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The relationship between pushing force and some bio kinematic variables, and the accuracy of the shooting skill while jumping forward in handball

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Abstract

The introduction of the research concluded that adhering to the results of kinetic analysis and implementing them practically in training leads to the improvement of human performance and constructing a philosophy specifically for developing kinematic aspects based on mechanical performance evaluation. This helps in identifying the areas of strength and weakness, and working on their development through achieving correct kinematic conditions, this type of shooting, which is shooting from a forward jump, requires a clear physical effort from the players during the competition. Mastering this type of shooting for long periods throughout the duration of the race is what tips the scale of success and victory in the competition through the number of well-executed goals that enter the goal of the opposing team in the matches. The problem of the research lies in the lack of information that definitively determines the most important bio kinematic variables that have the most impact on accuracy, which confuses the work of both the coach and the players. Consequently, reaching a correct performance that corresponds to and matches the optimal performance of this skill will raise the level of our players skilfully. The aim is to provide and equip all players and coaches with sufficient information that makes the shooting process, especially the skill of shooting from a forward jump and its biomechanical variables, within understanding, in order to reach the best achievements to keep pace with other teams, and this is what we all seek; therefore, the researchers considered the relationship between the push force and some bio kinematic variables in the skill of shooting from a forward jump in handball. The aim of the research is to identify the degree of push force in the steps of the shooting skill from a forward jump, the accuracy degree of the shooting skill from a forward jump, the differences in push force for the steps of shooting from a forward jump, and the relationship between the push force at the moment of rising, some bio kinematic variables, and the accuracy of shooting from a forward jump. The research hypothesized the existence of a significant correlation between the push force and some bio kinematic variables in the skill of shooting from a forward jump in handball. The descriptive method was used on a purposely selected sample of (10) players from Al-Karkh Sports Club. The researchers reached a number of conclusions, the most important of which was: the largest amount of push force was for the last step preceding the scoring. This confirms the increase in force and the smoothness of its transfer to the last step, then its transfer through the body parts, and then to the tool (the ball). The purpose of the high push is to reach the highest point for the purpose of shooting with power and accuracy, each variable of push force and the variables (contact time, flight time, height of the body's centre of mass, and foot strike) plays a major role in the accuracy of shooting skill from the forward jump. The researchers concluded with these recommendations: it's essential that coaches pay attention to the variables of push force, flight time, contact time, height of the body's centre of mass, and foot strike) due to their effective contribution to skill performance, along with explaining how to utilize them to achieve optimal performance

Keywords | **Push force - handball shooting skill**

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Introduction:

Kinematic analysis is a science that explores performance and seeks to study the components of athletic movement and its parts to reach the most precise details, striving for a better technique. Undoubtedly, mechanical laws and principles are of utmost importance in developing and improving athletic performance. They have entered directly and effectively to develop the various athletic achievements of games and contributed to providing different solutions to assist in obtaining advanced results.
Also, the use of the latest devices and software in kinematic analysis to enhance the level of skill performance and achieve the goal has resulted in a significant scientific renaissance. This has assisted researchers and coaches in reaching precise results that were previously difficult to obtain.
Handball is a beautiful and important team sport that has attracted the interest of athletes and is practiced by a large number of players of all age groups and both genders. The skill of shooting while jumping forward is important and difficult, given that the close distance tends to prompt the goalkeeper to come out in an attempt to narrow the shooting angle for the attacking player. On the other hand, the goalkeeper works on spreading his arms and legs, attempting to cover the largest possible area, which increases the difficulty in decision-making in the designated shooting area, given the difficulty of relying on observation to determine the biomechanical variables of performance, it is necessary to use advanced and modern devices such as the Arion Coach.

Through their observation of local tournaments, the researchers found that the lack of definitive information on the most crucial biomechanical variables, which significantly affect accuracy, can distract the efforts of both coaches and players, thus, reaching a correct performance that aligns and progresses with the optimal execution of this skill can raise the level of our athletes' proficiency. It's crucial to supply all players and coaches with enough information that could enhance the shooting process, especially the skill of forward jump shooting, and its biomechanical variables within their understanding. The aim is to reach the best achievements to keep pace with other teams, and this is what we all seek. Therefore, the researchers sought to find a relationship between the push of force and some biomechanical variables in the skill of shooting from a forward jump in handball.

