KINEMATIC ANALYSIS OF ARM MOTION DURING JUMP SHOT IN NIGERIAN FEMALE BASKETBALLERS

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JUNE, 2011

DECLARATION

I declare that this dissertation entitled, 'Kinematic Analysis of Arm Motion During Jump Shot in Nigerian Female Basketballers' has been written by me. The information derived from the literature has been fully acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma of any university.

Leah Olufunmilola Dominic

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Signature/ Date

CERTIFICATION

This dissertation entitled **"KINEMATIC ANALYSIS OF ARM MOTION DURING JUMP SHOT IN NIGERIAN FEMALE BASKETBALLERS"** by Olufunmilola Leah Dominic, meets the regulations governing the award of the degree of Doctor of Philosophy in Exercise and Sports Science in the Department of Physical and Health Education, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Prof. M. A. Chado Chairman, Supervisory Committee	Signature	Date
Prof. K. Venkateswarlu Member, Supervisory Committee	Signature	Date
Prof. J. A. Gwani Member, Supervisory Committee	Signature	Date
Prof. C .E. Dikki Head of Department	Signature	Date
Prof. A. A. Joshua Dean, School of Postgraduate Studies	Signature	Date

DEDICATION

This dissertation is dedicated to:

my husband, Elder S.A. Dominic

and my Children:

Oluwanifemi,

Oluwatobi,

Toluwaniogo,

and

Iyanuoluwa.

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All honour and glory be to the Almighty God, the One who says and it comes to pass for preserving the researcher's life throughout the study.

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ABSTRACT

The purpose of this investigation was to determine the relationship between the Kinematics characteristics of successful and unsuccessful shots during arm motion in Nigerian female basketball players and also the changes that take place in shooting techniques of players at three shooting distances of 2.74m, 4.67m and 6.40m shots. To achieve the purpose of this study, the purposive sampling technique was used to select the best Female Club champions, the First Bank of Nigeria Basketball team. The stratified sampling technique was used to select 14 Subjects, consisting of 5 guards, 5 forwards and 4 centre players who represented Nigeria at the May 2009 edition of the West Africa Club side Championships in Togo. Videography was used to collect the data and APAS software was used for processing the data. Descriptive statistics of mean and standard deviation were used to describe the data while inferential statistics of Pearson Product Moment Correlation Coefficient and one way ANOVA was used to test for significant correlation among the three shooting distances. It was found that there was no significant difference between shooting accuracy of the guards, forwards and centre players. Significant intra and inter variability were found in the linear displacement, joint angular displacements and segmental displacements and velocity parameters of the segments. The ball projection parameters revealed intra significant variability while group relationship was established between successful and unsuccessful shooting distances parameters. The group correlation showed that group analysis hide the true status and performance of the participants in shooting and this may lead to wrong information about any of the basketball player if the mean value for the group was to be used. From the findings, intra trial analysis gives true position of each female basketball player's jump shot status; therefore, it was recommended

amongst others that sports scientists should engage in intra trial studies than inter trial to enable individualistic approach to teaching and learning correct skill and techniques for optimal performance. The insignificant difference also found in the shooting accuracy and the elites' performance proved that players training and practice should extend beyond the player's perimetre of play.

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DEFINITIONS OF TERMS

Release angle- This is the minimal release angle that can be used with a particular release height and distance from the basket and still produce a clean or successful shot.

Release velocity-This is the resultant of the three velocity components of the arm angular velocities.

Release height-This is measured as the vertical distance to the centre of the ball.

Clean shot-This is a **successful shot** that passes through the hoop without hitting the ring or backboard.

Missed shot- This is an **unsuccessful shot** that does not pass through the hoop after being shot.

Margin for error (Em)- This is defined as the horizontal distance that the centre of ball at approach can be away from the centre of the hoop and still go cleanly through the basket.

Shoulder joint: - This is the relative motion between the trunk and arm.

Elbow joint: - This is the relative motion between the upper-arm and the forearm

Wrist joint: - This is the relative motion between the forearm and hand

Elite players:- These are categories of players who have been playing either in the national league, national sports festivals or international competitions.

Take-off: defined as the last first perceptible visible frame in which foot-ground contact is broken.

Ball release: defined as the first field in which hand/ball contact is broken with the ball**.**

CHAPTER ONE

INTRODUCTION

1:1 Introduction

Basketball is an exciting, highly competitive team sport. The game is one of the most popular sports in the world. This is evident from not only the audience level of National Basketball Association in USA but also the national and international basketball championships. Not only a complete organization of the game that is important, but also technical needs, tactics, agreement, experience and the potential for contest are shown in a game (Chiou, 2001; Tsai Chi-Yang, Wei-Hua Ho, Yun-Kung Lii, Chin-Lin Huang, 2006). To gain competitive advantage required for success in basketball, Malone, Gravis, and Steadward (2002) said one needs to fully understand and develop the fundamental skills involved in shooting, passing, and dribbling. Of the basic skills, shooting can be considered as the most important for determining the score and outcome of a game. Elliot (1991) cited by Malone et.al (2002) further explained that an understanding and application of arm movement mechanics are necessary if an athlete's potential is to be fully developed; and that only when good technique is used in training and practices, and during the game can a player reach his or her full potential**.**

Studies by Sanchez (1982), Burns (1990) and Malone (1999) explained that skilled shooters are not born, but instead can develop with proper training and this by using scientific approach (Brancazio, 1984). It has been established that one of the reasons for low performance in shooting is that most players have not learned the proper technique. Therefore the identification of key components related to success in jump shot is necessary for proper training and technique development among Nigerian basketball players.

Kinematics is the description of motion, including the pattern and speed of movement sequencing by the body segment that often translates to the degree of coordination an individual displays (Adrian and Cooper, 1995; Hall, 1999,). Kinematics is not concerned with the forces which cause the object or the body to move, but with the type of motion that is made from what position, displacement, velocity, acceleration and time of the movement (Wells and Luthegens, 1993, Adrian & Cooper, 1995). Sport kinematics analysis therefore studies the positions, angles, velocities and accelerations of body segments and joints during motion (Hall, 1999).

Basketball is a multidimensional game that more than one skill are involved and used primarily movement components of running, jumping, throwing, shooting and receiving patterns. These basic patterns are modified to fit the strategies, situations, rules, and regulations of the basketball game (Adrian & Cooper, 1995). The physical principles and factors such as velocity, acceleration, gravity, ground reaction forces, momentum, part of the centre of mass, lever principles, and angles of motion that govern movements in all human activities prevail in the basketball game.

Kinematics characteristics of angle of projection, velocity of release and the release height and position and direction of the body have been found to have influence on the performance of basketball players either in giving accurate passes, catching, dribbling, and shooting patterns which are significant to excellent outcome in basketball game (Hudson, 1982; Miller & Bartlett, 1996).

Martins (1981) suggested using a movement analysis approach to describe good shooting skill and advocated the use of kinematic principles. Yates and Holt (1982) examined kinematic characteristics (angle, velocity and height of release) of jump shot while Hayes (1989) examined ball velocity and the contribution that each body segment made to ball velocity. Hudson (1985) Tsarouchas, Giavoglou and Prassas (1990) analyzed basketball players' shooting. They found that though, in the early propulsion phase, the lower body was the main contributor, at the end of the propulsion phase the forearms' contribution increased and finally, just before release, the hand provided the major contribution.

Miller (2002) compared the kinematic characteristics of 6.40m successful and unsuccessful shots but no one has compared that of 2.74m and 4.67m successful and unsuccessful shots of basketball players. Furthermore, Miller studied male subjects and not female subjects. Group mean was also used to describe the shooters' kinematic characteristics and was not based on intra individual analysis. Most of these studies found variability between the shooters techniques. This negates Tsarouchas, et al (1990) and the widely held belief that skilled performance in basketball is characterized by minimization of shooting variability. Button and Davids (1999) explained that this could have resulted from the use of statistical techniques that hide information, such as group analyses and calculations of central tendencies from blocks of trials.

Some studies have been recently shown that individualized analyses of movement patterns should be used more frequently, particularly in studies of control and learning in sport science as in basketball shooting techniques (Button & Davids, 1999; Newell et. al, 2001). Button et.al (2006) also found that individual variability at several levels needs to be carefully interpreted by sport and exercise scientists rather than lumping them together. However, other researchers except Miller and Bartlett (1993, 1996) who studied the effects of increasing distance on basketball successful shots and positions, concentrated mainly on 2-dimensional study and mainly the free throw.

The researcher therefore is interested in undertaking individualistic approach to find out the kinematic characteristics of arm motion (angle, velocity and height of release) of basketball players' and the relationship between successful and unsuccessful jump shot at the three shooting distances in relation to the three playing zones of guards, forwards and centres.

1:2 **Statement of the Problem**

Basketball has changed in recent decades, and this is largely due to scientific innovations in application of biomechanical principles for improvement and optimal performance, especially in shooting. The accuracy of shooting has been attributed to application of the correct kinematic characteristics, degree of force and the rhythmic quality, irrespective of distance and position to the ring (Walters, Hudson &Birds, 1990; Elliot, 1991).

It is well documented in previous studies (Miller & Bartlett, 1996; Miller, 2002; Button et.al, 2006) that arm range of motion during shooting varies not only between individuals but also within individual performance. Physical (height and weight), anthropometric (body lengths) and physiological differences also have been identified, and that age and level of experience are causative factors of variability in performance (Oranugo, 1995). Tsarouchas et.al (1990) found some differences within good shooters in that some had ‘low’ elbow technique while others used a ’high’ elbow technique in their shooting form. However, this has been found to depend on individual’s unique structure and functional assets and liabilities; hence the need to investigate the kinematic characteristics of Nigerian basketball players. However, the poor statistics on Nigerian elite basketball players’ scoring in the previous National League, National Sports Festival and the last All Africa Games (AAG, 2003), the teams and players of an average score of 50 percent in free-throws, 35 percent in field shots and 25 percent in 3-point shots have constituted problems of scoring to win (Game Statistics, AAG, 2003). This might be a major limiting factor in the performances of the Nigerian top rated basketball teams and players at various national and international competitions. Furthermore, lots of inconsistencies in arm movement observed in the scoring chances, attempts and ratio scores of players during matches in the same championships provide the need for investigation. Therefore, this study is undertaken to

1) Identify the kinematic characteristics of Nigerian female basketball players' arm motion in the jump shot;

2) Analyze the common features of guards, forwards and centre players in the 2-point and 3-point jump shots in order to know the effect of each position on the scoring performances of the randomly selected players.

As part of the process of this study, the following research questions were formulated;

1. Are physical characteristics of Nigerian female basketball players and shooting accuracy related?

2. Is there any association between take off and release displacement parameters of each of the guards, forwards, and centres in both successful and unsuccessful shots?

3. Will successful shots at take off and release velocity parameters correlate with those of unsuccessful shots of each of the guards, forwards, and centres?

4. Will correlation be found between ball projection of successful and unsuccessful shots parameters of each of the guards, forwards, and centres for and also between the players?

Answers to these questions will be able to provide solutions and suggestions for corrections, and give room for improvements in shooting to score.

1:3 Purpose of the Study

The purpose of this study therefore was to conduct the kinematic analysis of arm motion of Nigerian female basketball players during jump shot and determine the relationships between the various components (of successful and unsuccessful shots) that contribute to shooting success.

1:4 Hypotheses

1:4:1 Major hypothesis

There are no significant relationships or differences in the kinematic characteristics of arm motion of Nigerian basketball players during jump shot of successful and unsuccessful shots at take off and release of three shooting distances of 2.74metres, 4.67metres and 6.40metres.

Sub- Hypotheses:

1. There is no significant relationship between physical characteristics and shooting accuracy of the Nigeria female basketball players.
2. There is no significant relationship between take off and release angular (linear, angular and segmental Displacements) displacements parameters of successful and unsuccessful shots at three shooting distances of the guards, forwards and centre basketball players.
3. There is no significant relationship between take off and release angular (linear, angular and segmental velocities) velocity parameters of successful and unsuccessful shots at three shooting distance of guards, forwards and centre basketball players.
4. There is no significant variability between ball trajectory parameters of successful and unsuccessful jump shots of Nigerian female basketball players.

1:5 Significance of the Study

Shooting is the key skill in the game of basketball, but confirmed to be one of the least correctly taught and rarely practiced. This may be one of the reasons for poor mechanics of shooting by most Nigerian female basketball players, and low level of shooting performance. The identification of the major components of successful shots is necessary for proper training and technique development in Nigerian female basketball players from grass-root level. Furthermore, identifying shooting errors in elite players would go along way to improve Nigerian basketball players' performance standard at both national and international competitions.

An understanding and application of shooting techniques are very necessary if Nigerian female basketball players' potentials are to be fully developed and to make their mark at the world championships.

Since analysis of athletes' movement is presently a developing area in sports science, relying on natural athletic talents of players and coaches, cannot take them far as required. This research finding will enlighten coaches and players on the techniques of each of the player and give suggestions that will contribute to jump shooting skill. This is especially important now that researches in areas of sports biomechanics are needed in Nigeria which is putting us at disadvantages when paired with our European counterparts. This study is hoped, will put Nigerian basketball players at par with their European counterparts, who have established their supremacy in the sport.

This study would further provide quantitative data and useful kinematic information on the jump shot of Nigerian female basketball players. This would not only help the Nigerian players, but also the coaches and the team as a whole. Since coaches in Nigeria provide diagnoses and also administer the prescription by good coaching points, this study would provide correct information to Nigerian basketball coaches on the major errors and give analytical solutions to the jump shot inadequacies. Furthermore, it will provide quantitative data on the release parameters of jump shot based on players' positions of playing.

Finally, the findings would also enrich research on jump shot kinematic characteristics as related to the players' positions of play. It may also serve as a pace setter in Nigeria to open up new area of research. It is therefore expected to stimulate interest in many Nigerian Sports science researchers in order to improve and promote optimal performance of Nigerian athletes not only in basketball, but also in other performance.

1:6 Delimitation of the Study

This study was delimited to the kinematic characteristics of guards, forwards, and centres elite female basketball players' arm motion of three shooting Distances of 2.74m, 4.67m and 6.40m shots. This is to make the research a workable one and cost effective. The kinematic characteristics included

1) Release parameters which include release angles, release velocities and heights of release of successful and unsuccessful shots.

2) Categories of players: The First Bank of Nigeria Female Team nicknamed the 'Elephant girls' was purposively selected. The three categories of players selected were five guards, five forwards, and four centre players. These are players who have played in both national and international competitions.

3) For accuracy test, 30 shots (10 shots block each) were taken from three specific distances on the court. These distances include 2.74m, 4.67m and 6.40m shots.

4) For kinematic analysis, five (5) successful and five (5) unsuccessful shots were selected for each of the players and analyzed randomly by picking pre-arranged number unknown to the players and the coaches.

1:7 Limitation of the Study

Within jurisdiction of the researcher, it is the first of its kind in Nigeria. This made the researcher experienced some difficulties as regards the study.

Some of the limiting factors were;

i. Unlike the developed countries, biomechanical laboratory is lacking in Nigeria. This hindered access to readily available equipment such as high speed cameras and accessories for motion analyses.

ii. The cost of the equipment, type of the cameras, software for capturing video data to the computer and the software for digitization and data analysis delayed the completion of the study.

iii. The location of data collection was also restricted to Ahmadu Bello Sports gymnasium because the Elephant girls of Lagos who were the subjects for the study were camping in Zaria. This further led to additional stress and cost as result of need for lighting and retraining of the camera men for the video recording. The first data was collected at the National Stadium indoor sports hall and the videographers were highly experienced and this would have produced consistency in data collection. This might have introduced some contamination in the data which were removed by the APAS software.

However, through the internet facilities, the researcher was able to contact prominent researchers in area of biomechanics. These able scholars sent their articles to the researcher for in-depth study, understanding and obtained resource materials for Literature review. Availability of camcorders and digital cameras also has made expertise out of our videographers in Nigeria. With little tutorials experts were made out of the videographers through collection of data with minimal contamination.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2:1 Introduction

This chapter was reviewed under the following headings;

2:2 Concept of Kinematics

2:3 Intervening Factors of Sports Movement Analysis

2:4 Kinematic Analyses of Sports Skills

2:5 Tools for Quantitative Analysis of Sports Movement

2:5:1 Image Analysis Techniques

2:6 Anthropometry and Performance

2:7 Kinematic Analysis of Basketball Shooting

2:7:1 Determinant Factors of a Successful Shot

2:7:2 Jump shot and the Basketball Game

2:7:3 Jump shot Kinematics

2:8 Critical Instant in Shooting the Basketball

2:9 Summary

It is unlikely that any two individuals will shoot in exactly the same manner, especially the jump shot. There are several reasons for this: each individual has unique structural body skills. There are many patterns of movement and paths of projection that can result in successful jump shots; and there is latitude for each player to add stylistic interpretations. However, in spite of the inevitability of individual variations, all mechanically sound movement patterns of shooting should be reproducible and accurate, regardless of the amount of fatigue or stress. The basic characteristics that an ideal arm pattern should include are: 1) minimal action outside the primary plane, 2) moderate velocity from a minimal number of body segments, 3) smooth integration of body segments, and 4) a projection path with a generous margin for error (Hudson, 1985).

Evolution of the rules and tactics of the game of basketball has resulted in the three basic playing positions; centre, forward, and guard (Miller & Bartlett, 1996). Players in all the three positions are expected to contribute to a team's scoring. Centres tend to be the tallest players (Mansfield, 1995; Oranugo, 2004; Dominic, 2005), and normally playing close to the basket in order to utilize their heights to the greatest benefits of the team (area A), whereas the shortest players (guards) tend to originate attacking patterns, a role which requires them to dribble the ball up the court (Krause, 1991; Miller & Bartlett, 1996).This in turn causes them to stay further away from the basket(area, B). Forwards tend to be of medium stature, and their role incorporates aspects of those of both centres and guards. They are expected to help guards in setting up attacking patterns and centres in defending opponents close to the basket. They also contest rebounds from missed shots, playing both the left and right hand side of the court between the zone and the side lines (Coleman, 1975; Miller & Bartlett, 1996). This is indicated by area in C. As players tend to play in specific areas of the court, it might be expected that shots attempted would tend to come from the area(s) in which the shooter plays. Notational analysis of shooting distances for 200 English National League matches played between 1984 and 1990 (Miller & Bartlett, 1993) revealed that at least 80% of the field goals were attempted from the following ranges; centres, 0-3.7m; forwards, 3.0-6.4m; guards, 5.5- 7.3m.These figures do not include free throws which accounts for 26% of all attempts.

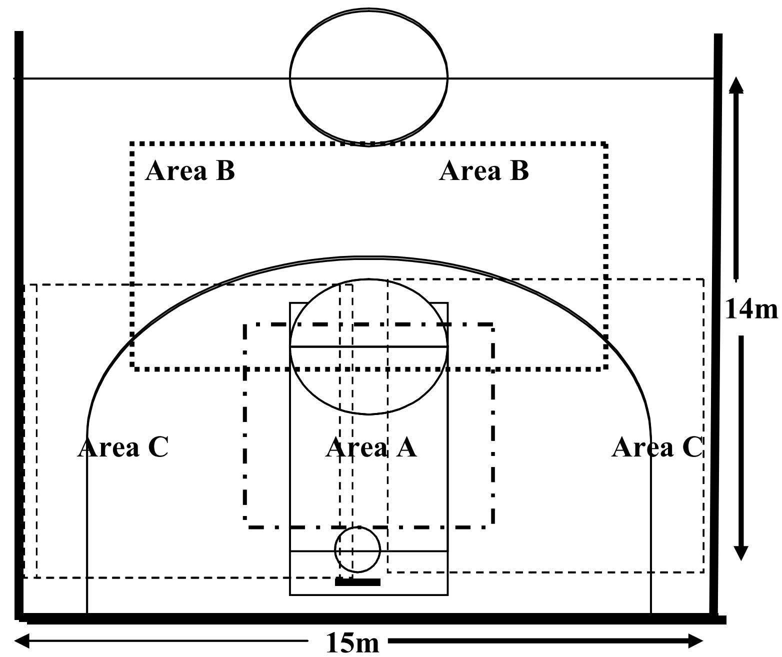


Fig. 1: Playing areas for the three major positions. (Adapted from Miller & Bartlett, 1996)

2:2 Concept of Kinematics

Biomechanical analysis is essential for evaluating performance in various sports. The biomechanical measures of performance describe the kinematics and kinetics of movement behaviour (Sasaki, et. al 2011). Carling et. al (2009) explained that biomechanical approach is ideal for the detailed analysis of technique related to field sports [performance.

Kinematics as earlier discussed is a subdivision of Biomechanics which uses mathematical representations to describe motion of athletes. Kinematics describes motion characteristics while kinetics describes force characteristics (Sasaki, et. al 2011). Hall (1999) describes kinematics as a description of motion including the patterns and speed of movement, sequencing by the body segment that often translates to the degree of coordination an individual displays. Kinematics involves the studies of geometry, patterns or forms of motion with respect to time. Wells and Luttegens (1993) referred to kinematics as the geometry of motion that describes the motion of bodies in terms of time, displacement, velocity and acceleration. The motion may be in a straight line which is referred to as *Linear Kinematics* or about a fixed point as in the joints of the body referred to as *Angular Kinematics*

Kinematics is not concerned with the forces which cause the object or the body to move, but concerns itself with the type of motion that is made from what position, displacement, velocity, acceleration and time of the movement. Sport kinematics analysis therefore studies the positions, angles, velocities and accelerations of body segment and joints during motion. When people or athletes learn a new motor skill or sport skill, a progressive modification of movement kinematics reflects effectiveness of the learning process. Is the skill correctly reproduced at the appropriate speed or velocity, or the form or pattern well sequentially coordinated? Answers found in the case of jump shot in basketball will determine whether the techniques were correct or not and may be improved.

2:2:1 Kinematic Concepts of Motion

Motion has been defined as the act or process of changing place or position with respect to time. Time of motion from a starting point must be located and the resultant motion described in terms of that point. The description of that motion, regardless of whether translatory or angular, may deal with how fast the object or human body has moved or how far it has moved. As earlier stated, Wells and Luttgens (1993) description of kinematics of motion with respect to displacement, velocity and acceleration makes it clear that forces causing or modifying the motion is not considered in the study of kinematics. Kinematics allows one to look at movement in terms of space, time and direction.

Relationships among displacement, velocity, acceleration and time may be expressed in equations of motion

$$V = u + at \qquad (1)$$

$V = u + 1/2\ at^2$ (2)

$V^2 = u^2 + 2\ as.$ (3)

Where V= velocity; u= initial velocity; a= acceleration; t= time; s= distance

(Hall, 1999; Well & Luttgens, 1993)

Angular Kinematics

The human skeleton is made up of a system of levers, and by definition are rigid bars that rotate about fixed joint when force is applied. The rate of rotatory displacement is called *angular velocity and is represented by* the symbol 'ω' called Omega. Angular displacement (ω) is equal to the angle through the radius turns divided by the time it takes for the displacement. $\omega = \theta/t$ and it is expressed as degrees / second, radians / sec. or revolutions / sec. Most human motions are highly variable and not uniform. The longer the time span through which the displacement is measured, the more variability is averaged. Moving the body segment at a high rate of angular velocity is a characteristic of skilled performance in many sports (Adrian and Cooper, 1995; Hall, 1999).

The angular kinematics quantities, which are angular displacement, angular velocity and angular acceleration, possess the same interrelationships as their linear counterparts. Angular displacement represents change in angular position, angular velocity defined as the rate of change in angular position while angular acceleration indicate the rate of change in angular velocity during a given time. Therefore human motions mainly compose angular movements and this must be maximized for optimal performance through correct configuration of the arm segments during training and practice.

2:3 Intervening Factors of Movement Analysis

Analyst should be aware that every performance of a motor skill is affected by the characteristics of the performer (Hall 1999). These include the performer's age, gender, anthropometry, the development and skill levels at which the performer is operating, and any physical or personality trait that may impact performance. Adrian and Cooper (1995) corroborated that the human body is not a machine, but a living entity which many factors can affect its performance. They listed them as muscle coordination, health and general condition of the person, level and type of techniques, readiness for action, previous experience, temperature, fatigue, anxiety, motivation, cultural setting, social expectation, gender and age of participants all to determine athletes' movement performance, including basketballers. These factors are causes of inter and intra variability in the performance of shooting by basketball players in shooting at all levels. If technique of jump shooting is wrongly learnt at the beginner's stage, this further affects the level that such a player may attain in his/her basketball career.

The possession of many unique modification of common anatomical structure by human being makes them not to have the same potentials to perform all movement to the same level of success; hence the need for kinematic analysis of each basketball player's technique in order to identify each one of them's unique characteristics, to optimize performance. The understanding of players' uniqueness will go a long way to positively influence basketball teams' performance in any championship. Therefore, there is a need to undertake individualized research analysis rather than group analysis, so that adequate information about each subject is available and will be beneficial for optimal performance (Button and Davids, 1999; Newell, et. al, 2001; Bartlett, 2007).

2:4 Kinematic Analyses of Sport Skills

Kinematic analysis covers both qualitative and quantitative forms of analysis. This involves identifying and then studying or analyzing and finally answering the problems of interest. Careful kinematics analyses of performance are invaluable for clinicians, physical activity teachers, and coaches. The analysis of Basketball shooting is not only valuable to coaches and physical educators, but also to the players .Like the basketball shot in Nigeria, it has been found that players, in the forty minutes playing time, hardly made forty percent of the jump shot, thus making kinematic analysis of Nigerian basketball players' jump shot very significant. There is a need to use kinematically analyse players shooting technique in order to be able to describe, correct, and improve shooting performance of basketballers.

2:4:1 Qualitative Methods of Analysis

Qualitative analysis methods are also referred to as *subjective* methods (Marshall &Elliot, 2005), involving a non- numerical evaluation of a skill, that is only observation of the performance is done without any measurement collected and logical judgment is then made. This is most frequently performed during direct observation of the movement. It is a *natural characteristic* of good coaches and clinicians. This is the description of quality without the use of number. This skill can be learned and improved through practice. Qualitatively describing kinematics of human movement will entail identifying the joint actions, including flexion, extension; adduction / abduction, rotation and so forth and detailed qualitative analysis might describe the precise sequencing and timing of body segment movement which culminates to the degree of skill evident on the part of the performer, like a basketball player when the coach repeatedly watch a particular skill (Hall, 1999).

Most qualitative analyses in sports, especially by coaches are carried out by visual observation, and as pointed out by Hoffman (1984), performance deficiencies may result from errors in technique, perception, or decision making. Hall (1999) responded to this that it will require more than visual observation to solve the performer's problem, making combination of both qualitative and quantitative analyses imperative in order to be able to scientifically prove our value judgment with facts. Basketball, a fast and explosive game, will also require more than visual observation in order to identify, analyze, correct and improve performance. In order to obtain correct information in this present study, quantitative analysis technique was used. Therefore, for viable kinematic study, quantitative analytical method needs to be undertaken for correct value judgment.

McPherson (1988), Hay and Reid (1988) proposed the employment of pre-observation phase, where a *model* of the skill to be analyzed is developed and mechanical variables concerned and their relationships are described (for example, the model of the free-throw shot by Gablonsky and Lang, 2005). From these modeled variables, the critical variables in the movement are determined and a method for observing these characteristics during the subject's performance is planned. This plan usually should involve repeated observations from selected viewpoints and may utilize some recording device such as a video-tape recorder. The same procedure has been used by coaches in teaching the basketball mechanics especially in the advanced countries, but not a common phenomenon in Nigeria, especially in teaching shooting techniques. This is because of lack of adequate information and accessibility to databases on part of the coaches. Furthermore, sports scientists do not make their findings available to the coaches and athletes.

There are two main sources of information available for diagnosing, and this include; i) kinematics or technique exhibited by the performer and

ii) The performance outcome. The result will enable the researcher to suggest ways to correct and improve the techniques. These include ensuring that body segmental configuration are properly aligned with the flexion of shoulder, preceding elbow extension, increasing the release height and release height ratio and using the correct angle and the velocity to produce good shot.

2:4:2 Quantitative Methods of Analysis

This method is otherwise referred to as *Objective technique* in biomechanical analysis. This is the collection, measurement, and evaluation of data from the activity of interest. Quantitative analysis implies that numbers are involved, According to Hall (1999) sports biomechanists often quantitatively study kinematic features that characterized an elite performances of a particular athlete. Sometimes, this type of analysis results in constructing a model that details the kinematics characteristics of sound performances for practical use by coaches and athletes as done by Gablonsky and Lang (2005) for free throw. Quantitave analytical method therefore is appropriate and will be adopted for this study in order to be able to give correct evaluation of kinematic characteristics of female basketball players in Nigeria.

Quantitative technique analysis relies on biomechanical data collection to identify key technique variables that affect performance, which are distinguished from other variables that affect performance. A quantitative technique analysis may be ideal for detailed evaluation and diagnosis of some part of a sports technique, but it is time consuming and may be unsuitable for identifying the characteristics of the overall body motion pattern (Michiyosh, Yu, Hiroyuki, & Norihisa, 2007).

At any level of movement analysis, there is a need for interaction between the coach and biomechanists if maximum performance is to be achieved. Objective or quantitative evaluation of movement requires that a permanent record be collected for a number of trials so that each can be viewed and analyzed. Recording of permanent data on movement may take a number of different forms; for example cinematography, videography, electromyography (EMG), accelerometer, dynamometry, electro goniometry or accelerometer, though some of these techniques may not be available for general use (Marshall and Elliot, 2005).

Videography, however, is readily available for studies and will be taken advantage of in this present study of Nigerian female basketballers.

2:5 Tools for Quantitative Analysis of Sports Movement

The tools used in the study of biomechanics of sports movement determine the types of analysis that are possible and the selections of tools depend on the types of measurements that are needed to be taken. According to Adrian and Cooper (1995) and Hall (1999), the nature, type and magnitude of data are limited by the tools we select. Therefore there is a need to ensure that appropriate tool is selected for a particular research analysis, the desire, types, precision and amounts of data needed, not the tool available, should dictate the selection of tools. Some of the tools include a variety of timing devices (chronoscopes), such as stop watches , counters, digital timers, switch mats, photoelectric cells, real-time computer clocks, and laser tubes which are now used to record speeds of the human being and its body parts. Others are electrogoniometre, accelerometer, force platforms and forceplates, electromyography and tracking methods like cineradiography, magnetic resonance imaging and computerized optical systems. Since kinematic analysis is the focus of this study, two-dimensional video recording of players shooting at three distances at 50 frames per second is adequate.

Adrian and Cooper (1995) pointed out that assessment may range from a rather superficial and grossly defined explanation of the movement pattern to a precise, analytically detailed numerical evaluation of each aspect of the movement. Although teaching, coaching, and clinical diagnosis have relied on the eye and brain, advanced technology is becoming a common part of these situations that sports scientists and coaches need to take advantage of.

2:5:1 Types of Measurement Systems

There are two major measurement systems for biomechanical analysis of sport movement. They are

1) Image analysis techniques and 2) Non- image analysis techniques.

2:5:1:1 Image analysis Techniques;

Image analysis techniques include both movie photography (cinematography) and videography. They provide the opportunity to capture complex movement sequences on film or video tape so that a detailed analysis can be performed (Marshall & Elliot, 2005). Both movie photography and Videography involve sampling processes that record information at discrete points during a continuous motion. Therefore, there is a need to understand the sampling frequency relative to photography or videography before discussing different image techniques.

Sampling Frequency- The sampling rate needed for an accurate representation of movement must be at least twice the value of the highest frequency (Shannon's sampling theorem; Marshall & Elliot, 2005). Although many researchers believe that sampling rates of 5 to 10 times the maximum frequency are necessary, but excessive sampling' either increases the cost when using high speed photography or limits the choice of cameras when using high speed videography; while 'under sampling' will cause vital movement characteristics to be missed, or distortions to arise (Marshal and Elliot, 2005).

At subjective level of analysis, film or video techniques may be used to record movement and allow general comments to be made on the observed characteristics of the players. However, at the objective level, as in this type of study, it is not sufficient to just record and observe movement, therefore specific equipment and procedures must be used if accurate objective data are to be collected using image analysis techniques. This position supports the earlier findings or suggestions by Hall (1999) and Marshall and Elliot (2005).

2:5:1:2 Types of Image Analysis Techniques

Image analysis techniques are of two types; *Cinematography* and *Videography.*

Cinematography

This is the motion photography. Marshall and Elliot (2005) confirmed that the collection of data from film for analytical purposes (digitizing) is the most time-consuming and tedious aspect of cinematographic research. This is because a stop action projector can move an X-Y co-ordinate system, until a pointer, pen, and light across hairs lie over the desired anatomical landmark to be digitized. The co-ordinates of these points are then stored on a computer. In order for the anatomical landmark to be located, it must be clearly marked on the subjects being filmed, so that an accurate identification of the segmental endpoint or joint centre is possible. These co-ordinates data are then smoothed, prior to being mathematically manipulated in the calculation of kinematic and kinetic data. A large sweep hand clock may be included in the photographic field to establish the frame rate of the camera. Internal camera lights which flash at a set rate may be used to mark the film and allow film speed calculation. A spatial scale, such as large meter rule, must also be filmed in the plane of the action to convert film scale measures to real values.

High speed photography permits a relatively flexible approach to data recording, with acceptable accuracy and minimal interference, to the subject's movements from the attachment of external measuring devise. Film costs' and time delays caused by processing and digitizing make film less than perfect medium to study motion. However, earlier and recent researchers in basketball used cinematography to analyze free throw (Hudson, 1974, and 1982), and jump shot (Poon, 1965; Szymanski, 1966; Scolnick, 1967; Penrose and Blansksby, 1976, Miller and Bartlett, 1996).

Advances in electronic image analysis technology now permits other techniques, which are frequently videotape based, to compete with film as a convenient, and accurate and cost effective tool to collect objective data on movement which recent researchers in sports like basketball are taking advantage of .

Videography

The word *videography* was derived from early Greek and later Latin word '*Video'* meaning ´I see' or 'I apprehend' with Greek terminal ending '*Graphy*' which means 'to write', Videography refers to the process of capturing moving images on electromedia such as the videotape or hard disc (The American Heritage Dictionary, 2004: Wilkipedia, 2006)

Video image analysis enables the user to analyze 2D or 3D motion patterns, but record the images from the camera(s) on videotape. This provides not only an image that can be viewed at a later date, but also the opportunity to modify and re-analyze the recording of the motion, a feature not available with the optoelectronic systems. This system also produces a wider user base in sports biomechanics. It is well documented that the collection of data from these approaches is far quicker than film analysis (Adrian & Cooper, 1995; Hall, 1999; Li & Buckle, 1999; Marshall & Elliot, 2005). Adrian and Cooper (1995) said taking advantage of advanced technology is possible without a great deal of training or money, since video systems are inexpensive and readily available to the practitioner, technician and general consumer. They highlighted the advantages of videography over cinematography as; the ability to synchronize two images on one screen, which is possible by means of a split- image, special effects generator; the direct and immediate transmission of the image to a computer, eliminating the human operator required in photographic analysis; and the direct playback capability to provide immediate feedback to both analyst and performer.

Hall (1999) explained that because of the wide spread availability, durability and ease of use of modern video cameras and playback units; video has become the most common motion picture medium used for qualitative analysis of human movement today. This could be taken advantage of by sport scientists as well as in this present study to not only describe and improve athletes' performance, but to put Nigeria at par with the world standard in sports, especially basketball players, the focus of this study..

Researchers have pointed out that an important consideration is the number of cameras required for adequate capturing of the motion, since most sports movement is not constraint to one plane of movement, therefore it is necessary to use two or more cameras to ensure that all of the movements can be viewed and recorded accurately for a detailed analysis (Marshall & Elliot, 2005). However, Hall (1999) added that when practicality dictates, a single camera can be used, especially in the case of Nigeria, but thoughtful consideration should be given to camera positioning relative to the movement being understudied. Such practicality applies to this study where biomechanics' laboratory and equipment are not available. Therefore, when human motion is occurring perpendicular to the optical axis of a camera are angles present at the joints viewed without distortion.

In the past, the major disadvantage of videography was the low resolution of videotapes, much lower than that of the highest quality movie film. Recently, this disadvantage has disappeared with the availability of the SVHS and Hi 8 formats in camcorders. These camcorders also have inputs to computers and frame by frame forward and reverse playbacks. Due to high technology also, videography has nearly equally outdistanced cinematography in computerization, filming rates (20,000Hz) and interfacing capabilities with other tools. Interfacing videography with a microcomputer is the least expensive high tech system for analyzing movement (Adrian and Cooper, 1995;

Hall, 1999; Marshall and Elliot, 2005). Therefore, this study is adopting a cost effective use of interfacing Videography with microcomputer to store, digitize and analyse the transformed images.

Advantages of Image Analysis Techniques over Non-Image Techniques

The advantages of the 2-dimensional or 3- dimensional motion analysis system over the other observational and direct measurements methods are that several joint segment movements can be recorded simultaneously for different actions; data analysis is simplified with the help of the sophisticated software; and the recorded data can be linked to particular activities (Li & Buckle,1999). Though, the image digitization can be very time consuming and the markers or positions of the body joints can be blocked or obscured by the body segments or objects handled, proper selection and positioning of the joint markers will eliminate or reduce the measurement error (Bauman et. al, 1998; Li & Buckle, 1999; Marshall & Elliot, 2005). However, for some sports movements, high speed cameras are required, though they are very expensive. Adrian and Cooper (1995) explained that many sports activities can be filmed at 80-150 frames per second if the shutter exposure time is short enough to reduce or eliminate the movement blur. Furthermore, if the camera is required to capture instances within the movement pattern, the camera will need to operate at the rates of between 150-300 frames per second for high speed movements as in contact of the tennis ball with the bat or racket. However, the type of movement to be recorded dictates the camera to be used.

For basketball shooting analysis, video cameras of 50-60 Hz have been widely used (Hudson, 1982; Miller & Bartlett, 1993 and 1996; Malone et. al, 2002; Todd & Wang, 2004; Satti, 2004; Skoglund et. al, 2005) while Sibila, Pori and Bon (2003) used video camera of 25 frames per seconds to study the kinematic differences between two types of jump shots techniques in handball. This indicates that video cameras with lower resolutions could be used in the absence of high speed cameras for shooting in basketball. The study however, is adopting the 50 frames rate.

Image analysis techniques also provide a permanent and visual record of performance and can be revisited and used for further studies of basketball players especially our Nigerian players in order to follow trends of their improvements, individually and as teams including the coaches' techniques of grooming players.

2:6 Anthropometry and Performance

Description of athletes and analysis of their performance concern Kin anthropometry, which is the study of human size, shape, proportion, composition and gross motor function in order to understand growth, exercise performance maturation, and dietary interventions. According to International Society for the Advancement of Kin Anthropometry (ISAK) (2001), anthropometric dimensions give a good description of the body as a whole (ISAK 2001).

Anthropometry is the branch of anthropology which concerns itself with comparative measurements of the human body composition and its type. Anthropometrics is the process of measuring dimensions of the human body and these measurements are then used to either describe size and proportion or to indirectly estimate body compositions (Toriola, 1999; Ajayi-Vincent, 2003).

Basketball is a game in which body weight, height, long limbs are pre-requisites and require specific body types and proportion for positional plays (Okuneye & Osman, 1996; Ackland, Schreiner & Kerr, 1997). Therefore, variability in kinematic parameters may be affected by the players' body dispositions.

The physical characteristics of athletes have long been associated with success or failure in sport competition. Agbonjimi (1985) observed that a panoramic view of physique and performance will show a striking relationship between physique and performance in most sports, and this may be less than obvious in others as that of stature and Basketball. This is supported by Reilly, Seecher, Small and William (1997) that individual physique and body composition either greatly limits or in some instances predisposes individual successful participation in one activity or the other. Oranugo (1995) added that competitive sport demands the utmost from the body and it is reasonable to expect to find in athletes' demonstration of the relationship between structure and function.

