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The kinematic analysis of the straight punch in two ways for amateur boxing players in Jordan

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ABSTRACT

This study aimed to identify some kinematic variables (distance between the feet, arm movement, punch speed, punch time, punch distance, ankle angle, knee angle, elbow angle, shoulder angle, pelvis angle) for the straight punch between two methods. The first method: performing a straight punch with the right hand towards the target without changing the distance between the feet and being on a straight line. The second method: performing a straight punch with the right hand towards the target without changing the distance between the feet, and the left foot is ahead of the right foot. A total of 8 amateur boxers in Jordan who were photographed using an iPhone camera at a frequency of 60 frames per second, participated in this study. The researchers downloaded videos on a computer (LAPTOP), which contains the Kinovea software (Kinovea. Setup.0.8.15.), and determined the best attempts for each player by watching the videos. Then, the researchers analyzed the attempts through the kinetic analysis program (Kinovea. Setup.0.8.15.) and extracted the study variables. The shorter the muscle contraction time of the straight punch, the greater the kinetic momentum and speed of the punch in both styles, and the greater the knee angle, the greater the punch and speed of the punch in both styles. Also, momentum and punch speed were better in the second method. We recommend a climatic and other clinical study of the straight stroke and to use the second method in the straight punch.

KEYWORDS

Kinematic Analysis; Boxing; The Straight Punch

1. INTRODUCTION

Boxing is one of the games that need continuous training on a lot of punches that are important in the fight, and among these punches is the straight punch, which is one of the necessary punches for every boxer because of its great importance in winning, especially if the boxer can practice it correctly. So, the premise is that the boxer must have physical measurements that qualify him to perform this task successfully. Therefore, identifying the physical measurements that contribute to the performance of the straight punch is a necessary requirement. Kinetic analysis is an important branch of biomechanics, and it is the basis on which this science is based and from which it derives its raw data. The basic principle for those interested in biomechanics is to be familiar with the rules of kinetic analysis and see them in some detail in order to know the sources of information and how to interpret the results.

Kinetic analysis is a science that depends mainly on the use of laws and foundations used in biomechanics for the purpose of studying movement and analyzing it anatomically and mechanically. A key to defining the behavior of human movement or its path, that is, the process of dividing the whole into parts in order to study the nature of those parts and the relationship between them by knowing the minutes of the movement path. The study of biomechanics in physical education, in particular the game of boxing, which is to study the causes of the occurrence of movement during punching by providing the most appropriate kinetic solutions using the kinetic analysis, which constitutes the basic and scientific principles to guide the sports coach in the various offensive punches. It is related to the nervous and muscular system in the first place, and therefore strengths and weaknesses can be revealed, and there is no doubt that straight punches require attention to these aspects.

The aim of this study is to identify some kinematic variables (distance between the feet, arm movement, punch speed, punch time, punch distance, ankle angle, knee angle, elbow angle, shoulder angle, pelvis angle) for the straight punch between two methods:

- The first method: performing a straight punch with the right hand towards the target without changing the distance between the feet and being on a straight line.

- The second method: performing a straight punch with the right hand towards the target without changing the distance between the feet, and the left foot is ahead of the right foot.

1.1. Research Questions

1. Is there a statistically significant relationship at the level ($\alpha \leq 0.05$) in some kinematic variables (distance between the feet, movement amount of an arm, punch speed, punch time, punch distance, ankle angle, knee angle, elbow angle, shoulder angle, pelvis angle) for the straight punch in the first style?
2. Is there a statistically significant relationship at ($\alpha \leq 0.05$) for some kinematic variables (distance between the feet, movement amount of an arm, punch speed, punch time, punch distance, ankle angle, knee angle, elbow angle, shoulder angle, pelvis angle) for the punch straight line in the second method?
3. Is there a statistically significant relationship at the level ($\alpha \leq 0.05$) of the relationship of the study variables to the speed and amount of punch movement in the first method?
4. Is there a statistically significant relationship at the level ($\alpha \leq 0.05$) of the relationship of the study variables to the speed and amount of punch movement in the second method?
5. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) differences in the study variables according to the straight blow method?

2. METHODS

2.1. Participants

8 amateur boxers in Jordan who were photographed using an iPhone camera at a frequency of 60 frames per second, participated in this study. The average lengths of the players in the research sample amounted to 1.77 meters, the average length of the arm was 66.75 cm, and the average masses of the research sample members reached 74.50 kg. As for the average age, it reached 24.00 years (Table 1).

