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Motion Analysis Jump Shot on Success Shooting Basketball Athlete

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Abstract

The aim of this study is to study the biomechanical characteristics of jump shot in the game of basketball. Five subjects were given five trials in turn and recorded, and the experimental results were processed into images and equipped with numerical data. The analysis results show that each subject has a different value; one subject, AV, succeeded in entering the ball four times and failed once, three subjects, ALA, FP, and MN, successfully entered the shooting rim when the athlete did jump shot. The knee angle before jumping 71.3°-100.9° (resulting in a jump height of 22–42 cm), elbow angle 73.1°-89.5°, and wrist angle 95.9°-134.4° (resulting in a height ball 359-421 cm) are the best and most effective jump shot angle based on the biomechanics of all experiments carried out by the subject. The results of the analysis show that there are 3 stages of technical movements jump shot, that is, (i) excessive knee flexion can cause significant stress on the extensor group; (ii) knee angle before jumping, body tilt angle, and arm angle before jump release, wrist angle before release, and whether or not the ball made it to the rim.

Keywords: *Analysis; Biomechanics; Technique; Jump Shot; Basketball; Dartfish*

Introduction

Basketball is a type of sport that is increasingly popular. It is a large ball game played with hands and played by two teams, each with five athletes. The goal is to score points in the opposing team's basket and prevent the opposing team from scoring points (Perbasi, 2022). According to (Bompa, Tudor O., Buzzichelli, 2018), there are several factors that need to be prepared to achieve achievement, including technical preparation, physical preparation, tactical preparation, and mental preparation. In accordance with the aim of the game of basketball, namely to score as many balls as possible, technique is something that every athlete must master so that they can get points. Shooting skills are the most important component and have a direct impact on the number of points scored in a match (Vencúrik et al., 2021; Zambová & Tománek, 2012). According to (Simanjuntak, 2019), score productivity is positively correlated with athletes' ability to master the basic techniques used in basketball matches. As a result, athletes can perform efficient movements.

Jump Shot is a technique shooting the best of the various kinds that exist in the game of basketball. One of the very dangerous shooting techniques is jump shot, which can be done in various positions and is done while jumping at the highest point. This is very difficult to prevent (Aldo & Mukhtarsyaf, 2020; Falah et al., 2018). Athletes who can shoot the ball from various distances will be very advantageous in basketball matches.

Jump shot is the motion in which the ball is released into the air. Usually, the release of the ball jump shot occurs near the top of the shooting athlete's vertical path (Okubo & Hubbard, 2020). Because athletes try to release the ball faster and from a higher position when facing an opponent, an athlete's ability to make a shot increases jump shot can harm their opponents. Therefore, this strategy can reduce the opponent's opportunity to block the ball, and the shooter's success depends on the speed and height of the ball release (Rojas et al., 2000).

According to data from the National Basketball Association (NBA), all NBA teams that score points during a game use jump shot amounting to 58.8%. In addition, 29.5% of all ball shots were taken after receiving a ball pass, which shows that 60% of goal field in the game of basketball originates from jump shot (Oudejans et al., 2012; Williams et al., 2016). Based on the information above, it can be concluded that jump shot is one of the most important ball shooting techniques, and that a basketball team's victory is greatly influenced by it. Biomechanical parameters can be used to examine various factors that influence performance shooting ball. Sports performance, sports injury rehabilitation and prevention, and performance enhancement are all outcomes of sports biomechanics (Bussey, 2013); (Chakraborty et al., 2019).

The results of biomechanical studies show that the shot jump shot is studied based on throws and depends on features such as speed, angle and height of ball release (Gorshahri & Khazaeli, 2018). Variables such as ball release height, angle, and speed are important factors in the success of the technique jump shot (Oudejans et al., 2012).

As far as the importance of movement is concerned jump shot in basketball, there are many variables that influence the movement patterns used by players (V. H. A. Okazaki et al., 2015). From this statement it is clear that team success can be supported by the application of sports science and sports biomechanics (Rohendi & Rustiawan, 2020).

Dartfish is a video program with analysis capabilities. By using analytical methods, this program allows users to make decisions that can improve athlete performance (Eltoukhy et al., 2012). Sports often use video analysis, which includes the study of the sport's basic movements and techniques aided by program features. In addition, the recordings processed by this program can be saved in the form of images, the so-called capture motion.

