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The Study of Biomechanics in Sports

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Abstract

Biomechanics is one of the main sciences of sports, when viewed from the origin it consists of two syllables, namely Bio and Mechanics which can be interpreted as the mechanics of living things in this case humans. So in terms of biomechanics is the study of the motion of living/inanimate objects and the forces that work and the resulting effects through a mechanical approach. While mechanics itself is part of the discussion in physics that studies how power can produce a certain motion as desired by athletics.

Keywords
study, biomechanics; sports.

I. Introduction

Physical activity is an inseparable part of the life of living things, ranging from simple to very complex activities. As a living creature, humans need physical activity as an effort to maintain the existence of their lives. Every individual in his life must be doing physical activities both intentionally and unintentionally, because physical activities are carried out with diverse and diverse purposes. (Sulaiman, et al. 2020)

Athletics is the mother of most sports (mother of sport), where the movements in athletics such as walking, running, jumping and throwing are owned by most sports, so it is not surprising that the government categorizes athletics as one of the athletic sports as one of the subjects of physical education that must be given to students starting from the elementary school level to the high school level, in accordance with the Decree of the Minister of Education and Culture No. 0413/U/87.

Man in motion is the main study in sports science. Therefore, perhaps one of the goals of sports science is to provide scientific knowledge about human movements in sports that are carried out effectively, efficiently, and with very little risk of injury. One of the goals mentioned above has been accommodated in the science of sports biomechanics as a branch of sports science. Basically, biomechanics is the applied science of mechanics to the locomotor system of the human body. Mechanics is a branch of physics. In its development there is the term sports biomechanics, so called because biomechanics examines human motion in the field of physical activity or sports, it is better if we know in advance about sports biomechanics. Several references have interpreted it as follows, among others: (1) Study of mechanics in a biological structure, such as: muscle activity and the principles related to the muscle movement; (2) The application of mechanical laws to the structure of life, especially to the locomotor system of the human body; (3) Studying the structure and function of biological systems using mechanical methods, and (4) Studying the internal and external forces acting on the human body and the effects produced by these forces.

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Thus, sports biomechanics is the study of the principles, mechanical laws and internal and external forces that apply to the human body when carrying out physical activities or sports and the effects it produces. For this reason, a mechanical method is applied in the study.

Before discussing the broad application of Biomechanics (Biomechanics) in the world of sports, it is better to first understand the notion of Biomechanics itself. Why is that, because at this time it is alleged that there are still many sports coaches, technical coaches, students and even observers who do not really understand exactly about the nature of biomechanics.

In Indonesia, there are still many technical trainers who are still difficult to apply, especially those who have not taught them. How is it possible that they can train techniques properly and correctly, let alone be creative in creating new techniques, in analyzing. “diagnose”, or evaluate motion-only errors or imprecision. Then fix it. Obviously the results are not perfect.

Biomechanics is one of the main sciences of sports science, when viewed from the origin it consists of two syllables, namely Bio and Mechanics, so in language it can be interpreted as the mechanics of living things in this case humans. So in terms of biomechanics is the study of the motion of living/inanimate objects, as well as the working forces and the resulting effects through a mechanical approach. While mechanics itself is part of the discussion in physics that studies how power can produce a certain motion as desired by athletics.

The study of sports biomechanics is divided into two fields, namely statics and dynamics. The field of statics deals with states when all the forces acting on the body are in states when the body is in an unbalanced state.

the field of ergonomics information research. Namely research on human physical strength when working and studying how to work and equipment must be designed to suit human physical abilities when carrying out these work activities. In biomechanics, there are many disciplines that underlie and are related to support the development of biomechanics.

Biomechanics, among others: To explain each component of all body systems and their interactions. To simulate hazardous conditions, it is difficult to measure the time and cost involved in doing a job. To estimate the maximum load that is safe to lift. So it is necessary for all workers to study or know the science of biomechanics in order to reduce the risk of accidents to workers as the next generation of writers feel compelled to write and explain about "biomechanics". Complicatively, the author's role is not much compared to the findings of the experts.