Table 1. Participant Characteristics

Player	Height/m	Arm's Length/cm	Mass/kg	Age/Year
1	1.78	68	74	22
2	1.73	65	67	24
3	1.77	67	77	23
4	1.79	69	84	27
5	1.77	68	70	23
6	1.80	69	79	26
7	1.74	63	70	24

8	1.76	65	75	23
Average	**1.77**	**66.75**	**74.50**	**24.00**
Standard Deviation	**0.02**	**2.11**	**5.34**	**1.63**

2.2. Procedures

The researcher downloaded videos on a computer (LAPTOP), which contains the Kinovea software (Kinovea. Setup.0.8.15.), and determined the best attempts for each player by watching the videos. Then, the researcher analyzed the attempts through the kinetic analysis program (Kinovea. Setup.0.8.15.) and extracted the study variables.

3. RESULTS AND DISCUSSION

The following table (Table 2), shows the results of the relationship of some kinematic variables with the speed of the straight punch implemented in the first method. These relationships with the punch speed variable are not statistically significant because the values of the calculated significance level shown in the last column of the table were greater than 0.05.

Table 2. The relationship of some kinematic variables to the speed of the straight punch implemented in the first method

Kinematic variables	Relationship value	Indication level	Results
Shoulder angle	0.050	0.855	Nonfunctional
Pelvic angle	-0.470	0.067	Nonfunctional
Knee angle	0.350	0.184	Nonfunctional
Ankle angle	-0.205	0.446	Nonfunctional
Distance	0.579	0.019 *	Positive function
Punch Time	-0.689	0.003 *	Negative function
Kinetic arm quantity	0.482	0.059	Nonfunctional
Distance between the feet	-0.559	0.024 *	Negative function
Shoulder angular velocity	0.145	0.593	Nonfunctional
Elbow angular velocity	0.612	0.012 *	Positive function
Pelvic angular velocity	0.566	0.022 *	Positive function
Knee angular velocity	-0.323	0.222	Nonfunctional
Ankle angular velocity	-0.183	0.498	Nonfunctional

The researchers attribute this result to the fact that the kinetic range of the body joint angle is less due to the player's stopping and thus affects the speed of the punch negatively.

Statistically significant relationships of an inverse nature were represented by the punch time variable and the distance between the feet variable. The negative sign indicates that the lower the

value of each of the two variables, the higher the punch speed and vice versa. The researchers attribute that the convergence between the feet gives the required tendency for the stump on the vertical axis for the purpose of achieving a good and appropriate motor field, which leads to the stump gaining appropriate momentum and thus affects a positive effect in time and thus in the speed of the punch. As for the punch time, there is a strong relationship, the less the time, the higher the speed.

Statistically significant relationships of a direct nature were represented by the distance variable, the elbow angular velocity variable, and the pelvis angular velocity, where the positive sign indicates that the less each of these variables increases, the speed of the punch increases and vice versa. The researchers attribute this result to the fact that the lower the distance, the greater the speed, and the sequence of movement from bottom to top helped increase the angular velocity of the pelvic joint and the angular velocity of the elbow joint, and this positively affected the speed of the punch.

Table 3 shows the results of the relationship of some kinematic variables to the momentum of the straight striking arm implemented in the first method.

Table 3. Relationship of some kinematic variables to arm momentum during the execution of the straight punch in the first method

Kinematic variables	**Relationship value**	**Indication level**	**Results**
Shoulder angle	0.061	0.821	Nonfunctional
Pelvic angle	-0.566	0.022*	Negative function
Knee angle	0.740	0.001*	Positive function
Ankle angle	-0.344	0.192	Nonfunctional
Distance	-0.157	0.562	Nonfunctional
Punch time	-0.843	0.000*	Negative function
Punch speed	0.482	0.059	Nonfunctional
Distance between the feet	-0.700	0.003*	Positive function
Shoulder angular velocity	0.667	0.005*	Positive function
Elbow angular velocity	0.707	0.002*	Positive function
Pelvic angular velocity	0.643	0.007*	Positive function
Knee angular velocity	0.410	0.115	Nonfunctional
Ankle angular velocity	-0.337	0.201	Nonfunctional

Non-statistically significant relationships were found in Table 3 (the relationship of shoulder angle, ankle angle, distance, punch speed, knee angular velocity, and ankle angular velocity). These relationships with the arm momentum variable were not statistically significant because the values of the calculated significance level shown in the last column of the table were greater than 0.05. The

researchers attribute this result to that the sequential motor transmission is not coherent from the bottom of the foot to the striking hand, which negatively affected the motor momentum of the arm. Bingul, B. (2018) also disagreed with Tong-lam, R. (2017).