Methodology

This study applies a quantitative-qualitative approach and uses descriptive analysis. Quantitative data such as knee angle (KA), jump height (JH), elbow angle (EA), wrist angle (WA), and maximum ball height (MBH) were obtained from the Dartfish program analysis. Explanatory sentences from research findings that support existing theories constitute the qualitative data of this research. This research uses proportional techniques purposive to choose the subject. The subjects were men aged 20 to 23 years, played predominantly right-handed, and had been practicing for 4-6 years. Thus, the number of subjects was 5 people. Dartfish software was used in this research. In addition, to help the data collection process, use materials and equipment such as a DSLR camera, standard size basketball, cone, stationery, and biodata sheets and research variable measurement sheets. The camera placed must be able to record the athlete's movement and the trajectory of the ball towards the rim. There must be a distance of 12 m between the athlete and the camera, a camera height of 1.1 m, a ruler calibration of 60 cm, and a distance of 5 m for jump shots with the rim. To collect data, the five subjects were given five trials in turn and recorded; The experimental results will be processed into images and equipped with numerical data. The data collection process begins after the data collection process is complete. Researchers use software dartfish to examine the variables under study and analyze the motion jump shot overall. Each subject was gathered and given instructions on what to do. After that, the subject warmed up and prepared for movement video recording jump shot on schedule. With the subject position behind the line free throw, each subject performed five shooting trials jump shot well. The recording process ends when the last ball touches the floor. After the recording process was complete, the subject was cooled. The entire video continues with usage software Dartfish to measure each variable. To evaluate any shot, the first consideration is whether the ball was a success if it went into the rim or a failure if it did not. The results of quantitative and qualitative processing are used to produce research conclusions.

Results and Discussion

Result

To make the research analysis easier to understand and conclude, the research results will be presented in table form according to the instruments that have been explained. The data presented consists of measurements carried out on five subjects during jump shot. The variables reviewed include jump height, knee angle before jumping, body tilt angle, and arm angle before jumping release, wrist angle before release, and whether or not the ball made it to the rim.

The following table shows the results of data recapitulation from movement measurements jump shot use dartfish. The analysis results show that each subject has a different value; one subject, AV, succeeded in entering the ball four times and failed once, three subjects, ALA, FP, and MN, succeeded in entering the ball three times and failed twice, and one subject, ARA, succeeded in entering the ball twice and failed twice.

Table 1. Experiment 1 Data

Initials	**Variables**					**Accuracy**
	KA	**JH**	**EA**	**WA**	**MBH**	
ALA	71,3	29	83	118,3	417	Succeed
ARA	73,3	26	64,2	126,2	401	Fail
AV	83,9	28	78,4	115,3	363	Succeed

FP	74,9	39	89,5	119,3	401	Succeed
MN	99,4	27	73,1	96,7	373	Succeed
$\bar{x}$	80,56	29,80	77,64	115,16	391,00	
σ	11,58	5,26	9,63	11,06	22,27	

In table 1 data, the four subjects who successfully entered the shooting rim were ALA, AV, FP, and MN. Based on variables measured when athletes perform jump shot, it can be seen that the subject forms a knee angle of 71.3°-83.9°, which results in a jump height of between 27 and 39 cm, and an elbow angle before release of 73.1°-89.5°, which results in a ball height after release of 96.7°-119.3°.

Table 2. Experiment 2 Data

Initials	**Variables**					**Accuracy**
	KA	**JH**	**EA**	**WA**	**MBH**	
ALA	71	31	72,4	134,3	429	Fail
ARA	77	29	70	125	386	Fail
AV	92,7	28	81,3	108,4	378	Succeed
FP	82,8	43	67,7	123,4	391	Fail
MN	98,6	31	61,7	116,6	385	Fail
$\bar{x}$	84,42	32,40	70,62	121,54	393,80	
σ	11,26	6,07	7,17	9,69	20,22	

Table 2 data shows that only subject AV whose shot managed to enter the rim. Based on variables measured when athletes perform jump shot, it can be seen that the subject forms a knee angle of 92.7°, which produces a jump height of 28 cm, an elbow angle before release of 81.3°, and a wrist angle before release of 108.4°, which produces a height of the ball after release of 378 cm.

