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## Kinematic analysis of the time variable and its relationship to some bio-kinematic variables and the performance of the wheel skill on the floor movements mat for gymnast players aged 7 – 9

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### Abstract

Controlling the time to perform each part of the human wheel movement in a way that serves the goal is one of the important factors that determine the success of the continuity of the movement performance. Therefore, it is very important for the athlete to learn the ability to control how to show acceleration during rotation, and show momentary stillness during balance. The success of executing the human cartwheel depends on the strength and speed of propulsion of the legs and hands, as well as on the mutual relationship between them. It is noted that one of the problems that many players fall into, which causes a decrease in the level of human cartwheel performance, is the weakness of the relationship between time variables in various parts of the movement on the one hand. As well as the weak correlation between time and the rest of the bio-kinematic variables and this leads to not employing the time variable and the bio-kinematic variables in the stages of implementing the human wheel in a way that serves the sequence of the motor path of the movement. The study aimed to kinematically analyze the time variable and some bio-kinematic variables in the skill of the human wheel, and to identify the relationship between the time variables in the track of the human wheel and the relationship of the time variables with the bio-kinematic variables, as well as the relationship between the performance of the human wheel and the bio-kinematic variables under investigation. The two researchers assumed that there is no statistically significant relationship. Between some time variables in the human wheel track. Likewise, there is no statistically significant relationship between some time variables and some bio-kinematic variables and the performance of the human wheel skill. The research sample included 12 players from the National Center for Nurturing Sports Talent in Gymnastics. The human wheel skill was photographed with a camera with a speed of 120 frames per second, and a group of bio-kinematic variables for parts of the stages were analyzed. The most important results reached by the two researchers: Most of the correlations were significant between time variables for different stages of the human wheel, and this confirms that players realize the importance of time in determining the quality of performance. The emergence of a large number of non-significant relationships between time variables and other bio-kinematic variables, as this indicates Due to the randomness in the use of time in the service of bio-kinematic variables, the non-significant results between time and other variables confirm their lack of harmony and consistency in working with each other. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Quality Education).

**Keywords** | analytical study, bio-kinematic variables, Technical gymnastics

**Introduction:** The human wheel skill is one of the Technical gymnastics movements that is performed on more than one device and is characterized by speed of execution. Its performance requires strength and flexibility, and contributes to feeling and controlling body movement. The human wheel is performed as an independent movement or as part of ground skills. It also contributes to facilitating the learning of several skills, including the Arabic jump, due to the similarity in the path of movement and body mechanics, which allows for effective transfer of learning. This confirms that mastering the human wheel skill contributes to and enhances the performance of other skills indirectly. Jumps in Technical gymnastics, including the Arabian jump and the human wheel, are among the important skills, especially in simple ground movements, as through them it is possible to change the direction of the body's movement as well as gain horizontal speed. There is no doubt that good knowledge of kinematic analysis is one of the basic foundations in evaluating performance, as it is based on studying movement by analyzing it into its parts and identifying the effect of apparent variables and the force that causes them in an effort to understand the subtleties of movement. The performance analysis of the human wheel is an interconnected series that begins with jumping, then the rhythm of the movement changes to pushing, and the movement continues as both the feet and hands land in an interconnected and independent manner. Therefore, it is very important for the player to learn the ability to control how to show acceleration during rotation, move in a continuous manner during execution, and show momentary stillness during balance, which requires the player to emphasize the smoothness of performance in rotation, balance, movement, and momentary stillness between parts of the body during the execution of the skill, and therefore the Controlling the timing of performing each part of the human wheel movement in a way that serves the goal is one of the important factors

that determine the success of the continuity of the sequence of movements when the player performs more than one movement in a row. (Wilkerson, Jerry D) points out that the human wheel is one of the important skills in a number of Technical gymnastics equipment, especially in floor movements, because through it it is possible to change direction and gain horizontal speed (17). Many trainers emphasize that the first step in Teaching and developing the wheel is to begin by emphasizing the speed of the driving leg's movement by connecting it and leaving it on the ground in the shortest possible period of time, especially when the second hand reaches the ground, as research indicates that the first foot must quickly break off contact and approach the second hand, in addition to emphasizing that The contact time of the hands and feet is quick and short. Debbie and others believe that the success of executing the human wheel depends on the amount of strength and speed of propulsion of the legs and hands, as well as on the mutual relationship between them. Priority is always given to the movement of the legs in relation to the speed and strength of the movement during training before performing any type of exercise. Movement of the hand or arm. (5). Some specialists, including (Debbie), attribute that (the reason for this is the important role that the legs can play in providing the body with a large amount of kinetic energy at the moment of movement; in addition to emphasizing that rotation in the human wheel must achieve equal curvature of the hips and shoulders. In addition, try to create one curved line along the entire body. (5). (Irwin G, Kerwin D.G) added, "It is difficult to perform acrobatic movements in Technical gymnastics with a weakness in performance speed." (8). It is noted that one of the problems that many players fall into, which causes a decrease in the level of performance of the human wheel, is the weak relationship between the time variables in various parts of the movement on the one hand, as well as the weak relationship between time and the rest of the bio-kinematic

