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RELATIONSHIP BETWEEN KNEE ANGLE AND FLIGHT DURATION IN VERTICAL JUMP SHOT IN HANDBALL

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ABSTRACT

Background: Handball is a fast-moving, intensely competitive sport. The game requires a lot of running, jumping, and throwing, which is quite taxing on the body. Playing handball requires a specific set of skills and talents. Identifying the performance metrics, such as throwing technique and jumping ability, can be aided by understanding biomechanical elements. In order to produce diverse handball shots, it is crucial to comprehend varied angles of up thrust or supporting leg.

Objective: To investigate and assess the maximum flexion angle of the knee joint of the up-thrust leg and its relationship to the player's flight duration during vertical jump shot.

Methodology: Sixteen national handball players (N=16) of U-18 representing Manipur were selected by using the stratified random sampling technique. For measuring the maximum flexion angle of the knee joint of the up-thrust leg, the instant frame was observed while the subject exhibited the maximum flexion angle on the final step just before the jump was executed. The total time taken from the instant frame of jumping to the instant frame of landing was measured. GoPro12 was used to capture the constant frames, and Kinovea was used to investigate and analyze the parameters of this study.

Result and Conclusion: A positive relationship between the knee angle of the up-thrust leg and the flight duration during a vertical jump shot was found in the handball. The result of the study indicated that more flexion of the up-thrust leg could produce longer flight duration and make an effort to a greater range of movement during the goal-shooting phase. Further, it also gives a space to analyze the range of movement.

Keywords: Kinematic, Angle, Flight Duration and Handball.

I. Introduction

Handball underwent numerous changes and innovations over the centuries and developed to its current state. Handball variations can be traced back to the history of the Greeks, Romans, and Egyptians^[1]. Handball continued to be played in various forms throughout Europe during the Middle Ages. Handball-like games are shown in prehistoric images and are mentioned in many ancient texts^[2-3]. The old grass ground handball was played by 11 players on each side. Handball as a modern game began in the middle ages in Germany and continued till the late 19th century where it turned into a sport. As the game began being played indoors, it gained popularity throughout the 20th century, mostly in the winter months when playing outside was impractical. The official form of indoor handball is sometimes called team handball or simply handball and is played by teams of seven players^[4]. Handball made its Olympic debut at the 1936 Berlin Games. It then became an indoor sport at the 1972 Munich men's competition, and the 1976 Montreal women's competition^[5].

It is a dynamic team sport, played by both male and female players. A handball match consists of two 30 minute halves separated by a 10 minute intermission. The contest is won by the team with the most goals scored during play. A game is deemed a draw if there is a tie in the final score. The court on which the game is played is 40 meters long and 20 meters wide. Halfway between the two halves of the court is indicated with a centre line. Over the years, handball has seen various innovations and rule changes aimed at improving the game's speed, safety, and entertainment value. These include changes to the playing court, advancements in equipment technology, and updates to regulations governing player conduct and game play. With professional leagues forming in numerous nations and a burgeoning global presence, handball has become an increasingly professional sport. Overall, handball has a rich and diverse history, evolving from ancient origins to become a popular and globally recognized sport played by millions of people around the world.

The game of handball is fast-paced and highly competitive. The game is physically taxing since it requires a lot of running, leaping, and throwing. While defending, body contact is permitted; nevertheless, repeated fouls result in penalization of players and the possibility of a player being ejected from the court. Handball players need specific skills and abilities for the sport. Studying and researching handball is crucial for various reasons. Research helps in identifying the needs of handball players, understanding the dynamics of physical training, analysing the relationship between physical qualities of athletes, and developing models for competitive activities^[6]. Furthermore, research in handball is essential for preventing injuries and illnesses in elite players by examining the impact of physical, psychosocial, and dual-career loads on athletes, as well as monitoring stress levels and biomarkers to enhance performance and well-being^[7]. Overall, research in handball contributes to player development, injury prevention, performance optimization, and career management, making it a vital aspect of the sport's advancement.

Biomechanics research is crucial in handball due to the sport's emphasis on movements like running, jumping, throwing, and abrupt changes in direction, which generate significant forces around different joints of the body^[8]. Understanding biomechanical aspects can help identify performance parameters, such as throwing technique and jumping performance, while also providing detailed information on joint loading and soft tissue stress during high-risk situations, aiding in injury prevention^[9]. Additionally, studying the biomechanics of

handball players can reveal postural adaptations and asymmetries, contributing to performance enhancement and injury prevention strategies^{[10][11]}. Studying various biomechanical variables in handball can lead to improvements in other biomechanical variables, creating a reciprocal relationship. For instance, research on hip and knee range of motion in handball players^[12] can provide insights into postural adaptations and potential injury prevention strategies. Additionally, focusing on core muscle exercises can enhance muscle strength levels and jump shooting performance in female handball players, impacting biomechanical variables associated with skill performance^[13]. Therefore, a comprehensive understanding and study of various biomechanical variables can contribute and is required to enhance performance in handball players such as the relationship of flight duration while executing a vertical jump shot with other biomechanical variables.

