

Exercise Physiology- Part 10

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--of a lot of the high school coaches in strength and conditioning, football coaches, things like that. And also, we may want to talk about the personal trainers that are going around now. And I think right now, I would have to say that football coaches and some of the strength and conditioning specialists in the high school are much better than they've ever been.

I think a lot of them really have stepped up when it comes to the academic portion. I was talking to someone on the break. You know, 20, 25 years ago, a lot of the coaches were just people who had played before. Not necessarily any academic background, any teaching background.

The trainers themselves, the personal trainers, were people who had worked out. So if you went to a personal trainer, generally, they were just working out with you. Whatever workout they used, that's what they were teaching you.

That's changed. When I look at the clubs now and the Y's, I'm very comfortable with a lot of the trainers and the certification programs they have. I mean, things have changed drastically. You know, I once played sandlot football with the coaches. And at that time, athletic trainers, certified athletic trainers, there weren't that many around. I mean, certified athletic trainer, really didn't-- they didn't start the certification process till the '60s.

So I remember playing football once, and basically getting knocked out. I was playing linebacker. Tackled the guy with my head. Took out his knee. I woke up on the sideline. For many of you have had that concussion, it's a very nice, floaty feeling. And you wake up, and you look at the sky, and the clouds are beautiful.

And at that point, the medical exam is, are you OK? Yes, Coach, I'm OK. Go back in. So we can see how things have changed. When I first started, you know, I started with sports injuries in '75. As a student athletic trainer, I first started out with athletic training. As a student athletic trainer, when I graduated, and I graduated with a physical education degree, I was working part time as a trainer. You didn't need certification.

Right? So I never went for the certification. Now, when I look at some of the certified athletic trainers around, these people are tremendous. They really are. They do a great job of diagnostic skills, their rehab abilities. I would trust them with a lot of things.

I think you sometimes have to differentiate, though. We were talking about, some of the certified athletic trainers who don't work full-time at the schools, they work for orthopedic or medical groups. This is a trickier situation. Because a lot of times, they're actually assigned two or three schools.

They're not full-time at one school. So they're bouncing around. They don't get to know the kids. They don't get to know the athletes and the teams as well. So they're probably a little more hesitant to do some of the rehab that they would do if they were there all day, or if they knew the kids full time.

So I think you still get good triage. And they refer a lot of these athletes back to their orthopedic or medical groups, but I don't think you get that daily training that you get with that full-time athletic trainer who's there every day, like some of the college trainers who are there every day. . I think the athletes are getting some tremendous care there.

All right? So that's something to keep in mind. So I think the personal training has also gotten better. So I think there's been an upgrade in the people doing this type of work and taking care of the kids. All right. When we talk about the personal training, and when we talk about any strength and conditioning, we're going to talk about all the different methods.

And whenever you discuss something and have all these different ideas and all these different methods, what does it usually indicate? It indicates that no one really knows. Because if we had something that worked fantastic, that's what everybody would be using. So the fact that we have so many different ways of doing things, I think it goes back to one of our original premises, is you need to match up the patient, or the athlete, the goals, and how you can get to those goals with the least risk possible.

Now, we were still working on muscular strength. And I want to pick up now on plyometrics, we talked about yesterday, is the use of the stretch reflex to produce a greater explosion, a greater contraction. And we talked about the counter movement.

So with the counter movement, the whole idea is, if I want to get a good explosion, I'm going to stretch the muscles first, use the elasticity of the muscles and connective tissue, along with the stretch reflex. So if I want to do that, though, it has got to be a quick move.

If I'm using a slow move, I'm not getting the maximum out of that stretch reflex. So it has to be a quick move. So a lot of plyometrics now is based on this. It's how can we increase that stretch reflex. How can we increase the force? So we start using gravity. And the concept behind that is, if I'm on this step now, what I do is, if I jump down from the step, I get a little bit more acceleration.

And if I hit and jump up as quickly as I can, now I can get more of a stretch reflex, because I'm jumping off a height, rather than just do a countermove. All right? So you'll see plyometrics also always involve-- not always-- but often involve jumping off boxes and platforms and things like that. All right. So when we talk about jumping off the box and jumping off the platform, we get to the next, well, how high should you go? OK. Is there an optimum? A little is good. Is a lot better? And I think whatever you do, I mean, you can get to the extreme.

Dr. Joe Horrigan, a chiropractor out of Los Angeles who does a lot of strength and conditioning, if you ever want to read a great conditioning book on hockey-- and I don't get any kickbacks from this-- Joe Horrigan and his hockey conditioning. He's worked with a tremendous amount of athletes. He was the strength and conditioning coach for the LA Kings for a number of years. Just does a great job.

And he described a case history of an athlete who thought that he could get more out of the plyometrics if he increased the height, so he jumped off the roof of his house. Obviously, he blew out his knee, and that was the end of his career.

