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BIOMECHANICS OF LONG JUMP. ANALYSING BIOLOGICAL FACTORS THAT CONTRIBUTE TO JUMP DISTANCE.

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HONORS DEGREE IN BIOLOGY EDUCATION

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DEDICATION

This study is dedicated to countless athletes who have dedicated their lives to the pursuit of long jump excellence. Their passion and determination has been a source of inspiration throughout this study. The paper is also humbly dedicated to coaches and trainers who tirelessly work to develop the next generation of long jump athletes. To my family, dear friends and colleagues I am thankful for all the encouragement you have given me.

ABREVIATIONS / ACCRONYMS

HBSCED- Honours Bachelors Science Education Degree

ABSTRACT

1.1 Abstract:

This study aimed to investigate the Biological factors contributing to better long jump performance. The study topic looked at Biomechanics of long jump performance, concentrating specifically on Anthropometric biological factors that contribute to long jump distance. Prior research has indicated that Anthropometric body measurements and characteristics can have significant role in improved long jump performance. The study sought to answer the question on which key biomechanical biological factors contribute to long jump performance in Zimbabwean long jumpers in Chegutu district. The contribution of biomechanical factors to long jump performance in relation to Biology was explored and answered. The use of modern technology in improving performance proved helpful. The use of biomechanical knowledge and anthropometric measurements to optimise performance proved valuable. The study population was from seven urban and peri-urban schools in Chegutu district in Mashonaland West. Stratified sampling was used followed by purposive sampling, targeting a specific population. Interviews, questionnaires, tests and observations were used to carry out the study. Data was analysed and presented in form of tables, line graphs, pie chart, and frequency distribution tables and percentages. The study employed a mixed-methods approach, incorporating both quantitative analysis of student jump distances in relation to body anthropometric measurements and qualitative interviews with both long jump coaches and athletes. Contributing factors which were explored included; body height, body weight, muscle mass, Leg limb length, and joint range of motion. The study recommended that future research to develop in-depth case studies of selected athletes to show the interplay of biological factors and biomechanics in long jump performance. Diverse athletes with varying anthropometric characteristics can also be recruited in future research to improve understanding and inform training practices. Training interventions and conditioning programmes as well as biological variables can be employed in future to enhance understanding of optimal long jump performance. Other factors like Physiological and environmental influences can also be looked at. Based on the findings, the research identified and evaluated potential interventions to improve long jump performance. Strategies which were considered included strength training, flexibility training and nutrition. The results of this study were expected to provide important insights to long jump coaches, athletes, scientists and equipment designers in order to help improve long jump performance in Zimbabwean long jump athletes. The findings could also inform similar efforts in other developing country contexts to help take long jump to higher levels.

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Chapter 1: INTRODUCTION

1.0 Chapter introduction

The chapter introduces the concept biomechanical Analysis of long jump technique from a global perspective and races is development. It also highlights the statement of the problem. Research objectives and research questions, significance of the study, assumptions and definition of key terms. This project will analyse long jumping techniques and factors that add to jump distance. The study aims to investigate biomechanical aspects of long jumping technique relating to biological factors.

1.1 Background to the study.

The global evolution and development of long jumping is quite an interesting phenomenon. The origination of long jump is attached to ancient Greece, where it is believed to have been used as an exercise for military training. According to Marlon (1984), the first modern long jump competitions were held as part of the first modern Olympic Games in 1986 in the Athens, the capital City of Greece. Evolution and improvement of long jumping technique have been influenced by the advancement in sports science, technology coaching methods and analysis of biomechanics. Coaches and athletes have refined and developed various techniques to improve distance and efficiency in long jump. There was improvement to hitch kick technique from a style known as the scissors where legs moved in scissors like manner at take-off. Each technique had a more efficient and fluid movement and allowed athletes to extend their flight phases and optimise distance. Later on the athletes realised the need to develop speed and power to generate momentum for the jump and so they had to incorporate strength training, sprinting and plyometric exercises to improve explosive power and speed. They also introduced resistance training and sprint mechanics as well as power development drills to achieve greater velocity at take-off. The approach run came into play and the athletes refined their approach to generate maximum speed while maintaining control and rhythm. .Approach run emphasised stride frequency, length and number of steps taken before take-off.

Video analysis and motion tracking technologies came into use, and they aided the evaluation and improvement of their approach, athletes then began to employ various take-off techniques like the hang, which involved extending the legs forward during flight to maintain balance and control.

Sail technique was later introduced, and this involved extending the legs backward in a sweep Motion to increase the horizontal distance coverage during flight. Techniques are still being improved, basing on the athletes individual strength and biomechanics of landing and pit work have also been improved with pits now being constructed with more softer and energy absorbing materials such as foam or airfield chambers to reduce impact on athletes during landing. Technological advancements have been significant in long jump evolution, there has been the introduction of technology such as runways with force plates, (Bosch and Dessing 2007) to help in the analysis and improvement of performance. The use of high speed cameras, motion capture systems, and force plates have allowed coaches and athletes to analyse and quantify various jump aspects and the data obtained has helped identify areas of improvement and thus helped in refining technique and improving training methods. Studies on optimal body position angles and forces have been made and this has helped in developing training programmes, refined technique and optimised performance. The long jump competitions have evolved over the years to include different techniques and approaches (Bezodis and Barrett 2018).

Some of the notable long jumpers over the years include Carl Lewis. Bob Beamon and Jesse Owens. In 1968, Bob Beamon set the world record with a jump of 8.9 metres, which stood for 23 years. Currently, the world record for long jump, which stands at 8.95 metres, is held by Mike Powell of United States in 1991 Olympic Games in Barcelona, Spain (Powell 1992). It has been difficult to break this long jump record and hence the need to look into long jump biomechanics in order to get in-depth knowledge for training, performance optimization and injury prevention. Biomechanics being a scientific area, helps in studying how anatomical structures such as muscles, tendons, bones, joints work together to generate force and motion needed for excellent jumps.

Techniques used in long jump have evolved over time due to the gaining of better understanding of the biomechanics of the sport by both the coaches and the athletes. Some other changes in the biomechanics of long jump include the adoption of the penultimate step, which is the last step before the athletes take off from the board. The penultimate technique gained popularity in the 1980s and was influenced by the success of athletes who used this approach Such as Bob Beamon and Carl Lewis. It became a standard and it is advantageous in that it allows the athletes to maintain a more upright posture during the jump, resulting in an excellent jump. There is also the discovery of centre of mass and angular momentum. Longitudinal and horizontal velocities in take-off angle and height, (Wright and Daanen 2014). Kilding and Roger (2010) say the run and jump approach that involves accelerating into the penultimate step, then taking a shorter final step and jumping from the take-off board began in the 20th century, as purpots Harris and Shough Nessy (2002). Steele, Causer, Bourne and Warburton (2004) Point out that this technique is allowed for a more powerful take-off and a longer jump. according to Harris and Humphries (2000) the use of starting blocks to allow a faster start, in a more explosive first few steps and became more pronounced in the 1970s. There have been developments with regards to the use of motion capture systems and force plates for a detailed analysis of the jump including the take-off angle height and force. This made it easier for more objective analysis of the jump. It has also resulted in the better understanding of factors that impact jump distance. In addition there has been the use of video analysis to allow the review of jumps and help the athletes identify areas they need to improve as propounded by, Mutsuo, Kurokawa and Takata (2011), (Hendrick 2007). Another Interesting development in jump techniques has been the use of psychological training in which many jumpers use mental imager in visualisation techniques to improve their performance (Kirschenbaum and Izzo 2006) and (Feltz and landers. 1983). Here, the athlete imagined themselves performing the jump perfectly to help them improve their confidence and focus.

Long jump is a field that consists of sprinting on the runway, take off on a wooden board, flighting through air and then landing in a sand pit. This athletic event requires speed, power and technique combination in a bid to achieve optimal performance. Biomechanical analysis, curtails investigating forces, motions and joint actions contributing to optimal performance. Biomechanics is an important part in making one understand and enhance or improve athletic performance. Biological factors contributing to long jump performance are musculoskeletal system, anthropometry, and neuromuscular coordination and energy systems.

1.2: Statement of the problem

Long jump is a field and track event in which competitors attempt to jump as far as possible from a running start. The biomechanical factors that influence long jump distance include take of angle, Height and speed of the athlete. Also of biological consideration, is the exploration of how biological factors such as muscle function and anatomical structures and physical attributes impact on long jump performance? This project seeks to investigate the human skeletal system and Anthropometric measurements in order to give an understanding on human optimal movements, leading to formation of proper training programmes to enhance optimal performance. There has been lack of knowledge on how the anatomical structures such as muscles, tendons, bones and joints work together to generate force and motion needed for great jumps. Coaches and athletes had a knowledge gap on how to take advantage of anthropometric measurements such as muscle mass, leg limb length, body height, body mass to optimise long jump performance. Biological factors in long jumping can be optimised in order to achieve maximum distance so as to help in contributing to the success of the long jump sport, (Zijian Shang 2022) and (Mizera 2002),for example in developing countries such as Zimbabwe.

1.3Research Objectives

1.3.1 Main objective

The main objective of this research is to analyse the bio mechanics of long jumping technique and to identify key factors that contribute to long distance.

1.3.2 Specific objectives.

To analyse the key biomechanical factors in relation to biology, that contribute to long jumping success.

To examine if these factors differ between male and female long jumpers.

To determine the role played by modern technology in improving performance in long-jump techniques.

To analyse how coaches can use biomechanical knowledge and anthropometric measurements in order to optimise the performance of long jump athletes.

1.4: Research questions

What are the key bio mechanical factors that contribute to success in long jumping technique and performance in Zimbabwean long jumpers in Chegutu district?

How do biomechanical factors in relation to Biology, contribute to improved performance in long jumpers?

How is modern technology helping in improving performance in the long jump technique?

How can coaches use biomechanical knowledge and anthropometric measurements to optimise the performance of long jump athletes?

1.5: Significance of the study.

There are several factors why the study is significant. First, the knowledge of biomechanics can be used by coaches to develop training programs that can help athletes to achieve success in the long jump technique. Biomechanics knowledge enables examination of anatomical role factors like limb length, body mass, body height, joint range of motion and body proportion. These variables can influence the athlete's ability to generate speed. Control body positioning and optimising force application during the jump. This poses implications for training and performance enhancement. Secondly, the knowledge of biomechanical factors that affect long jump distance can help support talented long jump athletes to achieve their goals. Coaches, trainers and athletes can utilise findings to tailor programs that cater for specific biological factors related to long jumping. This study can also significantly contribute to advancement of the sport and also understanding human's skeletal movement and muscles activation systems or patterns, anthropometric body measurements and how to develop them for optimal performance. The study can also help in injury prevention, technique optimization and development of targeted strength and conditioning. It will also enhance understanding of human movement capabilities, as well as physical activities that require explosive lower limb movements.

