

Introduction to Exercise Physiology & Sports Performance

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Lecture – 33

Body composition and its Implications (Part -1)

Lata is a college student and she is also a gymnast. She is very particular about her body image and presently she is in off-season. She asks you certain queries on body composition assessment. How frequently should I do a body composition analysis? What body composition method must be used? How to interpret the findings and set goals to achieve certain body composition goals before the competition? If you are looking for answers to such questions, you have landed in the right platform.

Welcome to this NPTEL offered course on introduction to exercise physiology and sports performance and to this module on body composition and its implications. You are with me Wing Commander Chandrasekara Guru. I am a sports medicine specialist and assistant professor in the field with armed forces medical services.

In this module, you will be learning about various models of body composition that has been proposed, body composition and its relation or association with performance, what is the current evidence, what are the various assessment methods that are available to analyze body composition and what is the general practice that is with respect to body composition globally and what is the best recommended practices for body composition.

So, body composition refers to all the components that make up the body. So, the components are water and the other fluids, muscle mass, body fat and bone mass.

So, let us see how body composition evolved. So, Dr. Albert Behnke is considered as the modern-day father of body composition. He was he in 1940s who conducted a study on body composition between football players and untrained adults. Later he also proposed reference man and women standards with respect to the body composition. Over a period, the composition in terms of various components have you know been identified and proposed with the advent of technology as well. So, initially you had two component model followed by three component models in 1960s and thereafter multi-component model with the advent of you know medical technology had multi-component models also from the 1990s. Also, the methods that were used to assess body composition also have evolved. Earlier it used to be simple underwater weighing or cadaver analysis during the 1940s. Now gradually they have kind of improved to such a state with you know development or you know inventions in the field of technology you have air displacement, plethysmography, also have 3d imaging systems to assess body composition. However, with such vast 90 years of evolution of body composition, there is not a single universally accepted gold standard measure of body composition. So, there's still a lot of scope for research to happen in this particular field.

So, let's see what are the different levels and models of body composition. So, I want you to focus on this particular table. So, when you see the table increases with respect to the various levels and the level starts from based on the organization of the human body. Say let's speak at

the level of atoms. So, atomic level you have the composition into multi-component model as oxygen, carbon, hydrogen, nitrogen, calcium and the remaining. In terms of next stage there is a molecular level. The molecular multi-component models involves the assessment of body composition in terms of the molecules that are involved in terms of carbohydrate, lipids, proteins, mineral deposits and water. Proceeding further in terms of a bigger organization that is as cells, then you have fat cells, body cell mass, inclusive the storage of fat, then you have the body fluids as ECF and ICF, and then you have the organic and the inorganic extracellular solids. Progressing further to level 4, it can be also in terms of tissues. So, the composition in terms of tissue as multi-components can be adipose tissue, skeletal muscle, bone, and blood. The final level 5 at a macro level would be the old body analysis as using, say, skin folds, girths, or the diameters, densitometry using a water as a reference method, and then segmental volumes. So, these are all kinds of old body methods of multi-component system analysis.

So, before proceeding further we need to understand certain terminologies. So, what is body mass? Body mass is the total amount of matter or material of the body. That is what the total body mass is. It is commonly interchanged with weight whereas it is not so. Weight is the one which has influence of gravity whereas mass doesn't have the influence of gravity, generally expressed in kg. The other important aspect is we divide the body mass into muscle mass. So, muscle mass is the total amount of skeletal muscles. It's very simple, and into body fat. The body fat percentage is the amount of fat relative to the body mass and it is again expressed as percentage of the total body weight. So, in the muscle mass similar to muscle mass you also have bone mass. Bone mass or bone mineral concentration or the density that is again the total amount of bone in the body. Further, body fat can be divided into two types of fat. One is the essential fat. Essential fat is the fat that is required for the normal day-to-day physiological function. Certain hormones are lipid-based hormones, they are required for your physiological function. They are not stored anywhere but then they are also considered as essential fat. Whereas you also have in the body the fat is accumulated in certain stores as storage fat. So, not only the adipose tissue which is called the storage form of fat also those, you know, fat which are stored around the organs, so, they are also considered the storage fat. And the entire mass which is divided of fat is called as fat-free mass FFM. FFM is total body mass minus the fat that gives you the fat-free mass. One common terminology which we keep on getting and it gets confused with fat-free mass is the lean body mass. Fat-free mass is not equal to lean body mass. How? Because lean body mass is also considering your physiological essential fat aspect. So, it is nothing but fat-free mass plus the essential fat that is the lean body mass. So, often it is confused with fat-free mass.