II. Review of Literature

2.1 Definition of Biomechanics

Biomechanics is a combination of mechanical science, anthropometry and basic medical science (biology and physiology). Biomechanics is a science that discusses the mechanical aspects of human body movements. In the world of work the concern is the strength of muscle work which depends on the position of the working limb, the direction of the work movement, the difference in strength between body parts and age. In addition, the speed and accuracy as well as the resistance of the body's tissues to the load.

Several definitions of biomechanics by experts include: Biomechanics of human movement is a science that investigates, describes and analyzes human movements (Winters, in Haryanto, 2000).

Biomechanics is a scientific resource discipline that integrates the factors that affect human movement, techniques and knowledge to analyze biomechanics drawn from basic knowledge such as physics, mathematics, physiology chemistry, anatomy and engineering concepts to describe the movement of these body segments in carrying out daily activities. days (Rendgers, in Haryanto, 2000).

Mechanics is a branch of science from the field of physics that studies the motion and shape changes of a material caused by mechanical disturbances called forces. Mechanics is the oldest of all branches of science in physics. There are names such as Archimides (287-212 BC), Galileo Galilei (1564-1642), and Issac Newton (1642-1727) who are the founders of this field of science. Galileo was the founder of analysis and experimentation in dynamics. While Newton summarized the phenomena in dynamics in the laws of motion and gravity.

Engineering mechanics, also known as applied mechanics, is the study of the application of the principles of mechanics. Applied mechanics studies the analysis and design of mechanical systems. Biomechanics is defined as the field of application of mechanics to biological systems. Biomechanics is a combination of the disciplines of applied mechanics and the sciences of biology and physiology. Biomechanics concerns the human body and almost all living bodies. In biomechanics, the principles of mechanics are used in drafting, analyzing, designing and developing equipment and systems in biology and medicine.

According to Frankel and Nordin in 1980 biomechanics is the science of engineering mechanics for the analysis of the human musculoskeletal system. (Chaffin, 1991) generally defines biomechanics, namely: Biomechanics uses physics concepts and techniques to explain the movement of various body parts and the forces acting on body parts in daily activities. The study of biomechanics can be viewed in two perspectives, namely kinematics which is more directed to the characteristics of the movement, namely examining the movement in terms of space used in a temporary manner without looking at the force that causes the movement. The study of kinematics describes the motion that causes how fast an object moves, how high it is or how far an object spans a distance. The position, velocity and acceleration are kinematics studies. The study of kinetics explains the forces acting on a system, such as the human body. The study of motion kinetics describes the forces that cause motion. Compared to kinetic studies it is more difficult to observe, in kinetic studies what is seen is the result of forces.

According to Agus Wibisino "Biomechanics is a science that uses the laws of physics and engineering concepts to study the movements experienced by several body segments, several body segments and the forces that occur on these body parts during normal activities". Biomechanics is a science that discusses the mechanical aspects of the movements of the human body. Biomechanics is a combination of mechanical science, anthropometry and basic medical science. Biomechanics can be applied to: 1. Redesigning existing work; 2. Evaluating work; 3. Screening of employees; 4. Manual handling tasks.

There are three basic biomechanics, namely:

a) Newton's First Law

   That is, an object will remain in a resting position or in the same state of motion unless given a force that can eliminate balance.

b) Newton's Second Law of Motion

   This law states that the acceleration of an object (how fast its speed increases) is proportional to the force exerted on it. This can be summarized by the following equation: Force = mass x acceleration. A force of 1 Newton applied to an object of mass 1 kg will give it a speed of 1 m/s (ms-1). Pushing a gurney imagine where you have to push a trolley or bed. At the beginning of the movement there is acceleration. Normally, an object is moved at a constant speed so it is no longer accelerating and is exerted less force. To

move an object we must overcome the object's inertia. If the inertia is exceeded, then the force required to keep it moving will be less.

c) Newton's Third Law of Motion

This third law states that 'for every action there is an equal and opposite reaction and this helps to explain the idea of balance of forces already mentioned. Figure 1.5 Patient lying in bed Patient lying on bed, we realize that the bed supports the patient. Without a bed, the patient will fall to the floor.