Height or stature and its reach play crucial roles in sports, especially in basketball playing ability and scoring. In the Oranugo's (1995) review of anthropometric variables of age, height, weight and somatotype of Sandi ego University students of Iowa, USA; USSR, and New Zealand Olympic professionals as well as and University of Ibadan's basketball players, all these traits were found to have significant relationship to winning in elite competitions.

2:7 KINEMATICS OF BASKETBALL SHOOTING

Basics of basketball are the fundamental movements. They are the essential tools for each player to learn in order to move effectively and also efficiently to maximize performance in basketball. Krause, Meyer and Meyer (1999) defined basketball as a game of balance and quickness, with all movement focused on the purpose of conceiving time and space and to reduce wasted motion. They espoused that basketball is a game of quickness, of hand and foot and spread of overall body motion, used at the proper time. Coaching or teaching the basic skill therefore should continually emphasize the principles of doing things right, doing things quickly and then making the right move quickly at the right time.

The game of Basketball involves throwing and catching, running, shooting, dodging, jumping and landing and striking. The rebound principles of striking are involved in the dribble and in the use of the backboard when shooting. (Broer & Zernicke, 1979). However the various method of throwing to another player or to the basket utilize all three basic throwing pattern: underhand, overhand, sidearm and variation of these patterns. The major ball handling skills in basketball includes passing, catching, dribbling and ends up in shooting to score. The arm mechanics according to Krause et al (1999) and Broer and Zernicke, (1979), ball handling skills of passing, dribbling and shooting are almost identical – the arm and hand motion is the same for each skill. The variability is found in angle of release, velocity of release, direction and distance, including the objective of the throw.

2.7.1 Shooting

Shooting is a type of specialized throwing action in which the ball is usually propelled upward toward an elevated target. Wooden (1980) as cited by Adrian and Cooper (1995) calls this throws 'a pass to the basket'. According to Krause et. al (1999), shooting is one of the best known fundamental skills that can be practiced alone and produces immediate feedback, while Malone, et. al (2002) said out of the basic skills, shooting can be considered as the most important for determining the score and outcome of a game. Adrian and Cooper (1995) opined that, one of the most difficult and perhaps, the most important skills in basketball is shooting. Shooting is characterized by slight and almost imperceptible medial rotation at the shoulder, by extension at the elbow, by forearm pronation, and by flexion at the wrist. A clear understanding of the extent of these actions is necessary.

Hay (1994) as cited by Tsai, et. al (2006) explained that shooting is the basic way to get score in basketball and for this reason it is the most frequently used technical action. The search for the determinants of success is compounded by the nature of shooting which allows for endless combinations of segmental contributions in conjunction with numerous projection angles and velocities, which can result directly or indirectly fall through the basket (Hudson, 1982). However according to Adrian and Cooper (1995), shooting should be intuitive, and that change in shooting style are difficult to perfect for the older player. Therefore players should learn the correct motion as youngster and corrected to a degree later because *bad habits die hard*. A player usually has only a few tenths or hundredth of a second to make decision on range, angle, and the velocity, and the path of the ball.

2:7:2 Determinants of a Successful Shot

From the moment the ball is released, the ball becomes a projectile, and is therefore subjected to the laws of motion and the factors that determine the path of a projectile which include height, angle, and speed at release (Miller and Bartlett, 1993; Malone, 1999). Although air resistance during flight is a factor in projectile motion, it is typically regarded as having little effect on basketball shooting due to the relatively low speed of the ball (Hay, 1985, 1993). Miller and Bartlett (1993), citing Hay, (1985) added that the effects of air resistance may be ignored as, despite a large cross-sectional area, the velocity of the ball through the air is relatively small, the latter aspect being more influential factor in determining drag forces.

Miller and Bartlett (1996) identified speed of ball release, angle of ball release and height of ball release as the three determinant factors for a shot that will be successful. Adrian and Cooper (1999) said, though the mechanics for preparing for the shots prior to launching are different; the release mechanics is the same.

The best shot therefore, does not pass through the centre of the hoop. The best trajectories pass through the hoop somewhere between the centre and the back of the rim (Gablonsky and Lang, 2005). Gablonsky & Lang (2005) from their model of free throw advised that taller players should shoot closer to the centre while shorter players should aim more towards the back rim (see appendix for the model of optimum trajectories for basketball players of various heights).

2.7.3 Projection of the Ball

At release, the ball becomes a projectile, and is therefore subject to the laws of projectile motion and the factors that determine the path of a projectile include height, angle and speed at release

For a certain release height, there will always be a range of projection angle and velocity combinations that will allow the ball to go into the basket. For any increase in projection angle, the velocity must increase at a greater rate (Malone, 1999). Satti (2004) in his own search for the perfect basketball shot concluded that though, no single factor is responsible for determining a good shot, but it is the right combination of both the angle and the right velocity provided the horizontal and vertical distances remain constant. He added that no one projection angle that would yield the perfect shot, but it is the combination of both the initial launch velocity, the angle of projection, the diameter of the ball as well as the rim. Each factor is more or less dependent on each other to get a perfect shot. Knudson (1993) indicated that velocity of the ball at release may be the significant factor determining shot success. Other researchers also suggested that vertical velocity of the body contributes to the ball's vertical velocity (Tsarouchas, Kalamaras et. al 1990; Walters et al, 1990) while Brancazio (1981) reported that for an appropriate angle of release, error tolerance in the correct ball speed is about 1%.

Therefore, release angle, release velocity of the body segments are imperative to good shooting, and this is dependent on the height of the shooter and the release height relative to the appropriate velocity plus the angle of release. From Hudson's (1982) research conclusion, a greater ratio of height of release to standing height is related to higher skill, while angle and velocity of projection, taken independently, are not related to skill level.

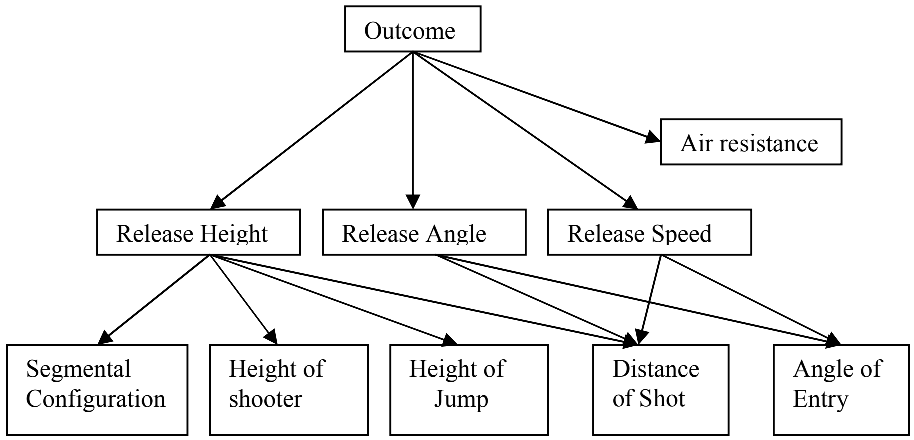


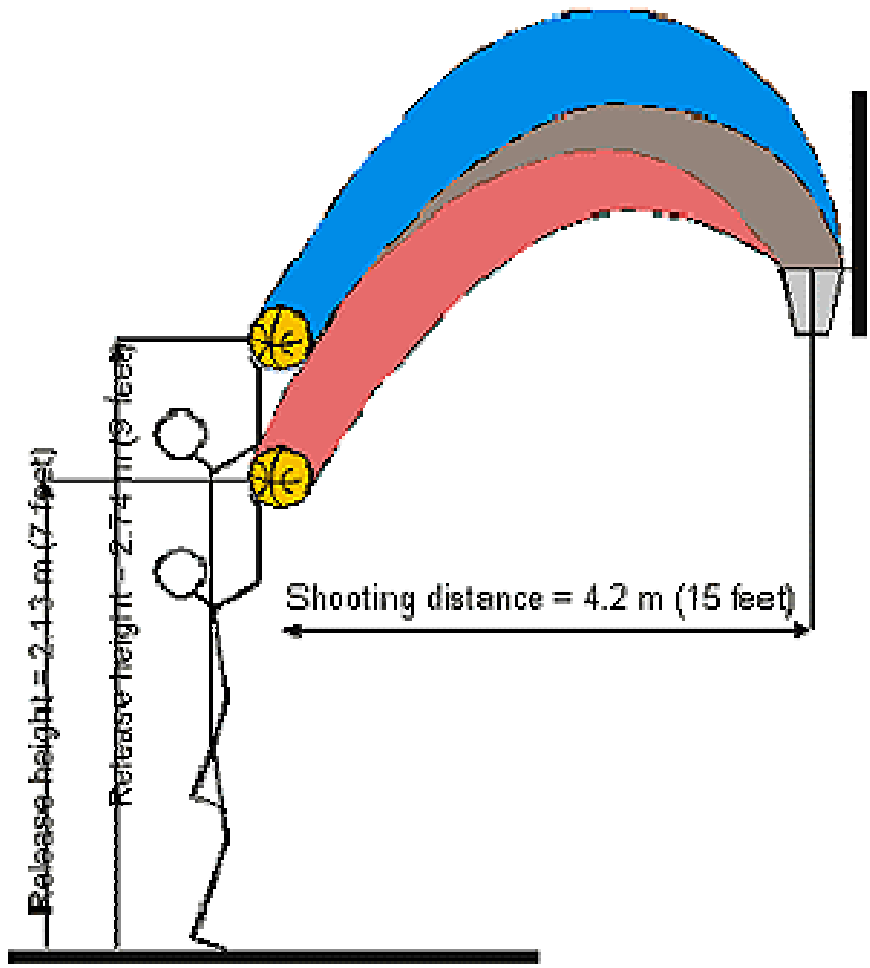
Figure2: Basic Factors determining Shooting Outcome (Miller & Bartlett, 1996)

2.7.4 Release height

The physical characteristics of the performer (Martin, 1981) and the position of the player's body at release (Hay, 1993) will determine at what height the ball is released during a basketball shot. It has been shown by Brancazio, (1981) mathematically, that shots released further from the ground are more likely to go through the basket. This is because a high release increases the size of the arc (trajectory) through which the ball can travel and still go through the basket. Furthermore, the higher the ball is released, the less time it is in the air before reaching the basket and the less time for off line velocity to act (Alexander, 2005).

As indicated by Brancazio (1981), as release height of the ball decreases, the necessary force and projection speed increase and the margin for error decrease, while Kreighbaum and Barthels (1996) explained that the closer the release height is to the height of the basket, the smaller the required angle and velocity of ball projection. Therefore, given equal ability to shoot, a shorter player is at a disadvantage compared to a taller player because of a decreased margin of error (Malone, 1999).

Brancazio (1981) as cited by Miller (2006) gave the example of changing the release height of a shot from 2.13m (7 feet) to 2.74m (9 feet), for which the width of the arc that would result in a successful shot increases by 17% In the diagram below, the blue 'scoring band' associated with a release height of 2.74 m (9 feet) gives a margin for error 18% greater than the red scoring band.



The obvious significance according to Miller (2006) is that players should be encouraged to develop a shooting technique that has a high release point. First of all by releasing the ball higher with respect to the body, that is, above the head can be achieved by flexing the shoulder, which raises the elbow. The second way to increase release height is to raise the body as high as possible - usually by jumping from the floor - and releasing the ball close to (but not after) the top of the jump (Miller, 2006).

Hudson (1982) however reported that there is unanimity among experts that a high point of release is desirable and that authors like Barnes (1966) Shutts (1969) and Wooden (1966) Schaafsma (1971) favoured a high release point because it is characteristic of good shooters.

Mortimer (1951), Cooper (1969), Cousy et. al (1970), Brancazio (1981) and Maugh (1981) prefer a high release point because

1. it decreases the distance to the goal
2. it decreases the minimum angle of projection
3. it decreases the minimum velocity of projection
4. it increases the margin of error ; hence increasing the chances of scoring as the height of release is increased.

From the above premises, suggestions were made by several authors on how to achieve a high release;

i. Using more flexion at the shoulder (Rush 1976; Alexander, 2005; Miller, 2006);
ii. Employing greater extension at the elbow (Mullaney, 1957; Hudson,1982; Adrian et. al, 1995; Miller and Bartlett, 1996: Alexander, 2005: Miller, 2006)
iii. Releasing the ball as the arm segments complete the range of motion (Tarkanian, 1981; Adrian & Cooper, 1995; Alexander, 2005)

A greater ratio of height of release to standing height, therefore, is related to higher skill and is one of the best predictors of shooting success (Hudson, 1982). Cousy and Power (1970) noted that the range of a shot is decreased with a higher release point, thereby making it more accurate, and this was buttressed by the results of Hudson's (1982a, 1985) studies in which she compared three groups of women basketball players with different skill levels. She found that the most skilled players released the ball (27cm) higher than the lowest skilled group and such players demonstrated greater flexion at the shoulder than the poorer performer. Successful shots were released at an average of 4 cm higher than those that were unsuccessful (Hudson, 1982).

2.7.5 Release angle

Release angle is a result of the position of the body segments and the resultant velocities of the segments end points at release (Elliot, 1992: Miller and Bartlett, 1992). To make the ball travel through the centre of the basket with a given velocity, the seriousness of a one degree error in the projection angle increases as the angle increases (Mortimer, 1951). Maugh (1981) indicated that using an angle of projection that is too small, which reduces the margin for error, is the most common fault in basketball shooting.

Gablonsky and Lang (2005) commented that some players shoot wrongly because they are shooting the ball at the wrong angle. Secondly, the shorter a player is, the larger the release angle should be. This makes sense physically as shorter people have vertical distance to cover when shooting than taller people. Similarly, someone who has serious trouble shooting with consistent release velocity should release the ball at a slightly higher angle than the average shooter. This further buttressed the observation of McGinnis (1975) that angle of ball release is to be closely related to the height of player than to the level of skill.

Based on the relative diameters of the ball and the basket, the smallest angle that the ball can approach the basket and still go through the hoop according to Hay (1993) as cited by Malone (1999) is 32º42’. For a shot taken from a distance of 4.57m (free throw line), Hay (1993) suggests a projection angle between 49º and 55º at a release height of 2.13m.

The angle of release at any distance is positively related to the angle of entry of the ball into the basket (Miller and Bartlett, 1996). This implies that there is a trade-off between the respective advantages to be gained from an increased margin for error when the ball passes through the basket, resulting from large release angles, in which the ball enters the basket more steeply, and those from an increased margin for error in release speed and angle for values of the latter which require close to the minimum release speed (Brancazio, 1981). Based on the allowable margin for error, Hay (1994) determined optimal release angles for a 4.57m shot to be in the range of 52º-55º. Alexander (2005) determined the angle of release of the two groups he studied to be 45-50. This variability indicates that there is no actual release angle for a successful shot, but peculiar to the disposition of individual or group of players.

2.7.6 Release Speed

Release speed is determined, to a large extent, by the angular velocities of the joints of the shooting arm and the linear velocity of the shoulder of the shooting arm at the moment of release (Miller and Bartlett, 1996).

The higher the angle of projection, the greater is the required projection velocity (Brancazio, 1981; Hay, 1993; Malone, 1999) and Hudson (1974) indicated that one of the best predictors for determining success of shooting is the velocity of ball projection. After experimenting with different combinations of release angles and velocities (with a given release height) (Malone, 1999), Mortimer (1951) determined that to achieve the most efficient shot a player should use the lowest possible projection velocity with an angle of release about 2º more than the minimum projection angle.

Miller and Bartlett (1992) depicted the approximate contributions made by each of the body movements to the speed at which the ball is released during shooting in the table below.

Movement	%Contribution to ball release speed.
Wrist flexion (snapping the wrist	59
Elbow extension (straighten the elbow	08
Shoulder flexion (lifting the upper arm)	14
Hip extension (straightening the hip)	6
Knee extension (straightening the knee)	- 2
Ankle extension (lifting heels off the ground	15

Presently, no data is available on release parameters of Nigerian basketball players except on anthropometric and general strength characteristics. It is noted that extending the knee is counter productive. From the above table, shooting is observed not to be all in the legs; only 19% of the ball speed is derived from leg movement, whereas 81% comes from the upper body.

2.8.1 Joint Kinematics

Joint displacements and velocities at the time of release will determine the release parameters of the ball (Elliot, 1992) and subsequent trajectory outcome (Malone, 1999). Movement of the upper extremity will largely determine the velocity of the ball (Elliot. 1991), and as pointed out by Miller and Bartlett (1996), the angular velocities of the shooting arm at moment of release will, to a large extent, determine release speed. Furthermore segmental configuration at release, especially of the trunk, upper arm and forearm segments also influences release height (Miller and Bartlett, 1996). According to

Alexandra (2005), in a mechanically correct shot, the wrist, forearm, upper-arm and right side of the body will be in a straight line and perpendicular to the floor (Ball, 1989; Hartley and Fulton, 1971). An increase in shoulder angle also increase release height within normal ranges of movement. However, common in shooting is to perform elbow extension, and shoulder flexion at the same time, so there is a lesser contribution from elbow extension in the shot as its contribution is combined with the shoulder flexion instead of adding to the velocity (Alexander, 2005).Therefore, shoulder flexion should precede elbow extension.

Flexing the wrist has been established both qualitatively and quantitatively to contribute importantly about 60% to the speed of ball, while shoulder flexion about 14% and elbow extension 8% (Miller, 2006). Wrist flexion is well established as important in generation of force and guidance of the ball release (Sharman, 1965; Martin, 1981; Malone, 1999). Martin (1981) as cited by Malone (1999), stated that, for a successful shot in basketball, the force resulting from the wrist flexion must be compatible with angle of projection and distance from the basket. But if the wrist and hand movements are started before the elbow, the ball will not receive proper back spin and will have no spin or spin around the incorrect axis, which will cause the ball to float like a knuckleball (Hartley, 1971; Alexandra, 2005). Therefore, the joints configuration must be correctly aligned to produce the desired outcome.

2:8:2 Jump shot and the Basketball Game

The jump shot is the most widely used today by Nigerian Players and other nationals, and when preceded by a fake, a quick accurate jump shot is almost impossible to block. Todd and Wang (2004) reported that basketball players have been using the jump shot favourably to score points during competition and it has been considered a very effective way in scoring points during competition. Allsen (1967) added that the jump shot was used 67.2% of 3,180 attempts recorded over 39 games. Likewise, most coaches feel the advent of the one hand shot has revolutionalized the basket game (Bartow & Smith, 1978).

The jump shot allows a shooter to elevate above defenders and reduces chances the shot will be blocked (Krause et.al, 1999; Todd & Wang, 2004). This results because the shooter is in the air (Wilkes, 1982). Todd and Wang (2004) explained that the widely use of jump shot is because of the opportunities provided to execute the shot, difficulty in defending it, and the increased range from which it can be taken. Cooper (1991) explained that since the successful offensive systems of the 1990s would spread out the floor, so the defensive team was forced to defend both inside and outside the defense zone. Research findings have established that shot accuracy increased when the jumping motion is vertical and the shot released at a higher cum minimum velocity. However, Szymanski (1967), Knudson (1993) as reported by Todd and Wang (2004), emphasized that any inadvertent movements in the air while performing the jump shot must be compensated for by adjustments of other elements within the shooting motion. This implies that the more adjustments in the shooting motion one had to make, the greater the likelihood of missing the shot. This may be one of the causative factors of poor shooting percentages among players during competitions. It is however established that successful jump shot is a product of a person's memory, how they remember how they shot, from where and with correct angle and velocity, achieved by hours of practice and playing (Darrick, 2003). Therefore, identifying and teaching proper technique will form permanent neural motor pathways in the central nervous system for better shooting accuracy and success.

2:8:3 Jump shot Kinematics

Jump shot has been established to be actually a one-hand shot as the dominant hand is always the last to touch the ball as it is being released. Adrian and Cooper (1995) summarized Yates and Holt's (1982) discussion of the jump shot as thus;

1. More successful shooters demonstrated a greater angle at the shoulder at the point of releasing the basketball. (lateral view)
2. More successful shooters used a similar elbow angle at the start of the shot than did the poorer shooters
3. A greater backspin during flight was associated with the high-performance shooters.
4. The successful shooters demonstrated a closer alignment of the upper arm with the vertical at release than in the lower-percentage shooters.

Cousy and Powers (1970) said that the jump shot can be executed from "a standing position, off a dribble and after a cut is made and the ball is received." While the mechanics of preparing for the shot prior to top launching the shot are different, the release parameters are the same. The mechanics used in the three-point shot are similar to the normal 2-point jump shot, however, since the distance from the basket is greater, and the trajectory of the ball is altered because the angle of release is steeper. The parabolic path is higher than a shot close to the basket, except for one launched within a very few feet of the basket over a taller opponent (Adrian and Cooper, 1995).

Many authorities believe that a one-step method is the best to use in an approach to execute the jump shot from a dribble, receiving a pass while stationary or while moving and receiving a pass (Adrian and Cooper, 1995)

Shoulder position. The "squared-up" position (right shoulder slightly in front of the left shoulder) is the one assumed by all performance in throwing and striking as the object is being thrown or struck. The basketball jump-shooter's position is comparable to the final position of all throwing action (Adrian & Cooper, 1995; Alexander, 2005).

The shooting Hand One key to a skilled shot is for the players to hold the position of the elbow in flexion (bent) while the shoulder is flexing at the beginning of the arm movement (Alexander, 2005). The starting position of the elbow is not important as the release position. Some coaches believe that elbow of the shooting arm should be pointed toward the basket as the ball is released Lehman (1981) said that elbow should be kept within the plane of the body, not lateral to the body. The elbow must be kept directly under the ball during elbow extension so the ball is pushed directly upward to the basket. (Haskell, 1985) Some players make the mistake of lining up their nose with the target and not the shooting shoulder. The ball must be kept lined up with the shoulder, and not with the midline of the body (Meyer & Litzenburger, 1974). Alexander (2005) analyzed the sequence of the upper body to be trunk extension, shoulder flexion, and then elbow extension and wrist flexion together. A common error in shooting is to perform elbow extension and shoulder flexion at the same time, so there is a lesser contribution from elbow extension in the shot as its contribution is combined with the shoulder flexion instead of adding to the velocity of the hand.

Hand position. The hand position in gripping the ball for the shot is generally thought to be one in which most of the ball rests on the fingers The ball comes off the index and middle finger last and the angle between the thumb and the first finger when holding the ball is about 70degrees (Krause, et. al, 1999). As a rule, however, a true palm shooter is an unsuccessful shooter. Sharman (1965) believed the thumb and the index finger of the shooting hand should form a V and should be in line with the shoulder of the shooting arm. Strength of the shooters, distance from the basket, and position and size of the defender are among the variables that helps determine release point.

Release of ball Shooting occurs at the peak of the jump because at this position the upward momentum and the force of gravity are neutralized. A shooter who is a long distance from the basket (35 feet\10.67m or more) may release the ball on the way as in the 3- point shot. At release, the shooter must have control over the speed of the movement and the angle is about 60 degrees above horizontal. However, most authors suggested release angle of 52-55 (Brancazio, 1981; Hay, 1993). Most players release angles are too low, which decreases the available target from above and lowers shooting percentages. Therefore high release angle is better.

Non shooting Hand The non shooting hand should drop off the ball just prior to the instant of release (Hartley & Fulton, 1971; Penrose & Blanksby, 1976), so that the shooter can retain control over the ball as long as possible. A study of jump shooters revealed that top players removed the non-shooting hand from the ball significantly later than did average group (Penrose and Blanksby, 1976), as the wrist is flexing for release, the non-shooting hand will drop off the side of the ball with the palm facing the ball. It is important that the non shooting hand remain in position facing the ball during release, so that it does impart any unwanted sidespin to the ball from lower arm pronation (hand facing backward) or supination (hand facing forward) during release. A common error in shooting is to rotate the non shooting hand to face forward or backward as it comes off the ball, to the possible detriment of the shot by imparting unwanted off center forces to the ball at release.

Follow-through The final phase of the shot is the follow through, in which all the joint continue to move through the end of their full range of motion following release of the ball (Alexander, 2005). The follow-through in jump shooting is a continuation of the shooting procedure. It prevents the shooters from stopping the shooting rhythm natural and smooth in transference of action from one component part to another (Adrian and Cooper, 1995). The shooting shoulder should be at least 140-150 degrees of shoulder flexion- the closer the upper arm is to the vertical the better the shot because the greater the vertical forces applied the ball. This movement of the joint to the end point of their range of motion will ensure that the joint do not stop moving prior to release of the ball, which would decrease the release velocity of the ball. The trunk should be rotated away from the shooting hand, to line up the shooting shoulder and arm more directly with the hoop. After the ball has left the hand the elbow should reach full extension. The wrist should be fully flexed, the lower arm should be in pronation and the fingers should be pointing slightly to the outside, indicating that pronation has occurred during the shot.

2:9 Critical Instant in Shooting the Basketball

The critical instant in shooting is the instant of ball release, since following release nothing the shooter can do will affect the flight of the ball. The shooting shoulder should be in 140-150 degrees of flexion, a position in which the shooting shoulder is almost pointing vertically to the ceiling (Alexander, 2005). As suggested by Alexander, (2005), a good coaching cue to look for is a near vertical shooting arm as the ball is released, to ensure optimal vertical velocity is imparted to the ball. The elbow should be approaching full extension at release, to ensure that this joint has made full contribution to the flight of the ball. However, there will be slight flexion in the shooting elbow, as the ball is released at the peak angular velocity of the elbow, and this occurs in mid range and not at full extension.

The wrist should be mid flexion at release, a position halfway between full extension and full flexion to ensure that the hand is moving at maximum velocity as the ball is being released. If the ball is released too early or too late, the velocity of the ball will not be optimum as the wrist and elbow joint will be spreading up or slowing down rather than being at peak velocity. Wrist flexion provides the final thrust for release of the ball and helps determine both the velocity and angle of projection of the ball (Hess, 1980; Martin, 1981; Alexander, 2005).

The optimal vertical velocity for a basketball free throw is between 6.0 and 6.3 metres \ sec, depending on the height of release; with an angle of release of 50-55 degrees (Brancazio, 1984). The theoretical angle and speed of release was determined experimentally to be 60 degrees and 7.3 m\s, but these values have not been measured directly from skilled player (Hamilton, 1997). The optimal angle of release of the ball is between 50-55 degrees to the horizontal (Brancazio, 1981); most shooters shoot with a lower angle of release than the optimal. In Alexander's study of two groups of elite university players, over 80% of the players released the ball at an angle of between 45-50 degrees showing variability between skilled and unskilled players.

From a player's perspective, attempting to reproduce a given angle ideal angle of projection is more difficult to execute since the ideal of projection depends on the distance from the basket (Schwark et.al, 2004). There are also elements of movement control other than mechanical efficiency that determine the particular mode of temporal organization in tasks requiring simultaneously speed and accuracy (Okazaki, 2007). Therefore other factors such as the distance from the basket, method of initiation of the movement, musculoskeletal conditions, training and opponents amongst others are some of the factors that affect release of the basketball shots.

2:10 Summary

Basketball is an exciting, highly competitive sport. To gain competitive edge required for success in Basketball, one needs to fully understand and develop the fundamental skills involved especially in shooting which is considered as the most important for determining the score and outcome of a game. An understanding and application of movement mechanics are necessary if an athlete's potential is to be fully developed; and that only when good technique is use in training practices and game matches can a player reach his or her full potential**.**

Kinematics is not concerned with the forces which cause the object or the body to move, but concerns itself with the type of motion that is made from what position, displacement, velocity, acceleration and time of the movement. Sport kinematics analysis therefore studies the positions, angles, velocities and accelerations of body segment and joints during motion.

The jump shot is the most widely used today and when preceded by a fake, a quick accurate jump shot is almost impossible to block. Basketball players have been using the jump shot favourably to score points during competition and it is considered a very effective way in scoring points during competition. Likewise, most coaches feel the advent of the one hand shot has revolutionalized the basket game. The jump shot allows a shooter to elevate above defenders and reduces chances the shot will be blocked. This result because the shooter shoots is in the air. Also, the widely use of jump shot is because of the opportunities provided to execute the shot, difficulty in defending it, and the increased range from which it can be taken. The defensive team is forced to defend both inside and outside the defense zone.

Evolution of the rules and tactics of the game of basketball has resulted in the three basic playing positions; centre, forward, and guard. Players in all the three positions are expected to contribute to a team's scoring. At release, the ball becomes a projectile, and is therefore subject to the laws of projectile motion and the factors that determine the path of a projectile include height, angle and speed at release

For a certain release height, there will always be a range of projection angle and velocity combinations that will allow the ball to go into the basket. For any increase in projection angle, the velocity must increase at a greater rate However for ball release, many researchers believe a high release angle is better because it decreases the distance to the goal, minimum angle of projection, minimum velocity of projection and increases the margin of error, but these be can achieved by using more flexion at the elbow and employing greater extension at the shoulder.

In basketball shooting analysis, video cameras of 50-60 Hz have been widely used Image analysis techniques also provide a permanent and visual record of performance. Image analysis techniques provide a permanent and visual record of performance. The advantages of the 2-dimensional or 3- dimensional motion analysis system over the other observational and direct measurements methods such as the Electrogoniometre and 44ccelerometer are that several joint segment movements can be recorded simultaneously for different actions; data analysis is simplified with the help of the sophisticated software; and the recorded data can be linked to particular activities. Though, the image digitization can be very time consuming and the markers or positions of the body joints can be blocked or obscured by the body segments or objects handled, but proper selection and positioning of the joint markers will eliminate or reduce the measurement error.

CHAPTER THREE
RESEARCH METHODOLOGY

3:1 Introduction

This Chapter deals with the methods and procedures that were used to collect relevant data for the study. The study was undertaken to identify the kinematics characteristics of arm motion in jump shot by Nigeria female basketball players in relation to the positions of play.

The chapter was discussed under the following sub-headings:

I) Research Design

II) Population of the study

III) Sample and sampling technique

IV) Instrumentation and Procedure

V) Methods of Data Analysis

3:1 Research Design

The research design for this study was three by two by three factorial design (3x2x3). This design was adopted because basketball players are of three categories based on position played namely; guards, forwards and centres. Two types of shots were also compared and analyzed namely; the successful and unsuccessful shots. Three shooting distances which are the common shooting zones in the game of basketball were chosen. Shooting from at 2.74m, 4.67m and 6.40m distances represented at least the zone of each of the player during play.

Position of Play	Type of Shot					
	Successful			Unsuccessful		
	Distance 1	Distance 2	Distance 3	Distance 1	Distance 2	Distance 3
Guards						
Forwards						
Centres						

3:2 Population of the Study

The population of the study comprised all the First Bank of Nigeria Female Basketball team tagged 'The Elephant Girls'.

3:3 Sample and Sampling Techniques

The Purposive sampling technique was used to select the First bank players because the team was the best in the 2009 National Women League. The team was to represent Nigeria at the West Africa Club Championship in Togo. The stratified sampling technique was used to select five guards, five forwards and four centre players each, who served as the sample for the study. This is a method of dividing the population by some characteristics on which they may differ (Thomas and Nelson, 1996). The players were stratified by positions of play (guards, forwards and centres). 14 players were selected from the 25 players that made up the team.

3.4 Participants

The participants were the fifteen female basketball players who were preparing for an International Club Championships. All the players had played at various national and international competitions and had varying basketball experience and proficiency. All the players are right-handed, and their age ranged from 19 to 25 years which is comparative to previous studies (Eddings, 1996, Rojas. et. al, 2000). They were provided with informed consent before taking part in the study. The coach objectively rated the players from 1-15 according to their shooting ability.

3: 5 Instrumentation and Procedure

The following instruments were used to collect data-

1. <u>Questionnaire:-</u> Questionnaire was used to collect personal demographic information data on the selected players. This included age; competition played and at what levels of play, years of experience, categories of exposure, training exposure.

2 <u>Basketballs</u>: The standard basketballs, Molten brand were used. These were used for shooting into the basket in order to get the necessary shots required for analysis.

I. For Accuracy test: Warm up was done prior to the shooting trials and a pre-test of 10 trials were conducted to classify the relative ability of each of the participant. This corresponded with the coach's rating. Each participant was then video recorded taking 30 experimental trials, in three blocks of ten (15 participants x three blocks x ten shots per block) for each of the shooting perimetre. Consequently, the total numbers of experimental shots were in three sessions, for both two and three point shots. The result of the experimental shots was not video recorded, but outcome scores were kept by the experimenter according to an objective rating system (Landin, Herbert & Fairweather, 1993; Button, et. al, 2006).

The researcher used the accuracy tests to measure and to compare players' performances in shooting accuracy with physical characteristics of height, weight and BMI.

Scoring System of the Accuracy Shots: 5-point scale was used and this was adapted from Landin et.al (1993) and Button et. al (2006) basketball free throw scoring system .

Score

1- Ball misses rim completely or hits backboard first

2- Ball hits outside of the rim and bounces away from the basket

3- Ball hits the top of the rim; would fall in or out of basket

4- Ball hits the inside of the rim and falls through the basket

5- Ball passes cleanly through the basket without touching the rim.

Measurements of Height, weight and Body mass Index (BMI)

The standard anthropometric protocol of international working group on Kinanthropometry (IWGK) as described by Ross and Marfell Jones (1983) were used in measuring height and weight. The standing height was measured in metres and centimetres. The weight was measured with the bathroom scale calibrated in kilogrammes. The subjects were dressed in minimal clothes and without shoes. The Body mass index (BMI) was determined by dividing weight by the square of height.

$$BMI = weight/\ height^2 = \frac{wt}{ht^2}$$

3.5.2 Videography

<u>Apparatus:</u> Panasonic Digital video camera, videotapes, basketball, survey poles, markers, television\VCR and masking tape.

i) **<u>Masking tape and markers</u>:** Masking tapes and markers were affixed on the vest for marking of bony landmarks following areas on the right arm; shoulder (glenohumoral joint), elbow, styloid process of the wrist, third metacarpophalangeal joint. Marks were drawn on the masking tape. This helped to eliminate some errors that might occur in the shooting process and plotting of dots (Skolung, et. al, 2005; Button, et.al, 2006).

ii) <u>Survey Poles:</u> Survey poles were used for the calibration of the activity space with sixteen control points. Four control points were calibrated at 0.0m, 0.8m, 1.60m and 2.4m on each of the survey poles.

<u>Research Assistants:</u> A total of ten (10) assistants were used. Two videographers, three recorders, five space calibrators were involved in the study. All the assistants were trained a day to the data collection. A simulated recording was carried out to prevent error and to ensure economy use of time.

3.5.3 Video Recording Procedure

Two digital cameras were used. A digital video camera was positioned to the right of the player's shooting position, perpendicular to the plane of intended motion of the ball. The other camera was positioned at about ten metres above the floor to enable a three-Dimensional performance images. The camera was mounted on gen-locked tripod. The optical axes were placed at approximately 70 degrees to maximize the accuracy of three dimensional co-ordinate reconstruction (Bartlett, 2007). Images were recorded on to videotape via video recorders. Following data collection, the video images of each trial was transferred to a computer as video files.

The co-ordinates of the external markers were used to calculate the following variables; release height of the ball, linear displacement and release velocity.

3.5.4 The Calibration

Four survey poles mounted in meters/centimeters were used for the space calibration. Three calibrations volumes were video recorded (4x3.5x2.4; 5mx3.5x2.4; 7mx3.5mx2.4m). The camera positions were not significant because the APAS software has been designed to use the reference points for space discreet positions. Prior to the recording of the shot, the space was calibrated for the purpose of data collection. The calibration space was sized to include the complete movement of the participants during all the three types of shot (2.74m, 4.67m and 6.40m) and to follow the path of the ball between 15 and 20 frames after release during recording .Wood and Marshall (1986) according to Malone (2004), explained that significant inaccuracies can occur in the three Dimensional reconstruction, if points of interest fall outside the field of calibration demonstrating the importance of this method. Therefore, the control points were located so as to surround the activity space, rather than be within the field as has been confirmed to produce greater reconstruction accuracy (Challis and Kerwin 1992; Malone 2004). A total manual record was kept to identify successful and unsuccessful shots.

3.5.5 Data Reduction

Ariel performance Analysis system (APAS 1972-2010) produced by Ariel Dynamics Inc. was utilized. Experimental testing by independent parties has found this system to meet clinical standards for reliability and validity (Klein and Deltaven 1995; Wilson, Smith & Gibson, 1997). The first step involved in data reduction was grabbing the specified video images and transferring them into a file for digitizing for each shot, the number of frames grabbed included ten (10) frames after the ball left the players hands to ensure that the same frames were grabbed from each view, the views from each of the two cameras were time matched. The next step was that specified points were digitized for conversion of the video image sequences to computer image sequences. From each grabbed file with every other frame used to define a sequence, the following points were manually digitized:

(1) Metacarpo-phalanges joint of the right middle finger (2) the right wrist joint (3) right elbow (between the lateral epicondyle of humerus and head of radius (4) right shoulder (greater tubercle of the humerus). (5) right hip (greater trochanter of the femur) connection were made between specific points to create the

following segments, i. Knuckle-wrist=hand, ii. Wrist to elbow=forearm iii. Elbow-shoulder-upper-arm. Iv .Shoulder-hip=trunk.

(2) The third step was the transformation of the digitized frame into absolute image space coordinates. The two-dimensional digitized view from each camera containing the X and Y position coordinates of each point were converted into three-dimensional image sequence using direct linear transformation (DLT) algorithm (Abdel-Aziz & Karara, 1971; Malone, 2004) implemented on the APAS system. The procedure of the DLT involves the use of the known image coordinates as well as the digitized coordinates of the control points as used by the APAS system to solve a set of simultaneous linear equations which related one of the coordinates to the other. This set of equations being over determined was solved using a linear least-square approximation which yielded the image space coordinates of each point, giving the digitized view coordinates of that point. With this method, measurement of the internal and external parameters of the cameras (for example, location and orientation, focal length and optical centre) was not needed (Allard, Blanchi & Aissaoui, 1995; Ladin,1995). Instead, by using a calibration procedure with a known set of control points, the relationship between the image space and each digitized views was directly determined. For a three-Dimensional (3-D) analysis, at least a six non-coplanar control points are required to solve the set of simultaneous equations (Abdel-Aziz and Karara, 1971). However, using more than the number of control points will allow additional unknowns to be added to the equations to account for the components of lens distortion and film deformation (Karara and Abdel-Aziz 1974; Malone, 2004). Malone (2004) and Shapiro (1978) suggested the use of 12-20 control points while Chen, Armstrong and Raftopoulos (1994) recommended the use of 16-20 control points to increase the accuracy of the

three-Dimensional. Based on these recommendations, therefore the present research used sixteen control points.

Trimming of the Video shooting sequence: To ensure that the same video sequence was captured for analysis for each of the participants, 10 frames after the shot was release was used to demarcate the frames for trimming each shot at 50 frames per second. The position of the body segments at take off and release of both successful and unsuccessful shots for five shots each were added together to get the mean and SD for the displacement and velocity parameters and these were recorded for correlation.

3.5.6 Smoothing of the Data

Due to inability to exactly locate the body joint centres when digitizing, small random errors referred to as 'noise' entered into the digitized data. This error has a frequency on the order of the digitized film or video frequently typically ranging from 30-200Hz,but human motion exhibits significantly lower frequencies ranging from 5 to 15Hz or less (APAS Users Manual 2011; Bartlett, 2007; Malone, 2004). Since the noise is above the frequency that can be found in true joint motion, it can be removed or attenuated with the use of the appropriate mathematical or filtering techniques (Wood, 1982; Bartlett, 2007). Therefore, the three-Dimensional coordinate data was smoothed using a Quintic-Spline algorithm with the smoothing factor of 0.5cm to1cm. According to Zernicke, Cardwell and Roberts (1976), Moleughin, Dillman and Lardner (1977) as reported by Malone (2004) and Bartlett (2007), spline functions are better suited for close approximation of human movement patterns than the global polynomials or finite differences technique.

3.6 Methods of Data Analysis

Five successful and unsuccessful shots were selected from each of the distances. Five successful and unsuccessful shots for each of the players for two and three point shots were selected for data analysis. This was to test intra-individual variability, while the shots for each group were later compressed together to find inter-individual variability (Schöllhorn and Bauer, 1998; Button, Davids, Bennett, and Tayler, 2000; Button et. al 2006).