II. Objective

1. To investigate and assess the maximum flexion angle of the knee joint of the up-thrust leg and the player's flight duration during vertical jump shot.
2. To find out the relationship between the angle of the knee joint of the up-thrust leg and the player's flight duration during vertical jump shot.

III. Methodology

Sixteen players (N=16) (16.12 ± 0.96 years, 171.25 ± 5.76 m, 72.75 ± 4.20 kg, and 24.81 ± 1.20 BMI) of Under-18 (U-18) were selected using a stratified random sampling technique so that the possibilities of selection of players from each position were uniform^[14]. A high-speed action camera (GoPro 12) was used to capture the frames for this study^[15] where the subjects were asked to throw the ball towards the goal beyond the 9m marking with 3 step running while executing vertical jump shot. For measuring the maximum flexion angle of the knee joint of the up-thrust leg, the instant frame was observed while the subject exhibited the maximum flexion angle on the final step just before the jump was executed. The flight duration was measured by calculating the total time taken from the instant frame of jumping to the instant frame of landing. Kinovea was used to process, investigate and analyze the parameters of this study. The videos were fitted in the software and necessary annotations were made for the study. The pertaining data were recorded on the following variables shown in table 1.

Table 1. Variables

Sl.no.	Variables	Units
1	Angle of the Knee Joint	Degree (°)
2	Flight Duration	Second (sec)

IV. Statistical Analysis

The pertaining data are analysed descriptively and presented as mean \pm standard deviation. Normality of distribution was assessed using the Shapiro–Wilk test ($p > 0.05$). A two-tailed Pearson's correlation analysis was used to examine the correlation between the angle of the knee joint of the up-thrust leg and the period of body flight of the player during vertical jump shots. The level of significance was set at $\alpha = 0.05$.

V. Result and Interpretation

The collected data were analyzed descriptively to observe the main attributes and nature of the data and a two-tailed Pearson's correlation analysis was used to examine the correlation between the maximum flexion angle of the knee joint of the up-thrust leg and the flight duration of the players during vertical jump shots. The descriptive investigation of the obtained data for the angle of the knee joint of the up-thrust leg and the flight duration of the player during vertical jump shot are presented in table 2.

Table 2: Descriptive of Maximum Flexion Angles of Knee of the Up-thrust Leg and Flight Duration of Handball Players.

Variable	N	Min	Max	Mean	SD
Angle of the Knee Joint	16	31	51	42.37	5.48
Flight Duration	16	0.74	1.21	0.95	0.13

Table 2 shows the means and standard deviations of the angle of the knee joint of the up-thrust leg and the flight duration. Means and standard deviations for the angle of the knee joint of the up-thrust leg and the flight duration were 42.37 ± 5.48 and 0.95 ± 0.13 , respectively. The graphical representation of means for the angle of the knee joint of the up-thrust leg and the flight duration has been shown in the figure 1.