The research aims to:

- Identify the degree of push force in the steps of shooting skill from a forward jump.
- Identify the degree of accuracy of the shooting skill from a forward jump.
- Identify the differences in push force in the steps of the shooting skill from a forward jump.
- Determine the relationship between the push force at the moment of rising and some biomechanical variables, and the accuracy of shooting from a forward jump.

Research Hypothesis:

- There exists a significant correlation between the push force and some biomechanical variables in the skill of forward jumping shot in handball.

1.Human field: Players from Al-Karkh Sports Club (Premier League clubs).
2.Temporal domain: From 4/5/2022 to 8/9/2022.
3.Spatial domain: The indoor hall of Wissam Al-Majd Club.

Pushing force: is a measure of the impact of force on the body over a specific period of time (10).

Method and Procedures:

The researchers utilized a descriptive method with a survey approach and correlational

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relationships. The research population consisted of players from Al-Karkh Sports Club, with a total of 12 players. The research sample was intentionally selected and comprised 10 players, representing 83.33% of the research population. The table below illustrates the homogeneity of the sample individuals.

Table (1)
It shows the homogeneity of the sample in terms of length, weight, age, and training age

The data / The Variables	Arithmetic mean	Standard deviation	The Median	skewness coefficient
Length (meters)	181	7.28	183	0.2
Mass (kg)	82.1	8.55	82	0.4
Age (years)	22.1	2.84	22	-0.3
Training Age	9.8	3.07	9	0.7

The results demonstrated sample homogeneity through a skewness coefficient ranging between (1+). This indicates a balanced distribution and homogeneity in the research sample.

Arabic and foreign references, the International Information Network (Internet), Arion Coach device, Kinovea analysis software, laptop computer, Video camera - 1 piece of Sony Digital, mobile phone (poco x3 GT), data collection form, assistant work team, accuracy squares (50*50) - 2 pieces, handballs - 8 pieces, length measuring tape, whistle 1-piece, adhesive tape with a width of 5 cm.

Field Research Procedures:
Shooting accuracy test from forward jumping (4).

Exploratory experience:
The researchers conducted the exploratory experiment on Wednesday 4/5/2022, at exactly 8:00 PM. They selected three players from Al-Karkh Sports Club. The experiment took place in the indoor hall of the "Wissam Al-Majd Club."

The Arion Coach (17)

It is one of the recently manufactured kinematic analysis devices in the sports field. It consists of two ultra-thin smart insoles, which provide all the information about each step and performance performed by the athlete. This device is a practical solution for dynamic analysis of pressures and forces that occur in the foot areas, as shown in Figure (1).

Figure (1) illustrates the Arion Coach device

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The researchers relied on the Arion Coach device to calculate some of the biomechanical variables, as illustrated below:

1- Push force: It is a measure of the rate of force per unit time.

2- Contact Time: It refers to the duration for which the foot remains in contact with the ground during each step. It can be an indicator of your progress.

3- Flight Time at the Moment of Shooting: It refers to the amount of time both feet are off the ground.

4- Foot Strike: It refers to which part of your foot first makes contact with the ground: your heel, mid foot, or forefoot. It is measured as a percentage.

As for the variable of the body mass center's height at the moment of shooting, the researchers used the (Kinovea) motion analysis program to calculate it:

1- Body mass center height at the moment of shooting: It is the vertical distance between the body's mass center and the ground.

2- The angle of inclination of the torso at the moment of Shooting: It is the angle between the torso line (from the shoulder joint point to the hip joint point) and the horizontal line passing through the hip joint point.

3- The angle of the knee joint at the moment of shooting: The angle was calculated by measuring the angle between the imaginary line of the thigh and the leg passing through the knee.

Main Experiment:

The researchers conducted the main experiment on Tuesday 7/9/2022, on (10) players from Al-Karkh Sports Club in the hall of Wissam Al-Majd Club. A video camera was used at a speed of (120) (frames per second), placed at a height of (1.25) meters and a distance of (2) meters from the middle of the test execution field. The ultra-thin smart insoles were worn inside the player's shoes, and its dedicated program was run on a mobile device to measure the research variables under study.