Two key moments were identified;

i) Take-off: defined as the first field of the breaking of ground contact; and

ii) Ball release: defined as the first field in which hand/ball contact is broken.

Statistical Tools

The descriptive statistics of mean and standard deviation were used to describe the data, while inferential statistics was used to test significant relationships and differences.

For intra- individual analysis, the Pearson's product moment correlation coefficient ('r') was used to test significant relationship between the techniques used in the successful and unsuccessful shots. For inter-individual data analysis, one way ANOVA was used to find significant variability between the group trials in shooting accuracy. The level of significance was set at 0.05.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This study was carried out to determine the Kinematic characteristics of arm motion during Jump shot in Nigeria female Basketball players. The physical characteristics of height, weight and BMI were collected and compared with shooting accuracy. Kinematic data were collected with the use of Videography at the Ahmadu Bello University Sports Gymnasium on 28thMay, 2009. The data collected were statistically analysed using the Statistical package of the Social Sciences (SPSS package 14.0). The results of this analysis are presented in this chapter and the decision to accept or reject the stated hypotheses was set at 0.05 alpha level of significance.

4.2 Results

Before the presentation of the results according to the stated hypotheses, preliminary information on the participants' physical characteristics and basketball experience were shown in table 4.2.1.

Table 4.2.1**:** Description of the Participants' Physical Characteristics and Basketball Experience of the participants.

Position	**Participant**	**Age (Yrs)**	**Weight (Kg)**	**Height(cm)**	**BMI Kg/m²**	**Years of Experience.**
G1	**Guard 1**	20	60	165	22.04	5
G2	**Guard 2**	22	67	175	21.88	8
G3	**Guard 3**	21	68	185	20.52	8
G4	**Guard 4**	20	68	183	19.87	5
G5	**Guard 5**	21	65	168	20.31	9
F6	**Forward 1**	23	67	175	23.03	8
F7	**Forward 2**	21	70	178	22.09	9
F8	**Forward 3**	24	85	188	24.05	11
F9	**Forward 4**	21	75	188	21.22	8
F10	**Forward 5**	23	70	180	21.60	8
C11	**Centre 1**	25	75	190	20.78	8
C12	**Centre 2**	22	80	193	21.48	5
C13	**Centre 3**	18	78	188	21.56	4
C14	**Centre 4**	25	77	188	22.21	4

Examination of Table 4.2.1 above reveals that age of the participants ranged from 18 to 25 years with basketball experience range of 4 -11years. All the players were members of the First bank of Nigeria female Basketball. The Body Mass Index of the participants indicates that they are not overweight. This is because the threshold for Risk level of BMI is 25kg/m^2 and above but all the players are below this level.

Hypotheses Testing

Major Hypothesis 1: There are no significant relationships between the kinematic characteristics of arm motion during successful and unsuccessful jump shot at three distances in Nigerian female basketball players.

Sub-Hypothesis one

1. There is no significant relationship between physical characteristics and shooting accuracy of Nigerian female basketball players.

Table 4.2.2a Participants' Scores and Percentages of shooting Accuracy at three shooting Distances

		2.74m shot		4.67m shot		6.40m shots		
	Participant	**Score**	**%**	**Score**	**%**	**Score**	**%**	**Coach's Ranking of Players**
G1	**Guard 1**	124	82.67	135	90.0	115	76.67	4th
G2	**Guard 2**	133	88.67	128	85.33	114	76.0	2nd
G3	**Guard 3**	136	90.67	143	95.33	116	77.33	3rd
G4	**Guard 4**	122	81.33	127	84.67	116	77.33	5th
G5	**Guard 5**	122	81.33	131	87.33	109	72.67	10th
F6	**Forward 1**	124	82.67	137	91.33	115	76.67	7th
F7	**Forward 2**	110	73.67	120	80.0	109	72.67	12th
F8	**Forward 3**	130	86.67	128	85.33	112	74.67	11th
F9	**Forward 4**	132	88.0	121	80.67	113	75.33	9th
F10	**Forward 5**	127	84.67	127	84.67	101	67.33	14th
C11	**Centre 1**	128	85.33	139	92.67	120	80.0	1st
C12	**Centre 2**	126	84.0	136	90.67	117	78.0	6th
C13	**Centre 3**	118	84.0	133	88.67	110	73.67	8th
C14	**Centre 4**	118	78.67	120	80.0	106	70.67	13th

The table (table 4.2.2a) presents the accuracy shots of the participants at three distances with the ranking of the coach. In 2.74m shots, except Forward 2 (73.67%) and Centre 4 (78.67%), all the participants scored above 80% while they all scored above 80% in the 4.67m shot. In the 6.40m shot, Centre 1 scored the highest (80%) while Forward 5 scored the lowest (67.33%). All other participants scored within the range of 70.67-78.0%. G3 and G2 came 1st and 2nd while F4, F3 and F5 ranked 3rd and 4th and 6th while C1 ranked 5th with C2 and C3 came 7th respectively. In the 4.67m shots, G3 again had the highest percentage (95.33%) while C1 came 2nd and forward 1 3rd. For 6.40m position, C1 and C2 ranked 1st and 2nd while G3 and G4 came 3rd. The result showed that no group dominated, that is, the ranking was shared between the guards, forwards and centre players. However, all the players have very ‘good’ score percentages as elite and international players. The guards were expected to perform poorly in the 2.74m shots, while better than others in 6.40m shots but this was not found to be so. These results showed that shooting accuracy of the players is not determined by their position of play, rather by other factors which may include training and practice.

4.2.2b: One- ANOVA for shooting accuracy of the Guards, Forwards and Centre Players at the three shooting Distances

Shooting Accuracy		Sum of Squares	Df	Mean Square	F-ratio	Prob
2.74m	Between Groups	111.214	2	55.607	1.085	.372
	Within Groups	564.000	11	51.273		
	Total	675.214	13			
4.67m	Between Groups	54.600	2	27.300	.535	.600
	Within Groups	561.400	11	51.036		
	Total	616.000	13			
6.40m	Between Groups	44.464	2	22.232	.884	.441
	Within Groups	276.750	11	25.159		
	Total	321.214	13			

$F_{(2,11)} = 3.98 < 0.05$ *Significant.

The result of the ANOVA (table 4.2.2b) shows that there is no significant difference between the shooting accuracy of the guards, forwards and centre players from the three shooting distances. This could be as a result of all the players’ scores which are at the elite class level and are so close to one another. No distinct differences in the score and the differences are not high.

Table 4.2.2c: Description of the Group Physical Characteristics and Shooting Accuracy at the three Shooting distances

	Weight(kg)	**Height(cm)**	**BMI(kg/m)**	**2.74mShot**	**4.67m shot**	**6.40m shot**
N	14	14	14	14	14	14
Mean (X)	71.79	181.71	21.62	125.00	130.36	112.36
Std. Error of Mean (SE)	1.81	2.27	.29	1.84	1.93	1.33
Std. Deviation(SD)	±6.76	±8.51	±1.09	±6.88	±7.21	±4.97
Minimum score	60.00	165.00	19.87	110.0	120.0	101.0
Maximum score	85.00	193.00	24.05	136.0	143.0	120.0
Total	1005.00	2544.00	302.64	1750.00	1825.0	1573.0

Table 4.2.2c reveals the mean, SD, minimum and maximum weight, height and shooting distances of the participants. The mean and SD of the inter participants are; weight 71.79± 6.76 years, height 1.81±8.51, 2.74m shots 125±6.88, 4.67m shots 130.36±7.21 and 6.40m 112.36±4.97. The highest scores was obtained in the middle distance shot (4.67m) while the lowest was scored in the long distance shot (6.40m shot). There are significant deviations of each of the participants 'score from the mean score of the group. For example, Guard 1who weighed 60kg with height of 165cm deviated from the mean (71.79kg) with 11.79kg and from height (181.71cm) with 15cm. This is also the trend in the three shooting distances. The implication is that with performance of shooting in Basketball, individual analysis is better for evaluating shooters for correct value judgment.

Table 4.2.2d: Correlations between the Physical Characteristics and Shooting Accuracy from Different Distance

N=14		Wt	Ht	BMI	2.74m	4.67m	6.40m
1.	Wt	1	0.857*	0.370	0.030	-0.181	-0.041
2.	Ht	.857*	1	-0.002	0.156	-0.026	.154
3.	BMI	0.370	-0.002	1	-0.069	-0.188	-0.196
4.	2.74m Shot	0.030	0.156	-0069	1	0.425	0.373
5.	4.67m Shot	-0.181	-0.026	-0.188	0.425	1	0.595*
6.	6.40m Shot	-0.041	0.154	-0.196	0.373	0.595*	1

*Correlation is significant at the 0.05 level (2-tailed) =0.497

Table 4.2.2d result reveals that there are no significant relationships between weight and BMI (0.370), 2.74m (0.030), 4.67m (-0.181) and 6.40m (-0.041<0.497) shooting distances except with height (.857> 0.625) of the participants at 0.05 level of significance. Height of the players also has no significant relationships with the three shooting distances of 2.74m (0.156), 4.67m (-0.188) and 6.40m (-0.154) shots and BMI (-0.002). 2.74m shooting accuracy has no significant relationship with 4.67m (0.425) and

6.40m (0.373) shooting distances.Correlation exists only between 4.67m and 6.40m shooting accuracy (0.595> 0.497) This may be due to both being higher distance shots. This results makes for the acceptance that there is no significant relationship between physical characteristics and shooting accuracy at the three shooting distances of the participants. Insignificance of BMI with weight and height shows that each independently is not related to BMI unless they are combined together. Therefore, height or weight independently cannot predict BMI nor overweight.

The insignificant correlation between height and shooting distance implies that though height may be a key factor in athletic ability, jump height, height release ratio but not significant for accuracy of the shot. The wrist has been established to play key role in the accuracy of the shot since it requires finess of movement.

Sub-Hypothesis 2: There is no significant relationship between take off and release angular (linear, angular and segmental Displacements) displacements parameters of successful and unsuccessful shots at three shooting distances of each of the guards, forwards and centre basketball players.

4.3 Section B: This section presents the Relationships Linear Displacements (LD3D), Joint Angular Displacements (JAD) and Segmental Angular Displacements (SAD) Parameters of Successful and unsuccessful shots of each of the Participants at Take-off and Release.

Table 4.3.1: Guard 1 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	2.74m		4.67m		6.40m	
LD 3D(m)	**Take off**	**Release**	**Before release**	**Release**	**Take-off**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.5405 ±0.34 0.4450 ± 0.164 0.304	0.5257±0.32 0.5320± 0.307 0.25	0.1439±0.211 0.1471±0.132 -0.31	0.1374±0.27 0.1406±0.23 0.41	0.354±0.40 0.364±0.31 0.83*	0.375±0.67 0.386. ±0.21 0.76
Elbow: Succes **Unsuccessful** **R**	0.8071 ±0.377 0.8500 ± 0.26 0.26	0.8742± 0.434 0.6771 ± 0.56 0.83*	0.4978±.115 0.5111±.093 0.44	0.4710±.223 0.4844±.15 -0.76	0.629±.34 0.599±51 0.67	0.669±.75 0.689±.27 0.56
Wrist: Succes **Unsuccessful** **R**	0.8253 ± 0.43 0.8428 ± 0.19 0.14	0.8646 ± 0.44 0.8341 ± 0.09 -0.14	0.5666±.091 0.6044±.05 0.53	0.5343±.123 0.4844±.15 0.36	0.673±.78 0.641±.37 0.21	0.716±47 0.737±.19 0.45
Hand: Succes **Unsuccessful** **R**	0.7998 ± 0.45 0.7880 ± 0.19 -0.80	0.8442± 0.475 0.9448± 0.424 0.06	0.5781±.03 0.6044±.05 -0.29	0.5525±.071 .5525±.071 0.28	0.531±47 0.504±.25 -0.23	0.567±.51 0.584.32 0.21
COM: Succes **Unsuccessful** **R**	0.5723 ± 0.32 0.5077 ± 0.17 0.054	0.5737 ± 0.32 0.5224± 0.16 -0.14	0.1266±.042 0.2732±.035 0.73	0.2526±.032 0.2595±.044 0.36	0.355±39 0.345±.18 0.65	0.376±.32 0.385±.25 0.78
JAD	**Joint Angular Displacement º**					
Shoul.: Succes **Unsuccessful** **R**	97.83 ± 11.66 124.70±21.26 0.61	104.42±21.26 130.52±17.54 0.34	95.46±30.76 97.40±35.70 -0.79	99.34±25.80 101.12±27.51 0.813*	112.70±23 110.67±46 -0.83*	117.45±14.67 121.56±23.56 0.59
Elbow: Succes **Unsuccessful** **R**	121.54±11.91 144.56±10.15 0.48	124.53±12.02 144.92±8.40 0.30	121.88±9.55 124.53±18.23 0.56	127.17±32.80 129.67±29.69 '.82*	133.20±12.32 128.78±17.56 0.67	137.59±18.8 145.78±34.78 0.38
Wrist: Succes **Unsuccessful** **R**	135.33±20.0 145.61±15.48 -0.68	127.26±19.38 128.38±12.81 -0.64	138.92±12.65 137.20±18.21 -0.48	137.08±12.81 136.29±18.62 -0.74	72.42±15.67 74.69±25 0.56	68.30±16.32 65.78±10.91 -0.78
SAD	**Segmental Angular Displacement º**					
Trunk: Succes **Unsuccessful** **R**	283.74±8.10 288.30±14.54 -0.33	280.94±7.21 285.26±13.83 0.41	269.64±11.92 270.02±12.31 0.51	269.80±15.81 270.42±10.61 '.833*	275.47±12.6 265.67±23.78 0.57	275.341±16.68 265.27±12.69 -0.45
Uparm: Succes **Unsuccessful** **R**	118.01±24.26 123.51±20.12 -0.77	205.93±88.94 208.61±93.52 -0.11	243.34±34.8 246.71±31.7 0.44	250.09±38.22 251.90±71.34 '.27	234.07±13.53 224.26±33.76 0.393	246.58±16.67 250.70±9.67 0.551
Forarm:Succe **Unsuccessful** **R**	271.80±22.72 273.72±31.96 -0.20	259.57±22.97 261.47±21.45 -0.47	255.07±14.87 256.17±21.48 0.53	257.27±23.59 258.34±27.52 '.814*	249.75±13.76 243.57±23.56 0.562	250.36±15.67 244.23±19.34 -0.803
Hand: Succes **Unsuccessful** **R**	114.29±212.80 116.12±215.13 0.65	114.70±216.73 114.93±221.75 -0.65	246.41±22.51 247.45±65.90 -0.38	248.49±51.38 250.01±42.81 '.74	307.12±25.56 301.36±33.76 0.49	316.16±11.89 332.68±13.9 -0.34

Shoul. = Shoulder; forearm= forearm ; *Significant = r = 0.811 P>0.05

In table 4.3.1 above, for 2.74m shooting distance shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=0.30, 0.25< crit.val. =0.81), wrist (r= 0.14,-0.21< crit.val.=0.81), hand (r= -0.80, 0.06< crit.val. r=0.81) elbow take off (r=0.26) centre of mass (0.054, -0.14< crit.val.=0.81) except in the elbow at release (r=0.83< crit.val.=0.81).This showed that the release LD3D at the elbow for both unsuccessful and successful shots are alike. In the Joint angular Displacement (JAD), no significant relationship was found in the shoulder (r=0.61, 0.31< crit.val. =0.81), elbow (0.48, 0.30< crit.val. =0.81) and wrist (r=-0.68, -0.64< crit.val. =0.81) at take off and release of successful and unsuccessful shots. For Segmental angular displacement, no significant relationship was found in the upper arm (-0.77, -0.11< crit.val. =0.81), Forearm (-0.20, -0.47< crit.val. =0.81), Hand (-0.65, -0.65< crit.val. =0.81) and the trunk (-0.33, -.041< crit.val. =0.81). This means that the segmental arm configurations for both successful and unsuccessful shots do not correlate. This implies that there is no significant correlation between the upper limb angular displacements parameters of 2.74m successful and unsuccessful shots of Guard 1 except at the release linear displacement of the elbow.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release of successful and unsuccessful shot at the shoulder (r=-0.31, 0.41< crit.val. =0.81), elbow (r= 0.44,-0.76< crit.val. r=0.81) wrist (r= 0.53, 0.36< crit.val. =0.81), hand (r= -0.29, 0.28< crit.val. r=0.81) and centre of mass (0.73, 0.36< crit.val. = 0.81). No significant relationship was also found in the JAD of the shoulder take off (r=-0.79 < crit.val. =0.81), elbow take off (0.56, < crit.val. =0.81) and wrist take off and release (r=-0.68, -0.64< crit.val. =0.81).However, significant correlation was found at the release JAD of shoulder (0.813> crit.val. r=0.811) and elbow (0.82> crit.val. r=0.81) successful and unsuccessful shots. This means the release joint angle at the shoulder of guard 1 for 4.67m shots are similar for both successful and unsuccessful shots. For Segmental angular displacement (SAD), no significant relationship was found in the take off and release of upper arm (0.44, 0.27< crit.val. =0.81), Hand (-0.38, 0.74< crit.val. =0.81); take off of forearm (0.53, < crit.val. =0.81), and the trunk (0.51, < crit.val. =0.81). However, significant relationship was found in the release SAD of trunk (0.833> crit.val. r=0.81) and forearm (0.812> crit.val. r=0.81) parameters of successful and unsuccessful jump shots. This implies that the trunk and the forearm alignment at release are similar.

In the 6.40metres shots, the LD3D data shows only significant relationship at the shoulder take off (0.83> 0.811) of successful and unsuccessful shots; and not at take off and release LD3D of the elbow (0.67, 0.56< crit.val. =0.81), wrist (0.21, 0.45< crit.val. =0.81); hand (-0.23, 0.21< crit.val. =0.81) and COM (-0.65, 0.78 < crit.val. =0.81) and release LD3D angle of the shoulder (0.76< crit.val. r=0.81). In JAD, significant relationship exists only between take off angle at the shoulder (0.83> 0.811) of successful and unsuccessful shots, revealing similarity of joint angle position of the shoulder when G1 took off from the ground. No significant relationship was found at take off angle of shoulder (0.47< 0.811), take off and release angle of elbow (0.67, 0.38< crit.val. =0.81) and the wrist (0.56, -0.78< crit.val. =0.81). This showed that their angular positions at both take off and release is variable. In the SAD, the data revealed that no significant relationship existed between segmental take off and release angles of the upper arm (0.57, -0.45< crit.val. =0.81), forearm (0.56, 0.80< crit.val. =0.81), hand (0.49, -0.34< crit.val. =0.81) and the trunk (0.57, -0.45< crit.val. =0.81).

The above results showed greater variability in most of the parameters. For example, there was a decrease of the LD3D in successful shot while an increase for unsuccessful shots at the shoulder, and though increase in both at the 4.67m shot but higher in the unsuccessful shots. The differential in the displacement is a major factor of of variability.

Table 4.3.2: Guard 2 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	**2.74m**		**4.67m**		**6.40m**	
LD 3D (m/sec.)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Success **Unsuccessful** **R**	0.223 ± .020 0.272± .040 -0.37	0.378 ± 0.048 0.376 ± .035- 0.28	0.056±0.29 0.062±0.18 -0.26	0.090±0.23 0.095±0.21 0.31	0.405±0.15 0.415±0.17 -0.56	0.425±0.23 0.436±0.18 0.862*
Elbow: Success **Unsuccessful** **R**	03573± .027 0.398± 0.077 0.34	0.664± 0.017 0.554 ± .86 0.092	0.232±0.153 0.261±0.145 0.32	0.431±0.166 0.460±0.130 0.23	0.717±0.042 0.739±0.068 0.37	0.76±0.08 0.781±0.07 0.39
Wrist: Success **Unsuccessful** **R**	0.344±0.027 0.401±0.055 0.20	0.6141± 0.016 0.5671± 0.01 -0.003	0.266±0.08 0.299±0.07 -0.28	0.497±0.13 0.529±0.08 -0.19	0.782±0.062 0.806±0.035 0.39	0.830±0.052 0.854±0.035 0.51
Hand: Success **Unsuccessful** **R**	0.378± '.05 0.487±0.103 -0.26	0.6812± 0.125 0.694 ± 0.131 -0.028	0.245±0.045 0.275±0.028 0.32	0.452±0.09 0.481±0.03 0.46	0.743±0.06 0.766±0.07 0.50	0.789±0.013 0.812±0.032 0.20
COM: Success **Unsuccessful** **R**	0.235±0.070 0.259 ±0.040 -0.35	0.344±0.036 0.353± 0.039 -0.51	0.073±0.132 0.080±0.143 0.18	0.119±0.025 0.125±0.019 0.834*	0.195±0.037 0.507±0.29 0.84*	0.520±0.036 0.533±0.291 0.79
JAD	Joint Angular Displacement (degree)º					
Shoul.: Success **Unsuccessful** **R**	93.78±32.36 71.64±5.61 -0.14	111.29±17.88 86.66±8.54 -0.46	58.704±78.67 64.80±60.86 -0.51	102.50±20.61 105.03±12.11 00.81	99.99±7.86 101.64±5.25 0.85*	53.24±20.34 104.71±16.92 0.79
Elbow: Success **Unsuccessful** **R**	128.46±25.46 112.10±16.21 0.19	385.02±53.39 138.08±8.63 0.71	106.03±36.73 111.11±20.64 00.57	145.89±28.55 151.02±20.36 0.49	141.21±36.33 142.47±21.47 0.83*	149.19±20.73 145.61±18.68 0.86*
Wrist: Success **Unsuccessful** **R**	164.11±12.62 145.61±15.25 -0.071	127.70±9.20 157.31±2.95 0.60	158.13±19.62 159.44±18.46 0.82*	134.35±18.55 129.61±12.36 0.78	131.76±9.62 129.16±6.48 0.69	128.15±5.93 126.44±15.63 0.75
SAD	Segmental Angular Displacement (degree)º					
Trunk: Success **Unsuccessful** **R**	92.89±7.99 139.37±8.06 0.76	72.92±118.82 196.22±15.70 0.06	110.49±20.67 113.76±15.36 0.54	249.20±12.79 256.57±8.96 0.73	225.73±5.76 234.46±8.11 0.53	234.46±6.79 237.19±4.86 0.86*
Uparm: Success **Unsuccessful** **R**	278.69±27.46 250.51±6.56 -0.32	284.0916.57 251.49±7.47 -0.37	244.71±10.38 246.60±7.92 0.73	257.55±5.69 259.35±11.36 0.66	268.21±16.88 270.35±10.96 -0.49	270.35±5.69 271.37±13.78 0.69
Forarm:Success **Unsuccessful** **R**	259.50±8.06 263.93±7.07 -0.075	273.83±35.27 264.25±4.51 0.34	224.35±21.89 222.45±23.18 0.87*	188.29±15.30 175.32±20.16 0.41	191.07±36.81 188.19±27.6 0.33	185.37±6.78 182.51±4.86 0.71
Hand: Success **Unsuccessful** **R**	273.04±4.61 275.98±3.790 0.19	272.31±5.02 278.02±2.13 0.10	275.55±2.69 274.93±3.61 0.76	271.03±3.98 270.36±5.31 0.27	276.01±7.39 275.96±3.05 0.51	275.89±1.79 275.81±2.31 0.82*

Shoul.= Shoulder; Uparm= upperarm; *Significant r = 0.811 P>0.05

For Guard 2 (table 4.3.2), in 2.74m shots LD3D, the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.37, 0.28< crit.val. =0.81), elbow (r=0.34, 0.092< crit.val. r=0.81) wrist (r= 0.20, -0.003< crit.val.=0.81), hand (r= -0.26, 0.028< crit.val. r=0.81) and centre of mass (-0.35, -0.51< crit.val.=0.81). No significant relationship was also found in the shoulder (r= -0.14, -0.46< crit.val. =0.81), elbow (0.19, 0.71< crit.val. =0.81) and wrist (r=-0.071, -0.60< crit.val. =0.81) JAD at take off and release parameters of clean and missed shots. For Segmental angular displacement, there is no significant relationship in the take off and release of the upper arm (0.76, -0.06< crit.val. =0.81), Forearm (-0.32, -0.37< crit.val. =0.81), Hand (-0.075, 0.34< crit.val. =0.81) and the trunk (0.19, -.10< crit.val. =0.81). This implies that there is no significant relationship between the upper limb arm motion LD3D of 2.74m parameters of successful and unsuccessful jump shots; indicating that the positions of the segments at both take off and release were variable. This makes for the acceptance of the hypothesis.

For 4.67m shots LD3D, the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.26, 0.31< crit.val. =0.81), elbow (r= 0.32, 0.23 < crit. val. r=0.81) wrist (r= -0.28, -0.19< crit.val. =0.81), hand (r= -0.32, 0.46< crit.val. r=0.81) centre of mass take off (0.18< crit.val. =0.81) with the exception of its release (0.83> crit.val. =0.81). No significant relationship was found in the JAD to the shoulder take off (r=-0.79 < crit.val. =0.81), elbow take off (0.56, < crit.val. =0.81) and wrist take off and release (r=-0.68, -0.64< crit.val. =0.81) except at the release of shoulder (0.81< crit.val. r=0.81) and elbow (0.82> crit.val. r=0.81) successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the upper arm (0.54, 0.73< crit.val. =0.81), forearm (0.73, 0.66< crit.val. =0.81), trunk (0.76, 0.27< crit.val. =0.81).release of the hand (0.41< crit.val. =0.81) but not in the hand SAD take off (0.87> crit.val. =0.81). This result shows that there are significant similarities between the COM LD3D at release, shoulder and elbow JAD at release and the hand SAD at take off of both successful and unsuccessful shots.

In the 6.40 metres shots, the LD3D data shows significant relationship at the shoulder release (0.86> 0.811) and COM take off (0.84> 0.811) but not at the shoulder take off (-0.56< crit.val. r=0.81), COM release LD3D angle (0.79< crit.val. r=0.81), take off and release LD3D elbow (0.37, 0.39< crit.val. =0.81), wrist (0.39, 0.51< crit.val.

=0.81); hand (0.50, 0.20< crit.val. =0.81). In JAD, significant relationship exists only between take off parameters of shoulder (0.85> 0.811) take off and release angle of elbow (0.83, 0.86> crit.val. =0.81) of successful and unsuccessful shots angle. No significant relationship was found at release angle of shoulder (0.47< 0.811) and take off and release JAD of the wrist (0.69, 0.75< crit.val. =0.81). In the SAD, the data revealed that no significant relationship exist between segmental take off angles of the upper arm (0.53< crit.val. =0.81) and the trunk (0.51< crit.val. =0.81), take off and release of forearm (0.49, 0.69< crit.val. =0.81), hand (0.33, 0.71< crit.val. =0.81) and the release SAD of the trunk (0.51< crit.val. =0.81) and upper arm (0.53< crit.val. =0.81). This makes for both the rejection and acceptance of the hypothesis that there is no significant relationship between the angular displacement parameters of successful and unsuccessful shots.

Table 4.3.3: Guard3 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	2.74m		4.67m		6.40m	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Success **Unsuccessful** **R**	0.929 ± .011 0.6478±.025 0.04	0.819±0.84 0.729±.02- -0.59	0.081±0.015 0.082±0.014 -0.11	0.121±0.024 0.132±0.12 0.067	0.4767±0.58 0.3983±0.43 -0.10	0.5119±0.062 0.4266±0.06 0.30
Elbow: Success **Unsuccessful** **R**	0.769±.020 1.059± 0.011 -0.84	1.10±0.01 1.159 ± .03 0.25	0.424±0.056 0.420±0.047 0.75	0.591±0.043 0.592±0.039 0.82*	0.8191±0.06 0.7166.06 -0.42	0.8819±0.071 0.7425±0.06 -0.16
Wrist: Succes **Unsuccessful** **R**	1.21± 0.02 0.975±0.01 0.25	1.019±0.014 1.07± 0.012 0.46	0.489±0.056 0.504±0.070 0.75	0.692±0.054 0.697±0.057 0.72	0.8114±0.055 0.7842±0.06 0.25	0.8615±0.042 0.8093±0.054 -0.27
Hand: Succes **Unsuccessful** **R**	1.10± 0.05 0.88±0.01 -0.68	0.839± 0.15 0.99 ± 0.011 -0.13	0.4547±0.026 0.473±0.032 0.65	0.6435±0.017 0.6336±0.022 0.59	0.8129±0.042 0.7339±0.055 0.28	0.8543±0.040 0.7679±0.059 0.32
COM: Succes **Unsuccessful** **R**	1.006±0.055 0.786 ±0.050 -0.52	0.823±0.010 0.832± 0.039 -0.94*	0.101±0.006 0.120±0.012 0.45	0.142±0.003 0.148±0.008 0.72	0.5667±0.084 0.5017±0.027 -0.75	0.5948±0.085 0.5190±0.034 -0.63
JAD	Joint Angular Displacement º					
Shoul.: Succes **Unsuccessful** **R**	95.62±4.08 101.98±19.34 0.77	106.72±7.96 112.72±12.42 0.32	129.23±9.62 113.78±18.35 0.44	131.13±1.53 116.31±12.46 0.51	138.2±10.13 136.41±7.71 -0.18	143.81±10.89 139.65±7.72 0.12
Elbow: Succes **Unsuccessful** **R**	128.46±25.46 112.10±16.21 0.19	385.02±53.39 138.08±8.63 0.71	134.72±10.23 118.39±15.61 0.46	135.14±7.69 120.65±15.56 0.27	150.53±22.96 143.37±3.83 0.824*	151.60±12.03 146.91±4.22 0.73
Wrist: Succes **Unsuccessful** **R**	159.16±7.21 165.64±19.36 -0.87*	183.87±9.77 183.86±12.47 -0.12	117.35±10.26 127.35±8.37 0.51	114.35±8.87 122.72±6.96 0.71	146.13±20.50 126.82±5.49 0.47	136.90±13.39 121.83±5.88 -0.67
SAD	Segmental Angular Displacement º					
Trunk: Succes **Unsuccessful** **R**	270.24±2.28 258.58±11.84 0.34	271.25±2.72 258.98±11.51 0.34	263.45±6.84 42.77± 15.53 -0.28	263.96±4.65 47.24±21.74 -0.12	87.34±197.50 61.89±58.32 0.73	79.10±190.36 -75.44±7.58 -0.54
Uparm: Succes **Unsuccessful** **R**	174.44±20.80 182.94±19.85 0.88*	222.44±3.71 228.62±5.84 0-.35	268.52±7.36 247.57±8.92 0.36	269.13±3.56 248.06±5.67 0.41	51.59±237.28 249.44±2.11 0.13	129.66±183.18 261.58±2.71 0.69
Forarm:Succe **Unsuccessful** **R**	253.06±4.46 258.81±13.14 -0.11	264.61±1.90 269.96±11.39 -0.88*	244.6±9.65 205.11±21.11 -0.27	242,29±11.71 203.64±15.52 -0.32	251.29±16.13 213.6±32.08 0.78	227.11±14.91 188.99±25.72 0.73
Hand: Succes **Unsuccessful** **R**	270.32±3.40 274.92±19.19 0.34	257.77±2.79 250.89±24.24 0.65	266.61±11.33 275.40±5.77 0.41	266.23±9.23 275.07±2.76 0.26	276.88±1.08 278.63±4.26 0.19	276.32±0.86 278.84±4.49 0.28

*Significant = r = 0.811 P>0.05

Table 4.3.3 presents the angular displacements parameters of guard 3. The LD3D of 2.74m parameters revealed that significant relationship exist at the elbow take off (r=-0.84>crit.>00.811) and inverse relationship at the centre of mass release (r=-0.94>crit.=0.811) LD3D of successful and unsuccessful shots which means the Linear displacement are similar. However, no significant relationship were found in LD3D take off and release parameters of the shoulder (r=0.04,-0.59<0.811) and hand (r=0.68,-

0.13<0.811) revealing variability. The JAD revealed only significant relationship at the wrist (-0.87> 0.811) JAD take off of the clean and missed shots; while none was found in shoulder (r=0.50, 0.38>0.811) and elbow (0.77, 0.35<0.811) take off and release JAD. Also in segmental angular displacement (SAD), significant relationship existed between the take off of the upper arm (r=0.88> crit. val.= 0.811) and fore arm release (r=0.887>0.811) only. However, variability was found at the hand and trunk SAD.

For the 4.67m shooting distance shots, no significant relationship was found between successful and unsuccessful shots LD3D of the shoulder (0.11, 0.067<0.811) wrist (0.75, 0.72<0.811), hand (0.65, 0.59<0.811), COM (0.45, 0.71<0.811) and take off of the elbow (0-75<0.811). In the JAD, no significant relationship was found between take off and release angle of the shoulder (0.44, 0.52<0.811), elbow (0.46, 0.21<0.811), and wrist (0.51, 0.71<0.811). The same insignificant relationship is also obtained for SAD (see table 4.3.3).

In the 6.40 metres shots, the LD3D data shows insignificant relationships at the take off and release of the shoulder (-0.10, 0.30< crit.val. =0.81), elbow (-0.42, -0.16< crit.val. =0.81), wrist (0.25, -0.25< crit.val. =0.81) hand (0.28, 0.32< crit.val. =0.81), COM (0.75, -0.63< crit.val. =0.81). In JAD, no significant relationship exists between take off and release angle of shoulder (-0.18, 0.12> crit.val. =0.81), wrist (0.47, -0.67< crit.val. =0.81) and release of elbow (0.73> 0.811) of successful and unsuccessful shots angle. In the SAD, the data revealed that no significant relationship exist between segmental take off and release of angles of the upper arm (0.73,-0.54< crit.val. =0.81), forearm (0.13, 0.69< crit.val. =0.81), hand (0.76, 0.73< crit.val. =0.81) and the trunk (0.17, 0.28< crit.val. =0.81). This makes for both rejection and the acceptance of the hypothesis that there is no significant relationship between the angular displacement parameters of successful and unsuccessful shots.

Table 4.3.4: Guard 4 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	2.74m		4.67m		6.40m	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul:Succes **Unsuccessful** **R**	0.160±0.12 0.148±0.13 0.45	0.267±0.32 0.376±0.024 0.48	0.351±0.001 0.342±0.022 0.39	0.368±0.011 0.377±0.012 0.42	0.406±0.012 0.393±0.103 0.13	0.539±0.011 0.525±0.004 -0.41
Elbow:Succes **Unsuccessful** **R**	0.228±0.14 0.210±0.16 0.51	0.586±0.02 0.574±0.012 0.65	0.709±0.011 0.687±0.022 0.25	0.753±0.006 0.775±0.004 0.38	0.706±0.021 0.662±0.003 -0.08	0.947±0.021 0.122±0.041 0.45
Wrist: Succes **Unsuccessful** **R**	0.231±0.12 0.212±0.09 0.49	0.748±0.03 0.591±0.004 0.41	0.688±0.012 0.666±0.011 0.50	0.732±0.032 0.754±0.004 0.47	0.686±0.003 0.682±0.11 0.43	0.927±0.002 0.903±0.014 0.51
Hand: Succes **Unsuccessful** **R**	0.270±0.12 0.248±0.07 0.53	0.585±0.272 0.705±0.051 -0.19	0.677±0.023 0.656±0.031 0.45	0.718±0.030 0.738±0.021 0.49	0.660±0.013 0.637±0.041 -0.13	0.896±0.003 0.813±0.025 0.56
COM: Succes **Unsuccessful** **R**	0.169±0.112 0.156±0.06 0.34	0.393±0.031 0.402±0.421 0.21	0.406±0.031 0.395±0.08 0.20	0.427±0.021 0.438±0.021 0.51	0.466±0.002 0.451±0.015 -0.26	0.616±0.012 0.599±0.021 0.63
JAD	Joint Angular Displacement °					
Shoul.:Succes **Unsuccessful** **R**	98.30±18.95 98.10±18.91 0.91*	117.98±12.26 113.46±9.04 0.30	172.03±26.31 114.90±90.73 0.78	117.76±19.38 120.43±10.31 0.85*	90.92±25.61 85.65±50.31 -0.37	130.96±12.86 133.42±20.96 0.49
Elbow:Succes **Unsuccessful** **R**	145.89±13.70 127.18±23.77 0.19	143.17±11.96 140.47±9.92 -0.04	126.54±16.86 129.34±10.36 0.83*	132.14±4.55 134.78±6.11 0.72	104.89±21.78 100.17±35.45 0.47	139.96±22.79 141.75±28.60 0.815*
Wrist: Succes **Unsuccessful** **R**	138.64±12.85 141.51±8.38 0.76	153.05±16.90 139.40±15.74 0.48	138.49±10.92 131.46±16.33 0.57	124.42±5.36 119.55±7.67 0.45	161.70±13.63 164.47±20.87 0.75	136.07±15.64 133.92±20.85 0.69
SAD	Segmental Angular Displacement °					
Uparm:Succes Unsuccessful R	125.46±157.75 262.73±14.30 -0.01	117.24±176.05 258.94±14.32 -0.19	226.60±11.36 231.47±19.85 -0.65	234.35±10.53 237.20±14.92 0.80	210.19±15.81 228.27±9.68 0.51	210.87±7.61 228.73±10.34 0.42
Forarm:Succe Unsuccessful R	183.71±164.20 44.24±189.38 0.43	30.54±208.21 -103.15±13.22 0.23	251.03±16.34 251.23±7.67 0.49	251.42±6.77 251.60±10.07 0.813*	270.76±8.67 268.61±10.35 -0.78	269.35±8.55 267.36±5.78 0.52
Hand: Succes Unsuccessful R	555.54±152.31 264.07±11.78 -0.58	207.80±64.25 241.58±26.47 0.97*	231.44±12.86 220.14±6.78 0.56	208.84±16.86 199.55±20.86 0.51	271.10±2.98 272.33±1.89 0.79	271.37±1.67 272.49±1.87 0.815*
Trunk: Succes Unsuccessful R	261.47±4.77 273.52±2.11 0.31	247.58±18.23 270.80±5.62 0.19	270.30±14.32 269.48±6.18 0.69	270.12±4.96 269.71±6.56 0.56	273.83±3.69 290.62±5.16 0.65	273.69±2.95 271.12±3.42 0.84*

r = 0.811 P>0.05

For Guard 4 (table 4.3.4), the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.45, 0.48< crit.val. =0.81), elbow (r=0.51, 0.65< crit.val. r=0.81) wrist (r= 0.49, 0.41< crit.val.=0.811), hand (r= 0.53, -0.19< crit.val. r=0.811) and centre of mass (0.34, 0.21< crit.val.=0.811). No significant relationship also exist in the JAD release of shoulder (r= 0.30< crit.val. =0.81), take off and release at elbow (0.19, -0.04< crit.val. =0.81) and wrist (r=0.76, 0.48< crit.val. =0.81); However, significant correlation was found at shoulder take-off JAD (0.91< crit.val. =0.81) of successful and unsuccessful shots. The SAD data shows only significant relationship in release of the hand (0.97> crit.val. =0.81) but not at the take off (-0.58< crit.val. =0.81) and both take off and release of upper arm (-0.01, 0.19< crit.val. =0.81) forearm (0.43, 0.23< crit.val. =0.81), and the trunk (0.31, 0.19, -.10< crit.val. =0.811) segments. This implies that there are both insignificant and significant correlations between the upper limb arm motion displacements of 2.74m parameters of successful and unsuccessful jump shots.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=0.39, 0.42< crit.val. =0.81), elbow (r= 0.25, 0.38< crit.val. r=0.811) wrist (r= 0.50, 0.47< crit.val. =0.81), hand (r= 0.45, 0.49< crit.val. r=0.81) centre of mass (0.20, 0.51< crit.val. =0.81). Also, no significant relationship was found in the JAD of the shoulder take off (r=-0.78 < crit.val. =0.811), elbow release (-0.04 < crit.val. =0.811) and wrist take off and release (r=-0.57, -0.45< crit.val. =0.811). But significant correlation were found at the release JAD of shoulder (0.812> crit.val. r=0.81) and elbow take off (0.82< crit.val. r=0.81) of successful and unsuccessful shots. For SAD, no significant relationship existed in the take off and release of the upper arm (-0.65, 0.80< crit.val. =0.81), hand (0.56, 0.51< crit.val. =0.81), trunk (0.69, 0.56< crit.val. =0.81), and forearm take off (0.49< crit.val. =0.81), and not in its release (0.814> crit.val. =0.81).