Table 3. Experiment 3 Data

Initials	**Variables**					**Accuracy**
	KA	**JH**	**EA**	**WA**	**MBH**	
ALA	72,3	31	77,1	120	416	Succeed
ARA	74,1	27	74,2	134,4	403	Succeed
AV	87,8	22	77,9	95,9	359	Succeed
FP	84,5	41	65,5	123,1	422	Fail
MN	100,9	25	76,4	106	380	Succeed
$\bar{x}$	83,92	29,20	74,22	115,88	396,00	
σ	11,57	7,36	5,07	15,07	26,22	

Table 3 data shows that four subjects (ALA, ARA, AV, and MN) successfully entered the rim when the athlete did jump shot. Variables measured when an athlete performs a jump shot include a knee angle of 72.3°-100.9°, which results in a jump height of between 27 and 31 cm, and an elbow angle before release 74.2°-77.9° and wrist angle before release 95.9°-134.4°, which results in the height of the ball after release.

Table 4. Experiment 4 Data

Initials	**Variables**					**Accuracy**
	KA	**JH**	**EA**	**WA**	**MBH**	
ALA	70,5	32	67	130,5	434	Fail
ARA	80,3	19	67,8	135	410	Fail
AV	81,4	20	62	103,9	384	Fail
FP	86,8	40	82,7	109,8	387	Succeed
MN	99,6	26	79	108,4	410	Succeed
$\bar{x}$	83,72	27,40	71,70	117,52	405,00	
σ	10,65	8,76	8,74	14,16	20,35	

Two subjects, FP and MN, succeeded in entering the rim in the shot, according to data in table 4. Based on the variables measured when the athlete did jump shot, it can be seen that the subject forms a knee angle of 86.8°-99.6°, which results in a jump height of between 26 and 40 cm, and an elbow angle before release between 79°-82.7° and wrist angle before release between 108.4°-109.8°, which results in the height of the ball after release 387-410 cm tall.

Table 5. Experiment 5 Data

Initials	**Variables**					**Accuracy**
	KA	**JH**	**EA**	**WA**	**MBH**	
ALA	72,6	28	77	118,6	421	Succeed
ARA	77,8	25	74,9	129,8	392	Succeed
AV	86,6	22	75,7	98,5	382	Succeed
FP	84	42	86,4	117,3	401	Succeed
MN	93,2	25	63,4	113,3	392	Fail
$\bar{x}$	82,84	28,40	75,48	115,50	397,60	
σ	7,95	7,89	8,18	11,30	14,71	

According to table 5 data, the four subjects who managed to get into the rim in their shots were ALA, ARA, AV, and FP. Based on the variables measured when the athlete performed the jump shot, it can be seen that the subject formed a knee angle of 72.6°-86.6°, which resulted in a jump height of

between 22 and 42 cm, and an elbow angle before release between 74.9°-86.4° and wrist angle before release between 98.5°-129.8°, which results in the height of the ball after release 382-421 cm.

In the third, fourth, and fifth trials, subjects ALA and AV were able to enter the ball three times in a row; FP subjects were able to enter the ball twice in a row on the second and third trials; and subject MN was able to enter the ball twice in a row on the fourth and fifth trials. It was explained that subjects ALA, AV, and MN were consistently able to maintain the rhythm of their firing movements well from the middle to the end of the experiment; FP subjects were only able to maintain the rhythm of their firing movements at the beginning of the experiment. In contrast, ARA subjects were unable to find and maintain the rhythm of their shooting movements well.

Discussion

The number of shots made during a match is one of the factors that determines victory in a basketball game. The more shooting a team does, the greater their chances of scoring points. Team success is directly influenced by taking very important shots (Button et al., 2003; Uzun & Pulur, 2018). Jump Shot is a type of shot where a jump is added, with the ball being released at the highest point of the jump. The mechanism is usually similar to a set shot or free throw. One of the main differences between the two is that the shot is taken at the highest height of the jump (Štirn et al., 2019). In technique jump shot, the ball is released at the highest point of the jump to avoid the opponent (Collins Dictionary, 2015; Rojas et al., 2000; Winata, 2021).

Biomechanics is a field of science that can help the movement evaluation process (Siahaan et al., 2020). Biomechanical analysis is the right method to determine movement efficiency in terms of an athlete's strengths and weaknesses in carrying out certain movements (Umar, 2018). Biomechanical analysis of movement can be carried out quantitatively or qualitatively. In quantitative analysis, aspects are assessed using numbers or statistics; in qualitative analysis, movement performance is assessed through the trainer's vision. Biomechanical analysis is intended to assess the athlete's movement performance so that the coach can determine what is important and not important, possible, effective, safe, and so on (Iskandar, 2013).