1. Style on the body

There are 2 types of force on the body, namely the force on the body in a static state. Gravity and Muscle Forces as a Collecting System The body in a state of static means that the body is in equilibrium, the sum of the forces and moments of the forces that exist is equal to zero. The bones and muscles of the human body function as a lever system. The body is in a state of static, meaning that the body is in a state of equilibrium, the sum of the forces and moments of the force being equal to zero. The bones and muscles of the human body function as a lever system.

2. Force on the body in a dynamic state. There are 3 classes of system collectors:
   a. First Class
   b. The fulcrum is between the force of gravity and the muscles Example of the head & neck
   c. Second Class
   d. Gravity between fulcrum and muscle force, for example, heel tiptoe
   e. Third Class

Muscular forces located between the fulcrum and gravity Example: arm muscles Forces are most often applied to stabilize an injured extremity neck, back, pelvic area Therapeutic traction is achieved by applying traction to the head of the body or limb in at least two directions, eg traction pull and opposing traction pull . The opposing traction force or both forces are usually derived from the patient's body weight at rest or other weights.

Application of Style Analysis in Applied Health Body Weight & Spine Healthy Sitting Position

Traction in Clinical Practice Traction is a resistance that is used with other heavy equipment to treat damage or disorders of bones and muscles. The purpose of traction is to treat fractures, dislocations or muscle spasms in an attempt to correct the deformity and promote healing. There are two main types of traction, skeletal traction and skin traction, in which there are a number of treatments.

The principle of traction is to pull a resistance that is applied to a part of the body, legs, pelvis or spine and to pull a resistance that is applied in the opposite direction which is called countertraction. Prisoners in traks are based on the third law (Footner, 1992 and Dave, 1995). Traction can be achieved by hand as manual traction, use of splints, and weights as in skin traction and through pins, wires, and tongs inserted into the bone for skeletal traction (Taylor, 1987 and Osmond, 1999). Traction can be performed through the skin or bone. The skin is only able to handle a traction load of about 5 kg in adults. If more than this is required, bone traction is required. Bone taxis are generally avoided in children because the growth plate can be easily damaged like bone pins. Indications for skin traction include for children who require closed production, temporary traction before surgery, traction requiring weights 5 The consequences of skin traction overload include skin necrosis, vascular obstruction, distal codem, and peroncal nerve palsy in leg traction. Bone traction is performed on adults who require a load of > 5 kg, there is skin damage or for long-term use of Tama Contratraction is needed to counter the traction force, ie by placing the leg higher on traction performed on the leg.

Basically biomechanics is a relatively new branch of science and is developing dynamically. However, in fact the field of science has existed since the fifth century Bolas Maschi when Leonardo Da Vinci (1452-1519) made a note of the significance of mechanics in his biological studies. Contributions from researchers in the fields of biology, medicine, basic sciences, and engineering coloring the development of biomechanics lately

2.2 The Importance of Biomechanics

The application of this knowledge is important in ergonomics, considering that in the work environment, especially in the industrial environment, humans are always in contact with the external physiological and mechanical environment which must be balanced with physiological reactions and internal mechanics.

The industrial environment here, unlike the agricultural environment for example, is a unique environment. First, because work in industry is designed by humans, carried out by and with the main goal of maximizing human performance with a measure of economic efficiency. The performance of the comfort of the working population has been proven to greatly support the level of worker productivity, thus the safety and comfort factors in thinking about the human biomechanical hazard factors, the person in charge of work must think about the biomechanical hazard factors.

Physiology and behavior that are often unthinkable in designing an industrial environment that is oriented towards economic efficiency in this modern industrial environment, efficiency is a by-product of industrial comfort, which does not cause back pain, shoulder or wrist pain that makes workers suffer.