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (0.13, -0.41> crit.val. r=0.81) elbow (0.08, 0.45< crit.val. =0.81), wrist (0.43, 0.51< crit.val. =0.81) hand (-0.13, 0.56< crit.val. =0.81) and COM (-0.26, 0.63 < crit.val. =0.81). In JAD, significant relationship exists only between release parameters of elbow (0.815> 0.811) of successful and unsuccessful shots angle.

No significant relationship was found at take off angle of elbow (0.47< 0.811), take off and release angle of shoulder (-0.37, 0.49< crit.val. =0.811) and the wrist (0.75, 0.69< crit.val. =0.811). Significant relationship however existed between segmental release angles of the hand (0.84> 0.811) and forearm (0.815> 0.811) and not in their take off angles; take off and release of the upper arm (0.51, 0.42< crit.val. =0.81) and take off at forearm (-0.79, 0.52< crit.val. =0.81).

Table 4.3.5: Guard 5 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	**2.74m**		**4.67m**		**6.40m**	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.304±'.046 0.15±0.067 -0.50	0.376±0.086 0.378±0.044 0.31	0.3842±0.008 0.374±0.009 0.73	0.4132±0.006 0.390±0.029 0.40	0.3146±.007 0.3427±.008 0.28	0.4503±.16 0.4632±.19 -0.31
Elbow: Succes **Unsuccessful** **R**	0.575±'.131 0.198±0.126 -0.40	0.690±0.259 0.329±0.137 -0.09	0.728±0.41 0.6632±0.040 0.80	0.747±0.054 0.6913±0.041 0.35	0.4872±.07 0.5327±.06 -0.12	0.7095±.008 0.7310±.005 .023
Wrist: Succes **Unsuccessful** **R**	0.528±'.088 0.212±0.139 -0.46	0.622±0.180 0.334±0.078 -0.03	0.679±0.041 0.6570.053 0.51	0.722±0.041 0.672±0.050 0.43	0.4911±.17 0.5669±13 -0.31	0.7209±055 0.7433±.045 -0.11
Hand: Succes **Unsuccessful** **R**	0.495±'.117 0.273±0.133 0.33	0.610±0.192 0.435±0.73 0.132	0.673±0.023 0.731±0.008 -0.26	0.684±0.021 0.749±0.015 -0.37	0.3085±.10 0.3355±.04 0.45	0.4371±.13 0.4490±.12 -053
COM: Succes **Unsuccessful** **R**	0.421±'.11 0.157±0.085 -0.17	0.527±0.187 0.259±0.044 -0.19	0.249±0.048 0.195±0.049 -0.29	0.255±0.051 0.200±0.071 0.45	0.2948±.09 0.3210±.07 0.43	0.4209±.22 0.4328±.20 0.76
JAD	Joint Angular Displacement °					
Shoul.: Succes **Unsuccessful** **R**	99.89±12.57 97.75±15.43 -0.73	104.82±14.69 105.71±23.17 -0.33	118.34±14.11 117.18±10.24 0.63	119.91±10.32 117.53±8.45 0.84*	95.46±20.75 97.67±32.75 -0.52	104.16±31.41 108.2±25.65 0.27
Elbow: Succes **Unsuccessful** **R**	137.21±10.94 113.10±27.35 0.08	140.61±10.25 125.66±21.68 -0.11	142.31±5.28 145.75±6.51 0.83*	148.13±9.68 149.10±6.87 0.71	22.53±30.70 24.93±45.31 -0.21	24.16±30.51 26.58±41.79 0.35
Wrist: Succes **Unsuccessful** **R**	135.89±6.71 140.79±8.02 0.40	127.11±11.32 146.15±19.71 -0.13	115.28±15.75 128.53±6.58 0.36	113.6±18.31 126.76±6.53 0.25	32.51±63.1 30.20±40.1 0.63	24.17±27.13 22.72±21.46 0.48
Segmental Angular Displacement °						
Uparm:Succes **Unsuccessful** **R**	168.12±124.122 04.07±9.46 0.55	175.44±139.63 204.88±9.90 0.59	229.52±21.76 233.02±8.81 0.86*	232.07±15.8 234.40±6.45 0.49	82.2±62.72 74.67±101.32 0.51	335.52±40.36 295.56±132.51 -0.46
Forarm:Succe **Unsuccessful** **R**	113.03±197.58 258.11±13.85 -0.35	94.50±214.53 255.31±10.28 -0.24	263.71±9.82 250.30±15.16 0.65	264.34±6.75 251.06±14.26 0.52	258.55±20.17 257.97±10.26 0.76	256.25±22.68 255.10±21.61 0.82*
Hand: Succes **Unsuccessful** **R**	181.26±18.90 241.39±27.14 0.54	179.49±21.15 240.76±26.89 0.56	186.02±11.8 191.87±6.80 -0.37	182.49±14.56 189.30±5.62 0.41	114.81±120.32 111.43±91.61 -0.41	102.2±115.21 97.18±133.53 0.36
Trunk: Succes **Unsuccessful** **R**	236.85±22.17 239.36±20.0 0.79	237.01±22.31 239.6±19.75 0.79	275.88±2.58 265.78±7.61 0.69	276.15±2.35 265.99±9.28 0.62	275.90±22.67 274.93±35.61 0.68	274.86±12.63 274.83±51 0.814*

r = 0.811 P>0.05

For Guard 5 2.75m shots Linear Displacement (LD3D) (table 4.3.5), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r= -0.50, 0.31< crit.val. =0.811) elbow (r=-0.40, -0.09< crit.val. =0.811), wrist (r= -0.46,-0.03< crit.val.=0.811), hand (r= -0.33, 0.132< crit.val. r=0.811) and centre of mass (-0.17, -0.19< crit.val.=0.81) No significant relationship was found in the JAD of shoulder (r= -0.73, -0.33< crit.val. =0.81), elbow (0.08, -0.11< crit.val. =0.81) and wrist (r=-0.40, -0.13< crit.val. =0.81) at take off and release parameters of clean and missed shots. For Segmental angular displacement, no significant relationship was found in the upper arm (0.55, 0.59< crit.val. =0.81), Forearm (-0.35, -0.24< crit.val. =0.81), Hand (0.44, 0.56< crit.val. =0.81) and the trunk (0.79, -0.77< crit.val. =0.81). This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.73, 0.40< crit.val. =0.81), elbow (r= 0.80,-0.35< crit.val. r=0.81) wrist (r= 0.51, 0.43< crit.val. =0.81), hand (r= -0.26, -0.37< crit.val. r=0.81) and centre of mass (-0.29, 0.45< crit.val.=0.81). No significant relationship was found in the JAD of the shoulder take off (r=-0.63 < crit.val. =0.81), elbow release (0.71, < crit.val. =0.81) and wrist take off and release(r=-0.36, 0.25< crit.val. =0.81) except at the release of shoulder (0.84> crit.val. r=0.811) and elbow take off (0.83> crit.val. r=0.81) of both successful and unsuccessful shots. For Segmental angular displacement, no significant relationship was found in the release of upper arm (0.49, < crit.val. =0.81), take off and release of the forearm (0.65, 0.52 < crit.val. =0.81) hand (-0.37, 0.41< crit.val. =0.81) and the trunk (0.69, 0.62 < crit.val. =0.81) except in the take off angle of the upper arm (0.86, > crit.val. =0.81) of successful and unsuccessful jump shots. This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

In the 6.40metres shots, the LD3D angle data reveals that no significant relationship at the take off and release of shoulder (0.28, -0.31> 0.811) LD3D angle (0.76< crit.val. r=0.81) elbow (-0.12, 0.23< crit.val. =0.81), wrist (0.31, -0.11< crit.val. =0.81) hand (0.45, 0.53< crit.val. =0.81) and COM (0.43, 0.76 < crit.val. =0.81). Also, in the JAD, no significant relationship exists between take off and release angles of the shoulder (-0.52, 0.27> 0.811) elbow (-0.21, 0.35< crit.val. =0.81) and the wrist (0.63, -0.48< crit.val. =0.81).of successful and unsuccessful shots. In the SAD, the data revealed significant relationships in the upper arm (0.82> crit.val. =0.81) and trunk (0.815> crit.val. =0.81) release angles. However, no significant relationship exists between segmental take off and release angles of the upper arm (0.51, -0.46< crit.val. =0.81), hand (-0.41, 0.36< crit.val. =0.81); take off forearm (0.51 < crit.val. =0.81), and trunk (0.68< crit.val. =0.81). This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

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Table 4.3.6: Forward 1 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

VARIABLES	**2.75m**		**4.6m**		**6.40m**	
LD 3D	**Takeoff**	**Release**	**Take off**	**Release**	**Takeoff**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.4898±0.11 0.6648±0.28 -0.012	0.6674±0.16 0.6519± 0.27 -0.825*	0.4844±0.008 0.374±0.019 0.10	0.513±0.006 0.390±0.009 0.40	0.4079±0.09 0.4037±.063 0.831*	0.4207±.10 0.4182±.05 0.95*
Elbow: Succes **Unsuccessful** **R**	0.6998±.082 0.8090±0.38 0.57	0.8030±19 0.8805±.43 0.879*	1.280±00.41 1.0698±0.040 0. 21	1.247±0.054 1.091±0.041 0.35	0.7658±.0.09 0.7467±.07 0.802	0.6352±.32 0.7825±.06 - 0.765
Wrist: Succes **Unsuccessful** **R**	0.7133±21 0.8267±43 0.07	0.9954±54 0.8659±44 0.13	1.379±0.041 1.0420.053 0.57	1.382±0.041 1.072±0.050 0.51	0.7720±.077 0.7820±.0.87 0.80	0.8131±.078 0.8207±.087 0.77
Hand: Succes **Unsuccessful** **R**	0.7013±26 0.7998±0.45 0.02	0.9655±0.30 0.8442±0.48 -0.18	0.873±'.023 0.871±0.008 -0.25	1.154±0.021 0.899±0.015 0.78	0.7316±'.093 0.7183±0.113 0.80	0.7729±0.097 0.7605±.118 0.78
COM: Succes **Unsuccessful** **R**	0.5481±0.070.60 44±.37 -0.28	0.6730±.05 0.5897±0.35 -0.26	0.249±0.048 0.195±0.049 -0.19	0.255±0.051 0.200±0.071 0.45	0.4665±.115 0.4306±.061 0.50	0.4866±.118 0.4650±.062 0.75
JAD	Joint Angular Displacement º					
Shoul.:Succ **Unsuccessful** **R**	120.70±20.88 117.89±8.27 0.75	126.50±16.60 121.556±6.71 0.10	117.24±15.11 116.08±10.24 0.63	118.91±10.32 117.53±8.45 0.84*	118.72±8.40 135.34±6.88 0.003	122.36±8.84 122.36±8.84 -0.09
Elbow: Succes **Unsuccessful** **R**	150.116±17.95 142.46±9.46 0.50	149.92±10.45 144.94±8.50 0.19	145.31±5.38 147.75±6.81 0.83*	147.13±9.68 149.10±6.87 0.73	145.69±8.82 155.48±9.90 0.062	148.59±6.07 160.92±10.80 0.31
Wrist: Succes **Unsuccessful** **R**	145.612±16.55 142.69±16.78 0.86*	128.40±142.43 -52.25±52.27 0.69	113.26±16.75 128.53±10.58 0.36	111.6±18.31 126.76±6.53 0.24	116.44±7.26 127.48±4.70 0.44	113.02±7.0 123.43±4.76 0.54
SAD	Segmental Angular Displacementº					
Uparm:Succe **Unsuccessful** **R**	190.72±147.18 -233.80±156.56 0.67	237.40±142.43 52.25±52.27 0.69	228.52±21.76 233.02±8.81 0.86*	231.07±15.8 234.40±6.45 0.49	245.41±8.61 180.14±15.88 0.65	249.23±7.11 182.38±16.32 0. 62
Forarm:Succ **Unsuccessful** **R**	-184.02±195.08 -149.12±44.96 0.926*	151.85±211.22 -38.20±35.66 -0.53	261.71±9.82 249.30±15.16 0.65	262.34±6.75 250.06±14.26 0.52	269.25±6.43 272.72±14.29 -0.59	271.59±6.68 272.82±15.39 -0.65
Hand: Succe **Unsuccessful** **R**	295.65±15.03 -129.48±27.52 -0.65	216.18±77.77 -175.69±2.03 0.07	175.02±16.8 191.87±5.80 -0.37	172.49±15.56 189.30±4.62 0.41	166.29±8.07 173.36±15.04 -0.43	163.58±10.37 165.87±8.47 -0.76
Trunk: Succs **Unsuccesful** **R**	275.55± 2.50 274.50±3.12 0.77	275.92±2.34 274.66±3.55 0.820*	277.88±1.58 261.78±7.61 0.39	278.15±1.35 261.99±9.28 0.57	271.96±1.28 271.45±5.14 0.06	272.29±1.39 272.36±6.04 -0.13

r = 0.811 P>0.05

Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the wrist (r= 0.07, 0.13< crit. val. =0.81), hand (r= 0.02, -0.18< crit.val. r=0.81)) and centre of mass (-0.28, 0.26< crit.val.=0.81); take off shoulder (r=-0.012 < crit.val. =0.81) and elbow (r=0.57< crit.val. r=0.81). Significant relationship was only found in at the shoulder (r=-0.825>0.811) and elbow (0.879>0.811) LD3D. No significant relationship also exists in the JAD take off and release of shoulder (r= -0.75, 0.10< crit.val. =0.81), of elbow (0.50, 0.19< crit.val. =0.81) and release of the wrist (r=0.69 < crit.val. =0.81); but only in the wrist release JAD was relationship found. The SAD data shows only significant relationship in the take off of the forearm angle (0.93> crit.val. =0.81) release of the trunk (-0.820.) but was not found in the forearm release (-0.53> crit.val. =0.81) both take off and release of upper arm (0.67, 0619< crit.val. =0.81, hand (-0.65, 0.07< crit.val. =0.81), and the trunk take off (0.77 < crit.val. =0.81) segments. This implies that there is no significant relationship between the upper limb arm motion displacements of 2.74m parameters of successful and unsuccessful jump shots.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=0.10, 0.40< crit.val. =0.81), elbow (r= 0.21, 0.35< crit.val. r=0.81) wrist (r= 0.57, 0.51< crit.val. =0.81), hand (r= -0.25, 0.78< crit.val. r=0.81) and COM (-0.19, 0.45< crit.val. =0.81). The JAD parameters shows no significant relationship at the shoulder take off (r=-0.63 < crit.val. =0.81), elbow release (0.73 < crit.val. =0.81) and at both wrist take off and release(r=0.36, 0.24< crit.val. =0.81) but significant at the shoulder release (0.81< crit.val. r=0.81) and elbow take off (0.83< crit.val. r=0.81) of successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the forearm (0.65, 0.52< crit.val. =0.81), hand (-0.37, 0.41< crit.val. =0.81), trunk (0.39, 0.57< crit.val. =0.81), upper arm release (-0.65, 0.80< crit.val. =0.81) and not at its take off (0.862> crit.val. =0.81).

In the 6.40metres shots, the LD3D data reveals only significant relationship at the take off and release angle of shoulder (0.832, 0.95< crit.val. r=0.81) but not at the elbow (0.802, -0.77< crit.val. =0.81), wrist (0.80, 0.77< crit.val. =0.81) hand (0.80, 0.78< crit.val. =0.81) and COM (0.50, 0.75 < crit.val. =0.81). In JAD, significant relationship did not exist between the take off and release parameters of shoulder (0.003, -0.09<

crit.val. r=0.81) the elbow (0.063, 0.30< crit.val. =0.81) and wrist (0.44, 0.54< crit. val. =0.81) of successful and unsuccessful shots angle. The SAD result shows that no significant relationship exists between the segmental release angles of the upper arm (0.65, 0.62< crit.val. =0.81), forearm (-0.59, -0.65< crit.val. =0.81) hand (-0.43, -0.76< crit.val. =0.81), and trunk (0.06, -0.13< crit.val. =0.81). This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

Table 4.3.7: Forward 2 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	2.74m		4.67m		6.40m	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.2383±0.51 0.2290±0.062 -0.03	0.2242±0.047 0.2089±0.071 0.21	0.3748±0.212 0.348±0.014 -0.62	0.3921 ±0.022 0.358±0.019 0.34	0.478±0.093 0.377±0.039 0.27	0.502±0.95 0.395±0.040 0.17
Elbow: Succes **Unsuccessful** **R**	0.4599±.11 0.4349.03 0.46	0.4223±0.12 0.3844±0.131 -0.17	0.5512±0.023 0.551±0.034 0.65	0.549±0.17 0.556±0.021 0.45	0.817±0.098 0.713±0.053 0.13	0.853±0.106 0.745±0.059 0.19
Wrist: Succes **Unsuccessful** **R**	04389±0.10 0.415±0.12 0.17	0.4022±0.13 0.3654±0.17 0.31	0.787±'.013 0.779±0.011 0.70	0.787±0.15 0.785±0.045 0.80	0.8194±0.101 0.762±0.057 0.77	0.867±0.106 0.789±0.054 0.69
Hand: Succes **Unsuccessful** **R**	0.4981±0.05 0.4907±0.07 -0.36	0.4572±0.12 -0.4149±0.18 -0.43	1.038±0.019 1.001±0.022 0.36	1.053±0.018 1.011±0.02 0.38	0.785±0.083 0.727±0.056 0.43	0.765±0.051 0.822±0.84 0.45
COM: Succes **Unsuccessful** **R**	02756±0.01 0.2633±0.02 0.61	0.2570±0.041 0.2375±0.052 0.58	0.310±0.014 0.277±0.003 0.60	0.312±0.013 0.289±0.025 0.54	0.565±0.087 0.496±0.022 -0.55	0.593±0.088 0.519±0.034 -0.64
JAD	Joint Angular Displacement					
Shoul.: Succes **Unsuccessful** **R**	95.83±22.79 97.70±20.10 0.73	103.29±15.61 106.96±21.32 0.85*	63.360±2.10 65.70±5.24 -0.46	60.088±2.18 63.84±5.13 -0.51	107.52±13.57 98.56±8.41 0.59	91.0±12.32 82.17±6.75 0.22
Elbow: Succes **Unsuccessful** **R**	108.21±31.63 110.77±23.71 0.49	118.43±37.57 123.44±50.12 0.58	102.43±11.70 186.63±5.53 -0.63	105.63±12.87 140.36±4.16 0.31	96.76±22.75 87.58±10.80 -0.60	81.06±21.67 72.29±13.41 -0.76
Wrist: Succes **Unsuccessful** **R**	164.23±17.21 162.90± 0.18	161.5±36.09 158.63±60.56 0.47	132.58±2.27 131.87±4.39 0.14	135.17±1.05 134.60±3.69 0.29	-70.66±12.06 -111.33±16.89 0.82*	-78.158±14.51 -109.56±18.56 0.76
SAD						
Uparm: Succes **Unsuccessful** **R**	213.25±17.31 204.21±21.06 0.44	227.11±32.6 232.22±21.31 0.51	-269.44±15.02 -257.21±21.61 0.84*	-257.08±9.83 -243.95±14.75 -0.55	-8.56±56.91 -25.34±114.58 0.47	-5.15±37.01 -12.36±110.73 0.61
Forarm:Succ **Unsuccessful** **R**	261.57±21.72 260.0±10.87 0.827*	264.74±10.70 266.34±15.42 0.48	45.36±15.82 44.21±20.31 -0.59	44.21±21.52 43.14±16.19 0.85*	1.37±25.97 14.77±92.85 0.64	1.50±25.44 44.48±22.58 0.57
Hand:Succes **Unsuccessfl** **R**	274.57±15.81 276.16±10.36 0.824*	271.30±9.13 269.63±8.62 0.39	-24.89±36.87 -23.56±55.96 -0.37	-23.56±42.35 22.24±23.45 0.29	22.63±129.93 -80.60±123.74 0.73	17.52±148.89 -74.20±113.46 0.75
Trunk: Succes **Unsuccessful** **R**	273.45±3.76 273.75±9.32 0.18	272.92±6.92 272.65±10.33 0.853*	-10.14±4.57 -3.15±7.23 -0.21	-9.75±3.45 -3.45±7.89 0.27	-16.76±4.64 -4.34±11.08 0.55	6.88±18.05 15.30±21.10 0.80

*Significant = r = 0.811 P>0.05

For Forward 2, Participant 7, (table 4.3.7), the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.03, 0.21< crit.val. =0.81), elbow (r=0.46,-0.17< crit.val. r=0.81) wrist (r= 0.17, 0.31< crit.val.=0.81), hand (r= -0.36, -0.43< crit.val. r=0.81)) and centre of mass (0.61, 0.58< crit.val.=0.81). No significant relationship also existed in the JAD take off of shoulder (r= 0.73, < crit.val. =0.81), take off and release of elbow (0.49, 0.58< crit.val. =0.81) and wrist (r=0.18, 0.47< crit.val. =0.81). The SAD data shows only significant relationship at take off of the forearm (0.827> 0.811), Hand (0.824>0.811) and trunk release (0.853>crit.val. =0.81). None was found at the take off and release of upper arm (0.44, 0.51< crit.val. =0.81) and forearm release (0.48< crit.val. =0.811) and trunk take off (0.55< crit.val. =0.81).

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.62, 0.34< crit.val. =0.81), elbow (r= 0.65, 0.45< crit.val. r=0.81) wrist (r= 0.70, 0.80< crit.val. =0.81), hand (r= 0.36, 0.38< crit.val. r=0.81) centre of mass (0.60, 0.54< crit.val. =0.81). No significant relationship was found in the JAD take off and release at shoulder (r=-0.46, 0.51 < crit.val. =0.81), elbow (-0.63, 0.31. < crit.val. =0.81) and wrist (r=-0.14, -0.29< crit.val. =0.81) of successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the hand (-0.37, 0.29< crit.val. =0.81), trunk (-0.21, 0.27< crit.val. =0.81), upper arm at release (-0.55, < crit.val. =0.81) and forearm at take off (-0.59< crit.val. =0.81), but significant at upperarm at take off (0.84> crit.val. =0.81) and forearm at release (0.85< crit.val. =0.81).

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (0.27, 0.17> crit.val. r=0.81) elbow (0.13, 0.19 crit.val. =0.81), wrist (0.77, 0.69< crit.val. =0.81) hand (0.43, 0.45< crit.val. =0.81) and COM (-0.55, 0.64 < crit.val. =0.81). In JAD, significant relationship exists only between take off parameters of wrist (0.82> 0.811) of successful and unsuccessful shots angle. No significant relationship was found at release angle of wrist (0.76< 0.811), take off and release angle of shoulder (0.59, 0.22< crit.val. =0.81) and the elbow (-0.60, -0.76< crit.val. =0.81). In the SAD, no significant correlation exist between segmental take off and release angles of the upper arm (0.47, 0.61< crit.val. =0.81) and forearm (0.64, 0.57< crit.val. =0.81), hand (0.73, 0.75< crit.val. =0.81) and trunk (0.55, 0.80< crit.val. =0.81).This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

Table 4.3.8: Forward 3 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	2.74m		4.67m		6.40m	
LD 3D(m)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.0369±0.123 0.05447±0.02 -0.18	0.2354±0.23 0.246±0.12 -0.27	0.05734±0.25 0.06148±0.19 -0.27	0.0913±0.22 0.096±0.20 0.32	0.406±0.15 0.415±0.17 -0.56	0.426±0.22 0.436±0.17 0.85*
Elbow: Succes **Unsuccessful** **R**	0.0384±0.18 0.057±0.25 -0.19	0.2586±0.235 0.2484±0.241 -0.28	0.2342±0.152 0.263±0.143 0.33	0.4312±0.166 0.460±0.130 0.24	0.717±0.042 0.739±0.068 0.37	0.76±0.08 0.781±0.07 0.39
Wrist: Succes **Unsuccessful** **R**	0.0382±.210 0.0566±0.124 0.48	0.2596±0.21 0.2484±0.26 -0.51	0.2663±0.08 0.299±0.07 -0.28	0.497±0.13 0.529±0.08 -0.19	0.782±0.062 0.806±0.035 0.39	0.830±0.052 0.854±0.035 0.51
Hand: Succes **Unsuccessful** **R**	0.0560±0.19 0.083±0.23 0.18	0.4162±0.26 0.396±0.29 0.69	0.2451±0.045 0.275±0.028 0.32	0.4521±0.09 0.4812±0.03 0.46	0.743±0.06 0.766±0.07 0.50	0.789±0.013 0.812±0.032 0.20
COM: Succes **Unsuccessful** **R**	0.0335±0.297 0.0493±0.238 0.33	0.2122±0.19 0.2042±0.22 0.74	0.073±0.132 0.080±0.143 0.18	0.119±2.25 0.125±5.19 0.43	0.195±0.037 0.507±0.29 0.25	0.520±0.036 0.533±0.291 0.79
JAD	Joint angular Displacement °					
Shoul.: Succes **Unsuccessful** **R**	79.35±10.22 84.67±25.22 0.63	112.91±20.62 118.32±18.55 0.80	58.704±78.67 64.80±60.86 -0.51	104.50±20.61 106.03±12.11 0.817*	98.99±7.86 101.64±5.25 0.85*	54.24±18.34 105.71±15.92 0.79
Elbow: Succes **Unsuccessful** **R**	86.342±76.02 93.60±29.24 0.80	129.21±30.55 37.02±29.15 0.79	106.03±36.73 111.11±20.64 0.57	145.89±28.55 151.02±20.36 0.49	139.21±36.33 142.37±21.47 0.53	146.19±20.73 145.51±18.68 0.31
Wrist: Succes **Unsuccessful** **R**	104.53±51.35 110.88±62.35 0.65	163.72±48.36 173.06±46.32 0.80	158.13±19.62 159.44±18.46 0.82*	134.35±18.55 129.61±12.36 0.78	132.76±9.62 128.16±6.48 0.69	129.15±5.93 125.34±15.63 0.78
Segmental Angular Displacement °						
Uparm:Succes **Unsuccessful** **R**	222.14±6.95 228.64±9.44 -0.33	242.15±5.82 242.18±3.12 -0.25	110.49±20.67 113.76±15.36 0.54	149.20±12.79 156.57±8.96 0.73	225.73±5.76 236.61±4.87 0.49	226.46±6.79 237.19±4.86 0.86*
Forarm:Succ **Unsuccessfu** **R**	240.58±17.31 241.58±18.62 0.56	251.72±11.35 252.43±12.13 -0.86*	244.71±10.38 246.60±7.92 0.73	257.55±5.69 259.35±11.36 0.66	268.21±16.88 270.35±10.96 0.49	270.35±5.69 271.37±13.78 0.69
Hand:Succes **Unsuccessfl** **R**	317.73±18.55 314.17±21.63 -0.29	264.38±47.61 265.77±2.65 -0.30	224.37±10.87 223.45±18.18 0.48	190.29±15.40 176.32±20.16 0.44	192.07±37.81 188.19±27.6 0.33	186.36±6.88 182.51±4.89 0.71
Trunk: Succes **Unsuccessful** **R**	278.21±5.45 277.71±2.73 0.76	270.11±15.18 271.12±13.96 0.48	274.45±2.79 274.93±3.61 0.75	271.03±.98 270.36±5.31 0.28	276.11±7.39 275.46±3.15 0.52	275.79±1.79 275.81±2.41 0.13

*Significant =0.05-0.811

For Forward 3 Participant 8, (table 9),the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.18, -0.27< crit.val. =0.811), elbow (r=-0.19, -0.28< crit.val. r=0.811), wrist (r= 0.48, -0.51< crit.val. =0.811), hand (r= 0.18, 0.69< crit.val. r=0.811) and centre of mass (0.33, 0.74<

crit.val.=0.81). No significant relationship exist in the JAD take off and release at shoulder (r= 0.63, 0.80< crit.val. =0.811), elbow (0.80, 0.79< crit.val. =0.811) and wrist (r=0.65, 0.80< crit.val. =0.81). The SAD data shows that there is no significant relationship at both take off and release of upper arm (-0.33, -0.25< crit.val. =0.811) hand (-0.29, -0.30< crit.val. =0.811), trunk (0.76, 0.48< crit.val. =0.811) and the forearm at take off (0.56< 0.811) segments. Inverse correlation was only found at the release of forearm (0.86> 0.811) segment.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.27, 0.32< crit.val. =0.811), elbow (r= 0.33, 0.24< crit.val. r=0.811) wrist (r= -0.28, -0.19< crit.val. =0.811), hand (r= 0.32, 0.48< crit.val. r=0.811 centre of mass (0.18, 0.43< crit.val. =0.811). No significant relationship was found in the JAD of the shoulder take off (r=-0.51 < crit.val. =0.811), take off and release at the elbow (0.57, 0.49< crit.val. =0.811), release at wrist (r=0.78< crit.val. =0.811) except at the release JAD of shoulder (0.817< crit.val. r=0.811) and wrist take off (0.82< crit.val. r=0.811) of successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the upper arm (0.54, 0.73< crit.val. =0.811), forearm (0.73, 0.66< crit.val. =0.811) hand (0.48, 0.44< crit.val. =0.811), and trunk (0.75, 0.28< crit.val. =0.811).

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of elbow (0.37, 0.39> crit.val. r=0.811) wrist (0.39, 0.51< crit.val. =0.811), hand (0.50, 0.20< crit.val. =0.811) COM (0.25, 0.79< crit.val. =0.811) and at shoulder take off (-0.56< crit.val. =0.81) not at its release (0.85> 0.811). In JAD, significant relationship exists only between take off at shoulder (0.85> 0.811) of successful and unsuccessful shots angle. No significant relationship was found at take off and release angle of elbow (0.53, 0.31< 0.811), take off and release angle of wrist (0.69, 0.78< crit.val. =0.811) and at shoulder take off (0.79< crit.val. =0.811). In the SAD, it was revealed that significant relationship exist only between segmental release angles of the upper arm (0.86> 0.811) and not at the take off of the upper arm (0.49< crit.val. =0.811) take off and release of the forearm (0.49, 0.69< crit.val. =0.811) and at the trunk (0.52, 0.13< crit.val. =0.811). This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots making for acceptance of the hypothesis.

Table 4.3.9: Forward 4 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	2.74m		4.67m		6.40m	
LD 3D (m)	Take off	Release	Take-off	Release	Take-off	Release
1. Shoulder **Successful** **Unsuccessful** **R**	0.510±0.025 0.526±0.031 -0.78	0.679±'.02 0.699±0.04 -0.46	0.2757±0.061 0.302±0.017 -0.46	0.292±0.007 0.322±0.015 -0.39	0.544±0.030 0.627±0.012 0.45	0.572±0.043 0.659±0.028 -0.32
2. Elbow **Successful** **Unsuccessful** **R**	0.869±0.009 0.778±0.15 0.28	1.159±0.051 1.006±0.073 0.45	0.574±0.04 0.612±0.012 -0.28	0.609±0.024 0.661±0.013 -0.51	0.9565±0.003 0.931±0.012 0.59	1.007±0.021 0.979±0.012 0.79
3. Wrist **Successful** **Unsuccessful**	0.749±0.012 0.699±0.131 0.33	0.997±0.030 0.913±0.025 0.58	0.611±0.021 0.632±0.054 0.66	0.648±0.031 0.652±0.025 0.54	1.098±0.052 0.995±0.034 0.38	1.155±0.013 1.048±0.035 -0.57
4. Hand **Successful** **Unsuccessful**	0.754±0.025 0.725±0.056 0.83*	1.005±0063 0.997±0.057 0.76	0'.592±0.003 0.624±0.012 0.23	0.626±0.031 0.652±0.025 0.48	1.047±0.02 0.975±0.15 0.29	1.102±0.03 1.026±0.052 0.31
5.Centre of mass **Successful** **Unsuccessful**	0.646±0.13 0.628±0.069 0.52	0.862±021 0.845±0.026 0.73	0.354±0.052 0.382±0.041 0.55	0.371±0.006 0.412±0.031 0.23	127.97±5.67 125.89±10.34 0.80	122.62±8.78 120.96±11.99 0.68
JAD	Joint Angular Displacement°					
1. Shoulder **Successful** **Unsuccessful**	165.72±4.76 170.30±5.63 0.73	149.89±15.68 158.56±9.33 0.57	121.04±6.89 119.36±9.63 0.79	123.73±5.92 121.65±10.67 0.51	152.95±6.8 136.68±11.82 -0.56	152.35±12.61 131.91±8.56 0.43
2. Elbow **Successful** **Unsuccessful**	136.39±9.94 141.63±5.36 00.48	140.82±15.61 147.57±8.75 0.51	123.4311.73 149.55±6.51 0.812*	128.88±12.76 155.36±6.34 0.63	125.58±6.52 154.85±8.11 0.48	122.04±7.84 157.48±13.46 -0.28
3. Wrist **Successful** **Unsuccessful**	99.63±9.66 117.78±4.72 0.38	97.99±6.92 115.10±4.88 -0.57	97.064±6.88 115.10±3.96 0.38	24.37±16.78 117.31±4.79 -0.27	99.63±9.66 117.78±4.72 -0.38	97.99±6.92 115.10±4.88 -0.57
SAD	Segmental Angular Displacement °					
1. Upper arm **Successful** **Unsuccessful**	97.99± 8.78 -101.82±12.56 -0.32	229.38±11.61 -102.89±36.71 -0.18	278.17±5.67 275.67±9.33 0.76	278.80±6.77 276.18±9.45 0.60	252.65±5.83 260.14±7.44 -0.49	253.23±4.38 260.93±3.47 -0.53
For armSucc. **Unsuccessful** **R**	231.07±10.67 266.39±5.44 -0.37	239.72±16.97 266.03±6.36 -0.51	256.23±11.36 245.74±19.72 0.46	256.69±10.33 246.18±8.64 0.51	-130.76±9.69 -143.78±4.77 0.56	-131.906.64 -144.18±9.89 0.38
Hand **Successful** **Unsuccessful**	219.95±23.82 181.67±21.64 0.39	230.35±19.60 177.96±25.57 -0.41	193.08±12.67 187.65±8.34 0.52	131.45±6.82 128.86±11.37 0.49	154.19±8.54 146.47±12.36 0.61	151.50±11.98 143.87±7.48 -0.57
Trunk: Succ. **Unsuccessful** **R**	287.63±11.88 276.62±2.89 -0.49	271.33±2.56 276.91±2.76 -0.36	271.01±5.52 268.10±15.81 -0.72	270.97±6.31 268.98±7.59 0.73	278.78±3.57 211.16±9.46 0.51	273.52±8.11 267.28±14.46 -0.46

*Significant = r = 0.811 P>0.05

`For Forward 4, participant 9 (table 4.3.9), the 2.75m shots Linear Displacement (LD3D) data revealed that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.78, -0.46< crit.val. =0.81), elbow (r=0.28, 0.45< crit.val. r=0.811) wrist (r= -0.33, 0.58< crit.val. =0.811), hand release (r= 0.76, -0.19< crit.val. r=0.81) and centre of mass (0.52, 0.73< crit. val. =0.81) except in the take off of the hand (0.83> 0.811) LD3D. No significant relationship exist in the JAD), take off and release of shoulder (r= 0.80, -0.68< crit.val. =0.81), elbow (0.73, 0.57< crit.val. =0.81) and wrist (r=0.48, 0.51< crit.val. =0.81) The SAD data also shows that no significant relationship in both take off and release at upper arm (-0.32, --0.18< crit.val. =0.81) forearm (0.37, 0.51< crit.val. =0.811), the hand (0.39, -0.41> crit.val. =0.81) and the trunk (0.49, -0.36 < crit.val. =0.81) segments. This implies that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=0.46, -0.39< crit.val. =0.811), elbow (r= -0.28, 0.51< crit.val. r=0.81) wrist (r= 0.66, -0.51< crit.val. =0.811), hand (r= -0.25, 0.48< crit.val. r=0.81) centre of mass (0.23, 0.55< crit.val. =0.81). Significant relationship was also not found in the JAD of the take off and release of shoulder (r=-0.78 < crit.val. =0.81), wrist (r=-0.38, -0.27< crit.val. =0.81) and elbow release (-0.63 < crit.val. =0.811) except at the elbow release angle (0.812>0.811) of successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the upper arm (0.76, 0.60< crit.val. =0.81), forearm (0.46, 0.51< crit.val. =0.81) hand (0.52, 0.49< crit.val. =0.81) and the trunk (-0.72, 0.73< crit.val. =0.81), and, and not in its release (0.814> crit.val. =0.81).