There are some Newton's laws at work when you do jump shot. Newton's laws apply when the ball remains stationary in the athlete's grasp before being released. Additionally, Newton's second law applies when the ball is released from rest and then pushed to release it; Once released, the ball will move at a constant speed until the gravitational force reaches its highest point. The hands will push the ball to move. If the ring is close to the athlete, the force applied should be less so that the ball does not move as quickly. On the other hand, if the ring is far away, the force applied must be greater so that the ball can move quickly. However, Newton's law II applies before the athlete jumps into the air: the athlete reacts by channeling force downwards or into the ground, thus creating a reaction with the same force upwards or into the air. Apart from that, this law also applies when an athlete performs an action by pushing the ball, so that the ball leaves its stationary position, or in his hand.

Stages of technical movements jump shot biomechanically, based on the results of the research data that has been obtained, there are 3 stages in carrying out jump shot, that is:

1.Initial Phase

At this level of technique jump shot, an athlete should hold the ball at waist height in a hand position ready to release the shot, with the arm parallel to the body (close to zero degrees) before taking the shot (Okubo & Hubbard, 2015). The athlete then positions the feet and knees in a balanced state, namely by opening the feet shoulder-width apart and bending the knees at an angle of 71°–100.9°. These results are in accordance with research findings by several researchers, such as (Gallahue, 2002) who

found that preparation for squatting with knee flexion was 60°–90°, and (Hermawan, 2014) stated that the success rate for shooting with a leg angle of less than 90°.

According to biomechanical analysis, excessive knee flexion can cause significant stress on the extensor group. As a result, the body cannot achieve good vertical speed (Zhen et al., 2015). By lowering the leg angle and deep bending the knee, the athlete can conserve vertical momentum when jumping with the leg extended. By bending their knees deeply, they can store greater potential energy to provide better kinetic energy (V. Okazaki & Rodacki, 2012).

2. Main Phase

Successful observations reached a height of 22–42 cm. The longer an athlete can maintain his body at peak position, the more likely he is to shoot well. Arm swings can also help jump higher than knee bends (Hara et al., 2006), so athletes feel safer when shooting even if an opponent is blocking them.

When the athlete is in the air, the hands and ball are in a good position to release the ball. During the jump shot, the athlete's elbow angle is 73.1-89.5°, and the wrist angle is 95.9-134.4°. The arm position must form the letter L so that the ball can enter properly (Hung et al., 2004; Taufik et al., 2020). Apart from that, (Hermawan, 2014) stated that lifting the elbows at a 90° angle is the initial stage carried out before shooting.

3. Final Phase

The ball will have a height of 359–421 cm after being released. It will be difficult for opponents to block the ball's path to the ring because of its height. Release angle, speed, and release height can all influence the ball's trajectory (A. J. Blazevich, 2007). When the ball is shot or released, the motion should be rotating with backspin. This is important because when an object is in the air, kinetic energy competes with the frictional force of the air, which causes gravity and air resistance, which reduces the ball's speed (A. Blazevich, 2012). Good backspin makes the ball more controlled when it bounces into the ring or backboard, allowing the athlete to rebound before putting the ball back into the ring.

After the ball is released, try to keep your arms straight as when releasing the ball, keep your elbows locked, and use the final push force from the wrist. Because when jumping athletes jump vertically rather than horizontally, return to the position when jumping as much as possible so that the opponent does not suffer injury when landing. In addition, the athlete's knee position when landing must be bent (not straight), flexible (not stiff), and not stiff.

Conclusion

Knee angle before jumping 71.3°-100.9° (resulting in a jump height of 22-42 cm), elbow angle 73.1°-89.5° and wrist angle 95.9°-134.4° (resulting in a height ball 359-421 cm) is the best and most effective jump shot angle based on the biomechanics of all experiments carried out by the subject. These differences are caused by different anthropometric forms and training experiences of athletes. In the game of basketball, there are many factors that influence technique shooting. Athletes' physical conditions are definitely different, so the flexion angles of the knees and other body parts will be different (Nakano et al., 2020; Rojas et al., 2000; Zhen et al., 2015).

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