2.3. Applied biomechanics

NIOSH (National Institute for Occupational Safety and Health) is an institution that handles occupational health and safety issues in America has conducted an analysis of the factors that influence biomechanics, namely:

1. The weight of the object being moved, this is determined by direct loading.
2. The loading position with reference to the body, is influenced by:
   a. Horizontal distance of the load displaced from the center of gravity of the body
   b. The vertical distance of the load transferred from the floor
   c. Angle of load transfer from a sagittal position (lifting position directly in front of the body)
3. Transfer frequency is recorded as the average transfer/minute for high frequency transfers
4. The period (duration) of the total time applied for transfer to a record. Biomechanics can be applied to:
   a. Redesign existing work
   b. Evaluating work
   c. Employee screening
   d. Manual handling tasks.

III. Result and Discussion

3.1. Motion and Style

Force is a concept used to describe the physical interaction of an object with its surroundings. Force in physics is defined as a quantity that can cause a change in the state of an object so the object is accelerating.

3.2. Human Body Movement

The Greek philosopher Aristotle (384-322 BC) was the first to conduct a systematic study of the movement of the human body

Many principles describe the action and movement characteristics of muscles. Although Aristotle's discoveries to explain movement are full of contradictions, the early efforts he has made have laid the foundation for later studies such as Galen's (131-201). Galileo (1564-1643), Borelli (1608-1679). Newton (1642-1727). and Marey (1830-1904) The studies of these philosophers and scientists have resulted in us being able to prove that the movement of the human body is a consequence of the interaction between muscles and gava caused by the environment around the human body. As Aristotle wrote that a walking animal makes
its position changes by pressing what is below it. This statement emphasizes that in the study of movement must emphasize on (Higgins, 1985):

- Characterization of physical interactions between animals (humans) and the environment
- Determine animal (human)organize the physical interactions. With a framework like this, the body movements of biological systems can be recognized as the result of interactions biological system with the surrounding environment, the following factors also determine the interaction:

That way:

- Structure of the environment
- (shape and stability)
- Field of force (direction relative to gravity, speed of movement).
- The structure of the system (bone structure, muscle activity, arrangement of body segments, size, fine motor integration)
- The role of psychological states (motivational activity level)

The shape of the movement to be worked on (the framework of the organization of the movement). Higgins stated that movement is an integral part of the structure that is support it and the environment define it

3.3. Goniometry

The term goniometry comes from the Greek. Gonia which means angle and metros which means measure. While the geniometer is a tool to measure the angle Gonimetry relates to the measurement of the angle formed by the segments of the human body organs that are connected by joints. In practice, the measurement of angles and joints is done by attaching a goniometer to the segment whose angle is being measured. Goniometer can be used to measure the angle at a certain position or continuously in carrying out a movement.

3.4. Modeling

Certain assumptions are needed to simplify a complex system so that an analytical solution can be achieved. A complete model takes into account the effects of all parts of the system in detail. However, a complete and detailed model is difficult to realize and if possible it will be difficult to produce a solution to the problem to be solved. It is not always possible to model a complete system and sometimes it is not even necessary to include every detail of

the system in the analysis. For example, in almost all movements of the human body, many muscle groups are involved in moving the organs of the body. However, for the purposes of analyzing the forces involved in the joints and muscles in a particular movement, the best approach is to predict which muscle group is the most active and ignore the other muscle groups.

In general, modeling a system always begins with a simple model. From this simple model, the complexity is gradually increased in line with understanding

system characteristics and from observations of the simple model Researchers can design a model that is simple enough to be analyzed so that it shows the phenomenon under study within certain limits of satisfaction. From the knowledge of the system modeled by a simple system, it is then refined. The more you learn, the more you understand from the system and the more detailed analysis you can do.

Modeling the movement of the human body can be classified based on the approach taken. A theoretical approach that uses a knowledge base in the field of physiology. mechanics, and robotics to design mathematical equations that express the motion of the human body. Furthermore, gait can be studied by simulation using the model and the results are compared with the original data measured from humans. Gait measurements directly to obtain a representative model describing the relationship between variables in the movement of the human body.

These two approaches will meet, especially if a study of human body movement is directed at a specific application, such as pathological analysis or rehabilitation of a particular paralysis.

