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The relationship of a number of biokinematic variables and dynamic balance with the accuracy and strength of the crescent kick performance of advanced taekwondo players

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Abstract

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The research aimed to identify the relationship between a number of biokinematic variables and dynamic balance and the accuracy and strength of the crescent kick to the head performance for advanced Taekwondo players. The researchers assumed the existence of a significant correlation between a number of biokinematic variables and dynamic balance with the accuracy and strength of the crescent kick to the head performance for Taekwondo players. The researchers used the descriptive approach to suit the nature and objectives of the research. The research sample included (7) advanced Taekwondo players in Nineveh Governorate. The researchers used the crescent kick to the head test to measure the accuracy and strength of the crescent kick, in addition to using the dynamic balance test (YBT) for the legs. The scientific and technical observation was carried out using digital cameras to photograph the crescent kick to the head test. The data were statistically processed using the (Spss) program. The researchers concluded that the variables (horizontal displacement of BMC, time, horizontal velocity of BMC, angular velocity of the kicking leg, radius of the kicking leg, resultant velocity of BMC) in the main phase of the crescent kick to the head have an effective role in achieving the accuracy and strength required for performance, in addition to the direct effect of dynamic balance in providing a good balance base for performing the crescent kick to the head for Taekwondo players.

1- Introduction and research importance

The level of good skill performance to achieve better athletic achievement is closely related to the development of modern sciences, including biomechanics, which is concerned with studying and analyzing movements in the sports field to reach mechanical solutions that contribute to improving athletic performance.

Taekwondo is a combat sport that relies heavily on the skills of the two men, in which kicks constitute the largest offensive aspect, which is characterized by accuracy, speed and strength. The conditions for scoring points obtained by the player are the strength of the kick, as well as the accuracy and high speed required by motor skills when performing in attack operations in order to win those points.

The crescent kick is one of the most important kicks in taekwondo and the most used skills in matches, as it is characterized by the diversity of performance methods, speed of implementation and the possibility of performing it with the front or back foot, as well as the possibility of directing the kick to the head of the opposing player, which requires the player to maintain his balance during the implementation of the crescent kick. Dynamic balance plays a vital role in the stability of the lower limbs of taekwondo players when performing kicks, including the crescent kick directed to the head.

The importance of the research lies in identifying the relationship of the most important biokinematic variables that have an effective role in achieving the required accuracy and strength as well as the relationship of

the dynamic balance of the two men with the accuracy and strength of the crescent strike of the Taekwondo players.

Research problem:

Through the follow-up of the researchers to the local taekwondo championships, they noticed a decrease in the level of performance of the kicks and the offensive skills of the game, especially the crescent kick to the head, although previous studies have reached results that proved that the crescent kick is one of the most used kicks by taekwondo players as it is one of the quick kicks that can be carried out towards the body or head of the opponent.

And that there are still problems associated with lack of focus during training on biokinematic aspects that affect the good performance of kicks, as well as a sport directed to the lower extremities, Taekwondo emphasizes the stability of one leg through its movement patterns. This means that the stability of the lower limbs is vital for Taekwondo players, thus highlighting the importance of the dynamic balance of the lower limbs that the player needs to maintain his balance while performing kicks, especially to the head. The importance of the crescent kick to the head as it is the most recorded of the points prompted researchers to study it through the use of kinetic analysis techniques through technical scientific observation and the adoption of modern dynamic balance tests in order to identify the most important biokinematic variables that are associated with the accuracy and strength of the performance of the crescent kick to the head of the opponent as well as studying the characteristics of dynamic balance of the lower limbs and rapid kick techniques that enable the athlete to perform well during fights from both sides of the body.

Research objectives:

Recognize the values of a number of biokinematic variables of the crescent kick to the head for advanced taekwondo players.

Recognize the accuracy and strength test values of the crescent kick to the head for advanced taekwondo players.

Manufacture of a special instrument for measuring dynamic equilibrium.