variables, and this leads to not employing the time variable and the bio-kinematic variables in The stages of implementing the human wheel in a way that serves the sequence of the motor path of the movement, as well as the smoothness of the transition of body parts, and this in turn is reflected in the correct performance of the movement; Accordingly, the two researchers see the necessity of examining the relationship between the variables and their subsequent impact on the level of human wheel performance. The aim of the research was: Kinematic analysis of the time variable and some bio-kinematic variables in the skill of human acceleration in ground movements , and identifying the degree of some bio-kinematic variables and the performance of the human wheel skill. The relationship between the time variables in the human wheel track and the relationship between the time variable and some bio-kinematic variables. As well as identifying the relationship between human wheel performance and the bio-kinematic variables under research. The research hypotheses were:. There is no statistically significant relationship between some time variables in the human wheel track, and there is no statistically significant relationship between some time variables and some bio-kinematic variables and human wheel skill performance.

**Table .1** shows the homogeneity of the sample in terms of length, mass, and age

Variables	Measuring unit	Mean	Median	Std. Deviations	Skewness
Length	Cm	1.33	1.300	0.16	0.56
Mass	Kg	28.66	28.00	4.23	0.47
Age	Year	9.26	9.00	0.87	0.89

The results showed the homogeneity of the sample through the skewness coefficient being limited to (+ 1), and this indicates a moderate distribution of homogeneity of the research sample. The researchers used Arab and foreign sources, the information network (the Internet), the kinovea program, a data collection form, an assistant work team, a medical scale to measure weight, a video camera (2) with a speed of (120

### **Research fields:**

- Human field: Gymnasts players aged 7-9.
- Time field: (2/7/2023) to (20/1/2024)
- Spatial field: Interior hall of the Specialized School for the Care of the Gifted.

### **Method and procedures:**

The two researchers used the descriptive approach to suit the research sample, (as the descriptive approach is defined as the precise analysis of the mutual relationship between society and development so that it gives pictures of the reality of the phenomenon in addition to indicators and building future predictions about the movement). (Wajjia Mahjoub) (15).

The research community was represented by gymnastics players aged 7 - 9 years in the specialized center at the Ministry of Youth and Sports, numbering (16). As for the research sample, it was chosen intentionally and numbered (12) players, from whom (2) players were chosen to conduct the exploratory experiment. The research sample represented (75%) of the original population, and in order for the sample to be homogeneous, the skewness coefficient was extracted, which included: (length, weight, age), as shown in Table (1)

images/second), Japanese-made, and a computer (1). CD, tape measure, whistle, tripod, 5cm wide adhesive tape.

Bio-kinematic variables of the human wheel:

Through the two researchers' access to sources and research, a number of bio-kinematic variables were selected and presented to a group of experts through a questionnaire form, numbering (5) in Appendix No. (2). the experts agreed (80%) on

choosing a number of variables and the bio-kinematic variables were measured. Researched using Kinovea motion analysis program

**First: Time variables:**

- The time when the pushing leg is supported.
- The time of the snatch leg swing: The time is calculated from the moment the snatch leg leaves the ground to the moment the first hand contacts the ground.
- The time when the first hand is supported.
- Time to lean on the second hand.
- The time period between leaning on the first and second hand.
- The total time to perform the human cartwheel.

**Second: Some bio-kinetic variables**

- The angle of the knee joint of the driving leg at the moment of leaving the ground.
- The angle of the snatch leg: from the moment the snatch leg leaves the ground until the moment the first hand connects with the ground.
- The angle of inclination of the torso at the moment the first hand contacts the ground.
- The distance between the pushing leg and the first hand the moment it touches the ground.
- The distance between the first and second hand.
- The distance between the second hand and the abductor leg now it lands and touches the ground.