Results:

Table (2)

shows the arithmetic means, standard deviations, median, and skewness coefficient for push force, some kinematic variables, and accuracy of shooting skill during a forward jump

Biomechanical variables	Unit of measurement	Arithmetic mean	Standard deviation	The Median	Skewness coefficient
Push force	Newton	484.5	47.31	491	0.56-
Contact Time	Second	1.29	0.78	1.31	0.40-
Flight Time	Second	35.9	6.50	38	1.78
Foot Strike	%	60.6	12.71	62.5	0.76
Angle of inclination of the torso	Degree	72.5	4.51	73	-0.33
Knee Joint Angle	Degree	155.83	3.82	156	-0.13
Body mass center height	Meter	1.35	0.79	1.32	0.9
Shooting accuracy from jumping Forward	Degree	24.2	2.74	25	0.21

Table (3)

shows the analysis of variance and LSD for the variable of push force for the three steps in the skill of shooting from jumping forward.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig
Between-	28221.067	2	14110.533	6.187	0.06

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groups					
within-group	61576.300	27	2280.604		
Total	89797.367	29			

Multiple comparisons Dependent Variable LSD

95% confidence interval		Sig.	Std.Error	Mean Difference (I-J)	Steps (I) Steps (J)	
Maximum Limit	Minimum Limit					
-1.18-	-88.82-	.045	21.357	-45.000-	2	1
-30.78-	-118.42-	.002	21.357	-74.600-	3	
88.82	1.18	.045	21.357	45.000	1	2
14.22	-73.42-	.177	21.357	-29.600-	3	3
118.42	30.78	.002	21.357	74.600	1	
73.42	-14.22-	.177	21.357	29.600	2	

*** The mean difference is significant at the 0.05 level**

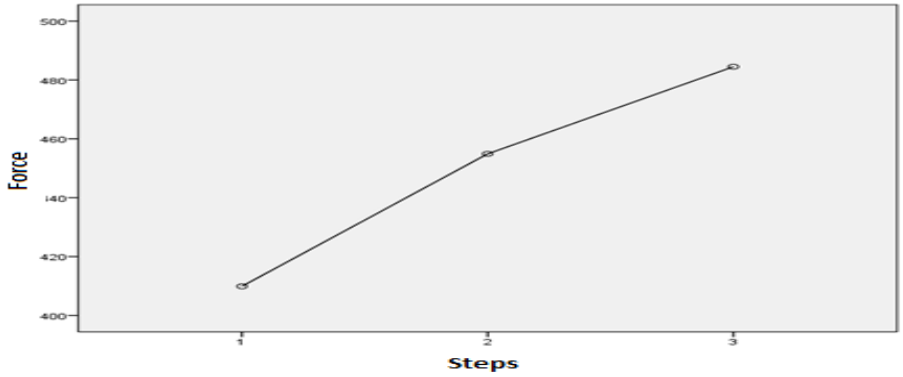

Table (4)

shows the correlation between the push force at the moment of rising and some biomechanical variables and the accuracy of shooting skill from jumping forward.

Variables	Correlation R coefficient	Sig	Significance
Contact Time	**0.60**	**0.026**	**Significant**
Flight Time	**0.59**	**0.047**	**Significant**
Body Mass Center Height	**0.62**	**0.031**	**Significant**
Angle of torso inclination at the Time of Shooting	**0.57**	**0.042**	**Significant**
Knee Joint Angle at the Time of Shooting	**0.61**	**0.040**	**Significant**
Foot Strike	**0.55**	**0.027**	**Significant**
Shooting Accuracy from Jumping Forward	**0.63**	**0.033**	**Significant**

The value of (R) under 2-10 degrees of freedom and a significance level of 0.05

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Discussion:

Through Table (3), it is shown that there is a significant difference in the variable of push force in the three steps, in favor of the third step in the skill of shooting while jumping forward. This is what Abdul-Jabbar Shaneen confirmed, stating that "the push force phase begins after the force reaches its maximum and the speed reaches zero at the moment of vertical stop at the maximum inclination of the knee joint" (2).

As observed from Table (4), there is a positive correlation between the push force and some of the bio kinematic variables (contact time, flight time, body mass center height, foot strike, knee joint angle, and Angle of inclination of the torso) that were studied for the skill of shooting while jumping forward in the individuals of the research sample.

