
A comparative study of biomechanical variables between the stages of performing the skills (Blank) and (Lu Yu Fu) On the jumping platform for the player qualifying for the final of the World Cup series in Qatar

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Abstract

The idea of the research came from the performance of one of the players who qualified for the final of the World Cup series in gymnastics held in Doha, the capital of Qatar, for the year 2023-2024 on the vaulting platform. In the individual final of the apparatus, this player performed two skills, the first was the “Blank” skill and the second was the “LuYuFu” skill. The two skills are different only in terms of direction. The first skill is performed while facing the device, that is, in the front direction, while the second skill is performed by the player from the back direction. Here, the research was done to find out what differences will appear in the biomechanical variables between both skills, and on the basis of dividing the movement stages, which is the vault table strike, then the first flight, then the push on the platform, then the second flight, and finally the landing. The performance of the player was photographed from the side with a camera with a speed of 240 images/second, perpendicular to the path line of the motor performance of both skills. And during his role, as being in the fifth place in the championship of the individual apparatus, after which motor analysis procedures were carried out using the MaxTRAQ program and the biomechanical variables common to the two skills were adopted according to the technical division for the performance stages on vault table. A comparison was made between the values of the

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variables according to each stage between the two skills, through which we noticed a difference in the body position at the vault strike through the distance and speed of landing on the vault table, which was reflected in the force of the strike. The results were in favor of the first skill, as is the case with the first flight, and the reason for this is due to the fact that The player will resort to change his direction in the second skill in order to do the Arabian jumb, i.e. half turn, to land on the platform to prepare for the second push and flight. As for the second stage of flight and landing, it was in favor of the second skill because when landing, the body is facing the horse, while in the first skill, the player's back is facing the horse. The process of adjusting the back landing is better than adjusting the front landing, with the exception of the deviation that occurred at the end of the skill due to the body twist over the vault table.

Keywords: biomechanical variables, performance stages, (Lu Yu Fu), (Blank), vault table, qualified player for the final, World Cup series in Qatar.

introduction

Sports performance at the world championship level is considered one of the most prominent manifestations that combine challenge, competitiveness and technical skill. Among the sports that require superior and highly difficult skills is gymnastics in general and the jumping platform in particular. Gymnastics is one of the most exciting and challenging sports in the world, as it requires the implementation of elaborate skills and enormous physical strength to achieve success. Among the players who have the skills and the abilities needed to shine in this sport are those who qualify to participate in international finals, such as the World Cup series.(Al et al., 2022)

This study aims to the following:

- 1- Identify the biomechanical variables of the skills (Blank) and (Lu Yu Fu) on the vault table for the player who qualifies for the final of the World Cup series in Qatar.
- 2- Identify the differences in the biomechanical variables between the skills (Blank) and (Lu Yu Fu) on the vault table for the player who qualifies for the final of the World Cup series in Qatar.
- 3- Exploring and analyzing the biomechanical factors that affect the player's performance in certain stages of executing the "Blank" and "Lu Yu Fu" skills on the vault table for the player who qualifies for the final of the World Cup series in Qatar.

This is achieved by extracting biomechanical variables and analyzing the performance of one of the players participating in the finals of the World Cup series in Qatar for the year 2023-2024.

This study is expected to provide a detailed and comprehensive look at the biomechanical differences between these two skills.

