Implications of Functional Anatomy in HMS

Hello, welcome to Module 3, Function Anatomy. Today we will be looking at the implications of functional anatomy in human movement science. So previously we have looked at the human body, the skeletal and the musculoskeletal system. We have also understood the neuromuscular system and the functions of all of these systems. Furthermore, we have looked at functional anatomy, looking at different planes of motion, axes of motion, how does movement occur, the joint types. So today, we will be looking at how important is this information for us and why is it crucial to understand human movement science.

So, the learning outcomes with this module would be understanding functional anatomy, just a quick recap of what it is and its significance in human movement science. We will also be looking at different key elements or functional elements of range of motion, flexibility, and mobility. So we will be defining these terms and understanding how they are important and why they are important. We will also be looking at anatomical discrepancies.

So, what is anatomical discrepancy? How does that have an impact when we study movement? So, anthropometry and its implication in human movement science. So functional anatomy, just a quick recap, it provides the foundation for movement analysis as it provides an understanding of the structural components and the mechanisms in the human body. It is fundamental in understanding the concepts of human movement science, injury mechanisms, and performance patterns. So, for an example, it aids in the identification of joint axis. So, we have looked at previously how the joint actions are involved, how it depends on the type of the joint, on the nature of the joint.

So, it helps us identify joint axes, planes of motion, muscle attachments, wherein understanding of force transfer between segments is quite important for us for kinetic calculations at a specific joint. So, what are some of the significance of functional anatomy for movement science? So let us look at these in total and then we will dwell into each one of them. So, they help us in identifying vulnerable structures, muscle functions, so they help us in understanding how the muscle functions. Performance patterns, quite important for us to understand how we are aligned if we have one or the other limb which is shorter or longer and hence that can have an, sorry, shorter or longer which might affect a performance pattern. It also has applications in ergonomics, so for example design of workspace environments like your workspace chair, giving you utmost comfort.

Lever systems, so it helps us understand the different lever systems in the body which we will be looking at in the upcoming modules in the module of biomechanics and kinesiology. You will be understanding the mechanics of lever systems and how they would be and how it is quite key to understand movement. We will also be looking at joint mechanics. So, in the upcoming modules, you will be looking at how biomechanics is key for us to understand movement science. So, we will also be looking at different assessments of functional anatomy and injury mechanisms.

So let us look at the first one, which is identifying vulnerable structures. So, identifying locations and function of vulnerable structures such as muscles, tendons, ligaments, and joints to comprehend the underlying mechanisms of injury risk. So, it is extremely important for us to understand if, for example, a certain joint or muscle is being overloaded, overworked, hence it becomes a vulnerable structure and possesses risk of injury. So quite keen for us to understand the vulnerable structures. Muscle function, so the knowledge of muscle origin, insertion, fiber direction, and the contractile properties are quite important, as we have looked at in the muscle physiology, which is in the previous module.

It is quite important for us to understand this knowledge, I mean to understand the origin, insertion, and fiber direction for us to understand movement. So that helps us in determining how muscles contribute to joint movement and force production. Lever systems, so we will be looking at these in details in the upcoming modules, but for our understanding over here, recognition of lever systems within the body are quite critical for understanding how force is generated, transmitted, and applied during movement. It is also essential to assess mechanical advantages. So based on how force is generated and transmitted, you will also be looking at certain mechanical advantages and disadvantages that an individual might possess that might hamper or help in efficient movement.

Joint mechanics, so the understanding of joint structures, joint types, joint range of motion and the role of ligaments and cartilage in joint stability is crucial for the understanding of joint biomechanics to study movement. Injury mechanisms, so the identification of potential risk factors, so for example, if you have any muscular imbalances that might create biomechanical alterations or anatomical discrepancies, which we will look at in detail in the coming few slides that has the potential to alter your movement patterns. right? So, this helps, this information helps the biomechanist to develop better strategies for injury management. So, if your one limb is shorter than the other, you need to have certain kind of considerations as a biomechanist to help the athlete manage the injury better. Performance patterns, again it helps us in the assessment of inefficient or dysfunctional movement patterns that may lead to any discrepancies in performance.