**Exploratory experience:**

**Table .2** shows the arithmetic means, standard deviations, median, and skewness coefficient for the time variable and some bio-kinematic variables in the human wheel.

Time variable	Arithmetic means	Standard deviations	Median	Skewness
Time of pushing leg supported	30.33	0.017	0.34	0.55
Time of the snatch leg swing	0.33	0.0106	0.33	0.47
Time of the first hand supported	0.441	0.016	0.445	0.26
Time of the second hand supported	0.360	0.013	0.360	0.10

The two researchers conducted the exploratory experiment on Saturday, July 20, 2023, at exactly two o'clock in the afternoon, with (3) players in the indoor hall. The members of the exploratory sample were photographed while executing the human wheel skill with (2) video cameras at 120 speed. /Second the aim of the experiment was to ensure the validity of the tools and devices, the location and dimensions of the cameras, as well as to identify the obstacles that the two researchers may face.

**Main experience:**

The two researchers conducted the main experiment test on the day of (7/26/2023) on (12) players in the indoor hall of the Specialized School for the Care of the Gifted. A video camera was used at a speed of (120 images/second) and was placed at a height of (1.27) m and a distance (5) m, from the middle of the test execution field and before the start of the test, a detailed explanation was given by the two researchers about the human wheel performance test. The skill performance evaluation was based on four arbitrators and the judging score was (10) degrees. The score was calculated by deleting the highest and lowest scores. Then add the remaining two degrees and divide them by (2) (Ibtihal & others) (3)

**Statistical methods:** The arithmetic mean, median, standard deviation, skewness coefficient, and Pearson correlation coefficient were used to treat the results statistically.

**Results:**

Time period between leaning on the first and second hand	0.227	0.0103	0.230	0.36
Total time to perform	0.945	0.052	0.975	0.68

**Table .3** shows the arithmetic means, standard deviations, median, and skewness coefficient for some biokinematic variables.

Time variable	Arithmetic means	Standard deviations	Median	Skewness
The angle of the knee joint of the driving leg at the moment of leaving the ground	139.6	8.21	142.0	0.72 -
snatch leg angle	98.56	4.45	97.00	0.16
Angular velocity of snatch leg	299.66	11.56	298	0.43
The angle of inclination of the torso when the driving foot contacts the ground	37.75	4.74	37.5	1
The distance between the pushing foot and the point where the first hand contacts the ground	49.31	1.86	49.50	0.24 —
The distance between the first and second hand	28.06	3.70	29.50	0.22 —
The angle between the legs at the moment of handstand	163.81	6.55	165.00	0.73 —
The distance between the second hand and the abductor leg at the moment it lands and touches the ground	22.37	1.06	22.50	0.45 —
Degree of human wheel performance	7.3	0.651	7.5	0.11

From Table (2,3) it is clear that the value of the skewness coefficient for the variables under study ranged between (1 - 0.10), and this confirms that the variables under research are moderately distributed.

**Table .4** shows the correlation between time variables in human wheel skill.

Variables	Time of pushing leg supported	Time of the snatch leg swing	Time of the first hand supported	Time of the second hand supported	Time period between leaning on the first and second hand	Time to perform
Time of pushing leg supported	—					
Time of the snatch leg swing	0.79	—				
Time of the first hand supported	0.46 -	0.12 -	—			
Time of the second hand supported	0.62	0.71	0.066	—		
Time period between leaning on the first and second hand	0.84	0.75	0.14	0.83	—	
Time to perform	0.98	0.71	0.47-	0.63	0.85	—

The tabular score (t) under the degree of freedom (12-2) and the level of significance (0.05) is equal to (0.57)

**Discussion:**

We note that there is a correlation between the human wheel performance time and the time variables investigated, except for the variable of the time of leaning on the first hand. It is also evident from the same table that there is a significant correlation between the time of leaning on the pushing leg and the swing of the snatching leg, as well as a significant correlation for each of them with the variable of the time of leaning on the second hand and the time. There is a significant correlation between the contact time of the first hand and the second hand and the contact time between the two hands. The two researchers can attribute the reason for this to the fact that the human wheel is one of the basic and important skills in Technical gymnastics equipment, especially the floor movements mat, and this importance comes from the fact that through it the direction of the body can be changed, as well as the body gaining horizontal speed that can be invested in highlighting the beauty of the movement in the event of its repeated performance or In determining the success of subsequent jumps. Some specialists in gymnastics, including (Muhammad Ibrahim), point out that “performing a series of interconnected movements with a good skill level cannot be achieved if there is a weakness in the speed of execution” (10). (Ban Faisal and others) point out that “the body’s ability to balance in its