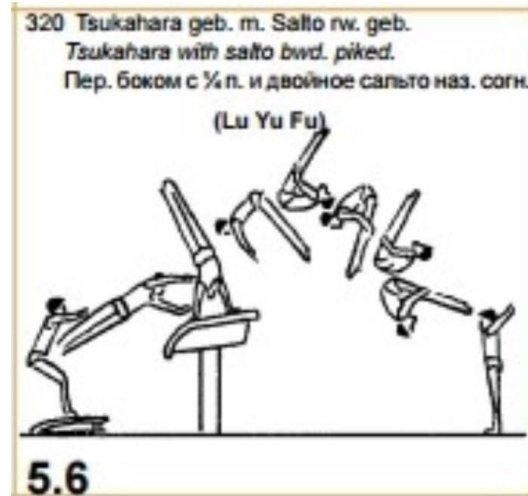
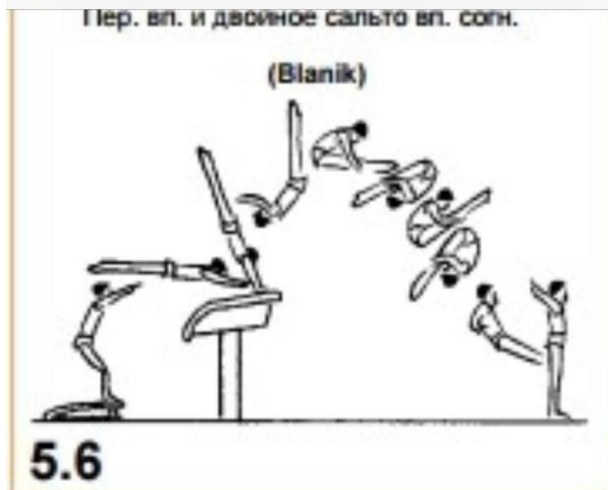


Figure (1) shows the sequence of performance for the skill (Blank) and the skill (Lu Yu Fu) and their value according to international law.

This study is based on an in-depth analysis of the movement and forces used during the stages of executing the two specific skills from the beginning until the end of the movement, using advanced techniques to measure and analyze movement and interpret the results based on the biomechanical data that will be collected from the player while implementing the two specific skills. Skill analysis methods and speed measurements will be used as well as measuring movement angles, times, heights, and distances during each stage of executing the two skills. (Kadhim, 2023)

Through the expected results of this study and a full understanding of the biomechanical factors affecting the players' performance in these skills, it will be crucial for coaches to develop training programs and physical preparation for athletes, as the resulting instructions and recommendations can be used to improve players' performance in certain stages of implementing vault skills and thus better results in international championships. (Easa et al., 2022)

According to the researchers' vision, the results obtained from this study will provide a comprehensive view of the biomechanical factors that determine the players' performance in both the "Blank" and "Lu Yu Fu" skills on the vault table and by better understanding of these factors, the programs of training and physical preparation for athletes can be developed with the aim of improving their performance and increasing their chances of success in international competitions. (Kazar & Kazim, 2020)

In short, this study represents an important contribution to a deeper understanding of the biomechanical factors that determine the performance of players in gymnastics, specifically in vault table, at the global level, and highlights the importance of integrating biomechanical variables in improving the performance of athletes. (Abdulhussein et al., 2024)

Method and tools

The researchers relied on the descriptive approach, which allows studying the reasons to reach better plans for the purpose of improving performance and conditions in the community concerned with the survey (Amer and Al-Samarrai 2009 AD, 193-194). The research community was represented by 8 players nominated for the individual apparatus championship on the vault table in the World Cup Series Championship in Qatar for the year 2023-2024. The research sample was chosen intentionally. He is the only player and his rank was the second in this championship. The reason for his selection was due to his performance of the required two movements in the research.

Thus, the percentage of the research sample to the community is (12.5%), and on 7/15/2023, Doha, Qatar, in the championship hall located in the Aspire Sports City, the site was prepared to photograph the right side of the vault, and on its horizontal level, the camera was installed in their desired location, which ensures the appearance of the player took of the last two steps before the vault table and to his landing point, perpendicular to the line of performance of the skill. Its height was (1.35 metres) and away from the middle of the performance area (15 metres). The zoom technique was used to control the vision area within the photographic frame. Then the main experimental procedures took place in the following way:

- 1- Before starting the filming process, data of the player's physical measurements and weight was recorded.
- 2- When the player is called to the performance location on the vault table apparatus according to the sequence that was given to him in the list of candidates. The camera is turned on and configured for the purpose of recording the two attempts.
- 3- The camera recording is switched on the moment the start signal is given to the player and is switched off after the performance is completed.
- 4- The two skills were recorded according to the player's performance according to the game law, then the films were taken and transferred to the computer to ensure the proper content.
- 5- The two skills were analyzed using (21) variables for each skill and according to the stages of performance using the MaxTRAQ analysis program, in addition to the player's final score set by the jury for the two skills.
- 6- The score for each skill was received according to the jury's evaluation and added to the variables table.