1.6: Assumptions of the study.

The researcher makes the assumption that the athlete's technique such as the athlete's strength, speed and flexibility, joint range of motion as well as anthropometry (Body mass limb length and muscle distribution) are the most important factors in determining the distance of the jump. Environmental factors such as wind, conditioning and the athlete's mental state on the day of the jump are not considered important. The researcher also assumes that biological factors like muscle function, anatomical structures and physical attributes also have a major role in determining jump distance.

1.7.0: Limitations of the study.

1.7.1: Environmental factors.

Long jump is typically performed outdoors on a track or sand pit, where environmental conditions like weather, surface condition, and wind may influence the biomechanics of the jump. A laboratory setting or a specific surface may be used in conducting the study, and this may not fully mimic the real world conditions for competitive long jump. Variations can influence jump performance and hence factor in variability data.

1.7.2: Ethical considerations.

Use of invasive measurement techniques or a potential risk of injury during data collection may limit the scope or methodology of the study. Biomechanical analysis involves collecting data through invasive procedures like attaching markers to the body, Inserting needles for electromyography or using force plates. These pose discomfort or risk, injury or infection to participants.

1.7.3: Equipment limitations.

High quality motion capture equipment is often expensive, and access may be limited. This can restrict the number of participants that can be studied. Outdated equipment can also limit the study's ability to capture and analyse biomechanical data more accurately and clearly (Hunter et al 2014).

1.8: Delimitations of the study.

The study focuses on long jumpers, enrolled in secondary schools in Chegutu district of Mashonaland West Province in Zimbabwe. This is mainly because the researcher works as a teacher in Chegutu district; hence it is cost effective to use these schools. The biological techniques and movements involved in long jump by athletes in schools will be analysed. Biological characteristics of Zimbabwean long jump athletes in Chegutu district in Mashonaland West will be explored in connection with biomechanics of long jump techniques. Factors like muscle strength, flexibility and atomical variations and body composition will be exploited to relate their contribution and influence to long jump performance. Techniques employed by Zimbabwean athletes in Chegutu district will be looked at. Aspects like body positioning stride length, take off angles and landing mechanics will be examined. Tape measures, stop watches and body markers will also be used to collect useful data on the long jump technique.

1.9 Definition of terms

This section briefly defines the terms biomechanics, long jump and jump distance, which are key to the research study.

1.9.1: Biomechanics.

Biomechanics of long jump is the scientific study of the mechanics of long jump, which includes analysis of the forces acting on the body during the jump such is gravity, inertia and force of the ground (Komi 1997) and (Nubler and Dorge 1985). Previous studies also mentions the study of movements of the body, such as angles of the limbs and velocity of take-off. With the goal of understanding how these factors affect the distance of the jump. However, Komi (1977) defines biomechanics as the study of biomechanical laws of human movement, Nubler and Dorge (1985) specifically posit that, it is a study of the mechanics of long jump. For this study, the specific definition by Nubler and Dorge (1985), is adopted as it relates and resonates well with physical laws of long jump.

1.9.2: Long Jump

Long jump is an event in which the athlete must sprint to a maximal velocity in the first half of the approach, then leaps as far as possible into a sand filled pit, (Komi 1976). To Wilmore and Brown (1992), long jump is an explosive dynamic movement that involves a horizontal projection of the body. On the other hand, Maass and Kruger (2004), advance the definition of long jump as a sequence of movements in which one starts with extensional posture, and in the following three phases, executes a run up and a jump and lands in a prepared area, which normally is a sandpit. Long jump in simple terms is therefore a sprint leading to a horizontal jump into a sand field pit from the take-off position.

1.9.3: Jump distance

Jump distance in the long jump refers to the horizontal distance travelled from the starting line to the point where the athlete lands in the sand pit, taking into account the angle in which the athletes takes-off and the horizontal speed at take-off, (Chaplin Turner, and Hubbard 1989), On the flip side, Sterzing and Hell (1990), view long jump distance in long jump as the horizontal distance between the take-off mark and the landing mark based on the assumption that the athlete leaves the ground at the take-off mark and lands at the landing mark. Put simply, jump distance is the distance in metres that measures how far an athlete lands in the landing area from the take-off board or position.

1.10 Chapter summary.

The chapter traced the evolution of long jump from the first Olympic Games held in Athens, Greece in the 19th century and in 1896 to be precise. It also highlighted how the biomechanics have evolved over time in order to set the tone for the current study. The statement of the problem, research questions, research objectives, assumptions, significance of the study were also advanced. Lastly, the chapter gave a brief definition of the key terms namely biomechanics, long jump and jump distance.

Chapter 2

Literature Review

2.0: Chapter introduction

The purpose of this chapter is to provide a review of literature on the development and improvement of long-jump distance. The chapter also discusses the previous research studies and gives a summary of the chapter. In this literature review, there is examination of the biomechanical analysis of long jump focusing mainly on the relationship between biomechanics and biological factors. Long jump requires a combination of speed, power and technique for maximum distance achievement (Yamauchi T, Ishi V 2007). Comprehending the usefulness of biological factors to long jump performance is paramount for optimising training strategies and Enhancing athletic outcomes by reviewing existing research, the study aims to identify key biological factors that influence long jump performance and interactions with biomechanical parameters.

Long jump, an event combining speed, power and technique tests the ability of an athlete to jump for distance, covering the greatest horizontal distance possible by leaping from a designated take-off point. The equipment used is runway, which is usually synthetic or natural material, straight level path leading to take off area, take-off board, usually a small wooden or plastic board embedded in the runway, serving as a starting point for the jump. Lastly, the landing area, which is a sand pit with soft landing surface, which absorbs impact and prevents injuries as Purports Jones et al (2020). The procedure for long jump is approach run, which is printing down the runway to generate speed for take-off, Followed by take-off, where the athlete takes off on one foot. Then the flight phase follows where the athlete goes through a hang phase with the body extended and parallel to the ground, and the arms maintain balance and generate a forward momentum with the legs being brought forward, so that they land in the pit with the feet first, (Yamauchi, et al 2007). Landing is next and the measurement is taken from the take-off line to the nearest mark made in the sand by any part of the athlete’s body. Key techniques in long jump are speed and power; take-off technique, flight position and landing. Speed and power is crucial as the athlete needs to develop speed and explosive power during take-off. During take-off the athletes must coordinate their steps, arm movements and body position to achieve optimal take-off angles and maximise distance. Streamlining the body position during flight is essential as the body is kept as horizontal as possible to minimise air resistance. When landing the athlete should aim to land with their feet first, digging into the sand and minimising backward movement. Biomechanical analysis is crucial in understanding performance as it helps in technique evaluation, performance optimisation, injury prevention, equipment optimization and talent identification.

2.1: THEORATICAL FRAMEWORK

Biomechanical analysis of long jump has an important role in providing comprehension of the complex movements as well as forces involved in long jump, that help coaches and athletes in optimising performance as well as helping equipment developers in designing proper and efficient equipment that promote optimum performance and provide accurate measurement instruments. Hunter et al (2014) says biomechanical analysis of long jump in relation to biology is a combination of mechanical aspects of the jump and the biological characteristics of the athlete’s body. It unfolds how structural and functional characteristics of the human body influence long jump performance. In relation to movement patterns. The anthropometric and morphological factors is a theoretical framework that says an individual's body size, limp proportions, muscle tendon, architecture can influence the biomechanics and performance capabilities in the long jumping which can be analysed within the framework of human biology and evolution. According to Arampatzus et al (2011) the lower limb muscles which are the strongest that is quadriceps, hamstrings and calf muscles help in generating propulsive forces for taking-off.

Tendon and ligament elasticity impact on the storage and release of elastic energy during the jump. This relates to the stretch shortening cycle framework, which is a crucial concept in muscle tendon mechanics. Where the pre-stretching of a muscle turned on unit (eccentric phase) is followed by an immediate shortening (concentric phase). In long jump, the stretch shortening cycle is observed in the take-off phase, where the leg muscles are first stretched during the lowering of the centre of mass and then rapidly contracted as necessary propulsive forces are generated.

The purpose of biomechanical analysis of long jump is to bring an understanding that skeletal structure and joint characteristics of the athlete is crucial in long jump. Length and limb proportion can affect the athlete's leverage and mechanical advantage at take-off in landing as underpinned by Arampatzus et al (2011), The range of motion and joints as well as stability facilitates optimal body positioning and force absorption at landing. Biological factors like muscle mass, body fat percentage and body segment length impacts the centre of mass and the centre of gravity and then a fixed balance and stability throughout the jump. The kinetic chain theory, taking a look at Newton's laws of motion under pins the idea of being able to exert force, accelerate and maintain balance basing on the muscular and neuromuscular systems governed by biological processes at Ramdan et al (2019). Newton's law of motion theory explains how the movements and forces generated at a part of the body are transmitted through a series of interconnected segments (The kinetic chain) to influence the movements in other parts of the body. In long jumping, the kinetic chain from the ground reaction forces, through the lower limbs, trunk and upper limbs is crucial for generating the necessary power and technique for an optimal jump.

Knowledge of biological aspects of long jump biomechanics, is crucial as it helps in optimising performance and reduces injury risk. Coaches and athletes can create training programmes that sharpen specific physiological attributes, critical for long-jump success. Individualised techniques and strategies are guided and this improves biomechanical strengths.

Biomechanical analysis of long jump involves application of principles and methodologies of biomechanics to study movement patterns force and joint actions encompassed in performing long jump and these are;

2.1.1:Kinematics

This principle analyses motion using high speed cameras, motion capture systems and video analysis software to capture and analyse movement patterns in long jump. Kinetics focuses on forces acting on the body during long jump movements, for instance, ground reaction forces, joint forces and moments at Witek et al (2020). Force platforms are also used to assess ground reaction forces during each phase of long jump. Understanding how forces are generated and distributed throughout the body, can help identify areas of high stress or potential risk of injury. It can also provide an insight into the efficient use of energy for maximising performance.

2.1.2: Electromyography

This methodology measures electrical activity of muscles during movement and provide insights into muscle activation patterns and timing like in a study by Bezodis et al (2017). Surface electrodes are placed on specific muscles to record and analyse muscle activity during the different phases of the long jump, thus help in identify optimal muscle activation sequences and coordination patterns. Muscles Involved in generating propulsive forces and absorbing impact are identified and the information guides coaches in optimising muscle recruitment strategies for enhancing performance.

2.1.3: Three dimensional motion analysis

This methodology is used where both the movement is captured in three dimensions. Here reflective markers are placed on specific anatomical landmarks and multiple cameras track the position of these markers to reconstruct movement in three dimensional spaces, for example, in an experiment by Linthorne (2017). This enables precise measurement of drained angles, segment velocities and body position during the jump.