Recognize the dynamic balance test values of advanced taekwondo players.

Identify the relationship of a number of biokinematic and dynamic balance variables with the accuracy and strength of the crescent kick to the head of advanced taekwondo players.

1-4 Hypothesis of Research

Researchers hypothesize a significant correlation between a number of biokinematic variables and dynamic equilibrium with the accuracy and strength of the crescent kick to the head of advanced taekwondo players.

RESEARCHED AREAS

- Human domain: Advanced Taekwondo players in Nineveh Governorate.
- Spatial scope: Volleyball court in Qaraqosh Sports Club.
- Temporal scope: For a period from 10/9/2024 to 5/11/2024.

Examination proceedings

3-1 Research Methodology

Researchers used the descriptive approach to suit the nature and objectives of the research|

The research community consisted of (24) Taekwondo players in Nineveh Governorate, while (7) players were selected to represent the research sample and by (29.17%) of the total research community for the purpose of applying the

main research experiment to them, and Table (1) shows the specifications of the research sample.

Table (1)

Shows the specifications of the research sample

Sr	Variables	Arithmetic Mean	Standard Deviation	Sig
1	Length _m	1,83	0.08	365
2	Leg Length/ m	1,06	0,03	467
3	Mass (kg)	75,67	11.29	980
4	Age (years)	21-39	1,98	198
5	Training age/ year	10 12	2,52	0,387

Researchers used scientific sources, tests, measurement, technical scientific observation, and biokinematic analysis as means of data collection.

3-3-1

Both (mass/kg, height/m, leg length/ m) were measured for the individuals of the research sample to indicate its specifications and normal distribution.

3-3-2

3-3-2-1 Dynamic Balance Test

The Balance Test (YBT) is a simple but reliable test used to measure dynamic balance. It was developed to standardize the modified Star Excursion test, improve its applicability and make it commercially available. Since then, it has become a very popular test due to its simplicity and reliability. (Kirthika et al, 2018,4)

The YBT requires the athlete to balance on one leg, and simultaneously reach, as far as possible, the other leg in three separate directions: anterior, posterolateral, and posteromedial. Therefore, this test measures the athlete's ability to stabilize, balance, and endure in different directions and has been supported as a way to assess dynamic balance. The benefits of YBT are that it takes less time to complete the test and has a standard protocol and high reliability. (Cordun & Roşu,2022,23,29)

Test Name: (YBT)Y Balance Test

The aim of the test: to measure the dynamic balance of the lower extremities.

Instruments used: Dynamic Balance Measurement Instrument (The researchers manufactured the instrument that is used in the YBT test and with the same specifications and measurements as approved.

Test Description: The YBT kit consists of a platform on which three plastic tubes with centimeter-defined markings have been attached, forming the anterior, posteromedial and posterolateral extension directions. The tubes were placed on the platform so that the angle between the posteromedial and posterolateral tubes was (90) degrees and the angle between the anterior extension tube and the other tubes was (135) degrees, Fig. (1).

The athlete arrives at the access points by pushing the boxes that slide on the tube. In the Lower Limb Balance Test application protocol, athletes are allowed to make three attempts on the balance platform.

Athletes are required to reach the furthest distance in (3) directions (anterior, posteromedial and posterolateral) with the other foot balancing on the right foot first, without crossing the red-marked foot on the balance foot on the podium (Fig. 2).

Participants were instructed not to place the foot above the tube and to place the plantar surface of the foot that touches the medial side of the slip block.

Recording the test: If the athlete gets help from the device, touches the ground with his feet or falls off the podium due to his loss of balance, the test is considered unsuccessful and he is asked to return to the starting position again. Athletes repeat the test (3) times and the maximum distance reached is recorded. The same test is repeated for the other lower limb. Athletes' lower limb balance scores are measured using access distance and limb length in each direction, touch distances should be recorded to the nearest 0.5 cm.