In order to analyze the two skills and extract their variables, each skill was divided according to the stages of its performance. The pictures below show the division of these stages for each skill.



Figure (2) shows the sequence of performance of the “Blank” skill



Figure (3) shows the sequence of performance of the skill (Lu Yu Fu)

Table (1)

The variables that were selected and extracted are:

No	Variables	Definition of variables
1	The horizontal distance to jump to the vault	It is the distance from the end of the last step until the first touch on the vault
2	Landing speed on the vault	It is the speed of the body's movement at the moment of landing and the first touch on the vault
3	Landing angle on the vault	The angle between the horizontal line and the body line passing through the point of contact
4	Vault strike time	It is the time period of a vault strike from the first touch until the last contact
5	The dent distance	The vertical distance the surface of the jumping device descends to the bottom when the glove is struck
6	Maximum knee flexion	The angle between the thighs and the leg at its maximum bend over the vault
7	angle of advancement	The angle between the horizontal line and the body line passing through the point of contact
8	Starting angle	The angle between the body's path during launch and the horizontal line
9	Starting speed	It is the speed of the body's travel the moment it leaves the glove
10	Flight time for the platform	The time period from the moment the glove leaves until the first touch of the platform
11	Angle of landing on the platform	The angle between the horizontal line and the body line passing through the point of contact
12	Contact time with the platform	It is the period of time that the platform is connected from the first touch until the last touch

13	The angle of rise from the platform	The angle between the horizontal line and the body line passing through the point of contact
14	Hip height end push	The vertical distance from the surface of the platform to the player's hip at the end of the push
15	Departure angle from the platform	The angle between the body's path during launch and the horizontal line
16	Starting speed	It is the speed of the body's travel the moment it leaves the platform
17	Highest height above the platform	The vertical distance from the surface of the platform to the highest height reached by the player
18	Flight time to landing	The time period from the moment you leave the platform until the first touch to the ground
19	Landing distance from the platform	The horizontal distance from the end of the platform to the first touch on the ground
20	Landing angle	The angle between the horizontal line and the body line passing through the point of contact
21	Hip height at the moment of landing	The vertical distance from the surface of the ground to the player's hip at the moment of landing
22	Final score for the jump	The total difficulty value and performance score are given by the arbitration committee

These variables were extracted once for the (Blank) skill and once for the (Lu Yu Fu) skill through analysis using the MaxTRAQ program, which is an international program approved in many scientific researches and in various universities in the world, as the capabilities of this program include two-dimensional analysis and three-dimensional analysis according to the method of filming, the required variables, and the form of skill performance.

In our research, we used the two-dimensional analysis feature, according to the photography angle available to us, taking into consideration that the filming took place within the real atmosphere of the championship, in which no one outside the champion organizers could move freely. The best location for photographing the skills on the vault table was from the side stands of the apparatus, which we used and it was at the same level as the location of the vault table. The issue was also related to the variables that the researchers adopted to study in this research, in which we tried to clarify the most important points of similarity and difference between these two skills from a biomechanical perspective and on the same player.(Ati et al., 2024)

Results and discussion

Table (2)

It shows the values of the biomechanical variables for the performance of the two skills by the research sample