2.1.4: Biomechanical models and simulations

Simulations, simulate forces, joint torques and muscle activations involved in the jump. The models can be used to predict effects of techniques, modifications or training interventions.

2.2: Comparative analysis

This is made use of by comparing techniques of elite jumpers to identify similarities and differences. This can help uncover biomechanical principles linked to optimal performance, and hence help in guiding training and technique development. Comparative analysis can also be done between female long jumpers and male long jumpers and this guides development of training programmes accordingly. The comparisons help in pinpointing areas of improvement and guiding athletes and coaches toward more effective programmes.

Biomechanics play a crucial role in identifying factors that contribute to optimal long-jump technique and performance.

2.2.1: Factors: Variables

2.2.2: Equipment and Experience

Studies in biomechanical analysis of long jump technique in relation to biology have been conducted in different locations around the world, in different populations and contexts globally. Some common locations where studies of biomechanical analysis of long jump were conducted include, High performance training centres were we find elite or high performance athletes. These provided a conducive environment for biomechanical analysis due to availability of advanced equipment and expert coaching staff. Many Biomechanical studies were also conducted in Universities and research Institutions where researchers have access to laboratory facilities and equipment. The studies involved college or university athletes as well as recreational and semi-professional athletes. National and international competitions also provided a stage for Biomechanical analysis of long jump for instance, National championships, Olympic Games or World championships and so researchers had the opportunity to collect data from a diverse range of athletes representing different countries or regions. Some researches focused on athletes who train at local athletics clubs or organizations. Such studies focused on examining the biomechanics and biological factors of long jump technique in a specific community or region.

2.2.3: Knowledge Gap

Long jump technique biomechanical analysis is relevant in addressing lack of knowledge on how anatomical structures such as muscles, tendons, bones and joints work together to generate force and motion for successful jumps. By integrating biomechanics in the study of long jump technique a gap can be bridged between the anatomical structures and their functional role in Generating force and motion. Biomechanical analysis provides quantitative measurements of joint angles, forces, torques and muscle activity during long jump hence provides a detailed understanding of how anatomical structures contribute to performance. For example, Researchers can determine specific muscle groups involved in generating power during take-off, the joint angles that optimize force production and the timing of muscle activations for efficient movement according to Juszczyk, Wozniak, Gluszek (2021). This underlines principles underlying successful jumps and gives insights into coordination and interaction of anatomical structures. Biomechanical analysis allows exploration of individual variations in long jump technique, by considering unique anatomical characteristics of athletes like limb lengths, muscle strength, and joint flexibility. This helps researchers understand how these influence force generation and hence formulate personalized training approaches that capitalize on the athletes specific biomechanical attributes leading to improved performance.

The knowledge gap to be bridged is to bring an understanding on the influence of biological factors on long jump performance. Investigating how various biological factors like muscle strength, power, flexibility, anthropometric measurements, neuromuscular coordination and energy systems affect the execution and efficiency of long jump technique. The relationship between these biological factors and the mechanical aspects of the jump, such as take-off velocity, jump distance and landing mechanics will be explored.

2.3: ISSUES

Several studies on the biomechanical analysis of long jump have been conducted, including;

2.3.1: kinematics and kinetic

Jürgen Fritsch (2010) utilized motion capture technology and force platforms to measure movement characteristics (kinematics) as well as forces and torques (kinetics) involved in long jump. His findings focused on identifying key factors contributing to successful long jumps like the approach run, take-off technique, and flight mechanics as well as landing strategies. He was able to identify optimal movement patterns and provide insights into how athletes can improve their performance by studying the biomechanics of elite jumpers. His findings influenced coaching practices and training methodologies in long jump sport and provided insights into optimal coordination of lower limb movements, helping athletes and coaches to better understand biomechanical aspects of the event and optimizing their training strategies. : Smith, et al (2019) also investigated muscle activation patterns of lower limbs during different phases of long jump. Electromyography data was collected from athletes performing the long jumps and the study revealed important information about the necessity of muscle recruitment patterns, coordination and timing in relation to jump performance. Alain Gillet (2010), looked at the influence of footwear characteristics on long jump performance. He analysed factors like shoe design, cushioning properties and traction patterns and looked at how these influence take-off, stability during flight and landing efficiency during long jump. Footwear seems to play a crucial role in maintaining stability of the long jumper during approach run and landing mechanics. The Kinematics and kinetics variables according to the studies proved to have a notable contribution to long jump technique. Wang, et al (2017), in his computational studies developed a biomechanical model to simulate and analyse the long jump performance. He combined data on athlete characteristics, environmental factors and mechanical issues and provided a clear understanding of complex interactions that influence long jump. Brown, et al (2016) investigated biomechanical factors contributing to injury risk in long jump. He analysed landing forces, joint angles and muscle loading patterns and hence identified key factors associated with common injuries like ankle sprains, knee injuries and stress fractures. Results from the analysis of the studies show that muscle activation patterns play a significant role in long jump performance.

2.3.2: Force Platforms

Erica Zemkova (2010), looked at relationships between technique, muscle function and performance outcomes. Force platforms in this research have proved to be valuable in helping to generate maximal velocity in the initial phase of the jump. Coaches used this knowledge to design strength and plyometric training programmes to enhance an athlete's ability to generate and transfer force effectively.

2.3.3: Effects of arm movement and initial knee joint angle

Wu, Wen-Lan et al (2003), also did a biomechanical analysis of long jump. The purposes of the study being to investigate the effects of arm movement and initial knee joint angle employed in standing long jump by ground reaction force analysis and three dimensional motion analysis. He also investigated how jump performance of the female gender is related to body configuration. Healthy female adults performed standing long jump on force platform using full effort and analysis of body segment and joint angles was analysed using motion systems. Kinetic and kinematic data, body trajectory, knee joint angle, magnitude of peak at take-off and impulse generation at preparation phase was calculated and long jump performances with free arm motion were better as compared to performances with restricted arm movement. Free arm movement proved to have a positive impact on jump distance. Take-off velocity with a higher initial knee angle was higher as compared to take-off velocity where knee angle was lower. This study indicates that arm action is paramount, it also plays a crucial role in helping propel the body forward during the jump.

Improving long jump is a global endeavour. Different countries have put up strategies to enhance skills techniques and overall performance of their long jumpers. In the United States athletes benefit from advanced sports science facilities and coaching expertise. High performance training centres and sports institutes offer state of art equipment for biomechanical analysis, strength conditioning programs and performance optimization. In Jamaica long jump is also developed. Coaches in Jamaica emphasize speed development, explosive power and technical proficiency in long jump training programs. Germany is also well known for its expertise in sports science and biomechanics which has contributed to the success of Germany long jump athletes. Researchers and coaches in Germany collaborate in conducting cutting edge studies on long jump technique, training methods and injury prevention strategies. Athletes have access to biomechanical laboratories and performance testing centres to optimize training and performance. Federations provide support for long jump athletes through talent identification programmers, coaching development initiatives and competition opportunities at national and international levels. Kenya has also produced talented long jumpers. Training programme in Kenya focus on speed development, strength, and jumping technique through a combination of track work, plyometric and strength training.

2.3.4: Effects of vertical and horizontal plyometric exercises on explosive capacity

Vazini Taher, Amir Ratko Pavlovich, Shahram Ahanjan, Iryana Skrypchenko and Marko Joksimovic (2021), studied the effects of vertical and horizontal plyometric exercises on explosive capacity and kinetic variables in professional long jump athletes. Their aim was to examine the response effects of horizontal and vertical plyometric training on explosive capacity and kinetic variables in long jump athletes. Some of their participants took part in Asian games and one of their athlete took part in the world track and field championships. Post training results in experimental group showed more improvement in 30m sprint, vertical jump, horizontal velocity at take-off and long jump completion in comparison to control group. A significant difference between the two groups was detected. Therefore vertical and horizontal plyometric training protocol was shown to be more effective in promoting improvement in explosive capacity than kinetics variables.

Liu, Pei Hua, Yun Bo Zhang and Xiao Dong Lian (2023), in their study of biomechanical study on Take-off Technique of Junior male long jumpers, in advanced materials research, concluded that related specifications of take-off directly affect long jumper performance. Biomechanics study method was used to analyse factors of take-off like the last 2 steps length and pace, the landing angle, jumping initial velocity and jumping angle. The main influencing factors were decided to be during take-off and concentrating on these factors during training proved to greatly influence performance. The studies have highlighted the importance of take –off angle around 20-25 degrees to maximise jump distance.

2.3.5: the role of Anthropometric characteristics in long jump performance

Ross tucker and Jonathan Dugas investigated the role of Anthropometric characteristics in long jump performance. They examined factors like body mass, limb length and muscle distribution and discovered that they influence an athlete's ability to generate power and achieve optimal technique in long jump. William Sands (2010) conducted a research on the relationship between flexibility and long jump performance. She looked at how joint range of motion and muscle flexibility affect the athlete's ability to achieve optimal take-off angles and generate maximum force during the jump. A sports scientist Erika Zemkova in (2003)conducted a research on physiological and biomechanical aspects of long jump exploring factors like muscle strength, power output and muscle activation patterns. She concluded that these play a crucial role I improving performance. In line with the conclusion with this research, muscle strength plays a crucial role in terms of its contractibility magnitude as it will allow maximum muscle activation patterns and hence contribute to improved performance.: Erick Simonsen (2008) also gave a specific emphasis on the functional anatomy and biomechanics of the lower limb during take-off and landing, aimed to optimize performance and reduce injury risk in long jump athletes. He concluded that stretch reflexes have an important role in in force enhancement thereby improving performance in long jumping. In a study by Hay, et al (2018) on biomechanical analysis of long jump by elite athletes, aspects such as approach speed, take-off angles flight mechanics and landing techniques were looked into. The study gave insights into optimal biomechanical strategies used by top long jumpers to achieve maximum distance.

2.4: CONCLUSION

Studies highlight the importance of biomechanical analysis in understanding technical aspects, performance optimization and injury prevention as well as equipment considerations in long jump sport, the importance of kinetics and kinematics in long jump analysis for performance optimization and equipment utilization, like the use of force plates is emphasized. Muscle strength and power do have an influence on long jump performance. Limb height and length, flexibility and joint range of motion, muscle fibre and composition as well as neuromuscular coordination and timing, play a crucial role in long jump optimization according to Hunter et al (2014). Approach run characteristics which are velocity, stride length, and stride frequency. Take-off mechanics which are angle, velocity and force. Flight mechanics that is posture and body position as well as landing mechanics encompassing force attenuation and stability work together to maximize performance. Biological and mechanical factors interaction influences jump performance. Biomechanics based training has shown a positive impact on jump performance. Technological innovations like the motion capture systems, force plates and simulation techniques have a positive impact in improving training programs and identifying areas that need reinforcements to improve long jump distance underpins Hay et al (2018)

Chapter 3

Research methodology

3.0: introduction

This chapter will outline Research paradigms and instruments used to collect data will be presented and described. Population sample and sampling techniques used will also be described. The chapter will also outline data collection procedure and then finally data analysis and presentation.