Statistically significant relationships of an inverse nature were represented by the variable pelvic angle, punch time, and distance between the feet. The negative sign indicates that the lower the value of each of the two variables, the faster the punch speed increases and vice versa. The researcher attributes that the convergence between the feet gives the required tendency for the stump on the vertical axis for the purpose of achieving a good and appropriate motor field, which leads to the stump gaining an appropriate momentum and thus having a positive effect in time and this gives a greater kinetic momentum for the arm.

Statistically significant relationships of a direct nature were represented by the variable knee angle, shoulder angular velocity, elbow angular velocity, and pelvis angular velocity, where the positive sign indicates that the more you decrease, the more each of these variables increases, the momentum of the striking arm increases and vice versa. The researchers attribute this result that the bends in the mentioned angle positively affected the angular acceleration in these angles, which leads to a greater amount of momentum.

Now, Table 4 shows the results of the relationship of some kinematic variables with the speed of the straight punch implemented in the second method.

Table 4. The relationship of some kinematic variables to the speed of the straight punch implemented in the second method

Kinematic variables	**Relationship value**	**Indication level**	**Results**
Shoulder angle	-0.333	0.207	Nonfunctional
Pelvic angle	-0.500	0.049*	Positive function
Knee angle	0.442	0.087	Nonfunctional
Ankle angle	-0.072	0.791	Nonfunctional
Distance	0.204	0.449	Nonfunctional
Punch time	-0.723	0.001*	Negative function
Kinetic arm quantity	0.905	0.000*	Positive function
Distance between the feet	-0.803	0.000*	Negative function
Shoulder angular velocity	0.333	0.207	Nonfunctional
Elbow angular velocity	0.623	0.010	Positive function
Pelvic angular velocity	0.491	0.053	Nonfunctional
Knee angular velocity	0.771	0.000*	Positive function
Ankle angular velocity	0.156	0.565	Nonfunctional

These relationships with the punch speed variable were not statistically significant because the values of the calculated significance level shown in the last column of the table were greater than 0.05. The researchers attribute this result that the bends that occur in the aforementioned angle negatively affected the angular acceleration at these angles, which negatively affects the speed of the punch.

Statistically significant relationships of an inverse nature were represented by the pelvic angle variable, punch time, and the distance between the feet variable. The negative sign indicates that the lower the value of each of the two variables, the higher the punch speed and vice versa. The researchers attribute that the convergence between the feet gives the required tendency for the stump on the vertical axis for the purpose of achieving a good and appropriate kinetic field, which leads to the stump gaining an appropriate momentum and thus affects a positive effect in time and also in the speed of the punch, according to Newton's third law, which states (for every action there is an equal reaction to it in magnitude and opposite in direction). The lower the angle of the pelvis, the closer the center of gravity is to the ground, and thus the velocity in this case is greater.

Statistically significant relationships of a direct nature, and these relationships were represented by the pelvic angle variable, the kinetic momentum variable of the striking arm, the distance, the elbow angular velocity variable, and the knee angular velocity, where the positive sign indicates that the less each of these variables increases, the speed of the punch increases and vice versa. The researchers attribute the kinematic field of the pelvis, the larger the angle, the greater the greater the distance traveled by the pelvis, and making the body mass move with a greater range, so the speed increases.

Next, Table 5 shows the results of the relationship of some kinematic variables to the momentum of the straight striking arm implemented in the second method. These relationships with the arm momentum variable were not statistically significant because the values of the calculated significance level shown in the last column of the table were greater than 0.05. The researchers attribute this result that the bends in the mentioned angle have a negative impact on the angular acceleration at these angles, which leads to less momentum for an arm. As for the result of the distance variable due to the range of motion of the body was less than what negatively affected the arm.

Statistically significant relationships of an inverse nature were represented by the variable shoulder angle, punch time, and distance between the feet. The negative sign indicates that the lower

the value of each of the two variables, the faster the punch speed increases and vice versa. The researchers attribute that the convergence between the feet gives the required tendency for the stump on the vertical axis for the purpose of achieving a good and appropriate motor field, which leads to the stump gaining an appropriate momentum and thus having a positive effect in time and also on the motor momentum.

Statistically significant relationships of a direct nature, and these relationships were represented by the variable knee angle, punch speed, pelvis angular velocity, knee angular velocity, and ankle angular velocity, where the positive sign indicates that the more you decrease, the more each of these variables increases, the momentum of the striking arm increases and vice versa. The researchers attribute this result when the punch is executed to the fact that the torque in the aforementioned angle becomes greater than the punch gains more momentum and speed.