The researchers believe, based on the established values, that there is a significant correlation between the push force and both the flight time variable and the body center of mass height variable for the skill of shooting while jumping forward, the researchers attribute that the longer the flight time is often considered as an increase in the height of the body's center of mass when shooting while jumping forward. This was confirmed by Ahmed Sabeeh that (an increase in legs strength leads to a player's flight speed, which in turn increases the player's height at the moment of striking the ball, thus increasing the time the athlete remains in the air) (1). The longer the player remains in the air, the greater their opportunity to control the ball and shoot at the area that the player sees best. Therefore, the task of pushing is to ensure a good flight for the player's center of gravity. Some researchers have indicated that "the fluidity of motor performance, characterized by the continuity of the motor tactical path, which expresses the motor compatibility" (16).

We also note a significant correlation between the push force and contact time for the skill of shooting from a forward jump. The researchers attribute this to the fact that the propulsion force depends on both the push force and the push time according to its mechanical law, and that time plays a fundamental role in measuring (push force).

There is a correlation between the variable of push force and the angle of the torso inclination at the moment of shooting the ball. The researchers attribute this correlation to the player's need to slightly lean their torso backwards, aligning with the knee joint's angle to maintain mechanical balance, which enhances the shooting skill with high accuracy, and this aligns with what was stated by (Mardan Hussein and others, 1999), "leaning the torso backwards significantly contributes to the value of the force." This indicates that the inclination of the torso at the moment of shooting plays a crucial role in establishing kinetic balance (8).

The researchers also pointed out that "the leg and torso are responsible for the majority of the push that is exerted on the ground during the rise" (9).

There is also a correlation between the push force and the knee joint angle. The researchers attribute this to the expansion of the knee angle during shooting, which provides the necessary mechanical benefit for the player. This has been confirmed by (Al-Sumaidaie Luay, 1987), because the player's body will be in the best mechanical position for the purpose of achieving the lowest torque and the push force from the striking leg, which in turn is transmitted to the ball (6).

The researchers also pointed out that "the movement of the knee and hip joint between flexion and extension is considered one of the mechanical variables that affect the level of performance" (14).

From the same table, we notice a significant correlation between the push force and the foot strike in the skill of shooting from jumping forward. The researchers attribute this to the fact that most players tend to rise and push upwards, that is, on the front of the foot, and the figure below illustrates this.

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Figure (2) illustrates the foot strike

We also observe a correlation between the push force and the accuracy of shooting from jumping forward. The researchers attribute this to the accuracy of shooting which shows the player's good level of shooting, in addition to achieving the training requirements for the skill. This was confirmed by Al-Ghrairy, "there is a correlation between strength and accuracy that has proven its vitality and relies heavily on large gains. Accuracy is one of the important and necessary components in handball. If we say that this component is strongly related to achieving victory, there is a high percentage of shots that fail to hit the target, and the reason is the lack of mastering shooting and the player's focus on strength alone, neglecting the element of accuracy" (5).

Therefore, we conclude that "the correct behavior to implement tactical sentences during performance acts as a motivator towards performance, and thus achieving the goal, which is the accuracy of shooting" (7). Similarly, it is "an interconnected series and the power generated from one part to another largely depends on good and correct timing" (3).

This is what Diyar Muhammed pointed out to "the importance of analysis for the purpose of raising and improving the level of sports performance" (12).

Similarly, some studies have confirmed the "importance of achieving appropriate actual pathways for body parts during the performance of this activity" (13).

The researchers pointed out that "accuracy is the result of other variables; the more the kinetic path is in the right direction, the higher the accuracy" (15).

Thus, "the use of the best methods and means to develop this activity optimally will reflect its effectiveness on the performance" (11).

Conclusions:

Through the discussion of the results, the researchers reached the most important conclusions:

1- The largest amount of the pushing force was for the final step that precedes the scoring, confirming the increase in force and the fluidity of its transfer to the last step, and then its transfer through the body parts, and then to the tool (the ball). This is because the push from a high push is in order for the body to reach the highest point for the purpose of shooting powerfully and accurately.

2- The increase in push force positively affected the height of the body's center of mass as well as flight time.

3- Each variable of pushing force and variables (contact time, flight time, height of body's center of mass, and foot strike) play a significant role in the accuracy of the shooting skill from jumping forward.

The researchers recommended:

1- The necessity for coaches to pay attention to the variables of pushing force, flight time, contact time, the height of the body's center of mass, and foot strike, due to their effective contribution to the performance of the skill, along with an explanation of how to utilize them to achieve better performance.

2- The necessity of conducting studies and research that include other mechanical variables for handball players.