All right. I often wonder-- if you watch kids, kids are often doing plyometrics without adult supervision. And the example I often bring up with kids is what they'll do is you'll see a kid-- you ever see it when they're on the stairs, they want to see how many steps they can jump down off the staircase? All right?

If you take two kids, let's say you take two brothers-- and I'm bringing this from personal experience. Take two brothers, one is eight, one is 10, the 10-year-old jumps first, then the eight-year-old will go up there. And you know what? The eight-year-old will look. And if the 8-year-old thinks it's too much, they'll come down a step or two, as long as no one's egging them on. They'll know what's good for them. All right.

In New York, when I grew up, we used to do it off fire escapes. And I think I probably overextended my height. I think I have hip dysplasia from jumping off fire escapes. Once again, we didn't know that jumping off fire escapes wasn't good for us at that time. The training has changed. Now the vertical jump test is an excellent indication of power.

The vertical jump test has some real good correlation to power. And the vertical jump test, is you can do this in your office. And what you would do is you want to standardize it, but you can just have them lean against a wall in here, and see how high they can go. And in office, when we did this in the school setting, we didn't have the money.

Have you seen the Vertec? It's this large thing, and it has like, the little pieces going across, and you slap the piece, and it tells you how high you jump. But that's a lot of money. So we used walls and chalk. And what you do is they just put some chalk on their fingertips and come in here, or you can just measure right there.

And then, after you have how high they are in the standard position, then you measure their jump. So they come in. We always standardize. You can either standardize where they can have one foot where they can take a single step and jump, or they can just do the counter move and jump. All right? Your choice. We just did the counter move and jump. And they jump as high as they can, and they hit the wall in here.

So there is some skill. There is some learning curve with this. You may want them to do it a couple of times. And you can measure the difference between here and their jump. And you now have their vertical. OK? Let's say they have a vertical 23 inches. You have a high school kid, some strength, not too much. 23 inch vertical jump.

Now, when they're doing the plyometrics, how high can they go? Well, what you can do is you can take a step now. And instead of-- what they do is you can take like, a 12 inch step. They drop down off the 12 inch step, and jump up as high as they can. They should have a greater vertical with that step than they do under normal conditions.

If they have a greater vertical jump, they can use that step. And then you can go to the next height, maybe 16 inches. You'll know it's too high, because what will happen is, when it gets too high, when they drop down, they don't have enough strength to reverse it, what we call the amortization, where you hit and you jump.

They end up using more strength just to help dampen the landing. So when they jump, their vertical is lower, because they don't have the strength necessary to jump off, say, a 20 inch box. So when they jump off that 20 inch box, they use some of their strength just to balance, because they can't absorb the force properly.

So when they reverse it, their vertical is a little lower. That step is too high. So that's how you can come up with an idea of just how high they should jump or shouldn't jump. And that's a very important safety technique too, to help limit injuries.

OK. So you have the height on that. Plyometrics also is a strength. This is a serious strength exercise, so you always want to make sure that you have-- you would never do plyometrics two days in a row. You always have at least one day recovery. When they talk about safety in plyometrics, they talk about low intensity versus moderate intensity versus high intensity, any kind of box jumps or death jumps would be more high intensity. The lower intensity plyometric would be simple, repeated jumps. For example, just jumping up and down real quickly, driving your knees up to your hands.

That would be more of a low to moderate intensity. And we often talk about hits per workout. How many high impact contacts are you taking? So, for example, for a light intensity workout, you might only want to do, let's say to begin with, 120 contacts per workout. So that would mean if they do a set where they're going to do a single leg balance, where they're on one leg, and they do single leg bounce, and they do a set of, say, six, that would be six contacts. So if you want to, you could 10 sets of six, if you were just doing that one exercise. And that would probably be within their ability to cope without getting an injury.

If you had two or three exercise, then you need to divide that up into 10 reps for each exercise. So 120 might be a very low value. And an athlete who is really working hard might end up to a workout 240 contacts per workout. Now, some of this has been changed a little bit. Now, they have-- have you seen? They've done water plyometrics too. Have you seen plyometrics in the water? Where to decrease some of the impact and some of the stress on the joints, they're actually doing jumps in the water. But that's not really plyometrics, because you decrease the speed. It's almost like they've done upper body plyometrics, where you throw a ball against a trampoline, and it comes back.

But if you're catching and going all the way back and coming in slow, that's not truly a plyometric to begin with. OK? If we look at the history of plyometrics, once again, where does all this stuff start? Well, it starts probably before we know, but it became popular-- plyometrics probably became popular, I think it was in '76 in Montreal with the Russian sprinter Borzov. A Russian sprinter hadn't won, and then he won the 100 meter.

And they said, well, how'd you do the training? And, well, it came out that he was doing plyometric training. But I think plyometric training was probably used in track and field for a number of years. A lot of their workouts really are almost plyometric type training.