So, it helps us identify if structurally we are any different athlete to athlete and helps us individualize that protocol for the athlete. Assessments, so performance analysts, strength and conditioning coaches, and healthcare professionals like physios, osteos, or any sports medicine professionals, they rely on functional anatomy assessments, right? So that is they also call functional movement screening. So functional movement screening or functional anatomy assessments are quite important to understand the underlying musculoskeletal conditions if any, that are associated with potential injury risk. Ergonomics, so ergonomics it helps us in designing workspaces, tools, and equipment that allow for any specific biomechanical considerations related to the natural movements, natural posture to keep them intact, and capabilities of the human body. So, this contributes to improved comfort and reduced risk of musculoskeletal injuries.

So, to understand functional movement, what are some of the fundamental prerequisites? Let's look at them. So, the functional elements help ensure that the body can move through the necessary transitions or necessary range of motion to perform functional movements safely and efficiently. So, it's the body's capacity to be able to perform the necessary range of motion safely and efficiently. So, what are some of the key concepts of the functional elements? So, the functional elements necessary for efficient movement are range of motion, flexibility, and mobility. So, let's look at these three concepts individually and how they have an implication on human movement.

Range of motion, so let's look at the definition of range of motion. Range of motion refers to the extent of movement, so the extent of movement achieved at a joint or a series of joints in the body and it's typically measured in degrees. So, what range of motion can a joint achieve? If it's actively achieved then it is active range of motion. So adequate range of motion in the joints allows the body to move through required range of motion for functional movements. So, you need an adequate range of motion to be able to perform the movement efficiently.

So, what are some of the range of motion assessments? How do we assess range of motion? So, goniometer is a specialized tool or a scale that helps us measure the joint angles. Another way of measuring range of motion is through active and passive range of motion. So, let's look at the active one. Active range of motion, the individual actively executes the movement. So, for example, if you touch your toes or if you flex your arm, you are actively performing the movement.

So that is looking at your active range of motion. Whereas for passive range of motion, it usually involves an external individual such as your physio or your doctor that move the joint to assess any restrictions or limitations. So, if you need to assess any restrictions or limitations usually your physio or your doctor would apply some kind of an external force or might look at just plain passive range of motion. So, what are the implications? Why is range of motion important for us to look at human movement? How does it have its implications? So, in sport performance, adequate range of motion, as we looked about earlier, is essential for performing various sporting techniques optimally. For example, a gymnast requires good shoulder range of motion to execute.

So good shoulder range of motion to execute complex maneuvers like handspring. So, imagine if you have restricted range of motion right, you won't be able to perform the movement actively no matter how strong you are. You need to have that free movement available at the joint. Let's look at injury prevention. So limited range of motion obviously increases the risk of musculoskeletal injuries. Now how would that happen? Imagine you are loading your tissues, you are loading your joint and you do not have that necessary range of motion right, and you are going above and beyond to produce a certain action.

So definitely cause limited range of motion will definitely cause stress or increased strain on the tissues or the skeletal elements, risking injury. For instance, limited ankle dorsiflexion, so as we can recap from the previous modules, ankle dorsiflexion happens in the sagittal plane may heighten incidence of ankle sprains, right, while playing soccer or any basketball. So, you know, ankle

sprains are quite common as a sport injury, so reduce range or a limited range of ankle dorsiflexion is one of the key factors or one of the important factors to look at if you are getting repeated ankle sprains. Another one would be in rehabilitation, so therapists work to restore or improve joint range of motion post-injury or post-surgery. So, when you are recovering from an injury, or you are recovering from a surgery before you get on to any kind of a strength training, you will always be looking at restoring the range of motion, the joint range of motion, for you to be able to then start regaining good functional movement.