So, having known about the basic terminology we should also know what is the normal body fat values. So, for a young adult man generally this range between 12 to 15 percent and for a woman, it would range from 25 to 28. So, why this variation? Because for obvious reasons women have additional kind of hormonal influence in terms of fat deposition and it's because of the physiological nature of the hormones. So, there is a specific distribution of fat and that is why there is increased in the fat content in terms of increased fat in the breast tissue and additional deposition of fat along the hip and the gluteal region and the thighs. So, that constitutes for the increased amount of fat. Further, these values are just a guideline that's why it's in a range and it's based on the general population. So, for specific sport setting for the athlete there are so many other determinants which influence the body composition and

normative values have to be developed for a specific type of sport with respect to age, gender, and also the ethnicity. So, accordingly that kind of range has to be utilized in sports.

So, how do we utilize body composition? The body composition can be utilized for performance for the appearance aspect as well and also for the health aspect as well. So, let's see one by one from the performance perspective you have certain sports like aesthetic sports you know you have weight-sensitive sports like our weight category sports like combat sports, you also have gravitational sports which require more of you know twisting and gravity associated during the activity like running you know you have the short put throws and weight lifting you know gravitational sports which require which gravity plays an influence in this performance of these athletes. So, here body composition plays a role and the other aspect is the appearance. The other aspect is the appearance with respect to appearance you have certain sports like body building where the winner or the winner is basically judged based on the appearance of certain the shape of the muscles and the body structure. So, their body composition assessment plays a very critical role also in certain aesthetic sports like figure skating, gymnastic. Where maintenance of a proper expected body figure is required and the third one is the psychological aspect of as well. So, you have the body image becomes a major determinant in terms of maintaining one's appearance as well. So, that is also becomes an important kind of utility for body composition assessment and the third aspect is the health aspect. So, even in general population in individuals who are obese if you want to kind of it's a it's an disease now so if you want to control obesity it is better control if you have a body composition assessment. So, accordingly you can target the weight loss journey and the other aspect with respect to the sports per se is the relative energy deficiency syndrome or relative energy deficiency in sports called as REDS. Earlier it was called as female athlete triad, no more it is only restricted to females it has been attributed in both males as well as in females because of the relative energy deficiency in such individuals also a body composition assessment would be required. So, why body composition assessment in sports one is what we saw just now for the assessment per se and the second one is monitoring so the athlete is not made in one day or one particular cross-sectional assessment so it has to be a longitudinal monitoring of the performance and also you need to have research protocols for developing normative standards right which we discussed before. So, assessment may be made based on the components which are depicted. It can be body fat percent and fat free mass, generally used. Monitoring is obviously any time better than just mean monitoring the body weight and the BMI because these are giving holistic idea and they've been though they mean correlated with various diseases and you know the prognosis of various cardiovascular diseases still for sports per se for monitoring with respect to the lean body mass and body fat percent the body composition gives a better view about the training effect on the body composition or rather all body composition can influence the performance so it's vice versa and the research protocol is basically because of the various determinant factors that we have in body composition because of this it is necessary to have specific normative standards for that particular sports and for the age gender and ethnicity so that again requires body composition assessment.

So, we'll be speaking about the determining factors. So, what are these determining factors? So, the determining factors are one of the genetic potentials one needs to understand that body composition always cannot be completely targeted and you can kind of bring it to their ideal situation because it is predominantly dependent on genetic potential, age of the athlete, with age the body composition varies wherein after you reach peak you know muscle gain thereafter

with the age more than say 25 to 28 onwards there is increase in the body fat percent as compared to the lean body mass percentage so the with age the body composition varies with gender also we saw that between male and female the body composition differs with respect to ethnicity also it changes with respect to sports which the individual play or the position in a particular sport also the body composition and the requirement varies. It is also seen that the body composition varies with the performance level. So, a body composition of a less experienced novice player to a experienced player to a player in state and district level to a national to international level the body composition varies. Health status again as we mentioned health status again plays a major role in terms of the body composition factors. Also, the training status. The training status also determines the body composition.