(Picot et al, 2021,286-287) (Cordun & Roşu,2022,28)

3-3-2-2 Crescent Kick to Head Test

Objective of the test: Measure the accuracy and strength of the crescent kick.

Tools used: Stool or training dummy, electronic headgear, electronic foot sensors, computer.

Test Description: The player has the right to use the leg with which he will perform the kicks.

Method of performance: The laboratory stands in front of the test instrument after selecting the man who will perform the kicks, and when given the start signal, the player begins to perform the crescent kick on the target within (10) seconds.

Registration: The score is calculated as follows:

- **Health points are calculated by registering points through the electronic device.**

- The force is calculated by registering the force through the electronic device.

3-3-2-3 Electronic Drip System for Offensive Kicks Tests

The accuracy and strength of the technical performance of the crescent kick to the head was tested using the electronic drip device in Taekwondo, which consists of an electronic head guard and electronic foot sensors. When the player performs the kick on the head guard, the electrical circuit is connected by touching the sensor inside the foot glove with the sensor inside the guard. The correct points are recorded by a wireless bus connected to the computer and then to the result display screen. The head guard is installed on the dummy so that the laboratory can perform the kick and record the points through the accuracy and strength of the kick carried out on the guard. Figure (3) shows the components of the electronic system used to :

- Record the force used by the player for correct kicks.
- Determine the time required to perform by scoring the correct points.
- Calculate only the correct kicks. (Al-Hafiz ,2022, 53-54)

4-2-3-3 System Components

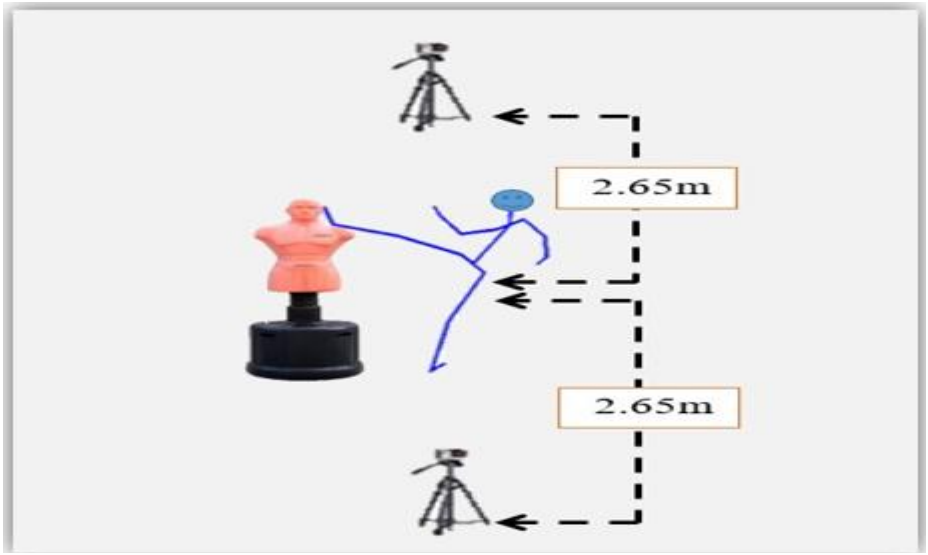
1- Head and chest protector containing point-shaped sensors in all permitted areas.

2- Foot and hand sensors: They contain sensors on the face, inside or bottom of the foot, andthe front of the fist.

3-The receiver and the system software: It connects the receiver to the computer, and the data is received wirelessly, and Figure (3) shows the components of the system. (Chan, 2013,11)

3.3.3 Technical scientific observation

In order to implement the scientific and technical observation, the (iphone14 pro max) at a speed of (120) images/ second, to film the players' performance of the crescent kick, as the first camera was placed on the right of the player who is kicking the right leg and at a distance of (2.65m) from the center of the movement performance, while the second camera was placed on the left of the player who is kicking the left leg and at a distance of (2.65m) from the center of the movement as well, and the height of the lenses of both the first and second cameras was (1.1m) off the surface of the ground, and the drawing scale with a length of (1m) was used, which was photographed in the center of motion horizontally and vertically before starting the experiment and Figure (4) shows the locations of the cameras.