3.1: Research paradigms

The research design will involve a parallel convergent mixed research approach. Qualitative and quantitative methods are combined to achieve a comprehensive view of the biomechanical analysis of long jump technique as well as analysing biological factors that contribute to long jump distance. There is no single instrument that can guarantee a complete truth, these methods complement each other's weaknesses and strength, (Cohen and Cowan 2011). Qualitative method will be used in the form of action research where through participation and collaboration, the researcher works together with the people directly involved in the in the long jump. The practical focus aims to address real world problems to improve long jump performance. Action research is qualitative and interpretive, as it often relies on qualitative data, participants' observations and interpretive analysis to understand the context and dynamics of the problem for instance, the influence of individual variations in biomechanical parameters on long jump performance. A quantitative paradigm is also employed through quasi-experimental, participants are not randomly assigned to experimental conditions, but are instead assigned based on factors like body composition, anthropometric measurements and genetic predispositions so as to investigate their effect on long jump performance. The objective of the study is to investigate the influence of biological factors on long jumping technique and identify key biomechanical variables related to a successful jump (Kapur, 2018).

Quantitative approach helps to quantify the problem by way of generating numerical data or data from the field and transform them into usable statistics.

3.2 instruments used to collect the data

The research instruments that were used in this study for the data collection were;

a) *INTERVIEWS*

Semi structured interviews – These were used as they are flexible as the researcher can probe deeper as well as making follow up questions allowing participants to provide rich, detailed and contextual information, in which long jump coaches and athletes described their observations, experiences and insights in relation to biomechanical aspects of long jump.

Simulated recall interviews – These were used as they allowed the researcher ability to study long jump in a more realistic and dynamic setting. The researcher presented the long-jump participant with video footage and visual aids related to long-jump and asked them to recall and describe their thought process, decision making and experiences during that specific event.

QUESTIONNARES

Self-report questionnaire – Long jumpers were made use of as they allow athletes to provide first-hand insights into their own experiences, behaviours and perceptions. This Self-evaluation described various aspects of their jump technique, such as their approach, take off, flight and landing mechanics. The responses were then be compared to the biomechanical data collected through motion capture.

Coaching evaluation questionnaires – Were also be employed as the coaches work closely with their athletes and have extensive experience observing and understanding factors that contribute to long jump performance and this can valuable context that will help in biological data interpretation. These were administered to long-jump coaches, asking them to provide their assessment and evaluation of the technical aspects of the long jump performed by the participating athletes. Coach's observations and feedback were compared to the biomechanical data providing a practical expert based perspective on athletes' long jump technique. The combination of these questionnaires provided contextual information, offering Comprehensive understanding of the factors influencing long jump performance.

Tests

Pre-tests were used in this research in order to identify individual differences in the athlete's biomechanics. The Athletes were asked to take a jump and their initial jump distance was recorded. Physical capabilities and biological attributes and these were baseline measurements. Data was collected on athlete's physical, characteristics such as height, weight, joint range of motion and muscle strength. Segment movements were analysed (kinematic analysis) as well as joint moments, (kinetic analysis). These pre-tests determined the athletes starting point, which was later used in comparisons.

Post-tests were later used for intervention and evaluation through training programmes, technique modification was aimed at improving long jump performance. Athletes were asked to take another final jump after technique modification through videos, verbal cues and training interventions. Post tests proved useful. They helped the researcher to understand how individual variability in biological factors influence the response to experimental conditions and long jump performance. Incorporating tests in the biomechanical analysis of long jump enable the researcher to gain more understanding of the relationship between biological factors and long jump performance leading to more effective training programmes and intervention strategies.

e) OBSERVATIONS

Through manual timing and measurement, experimental method was implemented where stopwatches or other timing devices were used to measure different phases of the jump, Such as approach, take-off and landing. Tape measures or other simple measuring tools were made use of to record the jump distance and other spatial parameters. Though not as detailed as automated systems, these manual measurements still provided useful data for the biomechanical analysis. Also, through video based analysis, using a standard video camera, long jump performance was recorded from multiple angles. Observations and recordings on the biomechanics of long jumpers were done in their natural environment Such as during training sessions or competitions.

3.3: population

The project focused on a population from 7 secondary schools around Chegutu district, in Mashonaland west province. The total number of long jump athletes was 460 athletes from all schools. A sample was taken from this population as a representation for study purposes.

3.3.1 Sample and sampling technique.

A sample is a part or subset of the population used to gain information about the whole population (Cohen et al 2018). Sampling is a process of selecting a number of individuals for a study in such a way that they represent the large group from which they were selected, (Kerlinger, 2017). Various sampling techniques were used in the study. The total number of long jump athletes from each school was twelve that is two boys and two girls from each of the three age groups, under 15 under 17 and under 20. Total population from the 7 schools was 84 long jump athletes and 7 long jump coaches, one from each school as the target population. Target population is a group of individuals, events or objects having common characteristics (Creswell, 2018).

3.3.2: Stratified sampling

Stratified sampling was used so that the population could be divided into distinct subgroups or strata, which were Under 15 age group, under 17 and under 20 as well as gender that is boys and girls. This ensured that the sample is representative of the overall population so that findings can be generalised to the broader population of long jumpers. Stratification into age group and gender in the research on biomechanical analysis of long jump allowed the researcher to directly compare the biomechanical characteristics of different gender and age groups which is crucial in understanding how biological factors influence long jump performance and technique. Stratification in this study helped to ensure that age groups and gender is adequately represented allowing a more comprehensive analysis.

3.3.3: Non-probability sampling

After stratifying the population, non-probability sampling in the form of purposive sampling was used where the researcher selected the sample based on own judgement in order to obtain participants with the desired anthropometric characteristics for the biomechanical analysis of long jump in relation to biology, that is, age group, body height, weight and limb length. The main idea was to select a sample that best helps the researcher answer the research question or achieve the research objectives. Purposive sampling allows a researcher to target a specific population or phenomenon that is of interest to the study, (Omari, 2021). The final population sample comprised of 18 long jumpers, 9 girls and 9 boys, three girls from each age group and three boys from each age group.

3.4. DATA COLLECTION PROCEDURE

Data collection procedure is a protocol followed, to ensure data collecting tools are applied correctly and efficiently (Bhat, 2015

The researcher got a confirmation letter from Bindura University of Science and Technology. Clearance to carry out the research was sought from The Ministry of Primary and Secondary Education through the District and School Heads in Chegutu District. The researcher through respective heads of schools had meetings with appropriate research participants once every week. Consent from parents was sought for their children’s involvement in the study. Verbally, participants were informed about the purpose and nature of the research. Voluntary participation and complete anonymity were guaranteed to all participants. Participants were requested to sign a consent form prior to commencement of data collection. All participants were assured of the strictest confidentiality and that information they provided would not be divulged. First long jump performance for each of the long jumpers was recorded using videos and was observed, Analysed to establish the baseline of each long jumper. The long jumpers having been filmed from multiple angles allowed for qualitative and quantitative analysis of technique and movement. Questionnaires were employed whereby information regarding the athlete's training history, injury records was collected. Subjective perceptions of their technique through questionnaires or interviews were analysed. This qualitative data complemented the quantitative bio mechanical measurements done through the use of tape measures. The tape measures were used to record the jump distance and other spatial parameters. Stopwatches and timing devices were used to measure the duration of different phases of long jump, such as the approach, take-off and landing. Measurements such as body mass, height, limb and length, as well as joint, girth were done in order to assess the relationship between an athlete's physical characteristics and long jump performance.

The vicon motion control systems could be made use of to analyse body position, joint angles and movements in order to get a detailed examination and comparison of the technique variations. The starting blocks could also be made use of in order to analyse the initial push off forces that will contribute to sprinting Ability, which in turn impacts on the take-off force for a successful jump.

3.5: Data analysis and presentation

Examining data that has been collected for the purpose of drawing conclusions is data analysis (Simon and Goes 2013). Descriptive statistics were used to analyse qualitative versus quantitative collected data. Statistical data was in form of frequency distribution tables and percentages. Information from interviews, questionnaires and observations was discussed and the researcher analysed the response to questions and interview guide. All variables and responses were assigned numerical values for easy tabulation and analysis. Data was coded and treated statistically to enable qualitative analysis using descriptive and inferential techniques such as percentage and frequency presented through tables. Graphs were used to present data and this helped to identify trends, patterns and relationships within data.

Comparative analysis was made use of where height, weight, leg length and body composition were compared and contrasted in terms of the biomechanical characteristics of different athletes, groups or techniques. Changes in technique over time was examined.

3.6: summary

The chapter presented the key steps taken by the researcher in the collecting and presenting data. The research design chosen for the study was ideal as there was need to choose the appropriate representative population sample with experience and had developed technical skills and physical capabilities necessary for biomechanical analysis of long jump. A sample of participants was selected based on age, gender and athletic background criteria. To collect data various instruments were employed, such as stopwatches, motion capture systems, cameras, tape measures. Variables accessed were velocity on the approach run, anthropometry, joint range of motion, time taking during the approach run between take-off and landing, landing distance, body weight, limb length, muscle mass and body coordination. Qualitative methods like video analysis and expert judgments were used to gain further insights into technique and performance improvement. Research tools such as questionnaires, interviews and observations were used to collect data from the field. Chegutu District was selected as a representative of other districts in the country. Population of study was made up of long jump athletes and long jump coaches. There was sufficient feedback from the filled questionnaires. Interviews supplemented gathered data. Unfortunately, the researcher was unable to use the more advanced technological equipment like the vicon motion capture systems Due to financial constraints. However, the manual timing and measurement was made use of such as stopwatches and tape measures. Though not as detailed as the automated systems these measurements still provided useful data for the biomechanical analysis.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0: INTRODUCTION

This chapter will present the results of biomechanical analysis of the long jump in relation to Biological factors impacting on the performance of long jump athletes. Biological factors were looked at and how they can be optimised to improve long jumping distance.

Data was collected from both long jump athletes and long jump coaches. Anthropometric measurements for the participants were taken and recorded such as height, weight, limb lengths, joint range of motion as these biological factors correlated with jump performance. Data was presented in the form of pie charts, frequency tables, graphs, tables and descriptive analysis of data from observations and interviews.

4.1: PRESENTATION

The study athletes had previous experience in long jump training within average of two years' experience.