3.5. Muscle Style

Movement and body balance controlled by muscle force This muscle style due to muscle contraction. While this muscle contraction is caused by external force stimulation

Example: If one of our limbs, for example the arm (figure 2.1) gets a force from the outside, the biceps will contract to react to the external force.

So that this event finally produces an action-reaction mechanical force.

Figure 1. *Arm Mechanism*

There are 2 types of movement that need to be known, namely:

Flexsion is movement inwards Extension movement outwards both of these movements actually involve a large number of muscles as locomotion. However it can be simplified as follows:

Primary mover muscles that play an important role in each movement Assistance muscles (assistors) function to prevent excessive movement by the primary mover.

The maximum force a muscle can exert on the joint area of the human body ranges from 40-50 lb/m? (1 kg = 2.21 lb)

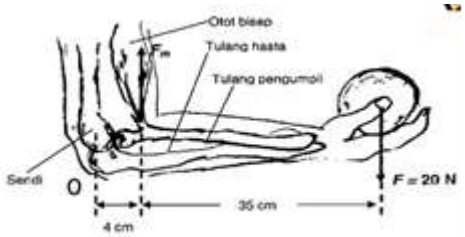

Figure 2. *Principle of Torque on the Arm*

Information :
1 = biscp (upper arm)
2 = triceps (forearm) la flanion
1b = extension- shoulder
0 = cubit
0" = tip of the cubit

3.6. Fundamentals of Anatomical Mechanics 3

There are several principles of mechanics that apply to the use of human anatomy, including:

1. Equilibrium (Newton's First Law F = 0)
2. Torka (Style Moment)
3. Unraveling (Vector)
4. Law of action-reaction (Newton's third law FF). In solving this anatomical mechanics problem, the things that need to be understood are the principles of mechanics above. In addition, it is necessary to master the arrangement of body parts, and be able to make schematic diagrams to make it easier to understand the application of physics concepts to the human body.

IV. Conclusion

1. Biomechanics is defined as the field of application of mechanics to biological systems. Biomechanics is a combination of the disciplines of applied mechanics and the biological and physiological sciences. Biomechanics concerns the human body and almost all living organisms. In biomechanics, the principles of mechanics are used in conceptualizing, analyzing, designing and developing equipment and systems in biology and medicine
2. Biomechanics is a scientific discipline that integrates the factors that affect human movement, which are taken from basic knowledge such as physics, mathematics, chemistry, physiology, anatomy and engineering concepts to analyze the forces that occur in the body.
3. Forces on the body are of 2 types, namely: Forces on the body in a static state and forces on the body in a dynamic state
4. Newton's First Law: An object continues to be at rest or moves at a constant speed unless the object is affected by an unbalanced force, or a net external force.
5. Newton's second law the acceleration of an object (a) is inversely proportional to its mass (m) and proportional to the net force (F) acting on it: F=ma.
6. Newton's third law: Forces always occur in pairs. If an object exerts a force on object B, an equal and opposite force is exerted by object B on object A.

References

Gabriel, S (1988) Medical Physics, Jakarta ECG

Mahayana, Mukti (2009) Biomechanics. From http://moektimaha 17 Ordpress.com/2009/11/03/biomekanika

Munasco. Hamid. A (2002) Physics is the Basics of Science for the Health Sector Jakarta: Citizens' Efforts

N. Ozkaya and M Nordin (1999) "Fundamentals of Biomechanics. Equilbrium, Motion, and Deformation." Second Edition, ISBN 0-387-98283-3, Springer-Verlag, NY

Norkin and D. J. White (2003) "Measurement of Joint Motion: A Guide to Goniometry, Third Sprial Edition, ISBN:0-8036-0972-8.F. A. Davis Company

Purnomo, Eddy (2007) Guidelines for Teaching Basic Arlenik Movement Yogyakarta Faculty of Sports Science, State University

RM Enoka (2002) "Neuromechanics of Human Movements. Third Edition, ISBN 0-7360-0251-0, Human Kinetics, IL

Sulaiman, et al. (2020). The Evaluation of Athletic Extracurricular Management of Dr. Soetomo and Jalan JawaJunior High School in Surabaya. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal. P. 11-19