3-4 Devices and tools used in the research

- **Electric vehicle length (25) m.**
- **Electronic Personal Scale**

- **Two (2) computers.**
- Two (2) digital cameras of the type (iphone14 pro max).
- **Electronic drip system consisting of (head protector, foot sensors, computer).**
- **Drawing scale.**
- **Measuring tape (Surv.)**
- **Camera holder (2).**
- **A post or training dummy to secure the head guard.**
- Adhesive tape with a width of (4) centimeters.

3-5 Exploratory experiment

A reconnaissance experiment was conducted on 14/9/2024 in the Taekwondo Hall at the Al-Hadba Youth and Sports Forum in Mosul in the presence of one of the players of Nineveh Governorate in Taekwondo in order to:

- Checkingthe lighting available on the site.
- Ensure the safety of the dummy to be used in carrying out the test.
- Ensure head guard sensors and two-leg sensors are working.
- Ensure that the electronic drip system is working.
- Locating cameras and their distance from the center of motion and the height of the camera lens.
- Determine the time required to perform the test.

3.6 Key Research Experience

The researchers conducted the main research experiment on Saturday, 21/9/2024 at 4:00 pm in the Taekwondo Hall at the Al-Hadba Youth and Sports Forum in Mosul on the research sample of (7), as all the necessary supplies and tools were prepared to conduct the experiment, and the players were given

enough time to warm up in order to reach the appropriate performance in the test. After explaining the method of performing the test to the research sample, a trial attempt was given to each player, and then the test was carried out by the players, where each player performs the largest number of kicks within (10) seconds and records the scores of each player in the test.

3.7 Identification of biokinematic variables

By analyzing the content of scientific sources and previous studies, the researchers identified the most important variables for the main stage of performing the crescent kick to the head, which starts from the standby position to the moment of touch in order to extract them during the process of biokinematic analysis of the crescent kick to the head. The following variables were selected:

- Horizontal Displacement (HO): The horizontal straight line that HO crosses from standby to the moment of touch.
- Vertical Displacement (VD): The vertical straight line that VD crosses from standby to the moment of touch.
- Resultant Displacement (NSG): The resultant displacement was extracted by applying the Pythagorean theorem.

Resultant of Displacement = (Horizontal Displacement) ^{2} + (Vertical Displacement) ^{2}

(Omar, & Abdulrahman,2011 ,28)

- Horizontal velocity (mth): The quotient of the horizontal displacement of (mth) divided by the time of its movement in the main stage.
- Vertical velocity (mth): Dividing the vertical displacement of mth by the time of its movement in the main stage.
- The sum of the velocity(mth): The sum of the displacement of (mth) divided by the time of its movement in the main stage.
- The angular velocity of the kicked leg: The quotient of the division of the angular displacement traveled by the kicked leg by the time of its movement in the main stage.
- Kicking leg circumferential speed:

circumferential velocity = angular velocity × radius÷ sector and its unit m/ s

(Omar, & Abdulrahman,2011 ,65)

- Radius of the kicked leg: The straight line from the point (M.S.) to the front of the kicked foot at the moment of touch.
- Time: The time of the man's kicking movement in the main stage from standby to the moment of touch.

3.8 Biokinetic analysis

After the performance of the crescent kick was filmed for the members of the research sample, the video was transferred to the computer, and then the best kick was selected for each player, which obtained the best accuracy and strength recorded through the electronic system, and the video was cut to obtain the required movement for each player to extract the measured search variables (offsets, angles, elevations, time) using the (Kinovea-0.9.5) program.

