0,209
Knee	159,9	38,9	-52,7	89,5	4,87	0,001*
Ankle	-108,1	67,5	-23,0	141,0	-1,22	0,258

*(P ≤ .05) at the degree of freedom of 8 See table 7.*

There are significant differences on average maximum wrist hyperextension and shoulder and knee angles between groups at hands touchdown see (table 6, 7). The overextension of shoulder observed on Szczecin Acrobatic indicated lack of balance control during the handstand position. The Szczecin Acrobatic less knee extension at hands touchdown may due to smaller knee angle at takeoff. The control of shoulder angle and more knee extension indicated good handstand position during back handspring. The faster knee angular velocity than the Szczecin Acrobatic suggests that the Szczecin gymnasts continue fast knee extension at hands touchdown. The primary reason for performance differences in these subjects was more likely the marked differences in skill and ability [13].

Table 8: Joint angles of back handspring at hands push-off unit: degree

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Shoulder	144,74	6,02	103,2	39,5	2,33	0,048*
Hip	133,8	12,6	105,17	2,25	5,00	0,001*
Knee	185,8	11,4	147,2	46,3	1,82	0,107
Ankle	127,23	9,01	110,9	32,2	1,09	0,306

( $P \leq 0.05$ ) at the degree of freedom of 8 See table 8.

Table 9: Joint angular velocities of back handspring at hands push-off unit: deg/s

Variables	Artistic gymnastics		Acrobatic		Indication level	
	Mean	SD	Mean	SD	t	p
Shoulder	-30,9	35,8	-21	170,0	-0,13	0,903
Hip	-300,6	84,4	-190,6	5,05	-2,91	0,020*
Knee	65,48	1,75	62,22	3,82	1,74	0,120
Ankle	-33,93	4,28	-29,71	1,98	-2,00	0,080

( $P \leq 0.05$ ) at the degree of freedom of 8 See table 9.

Show table 8 and 9 that the Szczecin gymnasts have greater hip angle and velocity than the Szczecin Acrobatic at hands push off the greater hip angle and velocity show the gymnasts fast extend the hip forceful hands push off to increase the rotation of trunk for the control landing. The less hip extension angle and slow hip angular velocity for the push off show lack of fast hip extension at hands push-off. The upper limbs must amortize the body weight and **instantly** create a push off: thus the arm alignment become crucial to avoid **additional stresses used to** correct the error. [6].

## Chapter 5

### 5. Conclusion and recommendations

#### 5.1 Conclusion:

- 1- Most of the results have shown statistically significant differences in favor of the technical performance of the players artistic gymnastics
- 2 - There is a correlation between the rise in the moment of take-off point of the hip and take-off angle to the joints and the two variables affect the values of the highest high to the point of the hip during take-off.
- 3- The increase in speed in the horizontal and vertical takeoff making skill pass from the horizontal position to a vertical position and this is important for this skill to obtain acceleration performance.

4- The increase in the joints of the shoulders and hip and knee and increase angular velocity in take-off led to the conversion of momentum horizontal to vertical.

5- The increase in extend shoulder joint, hip, knee, ankle and an increase in angular velocity lead to a soft landing.

6- Extending the shoulder and hip, knee, ankle detailed in the push-off phase leading to increase the angular velocity of the hip to convert energy potential energy to kinetic energy and this leads to work skill back tuck.

## 5.2 Recommendations:

1-adoption of the results of kinematics variables for players artistic gymnastics to be used by researchers yardstick for other similar studies.

2-use analysis movement league to follow the development in kinematics variables to work to promote the correct ones and to correct the imbalance on some of them through the development of alternative aspects responsible for it order that lead definitely to the development of these mechanical variables and integration for superior performance.

3- A correct execution performed by skilled could be used as a reference to reduce accidents also in less expert athletes.

4- Focus on the rapid technical performance of this skill is particularly to achieve the skill requirements.

5-Necessity focus during training this skill on the take-off angles and high hip point take-off moment as they both relationships identifying high gymnast's body during the main section of the skill.

7- Players training to achieve high-rising fitting to order that they can complete rotation requirements.

8- The need to emphasize the training of the players on the speed of rotation of the arms because of its importance in achieving good stability and especially in the final section of skill.

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