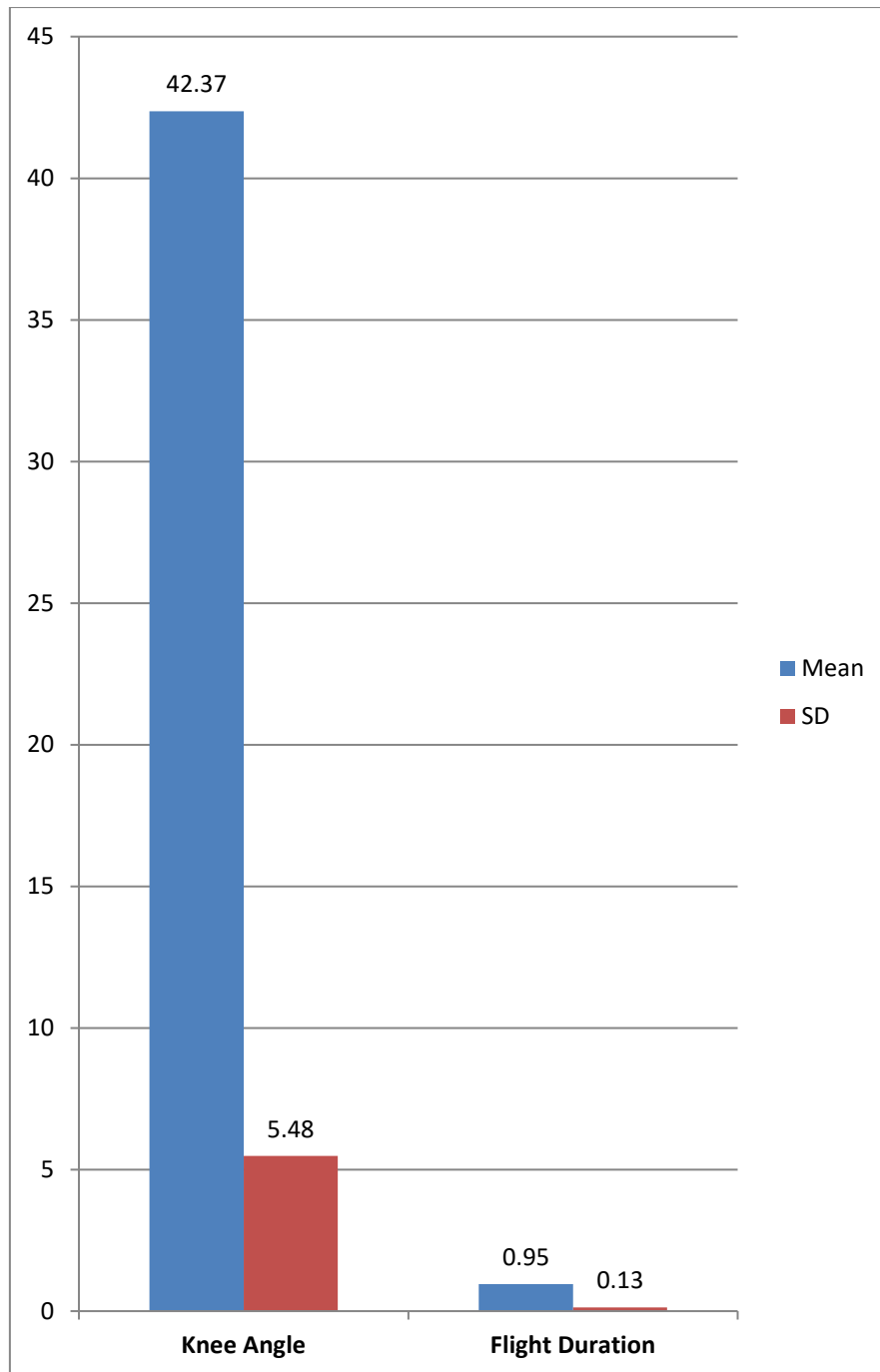


Fig. 1: Means of the maximum flexion angle of the knee joint of the up-thrust leg and the flight duration.

The correlation between the angle of the knee joint of the up-thrust leg and the flight duration was calculated using a two-tailed Pearson's correlation. Further the correlation between the two variables was shown in shown in table 3.

Table 3: Correlation between the Maximum Flexion Angle of the Knee Joint and the Flight Duration.

Variable		Flight Duration
Knee Angle	Pearson Correlation 'r'	0.61*
	Sig. (2-tailed)	0.01
	N	16
*Correlation is significant at the 0.05 level (2-tailed). $r=0.47$		

From the above table 2, it is observed that there was a significant correlation between the angle of the knee joint of the up-thrust leg and the flight duration during the execution of vertical jump shot in handball as the obtained value of $r_{(0.05, df-16)}=0.61$ was greater than the table value of $r_{(0.05, df-16)}=0.47$ and the obtained value of the $p=0.01$ was smaller than 0.05 level of significance. Further, there is also a positive correlation between the two variables, which indicate that, an improvement in one of the variables could have a positive improvement on the other.

VI. Discussion of the Finding

In this study, to assess and analyse the relationship between the maximum flexion angle of the knee joint of the up-thrust leg and the flight duration of the handball players during vertical jump shots, there was a significant positive correlation between the angle of the knee joint of the up-thrust leg and the flight duration during the execution of vertical jump shot in handball as the obtained 'r' value was greater the tabulated 'r' value.

From the above findings it can be concluded that higher the degree of the flexion of the up-thrust leg, could longer the flight duration during vertical jump shot. Hence, the knee angle plays a crucial role in vertical jump shot performance in handball. Similar study also showed that knee flexion at initial contact and range of motion significantly impact jump performance^[16]. Additionally, the ankle joint range of motion is highly correlated with vertical jump performance in handball players, emphasizing the importance of joint flexibility in generating impulse during jump tests^[17]. Furthermore, differences in knee kinematics, such as the frontal knee projection angle, can be improved through core strength training, leading to enhance the jump performance^[18] and the relationship between knee angle and flight duration in vertical jump shot in handball is influenced by various factors. Studies have shown that knee joint flexion angles significantly affect ankle joint range of motion (ROM) and vertical jump (VJ) performance^[17]. Additionally, core strength, particularly trunk flexion (TF) and back extension (BE), has been positively correlated with vertical jump performance in volleyball players, indicating the importance of core strength in explosive movements like jumping^[19]. Understanding these relationships can help optimize training strategies to enhance performance and reduce the risk of injuries in handball players.

VII. Conclusion

There is a significant correlation between the knee angle of the up-thrust leg and the flight duration while executing a vertical jump shot in handball ($P<0.05$). This finding indicates that studying the kinematic aspects of the vertical jump shot is important since most players use the same technique for this shot. Flight duration is crucial for maintaining power and precision. It has been observed that longer flight duration increases the chances of scoring, as it allows players more time to study the movement pattern of the goalkeeper. The results

could also provide insights into the kinematic parameters of other movements that may impact performance and help to identify the potential injuries by studying the range of motion. A targeted biomechanical analysis combined with a specific training program can enhance the performance of handball players.

Informed consent statement

The participants were fully aware of the nature of the study and have given their voluntary agreement to participate in this study.

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Disclosure statement

No potential conflict of interest was reported.

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Data Availability Statement

The corresponding author can provide the data used in the present study upon reasonable request.

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