kinetic state is reflected in the rapid change in the body’s position, and the ability to control any state the body takes, which occurs frequently in many sports, including flying and gymnastics events.” (4). The two researchers also believe that the human cartwheel skill is often used as a building block for more advanced movements such as spins, aerials, and hand jumps. Therefore, the time factor or the high speed of the movement of the arms or legs in the human cartwheel performance can help the gymnast develop momentum and strength that can be used to execute movements. More complex ground. (George G.S). points out that (the moment the athlete reaches the handstand stage, he works to complete the rotation with a quick and successive push with both hands for the purpose of achieving a rapid rotation of the body). (6). From the above, we can say that in order to achieve a good performance of the skill, the player is required to perform each part of the human wheel performance in a time that serves the time of the successive part of the movement; (Talha Hossam) emphasizes (that the interconnection and movement sequence between the participating body parts must be carried out smoothly, coordinated, and accurately with the movement rhythm, because of its role that is reflected in the quality of human wheel performance and economy of effort). (13).

**Table .5** shows the correlation between time variables and some bio-kinematic variables in human wheel skill.

Variables	Time of pushing leg supported	Time of the snatch leg swing	Time of the first hand supported	Time of the second hand supported	Time period between leaning on the first and second hand	Total time to perform
The angle of the knee joint of the driving leg at the moment of leaving the ground	0.74	0.61	0.40–	0.45	0.58	0.78
snatch leg angle	0.24	0.13	0.27–	0.25–	0.31–	0.23

Angular velocity of snatch leg	0.44	0.66—	0.61—	0.45	0.59—	0.52
The angle of inclination of the torso when the driving foot contacts the ground	0.72 –	0.48–	0.56	0.30–	0.48–	0.75
The distance between the pushing foot and the point where the first hand contacts the ground	0.69 –	0.36–	0.68	0.29–	0.51–	0.74–
The distance between the first and second hand	0.28	0.57	0.10	0.15–	0.58	0.16
The angle between the legs	0.19 –	0.45	0.26–	0.17–	0.71–	0.074
The distance between the abductor's hand and leg at the moment it lands and touches the ground	0.39 –	0.82–	0.28–	0.51–	0.59–	0.27–

The tabular score (R) under the degree of freedom (12-2) and the significance level (0.05) is equal to (0.57)

It is clear from Table (5) that there are a number of significant correlations between time variables in the human wheel track and some bio-kinematic variables in skill when comparing the calculated value with the tabulated value under a degree of freedom (10) and an error level of (0.05).

There is a significant correlation between the knee joint angle of the driving leg and some time variables, as well as a significant correlation of the angular velocity of the striking leg with some time variables. It emphasizes the significant role of flexion and extension of the knee joint of the pushing leg and the angular velocity of the snapping leg in contributing to increasing the force propulsion the moment it leaves the ground. The results of (Ibtihal and Intisar) indicate (that the angle of the knee joint has a major kinematic importance and role, in addition to that increasing the ranges of motion (angles) of the knee joint at the moment of pushing is an important factor and a necessary requirement to achieve the correct and good performance of the skill). (3). (Talha and others) also confirm (that the amount of angular movement of some parts of the body has a role and is the first and influential factor in the movement of the body during the performance of the movement) (14). It is clear from the same table that there is a significant correlation between the angle of inclination of the body with some

variables of time, as well as a correlation between the horizontal distance between the pushing leg and the first hand at the moment of contact with the ground and some variables of time. Therefore, the two researchers believe that the performance of the human wheel by the members of the research sample is moving towards investing variables. Bio-kinematics in the service of good performance; Where (Ibtihal Riad Omran) confirms (that the human wheel is carried out by inclining the body at an angle that tends in the horizontal direction in order to achieve a greater horizontal distance forward at the moment the first hand contacts the ground, provided that the level of inclination is directed and does not cause the player's body to fall). (2). Also, the significant relationship between the angle between the legs in the headstand phase of executing the wheel and the time between the hands confirms the attempt of the members of the research sample to achieve complete openness in this part of the movement. Where (Ibtihal and Intisar) indicates that the large angle between the two legs confirms the smooth transmission of force between the parts of the body, at appropriate ranges and speeds, and in the correct time sequence between the limbs of the body, in addition to that the small distance between the hands works to reduce the time

period and confirms that the rotation is carried out on a point. One and not on a straight line (9).