3.9 Statistical Methods

The Statistical Portfolio for Social Sciences (Spss) was used to process data to arrive at (arithmetic mean, standard deviation, Pearson correlation coefficient, independent samples (t) test, Shapiro-Wilk test value)

View and discuss the results.

4-1 Presentation and discussion of the results of the relationship of a number of biokinematic variables in the main stage with the accuracy index of the crescent kick to the head

[Table 2]

Shows the statistical parameters, correlation coefficient value r and error ratio (Sig) of the biokinematic variables in the main stage with accuracy index of the crescent kick to the head

Variables	Unit of measure	Arithmetic Mean	Standard Deviation	Value R	Sig
Accuracy Index	Degree of tilt	9.67	1.21		
Horizontal Offset (LDO)	Meter	0.16	0,02	0.991	0,000
Vertical Displacement (VD)	Meter	0.14	0.04	0.221	0.674
Resultant Displacement	Meter	0,23	0.03	.524*	0.285

(M.S.C.)					
Time:	Second	0.273	.018	-0,880	.021
Horizontal velocity (mth)	33m/s	0.60	0.10	959	002,
Vertical velocity (mth)	33m/s	0,59	0,15	508	.304
Velocity Resultant (M.S.C.)	33m/s	0,84	0,15	0,714	.304
Kicking Leg Angular Speed	± 500/s	372.	43.25	0,869	0,024
Kicking leg circumferential speed	33m/s	6.83	0.28	551	258
Radius of kicked leg	Meter	1.05	0.02	0,829	.041

Moral at Sig Ratio

From Table (2), it is clear that there is a significant correlation between the variables (horizontal displacement of MSC, time, horizontal velocity of MSC, angular velocity of the kicked leg, radius of the kicked leg) in the main stage with the accuracy index of the crescent kick to the head, as the error rate (Sig) is less than (0,05).

The researchers attribute the moral correlation between the horizontal displacement variable of MSC in the main stage and the accuracy index of the crescent strike to the head to the fact that the player, in his attempt to injure the opponent's head, works to approach the opponent with a distance that helps him touch the opponent's head by lifting the kicked leg as well as the movement of the body forward, thus increasing the horizontal displacement of the movement of MSC when the player tries to approach the opponent during the implementation of the crescent kick to the head to achieve accuracy in injuring the opponent's head.

(Mahmoud et al.,2013) confirm that "accuracy in Taekwondo plays a major role in turning the player's movement and effort into a tangible result, which is scoring points, as we see many players waste their efforts during the fight because the kick was not properly directed towards the protector, and that the good performance of Taekwondo without accuracy in scoring points or accurate movement and good technique in the fight will make this performance useless."

(Mahmoud et al.,2013, 413)

While the researchers attribute the significant correlation between the time variable in the main stage and the accuracy index of the crescent strike to the head to the fact that the player seeks to achieve the touch towards the opponent's head as quickly as possible and thus reduces the ability of the opponent to anticipate the kick and the difficulty of defense or avoid the player achieving the touch with the required accuracy.

(Al-Fadhli and Hussein ,2019) emphasize that "achieving high accuracy cannot achieve the goal of performance with the presence of a competitor and slow performance, and this applies to all kicks that require high accuracy with the appropriate speed of performance in order to achieve the goal of the motor duty of this kick. On this basis, accuracy can be associated with speed, resulting in the ideal performance of top-level players. "

(Al-Fadhli and Hussein,2019 ,201)

The researchers also attribute the significant correlation between the horizontal velocity of MSG in the main stage and the accuracy index of the crescent blow to the head to the increase in the horizontal displacement of MSG in the main stage and in a short time increases the horizontal velocity of MSG

and thus the speed of arrival of the kick towards the head of the competitor with high accuracy.

The maximum speed at the moment of impact is usually achieved at the expense of attack time, and the athlete needs the maximum speed at the moment of impact (faster attack) at the expense of less attack time. To gain points in sports competition, athletes must focus on reducing kick time and increasing average kick speed.