TABLE 4.1 DEMOGRAPHIC ANALYSIS OF THE RESPONDENTS

GENDER	FREQUENCY	PERCENTAGE
Female	9	50
Male	9	50
Total	**18**	**100**
Age		
14	3	16.6
15	3	16.6
16	4	22.2
17	2	11.1
18	4	22.2
19	2	11.1
Total	**18**	**100**
Long jump coaches		
Female	2	28.6
Male	5	71.4
Total	**7**	**100**

Table 4.1 above shows sex and age for boys and girls from Chegutu urban and peri-urban public schools. Fifty percent (50%) of the participants were boys, and fifty percent (50%) were girls. Long jump coaches comprised of 2 females and 5 males. For the study we had at a total of 25 participants. For the 15 years and under age group, we had 33.2 per cent .for the 17 years and under age group. We had 33.3% and 19 years and had 33.3 per cent. We had few female coaches for the study as compared to males.

Anthropometric characteristics of the long jumpers under study

Table 4.2 Height for 15 years and under age group long jump respondents

Participant gender and description	Height (cm)	Jump distance covered
Boys		
1	163	5.4
2	168	5.8
3	179	6.1
Girls		
1	160	4.6
2	164	4.8
3	170	5.23

Table 4.2 indicates that a better height or a taller, long jumper achieves greater or better jump distance. A boy long jumper number one, who is 163cm tall, achieved a jump distance of 5.4m and a boy long jumper number 3, who is 179 centimetres achieved their distance of 6.1 metres. And a girl athlete number one, who is 160 centimetres tall, achieved a jump distance of 4.6 metres, In comparison to a taller girl, long jumper who is 170 centimetres tall, who achieved a distance of 5.23m. (Linthorne, 2008), also expands that taller athletes typically have longer limbs which can provide biomechanical advantages in long jump and says taller athletes also have a higher centre of mass which can help them generate greater angular momentum during the take-off. This is proven by the better jump distances achieved by taller athletes in table 4.2. The research revealed that structural and functional characteristics of the human body influence long jump performance (Hunter et al 2014). Anthropometric measurements influence performance capabilities in long jump as seen in the above table that taller athletes are executing a better jump distance. The average height for boys in table 4.2 is 1.70m with a standard deviation of 8.185cm, their jump distance average is 5.77m with a standard deviation of 0.351cm. Average height for girls is 1.647m with a standard deviation of 5.03cm, their average distance jumped is 4.87m with a standard deviation of 0.321cm. The small values for the standard deviation indicates that data is evenly spread and therefore it means the research findings are reliable as they do not indicate a high level of variability. Girls are generally shorter than boys and therefore they execute shorter long jump distances.

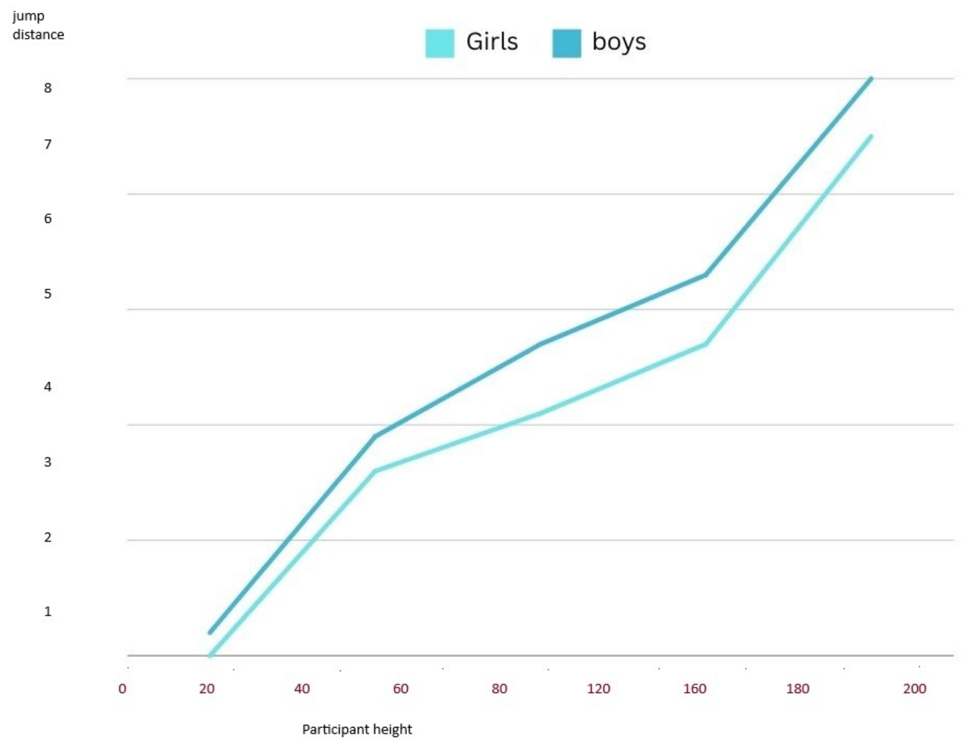

FIGURE 4.1. 15 YEARS AND UNDER BOYS AND GIRLS JUMP DISTANCE IN RELATION TO HEIGHT

The line graph also concurs that an increase in height also brings about an improvement in long-jump distance covered. Several studies for example by, (Coh and Mihajlo Vic, 2019), as well as Klobuk et al (2021) found a positive correlation between the athletes body height and long jump performance. The results of the research in harmony with their studies reveal that taller athletes tend to have longer limb length which can generate greater horizontal take-off. Optimal body height can give a mechanical advantage to a long jump athlete (Aramphatzus et al 2011) Table in fig 4.3 below echoes the same as jump distance seems to increase with an increase in height of the long jump athletes

Table 4.3. 17 years and under age group Height and long jump distance covered.

Participant	Height(cm)	Jump distance covered
Boys		
1	170	6.0
2	176	6.3
3	180	6.5
Girls		
1	160	5.1
2	164	5.3
3	170	5.6

In table 4.3 above average height for boys is 1.75m with a standard deviation of 5.03cm. The average jump distance covered by boys is 6.27m with a standard deviation of 0.252cm which is a smaller range of the spread. Mean height for the girls in the table is 1.64m, with a standard deviation of 5.03cm. Average jump distance covered by the girls is 5.33m with a standard deviation of 0.252cm. This measure of spread indicates that there is no greater variability. Generally boys perform longer jumps as they are taller than girls. This proves that height contributes to long jump distance performance. Long jump athletes with a better height perform better in distance coverage.

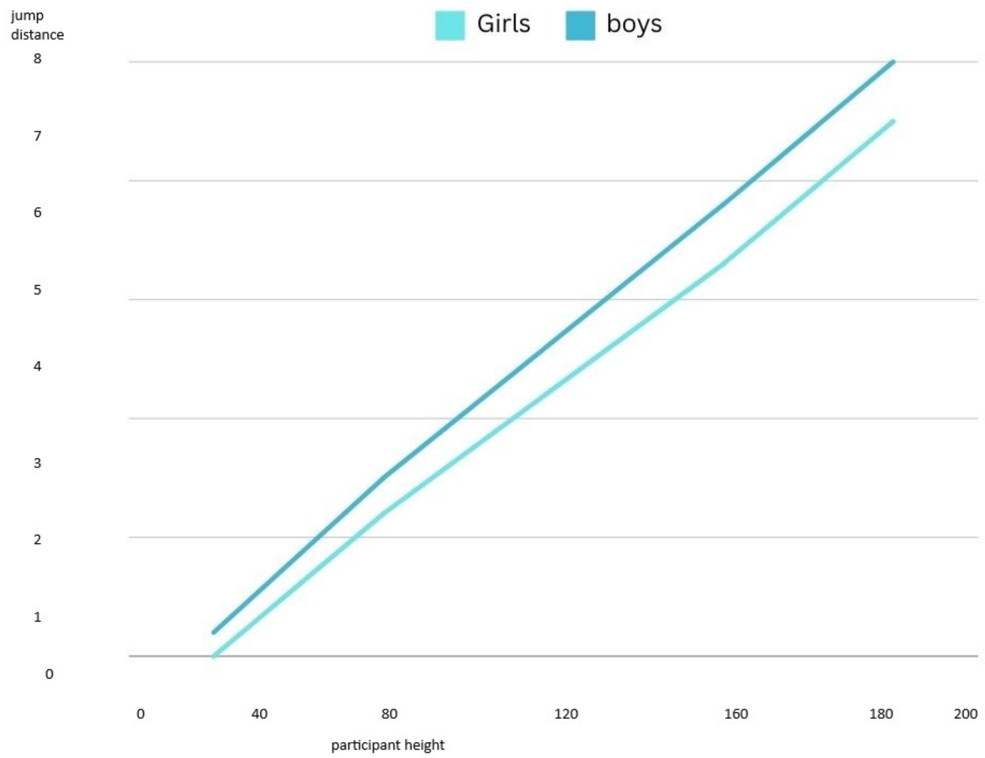

Figure 4.2. 17 years and under age group long jump distance covered in relation to height.

Fig 4.2 above shows a positive correlation between the height of long jump athletes and the long jump distance covered. (Klobuk et al., 2021), found out that height range between 1.80and 1.90m for men tend to achieve the best long jump results. Optimal height of the long jump participants affects the joint range of motion and hence impacts on optimal take-off (William Sands 2010)

Table 4.3. 19 years and under age group Height versus long jump distance covered

Participant	Height	Jump distance covered
Boys		
1	175	6.4
2	180	6.9
3	183	7.3
Girls		
1	160	5.6
2	166	5.8
3	170	6.1

In table 4.3 above mean height for boys is 1.79m with a standard deviation of 4.03cm. Their average height jumped is 6.87m with a standard deviation of 0.451cm. Mean height for girls is 1.65m with a standard deviation of 5.03cm. The average distance jumped by girls is 5.83m with a standard deviation of 0.252cm. Standard deviation is evenly spread suggesting a normal distribution of data points. There are no significant irregularities and this proves the data more suitable for modelling. Data is representative of the broader population and can enhance generalizability and external validity of the findings from the study.