Let's look at another concept which is flexibility. So, flexibility refers to the ability of the muscles, joints, and soft tissues to move through an unrestricted and pain-free joint range sorry pain-free range of motion. So, we've looked at range of motion. It's more about the joint's ability. Flexibility here refers to the ability of the muscles, joints, and soft tissue to move through an unrestricted and pain-free joint range of motion. So, it ensures that these structures the structures we looked at stretch or lengthen or contract without any limitations.

Now if they contract without any limitation, it allows for smooth and efficient movement. So how do we assess flexibility? So, one of the important or common tests to assess lower limb flexibility is the sit and reach test. So, the common flexibility assessments for the lower back and hamstring, so group of muscles in the posterior compartment and lower back. So, the individual sits with legs extended and reaches towards their toes. So, you can measure your flexibility for your lower back and your hamstring using the sit and reach test.

So, the different tests that look at flexibility. One such example is the sit and reach test. So, let's look at some of the implications of flexibility in human movement science. Why is it important for us to have good flexibility to perform efficient movement? So, for example, in sport performance, adequate flexibility is necessary to maintain good form or to have execute good technique. So, to maintain and execute good technique, for example, swimmers absolutely need good shoulder flexibility for an efficient freestyle stroke execution. Right, so imagine if there is no good range of motion or even if you have good range of motion, there's no good flexibility through which you can produce the force you're not going to be able to have an efficient or a sorry you're not going to be able to have an efficient stroke execution.

In injury prevention, so poor flexibility may lead to abnormal stress. So, you must have heard about pulling your hamstrings; if there's less flexibility or poor flexibility, it may lead to abnormal stress on structures and tissues that might result in tears. Right? So, muscle tears are due to pushing the muscle beyond their flexibility or straining them beyond their flexibility. It might happen that they are distant from the initial site of inflexibility. For example, tendonitis in the knee.

So, tendonitis is an injury of which is inflamed tendon. Right, so inflamed tendons in the knee or tendonitis can be related to calf tightness. So, if you have any kind of tightness in your calf muscles, it could result in tendonitis at the knee. So, rehabilitation, so flexibility exercises are often included

in rehabilitation programs as they may enhance postural stability, so you need good postural and balance, stability and control when combined with resistance training.

So, you will often find that if you're recovering from an injury or recovering from a surgery you will have flexibility protocols to improve your flexibility along with resistance training or strength training. Another concept that we want to look at here is mobility. So, we've looked at range of motion which is related to the joint. We've looked at flexibility, and now let's look at what is mobility. So, mobility refers to the ability of a joint or series of joint to move freely through their range of motion.

It's the ability to be able to move freely through their full range of motion. So, it involves the coordination of the skeletal structures like muscles, ligaments, tendons, and other soft tissues to control and coordinate the movement patterns. So be able to be mobile whenever you look at coaches telling your athletes we are certain strength and conditioning coaches you've used needs to be mobile. The joint needs to be mobile. It's the ability to move freely through their range of motion. So, it involves the coordination of all of these to be able to produce a coordinated movement pattern, and it's crucial for performing movement or sorry functional movements efficiently. So, let's look at how can we assess mobility. So, there are different ways of assessing mobility and together, these tests are called functional movement screening.

Functional movement screening are a series of tests that assess various functional movement patterns. So, for example, squat so your ability to squat or to lunge and or to reach. So functional movement screening looks at all of these abilities to ensure that you have good range of motion, good mobility as they assist in identifying movement limitations or dysfunctions. So again, just reiterating you need to have or your athlete who you're working with needs to have good range of motion, good flexibility, and good mobility for you to then proceed with loading those actions or those movement patterns for the athlete to start strength training. Implications of mobility in human movement and sport let's look at what are some of the implications.