**Table .6** shows the correlation between human wheel skill performance and the investigated variables

bio-kinematic variables	correlation coefficient
Time of pushing leg supported	0.36 —
Time of the snatch leg swing	0.36 —
Time of the first hand supported	0.44 —
Time of the second hand supported	0.67 —
Time period between leaning on the first and second hand	0.61 —
Total time to perform	0.43 —
The angle of the knee joint of the driving leg at the moment of leaving the ground	0.58
snatch leg angle	0.22
Angular velocity of snatch leg	0.66
The angle of inclination of the torso when the driving foot contacts the ground	0.62
The distance between the pushing foot and the point where the first hand contacts the ground	0.72
The distance between the first and second hand	0.21
The angle between the legs	0.47
The distance between the abductor's hand and leg at the moment it lands and touches the ground	0.22

The tabular score (R) under the degree of freedom (12-2) and the significance level (0.05) is equal to (0.57)

From Table (6) we notice that there is a significant correlation between the degree of performance of the human wheel and some of the variables investigated (the time of leaning on the second hand, the time between leaning on the first and second hand, the knee angle of the pushing leg, the angular velocity of the snapping leg, the angle of inclination of the torso, and the distance between the pushing leg and the first hand. moment of contact with the ground)

The human wheel skill path is relatively complex, as for good performance it requires a high degree of coordination between the vital kinematic variables throughout the skill path, and any deviation from the optimal level of coordination between these variables could lead to a decrease in the quality of performance. Therefore, the interconnection and consistency between the kinematic variables of the skill path is extremely important and must be maintained to achieve optimal performance. (Haider) believes that parts of the body move as an interconnected chain that does not move at one time or at one speed, as the

body contains many joints that work to move the body in different positions and with a smooth, coordinated movement between the parts of the body to achieve the motor task that is to be achieved. (7). (Saeed, W., Abed-Maleh, F., & Jary, H.S). add that muscle flexibility is an important factor in most gymnastics movements. Therefore, muscle harmony of the muscles surrounding the joints of the body works to improve the range of motion of the joints, which is reflected in speed and agility. Movement) (16). (Sarih Abdul Karim Al-Fadhli) adds (to the importance of flow in executing the movement, as it is considered one of the most important factors that can be relied upon in judging the quality of performance and evaluating its level, and the coordination of the movement of body parts along the path of movement and with high consistency reflects the player's possession of sufficient flow to achieve performance. The best). (12). On the other hand, there are weak correlations between time variables and other bio-kinematic variables with the performance of the human wheel. The



reason for the weak relations can be attributed to the level of the individuals in the research sample, as it still requires interconnected training with the use of motor analysis for the purpose of tracking the level of the players through careful analysis of the movement path. . (Shahad and Intisar) confirm that “by analyzing the movement kinematically, we can provide coaches with information about the player’s performance and how to invest the kinematic foundations in serving the goal of the movement.” (11). (Zubaida ,et al.) add, “The correct implementation and achieving balance in the movement path or motor duty can be one of the requirements for success in achieving good performance” (18), as the quality of performance is the result of the interaction of other kinematic variables that work in the form of an interconnected chain. . Therefore, (Zainab and Widad) believe that “knowing the players’ biokinematic variables can lead us to reach the correct path for executing the skill by knowing the exact relationship of each variable in performance and thus the ability to achieve optimal performance” (19). ( Abdel Hussein) confirms that “the movement begins in the shoulder joint and then continues in the rest of the joints with force and increases in speed, so the movement begins from the joints of the lower limb, passing through the torso and then ending with the wrist of the hand” (1).

### **Conclusions:**

- 1- Most of the correlations were significant between time variables for different stages of the human wheel, and this confirms that players realize the importance of time in determining the quality of performance.
- 2- The emergence of a large number of non-significant relationships between time variables and other bio-kinematic variables, as this indicates randomness in the use of time in the service of bio-kinematic variables.
- 3- The insignificant results between time and other variables confirm their lack of harmony and coordination in working with each other.

- 4- The emergence of some significant correlations between the performance of the human wheel and a group of variables investigated. This confirms the players’ attempt to execute the skill with good flow and work to emphasize the connection with some bio-kinematic variables.