So, what is an ideal body composition that we keep hearing? So, in this desire to always achieve a ideal body composition basically to improve performance in sports if you say so it is seen that the power to mass ratio depicted by the lean body mass has to have a role in the performance specifically in weight sensitive sports. The work efficiency also improves and it is correlated with the lean body mass in the in cases of aesthetic sports it is again the body fat percent which is generally taken into account accordingly it it helps me or accordingly the marking is given for the appearance so that again has a effect on the performance and as we discussed earlier the gravitational and the rotational movements are also dependent on the lean body mass so that lean body mass increase in the lean body mass is correlated positively in such sports in in also in this weight sensitive sports generally the target is to achieve this particular ideal body composition in a very short period using various pathogenic ways of weight loss. So, this is again not clearly backed up by evidence. Whatever I have said is all based on the perceived you know ideal body composition standards by the sports culture as such but then as this is again presented by the IOC the International Olympic Commission and Olympic Committee and the Medical Commission of that committee have come up with latest critical review wherein in 2023 wherein they have mentioned that there is no clear-cut you know high quality evidence to say direct association of body composition with the performance so there is still that is why I initially started and there is lot of scope for further research and further refinement of whatever perception that we already persist.

So, with respect to the body composition performance, as I mentioned in the latest critical review of various prospective and longitudinal studies and the intervention study, these are considered high-quality research studies. Based on these studies over the last few years, they have found out that most of the time, these studies are done with respect to body composition in endurance and long-distance sports. They've been done in team as well as in combat sports and weight-making sports. So, in this, they have some amount of evidence to state that with increasing lean mass, there is an indefinite positive correlation in increasing the peak power and the average power in cycling, increasing sprint performance and work economy in case of running events, long-distance endurance events. In case of racket sports, it is also seen that increasing lean mass is positively correlated with jumping skills, whereas the fat mass percentage or body fat percentage is negatively correlated in endurance sports with respect to the race time. Also, in team sports with respect to the average speed, this is the current evidence that we have with respect to body composition and performance.

In addition, in the case of weight-sensitive sports, there were a few intervention studies that have been done and they found that intervention in kind of maintaining the body weight by reducing less than 800 grams per week over a period of more than four weeks of extended

duration and the weight loss is not restricted to less than three percentage of the previous weight. So, in such scenarios, it has been found that they have contributed immensely to the performance of those athletes. So, these factors are essential and they've also found those who have used a short-term weight loss program and a pathogenic condition to lose weight, something like dehydration, not found to increase performance rather they are found to decrease the performance because of the sudden decrease in the lean mass as well. So, this is one thing that one needs to consider with respect to body composition and performance with the current available evidence. Also, in terms of lean athletes, those with less than 10% of body fat, it is found that the performance decreases with the decrease in the lean body mass as well as with respect to the power strength. Also, the cognitive performance of the individual is found to have low or negative mood aspects as well as some decrement in the health as well. So, that is one thing one needs to be aware of, especially they need to take care of individuals who are lean and they have less than 10 percentage of body fat. So, these people may have various deleterious health effects as well. Some studies were also done, prospective studies were done in talent identification, the role of body composition in talent identification and sports development, and it has been seen that body composition does play a role, but then it doesn't have a major chunk of the role. The major chunk of the role is mainly predominantly by the training-related or sports-related skills in these kids, in young athletes mainly the agility and the technical skills. Obviously, body composition has some role to play in addition with the other motor qualities with this required motor qualities and skills that are required for performance in that particular sports.

So, the ideal body composition. It is a perceived aspect that has been influenced by the role models, by the expectations within the sport from the coaches, from teammates, from the senior colleagues, from the administration, fans, also because of the existing sports culture per se. Also, in certain sports, the sports attire the athlete wears itself also gives a perceived thought about the ideal body composition and the perceived notion of athletic look. So, these are the various factors that have led to the perceived ideal body composition. Though at this point there's no specific ideal body composition which is been correlated strongly with performance, but still because of these social and cultural factors, we have this notion. Because of this, the athlete may even have adverse effects in terms of eating disorders or relative energy deficiency syndrome in an attempt to reach this perceived ideal body composition.

So, to summarize body composition, we saw about the definition of body composition and how body composition has evolved, the multi-component model from two component three component models, the way body composition assessment methods have progressed, but still the lack of a single gold standard method of measurement. Also, we looked into various terminologies which are commonly used in body composition assessment, the utility of body composition in various types of sports, the various determining factors, the body composition relation with performance with the current evidence that is available and advocated by the International Olympic Committee Medical Commission, and also, we discussed certain adverse effects of the perceived notion of ideal body composition.

So, for those of you who are interested further, you are directed to these textbooks. I will also want you to go through this open access article recently published in the British Journal of Sports Medicine as latest as 2023 this year by the International Olympic Committee, Medical Commission had a committee which has done this particular work on this best practices recommendation of body composition.

Thank you.