` In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (0.45, -0.32> crit.val. r=0.81) elbow (0.59, 0.79< crit.val. =0.81), wrist (0.68, 0.80< crit.val. =0.81) hand (-0.29, 0.51< crit.val. =0.81) and COM (-0.42, 0.51 < crit.val. =0.81). In the JAD, no significant relationship was found at both take off angle of the shoulder (-0.56, 0.43< crit.val. =0.81) elbow (0.48, 0.28< 0.811) and the wrist (0.38, -0.57< crit.val. =0.81). In the SAD, the data reveals no significant relationship between segmental release angles of the upper arm (-0.49, 0.53<

crit.val. =0.81), forearm (0.56, 0.38< crit.val. =0.81), hand (0.61, 0.-57< crit.val. =0.81) and the trunk (-0.51, 0.46< crit.val. =0.81). The results show that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

Table 4.3.10: Forward 5Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	**2.74m**		**4.67m**		**6.40m**	
LD 3D (m)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes	0.7404±0.029	0.8307±0.030	0.0596±0.22	0.640±0.03	0.6215±0.062	0.622±0.062
Unsuccessful	0.807±0.040	0.954±0.036	0.069±0.523	0.075±0.15	0.585±0.089	0.585±0.089
R	0.84*	0.75	-0.31	-0.07	0.015	0.015
Elbow: Succes	1.1841±0.030	1.318±0.031	0.534±0.031	0.544±'.023	1.118±0.016	1.120±0.017
Unsuccessful	1.245±0.032	1.449±0.033	0.554±0.05	0.564±0.013	0.999±0.057	1.006±0.065
R	0.80	0.79	0.62	0.75	0.057	0.06
Wrist: Succes	1.0438±0.031	1.230±0.020	0.628±0.032	0.643±0.38	0.750±0.81	1.125±0.025
Unsuccessful	1.163±0.018	1.367±0.030	0.658±0.015	0.674±0.031	1.049±0.044	1.049±0.045
R	0.22	-0.30	0.79	0.71	-0.32	-0.012
Hand: Succes	0.70±0.26	0.97±'.30	0.560±0.047	0.618±0.043	1.086±0.009	1.088±0.012
Unsuccessful	0.80±0.45	0.84±0.48	0.636±0.018	0.655±0.014	0.947±0.045	0.095±0.046
R	0.02	-0.18	0.73	0.59	0.56	0.25
COM: Succes	0.5478±0.07	0.6689±0.05	0.119±0.026	0.122±'.023	0.776±0.059	0.776±0.059
Unsuccessful	0.60±0.37	0.5876±0.35	0.125±0.039	0.129±0.025	0.55±0.105	0.556±0.094
R	0.78	-0.26	0.71	0.35	0.56	0.54
Joint Angular Displacement (JAD) °						
Shoul.: Succes	92.99±4.60	100.76±6.52	107.24±5.85	109.98±7.26	139.2±11.07	143.31±11.99
Unsuccessful	90.55±9.23	94.81±8.0	99.33±8.74	101.44±8.02	134.41±7.79	137.65±7.71
R	0.27	-0.30	0.54	0.48	0.29	0.37
Elbow: Succes	94.11±12.23	186.23±15.63	92.55±4.0	95.41±3.74	150.53±23.49	150.60±12.74
Unsuccessful	82.33±12.25	94.56±11.99	101.23±7.42	103.54±7.29	141.37±5.98	144.88±6.28
R	-0.09	-0.17	0.75	0.58	0.810	0.77
Wrist: Succes	155.53±5.07	181.86±6.75	168.41±5.30	169.52±1.89	148.11±20.74	138.93±14.93
Unsuccessful	157.08±12.67	179.106±9.98	150.58±10.8	167.59±8.27	124.80 ±7.45	119.81±7.75
R	0.80	0.21	0.48	0.68	0.78	0.75
SAD	**Segmental Angular Displacement°**					
Uparm: Succes	238.06±18.14	244.17±14.99	-60.35±15.59	-85.61±20.32	79.84±206.21	81.51±188.70
Unsuccessful	210.82±37.12	256.35±15.56	-65.61±22.32	-70.62±26.15	86.89±71.35	-75.44±7.59
R	0.57	0.64	0.31	0.75	0.79	-0.52
Forarm:Succe	252.10±2.70	256.34±4.77	252.62±3.86	253.52±4.81	51.62±237.31	129.68±183.10
Unsuccessful	247.99±9.25	252.55±8.41	253.52±4.39	254.40±5.11	249.44±2.11	261.58±2.71
R	0.20	0.819*	0.53	0.35	0.115	0.70
Hand: Succes	-99.61±4.02	-110.32±5.51	257.94±7.34	257.45±4.74	256.52±22.52	231.64±16.86
Unsuccessful	-99.95±6.60	-113.01±8.08	257.45±9.62	257.00±6.31	213.60±32.08	189.99±25.73
R	0.31	-0.42	00.83	00.21	0.75	0.73
Trunk: Succes	262.14±22.87	259.47±24.39	273.45±5.62	273.44±2.62	271.21±2.87	271.78±3.34
Unsuccessful	271.07±4.48	272.05±14.43	273.43±1.16	273.43±1.87	270.35±6.33	270.96±1.89
R	0.86*	0.817*	0.59	0.79	0.62	0.46

*Significant = r = 0.811 P>0.05

For Forward 5 participant 10 (4.3.10), the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the elbow (r=0.80, 0.79< crit.val. r=0.81) wrist (r= 0.22, -0.30< crit.val.=0.81), hand (r= 0.02, -0.18< crit.val. r=0.81)) and centre of mass (0.78, -0.26< crit.val.=0.81) and shoulder release (r= 0.75< crit.val. =0.81) except at the shoulder take off (r= 0.84> crit.val. =0.81). No significant relationship also exist in the JAD take off and release of shoulder (r= -0.27, -0.30<

crit.val. =0.81), elbow (-0.09, 0.17< crit.val. =0.81) and wrist (r=0.80, 0.21< crit.val. =0.81. The SAD data shows also that there is no significant relationship in both take off and release of upper arm (0.57, 0.64< crit.val. =0.81), hand (0.31, -0.42< crit.val. =0.81) and take off at forearm (0.20, < crit.val. =0.81). Significant correlation however is found at take off and trunk release (0.86, -0.817> crit.val. =0.81) and forearm release (0.819> 0.811) segments. The results show that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.31, -0.07< crit.val. =0.81), elbow (r= 0.62, 0.75< crit.val. r=0.81) wrist (r= 0.79, 0.71< crit.val. =0.81), hand (r= 0.73, 0.35< crit.val. r=0.81) and centre of mass (0.71, 0.35< crit.val. =0.81). No significant relationship was also found in the JAD take off and release of the shoulder (r=-0.52, 0.31 < crit.val. =0.81), elbow (0.75, 0.58 < crit.val. =0.81) and wrist (r=-0.48, 0.66< crit.val. =0.81) for successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the upper arm (0.31, 0.75< crit.val. =0.81), forearm (0.53, 0.35< crit.val. =0.81), the trunk (0.59, 0.79< crit.val. =0.81) and hand segmental release (0.21< crit.val. =0.81) and not in the take off (0.83>811) segments in clean and missed shots.

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (-0.015, 0.015> crit.val. r=0.81) elbow (0.057, 0.06< crit.val. =0.81), wrist -(0.32, -0.012< crit.val. =0.81) hand (0.56, 0.25< crit.val. =0.81) and COM (0.56, 0.54 < crit.val. =0.81). In JAD, significant relationship was not found at take off and release angle of shoulder (0.52, 0.31< crit.val. =0.81), elbow (0.61, 0.77< 0.811), and the wrist (0.48, 0.66< crit.val. =0.81). In the SAD, it was revealed that significant relationship exists only between take off segmental angles of the upper arm

(0.89<0.811 and hand (0.85>811) and not at the release SAD of these segments; shoulder (0.52<0.811) and hand (0.73<0.811). So also no significant relationship was found at both take off and release SAD of the forearm (0.12, 0.70< crit.val. =0.81) and the trunk (0.62, 0.46< crit.val. =0.81) of successful and unsuccessful shots angle. The results show that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

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Table 4.3.11: Centre1 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	2.74m		4.67m		6.40m	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes Unsuccessful R	0.3389±0.135 0.1213±0.25 -0.57	0.5396±0.217 0.241±0.276 -0.41	0.071±0.005 0.082±0.014 -0.11	0.101±0.004 0.120±0.012 0.68	0.4757±0.58 0.3973±0.43 -0.07	0.5109±0.062 0.4256±0.06 0.29
Elbow:Succes Unsuccessful R	0.6488±0.121 0.4404±0.303 -0.62	1.012±0.218 0.607±0.052 0.80	0.404±0.046 0.420±0.047 0.75	0.571±0.043 0.592±0.039 0.82*	0.8191±0.06 0.7166.06 -0.42	0.8819±0.071 0.7425±0.06 -0.16
Wrist: Succes Unsuccessful R	0.551±0.046 0.532±0.162 -0.62	0833±0.067 0.723±0.143 0.89*	0.487±0.057 0.502±0.070 0.76	0.689±0.063 0.695±0.069 0.73	0.8114±0.054 0.7841±0.06 0.22	0.8615±0.057 0.8094±0.054 -0.12
Hand: Succes Unsuccessful R	0.540±0.052 0.437±0.190 -0.65	0.831±0.107 0.642±0.388 0.79	0.4547±0.026 0.473±0.032 0.61	0.6436±0.017 0.633±0.022 0.60	0.8129±0.042 0.7339±0.055 0.28	0.8543±0.040 0.7679±0.059 0.32
COM: Succes Unsuccessful R	0.524±0.216 0.119±0.354 -0.67	0.788±0.33 0.159±0.282 -0.74	0.101±0.006 0.120±0.012 0.45	0.142±0.003 0.148±0.008 0.819*	0.5667±0.084 0.5017±0.027 -0.75	0.5948±0.085 0.5190±0.034 -0.63
JAD	Joint Angular Displacement°					
Shoul.:Succes Unsuccessful R	66.48±22.35 105.98±11.62 -0.37	97.711±19.54 108.98±13.67 0.72	129.23±9.62 110.88±18.35 0.41	129.13±1.33 114.21±12.46 0.51	139.2±10.13 136.41±7.71 -0.12	143.31±10.89 139.65±7.72 0.01
Elbow:Succes Unsuccessful R	86.52±17.91 116.60±10.44 -0.45	86.88±10.73 119.03±12.31 0.65	129.72±12.23 111.39±15.61 0.47	131.14±8.68 112.65±15.56 0.27	150.53±22.96 143.37±3.83 0.824*	150.60±12.03 146.91±4.22 0.77
Wrist: Succes Unsuccessful R	146.66±4.96 139.06±14.25 0.48	125.35±6.18 134.35±17.6 -0.60	116.35±10.26 127.35±8.37 0.50	114.35±8.87 122.72±6.96 0.72	146.13±20.50 126.82±5.49 0.87*	136.90±13.39 121.83±5.88 -0.67
SAD	Segmental Angular Displacement °					
Trunk:Succes Unsuccessful R	148.82±73.18 11.15±119.55 0.91*	201.76±43.55 45.16±179.03 0.65	252.45±6.84 41.77± 15.53 -0.28	252.96±4.65 46.24±21.74 -0.12	87.34±197.50 61.89±58.32 0.73	79.10±190.36 -75.44±7.58 -0.55
Uparm: Succe Unsuccessful R	249.53±10.89 247.83±4.41 -0.53	257.48±13.24 255.73±9.59 0.25	267.52±7.36 247.57±8.92 0.36	268.13±3.56 248.06±5.67 0.41	51.59±237.28 249.44±2.11 0.13	129.66±183.18 261.58±2.71 0.70
Forarm:Succe Unsuccessful R	103.24±183.83 169.01±149.26 0.49	102.46±191.7 152.96±146.9 0.49	243.6±9.65 203.11±21.84 -0.27	242,29±11.71 201.64±15.52 -0.32	253.29±16.13 213.6±32.08 0.86*	229.11±14.93 189.99±25.73 0.74
Hand: Succes Unsuccessful R	273.74±5.73 275.76±6.99 0.29	273.93±7.04 275.98±6.89 0.53	266.61±11.33 275.40±5.77 0.41	266.23±9.23 275.07±2.76 0.25	276.88±1.08 278.63±4.26 0.19	276.32±0.86 278.84±4.49 0.28

*Significant =0.05-0.811

For Centre 1, Participant 11, (table 4.3.11), the 2.75m shots Linear Displacement (LD3D) data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.-57, -0.41 < crit.val. =0.81), elbow (r= -0.62, 0.80< crit.val. =0.81), hand (r= -0.65, 0.79< crit.val.

r=0.81)) and centre of mass (-0.67, -0.74< crit.val. =0.81) with exception at release in the shoulder (0.88> 0.811) and wrist (0.89> 0.811) LD3D. No significant relationship also exist in the JAD at take off and release of shoulder (r= -0.37, -0.72< crit.val. =0.81), elbow (-0.45, 0.65< crit.val. =0.81) and wrist (r=0.48, -0.60< crit.val. =0.81) The SAD data also shows that no significant relationship in both take off and release at upper arm (-0.32, --0.18< crit.val. =0.81) forearm (0.37, 0.51< crit.val. =0.811), the hand (0.39, -0.41> crit.val. =0.81) and the trunk (0.49, -0.36 < crit.val. =0.81) segments.

` For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.11, -0.068< crit.val. =0.811), elbow take off (r= -0.75, < crit.val. r=0.81) wrist (r= 0.76, 0.73< crit.val. =0.811), hand (r= 0.61, 0.60 crit.val. r=0.81) centre of mass take off (0.45 < crit.val. =0.81). However, significant relationship was found at the elbow release (r= 0.82, < crit.val. r=0.81) and COM release (r= 0.819, < crit.val. r=0.81). Significant relationship was also not found in the JAD of the take off and release of shoulder (r=-0.78 < crit.val. =0.81), wrist (r=-0.38, -0.27< crit.val. =0.81) and elbow release (-0.63 < crit.val. =0.811) except at the elbow release angle (0.812>0.811) of successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the upper arm (0.76, 0.60< crit.val. =0.81), forearm (0.46, 0.51< crit.val. =0.81) hand (0.52, 0.49< crit.val. =0.81) and the trunk (-0.72, 0.73< crit.val. =0.81), and, and not in its release (0.814> crit.val. =0.81).

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (-0.07, -0.29> crit.val. r=0.81) elbow (0.42, 0.16< crit.val. =0.81), wrist (0.22, -0.12< crit.val. =0.81) hand (-0.28, 0.32< crit.val. =0.81) and COM (-0.75, 0.63 < crit.val. =0.81). In the JAD, no significant relationship was found at both take off angle of the shoulder (0.12, 0.22< crit.val. =0.81) elbow (0.76< 0.811) and wrist release (0.74< 0.811) In the SAD, the data reveals no significant relationship between segmental release angles of the upper arm (-0.73, 0.55< crit.val. =0.81), forearm (0.13, 0.70< crit.val. =0.81), trunk (-0.54, 0.79< crit.val. =0.81) and at release of hand (0.74 < crit.val. =0.81) excluding the take off (0.86 > crit.val. =0.81). But significant relationship was shown at the forearm take off (0.86> 0.811). The results show that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

Table 4.3.12: Centre 2 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	**2.74m**		**4.67m**		**6.40m**	
LD 3D	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Should: Succ Unsuccessf R	0.390± 0.15 0.37±0.47 0.25	0.439±0.120 0.406±0.045 0.16	0.223±0.02 0.216±0.04 -0.17	0.250±0.12 0.236±0.06 -0.26	0.430±0.070 0.415±0.044 0.095	0.459±0.079 0.444±0.040 -0.29
Elbow:Succ Unsuccessf R	0.668±0'.292 0.717±0.063 -0.19	0.754±0.263 0.743±0.059 -0.37	0.380±0.21 0.367±0.249 0.37	0.431±0.003 0.405±0.02 0.51	0.728±0.122 0.634±0.057 0.37	0.814±0.118 0.094±0.060 -0.30
Wrist: Succ Unsuccessf R	0.669±0289 0.784±0.060 -0.24	0.739±0.241 0.809±0.054 -0.12	0.452±0.023 0.437±0.011 0.29	0.509±0.03 0.481±0.06 0.47	0.750±0.094 0.689±0.072 -0.012	0.778±0.118 0.733±0.052 -0.11
Hand: Succe Unsuccessf R	0.660±0.254 0.734±0.055 -0.42	0.737±0.180 0.768±0.059 -0.53	0.532±0.30 0.516±0.06 0.42	0.599±0.002 0.566±0.68 0.39	0.752±0.012 0.663±0.044 -0.08	0.777±0.010 0.721±0.036 -0.79
COM: Succes Unsuccessful R	0.4638±0.198 0.502±0.027 0.73	0.511±0.162 0.519±0.034 0.84*	0.274±0.11 0.266±0.12 0.56	0.307±0.03 0.291±0.05 0.76	0.536±0.075 0.503±0.018 0.48	0.565±0.078 0.534±0.017 -0.58
JAD	Joint Angular Displacement°					
Shoul.: Succes Unsuccessful R	128.42±17.792 134.41±7.792 0.79	135.42±14.71 137.65±7.707 0.67	123.22±26.72 122.11±40.3 0.73	125.50±19.64 127.83±21.72 0.82*	122.584±4.46 126.79±5.97 0.47	129.46±6.02 130.12±6.12 0.49
Elbow: Succes Unsuccessful R	131.16±33.831 141.37±5.976 0.059	139.71±17.29 144.88±6.277 0.25	123.07±9.60 120.53±5.80 0.53	128.13±3.81 133.14±5.61 0.61	119.48±20.51 1931.79±11.63 -0.51	132.93±9.64 136.19±9.44 0.50
Wrist: Succes Unsuccessful R	139.85±18.783 124.79±7.454 0.74	134.88±14.84 119.81±7.751 0.75	131.87±15.81 133.37±6.36 0.78	129.40±32.3 127.44±10.4 0.41	128.65±10.65 121.49±11.72 0.01	123.43±14.16 118.70±9.78 -0.15
SAD	Segmental Angular Displacement °					
Trunk: Succes Unsuccessful R	87.345±197.50 89.89±73.507 0.79	79.101±190.35 -80.443±10.101 -0.65	-96.73±56.72 -95.383±42.51 0.64	-97.34±26.78 96.88±38.33 0.71	87.34±197.50 150.63±92.27 0.03	79.10±190.35 4.52±174.24 -0.62
Uparm: Succes Unsuccessful R	49.09±240.50 249.44±2.107 0.13	129.66±183.18 261.58±2.714 0.702	262.33±18.76 261.87±32.45 0.57	263.24±23.78 264.16±31.60 0.59	49.09±240.50 249.96±2.97 0.29	129.66±183.18 259.77±4.08 0.05
Forarm:Succ. Unsuccessful R	254.04±21.144 213.60±32.076 0.39	229.11±14.937 189.99±25.735 0.74	224.34±21.48 223.71±30.80 0.55	223.46±18.89 222.45±21.69 0.79	254.04±21.14 213.6±53.22 0.67	229.11±14.93 209.85±52.96 0.56
Hand: Succes Unsuccessful R	276.88±1.083 282.88±4.009 0.61	276.32±00.863 282.34±4.329 0.79	272.77±8.32 270.97±12.65 0.71	272.17±15.82 271.58±17.98 0.83*	276.88±1.08 280.17±6.48 0.76	276.32±0.86 279.07±0.63 0.71

*Significant =0.05-0.811

For Centre player 2 participant 12, the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r= 0.25, 0.16< crit.val. =0.81) elbow (r=-0.19, -0.37< crit.val. r=0.81), wrist (r= -0.24, -0.12< crit.val. =0.81), hand (r= -0.42, -0.53< crit.val. r=0.81)) and centre of mass (0.73, -0.71< crit.val.=0.81). No significant relationship also exist in the JAD take off and release of shoulder (r= -0.79, -0.80< crit.val. =0.81), elbow (-0.06, 0.25< crit.val. =0.81) and wrist (r=0.73, 0.75< crit.val. =0.81. The SAD data shows also that there is no significant relationship in both take off and release of upper arm (0.79, -0.65< crit.val. =0.81), forearm (0.13, 0.70< crit.val. =0.81), hand (0.69, 0.74 < crit.val. =0.81) and the trunk (0.61, .0.79> crit.val. =0.81) segments.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=-0.17, -0.26< crit.val. =0.81), elbow (r= 0.37, 0.51< crit.val. r=0.81) wrist (r= 0.29, 0.47< crit.val. =0.81), hand (r= 0.42, 0.37< crit.val. r=0.81) and centre of mass (0.56, 0.76< crit.val. =0.81). No significant relationship was also found in the JAD take off and release of the elbow (0.53, 0.61 < crit.val. =0.81), wrist (r=-0.78, 0.41< crit.val. =0.81) and shoulder at take off (r=-0.73< crit.val. =0.81) and not at the release (r=-0.82> crit.val. =0.81) for successful and unsuccessful shots.

For SAD, no significant relationship exists in the take off and release of the upper arm (0.64, 0.71< crit.val. =0.81), forearm (0.57, 0.59< crit.val. =0.81), hand (0.55, 0.79< crit.val. =0.81) and the trunk take off (, 0.71< crit.val. =0.81) and not in the take off (0.83>811) segments in clean and missed shots.

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (-0.01, -0.29> crit.val. r=0.81) elbow (0.37, -0.30< crit.val. =0.81), wrist (-0.012, -0.11< crit.val. =0.81) hand (-0.08, -0.79< crit.val. =0.81) and COM (0.48, 0.58 < crit.val. =0.81). In the JAD, significant relationship was not found at take off and release angle of shoulder (0.47, 0.49< crit.val. =0.81), elbow (-0.51, 0.50< 0.811), and the wrist (0.01, -0.15< crit.val. =0.81). In the SAD, it was revealed that no significant relationship exists between take off and release segmental angles of the upper arm (0.03, -62<0.811) forearm (0.29, 0.05< crit.val. =0.81), hand (0.67, 0.56< crit.val. =0.81) and the trunk (0.76, 0.71< crit.val. =0.81) of successful and unsuccessful shots angles. The results showed that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

Table 4.3.13: Centre 3 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots.

Variables	2.74m		4.67m		6.40m	
LD 3D (m)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes **Unsuccessful** **R**	0.1823±0.04 0.17776±o.15 0.47	0.2213±0.031 0.1986±0.023 0.20	0.232±0.181 0.225±0.176 0.43	0.245±0.122 0.251±0.096 0.52	0.375±0.113 0.414±0.114 0.32	0.427±0.16 0.453±0.12 0.36
Elbow: Succes **Unsuccessful** **R**	0.3515±0.012 0.3362±0.04 0.51	0.04571±0.021 0.4218±0.043 0.28	0.574±0.018 0.56±0.23 0.72	0.611±0.025 0.630±0.019 0.63	0.645±0.024 0.714±0.018 -0.31	0.738±0.051 0.761±0.014 0.73
Wrist: Succes **Unsuccessful** **R**	0.3381±0.014 0.3198±0.025 0.36	0.4333±0.012 0.4321±0.21 0.43	0.609±0.071 0.588±0.13 -0.29	0.649±0.024 0.670±0.015 0.36	0.639±0.04 0.770±0.041 -0.36	0.734±0.023 0.757±0.03 0.81*
Hand: Succes **Unsuccessful** **R**	0.3524±0.021 0.3263±0.42 0.34	0.4618±0.024 0.4467±0.011 0.47	0.581±0.145 0.561±0.129 0.63	0.619±0.093 0.639±0.078 0.87*	0.631±0.072 0.701±0.051 0.41	0.724±0.051 0.748±0.042 0.80
COM: Succes **Unsuccessful** **R**	0.2213±0.013 0.2169 0.41	0.2773±0.006 0.2668±0.009 0.53	0.305±0.052 0.295±0.097 -0.29	0.323±0.076 0.332±0.059 0.84*	0.435±0.14 0.480±0.16 0.58	0.494±0.005 0.509±0.02 -0.48
JAD	Joint Angular Displacement º					
Shoul.: Succes **Unsuccessful** **R**	97.51±15.21 101.34±10.36 0.51	109.03±15.61 116.46±08.20 0.46	118.58±22.78 121.03±29.62 0.89*	123.49±15.89 125.78±22.16 0.65	109.85±12.76 112.05±23.55 0.51	118.45±18.82 120.35±15.9 0.82*
Elbow: Succes **Unsuccessful** **R**	114.66±10.05 118.37±8.57 0.48	124.93±6.25 130.67±9.18 0.51	135.24±51.62 137.43±32.96 0.83	139.62±30.60 141.65±42.89 0.78	123.81±20.12 126.98±16.81 -0.56	132.81±9.77 134.82±12.81 0.64
Wrist: Succes **Unsuccessful** **R**	133.99±5.80 138.67±4.10 0.58	122.99±8.60 128.58±5.26 0.61	150.43±30.61 148.59±26.93 0.77	146.75±29.34 144.80±29.83 0.83*	165.28±31.62 162.60±25.18 0.46	154.65±17.11 152.16±22.46 0.69
SAD	Segmental Angular Displacement º					
Trunk: Succes **Unsuccessful** **R**	115.10±149.88 -83.05±30.26 0.14	144.44±44.40 -99.85±23.0 0.25	-78.52±120.39 -80.94±131.82 -0.31	-81.93±123.18 -83.14±101.62 -0.26	231.60±26.91 181.18±40.33 0.51	245.32±19.31 246.58±20.62 0.86*
Uparm: Succes **Unsuccessful** **R**	113.24±193.24 243.42±14.05 -0.09	91.71±211.79 258.07±17.10 0.26	258.09±20.31 259.18±18.68 -0.89*	260.27±23.62 261.36±25.85 0.58	258.88±12.96 231.53±28.16 0.42	261.48±23.62 257.17±15.64 -0.49
Forarm:Succe **Unsuccessful** **R**	170.16±32.44 221.70±11.44 -0.34	180.52±25.94 206.71±18.92 -0.13	283.42±9.86 284.20±5.43 0.86*	284.98±15.33 285.85±19.70 0.63	261.66±21.69 259.99±14.95 0.83*	259.23±15.35 258.07±19.79 -0.58
Hand: Succes **Unsuccessful** **R**	263.57±12.75 258.73±6.17 0.28	210.44±116.44 254.51±10.61 0.19	262.84±10.16 261.71±12.83 0.73	262.58±10.61 262.45±8.95 0.91*	273.12±3.76 272.69±2.35 0.79	274.09±2.32 274.87±1.97 0.82*

*Significant = r = 0.811 P>0.05

For Centre player 3 participant 13, the 2.74m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r= 0.47, 0.20< crit.val. =0.81) elbow (r=-0.51, 0.28< crit.val. r=0.81), wrist (r= -0.36, -0.43< crit.val. =0.81), hand (r= -0.34, 0.47< crit.val. r=0.81)) and centre of mass (0.41, 0.53< crit.val.=0.81). No significant relationship also exist in the JAD take off and release of shoulder (r= 0.51, 0.46< crit.val. =0.81), elbow (0.48, 0.51< crit.val. =0.81) and wrist (r=0.58, 0.61< crit.val. =0.81. The SAD data shows also that there is no significant relationship in both take off and release of upper arm (-0.09, 0.26< crit.val. =0.81), forearm (-0.34, -0.13< crit.val. =0.81), hand (0.28, 0.19 < crit.val. =0.81) and the trunk (0.14, .0.25> crit.val. =0.81) segments.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r= 0.43, 0.26< crit.val. =0.81), elbow (r= 0.28, 0.72< crit.val. r=0.81) wrist (r= -0.29, 0.36< crit.val. =0.81), take off at the hand (r= 0.63, < crit.val. r=0.81) and centre of mass (-0.29< crit.val. =0.81). However, significant relationship was found at the release of hand (0.87> crit.val. =0.811) No significant relationship was also found in the JAD release at shoulder (0.65< 0.811), elbow (0.78 < crit.val. =0.81) and take off at wrist (r= 0.77< crit.val. =0.81) Significant correlation was found at take off of the shoulder (r=-0.89> crit.val. =0.81), elbow (r= 0.83> crit.val. =0.81) and wrist at release (0.83> 0.811) for successful and unsuccessful shots. For SAD, no significant relationship exists in the take off and release of the trunk (-0.31, -0.26< crit.val. =0.81), at forearm release (0.63< crit.val. =0.81) and hand at take off (0.73< crit.val. =0.81), except at the take off of upperarm (-0.89< crit.val. =0.81), forearm (0.86>811) and hand at release (0.91> 0.811) segments in clean and missed shots.

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (-0.3, -0.36> crit.val. r=0.81) elbow (-0.31, -0.73< crit.val. =0.81), hand (0.41, 0.80< crit.val. =0.81), COM (0.58, -0.48 < crit.val. =0.811) and at wrist take off (-0.36,< crit.val. =0.81) and not at release of wrist (0.812> 0.811). In the

JAD, significant relationship was found at only release angle of shoulder (0.82> crit.val. =0.81) and insignificant relation at the elbow (0.56, 0.64< 0.811), and the wrist (0.46, 0.69< crit.val. =0.81). In the SAD, it was revealed that no significant relationship exists between take off and release segmental angles of the upper arm (0.40, 0.49 < 0.811) forearm release (-0.58< crit.val. =0.81), take off at hand (0.79< crit.val. =0.81) and the trunk (0.51< crit.val. =0.81) of successful and unsuccessful shots angles. The results show that there are both significant and insignificant relationships between the upper limb arm motion parameters of successful and unsuccessful jump shots.

Table 4.3.14: Centre 4 Shooting distances and upper limb displacements at take off and release for Successful and Unsuccessful shots

Variables	2.74m		4.67m		6.40m	
LD 3D (m)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes	0.2912±0.07	0.3387±0.09	0.205±0.152	0.235±0.182	0.488±0.028	0.437±0.061
Unsuccessful	0.44±0.16	0.55±0.16	0.202±0.175	0.215±0.195	0.478±0.072	0.504±0.032
R	0.69	0.78	-0.53	-0.48	0.39	-0.46
Elbow: Succes	0.7543±0.08	0.61±0.08	0.363±0.009	0.389±0.161	0.704±0.019	0.753±0.026
Unsuccessful	0.93±0.16	0.91±0.21	0.409±0.013	0.448±0.057	0.825±0.024	0.875±0.018
R	-0.25	-0.30	0.39	-0.27	0.52	-0.43
Wrist: Succes	0.65±0.10	0.65±0.10	0.431±'.021	0.461±0.062	0.715±0.053	0.766±0.21
Unsuccessful	0.91±0.19	0.92±0.23	0.457±0.053	0.489±0.053	0.765±0.035	0.825±0.035
R	-0.50	-0.19	0.79	0.61	0.49	-0.37
Hand: Succes	0.77±0.04	0.82±0.04	0.507±0.176	0.542±0.036	0.735±0.036	0.787±0.008
Unsuccessful	0.94±0.15	0.99±0.16	0.564±0.083	0.602±0.035	0.784±0.027	0.834±0.013
R	0.06	0.041	-0.47	0.46	0.58	0.26
COM: Succes	0.31±0.007	0.83±0.008	0.222±0.022	0.236±0.062	0.405±0.021	0.432±0.011
Unsuccessful	0.51±0.13	0.57±0.12	0.217±0.060	0.231±0.056	0.483±0.016	0.513±0.013
R	0.25	0.59	-0.56	0.62	0.61	-0.46
JAD	Joint Angular Displacement					
Shoul.:Succes	122.11±5.68	125.61±5.56	121.05±1.95	124.13±1.19	110.41±20.68	113.87±18.33
Unsuccessful	116.20±12.33	118.66±13.12	121.31±4.44	123.69±4..59	118.48±8.52	122.16±5.77
R	0.56	0.49	0.42	0.43	0.65	0.62
Elbow: Succes	110.61±6.92	115.61±17.36	111.48±3.32	119.02±4.09	115.00±19.62	119.59±8.33
Unsuccessful	110.87±11.45	115.61±25.57	116.31±6.55	121.37±6.0	121.96±7.96	127.67±6.86
R	0.51	0.43	0.84*	-0.37	0.45	0.61
Wrist:Succ.	128.41±15.58	121.18±18.36	135.65±7.09	122.07±10.06	144.62±12.81	138.97±12.68
Unsuccessf	155.05±5.86	144.82±101.17	153.47±8.01	143.92±3.57	148.31±6.67	141.89±5.69
R	0.38	0.48	0.74	-0.12	0.57	0.46
SAD	Segmental Angular Displacement °					
Uparm:Succ	-87.20±19.23	-100.73±9.89	-86.29±10.76	-87.77±15.81	227.43±6.68	236.75±12.81
Unsuccess	55.6±32.38	-95.91±24.54	-87.83±12.66	-90.56±22.06	236.57±5.97	242.62±6.96
R	-0.77	0.64	0.51	-0.32	0.53	0.42
Forarm:Suc	255.83±4.60	259.28±10.37	254.77±18.31	255.87±10.49	257.52±7.34	257.95±8.67
Unsuccess	239.87±13.39	255.72±18.90	255.22±12.48	257.02±9.85	265.61±5.69	266.21±5.37
R	-0.38	0.73	0.59	0.68	0.79	0.55
Hand:Succe	263.74±8.03	209.38±8.72	251.02±12.31	249.34±15.36	274.77±4.69	274.50±4.99
Unsuccess	220.51±12.85	203.59±20.31	263.66±8.76	265.39±6.87	276.48±2.85	276.21±2.31
R	0.26	0.71	0.62	0.83*	0.60	0.71
Trunk:Succes	270.28±5.21	269.56±3.91	270.17±3.36	269.72±4.81	269.76±4.33	269.48±5.61
Unsuccessful	219.64±9.32	220.58±9.36	269.12±4.53	268.77±6.49	271.65±2.46	271.28±2.78
R	0.48	0.56	0.93*	0.71	0.56	0.78

*Significant = r = 0.811 P>0.05

For Centre 4 player participant 14, the 2.75m shots Linear Displacement (LD3D) data reveals that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r= 0.69, 0.78< crit.val. =0.81) elbow (r=-0.25, -0.30< crit. val. r=0.81), wrist (r= -0.50, -0.19< crit.val. =0.81), hand (r= -0.06, -0.04< crit.val. r=0.81)) and centre of mass (0.25, 0.59< crit.val.=0.81). No significant relationship also exist in the JAD take off and release of shoulder (r= 0.56, 0.49< crit.val. =0.81), elbow (-0.51, 0.48< crit.val. =0.81) and wrist (r=0.38, 0.48< crit.val. =0.81. For SAD, no significant relationship exists in the take off and release of the upper arm (0.77, 0.64< crit.val. =0.81), forearm (0.38, 0.73< crit.val. =0.81), hand (0.26, 0.71< crit.val. =0.81) and the trunk (, < crit.val. =0.81) segments in clean and missed shots.

For 4.67metres shots Linear Displacement (LD3D), the data shows that there is no significant relationship between the take off and release parameters of successful and unsuccessful shot at the shoulder (r=--0.53, -0.48< crit.val. =0.81), elbow (r= -0.31, 0.27< crit.val. r=0.81) wrist (r= 0.79, 0.61< crit.val. =0.81), hand (r= -0.47, 0.46< crit.val. r=0.81) and centre of mass (-0.56, 0.62< crit.val. =0.81). No significant relationship was also found in the JAD take off and release of the shoulder (0.42, 0.43 < crit.val. =0.81), wrist (r=-0.74, -0.12< crit.val. =0.81) and elbow release (r=-0.31< crit.val. =0.81) not at the take off (r=-0.84> crit.val. =0.81) of successful and unsuccessful shots. The SAD data shows also that there is no significant relationship in both take off and release of upper arm (0.51, -0.32< crit.val. =0.81), forearm (0.59, 0.68< crit.val. =0.81), hand segment take off (0.62, < crit.val. =0.81) and the trunk (0.73, .0.71> crit.val. =0.81) excluding the release of hand (0.83> crit.val. =0.81) segments.

In the 6.40metres shots, the LD3D data shows no significant relationship at the take off and release angle of shoulder (0.39, -0.46> crit.val. r=0.81) elbow (0.52, -0.43< crit.val. =0.81), wrist (0.49, -0.37< crit.val. =0.81) hand (-0.58, -0.26< crit.val. =0.81) and COM (0.61, -0.46 < crit.val. =0.81). In the JAD, significant relationship was not found at take off and release angle of shoulder (0.65, 0.62< crit.val. =0.81), elbow (0.45, 0.61< 0.811), and the wrist (0.57, -0.46< crit.val. =0.81). In the SAD, it was revealed that no significant relationship exists between take off and release segmental angles of the upper arm (0.53, 0.42<0.811) forearm (0.79, 0.55< crit.val. =0.81), hand (0.60, 0.71< crit.val. =0.81) and the trunk (0.56, 0.78< crit.val. =0.81) of successful and unsuccessful shots segmental angles.

From table 4.3.1 to table 4.3.14, the results show that there are between there are both significant and insignificant relationships at take off and release parameters of successful and unsuccessful shots in LD3D, JAD and SAD of 2.75m, 4.67m and 6.40m shooting distances.

Sub-Hypothesis 3

There is no significant relationship between take off and release angular velocity (linear, angular and segmental velocities) parameters of successful and unsuccessful shots at three shooting distances of the guards, forwards and centre basketball players.

4.4 .0 This section presents the Relationships between Linear Velocities (LV3D), Joint Angular Velocities (JAV) and Segmental Angular Velocities (SAV) Parameters of Successful and unsuccessful shots of each of the Participants at Take-off and Release.

4.4.1 Guard 1 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots

Variables	**2.74mshots (m/s)**		**4.67m**		**6.40mShots**	
LV3D (m/s)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Success. **Unsuccessful** **R**	3.67±2.33 4.36±1.43 -0.62	3.61±2.40 3.53±1.68 0.27	0.4027±.023 0.4067±-045 0.72	0.4106±0.072 0.4158±.053 0.58	1.128±2.11 1.066.78±2.61 0.803	1.088±1.89 1.0568±1.87 0.75
Elbow:Success. **Unsuccessful** **R**	5.44±3.29 6.65±1.55 -0.70	4.57±2.57 5.21±1.45 -0.67	1.3802±.23 1.377±.74 0.70	1.3742±.122 1.3718±.025 0.65	1.20±2.34 2.0189±1.67 -0.75	2.013±2.45 2.001±1.98 0.821*
Wrist:Success **Unsuccessful** **R**	5.40±3.55 6.86±1.64 -0.77	4.54±2.91 5.36±1.47 -0.70	1.6320±.156 1.6308±.071 0.49	1.6296±.96 1.6287±.032 0.822*	2.1077±1.89 2.566±1.45 0.69	2.178±2.19 2.568±4.45 0.46
Hand: Success **Unsuccessful** **R**	3.38±2.75 5.38±1.21 -0.78	4.20±2.60 4.84±1.35 -0.64	1.7351±.039 1.737±.052 0.76	1.7368±.032 1.7377±.061 0.75	1.779±2.76 1.479±1.69 0.39	1.892±3.34 1.458± .98 0.51
COM: Success **Unsuccessful** **R**	1.56±0.50 2.01±1.32 -0.79	1.76±0.74 1.83±0.21 -0.54	0.735±.056 0.7377±.061 -0.89*	0.7346±.042 0.7382±.049 -0.75	1.065±1.13 1.0567±1.87 0.824*	1.049±1.07 1.458±1.23 0.57
Joint Angular Velocity (JAV) (radian/s)						
Should:Succss **Unsuccessful** **R**	2.79±1.52 3.03±1.75 0.17	5.01±4.68 3.77±2.95 0.43	3.99±0.47 4.02±0.63 0.82*	3.61±'.36 3.37±0.27 0.42	4.97±0.61 4.99±0.43 0.45	4.30±0.37 4.37±0.64 0.37
Elbow:Succss **Unsuccessful** **R**	2.27±0.88 2.15±0.84 -0.39	1.24±0.34 1.11±0.27 0.68	5.06±032. 5.05±0.44 0.63	4.81±'.32 4.73±0.37 0.59	4.03±0.37 4.21±0.60 0.29	3.64±0.37 3.45±0.60 0.51
Wrist: Success **Unsuccessful** **R**	-2.00±1. 06 -1.33±1. 15 -0.32	2.23±0.55 1.87±0.27 -0.32	1.72±0.27 -1.60±0.37 0.47	-1.49±0.32 -1.60±0.37 -0.79	-3.77±0.54 -3.98±0.80 -0.31	-3.42±0.22 -3.28±99 -0.22
Segmental Angular velocity º (SAV)						
Uparm:Success **Unsuccessful** **R**	55.839±302.62 -90.66±233.66 -0.43	-96.786±527.94 -92.433±113.07 -0.17	481.56±90.67 358.63±51.85 0.46	235.69±35.11 187.50±58.25 0.53	781.05± 201.8 824.61±131.23 -0.57	632.62±154.56 566.13±126.54 0.34
Forarm:Succe. **Unsuccessful** **R**	-12.34±17.24 -13.07±121.24 -0.54	-7.88±9.72 -55.46±116.55 0.62	111.16±30.14 112.0±22.98 0.83*	108.83±47.36 106.51±25.07 0.49	31.41±25.78 33.37±62.34 -0.83*	29.51±25.79 27.60±34 0.76
Hand:Succe **Unsuccessf** **R**	-23.68±57.47 15.27±29.49 0.53	-28.41±52.41 4.37±30.98 -0.43	100.68±15.30 104.11±9.86 0.65	107.55±31.62 111.20±24.71 0.39	354.72±45.67 293.90±21.78 0.67	569.34±34.89 748.49±45 0.68
Trunk:Succes **Unsuccessful** **R**	-9.76±14.77 6.88±15.56 0.53	-16.53±20.41 8.03±27.41 0.44	8.112±8.21 7.973±6.510 0.61	7.835±14.52 7.690±16.31 0.84*	-6.77±-10.98 -7.90±49.9 0.815*	-6.65±22.37 -7.58±6.89 0.45

*Significant =0.05-0.811

Guard 1's 2.74m successful and unsuccessful shots did not reveal any significant relationship at the LV3D of the shoulder, elbow, wrist, hand and the COM (see table 4.3.1). In the JAV also, no significant relationship was found between the shoulder (0.71, 0.43), elbow (0.39, 0.68) and wrist joint (-0.32, 0.32) successful and unsuccessful shots. So also in segmental angular velocity, there were no significant relationships between the take off and release parameters of the clean and missed shots segmental velocities; Upper arm (-0.43,-0.17), fore arm (r=-0.54, 0.62) hand (r=-0.53,-0.43) and the trunk (r=0.53, 0.44).