NO	variables	measuring unit	Blank	Lu Yu Fu
1	The horizontal distance to jump to the glove	M	2.81	1.97
2	Landing speed on the gauntlet	m/s	11.8	8.75
3	Landing angle on the glove	degree	57	57
4	Glove strike time	second	0.112	0.121
5	Glove dent distance	M	0.17	0.13
6	Maximum knee flexion	Degree	144	156
7	Rising angle	Degree	83	83
8	Starting angle	Degree	25	35
9	Starting speed	m/s	8.7	8.5
10	Flight time for the platform	second	0.158	0.175
11	Angle of landing on the platform	degree	23	31
12	Contact time with the platform	Second	0.117	0.121
13	The angle of rise from the platform	Degree	113	107
14	Hip height end push	Degree	1.2	1.13
15	Departure angle from the platform	Degree	65	32
16	Starting speed	m/s	7.8	5.42
17	Highest height above the platform	Cm	2.43	2.02
18	Flight time to landing	Second	1.104	1.054
19	Landing distance from the end of the platform	M	2.48	3.29
20	Landing angle	Degree	61	79

21	Hip height at the moment of landing	Cm	0.87	1.1
22	Final score for the jump	Degree	14.800	14.533

Discussion of results

Through the table of the biomechanical variables values for the performance of the two skills by the research sample, who is the player participating in the individual apparatus finals and ranked fifth among the performance of the eight players in the individual apparatus championship, we see a very clear discrepancy in the values of the variables between the two skills (Blank) and (Lu Yu Fu). We will sequentially explain these variables and compare them on the basis of the performance of each skill. (Yasser Najah Hussein. 2017)

The first variable, which is the horizontal distance for jumping only, was greater in the first skill (Blank) than it was in the second skill (Lu Yu Fu), with a difference of (84 cm). The same is true for the variable of the speed of landing on the vault, with a difference of (3.05 m/s) in favor of the first skill, and this gives an indication that the skill performance requirements on the vault table apparatus when the body is facing the device requires greater speed and therefore a greater distance for the purpose of landing with the greatest horizontal speed on the vault.(Kazim et al., 2019)

In light of what we observed in the variable of landing speed on the vault table, and despite the equality of the landing angle and the rising angle on the vault, the difference was in line with each of the three variables, namely the time of the vault strike, the distance of the jumping dent, and the maximum knee flexion, in which the difference was also in favor of the first skill,(Mhaidi & Dakhil, 2022) as the difference was recorded (0.009 seconds).) In the time of the vault strike, the difference is (4 cm) in the dent distance, and the difference is (12 degrees) in the maximum flexion. The greater speed caused a greater dent in the vault, and thus the impact time became less due to the springiness of the vault, and this is the case with the angular difference in the flexion of the knee on the vault.(Yasir et al., 2020)

Because of the change of the body position and its rotation when exiting the vault in the second skill and due to the specificity of this skill, the differences serve in favor of the first skill in both the starting angle variable with a difference of (10 degrees) and the starting speed variable with a difference of (0.2 m/s), so the first skill, the player tries to stay on the path as the body approaches the horizontal position while the second skill increased the angle by a difference of 10 degrees to operate the vertical factor needed for the skill performance requirements so that the body is in a suitable position in touch with the vault table, while he is in a half turn. For this reason, the flight time is less for the first skill than in the second skill by a difference of 0.17 seconds.(Ali et al., 2020)

This was reflected in the angle of landing variable on the platform, and certainly in the second skill the value of the angle was greater than the first skill by a difference of (8 degrees), while the rising angle from the platform was greater in the first skill by a difference of (6 degrees)

than the second skill. The reason for this is that the first skill, because it is performed from beginning to end where the body is facing the vault and requires it to obtain a highest height in order to perform two bent flips. Therefore, it tries to gain the greatest horizontal speed and convert it to vertical speed when leaving the vault, and therefore the difference in the time of pushing on the vault was very small, which is (0.004 seconds). (Hussein, Y.N. 2015).