### **Recommendations:**

- 1- Adopting kinetic analysis is a fundamental pillar in performance evaluation.
- 2- Coaches’ interest in transferring kinematic information related to skill to players.
- 3- Training players on how to invest biokinematic variables in serving their motor duty.

### **Author’s declaration:**

**Conflicts of interest:** None

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

**Ethical-Clearance:** this manuscript approved by local ethical committee of physical education and sport sciences college for women on (February /2024)

### **Author’s contributions:**

All contributions of this study were done by the researchers (I.K. and A.H.) who get the main idea and work on writing and concluding also with number of experts, Mohammed Dawai Rishak (Ministry of youth and sport) in Statistics, Huda Shihab in revision, Hussein Nassir in translating, Ali Makki in proofreading

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## التحليل الميكانيكي لمتغير الزمن وعلاقته في بعض المتغيرات البايوكينماتيكية وأداء مهارة العجلة في بساط الحركات

الأرضية للاعبين الجمناستك بأعمار من 7 – 9

فاطمة الزهراء نفعت كاظم 1 ، انتصار كاظم عبد الكريم 2

2&1 جامعة بغداد / كلية التربية البدنية و علوم الرياضة للبنات – العراق

أن التحكم في زمن أداء كل جزء من حركة العجلة البشرية بالشكل الذي يخدم الهدف يعد من العوامل المهمة التي تحدد نجاح استمرارية أداء الحركة، لذلك من المهم جدا ان يتعلم اللاعب القدرة على التحكم في كيفية اظهار التسارع اثناء الدوران ، و اظهار السكون اللحظي اثناء التوازن. ويعتمد نجاح تنفيذ العجلة البشرية على مقدار قوة وسرعة الدفع للرجلين واليدين وكذلك على العلاقة المتبادلة فيما بينهم ، ويلاحظ ان من المشاكل التي يقع فيها الكثير من اللاعبين والتي تسبب انخفاض في مستوى أداء العجلة البشرية هو ضعف العلاقة بين متغيرات الزمن في أجزاء متعددة من الحركة من جهة وكذلك ضعف الترابط بين الزمن وباقي المتغيرات البايوكينماتيكية ، وهذا يؤدي الى عدم توظيف متغير الزمن والمتغيرات البايوكينماتيكية في مراحل تنفيذ العجلة البشرية بالشكل الذي يخدم تسلسل المسار الحركي للحركة. وهدفت الدراسة الى التحليل الميكانيكي لمتغير الزمن وبعض المتغيرات البايوكينماتيكية في مهارة العجلة البشرية والتعرف على العلاقة بين متغيرات الزمن في مسار العجلة البشرية وعلاقة متغيرات الزمن مع المتغيرات البايوكينماتيكية وكذلك العلاقة بين أداء العجلة البشرية والمتغيرات البايوكينماتيكية قيد البحث، وقد فرضت الباحثتان بعدم وجود علاقة ذات دلالة إحصائية بين بعض متغيرات الزمن في مسار العجلة البشرية. وكذلك لا توجد علاقة ذات دلالة إحصائية بين بعض متغيرات الزمن وبعض المتغيرات البايوكينماتيكية وأداء مهارة العجلة البشرية . اشتملت عينة البحث على 12 لاعب من لاعبين المركز الوطني لرعاية الموهبة الرياضية للجمناستك. وقد صورت مهارة العجلة البشرية بكاميرا ذات سرعة 120 صورة/ثا وتم تحليل مجموعة من المتغيرات البايوكينماتيكية لأجزاء مراحل. اهم النتائج التي توصلت لها الباحثتان : ان معظم علاقات الارتباط كانت معنوية بين متغيرات الزمن لمرحل مختلفة من العجلة البشرية وهذا يؤكد على ان اللاعبين يدركون أهمية الزمن في تحديد جودة الاداء. ظهور عدد كبير من العلاقات الغير معنوية بين متغيرات الزمن والمتغيرات البايوكينماتيكية الأخرى حيث يشير هذا الى العشوائية في توظيف الزمن في خدمة المتغيرات البايوكينماتيكية، النتائج الغير معنوية ما بين الزمن والمتغيرات الأخرى يؤكد الى افتقارهما للتناغم والتناسق في العمل مع بعضهما البعض. وهذا ما يحقق احد اهداف التنمية المستدامة للامم المتحدة في العراق (التعليم الجيد).

مستخلص البحث

دراسة تحليلية، المتغيرات البايوكينماتيكية، الجمناستك الفني.

الكلمات المفتاحية