4.67m shots reveals only significant relationships at the LV3D COM take off (0.898>0.811), JAV take off at shoulder (0.82> 0.811) and SAV of the forearm (0.85> 0.811) at take off and of the trunk (0.84> 0.811) at release. In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the COM LD3D (0.824> 811) and SAV trunk release (0.821> 0.811) (see table 4.4.1). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.2 Guard 2 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul:Succes	1.05±0.09	0.89±.07	.2957±22	0.3215±.12	1.1101±.012	1.1020±.15
Unsuccessful	1.13±0.03	3.53±1.68	0.2891±33	0.3294±.11	1.1155±.018	1.0994±.07
R	0.44	0.27	0.32	0.54	0.37	-0.28
Elbow:Succes	1.56.±0.54	1.69±0.06	1.4369±.03	1.4571±.023	2.1877±.06	2.1876±.003
Unsuccessful	1.69±0.15	1.53±0.12	1.4364±.09	1.4607±.021	2.1884±.05	2.1883±.005
R	-010	-0.86	0.23	0.51	-0.86	-0.75
Wrist:Succes	1.76±0.79	1.65±0.15	1.6540±0.13	1.6488±0.052	2.4242±0.23	2.4262±0.25
Unsuccessful	1.74±0.08	2.02±0.33	1.6523±0.03	1.6490±0.044	2.4237±0.31	2.4277±0.21
R	-0.95	0.27	-0.53	0.85	-0.17	0.15
Hand: Succes	1.71±0.04	1.59± 0.60	1.5041±0.015	1.4954±0.022	2.2868±0.017	2.839±0.007
Unsuccessful	2.19±0.36	2.02±0.33	1.4925±0.023	1.4563±0.03	2.2884±0.014	2.2827±0.19
R	-0.10	-0.30	-0.35	0.54	0.47	0.32
COM: Succes	0.87±0.12	0.78±0.14	0.3913±0.24	0.3624±0.19	1.3952±0.05	1.3856±0.21
Unsuccessful	1.05±.05	0.89±0.03	0.3801±0.26	0.3654±0.16	1.4011±0.04	1.3818±0.104
R	-0.65	-0.49	0.13	0.59	0.48	0.82
JAV	Joint Angular Velocity (rad/s^{-1})					
Shoul:Succes	2.22±1.20	2.26±1.41	5.13±0.48	4.65±0.36	2.98±0.31	2.70±0.45
Unsuccessful	2.21±04	2.31±0.44	5.49±0.39	4.42±0.79	3.12±0.27	2.84±0.33
R	0.18	0.26	0.24	0.26	0.58	0.79
Elbow:Succes	4.95±0.32	4.87±0.37	4.19±0.88	4.64±0.29	2.87±0.84	2.49±0.79
Unsuccessful	3.59±0.97	3.92±0.44	4.66±0.46	4.47±1.09	3.04±0.48	2.68±0.41
R	0.38	0.06	-0.47	0.18	0.36	0.79
Wrist: Succes	8.90±8.30	-1.37±1.07	1.93±1.02	-4.37±0.71	-3.22±0.36	-3.07±0.98
Unsuccessful	4.67±2.45	7.14±8.58	0.24±2.67	-4.13±0.45	-3.28±0.32	-3.15±0.46
R	-0.15	-0.18	-0.19	0.57	0.85*	0.38
SAV	Segmental Angular velocity º					
Uparm:Succs.	78.95±292.94	94.77±464.84	129.86±178.56	504.70±100.30	559.98±150.61	337.76±45.69
Unsuccessful	533.65±99.50	-93.13±442.99	205.64±86.21	386.05±25.85	448.87±49.69	278.98±51.61
R	0.41	-0.47	0.07	0.35	-0.83*	-0.66
Forarm:Succ	1.62±50.54	-3.94±49.17	94.694±48.6	89.963±22.11	109.6±96.55	104.49±63.98
Unsuccessfu	13.54±15.20	7.66±20.66	93.53±34.98	89.820±98.63	107.08±87.50	102.06±47.30
R	0.33	-0.15	0.56	0.72	0.84*	0.94*
Hand:Succe	-23.68±57.47	-28.41±52.41	-82.75±90.36	-585.55±170.04	277.40±8.61	-285.38±15.62
Unsuccessf	15.27±29.49	4.37±30.98	-108.16±58.70	-704,30±150.51	281.40±5.51	-284.98±17.7
R	-0.53	-0.43	-0.58	-0.47	0.78	0.818*
Trunk:Succes	-36.19±167.0-	-314.64±544.24	-30.94±18.61	-33.373±4.67	-7.470±3.3	7.734±12.61
Unsuccessful	108.54±21.33	-261.72±26.76	-31.37±8.31	-33.607±4.76	7.60±4.92	7.861±12.10
R	0.54	0.06	0.49	0.35	0.32	0.82*

*Significant =0.05-0.811

For Guard 2, 2.74m shots successful and unsuccessful shots did not show any significant relationship in LV3D of the shoulder, hand and the COM except take off of the elbow (0.86> 811) and the wrist (0.85> 0.811); JAV and SAV angular velocities.(see table 4.3.2). The 4.67m shooting distance shots reveals only significant relationships at the LV3D take off of the wrist (0.85>0.811), and insignificant relationships at the remaining angular velocity segments at both take and release. However, in the 6.40m shooting distance, significant relationship was found between angular velocities of successful and unsuccessful shots of the elbow take off (0.86> 811) and COM release

LV3D (0.824> 811) The JAV revealed a significant relationship only at the wrist take off (0.85>811) (see table 4.4.2). The SAV showed significant relationship at the upper arm take off (0.83)and release velocity of the take off and release at the fore arm segment (0.84, 0.94> 0.811); including the release of the hand (0.819> 0.811) and trunk (0.82>0.811). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.3 Guard 3 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

	2.74m		4.60m		6.40m	
LV3D	**Take off**	**Release**	**Take off**	**Release**	**Take off**	**Release**
Shoul:Succes **Unsuccessful** **R**	0.623±.044 0.736±.037 0.72	0.367±.053 0.602±0.22 0.851*	0.1643±0.05 0.174±0.051 -0.26	0.167±0.053 0.173±0.051 -0.10	0.62±0.062 0.580±0.088 0.014	0.62±0.062 0.578±0.089 0.15
Elbow: Succes **Unsuccessful** **R**	0.950±.081 1.10±.07 -0.12	0.63±02 0.87±.023 0.863*	0.782±0.046 0.753±0.068 -0.005	0.783±0.047 0.751±0.068 0.016	1.099±0.047 0.981±0.079 0.71	1.099±0.047 0.986±0.086 0.66
Wrist: Success **Unsuccessful** **R**	1.06±.06 .85±.053 -0.13	0.85±.051 0.94±.022 0.92*	0.921±0.019 0.871±0.072 0.75	0.880±0.083 0.871±0.072 0.64	0.736±0.802 1.046±0.042 -0.38	1.125±0.025 1.051±0.040 -0.012
Hand: Success **Unsuccessful** **R**	1.14±.04 1.15±.02 0.30	.98±.03 1.07±.82 0.21	0.817±0.034 0.772±0.075 0.807	0.809±0.080 0.773±0.075 0.820*	1.086±0.009 0.947±0.045 0.56	1.088±0.013 0.945±0.046 0.25
COM: Success **Unsuccessful** **R**	0.66±.06 0.80±.05 -0.14	0.44±.05 0.60±.03 0.72	0.257±0.083 0.199±0.059 -0.26	0.239±0.089 0.199±0.057 -0.33	0.76±0.059 0.548±0.108 0.55	0.776±0.60 0.558±0.098 0.54
JAV	JOINT ANGULAR VELOCITY (rad./s−¹					
Shoul.: Successfl **Unsuccessful** **R**	1.18±0.07 1.4±0.10 -0.02	1.12±0.06 1.24±0.09 0.09	1.64±0.26 1.55±0.22 0.52	1.52±0.15 1.36±0.27 0.71	3.04±0.15 2.83±0.01 0.68	2.55±0.12 2.45±0.24 0.63
Elbow: Succes **Unsuccessful** **R**	1.16±0.15 1.30±0.25 0.89*	1.60±0.18 1.74±0.24 0.70	1.31±0.38 0.62±0.75 0.19	1.78±0.50 0.48±1.06 0.23	2.71±0.29 2.71±0.40 0.82*	2.25±0.22 2.37±0.30 0.83*
Wrist:Success **Unsuccessful** **R**	2.16±0.13 2.29±0.06 0.83*	1.13±0.48 1.20±0.63 0.79	-1.53±0.38 -2.05±0.45 -0.53	-1.50±'.40 -2.00±0.53 0.21	-2.03±0.18 -1.81±0.19 -0.103	-1.69±0.58 -0.23±1.92 -0.38
SAV	Segmental Angular Velocities °					
Uparm:Succ **Unsuccessful** **R**	174.44±20.80 173.94±19.85 0.88*	127.44±3.71 22.62±5.84 -0.35	-286.56±12.8 28.86±10.11 0.43	204.89±15.81 25.80±19.6 0.37	-22.60±51.88 -26.34±113.79 0.35	-13.44±34.31 -13.36±110.20 0.57
Forarm:Succ **Unsuccessful** **R**	253.06±4.46 258.81±13.14 0.11	264.61±1.90 269.90±11.39 -0.89*	25.49±47.81 36.509±51.6 0.58	24.369±14.76 30.173±24.369 0.49	-0.63±23.0 12.77±91.30 0.63	-00.50±22.47 42.48±19.61 0.44
Hand:Success **Unsuccessf** **R**	270.32±3.40 274.92±19.29 0.34	257.97±2.80 250.89±24.24 0.65	-72.87±22.61 -62.40±33.62 0.42	-73.758±5.84 -68.931±10.35 0.33	24.63±127.16 -80.60±23.74 0.74	19.52±146.13 -74.20±113.46 0.76
Trunk:Succs **Unsuccessfl** **R**	18.36.28±1.0 7.67±10.42 0.36	18.78±1.47 7.97±9.89 0.41	-16.70±2.98 -19.41±1.25 0.51	-16.66±3.21 -19.46±1.25 0.61	-15.16±4.94 -4.34±11.45 0.79	6.48±17.45 17.30±23.86 0.67

*Significant =0.05-0.811

Guard 3's 2.74m successful and unsuccessful shots did not reveal any significant relationship except at the LV3D of the shoulder (0.851> 0.811) and inverse relationship at elbow (0.863>0.811) release (see table 4.4.3). The JAV of 2.74m shows insignificant relationships at the take off and release of the shoulder, and release of the elbow and wrist; but significant relationship are found at the JAV take off velocities of the elbow and wrist as well as inverse relationship at SAV of upper arm take off and forearm release of guard 3 (see table 4.4.3).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of guard 3 at both take off and release parameters of successful and unsuccessful shots (see table 4.4.3). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the JAV of elbow take off and release (0.82, 0.83> 811) (see table 4.4.3). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.4 Guard 4 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes	1.221±0.145	0.867±0.121	0.691±'.110	0.892±0.103	1.358±0.006	1.357±0006
Unsuccessful	1.202±0.201	0.859±0.142	0.905±0.122	0.880±0.020	1.373±0.015	1.368±0.005
R	0.63	0.49	0.43	0.47	0.53	0.52
Elbow: Succes	1.805±0.056	1.333±0.032	2.249±0.22	2.240±0.301	2.458±0.03	2.453±0.06
Unsuccessful	1.790±0.110	1.521±0.041	2.244±0.281	2.365±0.304	2.462±0.022	2.4561±0.05
R	0.41	0.56	0.38	0.34	0.76	0.807
Wrist: Succes	2.70±0.46	1.612±0.361	2.218±'.215	2.212±0.302	2.431±0.024	2.449±0.05
Unsuccessful	2.81±0.17	1.602±0.284	2.215±0.323	2.209±0.121	2.440±0.013	2.447±0.021
R	0.62	-0.79	0.45	-0.56	0.47	0.38
Hand: Succes	2.184±0.212	1.985±0.021	2.074±0.341	2.051±0.031	2.365±0.023	2.382±0.12
Unsuccessful	2.173±0.22	1.976±0.03	2.062±0.210	2.040±0.023	2.378±0.019	2.380±0.010
R	0.49	-0.83*	0.47	0.47	-0.82*	-0.65
COM: Succes	1.298±0.025	0.962±0.09	1.140±0.412	1.121±0.352	1.563±'.025	1.533±0.011
Unsuccessful	1.281±0.031	0.947±0.056	1.131±0.22	1.112±0.243	1.536±0.031	1.534±0.012
R	0.39	-0.26	0.31	0.45	-0.49	-0.28
JAV						
Shoul.: Succes	3.28±0.10	3.11±0.41	5.14±0.64	3.96±0.24	9.11±2.10	4.65±0.49
Unsuccessful	1.46±1.5	3.16±0.27	4.99±0.44	4.66±0.28	8.80±0.62	4.29±0.28
R	0.809	0.49	0.62	0.47	0.19	0.28
Elbow: Succes	3.19±0.25	3.16±0.99	5.02±0.30	4.75±0.14	8.16±1.67	3.81±0.57
Unsuccessful	1.50±0.17	3.24±0.17	4.90±0.38	4.60±0.38	7.86±2.28	3.47±0.71
R	0.48	-0.33	0.40	0.83*	-0.21	0.32
Wrist: Succes	2.70±0.46	0.75±0.25	-14.28±1.05	-10.25±7.05	-4.83±0.23	3.91±0.19
Unsuccessful	2.81±0.17	0.66±0.32	-12.27±0.54	-8.61.±0.56	-4.80±0.36	-3.77±0.54
R	0.52	0.46	-0.36	-0.58	-0.36	-0.11
SAV	Segmental Angular velocity					
Uparm:Succes	-140.28±156.56	-31.35±52.27	452.31±42.61	330.17±98.64	42.36±144.68	33.62±81.66
Unsuccessful	413.15±107.82	117.66±11.47	536.78±20.36	288.30±84.61	34.82±106.34	27.59±62.24
R	0.13	-0.13	0.36	0.22	0.37	0.52
Forarm:Succ	-75.47±54.49	31.60±35.43	19.998±142.36	18.78±3.65	39.86±109.36	43.68±79.42
Unsuccessf	80.28±13.25	37.90±2.93	20.59±151.62	18.162±1.58	33.47±89.14	39.92±60.31
R	-0.16	-0.33	-0.71	-0.845*	0.42	0.39
Hand:Succe	-50.45±14.44	-61.44±93.77	107.3±720.51	-109.52±46.77	32.68±45.98	-69.82±22.33
Unsuccessf	-3.26±14.22	-1.70±28.52	980.29±250.11	963.60±30.82	-56.92±21.64	68.35±31.62
R	0.57	-0.37	0.38	-0.57	0.46	0.58
Trunk:Succes	-16.039±2.89	-8.410±5.62	-8.794± 0.198	-8.543±2.34	-12.68±2.33	-11.09±3.62
Unsuccessful	-13.691±3.62	-9.314±6.49	-9.052±3.11	-8.423±2.03	-14.79±1.69	-13.69±2.44
R	0.69	'.76	-0.29	0.68	0.49	0.51

*Significant = r = 0.811 P>0.05

Guard 4's 2.74m successful and unsuccessful shots did not reveal any significant relationship in the LV3D, JAV and SAV of the body segments except an inverse relationship found at the LV3D of the hand at release (-0.83> 0.811) (see table 4.4.4).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of guard 4 at both take off and release parameters of successful and unsuccessful shots with the exception at the fore arm SAV (-0.845> 0.811) where inverse relationship is demonstrated(see table 4.4.4). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the LV3D of the hand at take off (0.82> 811) (see table 4.4.4). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.5 Guard 5 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV (m/s)	**Take off**	**Release**	**Take-off**	**Release**	**Take-off**	**Release**
Shoul: Succes	0.59±0.052	0.593±0.051	0.5910±0.12	0.5671±0.22	1.472±0.051	1.393±0.13
Unsuccessful	0.90±0.046	0.817±0.011	0.4876±0.23	0.4436±0.23	1.426±0.082	1.383±0.053
R	0.39	0.49	0.27	0.28	-0.19	-0.24
Elbow: Succes	1.130±0.060	1.131±0.063	1.0862±0.43	1.070±0.41	2.99±0.026	2.252±0.062
Unsuccessful	0.890±0.049	0.823±0.038	1.021±0.51	1.004±0.32	2.289±0.055	2.241±0.073
R	0.84*	0.47	0.54	0.56	-0.55	-0.47
Wrist: Succes	1.201±0.17	1.160±0.201	1.1923±0.43	1.182±0.45	2.355±0.026	2.230±0.041
Unsuccessful	1.229±0.049	1.158±0.019	1.0576±38	1.0451±0.51	2.346±0.037	2.311±0.057
R	-0.50	0.33	0.37	0.45	0.29	-0.17
Hand: Succes	1.191±0.294	1.189±'.289	1.2345±0.51	1.2232±0.38	1.378±0.022	1.320±0.025
Unsuccessful	1.764±0.053	1.673±0.022	1.1792±0.37	1.1084±0.28	1.363±0.035	1.307±0.031
R	0.017	0.18	0.48	0.42	-0.51	-0.79
COM: Succes	0.729±0.078	0.739±0.081	0.7251±0.35	0.7041±0.25	1.340±0.022	1.255±0.059
Unsuccessful	0.782±0.055	0.693±0.023	0.5436±0.25	0.5341±0.46	1.382±0.016	1.286±0.026
R	0.33	0.22	0.37	0.23	-0.76	0.84*
JAV	Joint Angular Velocity (rad./s−¹)					
Shoul.: Succes	1.88±1.03	60.67±69.79	72.625±47.19	71.54±23.57	224.39±2.76	209.14±25.6
Unsuccessful	89.13±14.64	87.88±13.16	81.28±50.18	79.82±45.29	221.15±4.35	203.9±21.81
R	0.44	-0.30	0.43	0-51	0.64	0.51
Elbow: Succes	161.82±68.29	66.25±137.78	124.69±45.78	123.71±31.59	221.61±14.39	199.24±6.35
Unsuccessful	186.79±53.30	192.23±40.73	133.45±19.56	131.67.32	216.70±22.88	191.90±
R	-0.61	-0.45	0.51	0.49	-0.69	0.73
Wrist: Succes	-173.28±103.64	-170.56±83.87	-279.47±46.32	-260.74±48.45	-254.10±25.01	164.55±11.77
Unsuccessful	57.27±238.02	-5.13±300.17	-221.61±32.67	-218.6±33.14	-231.13±20.5	-144.84±20.6
R	-0.54	-0.72	0.47	0.35	-0.53	-0.51
SAV	Segmental Angular velocity°					
Uparm:Success	118.07±280.92	153.31±226.3	502.31±21.45	443.78±12.67	-383.54±67.56	-4873.9±322.86
Unsuccessful	254.85±51.81	149.39±22.9	367.54±46.91	287.32±41.32	-437.61±37.98	-2982±215.76
R	-0.69	0.61	0.21	0.19	0.32	0.19
Forarm:Success	-49.01±83.24	24.60±27.37	30.268±41.56	30.496±9.78	-57.384±18.9	-57.50±25.67
Unsuccessful	49.15±19.64	49.55±19.94	43.67±52.76	43.98±12.96	67.36±21.32	-67.64±35.73
R	-0.52	0.58	0.19	0.34	0.28	0.46
Hand:Success	228.05±192.74	-218.45±188.1	-388.06±23.76	-402.45±10.8	-362.12±41.45	-270.78±25.74
Unsuccessful	-292.98±34.48	-348.41±48.61	-341.77±51.11	-389.26±32.12	-425±52.34	-359.26±59.31
R	-0.50	0.21	0.32	0.27	0.48	0.39
Trunk:Success	-15.31±2.77	-11.20±12.48	-17.870±5.78	-17.989±4.23	-2.58±12.67	-1.83±13.79
Unsuccessful	-15.37±13.78	10.97±4.33	-13.76± 9.69	-13.876±2.78	-3.35±8.45	-3.67± 9.45
R	-0.51	0.27	0.52	0.24	0.41	0.28

*Significant = r = 0.811 P>0.05

2.74m shooting distance of Guard 5 successful and unsuccessful shots did not reveal any significant relationship in the JAV, SAV and LV3D except at the LV3D of the elbow take off (0.84> 0.811) (see table 4.4.5). The JAV of 2.74m shows insignificant relationships at the take off and release angular velocities of the upper limb segments of the shoulder, elbow and wrist and the SAV (see table 4.4.5).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of guard 5 at both take off and release parameters of successful and unsuccessful shots (see table 4.4.5). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the LV3D of COM take off (0.84 > 811) (see table 4.4.5). Thereore the data demonstrates that there is no significant relationship between take off and release LD3D, joint angular and SAD of the participant.

4.4.6 Forward 1 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV (m/s^{-1})	**Take off**	**Release**	**Take-off**	**LV**	**Take off**	**Release**
Shoul: Successful	0.651±5.0	0.65±0.94	0.47±0.054	0.48±0.07	0.778±0.056	0. 796±0.065
Unsuccessful	0.72±0.221	0.72±0.122	0.49±0.046	0.049±0.04	0.821±0.05	0.825±0.048
R	0.80	0.62	0.38	0.59	0.45	0.43
Elbow: Successful	1.245±0.11	0.242±0.11	0.892±0.05	'.742±0.37	1.479±0.056	1.244±0.37
Unsuccessful	1.19±0.59	1.18±0.06	0.88±0.09	0.89±0.078	1.465±0.087	1.490±0.08
R	0.07	0.08	0.78	0.14	0.76	0.15
Wrist: Succesful	1.21±0.26	1.19±0.27	0.92±0.07	'.942±0.06	1.540±0.08	1.567±0.06
Unsuccessful	1.15±0.167	1.14±0.17	0.90±0.06	0.92±0.05	1.513±0.07	1.559±0.078
R	0.43	0.93*	0.87*	0.71	0.879*	0.817*
Hand: Succes	1.40±0.44	1.24±0.45	0.86±0.05	'.85±0.018	1.429±0.052	1.459±0.045
Unsuccessful	1.37±0.38	1.24±0.29	0.82±0.08	0.84±0.08	1.371±0.078	1.397±0.075
R	0.72	0.28	0.71	0.19	0.70	0.68
COM: Succes	0.83±0.61	0.83±.05	0.54±0.07	'.55±0.08	0.891±0.067	0.911±0.08
Unsuccessful	0.79±0.93	0.79±0.9	0.54±0.05	0.55±0.05	0.892±0.046	0.919±0.048
R	-0.05	0.10	0.50	0.80	0.44	0.801
Joint Angular Velocity (JAV) $Rad./s^{-1}$						
Shoul.:Succes	1.75±0.99	2.18±0.44	1.61±0.78	1.48±0.08	1.61±0.78	1.48±0.08
Unsuccessful	1.74±0.83	0.60±0.54	1.79±'0.09	1.58±0.08	1.79±0.09	1.58±0.08
R	0.91*	0.34	0.46	0.47	0.806	-0.41
Elbow:Succes	1.78±2.21	-0.55±1.28	1.97±0.01	1.80±0.10	1.97±0.01	1.80±0.10
Unsuccessful	2.26±1.27	1.20±0.52	1.56±0.15	1.25±0.15	1.56±0.15	1.25±0.15
R	0.84*	0.10	0.52	0.51	-0.63	0.15
Wrist: Succes	-0.09±1.91	-0.42±2.33	-1.46±0.05	-1.40±0.08	1.46±0.05	-1.40±0.08
Unsuccessful	2.25±0.34	2.15±0.32	-1.97±0.04	-1.90±0.12	1.97±0.04	-1.90±0.17
R	0.74	0.51	0.87*	0.80	0.711	0.888*
SAV	SEGMENTAL ANGULAR VELOCITY °					
Uparm:Succe	-233.80±56.56	-52.25±52.27	136.02±64.59	119.10±80.55	44.18±164.59	31.10±80.55
Unsuccessful	-454;89±5.06	-419.89±5.77	7.04±117.82	-84.22±106.55	7.04±117.82	-84.22±106.55
R	0.89*	0.62	-0.75	0.88*	0.75	0.883*
Forarm:Succ.	-152.45±40.20	-42.82±45.47	32.98±67.36	32.54±47.81	12.98±67.36	22.54±47.81
Unsuccessful	98.12±22.45	77.01±11.40	16.18±46.05	7.57±40.22	16.18±46.05	7.57±40.22
R	0.40	-0182	-0.65	-'.562	-0.75	-0.66
Hand:Success	21.24±25.70	130.81±23.08	-130.51±24.03	-123.82±19.8	-94.22±54.87	-102.78±56.09
Unsuccessful	-34.79±11.44	-31.41±9.34	-127.57±5.04	-129.29±9.82	-15.99±498.41	28.02±498.36
R	0.12	-0.72	0.72	0.612	0.57	0.265
Trunk:Succes	-4.51±24.03	-18.82±19.8	13.86±3.62	13.77±2.94	-113.62	-1.09±12.94
Unsuccessful	-22.57±35.04	-11.29±21.82	24.39±62.05	25.08±64.24	24.39±62.04	-25.08±64.24
R	0.72	0.78	-0.26	-0.19	-0.26	-0.194

*Significant = r = 0.811 P>0.05

2.74m shooting distance of Forward 1's successful and unsuccessful shots did not reveal any significant relationship in the LV3D except at the LV3D of the wrist release (0.93> 0.811) (see table 4.4.6). In the JAV of 2.74m shows significant relationships at the take off angular velocities of the upper limb joints of the shoulder (0.91> 0.811), and elbow (0.84> 0.811) while among the SAV of the segments, significant relationship is found at the upper arm (0.89> 0.811), (see table 4.4.6).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV with exceptions to take offs at the LV3D wrist (0.91> 0.811); JAV wrist (0.84> 0.811), and SAV upper arm (0.89> 0.811) of forward 6 release parameters of successful and unsuccessful shots (see table 4.4.6). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at LV3D take off and release of the wrist (0.879, 0.817 > 811) JAV release at the wrist (0.888> 0.811) and SAV release of the upper arm (0.883>0.811)(see table 4.4.5).

4.4.7 Forward 2 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variables	2.74mshots		4.67m		6.40mShots	
LV	**Take off**	**Release**	**Take-off**	**LV**	**Take off**	**Release**
Shoul:Success	0.922±0.32	0.535±0.45	0.3748±0.012	0.392 ±0.022	0.476±0.093	0.5025±0.95
Unsuccessful	0.895±0.025	0.524±0.02	0.348±0.014	0.358±0.019	0.377±0.039	0.395±0.040
R	-0.28	0.35	-0.61	0.33	0.26	0.17
Elbow:Succes	0.961±0.004	0.586±'009	0.5512±0.023	0.547±0.37	0.819±0.098	0.873±0.106
Unsuccesful	0.934±0.08	0.553±0.05	0.551±0.034	0.556±0.81	0.717±0.053	0.748±0.059
R	0.846*	0.68	0.67	0.45	0.124	0.189
Wrist:Success	0.956±0.003	0.573±0.018	0.789±0.013	0.789±0.15	0.8194±0.101	0.867±0.106
Unsuccesful	0.093±0.015	0.560±0.013	0.779±0.011	0.789±0.045	0.762±0.057	0.789±0.054
R	-0.46	-0.51	0.70	0.81*	0.77	0.69
Hand:Success	1.400±0.007	1.048±0.03	1.040±0.19	1.059±0.018	0.789±0.083	0.769±'.056
Unsuccesful	1.377±0.025	1.037±0.55	1.011±0.22	1.021±0.22	0.737±0.056	0.832±0.084
R	0.87*	0.52	0.30	0.35	0.46	0.40
COM:Success	0.837±0.07	0.417±0.357	0.300±0.014	0.312±0.013	0.565±0.087	0.593±0.088
Unsuccesful	0.808±0.08	0.403±0.48	0.277±0.003	0.289±0.025	0.496±0.022	0.519±0.034
R	0.17	0.31	0.60	0.54	-0.55	-0.64
Joint Angular Velocity (JAV) rad/s^{-1}						
Shoul.: Succes	2.70±3.67	3.85±0.88	4.50±0.04	4.47±0.04	1.88±0.24	3.33±0.22
Unsuccesful	1.62±2.19	2.20±0.48	1.15±0.09	1.11±0.09	1.72±0.15	1.43±1.18
R	-0.89*	0.39	-0.42	-0.49	0.59	0.22
Elbow:Succes	2.03±1.11	2.46±12.40	1.77±0.03	1.82±0.03	1.69±0.40	1.41±0.38
Unsuccesful	2.19±0.86	2.44±0.62	3.26±.0.10	2.70±0.07	1.53±0.19	1.26±0.23
R	0.76	0.46	-0.63	0.	-0.60	-0.76
Wrist: Succes	1.56±0.45	3.90±0.32	2.31±0.03	2.36±0.02	-1.23±0.21	-1.36±0.25
Unsuccesful	2.16±0.32	3.68±0.45	0.54±0.08	2.35±0.06	-1.94±0.29	-1.91±0.32
R	0.55	0.22	0.14	0.29	0.82*	0.76
SAV	Segmental Angular velocity°					
Uparm:Succs	472.85±45.31	4.128±202.55	-269.44±15.02	-257.08±9.83	-8.56±56.91	-5.15±37.01
Unsuccesful	254.17±70.29	3.313±2.243	-257.21±21.61	-243.95±14.75	-25.34±114.58	-12.36±110.73
R	-0.19	0.26	0.84*	-0.55	0.47	0.61
Forarm:Succs	76.99±21.65	27.70±71.31	45.36±15.82	44.213±21.52	1.37±25.97	1.50±25.44
Unsuccessful	39.58±70.52	28.23±82.50	44.21±20.31	43.14±16.19	14.77±92.85	44.48±22.58
R	0.59	0.43	-0.59	0.85*	0.64	0.57
Hand:Success	78.95±32.91	135.34±59.31	-24.89±36.87	-23.56±42.35	22.63±129.93	17.52±148.89
Unsuccessful	156.01±102.52	-138.84±45.3	-23.56±55.96	22.24±23.45	-80.60±123.74	-74.20±113.46
R	0.61	0.18	-0.37	0.29	0.73	0.75
Trunk:Succs	-13.158±3.56	-13.286±9.45	-10.143±8.23	-10.89±12.45	-16.76±4.64	6.88±18.05
Unsuccesful	-11.45±9.34	-11.98±8.56	-17.45±12.45	18.12±7.87	-4.34±11.08	15.30±21.1
R	0.29	0. 26	0.31	0.19	0.55	0.79

*Significant = r = 0.811 P>0.05

In the Angular velocity parameters of Forward 2, 2.74m successful and unsuccessful shots did not reveal any significant relationship except at the LV3D take off at the elbow (0.846> 0.811) (see table 4.4.3). The JAV of 2.74m shows significant inverse relationship at the take off of the shoulder (-0.89> 0.811) and SAV at take off of the upperarm (0.84> 0.811) and forearm at release (0.85> 0.811) of the body segments of successful and unsuccessful shots (see table 4.4.3).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of Forward 2 at both take off and release parameters of successful and unsuccessful shots (see table 4.4.3). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the JAV of elbow take off and release (0.82, 0.83> 811) and SAV of (see table 4.4.3). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.8 Forward 3 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variable	**2.74mshots**		**4.67m**		**6.40mShots**	
LV (m/s)	**Take off**	**Release**	**Take-off**	**Release**	**Take off**	**Release**
Shoul: Success **Unsuccessful** **R**	0.922±0.012 0.895±0.025 -0.28	0.535±0.05 0.524±0.02 0.35	0.2957±'.22 0.2891±33 0.32	0.3215±.12 0.3294±.11 0.54	1.1101±.012 1.1155±.018 0.37	1.1020±.15 1.0994±.07 -0.28
Elbow: Success **Unsuccessful** **R**	0.961±0.004 0.934±0.08 0.84*	0.586±0.09 0.553±0.05 0.68	1.4369±.03 1.4364±.09 0.23	1.4571±.023 1.4607±.021 0.51	2.1877±.06 2.1884±.05 -0.86*	2.1876±.003 2.1883±.005 -0.75
Wrist: Success **Unsuccessful** **R**	1.956±0.03 1.093±0.015 -0.46	1.573±0.018 1.560±0.013 -0.51	1.6540±'.13 1.6523±0.0 -0.53	1.6488±0.052 1.6490±0.044 0.85*	2.4242±'.23 2.4237±0.31 -0.17	2.4262±0.25 2.4277±0.21 0.15
Hand: Success **Unsuccessful** **R**	1.600±0.007 1.477±0.025 0.37	1.248±0.03 1.137±0.05 0.42	1.5041±00.015 1.4925±00.023 -0.35	1.4954±0.022 1.4563±0.03 0.54	2.2868±'.017 2.2884±0.014 0.47	2.839±0.007 2.2827±0.19 0.32
COM: Success **Unsuccessful** **R**	0.837±0.07 0.808±0.08 0.17	0.417±0.357 0.403±0.48 0.31	0.3913±0.24 0.3801±0.26 0.13	0.3624±0.19 0.3654±0.16 0.59	1.3952±'.05 1.4011±0.04 0.48	1.3856±0.21 1.3818±0.11 0.82*
JAV	Joint Angular Velocities rad/s⁻¹					
Shoul.: Success **Unsuccessful** **R**	0.95±3.67 1.62±2.19 -0.89*	2.10±0.88 2.20±0.48 0.39	5.13±0.48 5.49±0.04 0.24	4.65±0.36 4.42±0.79 0.26	2.98±0.31 3.12±0.27 0.58	2.70±0.47 2.84±0.33 0.79
Elbow: Success **Unsuccessful** **R**	2.03±1.11 2.19±0.86 0.76	2.46±12.40 2.44±0.62 0.46	4.19±0.88 4.66±0.46 -0.47	4.64±0.29 4.47±1.09 0.18	2.87±0.84 3.04±0.48 0.36	2.49±0.79 2.68±0.46 0.79
Wrist: Success **Unsuccessful** **R**	1.56±0.45 2.16±0.32 0.55	3.90±0.32 3.68±0.45 0.22	1.93±1.02 0.24±2.67 -0.19	-4.37±0.71 -4.13±47 0.57	-3.22±0.36 -3.28±0.32 0.85*	3.07. ±0.98 -3.15±0.46 0.38
SAV- Segmental Angular Velocities º						
Uparm:Succe **Unsuccessful** **R**	412.85±45.31 254.17±70.29 -0.19	4.128±202.55 3.313±2.243 0.26	129.86±178.56 205.64±86.21 0.07	504.70±100.30 386.05±25.85 0.35	559.98±150.61 448.87±49.69 -0.45	337.76±45.69 278.98±51.61 -0.66
Forarm:Suc **Unsuccesful** **R**	39.99±61.65 39.58±70.52 0.59	27.70±71.31 28.23±82.50 0.43	94.694±48.6 93.53±34.98 0.56	89.963±122.11 89.820±98.63 '.72	109.6±96.55 107.08±87.50 0.44	104.49±63.98 102.06±47.30 0.54
Hand:Success **Unsuccesful** **R**	150.95±122.91 156.01±102.52 0.61	135.34±59.31 -138.84±45.3 0.18	-82.75±90.36 -108.16±58.70 -0.58	-585.55±170.04 -704,30±150.51 -.47	277.40±48.61 281.40±35.51 0.58	-288.38±15.62 -284.98±17.7 0.79
Trunk:Succes **Unsuccessful** **R**	-24.96±15.78 -7.7283±14.34 0.34	-25.95±11.45 -6.77±9.78 0.42	-30.94±18.61 -31.37±8.31 0.49	-33.373±4.67 -33.607±4.76 '.35	-7.470±3.3 7.60±4.92 0.32	7.734±12.61 7.861±12.10 0.826*

*Significant = r = 0.811 P>0.05

In the observation of Forward 3 data of successful and unsuccessful shots, there is only significant relationship at the 2.74m take offs of LV3D at the elbow (0.84>0.811) and inverse relationship at JAV of the shoulder (0.89>0.811) and none in the SAV parameters (see table 4.4.8).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of forward 3 at both take off and release parameters of successful and unsuccessful shots (see table 4.4.8) with exception to LV3D of the wrist at release (0.85>0.811). The 6.40m shooting distance result shows that there are significant relationships at the LV3D take off of the wrist (0.86>0.811) and COM at release (0.82>0.811). Only significant relationship was in evident between JAV take off of wrist (0.85>0.811) successful and unsuccessful shots and SAV trunk release (0.826>0.811) (see table 4.4.8). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

Table 4.4.9: Forward 4 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots and Unsuccessful shots.

Variable	2.75mshots		4.67m		6.40mShots	
LV (m/s)	**Take off**	**Release**	**Take-off**	**LV**	**Take off**	**Release**
Shoul: Success	0.849±0.03	0.849±0.05	0.832±0.161	0.834±0.214	0.716±0.042	0.716±0.031
Unsuccessful	0.953±0.431	0.953±0.33	0.792±0.196	0.791±0.356	0.825±0.036	0.825±0.036
R	-0.72	0.52	-0.29	-0.42	0.29	0.26
Elbow: Success	1.449±0.041	1.450±0.013	1.799±'.076	1.803±0.035	1.859±0.009	1.260±0.020
Unsuccessful	1.368±0.052	1.368±0.042	1.696±0.095	1.699±0.026	1.225±0.126	1.225±0.013
R	0.47	-0.53	0.41	-0.39	-0.12	0.31
Wrist: Success	1.247±0.025	1.247±0.031	1.868±'.026	1.865±0.043	1.444±0.002	1.444±0.121
Unsuccessful	1.215±0.061	1.215±0.054	1.557±0.58	1.554±0.056	1.31.±0.53	1.310±0.173
R	-0.76	0.32	0.46	-0.56	-0.61	0.43
Hand: Success	1.257±0.046	1.256±0.046	1.745±0.023	1.733±0.065	1.378±0.023	1.378±0.141
Unsuccessful	1.157±0.132	1.157±0.062	1.656±0.131	1.645±0.087	1.283±0.130	1.283±0.062
R	-0.39	-0.45	-0.31	0.43	-0.18	0.36
COM: Success	1.077±0.012	1.077±0.052	1.052±0.126	1.052±0.437	0.845±0.045	0.845±0.133
Unsuccessful	1.039±0.131	1.038±0.231	1.106±0.174	1.105±0.159	0.868±0.121	0.868±0.412
R	0.75	-0.63	-0.46	0.50	-0.78	0.53
JAV	Rad./s^{-1}					
Shoul.:Success	1.49±0.37	0.39±1.15	2.39± 0.32	2.30±0.10	1.05±0.54	0.84±0.52
Unsuccessful	1. 58. ±0.23	1.40±.0.29	2.26±0.49	0.21±0.16	1.58±0.22	1.40±0.32
R	0.39	-0.29	0.34	0.61	0.36	0.51
Elbow:Success	0.27±1.42	-0.92±0.67	4.82±0.27	4.68±0.12	-0.21±0.82	-0.31±0.86
Unsuccessful	1.28±0.30	1.14±0.36	2.73±0.22	4.39±0.32	1.28±0.29	1.14±0.37
R	0.46	0.76	0.21	0.48	-0.17	-0.12
Wrist: Success	-1.26±0.39	-1.40±0.64	-3.57±0.56	-1.80±0.40	-1.57±0.32	-1.57±0.24
Unsuccessful	-1.20±0.32	-1.17±0.44	-3.93±0.39	-0.25±0.35	-1.20±0.34	-1.17±0.38
R	0.71	0.36	-0.76	-0.38	-0.45	0.36
SAV °						
Uparm:Success	97.998±25.62	229.31±49.31	35.552±86.77	27.569±82.11	12.275±17.82	12.463±16.33
Unsuccessful	57.778±20.61	215.73±15.6	40.17±29.62	32.28±29.68	52.78±0.157	-49.892±26.76
R	-0.36	0.49	0.45	-0.56	0.13	0.28
Forarm:Success	-43.74±97.88	15.9 0±35.95	23.468±36.66	22.889±18.19	-8.645±5.88	7.662±4.54
Unsuccessful	46.87±1.08	44.17±0.75	32.48±46.72	31.79±19.36	-18.319±7.53	-17.878±1.85
R	0.132	-0.73	0.67	0.43	0.21	0.33
Hand:Success	219.95±15.6	230.95±22.02	-927.10±23.45	-4235.37±34.32	-69.370±19.32	-65.034±11.66
Unsuccessful	-186.25±19.98	168.74±29.36	-567.78±89.56	-235.89±45.34	-656.2±56.67	-786.04±45.56
R	-0.23	0.46	0.29	0.35	0.51	0.32
Trunk:Succes	273.72±6.29	271.33±5.24	-1.860±6.84	-1.892±7.33	10.785±5.96	-10.696±6.9
Unsuccessful	271.18±7.45	269.28±8.75	-12.46±2.81	-12.52±3.12	14.70±4.67	14.62±3.79
R	0.80	0.79	0.22	0.19	-0.28	0.46

*Significant =0.05-0.811

In the examination of Forward 4's data, it was shown that there is no significant relationship in any of the LV3D, JAV and SAV parameters of successful and unsuccessful shots (see table 4.4.9). This is only player who did not record any significant correlation in any of the parameters making the hypothesis to accept that there is no significant relationship between the displacements of successful and unsuccessful shots parameters.