Table 5. Relationship of some kinematic variables to the momentum of the arm during the execution of the straight punch in the second method

Kinematic variables	Relationship value	Indication level	Results
Shoulder angle	-0.576	0.020*	Negative function
Pelvic angle	-0.308	0.246	Nonfunctional
Knee angle	0.498	0.050*	Positive function
Ankle angle	0.046	0.866	Nonfunctional
Distance	0.196	0.487	Nonfunctional
Punch time	-0.639	0.008*	Negative function
Punch speed	0.944	0.000*	Positive function
Distance between the feet	-0.793	0.000*	Negative function
Shoulder angular velocity	0.223	0.406	Nonfunctional
Elbow angular velocity	0.374	0.142	Nonfunctional
Pelvic angular velocity	0.578	0.019*	Positive function
Knee angular velocity	0.646	0.007*	Positive function
Ankle angular velocity	0.224	0.405	Positive function

Table 6 shows the results of the t-test for differences in some kinematic variables during the execution of the punch.

Table 6. T-test results for the differences in some kinematic variables during the execution of the straight punch between the first method and the second method

Kinematic variables	First Style		Second style		T value	Indication level
	SMA	Standard deviation	SMA	Standard deviation		
Shoulder angle	100.25	3.30	124.63	5.14	15.63	0.000*
Pelvic angle	165.50	5.63	188.63	11.35	7.53	0.000*

Knee angle	181.25	4.37	189.13	1.67	8.05	0.000*
Ankle angle	93.13	2.03	117.00	6.73	15.55	0.000*
Distance	1.41	0.05	1.78	0.08	15.32	0.000*
Punch time	0.81	0.04	0.70	0.04	10.57	0.000*
Punch speed	1.74	0.08	2.55	0.13	22.72	0.000*
Arm momentum	3.68	0.32	5.41	0.65	17.05	0.000*
Distance between the feet	34.50	2.19	72.75	2.41	46.99	0.000*
Shoulder angular velocity	92.55	5.02	145.88	19.32	10.24	0.000*
Elbow angular velocity	160.58	6.11	179.38	8.62	8.35	0.000*
Pelvic angular velocity	18.03	7.43	18.75	7.09	0.28	0.783
Knee angular velocity	4.33	4.07	5.00	4.07	1.06	0.305
Ankle angular velocity	3.85	2.28	38.63	8.64	17.66	0.000*

The straight line between the first method and the second method and by reviewing the significance level values shown in the last column of the table and comparing these values with the value (0.05), which represents the upper limit for accepting the existence of differences between the mean values, most of these values were less than 0.05, which indicates that the differences in the mean values between the two methods The first and the second is considered an important difference from a statistical point of view, as the significance of the difference between the two methods was in favor of the second method, which gave a greater punch speed and also gave a greater amount of movement for the striking arm. Therefore, the values of angles and angular velocities in the second method were the best because it led to better results in terms of speed and the momentum of the striking arm.

The angular velocity of the pelvis and the angular velocity of the knee are excluded from these results, where the values of the significance level of these two variables were (0.783) and (0.305), respectively, which means that the difference in the mean values of the first and second methods in these two variables is not statistically significant.

The researchers attribute that the straight punch in the second method was better because of the difference in the stance, which made there a greater range in the body's movement and giving a higher distance, which directly affects the speed and angular velocity of the mentioned joints. The speed, distance, and momentum are less, which makes the second technique more important and more important to the punch.

General results are listed below:

- Variables affecting the velocity of the straight blow in the first method were the distance of the punch, the speed of the punch, and the elbow angle.
- Variables affecting the amount of straight punch in the first method were the pelvic angular velocity, shoulder angle, knee angle, and pelvic angle.
- Variables affecting the velocity of the straight punch in the first method were the angle of the elbow and the angular velocity of the knee.
- Variables affecting the amount of punch movement in the second method were the knee angle, punch speed, pelvis angular velocity, pelvis angular velocity, knee angular velocity, and ankle angular velocity.

4. CONCLUSIONS

In conclusion, the shorter the muscle contraction time of the straight punch, the greater the kinetic momentum and speed of the punch in both styles, and the greater the knee angle, the greater the punch and speed of the punch in both styles. Also, momentum and punch speed were better in the second method.

5. RECOMMENDATIONS

Based on our study results, we recommend a climatic and other clinical study of the straight stroke. We also recommend to use the second method in the straight punch.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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