Because of the difference in the body position at the moment of letting go between the two skills, the differences were clear, especially in the starting angle. The difference between them reached (33 degrees), and the hip height was higher in the first skill by (7 cm) than in the second skill, and in the final achievement the difference was in the value of the starting speed which is in favor of the first skill by a difference of (2.38 m/s). The reason for this is due to the percentage of loss of strength and speed resulting from the change in the angles of the body's joints, as well as shifting the paths of the body parts in the linear and circular direction in the second skill more than what occurred in the first skill.(Kadhim, 2023)

Despite the difference in the increase in the launch angle in the vertical direction for the second skill, the variable of the highest height above the vault was in favor of the second skill by a difference of (41 cm). The reason is due to the difference in the launch speed in the first skill, which caused an increase in flight time with a difference of (0.05 seconds) over the second skill, in which the landing distance was greater by a difference (81 cm) than in the first skill. The reason is certainly due to the speed and angle of starting, which were greater in the first skill, and this is one of the basics of motives. (Mohammed, I. I., Jawad, U. A. M., & Hussein, Y. N. (2015).

In the end, the landing angle, which was recorded as a difference of (18 degrees), and the height of the hip at the moment of landing with a difference of (23 cm), comes with an increase in the second skill for both of them compared to the first skill. The reason is due to the position of the hip position and its location at the moment of landing, as the body is in its landing and at the moment of contact with the ground with the flexion for the purpose of absorbing the hit will be the hip behind the landing point and down due to the position of the body that places the apparatus behind it, while the situation is the opposite when landing in the second skill. The body, after rotating 180 degrees at the moment of touch, will be facing the device, and thus the hip will be almost above the landing point and upwards.(Jawad Kadhim, M., & Salman Ahmed, 2016)

Last but not least, we come to the final score set by the judges from Committee D and Committee E. Although the difficulty score values are equal for the two skills, which is (5.6), the performance score was better for the first skill, with a difference of (0.267) of the score, and this gave a picture of the amount of errors that occurred between the two skills, which was clearly reflected in the comparison between their biomechanical variables.(Salman et al., 2022)

Conclusions

1- The requirements for skill performance on the vault table apparatus when the body is facing the device requires greater speed and therefore a greater distance for the purpose of landing with the greatest horizontal speed on the vault. It is different from what it is when performing while the body is not facing, meaning there is a rotational movement around the longitudinal axis to perform a half turn on the vault.

2- The greater speed of the player causes a greater dent in the vault and thus will make the strike time shorter due to the springiness of the vault. This is also the case with the angular difference in the flexion of the knee on the vault and this will be reflected in the first flight and the variables of push on the vault and according to the requirements of each skill.

3- Due to the change in body's position and rotation when leaving the vault in the second skill, and due to the specificity of this skill, we find that the differences are better in favor of the first skill in both the variable start angle and the variable start speed. In the first skill, the player tries to maintain the body's path closer to the horizontal position while the second skill increases the angle for the purpose of increasing the vertical factor of the skill performance requirements so that the body is in a suitable position in contact with the vault at the end of the half turn. Therefore, the flight time is less for the first skill than for the second skill.

4- The variable angle of landing on the vault in the second skill has a greater angle value than the first skill, and the same is true for the angle of rising from the vault. The reason for this is that in the first skill, and because it is performed from beginning to end, the body is facing the vault and requires it to obtain a highest height to perform two bent flips. He tries to gain the greatest horizontal speed and convert it to vertical speed when leaving the vault table.

5- Due to the difference in the body position at the moment of letting go between the two skills, there were clear differences in the increase, especially in the starting angle, starting speed, and hip height, in favor of the first skill. The reason for this is due to the percentage of loss of strength and speed resulting from the change in the angles of the body's joints, as well as shifting the paths of the body parts in a linear direction and the circle in the second skill is more than what occurred in the first skill.

6- The body is landing, and at the moment of contact with the ground with flexion for the purpose of absorbing the hit, the hip will be behind the point of landing and down due to the position of the body, which places the vault behind it, while the situation is the opposite when landing in the second skill. The body, after rotating 180 degrees, will be facing the vault table at the moment of touch. Thus, the hip is almost above the landing point and to the top.

7- Although the difficulty score values are equal for the two skills, which is (5.6), the performance score was better for the first skill, with a difference of (0.267) of the score, and this gave a picture of the errors that occurred between the two skills, which was clearly reflected in the comparison between their biomechanical variables.

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