So, in sport performance, athletes with adequate mobility allow for smooth transition of moments. So, we've also already looked at this before. Injury prevention so good mobility obviously risks reduces the risk of overuse injuries. So, for example, proper hip mobility can prevent knee pain in runners so that your alterations of mechanics that are happening happening due to limited hip mobility might increase the load on the knee that might lead to knee pain. So, you need to ensure that you have good hip mobility to avoid the same. Now let's look at rehabilitation so mobility exercises are crucial in rehab programs, as we discussed before, and it's not only to address range of motion and flexibility, but it overall improves the functional movement pattern efficiency.

So, all these three, as you can see are the important functional elements in movement science. Now let's look at anatomical discrepancies. So, what does it mean by a discrepancy? So, discrepancy are can say changes or alterations. So anatomical discrepancies and movements so discrepancies in structural anatomy, so imagine your structural anatomy, and if there are any

alterations or changes so for example, variations in bone structure, muscle structure, and, or imbalances right, you could also have discrepancies in joint shape and other physical differences within the individual can have several impact or implications for efficient movement execution. So, let's see how do we work around these discrepancies and what these discrepancies could be. So, understanding these structural discrepancies is extremely important. So, if you're working with athletes, if you're a coach or if you're a sports scientist, or any kind of health professional working with athletes engaging in physical activities, it's absolutely important to understand if there are any anatomical discrepancies.

Why this would be important? So, if you're looking at tailored training programs, rehabilitation, and injury prevention strategies, it's important that we address and assess these discrepancies as they provide an opportunity for us to optimize performance accordingly. So, optimize individualized performance, and reduce the risk of injuries that might be associated with them. So, let's look at some of the implications. How do these anatomical discrepancies affect movement? How do they change it, and what are our considerations? So joint shape and range of motion so the implication would be individuals with variation in joint anatomy. So, for example, it could be a different shape, or you could have reduced range of motion or reduced mobility due to the change in joint anatomy. It could you could be susceptible, or the athlete could be susceptible to hip impingement or shoulder impingement, right, and they may have limited range of motion in certain movements. So based on the design of your joint or the shape of your joint, if there are any discrepancies, you could have hip impingement or shoulder impingement-like injuries due to limited range of motion. So how would that impact? So, reduce range of motion would affect your performance obviously by limiting the ability to optimally perform specific techniques. If you have a shoulder impingement doing anything like a shoulder adduction abduction, any kind of vertical motions, or even circumduction, everything will be limited. It may also increase the risk of overuse injuries as the body segments will compensate. So, for example, if your shoulder is not able to take the load or if there is limited range of motion and you're going beyond it, you might add stress or strain to the joint, or they might be some other joint that needs to compensate hence risking the injury sorry hence risking overuse injury. So structural differences in muscle anatomy, like variations in muscle length and diameter. So, from limb to limb, may potentially lead to muscular imbalances, and how would that affect? So that might impact movement patterns, of course, leading to inefficient or asymmetrical patterns. right? So, from limb to limb, if you have differences in muscle length, it might have an effect on asymmetrical movements. You would be stronger on one limb and not that strong on the other side, make compromise performance. So, for example, if you're a biker and you're on your bicycle or your cycle and if you have discrepancies in quadricep length or quadricep diameter, you might have the the limb that has stronger muscles on one side due to an advantage and weaker muscles on the other limb and it might cause compromise on overall performance, and if the activity is continued, it may pose high injury risk.