4.4.10 Forward 5 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shots.

Variable	2.74mshots		4.67m		6.40mShots	
LV (m/s)	**Take off**	**Release**	**Take-off**	**LV**	**Take off**	**Release**
Shoul:Succes **Unsuccessful** **R**	0.789±0.027 0.935±0.048 0.25	0.575±0.023 0.772±0.021 0.18	0.3748±0.012 0.348±0.014 -0.61	0.392 ±0.022 0.358±0.019 0.33	0.476±0.093 0.377±0.039 0.26	0.5025±0.95 0.395±0.040 0.17
Elbow:Succ. **Unsuccessful** **R**	1.460±0.031 1.368±0.013 0.023	0.767±0.030 0.974±0.033 0.075	0.5512±0.023 0.551±0.034 0.67	0.547±0.07 0.556±0.021 0.45	0.819±0.098 0.717±0.053 0.124	0.873±0.106 0.748±0.059 0.189
Wrist:Succes **Unsuccessful** **R**	1.262±0.021 1.389±0.049 0.48	1.060±0.019 1.195±0.046 0.78	0.789±0.013 0.779±0.011 0.70	0.789±0.15 0.797±0.045 0.806	0.8194±0.101 0.762±0.057 0.77	0.867±0.106 0.789±0.054 0.69
Hand: Succes **Unsuccessful** **R**	1.439±0.0002 1.562±0.011 0.36	1.422±0.09 1.427±0.019 0.84*	1.040±0.019 1.011±0.022 0.30	1.059±0.018 1.021±0.02 0.35	0.789±0.083 0.737±0.056 0.46	0.769±0.056 0.832±0.084 0.40
COM: Succes **Unsuccessful** **R**	0.9563±0.32 1.168±0.036 -0.27	0.633±0.033 0.856±0.033 0.47	0.300±0.014 0.277±0.003 0.60	0.312±0.013 0.289±0.025 0.54	0.565±0.087 0.496±0.022 -0.55	0.593±0.088 0.519±0.034 -0.64
JAV	Joint Angular Velocity Rad./s-¹					
Shoul.:Succes **Unsuccessful** **R**	0.82±0.18 1.28±0.97 0.76	1.02±0.28 1.28±1.09 0.92*	1.00±0.04 1.15±0.09 -0.42	0.98±0.04 1.11±0.09 -0.49	1.88±0.24 1.72±0.15 0.59	1.59±0.22 1.43±0.12 0.22
Elbow:Succ **Unsuccessful** **R**	2.99±2.07 1.87±1.97 0.41	3.18±1.63 2.23±1.86 0.55	1.77±0.03 3.26±0.10 -0.63	1.82±0.03 0.07±0.07 0.12	1.69±0.40 1.53±0.19 -0.60	1.41±0.38 1.68±0.23 -0.76
Wrist: Succes **Unsuccessful** **R**	0.81±5.72 2.37±0.73 0.41	0.50±0.93 2.56±5.60 -0.37	2.31±0.04 0.54±0.08 0.14	2.36±0.02 2.35±0.06 0.29	-1.23±0.21 -1.94±0.29 0.82*	-1.36±0.25 -1.91±1.32 0.76
SAV	Segmental Angular velocity °					
Uparm:Succ. **Unsuccessful** **R**	147.13±194.68 172.84±459.94 0.61	51.06±39.26 53.08±284.23 -0.76	-269.44±15.02 -257.21±21.61 0.84*	-257.08±9.83 -243.95±14.75 -0.55	-8.56±56.91 -25.34±114.58 0.47	-5.15±37.01 -12.36±110.73 0.61
Forarm:Succ. **Unsuccessful** **R**	9.40±89.27 7.33±38.74 -0.77	21.75±19.24 1.45± 36.45 -0.06	45.36±15.82 44.21±20.31 -0.59	44.213±21.52 43.14±16.19 0.85*	1.37±25.97 14.77±92.85 0.64	1.50±25.44 44.48±22.58 0.57
Hand:Succes **Unsuccessful** **R**	-55.86±22.25 132.35±132.35 0.15	-20.36±71.72 -86.72±105.24 -0.43	-24.89±36.87 -23.56±55.96 -0.37	-23.56±42.35 22.24±23.45 0.29	22.63±129.93 -80.60±123.74 0.73	17.52±148.89 -74.20±113.46 0.75
Trunk:Succes **Unsuccessful** **R**	-4.71±10.34 -18.33±16.06 0.19	-11.70±9.04 -5.132±24.58 0.30	-0.1426±12.56 -10.143± 17.12 0.39	-0.4507±12.67 -9.57±9.89 0.48	-16.76±4.64 -4.34±11.08 0.55	6.88±18.05 15.30±21.10 0.34

*Significant r = 0.811 P>0.05

Forward 10's 2.74m successful and unsuccessful shots did not reveal any significant relationship except at the LV3D of the hand at release (0.84> 0.811) and JAV relationship of shoulder (0.92>0.811) at release and none at SAV (see table 4.4.10).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV except at the SAV of Forward 5's upper arm take off (0.84 > 811) and fore arm release (0.85, > 811) parameters of successful and unsuccessful shots (see table 4.4.10). In the

6.40m shooting distance, no significant relationship was found between LV3D, SAV and JAV of successful and unsuccessful shots except at the JAV of wrist take off (0.84> 811) (see table 4.4.3). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots.

4.4.11 Centre 1 Shooting distances and upper limb Velocities at take off and release for Successful and Unsuccessful shot**s**

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV (m/s)	**Take off**	**Release**	**Take-off**	**Release**	**Take off**	**Release**
Shoul: Succes	0.811±0.097	0.811±0.097	0.164±0.05	0.170±0.053	0.62±0.062	0.62±0.062
Unsuccessful	0.156±0.052	0.156±0.052	0.177±0.051	0.177±0.051	0.584±0.088	0.584±0.089
R	-0.02	-0.12	-0.26	-0.10	0.14	0.15
Elbow: Succes	1.349±0.054	1.347±0.054	0.782±0.046	0.783±0.047	1.099±0.047	1.099±0.047
Unsuccessful	0.777±0.052	0.777±0.052	0.753±0.068	0.751±0.068	0.981±0.079	0.986±0.086
R	0.47	0.48	-0.05	0.016	0.71	0.66
Wrist: Succes	1.175±0.087	1.156±0.054	0.921±0.019	0.880±0.083	0.736±0.802	1.125±0.025
Unsuccessful	0.610±0.407	0.609±0.411	0.871±0.072	0.871±0.072	1.046±0.042	1.051±0.040
R	-0.26	0.02	0.75	0.64	-0.38	-0.012
Hand: Succes	1.116±0.055	0.976±0.159	0.817±0.034	0.809±0.080	1.086±0.009	1.088±0.013
Unsuccessful	0.937±0.181	-0.958±0.12	0.772±0.075	0.773±0.075	0.947±0.045	0.945±0.046
R	-0.04	0.49	0.807	0.820*	0.56	0.25
COM: Succes	1.043±0.059	1.096±0.111	0.257±0.083	0.239±0.089	0.76±0.059	0.776±0.60
Unsuccessful	1.208±0.052	1.207±0.052	0.199±0.059	0.199±0.057	0.548±0.108	0.558±0.098
R	0.91*	0.77	-0.26	-0.33	0.55	0.54
JAV	Joint Angular Velocity(rad./s-¹)					
Shoul.: Succes	4.85±3.52	6.14±3.81	1.64±0.26	1.52±0.15	3.07±0.15	2.57±0.12
Unsuccessful	2.30±0.66	1.43±0.72	1.55±0.22	1.36±0.27	2.83±0.01	2.45±0.24
R	0.09	0.16	0.52	0.71	0.68	0.63
Elbow: Succes	2.50±3.64	-0.92±0.70	1.31±0.38	1.18±0.50	2.71±0.29	2.25±0.22
Unsuccessful	2.20±0.81	1.11±0.88	0.62±0.75	0.48±1.06	2.71±0.40	2.37±0.30
R	0.025	-0.08	0.19	0.23	0.82	0.83
Wrist: Succes	-1.44±0.18	-0.63±1.08	1.73±0.17	-1.50±0.40	-2.03±0.18	-1.67±0.58
Unsuccessful	-2.44±0.17	-2.25±0.15	1.70±0.15	-2.00±0.53	-1.81±0.19	-2.24±0.18
R	-0.08	-0.38	0.51	0.21	-0.103	-0.38
SAV	Segmental Angular velocity °					
Uparm:Succe	-48.043±9.62	89.53±158.19	-286.56±12.8	204.89±15.81	-22.60±51.88	-13.44±34.31
Unsuccessful	-177.77±29.40	-93.02±151.31	28.86±10.11	25.80±19.6	-26.34±113.79	-13.36±110.20
R	-0.34	-0.50	0.43	0.37	0.35	0.57
Forarm:Suc	32.53±62.99	16.74±37.50	25.49±47.81	24.369±14.76	-0.63±23.0	-00.50±22.47
Unsuccessful	44.63±41.29	28.89±32.20	36.509±51.6	30.173±24.369	12.77±91.30	42.48±19.61
R	-0.24	-0.69	0.58	0.49	0.63	0.44
Hand:Succe	-47.53±64.32	-62.90±64.19	-72.087±22.61	-73.758±5.84	24.63±127.16	19.52±146.13
Unsuccessful	-99.05±85.69	-98.55±75.75	-62.40±33.62	-68.931±10.35	-80.60±23.74	-74.20±113.46
R	-0.54	0.29	0.42	0.33	0.74	0.76
Trunk:Succes	-1.69±9.96	3.06±5.15	-16.70±2.98	-16.66±3.21	-15.16±4.94	6.48±17.45
Unsuccessful	-1.04±2.48	3.13±8.79	-19.41±1.25	-19.46±1.25	-4.34±11.45	17.30±23.86
R	0.07	0.40	0.51	0.61	0.89*	0.72.

*Significant = r = 0.811 P>0.05

Centre 1's results show that there is no significant relationship between 2;74m successful and unsuccessful shots' LV3D, JAV and SAV parameters except at the COM take off (0.92, > 811). (See table 4.4.3).

In the 4.67m shots, no significant relationship is revealed of the JAV, SAV and LV3D except at the hand release (0.820> 811) parameters of successful and unsuccessful shots of centre 1 (see table 4.4.11). In the 6.40m shooting distance, no significant relationship was found between LV3D and JAV angular velocities of successful and unsuccessful shots except at the SAV trunk (0.89> 811) take off (see table 4.4.3). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shot

Table 4.4.12: Center 2 Shooting distances and upper limbs Velocities at take off and release for Successful and Unsuccessful shots

Variable	**2.74mshots**		**4.67m**		**6.40mShots**	
LV m/s	**Take off**	**Release**	**Take-off**	**Release**	**Take off**	**Release**
Shoul: Success **Unsuccessful** **R**	0.80±0.082 0.790±0.031 -0.56	0.609±0.06 0.575±0.122 0.48	0.694±0.102 0.692±0.067 0.78	0.697±0.025 0.702±0.052 0.51	0.809±0.293 0..772±0.307 0.75	0.918±0.402 0.710±0.391 0.53
Elbow: Success **Unsuccessful** **R**	1.006±0.121 0.992±0.032 0.51	0.875±0.116 0.856±0.322 0.82*	1.288±0.101 1.281±0.082 0..74	1.304±0.06 1.320±0.041 0.51	1.296±0.448 1.446±0.554 0.48	1.270±0.472 1.493±0.549 0.37
Wrist: Success **Unsuccessful** **R**	1.060±0.192 1.050±0.212 -0.33	0.917±0.05 0.895±0.02 0.47	1.476±0.002 1.470±0.024 -0.35	1.487±0.213 1.499±0.202 -0.53	1.272±0.458 1.480±0.597 0.62	1.283±0.458 1.471±0.597 0.454
Hand: Success **Unsuccessful** **R**	1.409±0.051 1.397±0.101 -0.27	1.226±0.14 1.194±0.10 0.62	1.675±0.002 1.664±0.13 -0.38	1.6787±.051 1.4988±0.14 -0.27	1.349±0.428 1.491±0.683 0.90*	1.315±0.428 1.415±0.678 0.806
COM: Success **Unsuccessful** **R**	0.857±0.021 0.843±0.033 0.46	0.642±0.04 0.604±0.06 0.23	0.857±0.025 0.845±0.033 0.75	0.861±0.033 0.866±0.032 0.78	0.876±0.289 0.964±0.542 0.38	0.716±0.194 0.960±0.525 -0.62
JAV	Joint Angular Velocity Rad./s^{-1}					
Shoul.: Success **Unsuccessful** **R**	1.49±0.36 1.59±0.47 -0.52	2.19±0.44 2.10±0.79 0.36	1.97±'.99 1.94±4.37 0.22	2.01±0.64 2.05±0.80 0.810	1.84±0.29 1.65±0.37 -0.14	1.65±0.37 1.70±0.49 0.36
Elbow: Success **Unsuccessful** **R**	3.19±0.56 3.29±0.47 0.48	-3.79±0.47 -3.77±0.70 0.58	-4.43±1.38 -4.44±0.70 0.31	-4.40±0.39 -4.35±0.73 -0.65	-1.98±0.73 2.73±1.03 0.46	1.86±1.11 2.67±1.27 0.68
Wrist: Succes **Unsuccessful** **R**	1.78±0.64 1.84±0.32 0.827*	-2.19±0.56 -2.36±0.33 -0.45	-2.39±.1.17 -2.61±2.11 0.22	-1.93±0.98 -1.49±0.86 0.49	-1.26±0.31 -1.01±0.01 -0.91*	1.45±0.43 -1.80±0.37 0.48
Segmental Angular velocity (SAV)						
Uparm:Succe **Unsuccessful** **R**	-75.41±61.32 -62.37±45.54 -0.37	-22.859±91.65 -19.39±69.19 0.28	-33.42±125.61 -34.908±210.6 0.57	28.67±112.6 -25.771±132.81 0.51	33.95±62.0 -73.35±117.49 0.33	-1.04±31.32 -42.40±108.26 0.60
Forarm:Succ. **Unsuccessful** **R**	56.50±35.19 56.55±46.26 0.50	54.727±49.58 53.86±32.73 -0.51	45.829±150.17 40.248±110.1 0.76	45.79±180.32 40.569±201.41 -0.82*	6.64±33.03 -21.09±9.61 -0.37	6.45±32.10 81.06±99.21 -0.25
Hand:Succe **Unsuccessf** **R**	-61.040±40.33 -64.283±29.72 0.57	-84.851±26.82 -88.34±18.35 -0.63	-40.667±15.36 -37.429±81.78 -0.81*	-47.103±20.17 -53.46±96.3 -0.86*	103.32±105.63 -183.95±96.41 -0.14	108.10±20.54 -174.15±30.16 -0.07
Trunk:Succes **Unsuccessful** **R**	-1.758±2.41 -1.924±7.85 0.68	-3.044±5.33 -3.27±3.51 -0.39	-19.34.±12.78 -29.56±5.78 0.49	19.86±10.75 -28.62±8.78 0.51	-12.438±7.44 -17.50±12.70 0.23	-3.66±12.01 52.34±125.36 0.57

*Significant = r = 0.811 P>0.05

Centre 2's 2.75m successful and unsuccessful shots reveals significant relationship in the elbow release LV3D (0.82> 0.118), and JAV wrist take off (0.82> 0.118). However, none exists in the SAV parameters (see table 4.4.12).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV but only at the hand take off and release of SAV (-0.82, -0.86> 0.118) of center 2 parameters for successful and unsuccessful shots(see table 4.4.3). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the hand (0.90> 0.118) LV3D take off, JAV of wrist take off (0.91> 811) and none at SAV(see table 4.4.3).

Table 4.4.13: Center 3 Shooting distances and upper limbs Velocities at take off and release for Successful and Unsuccessful shot

Variables	**2.74mshots**		**4.67m**		**6.40mShots**	
LV (m/s)	**Take off**	**Release**	**Take-off**	**Release**	**Take off**	**Release**
Shoul: Success **Unsuccessful** **R**	0.5602±0.14 0.4997±0.34 0.19	0.5161±0.63 0.4892±0.31 0.23	0.700±'.041 0.702±0.015 0.15	0.704±0.035 0.706±0.013 0.38	1.335±0.22 1.331±0.231 -0.49	1.347±0.15 1.351±0.136 -0.55
Elbow: Success **Unsuccessful** **R**	1.3459±0.21 1.4531±0.31 0.32	1.3687±0.25 1.4621±0.15 0.27	1.893±'.008 1.903±0.006 0.51	1.910±0.005 1.918±0.009 -0.43	2.339±0.022 2.331±0.132 -0.69	2.358±0.16 2.364±0.21 0.52
Wrist: Success **Unsuccessful** **R**	1.3169±0.24 1.451±0.31 0.26	1.3698± 0.41 1.4672±0.098 0.27	2.0450.006 2.055±0.004 -0.19	2.065±0.002 2.075±0.003 0.27	2.368±0.13 2.354±0.14 0.53	2.3990±'.10 2.407±0.31 -0.39
Hand: Success **Unsuccessful** **R**	1.3745±0.17 1.5231±0.079 0.32	1.3998±0.098 1.5432±0.19 0.19	1.946±0.003 1.955±0.002 0.49	1.964±0.008 1.973±0.005 0.59	2.336±0.63 2.323±0.57 0.74	2.364±0.62 2.371±0.54 0.48
COM: Success **Unsuccessful** **R**	0.7592±0.21 0.8123±0.12 0.18	0.7411±0.19 0.8281±0.09 0.28	0.965±0.007 0.968±0.004 -0.78	0.972±0.009 0.976±0.006 -0.53	1.523±0.162 1.542±0.573 0.83*	1.527±0.25 1.534±0.47 0.62
JAV	Joint Angular Velocity (rad./s-¹)					
Shoul.: Success **Unsuccessful** **R**	2.48±0.14 2.31±0.12 0.48	2.50±0.20 2.41±0.10 0.31	4.43±0.36 4.29±0.61 0.64	2.16±1.44 3.98±0.27 -0.23	3.95±0.31 3.84±0.45 -0.810	3.51±0.39 3.23±0.67 -0.51
Elbow: Success **Unsuccessful** **R**	2.21±0.22 2.44±0.19 0.39	2.22±0.21 2.45±0.17 0.28	3.96±0.33 3.82±0.90 0.33	2.44±1.34 202.12±32.65 0.49	4.14±0.81 4.04±0.53 0.63	3.65±4.70 0.32±1.15 0.46
Wrist: Succes **Unsuccessful** **R**	-1.77±0.22 -2.15±0.17 0.26	-2.34±0.16 -2.51±0.14 0.34	-3.01±0.97 -3.18±0.01 -0.38	2.56±0.67 3.38±0.46 0.76	-4.62±0.87 -4.65±0.32 0.37	-4.49±0.37 -4.20±0.74 0.44
SAV	Segmental Angular velocity º					
Uparm:Success **Unsuccessful** **R**	-233.80±156.56 -64.39±217.95 0.33	203.01±52.27 -345.63±149.48 0.61	-230.63±19.81 -188.41±70.63 -0.79	-146.19±56.32 123.26±80.86 0.19	109.5±30.61 106.9±250.11 -0.46	170.39±29.96 130.70±56.37 -0.21
Forarm:Succes **Unsuccessful** **R**	43.78±54.49 41.85±98.34 0.22	40.243±35.43 -343.08±102.18 0.58	109.18±68.55 108.20±48.21 0.78	109.21±35.64 110.11±67.82 0.49	86.67±29.62 87.54±31.34 0.51	86.80±24.85 89.74±18.46 0.79
Hand:Succe **Unsuccessf** **R**	39.45±28.94 -28.34±81.31 -0.65	28.83±32.67 46.0±43.21 -0.46	73.72±45.29 78.10±28.61 0.84*	82.30±60.33 86.99±42.58 0.63	-40.02±21.79 -37.20±61.55 -0.45	-53.92±45.39 -58.22±29.62 -0.51

Trunk:Succes	-10.92±12.75	-11.595±16.37	-12.82±3.68	-13.170±4.91	22.38±6.78	22.55±3.39
Unsuccessful	262.843±16.75	209.74±116.06	-11.99±4.71	-12.34±5.36	21.32±2.63	20.57±5.92
R	0.85*	0.89*	0.83*	0.71	0.51	0.63

*Significant = r = 0.811 P>0.05

Centre 3's data on 2.74m successful and unsuccessful shots did not reveal any significant relationship in the LV3D and JAV parameters (see table 4.4.3). Significant relationship was found only in Centre 3 SAV trunk take off and release (0.85, 0.89 > 811) (see table 4.4.3).

In the 4.67m shots, significant relationship is shown only in the SAV of the hand (0.84 > 811) and trunk at take off (0.83 > 811). No significant relationship is revealed at the LV3D and JAV parameters of successful and unsuccessful shots (see table 4.4.13). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the LV3D COM (0.83> 811) take off (see table 4.4.3). The results show that there are both significant and insignificant relationships between the upper limb arm motion velocity parameters of successful and unsuccessful jump shots

Table 4.4.14: Center 4 Shooting distances and upper limbs Velocities at take off and release for Successful and Unsuccessful shots.

Variable	2.74mshots		4.67m		6.40mShots	
LV (m/s)	Take off	Release	Take-off	Release	Take off	Release
Shoul: Succes Unsuccessful R	0.6593±.16 1.188±0.18 0.24	0.6412.068 0.6552±.031 -0.51	0.7542±0.22 0.6593±0.21 -0.22	.7319±0.62 0.6552.032 0.24	1.4672±0.36 1.3883±.151 -0.28	1.4764±.018 1.3994±.125 0.23
Elbow: Succes Unsuccessful R	1.5134±.006 1.4745±.082 0.31	1.5132±.034 1.6744±.023 0.25	1.3298±.13 1.4745±.03 0.48	1.3384±.153 1.4744±.002 -0.78	2.5199±0.18 2.3287±.152 0.52	2.5266±.02 2.3381±.15 -0.68
Wrist: Succes Unsuccessful R	1.7037±.045 1.61.50±0.035 -'.28	1.7041±.051 1.6152±.034 0.25	1.5223±.076 1.6150±.033 0.43	1.5235±.131 1.6152±.041 -0.63	2.5856±.052 2.376±0.181 0.35	2.5957±071 2.3381±.15 -0.44
Hand: Succes Unsuccessful R	1.8651±0.031 1.9001±.025 0.47	1.8645±0.061 1.8851±.017 .0.63	1.7239±.134 1.5001±.021 -0.78	1.7129±0.73 1.8851±0.19 0.36	2.6042±0.032 2.495±'.022 -0.58	2.6054±.063 2.5095±.141 0.71
COM: Succes Unsuccessful R	0.6898±.024 0.709±.014 -0.21	0.6896±.024 0.7045±.012 -0.37	0.7378±.058 0.7091±.011 -0.823*	.7352±.009 67045±.071 -0.62	1.3844±0.05 1.2952±.061 -0.29	1.3837±.0.008 1.2946±0.015 0.37
JAV	Joint Angular Velocity (rad./s-¹)					
Shoul.: Succes Unsuccessful R	1.41±0.43 1.39±0.62 0.47	1.41±0.45 1.39±0.56 0.51	2.01±0.32 2.18±0.17 0.49	2.02±0.30 2.12±0.20 -0.64	3.12±0.35 3.16±0.32 -0.55	2.90±0.31 2.97±0.22 0.53
Elbow: Succes Unsuccessful R	4.05±0.08 4.09±0.27 -0.38	3.75±0.04 3.58±0.10 0.45	4.38±0.12 39.09±0.18 0.80	4.36±1.21 4.09±2.02 0.82*	4.12±0.50 4.21±0.79 -0.51	3.89±0.26 3.73±0.34 0.48
Wrist: Succes Unsuccessful R	2.81± 0.57 2.30±2.54 0.52	-12.92±0.64 -8.40±1.03 0.46	-7.26±1.59 9.61±22.81 -0.26	-5.40±2.15 -8.10±1.56 -0.47	5.07±0.06 0.50±0.09 -0.53	4.74±0.09 4.70±0.12 0.48
SAV	Segmental Angular velocity °					
Uparm:Succe Unsuccessful R	-126.71±23.5 -351.40±26.62 0.21	-74.59±26.33 -64.50±21.86 0.32	-82.249±31.61 -158.41±5.81 0.31	-65.79±25.33 -116.94±12.65 -0.28	588.40±46.03 496.53±120.61 -0.37	365.30±68.74 305.42±81.39 0.48
Forarm:SucUnsu ccess R	74.15±45.33 76.37±34.25 0.69	71.45±12.68 70.38±18.31 0.46	-55.91±22.61 90.60±8.35 0.28	54.02±28.26 89.30±15.71 0.47	21.38±28.33 36.56±20.63 0.47	21.78±35.07 36.63±26.51 0-18
Hand:Succe Unsuccessf R	-122.79±22.54 -40.38±32.44 0.38	-316.86±11.57 -450.11±22.82 0.31	-76.24±8.38 86.14±5.33 -0.39	-92.34±9.68 86.55±6.73 0.46	-13.24±58.51 30.84±19.99 -0.21	-13.07±62.5 30.63±29.66 -0.18
Trunk:Succes Unsuccessful R	-10.46±2.61 -11.58±3.12 -0.61	-9.61±5.36 -9.32±7.61 -0.53	-22.30±3.52 -17.36±5.42 -0.61	-22.54±3.82 -17.57±5.66 0.59	-14.28±3.56 -11.68±5.62 -0.66	-13.78±5.41 -10.84±6.63 0.47

***Sig.** r = 0.811 P>0.05

Table 4.4.14 shows the segmental velocities of Centre 14.For the 2.74m parameters, there is no significant relationship in the LV3D, JAV and SAV take off and release parameters of the upper limbs successful and unsuccessful shots. 4.67m shots showed only significant relationship at the LV3D of the COM (0.823> 0.811). Insignificant relationship was also found in the JAV and SAV. The take off and release4 parameters (see table 4.4.14).

In the 4.67m shots, no significant relationship is revealed at the LV3D, JAV and SAV of guard 3 at both take off and release parameters of successful and unsuccessful shots (see table 4.4.3). In the 6.40m shooting distance, no significant relationship was found between angular velocities of successful and unsuccessful shots except at the JAV of elbow take off and release (0.82, 0.83> 811) (see table 4.4.3). So also, in the 6.40m shots, no significant relationship was found in the take off and release parameters LV3D, JAV and SAV parameters.

Conclusively, From table 4.4.1 to table 4.4.14, the results show that there are both significant and insignificant relationships between take off and release parameters of successful and unsuccessful shots in LV3D, JAV and SAV of 2.75m, 4.67m and 6.40m shooting distances.

4.5.0 This section presents the parameters of Ball trajectory for the three shooting distances.

HYPOTHESIS 4: There is no significant variability between Ball trajectory parameters of successful and unsuccessful jump shots of the Nigerian female basketball players.

Table 4.5.1: Description and Correlation (r) of the Ball projection angle (º) at three Shooting Distances.

	2.75 angle Parameters				**4.67m angle Parameters**				**6.40 m angle Parameters**			
	Succssful		**Missed**		**Succ.**		**Missed**		**Succ.**		**Missed**	
Partici-pants	**TO**	**Rel.**	**TO**	**Rel.**	**TO**	**Rel.**	**TO**	**Rel**	**TO**	**Rel.**	**TO**	**Rel.**
G1	44.88	45.29	46.76	47.36	54.17	54.70	61.37	61.30	56.85	56.93	55.21	55.46
G2	51.95	50.82	40.61	40.44	53.03	53.44	35.72	42.0	58.33	58.49	58.49	58.64
G3	41.48	41.87	32.56	29.96	50.36	50.78	41.66	42.76	46.33	46.84	45.62	45.76
G4	42.97	44.27	45.64	49.81	52.97	54.07	48.31	50.21	60.67	62.44	58.71	60.67
G5	60.37	60.37	28.20	27.75	60.40	60.37	60.21	60.32	54.43	54.95	27.52	27.40
F6	48.87	48.86	51.78	51.81	57.14	57.23	48.18	48.18	46.09	46.13	50.43	50.44
F7	43.20	43.23	46.62	46.82	50.36	50.35	53.61	53.72	52.36	52.54	51.23	51.32
F8	37.99	39.20	41.46	41.97	49.63	49.89	51.36	51.42	38.72	41.41	48.51	49.64
F9	40.85	40.86	45.56	45.58	61.78	61.91	60.23	60.34	61.40	61.39	51.24	51.24
F10	43.11	42.23	29.32	26.34	51.86	51.48	50.56	50.36	49.68	49.68	50.10	50.14
C11	50.75	50.76	61.76	61.77	65.39	65.39	62.09	62.08	51.26	51.18	53.61	53.58
C12	33.04	35.84	35.67	38.78	53.76	54.05	48.56	51.75	53.76	54.05	54.32	55.12
C13	52.97	52.88	51.62	51.58	58.48	58.48	51.45	53.82	56.78	57.05	55.31	55.03
C14	46.91	47.37	49.63	49.58	49.10	49.32	50.65	50.82	53.01	53.51	52.31	55.19
Minim.	33.04	35.84	28.20	26.34	49.10	49.32	35.72	42.00	38.72	41.41	27.52	27.40
Maxim	60.37	60.37	61.76	61.77	65.39	65.39	62.09	62.08	61.40	62.44	58.71	60.67
N	14	14	14	14	14	14	14	14	14	14	14	14
Mean	45.67	45.99	43.37	43.54	54.89	55.10	51.71	52.79	52.83	53.33	50.90	51.40
SD	6.94	6.37	9.46	10.13	5.01	4.93	7.56	6.40	6.20	5.94	7.64	7.92
R	0.993 *		0.985*		'.998*		0.979*		0.99*		0.994*	

Table 4.5.1 presents the participants' score (mean) minimum and maximum scores, group mean, SD and 'r' at take –off and release of successful and missed shots for guards, forwards and centre players.

Guards' successful 2.74 metres shot release angle of ball ranges between 41.48º and 60.37º; forwards 39.20ºand 48.86º while that of centres' range falls between 35.67º and 52.88º. The missed shot angle for the participants fell within the following ranges: guards- 27.75º and 60.40º; forwards 26.34º- 51.81º and centre 38.78º - 61.77º.

For the clean 4.67metres' shooting distance, the range for the guards is 53.44º-60.37º; forwards- 49.89º- 61.91º; centres- 49.32º - 65.37º; while for the missed shot ranges fell thus; guards-42.0º- 61.32º, forwards- 48.18º-60.34º and centres -51.75º and 62.08º respectively. The ranges for the 6.40metre shooting distances angle of projection for Missed shots are guards- 27.40º-60.67º, forwards- 49.64º-51.44º; centres 53.58º-55.19º; successful shots; guards -46.84º-62.44º, forwards- 41.41º-61.39º; and centres 51.18º-57.05º respectively. The lowest mean angle is obtained by C2 (35.84 º) while the maximum score is obtained .by G5 (60.37 º) (see table 4.5.1).

Group mean and SD at take off and release for successful and unsuccessful shots for the three shooting distances shows that there is significant relationship between the take off and release projection angle of successful and unsuccessful shots at 2.74m (r= 0.993>0.514.), 4.67m (r= 0.985>0.514) and 6.40m (0.994>0.514). This makes for the rejection of the hypothesis that there is no significant relationship between take off and release of clean and missed shots angle of projection.

Table 4.5.2: Participants' Ball Velocity (m/s) Trajectory Parameters for three Shooting Distances.

	2.74m Velocity				**4.67m Velocity**				**6.40m Velocity**			
	Succ.		**Missed**		**Succ.**		**Missed**		**Succ.**		**Missed**	
Partici pants	**TO**	**Rel.**	**TO**	**Rel.**	**TO**	**Rel.**	**TO**	**Rel**	**TO**	**Rel.**	**TO**	**Rel.**
G1	3.67	3.77	3.76	3.83	4.35	4.40	4.34	4.39	4.84	4.89	5.12	5.19
G2	5.55	5.79	3.66	4.05	3.84	3.90	1.10	.99	4.88	4.93	4.92	4.93
G3	3.03	3.22	3.46	3.96	3.22	3.47	3.67	3.68	4.07	4.23	3.98	4.08
G4	3.13	3.49	3.43	3.54	4.58	4.61	3.73	3.84	3.85	4.06	3.78	3.96
G5	2.92	2.92	4.49	4.60	2.91	2.98	2.96	3.03	5.56	5.65	4.47	4.55
F6	3.23	3.28	3.67	3.68	2.54	2.55	2.31	2.31	2.80	2.79	2.67	2.67
F7	2.67	2.67	2.83	2.84	3.19	3.58	3.21	3.40	3.15	3.26	3.61	3.63
F8	2.30	2.55	2.48	2.79	3.96	4.35	5.31	5.39	4.25	4.53	5.02	5.26
F9	2.68	2.68	2.76	2.81	4.13	4.18	4.21	4.26	3.18	3.17	2.91	2.91
F10	2.71	3.05	3.40	3.87	3.68	3.76	4.10	4.16	2.89	2.89	3.12	3.12
C11	2.62	2.73	2.46	2.46	2.33	2.33	2.47	2.47	2.85	2.85	2.90	2.90
C12	3.56	4.37	3.57	4.10	3.67	3.72	3.35	3.58	3.67	3.72	4.67	4.72
C13	2.83	2.95	3.12	3.33	3.83	3.88	3.75	3.81	4.59	4.71	5.10	5.16
C14	4.18	4.36	4.62	4.71	4.17	4.21	4.33	4.38	5.10	5.20	5.42	5.54
Minim.	2.30	2.55	2.46	2.46	2.33	2.33	1.10	0.99	2.80	2.79	2.67	2.67
Maxim	5.55	5.79	4.62	4.71	4.58	4.61	5.31	5.39	5.5 6	5.65	5.42	5.54
Mean	3.22	3.42	3.41	3.612	3.60	3.71	3.49	3.55	3.9 8	4.063	4.12	4.99
SD	.833	.900	.652	.833	.900	.652	.689	.674	.685	1.049	1.09	.922

Minim= Minimum ; Maxim.= Maximum

The observation of the take off and release velocity by the participants (see table 4.5.2) reveals the minimum and maximum scores, mean and SD obtained at ball projection take off and release of successful and unsuccessful velocity. The minimum velocity obtained for clean shot and was scored by G8 (2.55m/s) while the highest was scored by G2 ($5.79m/s^{-1}$) in the 2.74m the minimum velocity score was obtained. The Minimum and Maximum for 4.67m was scored by C11 (2.33m/s) and G4 (4.61 m/s) and for 6. 40m shots, it was scored by F6 (2.79m/s) and G5 (5.65m/s). The result above shows that there is no significant variability in the release ball angle projection between the successful and unsuccessful shot of the players.

Table 4:5.3a: The Release Height Parameters at take-off and release of Successful and Missed shots for the three shooting Distances of the Participants

	HT 2.75m				HT - 4.67m				HT 6.40m			
Partici -pants	**Succ.**		**Missed**		**Succ.**		**Missed**		**Succ.**		**Missed**	
G1	2.10	2.26	2.09	2.25	2.39	2.46	2.22	2.30	2.30	2.38	2.29	2.40
G2	2.14	2.54	2.07	2.48	2.22	2.28	1.65	1.76	2.32	2.41	2.41	2.49
G3	2.37	2.54	2.19	2.37	2.15	2.38	2.22	2.21	2.34	2.48	2.32	2.46
G4	2.12	2.59	2.15	2.49	3.12	3.19	2.16	2.64	2.14	2.49	2.08	2.43
G5	2.50	2.50	2.27	2.36	2.43	2.47	2.23	2.31	2.32	2.51	1.74	1.69
F6	2.43	2.52	2.47	2.53	2.46	2.50	2.34	2.38	2.91	2.95	2.91	2.99
F7	2.34	2.67	2.29	2.58	2.53	2.57	2.49	2.53	2.47	2.53	2.45	2.52
F8	2.26	2.68	2.26	2.75	2.59	2.70	2.63	2.73	2.23	2.61	2.29	2.71
F9	2.31	2.62	2.28	2.57	2.60	2.67	2.65	2.69	3.08	3.19	3.18	3.28
F10	2.28	2.61	2.18	2.55	2.40	2.45	2.41	2.47	3.10	3.19	2.63	2.71
C11	2.21	2.83	2.34	2.86	2.88	2.92	2.81	2.86	3.11	3.19	3.13	3.22
C12	2.20	2.30	2.23	2.32	2.42	2.48	2.38	2.44	2.42	2.48	2.58	2.66
C13	2.41	2.55	2.46	2.61	2.28	2.35	2.25	2.40	2.38	2.54	2.40	2.56
C14	2.28	2.53	2.31	2.56	2.42	2.49	2.46	2.53	2.42	2.58	2.45	2.63
Minim	**2.10**	**2.26**	**2.07**	**2.25**	**2.15**	**2.28**	**1.65**	**1.76**	**2.14**	**2.38**	**1.74**	**1.69**
Maxim.	**2.50**	**2.83**	**2.47**	**2.86**	**3.12**	**3.19**	**2.81**	**2.86**	**3.11**	**3.19**	**3.18**	**3.28**
Mean	**2.28**	**2.55**	**2.26**	**2.52**	**2.49**	**2.57**	**2.35**	**2.45**	**2.54**	**2.68**	**2.49**	**2.63**
SD	**.121**	**.144**	**.119**	**.164**	**.254**	**.241**	**.277**	**.268**	**.348**	**.306**	**.387**	**.388**

The table above (table 4.5.3) shows the take off and release height for successful and missed shots at the three distances and the group mean and SD. The maximum scores are found to be higher than the minimum at the take off for the 2.74m, 4.67m and 6.40m shots (see table). The range between the individual mean score and group minimum and maximum score obtained revealed that there are variabilities in the release height of the players. Since actual performance is what is required for shooting accuracy, individual shooter should be specifically coached and corrected according to her parametres not based on group decision as shown by G1 who is the shortest and has the lowest Release height is 13cm away from the mean. Guard 5 has the height jump while the forwards and centres were lower. This implies that the taller a shooter is the less the height to be covered. Guards tend to strive for height than the forwards and centres.

Table 4:5.3b: Standing Height, (SHT), Mean Release Height (cm) (MRHT), Release Height Ratio (m) (RHR) for Three Distances Shooting

	2.75m shot					**4.67m**				**6.40m**			
Partici-pants	**SHT**	**SMRHT**	**USMRHT**	**SRHR**	**USRHR**	**SMRHT**	**USRHT**	**SRHR**	**USRHR**	**SRHT**	**USRHT**	**SRHR**	**USRHR**
G1	165	226	225	**1.37**	**1.28**	246	230	**1.49**	**1.39**	238	240	**1.44**	**1.45**
G2	175	254	248	**1.45**	**1.42**	228	196	**1.30**	**1.06**	241	249	**1.38**	**1.42**
G3	185	254	248	**1.37**	**1.28**	228	221	**1.29**	**1.19**	248	246	**1.36**	**1.33**
G4	183	259	249	**1.42**	**1.36**	212	264	**1.74**	**1.44**	249	243	**1.36**	**1.33**
G5	168	250	236	**1.49**	**1.40**	248	231	**1.47**	**1.38**	251	176	**1.49**	**1.01**
F6	175	267	258	**1.53**	**1.47**	250	238	**1.43**	**1.36**	295	299	**1.69**	**1.71**
F7	178	252	253	**1.40**	**1.33**	257	253	**1.44**	**1.42**	253	252	**1.42**	**1.42**
F8	188	268	275	**1.43**	**1.46**	270	273	**1.44**	**1.45**	261	271	**1.39**	**1.44**
F9	188	262	257	**1.39**	**1.37**	267	269	**1.42**	**1.43**	278	289	**1.48**	**1.54**
F10	180	261	255	**1.45**	**1.42**	245	247	**1.36**	**1.37**	261	271	**1.45**	**1.50**
C11	190	283	286	**1.49**	**1.51**	292	287	**1.54**	**1.51**	319	322	**1.68**	**1.69**
C12	193	230	232	**1.19**	**1.20**	248	244	**1.29**	**1.26**	248	266	**1.29**	**1.38**
C13	188	255	261	**1.36**	**1.39**	235	240	**1.25**	**1.28**	254	256	**1.35**	**1.36**
C14	188	253	256	**1.35**	**1.36**	249	253	**1.32**	**1.35**	258	263	**1.37**	**1.40**
Minim	165	226	225	**1.19**	**1.20**	212	196	**1.25**	**1.06**	238	176	**1.29**	**1.01**
Max.	190	283	286	**1.53**	**1.51**	292	287	**1.54**	**1.51**	319	322	**1.69**	**1.71**
Mean	181.7	252.78	255.3	**1.41**	**1.38**	248.2	232.3	**1.41**	**1.35**	241.3	239.78	**1.44**	**1.43**
SD	8.51	15.86	14.42	**0.082**	**0.83**	19.89	68.83	**0.13**	**0.12**	72.01	75.54	**0.12**	**0.17**

***JHT- Jump Height; *SMRHT- Successful Mean Release Height; * USMRHT- Unsuccessful Mean Release Height; RHR- Release Height Ratio**

Table 4:5.3b shows the standing height, the release height and release height ratio of individual's mean, group mean and SD, minimum and maximum sores for the participants for both successful and missed shot at the three shooting distances. The minimum scores are significantly lower to the group means and the highest scores. This implies that there significant inter variability among the group release height parameters.