(Mailapalli et.al, 2015,147)

"**The kinetic speed is one of the characteristics of high level taekwondo players, and the successful kinetic speed during performance depends on the accuracy and selection of the correct time to perform kicks, and the results of players in taekwondo games depend on the speed of their performance of different kicks.**" **(Zahran, 2004, 182)**

While the researchers attribute the moral correlation between the angular velocity of the kicking man in the main stage and the accuracy index of the crescent strike to the head to the fact that the player moves the kicking man from the standby position to the moment of touching the head of the opponent is done with an arc movement similar to the crescent, thus the kicking man crosses an angular path and in a relatively short time increases the angular velocity, which in turn contributes to the speed of the kicking man's arrival at the opponent's head with the required accuracy.

"The rapid movement of body parts during performance enables the player to have maximum motor transfer between these parts." (Ueye, 1992,57)

The researchers also attribute the moral correlation between the radius variable of the kicker in the main stage and the accuracy index of the crescent strike to

the head to the fact that the player extends the knee joint as well as the ankle joint of the kicker before the moment of touching in an attempt to reach the head of the opponent and hit him with the accuracy required to score points, thus increasing the radius of the kicker to contribute to the speed of the arrival of the kicker to the goal.

(Zahran & ElSeoufy, 2010) points out that "because of the nature of the skill that requires the contraction of the thigh, knee and ankle joints to make good preparation for the kicking foot, which increases the kinetic energy to benefit from the reactions and then the full expansion of all the joints of the kicking foot with a smooth flagellar movement to reach the goal very quickly and accurately in control." (Zahran & ElSeoufy, 2010,923)

4-2 Presentation and discussion of the results of the relationship of a number of biokinematic variables in the main stage with the strength index of the crescent kick to the head

TABLE 3

Shows the statistical parameters, correlation coefficient value r and error ratio (Sig) of the biokinematic variables in phase with the strength index of the crescent kick to the head

Variables	Unit of measure	Arithmetic Mean	Standard Deviation	Value R	Sig
Strength Meter	Newton.	428	15.02		
Horizontal Offset (LDO)	Meter	0.16	0,02	0.884	0,019
Vertical Displacement (VD)	Meter	0.14	0.04	0.439	0.384
Resultant Displacement (M.S.C.)	Meter	0,23	0.03	0.678	0.139
Time:	Second	0.273	.018	-0,885	0,019
Horizontal velocity (mth)	33m/s	0.60	0.10	0,892	017
Vertical velocity (mth)	33m/s	0,59	0,15	761	.079

Velocity Resultant (M.S.C.)	33m/s	0,84	0,15	0,824	− 0.044
Kicking Leg Angular Speed	± 500/s	372.	43.25	0,822*	0,045
Kicking leg circumferential speed	33m/s	6.83	0.28	0,797	0,058
Radius of kicked leg	Meter	1.05	0.02	0,823	− 0.044

Moral at an error rate (**Sig**)≤ (0,05)

From Table (3), it is clear that there is a significant correlation between the variables (horizontal displacement of mth, time, horizontal velocity of mth, velocity outcome of mth, angular velocity of the kicked leg, radius of the kicked leg) in the main stage with the force index of the crescent kick to the head, as the error rate (Sig) was less than (0,05).

The researchers attribute the moral correlation between the horizontal displacement variable of the head to the fact that the player's movement towards the opponent to carry out the crescent kick to the head requires the movement of the entire body forward while lifting the kicked leg up to injure the opponent's head guard with the accuracy and strength required in order for the points to be recorded by the sensors in the head guard, which the law of the game determined the force required for its work, and thus the horizontal displacement of the head will increase as it moves forward to contribute to the transfer of force from the torso to the kicked leg.

