

Introduction to the concepts of biomechanics

Hello everyone and welcome to this module on Introduction to the Concepts of Biomechanics. In this section, we will start with a quick recap of the concepts covered so far. Then we will look at the scope and importance of quantification of movement. In the previous module, we studied about the muscular and skeletal system, which consists of bone, muscles, tendons, ligament, and soft tissue. Musculoskeletal system provide body its shape and structure. Let us assume there is no musculoskeletal system; then, our bodies will be nothing but a sack of gel.

Musculoskeletal system also help to protect the vital organs of the body, such as lungs and heart, from the external forces or trauma. However, our main reason to study musculoskeletal system in this course is because of its importance in movement production. We also discussed about the various anatomical motions at different joints. These movements help us to visualize and understand the action of muscles on the skeletal system.

For example, how different segments move with respect to each other. Knowledge of this terminology also help us to perform a detailed analysis of movements. For example, when a complex movement occurs during day-to-day activity or during a sporting activity, we can break down that complex movement into simpler movements using this terminology. This also help coaches, athletes, and sports science staff to talk in a common language. For example, like it work as a language between people who are from different geographical locations, but in order to convey their ideas or have a conversation, they need to understand or learn a common language.

So these anatomical movements will provide that communication between different stakeholders, for example, athletes or coaches, or sports science staff. So, the next thing which comes to our mind is why we have to quantify the movement. So, there are like certain activities. For example, like there might be individualistic activities or there might be like team sports activities. So why we need to quantify these movements? So, quantification of movements provide a solid foundation for understanding, analyzing, and enhancing athletic performance. That is, it will help us to understand, analyze, and enhance the athletic performance while we can reduce the risk of injuries.

It also allows us like to have a evidence-based decision-making process for coaching, training, and research activities in the sports science. There are several reasons why we need to quantify the movement in biomechanics. However, some of the important ones include mechanics of movement. So this includes the mechanical aspects of motion. So here, we will utilize the principles from physics and engineering to examine and understand the movement.

This analysis will provide us information with joint angles, like how different joints are moving during that activity or the moments and forces being produced at different joint, or how the muscles are activating or deactivating during that movement. This analysis also helps us to understand the movement pattern during various activities. For example, in day-to-day activities like walking, what is the typical movement pattern when a normal human being walks or a specific sporting activity for example, a throwing in cricket or bowling in cricket? So how those movement pattern

will look like? So, this mechanics of movement, the concepts from mechanics of movements, will help us to understand those movement patterns. Another important aspect like which we can use quantification of movement will help us to understand or identify and treatment of the injuries.

So, it helps us to identify the abnormal movement patterns. For example, how to land properly after a jump? So, if we know exactly how we should land during a jumping activity, that might result in prevention of an injury which might be due to abnormal movement patterns. This also help us to have information on the forces which act on the body parts during activities or a specific activity. For example, when a sprinter is running, how much forces or movements being generated at different joints, such as like ankle joint or the knee joint? This understanding will help us to identify the cause of an injury and later on help us to treat that specific injury. Musculoskeletal injuries results from like overuse or sometime with the abnormal forces.

So this quantification of movement will help us to understand those extreme range of motions or the forces being exerted on different body segments. Movement quantification also help us during the rehabilitation process. Once an athlete or an individual got injured by providing inputs on the progression of the loading during the rehabilitation process and in totality, it will help us to make the athletes ready to return to sport after an injury in a timely manner. Another important aspect which we look from quantification of movement is in performance enhancement. So performance enhancement provide objective feedback.

For example, every athlete is different and respond differently to a training program. So, this objective feedback will help coaches or the trainers to provide athlete specific training programs. It also help in minimizing the inefficient motions. For example, during sprinting, how much upper body or upper limb should move in your transverse plane? So, in that, it will help us to understand those inefficient motions and then optimize the technique or strategy to make certain adjustments that can help in optimizing the performance.

In recent few years, quantification of movement is also widely used in the design of equipment which can range from training equipment or the implements being used in sporting activities. This help in the design and modifications to maximize the performance. For example, design of resistance machine which ensure the forces which are applied should match the body's natural environment or movement patterns to avoid the injury. So this design, based upon the biomechanical factors, help in the reduction of injuries. For example, the newly designed and modified treadmills or elliptical machines, or stationary bikes provide better and efficient as well as ergonomic exercises, which will reduce the risk of injuries.

It also help in the designing of equipment which are safe and efficient. For example, running shoes is a very common example that reduce the risk of injury and also enhance the running efficiency. Another example would be badminton and tennis racquets. So, they were designed in such a way which can optimize the power and control. How they do it? By controlling the stiffness of the racquets, weight distribution as well as the grip size of the racquets.

This information from the movement quantification also help in designing the latest protection and safety gears. For example, the new helmets can absorb and distribute impact loads or forces more effectively and reduce the risk of head injuries. Knee and elbow pads which are generally used in sporting activities, are designed in a such a way they provide both protection as well as mobility for the better performance. With these specific examples, we now have a better understanding of the scope and importance of quantification of movement. So, in summary, we can say the quantification of movement help us to understand the mechanics of movement by looking at the position and forces of the by looking at the position of various segments and joints of the body or looking at the force distribution at various joints.

It also help us to identify and treat the injuries, which include the diagnostic as well as rehabilitation purposes. It will also help us to improve the performance by identifying the areas where the technique can be further improved and then optimize for better performance. And finally, in the design of equipments where this knowledge will help us to design more efficient and comfortable equipment. In the following sections, we will discuss more about the methods and tools used for quantification of movement.