Let's look at limb length discrepancies. So, the implication would be individuals with differences in limb length, such as one leg being shorter than the other, may experience gait abnormalities. So

of course, if you have one leg shorter than the other or any kind of limb shorter than the other, then you would have differences in your gait cycle as the time, time of flight, all of the phases that we'll be looking at in the next few modules everything would differ. So how would that impact? So, these abnormalities can then affect your running and walking mechanics. There'll be a change or alteration in your mechanics. These could potentially lead to discomfort and injury, so it could be that the longer limb is taking lot of the load, and you are low, and repeated such loading is then causing a risk of injury, so it's causing discomfort and injury. So, what you might need in such scenarios are custom orthotics or insoles or any kind of shoe modifications that may give some height increase, or any such kind of modifications might be necessary to address these structural discrepancies. So spinal curvature variations such as scoliosis, for example, affects your posture and spinal mobility. Right? So having an extended perturbed curve at the spine at the cervical spine or at the lumbar spine affects your postural and spinal mobility. So, the impact of this would be all of your different curvature alterations might impact your performance, of course, and pose risk of injury as they affect your balance, your stability, your mobility functions, and your function alignment, importantly right during movement. So, they need to be taken into consideration and you need to have proper training programs in order to attend to these. Another anatomical discrepancy would be joint hypermobility. So, you might have heard you know individuals that have more joint range of motion at one or particular joint, so individual with hypermobile joints they have an extra allowance of a range of motion, so they have excess range of motion, now this could be good, and it could be bad as well. So, hypermobility can be advantageous in activities requiring extreme flexibility, for example, gymnastics or dance. So, if you do have hypermobile muscles, you can sorry hypermobile joints you might be able sorry you would be naturally having good range of motion and good at sport like gymnastics or dance. However, if you continuously keep on loading them, you might have risk of joint instability. Right? And pose an injury risk during loaded or rapid change in movement right or rapid change in direction. Another discrepancy would be bone density and strength, so variation in bone density so bone mineral density, and variation in bone strength depending on its diameter, nature, the length can affect an individual susceptibility to different stress fractures. So, example, if you have low density so low density would increase the risk of stress fractures.

For example, imagine cricket fast bowlers. They have a lot of loading happening through their spine, and if you have low bone density, that makes them more susceptible to stress fractures in the spine or any other bone-related injuries. So, it's important for us to monitor our bone health, bone density and to look at training programs or supplements accordingly. So, of course, how does an impact an athlete so athlete with lower bone density may be more prone to stress fractures and hence requires continuous monitoring, as we discussed, and incorporation of strategies to address these discrepancies. So, the last concept we'll be looking at is anthropometry. So, what is anthropometry? So, anthropometry is a concept that involves the systematic measurement of physical dimensions measurements and proportions of the human body. So, it involves various aspects of quantifying so it involves quantifying various aspects of the body's size, shape, and composition.

So, when we do biomechanical analysis, as you will look at in the further few modules, you will be needing anthropometric measurements, basic measurements of height, weight so these are your basic measurements, and if you're doing any kind of 3D analysis, you will also be requiring your limb length measurements, right? You would be also requiring that's it just keep. It should be also requiring limb length measurements. So, these are some of the key measurements that we require when we do biomechanical analysis. So why anthropometry is quite important for us in human movement science, and what are its implications? Let's look at them. So, it provides valuable data that provides insights for the design of equipment, training and rehabilitation strategies, assessment of performance to optimize movement patterns based on individual's physical characteristics. So, for example, if you're looking at the sport of tennis, if you're choosing a tennis racket for example, you would have to take into consideration the span of your you know of your hand, the length of your fingers, how do you grip around that if you need a wider grip, if you need a smaller grip and such case.

So, let's look at another example which is leg length. So, leg length is crucial for assessing gait mechanics, for example like stride length in running. Of course, your stride length in running differs if you're a shorter person. You would have a smaller, you know, stride length tendency to have a smaller stride length, whereas if you're a taller person, you might have a massive stride. So hence leg length is quite important for us to assess so that we can correlate with the findings when you do a gait test or gait assessment, or any running mechanics. This is also important for us to understand to adjust the saddle height for the cyclist. So, you would be if you are a cyclist; anthropometry plays a major role over here. So, the height of the saddle is adjusted according to your leg length.