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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 (March /2023)

Author's contributions:
All contributions of this study were done by the researchers (Z.S. and I.K.) who get the idea and work on writing and concluding and made the whole procedures also with number of experts, Intisar Aldouri who did and collect Statistics, Huda Shamil in revision, Inaam Ghalib in translating, Ahmed Rajab in proofreading

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علاقة دفع القوة ببعض المتغيرات البايوكينماتيكية ودقة مهارة التصويب من القفز اماما بكرة اليد

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3 جامعة الزقازيق / كلية التربية الرياضية – بنين – مصر

مستخلص البحث

تلخصـت مقدمة البحث بأن إتباع نتائج التحليل الحركي وتطبيقها بشكل عملي في التدريب يؤدي إلى تحسين الأداء البشري وبناء فلسفة خاصة بتطوير النواحي الكينماتيكية قائمه على تقييم الأداء ميكانيكا، مما يساعد في التعرف على نواحي القوة والضعف والعمل على تطويرها عن طريق تحقيق الشروط الكينماتيكية السليمة، هذا النوع من التصويب وهو التصويب من القفز اماما يتطلب جهد بدني واضح من قبل اللاعبين اثناء المنافسة وان إتقان هذا النوع من التصويب لفترات طويلة على طول فترة السباق هو الذي يرجح كفة النجاح والفوز في المنافسة من خلال عدد الأهداف المتقنة التي تدخل مرمى الفريق المنافس في المباريات. تكمن مشكلة البحث ان عدم توفر المعلومات التي تحدد بشكل قاطع اهم المتغيرات البايوكينماتيكية التي تكون الأكثر تأثيرا على الدقة مما يشتت عمل المدرب واللاعبين على حدا سواء وبالتالي الوصول الى أداء صحيح يوافق ويساير الأداء الأمثل لهذه المهارة مما يرفع من مستوى لاعبينا من الناحية المهارية والعمل على توفير وتزويد جميع اللاعبين والمدربين بالمعلومات الكافية التي تجعل من عملية التصويب وخاصة مهارة التصويب من القفز أماما ومتغيراتهما البيوميكانيكية ضمن إدراكهم بغية الوصول إلى أفضل الإنجازات لمواكبة الفرق الأخرى وهذا ما نسعى إليه جميعاً ، لذلك أرتأت الباحثتان الى علاقة دفع القوة ببعض المتغيرات البايوكينماتيكية في مهارة التصويب من القفز اماما بكرة اليد. وهدف البحث التعرف على درجة دفع القوة لخطوات مهارة التصويب من القفز اماماودرجة دقة مهارة التصويب من القفز اماما،والفروق في دفع القوة لخطوات مهارة التصويب من القفز اماما والعلاقة بين دفع القوة لحظة النهوض وبعض المتغيرات البايوكينماتيكية ودقة التصويب من القفز اماما. وفرض البحث وجود علاقة ارتباط معنوية بين قوة الدفع وبعض المتغيرات البايوكينماتيكية في مهارة التصويب من القفز اماما بكرة اليد. وتم استخدام المنهج الوصفي على عينة اختيرت بالطريقة العمدية قوامها (10) لاعبين نادي الكرخ الرياضي .وتوصلت الباحثتان الى عدد من الاستنتاجات كانت أهمها :ان أكبر مقدار لقوة الدفع كان للخطوة الأخيرة التي تسبق التهديف وهذا يؤكد على تزايد القوة وانسيابية انتقالها الى اخر خطوة ومن ثم انتقالها عبر أجزاء الجسم ومن ثم الأداة (الكرة) لان الهدف من الدفع عاليا هو من اجل وصول الجسم لأعلى نقطة لغرض التصويب بقوة ودقة ، ان لكل متغير دفع القوة ومتغيرات (زمن التماس وزمن الطيران وارتفاع مركز كتلة الجسم وضربة القدم) دور كبير في دقة مهارة التصويب من القفز اماما . وخرجت الباحثتان بهذه التوصيات ضرورة اهتمام المدربين بمتغير دفع القوة ومتغير زمن الطيران وزمن التماس وارتفاع مركز كتلة الجسم وضربة القدم لمساهمتة الفعالة في اداء المهارة مع بيان كيفية استثمارها في تحقيق الاداء الأفضل.

الكلمات المفتاحية | **دفع القوة ، مهارة التصويب بكرة اليد**