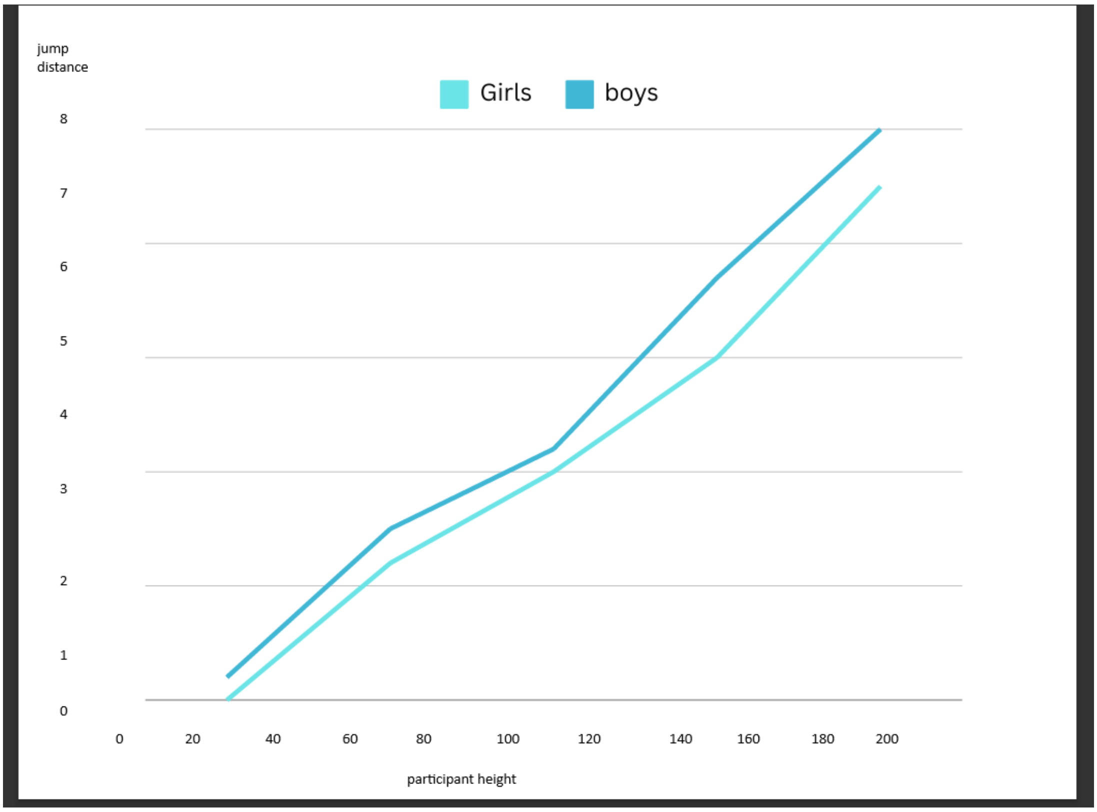

Figure 4.3 19 years and under age group participant's height in relation to jump distance

Information from the above tables and line graphs indicate that much taller, long jumpers can achieve a better and greater jump distance. Longer legs provide more leverage and power transfer during the take-off phase. Taller athletes can generate more force into the ground, propelling themselves further forward. Taller athletes can maintain a more advantageous body position in air, helping them maximise their flight distance and control their landing(Hunter et al 2014), limb proportions of an athlete can influence long jump distance covered. Taller athletes achieve higher horizontal approach due to their greater stride length say, (Coh and Mihajlovic, 2019). The research study has also proven the greater stride length due to body height, leads to higher horizontal approach. Lower limbs, trunk and upper limbs are crucial for power generation and technique for optimal jump (Ramdan et al 2019)

Anthropometric measurements

Table 4.5 Body weight measurements of respondents in relation to age group, long jump distance covered and total approach run time taken.

AGE GROUP	WEIGHT(kg)	LONG JUMP DISTANCE COVERED(m)	TOTAL APPROACH RUN TIME(s) in seconds
15 years and under girls			
1	50	4.8	3.7 - 4.1
2	54	5.0	3.9 – 4.3
3	59	5.3	4.0 – 4.5
15 years and under boys			
1	60	5.5	3.8 – 4.2
2	65	5.8	3.9 – 4.3

3	71	6.1	4.0 – 4.6
17 years and under boys			
1	70	6.4	4.0 – 4.4
2	74	6.7	4.1 – 4.5
3	80	7.0	4.2 – 4.6
17 years and under girls			
1	55	5.2	3.9 – 4.3
2	59	5.4	4.0 – 4.4
3	65	5.6	4.1 – 4.5
19 years and under girls			
1	60	5.6	4.0 – 4.4
2	63	5.8	4.1 – 4.5
3	70	6.0	4.2 – 4.6
19 years and under boys			
1	70	6.5	4.0 – 4.5
2	74	6.8	4.1 – 4.5
3	80	7.0	4.2 – 4.7

The above table looks at body weight anthropometric measurement in relation to total approach runtime and long jump distance covered for the age groups, 15 years and under, 17 years and under as well as 19 years and under age groups. The results show a positive correlation between body weight and total approach run as well as the jump distance covered by the long jumper. Optimal body weight is linked to higher approach run velocities, athletes within this optimal range could cover the approach distance in a shorter time compared to those who are for example overweight. Approach speed is important in improving performance (Hay etal2018). (Laffaye et al, 2015), supports this finding explaining that Excessive body weight can negatively impact on approach speed and also elaborates that, optimal body weight helps to maintain proper technique and minimise energy losses during the approach run allowing the athlete to achieve higher horizontal velocities. Laffaye et al (2015), for 18 years and 19 years female long jumpers a lean muscle mass in the range 55-65kg is considered optimal. In the table above looking at 19 years and under girls, girl athlete number 1 with body weight of 60kg has an approach velocity of 4.0-4.4 seconds, girl no 2 has approach velocity of between 4.1-4.5 seconds and her body weight is 63 kgs, and lastly girl long jump athlete no 3 with a body weight of 70kgs has an approach run time of between 4.2- 4.6 seconds. This reiterates the idea that excess body weight either due to fat or muscle mass can negatively impact speed during the approach run. Biomechanical analysis allows exploration of individual variations. This helps coaches to understand how these influence force generation and hence help formulate personalised training approaches to capitalise on the athlete's specific attributes leading to improved performance (Juszczyk, Wozniak, and Gluszek 2021).For all age groups in table 4.5 above average weight is 65,4kgs with a standard deviation of 8.72g. Average jump distance covered is 5.92m, with a standard deviation of 0.686cm. Mean for approach run is 4.23seconds with a standard deviation of 0.521 seconds. The jump distance and weight and approach run time of the athlete are weakly positively correlated.

Body weight measurement.

Table 4.6 for age group 19 years and under, **Landing distance time in relation to weight.**

ATHLETE	WEIGHT(KG)	LANDING DISTANCE	LANDING DISTANCE TIME(s)
GIRLS			
1	60	5.6	0.45 – 0.55
2	64	5.8	0.5 – 0.6
3	70	6.0	0.55 – 0.65
BOYS			
1	70	6.5	0.5 - 0.6
2	74	6.8	0.55 – 0.65
3	80	7.1	0.6 – 0.7

The table indicates a relationship between a heavier weight and a better long jump distance. Female long jumper number one in the table weighing 60KG's reaches a jump distance of 5.6 metres And jumper number three weighing 70KG lands at 6.0m. Landing distance time refers to time it takes the athlete to decelerate from their maximum horizontal velocity and come to a complete stop according to (Linthorne 2008). Longer distance times are associated with greater jump distances, as the athlete is able to maintain high horizontal velocity for a longer period.

The landing distance time for a male athlete, number one, weighing 70 KG, is between 3.5 to 0.6 seconds at a distance of 6.5 metres; In comparison to male long champion number 3 weighing 80KG with landing time of between 0.6 to 0.7 seconds at a distance of 7.1 metres. It has been noted that heavier athletes can generate more force and power during the take-off phase of the long jump. Increased power output translates to greater jump distances. Increased body weight also results in greater momentum during the approach and take-off. This can help to carry jumper further through the air. Jumpers who are too light may struggle to generate sufficient power and momentum for maximum jump distances. Optimal weight enabled adequate muscle activation patterns for an adequate explosive force (Smith et al 2019). In the table the mean weight for the girls is 64.7kgs, with a standard deviation of 5.03g. The average landing distance for girls is 5.8m with a standard deviation of 0.2cm. Girl's average landing distance is 0.55 seconds with a standard deviation of 0.05seconds. Boy participants in the table have an average weight of 74.7kgswith a standard deviation of 5.03g. Mean landing distance for boys is 6.8m with a standard deviation of 0.3cm. Average landing distance time for boys is 0.6seconds with a standard deviation of 0.05 seconds. Therefore weight and landing distance as well as landing distance time are strongly positively correlated. Weight and muscle mass which is greater helps in generating power output and hence longer time taken in the flight phase leading to a greater jump distance.

Table 4.7

Limb length measurement for 19 years and under age group, in relation to number of steps taken in the approach run and jump distance.

AGE GROUP	ATHLETE	LIMB LENGTH(cm)	No steps on approach run	JUMP DISTANCE
19 YEARS AND UNDER GIRLS	1	80	16-18	5.5
	2	83	14-16	5.8
	3	87	12-14	6.0

19 YEARS AND UNDER BOYS	1	90	18-20	6.5
	2	93	17-19	6.8
	3	97	16-18	7.0

The anatomy and biomechanics of the lower limbs during take-off and landing can optimise performance and reduce injury risk (Erik Simonsen 2008). Longer legs allow for longer strides, resulting in fewer steps needed to cover the same distance during approach run. For example, in the above table, a girl long jumper with leg length of 8.7 takes a total of between 12 to 14 steps in the approach run and finally covers the jumping distance of 6.0 metres as compared to one Limb length of 80 three centimetres would take about 14 to 16 steps In the approach run, leading to a jump distance of 5.8 metres. A male long jumper with limb length of 97 cm takes about 16 to 18 Approach run steps and makes a jump of 7.0 metres in comparison to boy athlete number 1, who has 90 centimetres limb length and takes 18 to 20 approach run steps, thereby taking a jump of 6.5 metres.

This shows that leg limb measurements are an important factor that contributes to long jump distance. Longer legs enable taller athletes to take fewer strides to reach maximum speed during approach. This may lead to more efficient and powerful take-off (Ramdan et al 2019).

In table 4.7 above girls have an average limb length of 83.3cm with a standard deviation of 3.51cm. Average no of steps taken in the approach run is 15 with a standard deviation of 2 steps. Average long jump distance covered is 5.77m with a standard deviation of 0.252cm. Boys have an average limb length of 93.3cm with a standard deviation of 3.51cm. Average number of steps in the approach run is 18 steps with a standard deviation of 1 step. The average jump distance for boys is 6.78m with a standard deviation of 0.252cm. Therefore limb length is strongly positively correlated to long jump distance. Limb length plays a crucial role in long jump performance.