This is consistent with his mention (Abdul Azim et al.,2020) that "the movement starts from the trunk and then to the thigh and then the leg and foot, and then to the opponent, and it is normal for the player to use the movement of the trunk as an auxiliary movement, in order to raise the level of performance or to increase the force used to accomplish the movement." (Abdelazim et al. ,2020 ,60)

(Al-Hiti, 2010) states that "obtaining the maximum force of the kick requires the player to use all the muscles of the leg from the hip to the foot to carry out the kick as quickly as possible." (Al-Hiti,2010 ,115)

While the researchers attribute the significant correlation between the variables (time, horizontal velocity of mth, velocity sum of mth) in the main stage

and the strength index of the crescent strike to the head to the fact that the movement of the torso forward as well as the lifting of the kicked leg up towards the head of the competitor results in a movement (mth) with a horizontal and vertical displacement resulting in a resultant displacement, and since the attack movement to carry out the crescent kick to the head takes place in a short time, as a result, both the horizontal velocity and the velocity sum of mth increases.

“Taekwondo's kicking tactics are to try to hit a specific spot in the opponent's body in the shortest possible time, so the ability to generate power is very important to achieve an effective attack,” (Wąsik & Shan, 2015). (Wąsik & Shan, 2015,116)

He asserts (Amin, 2014) "Kick performance in taekwondo is related to the biological limits of strength as it requires the athlete to perform the kick with maximum force and the shortest possible time in order to hit the opponent's shield and score points."

"Performance must be consistent, streamlined, and at high speed in order to ensure that the amount of movement is transferred correctly so that it moves from the torso, which is the largest mass in the body, to the kicked leg, represented by the hip, knee, and ankle joints, to perform the kick with greater force and less time." (Amin, 2014 ,47, 123)

The researchers *also* attribute the moral correlation between the two variables (the angular speed of the kicked man, the radius of the kicked man) in the main stage and the strength index of the crescent blow to the head to the fact that the player's transfer of the kicked man while trying to hit the head of the opponent player is done in an angular path and in a short time increases the angular speed of the kicked man as well as the player's extension of the kicked man from the knee joint and the extension of the ankle joint to reach the head of the opponent increases the rotation radius of the kicked man and thus increases

the angular speed and length of the kicked man's radius to achieve the arrival of the kicked man at the required speed to increase the kick force and achieve the points.

"Increasing angular velocity and linear velocity means increasing the rate of acceleration of the object or part of it so that there is no stop between the movements of the parts, but these parts must move so that they overlap, which leads to an increase in the productive force of the object or moving part." (Al-Fadhli and Hussein,2019 ,153)

(Mailapalli et al, 2015) point out that "the force of the kick is directly determined by the speed of the kicked foot, as it heads towards its goal. The degree of kicking leg extension and angular velocity should thus maximize the kicking leg's velocity. " (Mailapalli et al, 2015,145)

4-3 Presentation and discussion of the results of the dynamic equilibrium relationship with the accuracy and strength index of the crescent kick to the head

table (4)

Shows arithmetic averages, standard deviations, and differences in composite arrival distance for dynamic equilibrium testing

Variables	Unit of measure	Arithmetic Mean	Standard Deviation	Value o	Error ratio
Composite Arrival Distance (Right Leg)	Meter	0,74	0,05	116.	910
Composite Arrival Distance (Left Leg)	Meter	0,75	0.06		

From Table (4), it is clear that there are no statistically significant differences in the installed distance of arrival between the right and left men, as the calculated value of (t) was (0,116) with an error rate greater than (0.05).

Researchers attribute this to the fact that the taekwondo player uses both dominant and non-dominant legs to perform offensive kicks during fights.

(Zahran & ElSeoufy, 2010) states that "the sport of taekwondo relies on attacking both the right and left legs mainly, whether positioned on the ground or flying in the air."