Arm span. So, arm span is significant in a sport like basketball, for example and swimming, wherein an athlete's reach is quite influenced. So, if you are a basketball player, there's a tendency that you would see that the basketball players are quite tall, it gives gives them an advantage to reach the basket or to shoot the arc. Also, with swimmers you, you would have also noticed that swimmers who are taller or who have a wider arm span have an advantage over the others as it helps them in having a good reach. Foot dimensions. So, foot length, width, and arch height, which is quite important, is vital in selecting appropriate footwear.

So, you would know if you go to a lot of the sport shop these days that there are shoes that help you support your arch. So, if you they always ask question are you normal arched, or you have a high arch, or if you have a low arch and there are different shoes that cater to different arch heights and foot length and width. So, it's quite key for us to know that information when we are selecting appropriate footwear right for various activities like running, soccer, rock climbing or basically any prolonged activity. Another important significance of anthropometry is body composition. So, as we've looked at, measurements of body fat percentage and muscle mass are essential for us to assess an individual's body composition that may have an impact on performance.

So, for example, wrestlers, they need to maintain a certain weight or gain a certain weight to be able to, so BMI, which is your body mass index, you need to maintain a certain BMI to be able to compete and to be able to perform effectively. Also, endurance runners, so you will see a lot of the time that the endurance runners are quite lean and have quite lean muscle mass. So different body compositions are different requirements of different sport and they help us to optimize performance. So, understanding knowledge of your body composition is quite key to optimize performance. Shoulder width, so shoulder width can affect swimmers, stroke mechanics, for example of course leading to biomechanical alterations.

So, another one would be your hip width or shoulder width or arm span, as we looked at. So, all of these natural anthropometric measurements have an effect on swimmer's stroke mechanics. Designing equipment and environments, so anthropometric data as we looked at also helps us in equipment designing as we spoke about the tennis racket, workspaces. So, for example, your chairs you must have heard of ergonomic chairs that better support back and better support your spine if you're looking at prolonged activities or prolonged day at work in the office. Also, environments that are ergonomically sound, they accommodate the physical characteristics of the targeted population.

So, you must have heard if you're driving a vehicle for a long time, you also have lumbar support pillows. So, all those devices, sorry all those accessories are designed taking into consideration anthropometric data in mind. So, for example Formula One car, so car designing as we've looked at right now, designing car seats that accommodate different wide range of body sizes and shapes. So, if you're a petite person, whether if you're a tall person, if you had wide hips, or you have different shoulder span, your customized car seats would be according to your measurements to accommodate them.

So, let's look at implications of anthropometry. So specifically in biomechanical modeling. So anthropometric data is often fed into mathematical models to simulate and analyze movement patterns. So, we've looked at this earlier where we looked at limb length, height, and weight, height, and weight being absolutely important for us to feed into these mathematical models and then calculate your kinematics and kinetics. For example, if you want to analyze golf swing mechanics, you require information on individual's height, arm length, and joint angles. For clothing and equipment design, so parallel industries use anthropometric data to curate clothing and your gear that fits comfortably.

So of course, for your sizing, you need your anthropometric data. So, example designing running shoes that provide proper support based on foot dimensions, as we've looked at earlier. So let's understand what we've looked at in this module. So functional anatomy provides a foundation for movement analysis by providing an understanding of the underlying structural components and the mechanisms of human body. Functional elements such as range of motion, mobility, and flexibility, they help ensure that the body can move through the necessary ranges of motion to perform safe and efficient movement. And understanding concepts like anatomical discrepancies,

anthropometry is extremely important for us coaches, sports scientists, and healthcare professionals while working with the athletes or individuals that are engaged in physical activity.

Now this is very important to optimize performance and help reduce risk of injury. And lastly, anthropometry involves the systematic measurement of physical dimensions, measurements, and proportions of the human body. And it's quite a key concept in biomechanical modeling for clothing and gear designing and to understand underlying movement patterns.