Percentages of some biomechanical factors contributing to long jump distance, according to some coaches interviewed

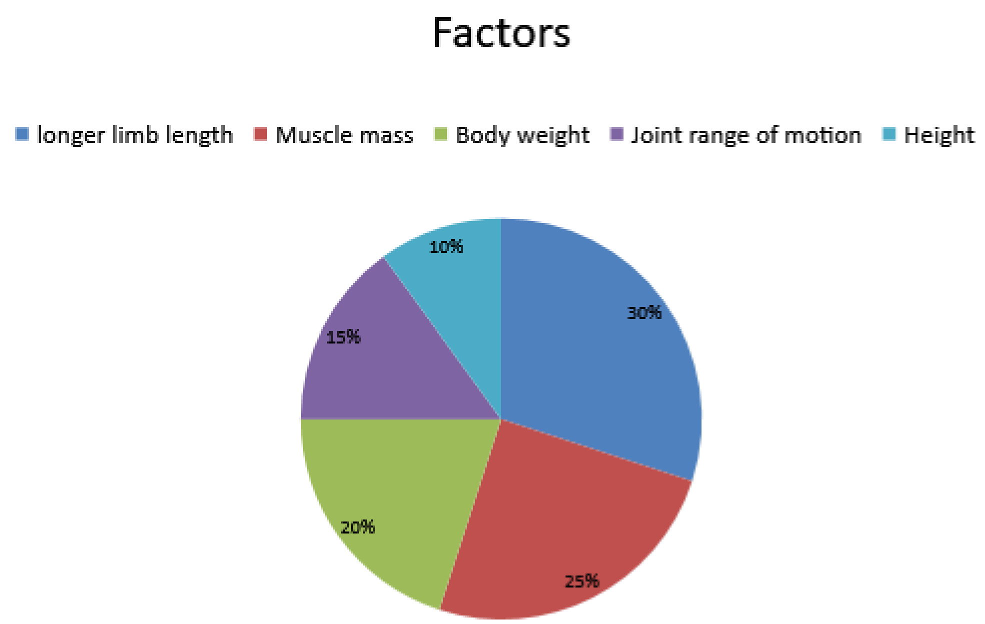

FIGURE 4.4 FINDINGS ON BIOLOGICAL CHARACTERISTICS CONTRIBUTION TO LONG JUMP PERFORMANCE IN PERCENTAGES

Leg limb length

The majority of coaches indicated that longer leg limbs helped to generate greater force and impulse during take-off. According to long jump coaches, taller athletes with longer legs achieved greater jump distance. This is synonymous with the findings in this research which revealed the same as taller athletes with longer lengths also proved to achieve greater jump distance. Leg limb length contributes about 25 to 30 per cent to long jump distance (Challis, 1998). -

Muscle Mass

Muscle must contribute about 20 to 25 per cent to long jump distance. Increased muscle mass, especially in the lower body, can enhance an athlete's power output and explosiveness, which are crucial for long jump performance. Greater muscle mass can increase the ability of an athlete to generate horizontal forces and maintain velocity during the landing phase leading to a better jump distance (Samozino et al., 2010).

Body weight

The pie chart indicates that body weight contributes abroad 15 to 20 per cent to long jump distance. Heavier body weights with a suitable muscle to fat ratio Contributes to momentum and force production during the jump. Too much body weight can hinder speed and technical execution.

Joint range of motion

Joint range of motion contributes about 15 to 20% of the long jump distance covered. Adequate joint range of motion particularly in the hips, knees and ankles allows better technique and enables efficient use of stretch shortening cycle during long jump (William Sands 2010).

Body height

Ten to fifteen percent (10 to 15%) contribution to long jump distance is due to body height. Some taller athletes have a slight advantage in the long jump due to longer limbs and greater potential for power generation.

4.2: Coaches' responses on which elements are effective for long jump training and coaching

Responses indicated that;

a) ***Plyometric exercises improve power and explosiveness.*** For example, box jumps, depth dumps, bounding and broad jumps. These exercises train muscles to produce force more rapidly and hence translate to greater power output at take-off phase (Vazini Taher, Amir Ratko Pavlovich, Shahram Ahanjang, and Marko Joksimovc 2021). Vertical and horizontal plyometric training was more effective in promoting improvement in explosive capacity.
b) ***Technique focussed drills***, which help to refine approach run, take off, flight and landing, for example, acceleration runs, marker drills, hurdle hops for approach, hang drills for take-off, in air drills like arm swing and leg kick drills, landing drills like soft landings. These drills, according to coaches, develop consistency and efficiency in long jumpers. Free arm movement has a positive impact on long jump performance in propelling the body forward (Wu, Wen-Lan et al 2003).
c) ***Strength training***, which helps to build lower body strength and core ability e.g. squads, deadlifts, bench press, planks, pull up and shoulder presses. Muscle strength, power output and muscle activation patterns are developed and this helped to improve on performance in long jump (Zemkova 2003)
d) ***Speed and agility work*** to enhance printing speed and body control. For example, A-skips B-skips, high knees, 10-30, 30m accelerations, resisted sprints, zig zags, ability cones, jumping jacks.
e) ***Video analysis to provide feedback and technical adjustments***. For example, in analysing approach run the athletes make, is filmed to evaluate acceleration, Speed rhythm and foot placement. Inconsistencies or inefficiencies are identified to be improved. Video analysis enabled identification of risk injury factors as well as muscle activation patterns(Wang et al 2017)
f) ***Periodized training plans***. These gradually build fitness and skills over time. For example, drills exercises and progressions.

4.3: Findings from observations by the researcher

1) Athletes with higher levels of muscle strength, especially in the lower body, were able to generate more power during the take-off phase resulting in longer jump distances. Muscles involved in generating propulsive forces and absorbing impact when identified helped in guiding coaches in optimising muscle recruitment strategies to improve performance (Bezoids et al 2017)

2) Athletes with greater flexibility in the hip and ankle joints were able to achieve a more efficient take-off position, leading to a better performance in the jump. Joint characteristics give a mechanical advantage at take-off and landing (Aramphatzis et al 2011).

3) Athletes with lower body fat percentages and higher muscle mass had a more favourable power to weight ratio, allowing them to achieve greater jump distances, (Arampatzis et al.,

2006). More elastic tendons can store and release energy more efficiently, allowing the athlete to generate more force and power output during the take-off phase.

4) Certain genetic factors such as muscle fibre type and tendon elasticity played a significant role in determining an athlete's potential for long jump performance.

4.4: Optimization strategies

Based on findings, the following strategies were recommended and for optimising long jump performance.

Strength training - Focus should be on developing lower body strength through exercises such as squats, deadlifts and plyometric to improve power generation during the take-off phase.

Flexibility training - Incorporating regular stretching and mobility exercising targeting the hip and ankle joints can improve the athletes' ability to achieve an optimal take-off of position.

Nutrition - A balanced diet that promotes muscle growth and recovery should be maintained as it is essential for long jump athletes to optimise their performance.

4.5: Limitations and future directions

Despite the valuable insights gained from the study, several limitations should be considered. The sample size was relatively small, and future studies with larger sample size could provide robust conclusions. Focus was mainly on biomechanical and biological factors, but there are other factors such as physiological and environmental influences, which could also impact long jump performance.

The future research can also look at interactions between different biological factors and how they collectively contribute to long jump performance.

Effects of training interventions like strength and conditioning programmes on biomechanical and biological variables can further enhance understanding of optimal long-jump performance.

They study overall provided valuable insights into the biomechanical analysis of long jump in relation to biology and shows the importance of considering biological factors in the training and development of long jump athletes. Optimising these factors helps athletes to maximise their performance and achieve greater success in the sport.

4.6: What has contributed to your improved long jump distance?

The respondents were asked to elaborate on aspects that have contributed to the improved long jump distance.

Respondents indicated that;

1) Video recordings and provided visual feedback by their coaches has helped them as long jump athletes to identify areas of improvement
2) Video simulations have helped long jump athletes in many instances to understand movement patterns. Demonstrations by proficient athletes has also helped them focus on key technical cues.
3) Cue words or phrases by coaches during training sessions have helped athletes make corrections. For example, phrases like 'stay tall at take-off', 'drive your knees forward'.
4) Varying drill parameters like distance, height or speed has helped athletes to feel challenged to address different aspects of the long jump technique

4.7: Contribution of the study to knowledge

The research will help coaches to identify talent and development programmes in long jump will be able to consider anthropometric measurements for optimal performance. Physical and technical interactions in long-jump should be considered in identifying and nurturing athletes while also addressing their specific strengths and weaknesses to maximise long jump performance,(Mackenzie et al, 2020)

Knowledge on how to optimise the athletes' body composition has been improved, focusing on developing lean muscle mass can contribute to improved long jump performance.

Biomechanical research sheds light on injury risk factors Associated with long jump such as joint loading, impact forces and technique flaws, (king and Yeadon, 2015). This can inform development of injury prevention strategies, training programmes and rehabilitation protocols to help athletes maintain their performance while reducing risk of injury.

Biomechanical research gives insight on specific biological factors contributing to long-jump performance. For example, muscle power, joint flexibility and body composition. This knowledge, can guide development of targeted training programmes and interventions to optimise physical capabilities of athletes and their application to long jump (Coh and Mihaljovic, 2019).

Biomechanical analysis can inform the design and development of specialised long-jump equipment such as shoes, approach surfaces and take off boards. Researchers can use biomechanical data to evaluate effects of different equipment and technology on long term performance and this can lead to improvements in equipment design. Footwear characteristics influence take-off and sustains stability during landing (Allain Gillet 2010)

4.8: Summary

In summary, researchers have consistently found that an optimal body weight with a balance of muscle mass and low body fat is associated with longer landing distance because increased body weight reaches a point where it enables the athlete to generate greater horizontal forces. Taller athletes have certain biomechanical advantages in long jump, but according to research, there is an optimal height range for maximising performance.

Other factors to consider when selecting and developing long jump talent are;

Power and explosiveness - The athlete should be able to generate high levels of muscular power and explosiveness at (Mackenzie et al, 2020) sprint speed and acceleration. Improving an athlete's top end speed and acceleration can greatly enhance long jump distance.

Technique coordination – Developing an athlete's technical skills, coordination and body awareness significantly improves long-jump distance.

Beyond height, other Anthropometric factors such as Limb length, body composition and joint range of motion can influence athletes' long jump potential. Incorporating mental training strategies and verbal cues can help athletes develop the psychological skills necessary for long jump. A combination of physical abilities and mental skills helps athletes to focus, have confidence and ability to manage pressure.

Lastly, effective long jump talent and development requires collaborative approach Involving coaches, sports scientists, physiotherapists. Open working brings in understanding of crucial factors to help in a holistic development of long jump athletes.

Chapter 5

Summary, conclusions and Recommendations

5.0 Introduction

Summary of the main findings, conclusions and recommendations are given in this chapter. Findings were presented in relation to the research objectives research questions. Findings were formulated from the objectives and biomechanical factors contributing to long jump distance performance in relation to biology. The research project examined the relationship between various biological and mechanical factors and their impact on long-jump distance. Specifically influence of factors such as limb and leg length, muscle mass, joint range of motion, body weight, body height, approach run velocity and time taken during the landing phase were investigated. The combination of biomechanical analysis with physiological measurements revealed the important role of athletes' biological characteristics in determining long jump performance

5.1: Summary

The Summary presents findings, conclusions and recommendations based on the results of the study.

The study was done in Chegutu District involving three secondary schools as the symbol, among other schools in Chegutu district to represent other districts in Zimbabwe. The schools were located in urban and Peri- urban areas of Chegutu. The participants of the study were 18 long jump athletes who were purposively selected from the total population of 84 long jump athletes, in order to make sure that they possessed the desired biological characteristics needed to carry out the study.