(Zahran & ElSeoufy, 2010,926)

He adds (Aldhabi et al, 2024) "The nature of taekwondo requires a player to stand on one end for most of the kick time while using the other end to kick the opponent. However, most players prefer to use their limbs interchangeably to deceive their opponent. Thus both limbs may be exposed to higher levels of sensorimotor performance resulting in higher lower limb performance. (Aldhabi et al, 2024,152)

Table (5).

Shows correlation coefficient and error ratio (Sig) values for Dynamic Equilibrium Test Composite Arrival Distance with Strength and Accuracy Index for Crescent Blow to Head

Variables	Accuracy Index		Strength Meter	
	We know the value of r.	Sig	We know the value of r.	Sig
Composite Arrival Distance (Right Leg)	J911.	.011	0.866	.026
Composite Arrival Distance (Left Leg)	**956**	**0,003**	**837**	**038**

Moral at an error rate (**Sig**)≤ (0,05)

From Table (5), it is clear that there is a significant correlation between the variable of the compound arrival distance of both legs (right, left) with both accuracy and strength indicators of the crescent kick to the head. The

researchers attribute this to the fact that the implementation of kicks in Taekwondo is done from movement and by leaning on one leg while lifting the other leg to injure the head of the opposing player and therefore needs a good dynamic balance to maintain his center of gravity within the base of the fulcrum in order to implement the crescent kick with the accuracy and strength required to score points as well as not to fall and lose any point.

(Booysen et al, 2015) have proven the relationship between strength and dynamic balance using the Y-Balance test. The relationship between the strength of the lower limbs and balance may be due to the same neuropsychological structure responsible for controlling the position and strength of the lower limbs. (Rao & Kanika, 2024,96)

"At the time of kicking, the body position is based on only one leg, so good balance is required for athletes to be able to display good kicking techniques, and balance is necessary because it has an important relationship to the athlete's technical skills, whether in gaming or in self-defense sports."

(Fachrezzy et al, 2021,541)

as you transition from defending to attacking. This transition of the body should be rapid but dynamically balanced, as it provides a basis for lifting and lowering the kicking leg. A good balanced transition will increase the quality of the attack as well as increase the range of motion of the hip joint. Thus, the hip extensor muscles will be lengthened. This dynamic lengthening of the pre-muscles thus generates greater muscular forces based on muscle-length-tension relationships, thus increasing the effectiveness of the kick, i.e. increasing the kick force. (Wąsik & Shan, 2014,35)

Taekwondo sports are characterized by dynamic kicking techniques that require strength, speed, endurance, balance, flexibility and coordination, and the

taekwondo player needs dynamic stability on the supporting end to carry out fast and intermittent movements of the kicking party. (Son et al, 2018,405)

Conclusions and recommendations

5.5.1 CONCLUSIONS

Through the results, the researchers reached the following conclusions:

1- The variables (horizontal displacement of the KMT, time, horizontal velocity of the KMT, angular velocity of the kicked leg, radius of the kicked leg) in the main stage of the crescent kick to the head had an active role in achieving the maximum speed of the kick performance and obtaining the maximum kinetic transfer between these parts to reach the goal very quickly and accurately in control.
2- Variables (horizontal displacement of the KMT, time, horizontal velocity of the KMT, velocity sum of the KMT, angular velocity of the kicked leg, radius of the kicked leg) in the main phase of the crescent kick to the head effectively contributed to increasing the force used to accomplish the movement as well as generating the force required to injure the opponent's shield and score points.
3- Dynamic balance had the direct effect of providing a good balance base, as well as ensuring a well balanced transition between body parts that increases attack quality and the effectiveness of the crescent kick to the head with the accuracy and strength required to score points.

5.2 Recommendations

Through the conclusions, the researchers recommend the following:

1- Emphasis on performing the crescent kick to the head with high speed and maximum strength.

2- The need for attention by the trainers to the biokinematic variables that had an effective role in achieving the accuracy and strength of the crescent kick to the head.

3- Emphasize interest in developing a dynamic two-man balance of taekwondo players during the training modules.

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