Table 4:5.3c: Ball Trajectory Mean Heights and Jump Height (cm) for the Three Distances of Shooting in Relation to Standing Height of the Participants

		2.75m shot				4.67m Shots				6.40m Shots			
Parti ci- pant	**SHT (cm)**	**MSRH**	**JHT**	**USRH T**	**JHT**	**SR HT**	**JHT**	**USRH T**	**JHT**	**SRHT**	**JHT**	**USRH T**	**JHT**
G1	165	226	61	225	60	246	81	230	65	238	73	240	70
G2	175	254	79	248	73	228	53	176	11	241	66	249	74
G3	185	254	79	248	73	228	53	221	36	248	63	246	61
G4	183	259	76	249	66	212	29	264	81	249	66	243	60
G5	168	250	82	236	68	248	80	231	63	251	83	176	18
F6	175	267	92	258	83	250	85	238	63	295	120	299	124
F7	178	252	74	253	75	257	79	253	75	253	75	252	74
F8	188	268	80	275	87	270	82	273	85	261	73	271	83
F9	188	262	74	257	69	267	79	269	81	319	121	318	130
F10	180	261	81	255	75	245	65	247	67	319	139	271	83
C11	190	283	90	286	96	292	102	287	90	319	129	322	142
C12	193	230	37	232	39	248	55	244	51	248	55	266	76
C13	188	255	67	261	73	235	67	240	52	254	66	256	63
C14	188	253	65	256	68	249	61	253	65	258	70	263	75
Min.	**165**	**226**	**37**	**225**	**39**	**212**	**29**	**176**	**11**	**238**	**55**	**176**	**18**
Max.	**193**	**283**	**92**	**286**	**96**	**292**	**102**	**287**	**90**	**319**	**139**	**322**	**142**
Mean	**181.7**	**255.28**	**74.07**	**252.79**	**71.79**	**248.2**	**69.36**	**245.21**	**63.21**	**222.96**	**85.64**	**265.14**	**83.07**
SD	**8.51**	**14.42**	**13.73**	**15.86**	**13.16**	**19.89**	**18.33**	**20.52**	**20.99**	**95.60**	**28.35**	**29.96**	**28.36**

***STH= Standing Height; *SRHT=Successful shot Release Height**
***USRHT=Unsuccessful shot Release Height *JHT=Jump Height**

Table 4:5.3c reveals the ball trajectory mean heights of the players at release and the Jump height in relation to the height of each of the player. The group mean, SD, minimum score and the maximum is also shown by the table (see table 4.5.3c). The minimum score was obtained by Guard 1 and this is the successful mean release height (226cm) differentiates greatly from the group mean (255.28cm) which reveals a great variability between the release height. The SDs also shows that there significant variability between the minimum scores and group mean of both 4.67m and 6.40m shots. This shows that there is no significant relationship between the intra individual release heights but in the group mean.

Table 4:5.3d: Correlation among the Release Height Ratios of successful and unsuccessful shots

N=14	Unsuccessful 2.74m RHR	Successful 2.75m RHR.	Successful 4.67m RHR	Successful 6.40 RHR	Unsuccessful 6.40m RHR	Unsuccessful 4.67m RHR
Unsuccessful .2.74m RHR	1	0.849(*)	0.241	0.678*	0.394	0.319
Successful 2.75m RHR.	0.849(*)	1	0.406	0.742*	0.219	0.270
Successful 4.67m RHR	0.241	0.406	1	0.334	0.048	0.678*
Successful 6.40 RHR	0.678(**)	0.742(**)	0.334	1	0.579(*)	0.457
Unsuccessful 6.40m RHR	0.394	0.219	0.048	.579*	1	0.242
Unsuccessful 4.67m RHR	0.319	0.270	0.678*	.457	.242	1

*significant -0.05 =

The table above (table4.5.3d) shows the correlation between the Release Height Ratio of the participants for both successful and unsuccessful shots Release Height Ratio at the 2.74m, 4.67m and 6.40m shooting distances. Significant relationship was found only between unsuccessful shots and successful shots Release Height Ratio for 2.74m (0.849*) and also between unsuccessful Release Height Ratio and unsuccessful release Height Ratio of 6.40m shots (0.678*).

Discussion

Generally, all the participants' scores at 2.74m (73.67-90.67%), 4.67m (80.0-95.33%), and 6.40m (67.33-80.0%) demonstrate elite and international standard. Their scores were found to be greater than that of the elite and international free throw shooters (78±8 mean) who were studied by Hudson (1982). Of the three national players studied by Button et. al (2006) only the senior player scored 90%. The remaining two shooters scored 70% and 66% respectively. Similarly, on their 5-point scale experiment throwing score for 30 free throws, they scored 114, 116 and 122 in order of performance; whereas, the lowest score in this study for the middle distance score experimental shots were 120 while the highest was 143. The above showed that the participants are highly skilled players in shooting. Apart from Hudson (1982) who studied female shooters in free throw and Elliot (1991), Eddings included only 2 females in his 22 subjects, this is a study that did a comprehensive investigation on the three shooting distances for females. The female compared favourably with other studies.

Tsarouchas et. al (1988) who used accuracy as a strategy to also classify the elite players in their study postulated that the 'good' shooters were those who shot above 80% and the 'poor' shooters were those who shot below 65%. Comparing the shooters in this study to other findings they could be placed as highest skilled players according to Eddings (1996). It was found that the participants performed well in the middle distance shot than the short distance and the long distance shots. This could result because most of the basketball players shoot consistently within this range for the uncontested shot (free throw) and mostly practiced it as penalty shot. It is a well known fact (AAG, 2003,) that basketball players perform well in this shot than the jump shot because it is a closed skill that requires specific consistent segmental angular configuration and velocity and ball projection. It was found that majority of the players release the ball at the same time and could score 10 out of 10. However the performance of guard 3(1^{st}) and 2 (2^{nd}) was not expected in 2.75m shots because they tend to play more at the top of the key rather than at the perimeter which is a common zone for forward and centre players not the guards (see Fig.1, page 12). This demonstrates the effect of practice and training rather than position of play zone. The implication of this to teaching and coaching of upcoming players is that they should be trained to be an all round shooter if excellence must be attained. Though positional adaptation is good, it should not be tailored towards offensive plays in area of shooting to prevent players' potentials being limited.

The findings on the relationship between physical characteristics and shooting accuracy revealed that shooting accuracy does not depend solely on the height and weight of the shooter but it is signifcant for athletic and playing ability of basketball shooting. Though the height and weight of the basketball players have been well documented to be an advantage for higher release height and release height ratio.(Hudson, 1982; Eddings 1996; Miller and Bartlett 1993 &1996), not for prediction of shooting accuracy. Hudson (1974) found that velocity of wrist flexion just prior to release was one of the best predictors. This implies that physical characteristics might be of advantage in reducing the distance of projection of the ball to the basket but does not significantly contributes to the accuracy of the shot since basketball is a game in which body weight, tallness, long limbs are pre-requisites and require specific body types and proportion for positional plays (Okuneye & Osman, 1996; Ackland, Schreiner & Kerr, 1997).

There is a significant similarity between middle distance shot and long distance shots. Several factors are associated with success of any shot at any shooting distance. The segmental angular Displacement (SAD) have been documented (Miller & Batlett 1996) to influence the vertical height that is reached by shooters. The well alligned the upper arm, fore arm ,hand and the trunk segments are, the higher the height of release and the shorter the distance to the basket and the accuracy of the shot.

The linear displacement of the upper limbs is expected to increase from takeoff to release. Shooters are expected to release the ball at the peak of the displacement that is, the Jump. This implies that the ball should be released either prior for shorter shot at the peak of the jump but not after. However, some of the shooters: guard 3, (successful release of shoulder, hand and COM LD3D) forward 2 and 3 (LD3D from shoulder to COM) released the ball after the peak of displacement for 2.74m shots which demonstrates either a brief suspension in the air or trunk.

A good technique of release in basketball shot is expected to be one that the ball linear displacement peaks at release. Rojas et at (2000) observed that displacement of the upper limb segments increase significantly in the presence of an opponent which helps the player to avoid opponent interception of the ball. Other shooters however release the ball either prior to the peak or at the peak of their linear displacement. This indicates that majority of the players tend to release the ball at the peak of their displacement indicating high release point which is expected for good shots. The advantages have been summarized by several scholars; Mortimer (1951), Cooper (1969), Cousy et. al (1970), Brancazio (1981) and Maugh (1981) to include decrease release angle of projection, release velocity of projection and distance to the goal including increase of margin of error.

The take-off generally of the shooters to the release distance varies. This could result because of the differences in mode of approach to the shots which were either from a dribble after a pass, a run to collect the ball and take the shot or stationarily collecting the ball and taking the shot. These factors have implication for take-off and release linear displacement. However,

Another factor could be as a result of training and practice. Rojas et. al (2000) explained further that when shooting against an opponent than without an opponent, even though the height reached by the centre of gravity from the take-off does not increase, a more vertical orientation of the arm at release increases the release displacement. The implication of this in this present study is that, the center of mass followed its normal increase in LD3D but the arm might not have been fully vertically oriented at release. Further more, since the presence of an opponent is a factor of peak linear displacement of the arm or of the upper limb at release, the shooters might not fully extend their arms.

For player 10, displacement increased in almost all the segmental angular prior to ball release, but not after release. This could account for the difference in release time and variability in the shooting parameters since all the players are not shooting from the same space or exact point in space, position and also do not use the same time for take off and release.

Generally, for Joint Angle Displacement (JAD) there was no significant relationship found in the 2.75m JAD displacement of the release of successful and unsuccessful shots release JAD of all the guards except inverse relationship at the take-off of Guard 3 wrist (-0.87>0.811) and Guard 4 shoulder take – off (0.91>0.811). However, the range of the shoulder release JAD among the guards is lower 104.42 ± 21.26 – 117.98±12.26 compared to the guards in Miller and Bartlett (1993) (137± 7.5) and Elliot (1991) and (1992) mean shoulder flexion angle at release of 146* for male and 145* for female. This could be as a result of the physiological as well as the environment in which the data were collected. Miller and Bartlett (1993) observed there could be greater variability in the JAD due to some physiological and special factors that determine joints configuration. The present data was collected during the preparation of the players for West Africa Club Championships and without opponents challenging the shot. In Button et. al (2005) individual analytical study, there was also no significant relationship found in the analyzed free throw shot.

In the middle distance shot, (4.67m) significant relationship was found in the release joint angle displacements of successful and unsuccessful shots of Guard 1, 2, 4 and 5 at the shoulder but not at the elbow and wrist. The JAD of the shoulder and elbow increase from take- off to release while at the wrist the JAD decreased. This relationship could be reproduced as a result of the same distance and its being an uncontested shot unlike the 2.75m and 6.40m shots. In also the 6.40m shot, among the guards only at the elbow of guard 2 and 4 were significant relationship found at the JAD release of successful and unsuccessful shots. Among the 3 groups, similar trends are observed at the JAD at release for both successful and unsuccessful shot except with forward 3 and 10. Though some of the players in the groups had similar shoulder and elbow JAD with the Groups 1, 2, and 3 of Miller and Bartlett’s (1996) study shoulder of the Guards (133± 9; 129±10; 124±8) Forward (133±11; 133±11; 131±5) and Centres (126±9; 121±9;

115±22); the elbow: Guards (142±11,136±13,135±5); Forwards:144±11, 140±13,143±15) and Centres: (141±19, 135±17, 143±14).

Malone (2002) explained that any activity involving projection of an object depends on the goal of the activity; success depends primarily upon velocity or accuracy of projection. In Basketball shooting, the overall performance objective is maximum accuracy (Kreighbaum & Barthels 1996; Miller, 1998; Malone, 2002). Basketball shooting which is entails a push-like movement requires high accuracy. Hay (1993) pointed out that the need to develop high velocities at release. Therefore, the decrease in the JAD of the wrist is to ensure the reduction of force in order to ensure high accuracy. Basketball shooting is a sequential motion of arm segments according to Elliot (1991, 1992) which he found to follow a pattern such as simultaneous flexion of the upper arm at the shoulder and extension of the forearm at the elbow, followed by final movement of the hand at the wrist which is also the common trend found among the participants of this study.

The same trend was found for the 6.40metres shot (long distance shots) shoulder and elbow take-off and release. There were increases in the releases angles from take-off to release of the participants in the wrist JAD. There was also a general decrease at release after take-off for the guards, forwards and centres. This further confirms the statement of Kreighbaum & Barthels (1992) that the need for accuracy far outweighs high velocity.

For Joint Angular Velocities (JAV) of the arm segments, a general trend was observed. There is increase of velocity at the shoulder, elbow and wrist from the time the shot is initiated until take-off, but after take-off, there is a decrease in the JAV until ball release of both successful and unsuccessful shots. The deceleration is however, minimal at the shoulder and elbow but greater at the wrist. The only exception found was in forward 2, (table 4.4.6) where the mostly velocities increase from take-off until release in both successful and unsuccessful shot. However, there is great variability within the velocity of the participants' shots in all the shots. This implies that no particular player can reproduce exactly a shot to obtain the same parameters.

Only Miller and Bartlett (1993) and (1996) have conducted this type of study. Some of the participants in this study fell within the velocity obtained by Miller and Bartlett (1993) group 1 to 3, whose shoulder velocities were 3.04±0.65; 4.71±0.74 and 6.40±0.8 rad.s^{-1} In 1996, they found this result for 2.74m; guards 4.2± 1.9 rad.s; forwards 3.6±1.6 and centres 3.6±1.7. Comparing their result with this study, apart from Guard 1's 2.75m JAV (5.01 ± 4.68) and centre 1 (16.14±3.81rad.s^{-1}) who had higher JAV at the shoulder, other participants had lower JAV than Miller and Bartlett (1993) and (1996) subjects. Guard 2, whose JAV was though lower (2.26±1.41), increased at take off till release. In the 4.67m shot (4.65±0.36) and at the 6.40 m shot (2.70±0.45) JAV, release was lower at release. The lowest velocity was found among the forwards; F4 and F5 who had decrease JAV at the three shooting distances especially at the 2.74m and 6.40m (see tables 4.4.4 & 4.4.5).

At the elbow, Miller and Batlett study groups of 1993 and 1996 had very high JAV compared to all the participants of this study. Only in the 1993 study whereby the guards had lower JAV of 5.28±1.7, forward had 7.51± 1.4 while centres had 8.17 ±1.3. The range of guards for the elbow at release of 1.24±0.34- 4.87±0.37 (2.74m), decreased at 4.67m and ranges between 1.78± 0.50 (G3) and 4.81±0.32 (G1). In 6.40m shots 3.81±0.57 rad.s^{-1} is the highest while 2.25±0.22 rad.s^{-1} (G3) is the lowest. The general trend is higher JAV at take off and decreases at release. At the wrist only G4 (10.25±7.05 rad.s^{-1}) compared favourably with Miller and Bartlett's (1993) forwards and centres of 9.4±0-.4 rad.s^{-1} but not with guards' (11.3±2.9 rad.s^{-1}) wrist velocity. All the forwards and centres of this study had lower JAV than the guards. However, the trend of decrease at take off to release is far more common than the increase at take off. In other studies apart from Miller and Bartlett 1993 and 1996, the JAV were found to be very high in the 4.57m-5m shots (Button et. al, 2006; elbow 1782± 275 º; wrist 2295±233.9º) Miller (2002) study recorded 6.06± 3.11 and 6.30±2.86 for shoulder and 16.49±3.68 and 16.77±3.25 for 6.40m successful and unsuccessful shots respectively. These results proves that there several factors though not studied in this work that may have implication for variability in technique parameters. Kreighbaum and Barthels (1996) explained that the closer the release height is to the height of the basket, the smaller the required angle and velocity of ball projection will be. This could be a major reason for the lower angular velocities of the under studied players.

According to Miller (2002) the expectation that lower variability will be found for successful shots was only realized for the hip and knee among his study group. He confirmed that findings are supported by recent evidence which challenges the wide held belief that skilled performance is characterized by minimization of variability.

Button et. al (2006) highlighted that the generally of observations has recently been questioned as researchers have become increasingly interested in the role of variability in movement co-ordination. So also in order to become skilled at a sport, the shooter must discover how best to coordinate their body movements in a given situation. This process of learning a skill has been described as a gradual release of the rigid control of degrees of freedom and their incorporation into dynamical controllable system (Button et. al 2006; Vereijken, Van Emmerick, Whiting &Newell, 1992). Expert players are expected to move in a more fluid, unconstrained manner according to Bernstein (1967) as reported by Button et. al (2006). The release of degree of freedom, which increases the range of motion about key joints as expected leads to the strong couplings between associated joints being weakened, thus the increase in joint-space variability (Bernstein 1967). Therefore, there is a need to reconsider the general traditional belief whereby movement variability is interpreted as a problem or noise that must be minimized for optimal performance at a given task (Newell & Corios, 1993) rather than attributes of expertise.

From the Dynamical systems perspective, variability is seen as an index of fluctuations that are necessary to allow the movement system to adapt to changing constraints from one situation to the next (Wenderoth & Bock, 2001).

Movement variability is more commonly defined as the degree of change in coordination patterns within and believed trials. Movement variability can be considered at several levels of analysis as done in this study (Vercijken et al 1992; Bootsma & Van Wieringen 1990) and are found to increase with practice. Schollhorn and Bauer (1998) provided an example of how the coordination patterns of elite's athletes can vary during training through a clustering algorithm applied to joint angles and angular velocity data from 2 discus throwers. This findings further question the commonly held view of expert performance being characterized by invariant features at all times.

In this study, the 2.74m mean angle projection of ball release for guards' range is between 41.87° and 60.37°; forwards is 39.20 and 48.86 and centres between 35.48° and 52.88°. Significant variability was found among all the players' 2.74 angle of projection. Apart from G2 (51.82°), whose angle of ball projection fell within the range of other researchers, G1(45.29°), G3 (41.87°) and G4 (44.27°) release angles are lower than the release angles of the participants of other researchers (Miller & Bartlett 1996, Hudson, 1982; Satern, 1988, Hay, 1978; Tsaronchas, 1988) except for Hamilton and Reinschmidt (1997) who had a minimum angle of projection of 38°-48° for free throw shots. G5 also had a higher angle of release (60.70°) greater than what was found by Miller and Bartlett (1992) for guards (55±3°) and in 1996 for guards (48.8±10.1°), forwards (47.8±5.82°) and centres (51.9° ±5.50°) at 2.74m shooting distance. The forward elite players apart from F8 who had a very low release angle (39.20°), all other forwards and centres except C2 (35.84) fell within Hamilton and Reinschmidt (1997) (38-48°) range and of Rojas et.al (2000) study with projection release angle of 45°. However, in Miller & Bartlett's (1993) study, based upon Brancazio's equation, and assuming a release height of 2.75m and shooting distance of 4.57m, they pointed that minimum force required for the ball to reach the basket would be at release angle of approximately 46.5°. Mullaney (1957) recommended an angle of 45 for free throw (4.67m range shot) Mortimer (1951)'s recommended that for a 12ft distance shot (3.66m) little change in velocity is required for angles between 56° and 59°.

From the above release angle of projections of the different findings, this research studied groups are found to fall within one category or the other. Variability in their angle of projection is the normal trend found in all the studies.

Hay (1978) used a mathematical model to obtain angle of entry/ projection for a shot released from a distance of 15ft (4.57m) and a height of 2.1336m and indicated an angle of release between 49° and 55° which provides the greatest tolerance for small errors thus giving the shooter the best chance at success for shots from (10ft -25ft) 3.048m – 7.62m distance from the basket, and release height of (7.5ft) 2.286m (the angle of incline distance from the release height to the height of the hoop), (Brancazio 1981, p361).

Hamilton and Reinschmidt (1997) found that optimum angle of projection was 52º for a free throw released about 4m from the centre of the basket and 2.05m above the floor. Hudson (1982) estimated means and standard error of 52.90º±3.2 for international group of her study of which some of the participants of this study fell within the ranged angle. So also in Satern (1988) study, mean angle of projection for adult male was 52º and adult female 55º which these groups fell within.

Tsarouchas et. al (1988) found mean angles of release for the shooters to be within one degree of 50º and their ball follow the same parabola before and after release.

Elliot and white (1989)'s kinematic investigation characteristics of 10 elite female basketball players shooting jump shots at two distances (4m and 6.25m) mean angle of projection was 52.8º for the 4m shot and 51.1º for the 6.25m shot. Eddings (1996) summarized researchers' absolute mean angles of projection for free throw of adult female as 52-55º, adolescents 49º and other distances for adult women to be 49-53.º These results are not significantly different from the majority of the present study participants' range of for 4.67m 49.32-65.39º successful shots group mean of 54.10±4.93º, and for 6.40m shot 41.41º-61.39º . From various researches projection angles above, variability found in this study does not differ (see table 4.5.1).

From the above premise, it could be deduced that there are other factors apart from the mechanical principles, that influence athletes' techniques and optimal performance. Wadie et. al (2010) opined that performer characteristics like age and strength or environmental factors such as (defence, basket height, ball size) can all influence the critical features of shooting in a specific situation.

Conclusively, Schwark, Mackenzie and Springings (2004) reported that controlling the speed of release was an order of magnitude more important than was controlling the angle of release in terms of making a successful basket. Brancazio's conclusion is that the best release condition would result from using the lowest speed capable of making a successful basket, and it is the easiest the condition for the player to reproduce. The lower the release speed for sequential actions of the muscles coordination, the higher the shot tends to accuracy. This could be the reason for the low velocity that the participants have both in angular velocity and ball velocity projection.

Hay's (1993) mathematical model for the optimal speed and release angle was found to be 7.398m/s and 50.684º respectively. Schwark et.al (2004) explained that the less muscle torque a player has to generate to accelerate the ball, the more consistent the player should be in replicating the optimal release conditions. However, Hubbard, De Mastre and Scott (2001) in their study of optimal release variables for shooting, as reported by Schwark et. al (2004) warned against determining the optimal angle of projection without considering the musculoskeletal constraints of the individual athlete, though the shot put does require maximum effort unlike the basketball shot.

Miller (2002)' s subjects mean release speed for basketball was 3.04m/s-^{1}. This compared with the findings of this study in which the group means for the successful and unsuccessful shots at 2.74m are 3.42±0.90 m/s^{-1}, 3.61±0.833m/s^{-1} and for 4.67m are 3.71±0.652 and 3.55±0.674 while at 6.40m are greater (4.063±1.049m/s^{-1};4.99±0.922m/s^{-1}) than for the2.74m and 4.67m and the that of (Miller, 2002). Gablonsky and Lang's (2005) model of free throw minimum projection velocity was for 1.83m height is 7.02m/s with 54.60º angle of release. The velocity is higher than what was found by this study. Miller and Bartlett's (1993) velocities for group 1 of 3.04±0.65m/s^{-1} group 2 4.71±0.74m/s^{-1} did not discriminate from it unless that of group 3 6.24m/s^{-1} which is higher than this study's participants' projection velocity. The velocity parameters are accompanied by lower release angle which is what was also predominant in this research. The maximum projection velocity increased from take off to release. However, when the projection velocity was analysed individually, significant variability were found between the players. The minimum was 0.99 m/s^{-1} whereby the maximum was 5.39m/s^{-1} and the mean of 3.55±.674m/s^{-1}. The variability showed that individualized analysis gives correct information about the technique of each player. This also applies to all parameters.

Furthermore, segmental angular Displacements and velocities have been well documented to contribute to the speed of the joints and displacement. Due to the greater displacement at most of the segments, less effort is required to produce the effort for ball release. In most of the studies were higher displacements and velocities were found, the segmental displacements were very low. The higher segmental displacements could be one of the factors for lower velocities.

The best way to increase the release height is to raise the body as high as possible by jumping from the floor and releasing the ball close to (but not after) the top of the jump (Miller, 2006). High release point has been established as the characteristics of good shooters (Mortimer, 1951; Cooper, 1969, Cousy et. al 1970; Brancazio 1981; Maugh, 1981; Miller & Bartlett 1993,1996) because it did not only decrease the maximum angle of projection, minimum angle of velocity and increases margin of error, thus increasing the chances of scoring as the height of release is increased.

Kreighbaum and Barthels (1996) explained that the closer the release height to the height of the basket, the smaller the required angle and velocity of ball projection. This could be one of the reasons for the majority of the participants' lower angle and velocity of release. According to Rojas et. al (2000), a lower release angle of 45° may be due to the greater height of the release of the ball, caused by either the greater height of the subject (1.95m, 1.93m) as against the mean of 1.83m recorded on the studies of Mortimer (1951), Brancazio (1981), Hudson (1982, 1985), Satern (1988), Walters et.al (1990), Miller and Bartlett (1993, 1996).

Factors such as shot distance and release height is well documented to affect the optimal release conditions for a shot (Wardie, et. al, 2010; Okazaki, 2007). Gablonsky and Lang (2005) from their model of free throw proved that the taller a player is, the lower the release angles and release velocities thereby having easier time shooting successful shots. So also, the higher the ball is released, the less time it is in the air before reaching the basket and less time for off line velocity to act. Studies have reported that shots of highly skilled players are released higher than those of less skilled players;

and a higher release is related to greater flexion at the shoulder which is desirable (Hudson,1982) and this was established in Hudson's research where successful shots were released at an average of 4cm higher than those that were unsuccessful. Alexander found that at 140-150 shoulder flexion, the closer the upper arm to the vertical, the better the shot because the greater the vertical forces applied to the ball.

Hudson (1982) concluded in her research that a greater ratio of height of release to standing height is related to higher skill while angle and velocity of projection taken independently are not related to skill level. The participants in this study had higher release height (see table 4.5.3 a), and release height ratio than the study of Hudson (1982) (1.31 RHR) indicating their status. Center 1(190cm) and centre 2 (193cm) who were the tallest and therefore were expected to have the highest release height as well as release height ratio (RHR). But this it was not found to be so for centre 2. Center 1 who is next inline however, had higher RHR (283cm), jump height and RHR (see table 4.5.3a-d) as it is expected which is contrary to Miller and Bartlett's (1996) findings where all the centres had lower Release height. The jump height was highest in 2.74m shot and was made by forward 1 (F6) who is of 175cm height (see table 4.5.3c, d). This is however, supported by Gablonsky and Lang (2005) that shorter players have longer distance to cover than taller shooters. Also, the scores on shooters release height parameters were higher than that of Button et. al (2006) elite player of 59.5±0.207cm.

The participants of this study are found to possess better release parameters when compared with other studies. However, the group mean exaggerated the intra score (see table 4.5.3b-d). This tends to hide the true position of each shooter. That is why this study involving individual analysis is of advantage for prescribing corrections and suggestions for athlete's optimal performance (Button and Davids, 1999; Buttton, et. al 2006).

As regards consistent variability that are found in most of the release parameters, Darrick (2003) observed that successful shot is not only the element of mechanical factors but also a product of a person's memory, that is, how they remember how they shoot, from where and with correct angle and velocity, achieved by hours of practice and playing which the players of this study had.

Miller (1996) reported that the slightly greater standard deviation for basketball group (0.79±0.52) compared with Handball group released the ball after the peak of the centre of mass. Ball release prior to the COM reaching its peak has been cited as an aid to the provision of the required release speed, though not a necessary strategy for a short range shots. The joint angular velocities also revealed a general trend of decrease from take off to release with insignificant relationship between the take off and release of both successful and unsuccessful shooting distances of all the participants in the majority of the JAV and SAV. Apart from G1 (5.01 $rad.s^{-1}$) who had higher JAV at the shoulder at 2.74m shots .

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

In recent years, Biomechanical studies have been carried out on shooting of successful shots at various distances and their characteristics. Miller (2002) compared unsuccessful shot with successful shot of male players only at 6.40m and shooting at three distances for male but no study has compared successful and unsuccessful shots at three shooting distances and among guards, forwards and centre players except for successful shooting distances. From my own database search, this is the first of its kind for female basketball players. To date, this researcher has not come across any study in Nigeria on kinematic characteristics of athletes generally and particularly of basketball players and their shooting characteristics. Furthermore, almost all studied players have played at all levels of basketball competitions. This investigation was therefore conducted to determine the kinematic characteristics of arm motion during jump of Nigerian female basketballers.

To achieve this purpose, 14 players of the First Bank of Nigeria Basketball female champions' Club of Lagos was purposively selected to serve as participants while stratified random sampling technique was used to select 15 players and classify these players according to their playing position (guards, forwards, centres). Bio data of the participants were collected using a questionnaire and the participants' height, weight and Body mass index measurements were taken. Also, for accuracy test, 30 shots at three blocks of 10shots for each of the shooting distances (3×10shots×3shooting distances). Videography was used to collect video files on 5 successful and 5 unsuccessful shots for each of these players. Following the video data collection, the video images for each of the players were transferred and stored on a computer as video files with Studio 11 DV software. Each trial was then digitized using The Ariel Performance Analysis system software (APAS, Ariel Dynamics Inc, 1972-2011) for analyzing of human motion was used to process the data. The body angular displacements and velocities and ball projection parameters were obtained for successful and unsuccessful shots. Intra individual relationship was determined between successful and unsuccessful shots at three shooting distances for each of the players. The data collected were statistically analysed to test the hypotheses of the study.

5.2 Conclusions

From the findings of this study, and in view of its limitations, the following conclusions are drawn:

5.2.1 The shooting accuracy of the guards, forwards and centre players at the three basketball shooting distances do not differ significantly.

5.2.2 Physical characteristics of weight and height do not make significant contribution to accuracy of shooting in basketball.

5.2.3 Majority of the female basketball players' linear and angular displacements at take off and release of successful shots did not correlate with those of unsuccessful shots at the three shooting distances.

5.2.4 Intra- variability was mostly the trend displayed in the linear and angular velocities at take off and release between the successful and unsuccessful shots at the three shooting distances among the female basketball players.

5.2.5 Successful shots ball take off and release projection parameters of the guards, forwards and centre players' were not significantly related with take off and release angle, release height and release velocity of unsuccessful shots.

5.3. Recommendations

On the basis of the findings of this study, the following recommendations were made: That

5.3.1 since intra trial analysis gives the true position of each female basketball player's status, therefore, Basketball players should be evaluated using intra trial study rather than inter trial in order to enable individualistic approach to teaching, learning and improvement of skill and techniques of shooting for optimal performance.

5.3.2. As researches are confirming the insignificant relationship between players shooting parameters at all levels as also found in this study, player's physical disposition should be considered when techniques of skills especially shooting are taught rather than just established and generalized coaching points. This will assist go along way for the player to develop a pattern consistent to his/her own potentials and physiology.

5.3.3 Basketball players should be encouraged to shoot from all positions on the court during training/practice and should be trained to be all round cum all situational shooters. This will not allow the players to be constrained to their perimetre and further gives room for dynamism in shooting.

5.3.4. Since height of release and its ratio has implication for ball trajectory and accuracy, players jumping ability should be developed in relation to shooting. Shooting pattern should be simulated so that Players could use minimal release angle, release speed and higher release height for optimal shooting success.

5.3.5 Gender may not be a factor of discrimination in shooting accuracy parameters. Therefore, shooting practice/training should be based on individual disposition and equal time or chance should be given to develop good technique and strength of shooting accuracy for optimal performance.

RECOMMENDATIONS FOR FUTURE RESEARCH

In the course of this research, the investigator, experienced in adequacy in studying human motion especially basketball shooting without considering the physiological make up of the human system and determinant factors affecting the human system performance. Therefore, from these experiences, some problems are identified for future research and are stated below.

5.3.6 As there is inconclusive evidence about the relationships between shooting and biomechanical characteristics for optimal performance, studies are needed to find out:

a) Relationship between physical fitness and shooting dynamics

b) Relationship between body anthropometry and shooting accuracy

c) Differences between male and female shooting techniques since both are genetically and physiologically different.

5.3.7 Available evidence suggests that height of release ratio has advantage for ball trajectory and successful shooting accuracy. Therefore, more researches should be conducted on the plyometric programme that could develop the jump ability of basketball players and accuracy shooting configurations.

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Appendix I

The optimum trajectories for people of various heights.

Height	**Height**	**Release angle**	***Release velocity***	**Max error 0**	**Max error v_o**
5’	1. 52 m	56. 64′	7. 34 m / s	2. 08′	0.0.538 m / s
5’1”	1. 55 m	56. 47′	7. 32 m / s	2. 09′	0.0542 m / s
5’2”	1. 57 m	56. 13′	7.29 m / s	2. 11′	0.0547 m / s
5’3”	1. 60 m	56. 14′	7. 26 m / s	2. 13′	0.05551 m / s
5’4”	1. 63 m	55. 97′	7. 24 m / s	2. 15^0	0.0555 m / s
5’5”	1. 65 m	55. 80′	7. 21 m / s	2. 17^0	0.0560 m / s
5’6”	1. 68 m	55. 63′	7. 18 m / s	2. 18^0	0.0564 m / s
5’7”	1. 70 m	55. 45′	7. 16 m / s	2. 20^0	0.0568 m / s
5’8”	1. 73 m	55. 28′	7. 13 m / s	2. 22^0	0.0573 m / s
5’9”	1. 75 m	55. 11′	7. 10 m / s	2. 24^0	0.0577 m / s
5’10”	1. 78 m	54. 94′	7. 08 m / s	2. 26^0	0.0581 m / s
5’11”	1. 80 m	54. 77′	7. 05 m / s	2. 27^0	0.0585 m / s
6’	1. 83 m	54. 60′	7. 02 m / s	2. 29^0	0.0590 m / s
6’1”	1. 85 m	54. 43′	7.00 m / s	2. 31^0	0.0594 m / s
6’2”	1. 88 m	54. 25′	6. 97 m / s	2. 33^0	0.0598 m / s
6’3”	1. 91 m	54. 08′	6. 95 m / s	2. 35^0	0.0602 m / s
6’4”	1. 93 m	53. 91′	6. 92 m / s	2. 36^0	0.0607 m / s
6’5”	1. 96 m	53. 74′	6. 89 m / s	2. 38^0	0.0611 m / s
6’6”	1. 98 m	53. 57′	6. 87 m / s	2. 40^0	0.0615 m / s
6’7”	2. 01 m	53. 40′	6. 84 m / s	2. 42^0	0.0619 m / s
6’8	2. 03 m	53. 22^0	6. 82 m / s	2. 43^0	0.0623 m / s
6’9”	2. 06 m	53. 05^0	6. 79 m / s	2. 45^0	0.0627 m / s
6’10”	2. 08 m	52. 88^0	6. 76 m / s	2. 47^0	0.0632 m / s
6’11”	2. 11 m	52. 71^0	6. 74 m / s	2. 49^0	0.0636 m / s
7’	2. 13 m	52. 54^0	6. 71 m / s	2. 50^0	0.0640 m / s
7’1”	2. 16 m	52. 37^0	6. 69 m / s	2. 52^0	0.0644 m / s
7’2”	2. 18 m	52. 20^0	6. 66 m / s	2. 54^0	0.0648 m / s
7’3”	2. 21 m	52. 02^0	6. 64 m / s	2. 55^0	0.0652 m / s

(Curled from Gablonsky & Lang, 2005)

Appendix II

DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION.
AHMADU BELLO UNIVERSITY,
ZARIA.

CONSENT FORM

I, the undersigned subject voluntarily agree to take part in the study. As part of the said study, I understand and agree that during participation, complication may arise, if I am not tolerating work well, it usually becomes necessary that exercise can be stopped by my decision or that of the investigator or her representative. Other risk, in addition to dizziness, nausea, vomiting or even fainting may occur during participation but rare. The video recording may also be used for further educational purposes.

Participant's Signature: _________________________

Date: ____

Witness name: ________________________________

Signature: ____________________________________

Date: ____

APPENDIX III

DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION

AHMADU BELLO UNIVERSITY, ZARIA - NIGERIA

(OFFICE OF THE HEAD OF DEPARTMENT)

Vice Chancellor: Professor Shehu U. Abdullahi, DVM (ABU) Ph.D (Min) FCVSN, FIMC, mni
Head of Department: Dr. A. I. Kabido, B.Ed., M.Ed., Ph.D. (ABU), AMNIM

12th July, 2007.

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Dear Sir/ Madam,

A LETTER OF INTRODUCTION

DOMINIC, Olufunmilola Leah (Mrs.) is a Ph. D. student in this department. In partial fulfillment of the requirement of her Doctoral programme in Exercise and Sport Sciences, She is conducting research on Kinematic characteristics of Arm- Motion of Jump Shot in Basketball.

In this regard, video-recording of players jump shot is required to collect data needed for analysis.

In view of the exceptional performance of your team in National/International Competitions, your Team/ Players have been chosen as subjects for the research.

The Department shall be much delighted if she is given the needed assistance and cooperation in this regard.

Thank you.

PROFESSOR M. A CHADO
MAJOR SUPERVISOR

APPENDIX IV

PERSONAL INFORMATION DATA (BIODATA)

Confidentiality is highly ascertained. Instruction: Respond as necessary

NAME (optional)..

CLUB/TEAM:

AGE: ___________________________

POSITION: Guard ( ) Forward ( ) Centre ( ) Coach ( )

1) What year did you start playing Basketball?...

2) Your first competition and the year..

4) Year(s) of experience:..

LEVEL OF PLAY/EXPOSURE: Tick (√) as necessary

National:	**International:**	**Intercollegiate:**
Junior ( )	**Junior ( )**	**NSSF ( )**
Senior ( )	**Senior ( )**	**NUGA ( )**
Sports Festival ( )	**All African Games ( )**	**NATCEGA/NIPOGA ( )**
League-Division:	**Olympic Games ( )**	**WAUG ( )**
One ( )	**Others ……………………………………….**	
Two ( )	**..**	
Three ( )	**..**	
Professional ( )		

COACHING CLINICS ATTENDED

.1.. YEAR.......................

2.. YEAR........................

3.. YEAR.......................

4.. YEAR.......................

5.. YEAR.......................

CLUBS/TEAM PLAYED FOR

1.. YEAR.................

2.. YEAR.................

3.. YEAR................

TRAINING SCHEDULE PROGRAMME.

Year-round: YES ( ) NO ( ) Monthly: YES ( ) NO ( ) Weekly: YES ( ) NO ( )

TIMES OF TRAINING	**In a Week:**	**In a Day:**
	i) 5 days per week ( )	**i) Once a day ( )**
	ii) Weekends ( )	**ii) Twice a day ( )**
	iii) 3 days per week ( )	**iii) Alternate days ( )**

General comments:……………………………………………………………………………….

………………………………………………………………………………………………………..

APPENDIX V

Basketball Scoring sheet

SR. NO	NAME OF THE PLAYER	POSITION	2.74m				4.67m				6.40m			
			10	10	10	30	10	10	10	30	10	10	10	30