In the findings limb measurements were taken and long jump distances covered by each long jump athlete in relation to the leg limb measurement were tabulated. Longer Limb and leg length were positively correlated with greater jump Distance. The long jump leg length allowed athletes to generate and transfer more force during the take-off phase. Longer legs allowed athletes to cover more ground as they have increased stride length which helped in building momentum. Longer legs facilitated a longer time in air, allowing athletes to stay in air for longer periods and cover more distance before landing.

Greater lower body muscle mass in quadriceps and hamstrings showed a link to a better long jump performance as they increased force production, enabling athletes to generate a greater force and power. Leading to faster approach runs and explosive take-offs. Greater muscle mass in lower body gave strength to the athlete to support the body during the jump and this enabled them to maintain Control and technique. Muscle mass also improved acceleration as the legs enabled the athlete to accelerate faster, to maintain top speed for a greater period and this resulted in longer jump distance. Lower body, great muscle mass, enabled the athlete to propel themselves further into the air and hence led to a greater distance covered.

Flexibility in participants allowed effective use of the stretch shortening cycle during the take-off. A good range of motion was noted in the hips, knees and ankles, allowing athletes' technique to be efficient and powerful, and therefore covered more distance. Flexibility in the hips and gluteus Maximus allowed athletes to fully extend their hips, generating more force and propulsion. Flexibility in knees and ankles Enabled athletes to absorb landing more effectively, reducing the impact and maintaining control. Maintenance of high speeds during approach run helped in momentum building, to propel the athlete forward and further. A faster approach run translated to higher take off velocity and hence a longer jump. More force generated during take-off due to maintaining velocity during approach run led to a more explosive jump.

A moderate body weight proved to be of benefit to the long jumpers, as it enabled efficient energy transfer and hence an explosive jump. The long jumpers could also accelerate faster and maintain top speed for longer time which then translated to a better jump distance. Too light an athlete lacked the strength and power needed for explosive jump and too heavy an athlete seemed to struggle with speed, acceleration and technique maintenance.

Long jumpers who spent longer Time in the landing phase had a more controlled and stable landing, which was correlated with increased jump distances.

However, the researcher faced constraints like.

a) Limited sample size. This was due to limited access to elite long jumpers and resources. And this made it difficult to generalise the findings.
b) Athletes' bodies are unique, making it challenging to determine universal relationships between biological factors and long jump performance.
c) Measurement errors. Factors like muscle mass body weight and leg length was challenging and small arrows can impact on results significantly.
d) Measurement techniques were invasive and therefore unethical
e) Funding constraints limited the scope and depth of the research
f) Some confounding variables were challenging to control, for instance, factors like training, nutrition and genetics. These impacted the relationship between biological factors and performance

5.2: Conclusions

Based on the research, the following conclusions were made.

a) Body height and leg length are positively correlated with long jump performance. Showing that taller athletes with longer legs tend to perform better.
b) Body height and muscle mass are as well positively correlated with performance. And this suggests that athletes having more muscle and a higher body weight tend to perform better. Anthropometric factors body height, leg length and muscle mass are interrelated and influence performance. However, this relationship may be influenced by the factors such as technique and power.
c) Athletes who can maintain a high velocity during the approach run tend to perform better. Hence, a good approach run velocity leads to a better long jump performance.
d) Excessive or insufficient body weight and muscle mass may negatively affect performance.
e) Technique and power output are important factors in long jump performance. Even if an athlete possesses optimal biological characteristics, they still have to develop proper technique and power output to Achieve success.

The biological characteristics and techniques of each individual differ and hence each athlete has a varying optimal approach. This therefore means coaches and trainers should consider individual differences when developing training programmes.

Video analysis was used to allow a frame by frame analysis for a detailed examination of the approach run, take-off, flight and landing mechanics. Technical strengths, weaknesses and areas for improvement for example, limb coordination, and force application were identified. Progress of an athlete could also be tracked over time to identify changes. Immediate visual feedback allowed both the coach and the athlete to identify and address technical issues.

5.3: Recommendations

1) Focus was mainly on biomechanical and biological factors but there are other factors such as physiological and environmental influences, which could also impact long-jump performance. This can also be explored in the future.
2) Future research can also explore interaction between different biological factors and how they collectively contribute to long jump performance.
3) Training interventions like strength and conditioning programmes on biomechanical and biological variables can further enhance understanding of optimal long jump performance. Training programmes should focus on developing optimal anthropometric and biomechanical characteristics for long jump performance. Coaches and trainers should consider individual differences in anthropometric and biomechanical characteristics in developing training programs.
4) Training and development of long jump athletes to maximise their performance should consider biological factors.
5) Further research to recruit a diverse sample of long jump athletes with varying anthropometric characteristics. To examine also potential gender differences. Investigating relationship between biological factors and long-jump performance in diverse populations and Contexts will further improve understanding and inform training practises. Due to travelling costs and financial constraints, the researcher only focused and did research in schools from Chegutu urban and peri-urban which are in close proximity. This limited sample diversity
6) Researchers in the future to make use of 3D motion capture systems to record athletes' movements during approach runs, take-off and landing phase of the jump as well as measurement of joint angles, angular velocities and linear velocities at touchdown, take-off and landing. Findings in this research, could not make use of the Vicon motion capture system due to financial constraints, and therefore the standard video cameras were used rather than the advanced systems.
7) Future research can also develop in-depth case studies of selected athletes to show the complex interplay between biological factors, biomechanics and long jump performance.

8) For more detailed biomechanical analysis of long jumping future research can make use of the automated systems to analyse take off mechanics, Flight mechanics landing mechanics, kinetic and kinematic variables in order to gain a comprehensive understanding of an athlete's long jump technique identifying areas for improvement and develop targeted training programs to enhance their performance. Technology integration can help the scientific community in continuing to advance understanding of long jump biomechanics. And hence improve long jump athlete performance.

9) Future research can also examine the effects of training interventions, injury, and rehabilitation on the development of the athletes' long jump technique. Collaboration with sports medicine professionals will also help in future research to understand the injury risk factors and this can help to foster injury prevention strategies.

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APPENDIX A : MEASUREMENT PROTOCOLS

a) Height was measured in cm using a stadiometer, with the participant standing upright with their back against the wall and the vertical back plate, feet flat on the floor together, heels, buttocks, shoulders and head should be touching the backboard.

b) Limb length was measured using a tape measure with the participant lying down measuring from the ASIS to the superior boarder of the patella.

c) Muscle mass was measured by taking physical measurements of the body like limb circumferences, like thigh and calf muscles

d) Approach run time was calculated using a stop watch. Approach run area was marked with start and end points. The researcher had to stand at the end point of the approach run ready to stop the watch as the participant's take-off foot leaves the ground at the end of the approach run.

e). Landing distance time ; The take-off point and the boundaries of the landing pit were marked clearly and the researcher was positioned at the take-off line with the stop watch ready. The stop watch was started as the participant's foot left the runway, and the stop watch was stopped precisely at first point of contact by the participant in the sand landing pit. Time was recorded in seconds.

APPENIX B QUESTIONNAIRES

QUESTINNAIRE FOR LONG JUMP COACHES

The researcher Phephelaphi Ncube is a student at Bindura University of Science Education and is conducting a research on biomechanics of long jumping technique. Analysing factors that contribute to jump distance. Note that information will be confidential and will remain anonymous.

Instructions for completing the questionnaire

- Do not write your name on the questionnaire

Questions

1. What do you think are the key biomechanical factors contributing to long-jump success and what contributes or causes poor long jump performance?...
2. Which coaching methods have you used or once implemented that have had a positive result in improving long jump performance?
   ………………………………………………………………………………………………….
3. What positive impact does technology have in improving long jump performance?
   …………………………………………………………………………………………………..
4. What are the most common errors or faults that need to be addressed in relation to jump technique execution in long jump athletes?
   ………………………………………………………………………………………………….
5. What are your observations in terms of the contribution of body mass height, limb length, muscle mass in the proper and optimal execution of long jump technique?...
6. Which measures do you think should be put in place to address or prevent injuries?
   ………………………………………………………………………………………………..
7. Which training interventions have you implemented to improve long jump distance covered?
   ………………………………………………………………………………………………

Questionnaire for long jump athletes

The information you share will be used only for the purposes of this research study and will be kept in strictest confidentiality. Your participation is voluntary, and you may choose not to answer any question. You are not comfortable with.

1. Age…………………………
2. What is your experience in long jump in terms of years or highest level of competition? High school, zonal competitions or District or provincial or national competitions.
   ……………………………………………………………………
3. What is your personal Best long jump distance…?
4. Which type of training do you actually engage in? And how many hours do you train per week? ……………………………………………………………………………..
5. Which type of technique do you use in your long jump (hang, hitch kick, double arm)………………………………. And why ……………………………….
6. Which factors among the following do you think contributes to your better long jump distance? Tick those that apply to you?
   Body height ☐
   Body weight ☐
   Joint flexibility ☐
   Approach run speed ☐
   Leg limb length ☐
7. Provide any other comments and factors you believe influence long jump performance
   …………………………………………………………………….
8. Have you undergone any specific physical training to improve your long jump performance?
   ………………………………………………………………….
9. What type of drills or exercises do you include in your training?
   …………………………………………………………………..
10. Do you have any injuries that affect your long and performance?
    …………………………………………………………………..
11. How frequently do you compete in long jump events?
    …………………………………………………………………..

Thank you for your honesty and openness in completing this questionnaire.

APPENDIX C: INTERVIEW GUIDE

Interview guide for coaches

1. Explain how anthropometric measurements like leg limb length, muscle mass, body weight, body height influence long jump distances.

2. From your observations during training sessions and video analysis of the long jumper's performance, what is the ratio in terms of percentage of the contribution of flag limb length body weight, muscle mass, joint range of motion and body height to overall long jump performance?
3. Which elements are effective for long jump training and coaching?

Interview guide for long jump athletes or participants

1. How has video recordings and simulations as well as feedback by coaches helped in improving your long jump performance?
2. Which drills have helped to address your flaws in long jump to improve performance

APPENDIX D : BUSE CONFIRMATION LETTER

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 10 APRIL 2024

TO WHOM IT MAY CONCERN

NAME: NCUBE PHEPHELAPHI REGISTRATION NUMBER: B225387B

PROGRAMME: HBScEd BIOLOGY PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBSC Ed BZ programme. The research topic is:

BIOMECHANICAL ANALYSIS OF LONG JUMPING TECHNIQUE AND IDENTIFYING KEY FACTORS THAT CONTRIBUTE TO JUMP DISTANCE.

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2024
P. BAG 1020
BINDURA

MINISTRY OF PRY & SEC EDUCATION
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