So you want to worry about safety from a clinician's standpoint. Plyometrics, the key to plyometrics, is decreasing ground contact time. You don't want the heel to hit the ground. When you're doing these plyometrics, you don't want the heel hitting the ground. You want everything coming off the toes. So what happens is you end up with a lot more pressure on the 4 foot.

So from a clinician standpoint, you may be looking to do a little bit more extremity adjusting in the foot to see if they're tightening up, a little more soft tissue in that gastroc and soleus. If they're hitting properly, there's probably a little less pressure on the knee than some of the other type of strength training they're doing.

And that is just a pretty-- just a real brief kind of introduction to plyometrics, you can get into sport-specific plyometrics. When we talk about plyometrics in training, really, the limit is your imagination. So when we used to train our basketball players-- because whenever you train athletes with strength, whether it's plyometrics or weight training-- the biggest thing you're worried about is, are you going to upset their motor skill?

Because strength training should be a supplement to their motor skills. You don't want to mess that up, and I have seen athletes who worried so much-- I've seen basketball players who do all their strength training, and they end up messing their jump shot up, because they're getting so much stronger. They're not used to it. So a lot of times, you can combine the plyometrics with the skill. So what we used to do to get the athletes, the basketball players used to, the increase in strength, the plyometric that we used to do for their jump shot is we would have him stand outside, and we would have just a simple milk crate or some sort of platform, and the jump shot would be is they would jump off of the box, and land, and do their jump shots. So rather than just practice jump shots, they would jump off the box, and that's where they would get the plyometric impetus. OK. Very effective.

You know, when you look at it- I don't know how many of you are basketball players and coaches. There's a reason why a lot of basketball players can go eight out of 10 during practice and one out of 10 during a game. First of all, they're not being covered. And two is, some of the best shooters I've seen in Minnesota coaching traveling, I've seen some great shooters. 13, 14. And you look at them and you say, they cannot make it. Why? Their release is too slow. So unless they develop a quicker release-- and they may develop it.

But so much of it is quickness. And if you can develop that during the practice session, they can then use it during the game. So that's the plyometrics. Now let's look at some of the systems of weight training.


And some of the basics, we'll break this down. I think the most basic is the multiple set system. Multiple sets. And if you're going to do multiple sets, single set. And the single set system has been-- I've seen it sometimes referred to as HIIT, which is High-Intensity Training. And there's also always been some debate over, which is better? Multiple sets or single sets for weight training?

And I would say up until the last couple of years, you could make a case for either one. There was good research behind either one. But I think clearly, we see that multiple sets works better. You get more of a return.

Now when we talk about multiple sets, how many sets are we talking about? Generally, three sets will do it for you. Can you get greater strength with a fourth set or fifth set? I think you can. Apparently, you can. But it's all about, how much return are you getting for the extra time you're putting in? You're probably going to be most efficient at getting three sets.

And when we talk about athletes, what we're trying to-- we don't want them living in the weight room. Three sets seems to be the best. Now, when we talk about the single set, you can get benefit from the single set. And some schools, they still rely on single set system, once again, because it does keep them out of the weight room too long, and they can still work on a lot of their skills and work their team practices.

OK. So they can get good benefit. I've seen a lot of cases, though, where some people, they need that first set just to warm up and can't really go to a single set. The other thing is, in the single set system, they say, you know, you just do one set until failure, and you move on to the next exercise.



But if they do eight or 10 exercises, often, they using some of the same muscles. So those same muscles are probably getting four to five sets of exercise at different angles and a little slightly different, maybe, motor pattern. But they're still getting primarily four to five sets of exercise still. So that's multiple set versus the single set.

Circuit training is another one that's often used. And this is where you go from exercise to exercise with no stop. You try to get a cardiovascular effect at the same time. You're trying to add some endurance. Now will you get an actual endurance effect? Yes. If you can go from machine to machine without resting, a lot of times what you'll do is you'll do upper body, lower body, upper body, lower body.

So while you're doing your lower body, your body gets a chance to recover a little bit. You do that, you can get an effect. You're not going to get near the effect that you would get if you were doing an endurance exercise. You can't think that circuit training is going to replace it.

OK? Many athletes, though, have had some really good results with doing circuit training as a supplement. Once again, it's quick, it's efficient, and it can work very well. I think when we talk about weight training, you want to talk about what they call the split routine.


And there are a number of different ways of splitting up a routine. The whole idea is you work out every day, but while one day you work out one part, the other day while you're working that out, you get a chance to recover.

So a split routine-- now a split routine could easily be divided up into one day, you do upper body, one day, you do lower body. Some will do, they'll split it up differently. They'll say, OK, let me do arms and back and legs and shoulders. And I'll do the abdominal every day. So they'll do that kind of split.

There's also the system, what they call the pull press system, where one day you'll do all pulling movements, which are generally going to be a lot of the upper back, all pulling. And then the next day, you'll do almost all pressing movements to work the opposite. So you can do those kind of split routines also.

Heavy light. You know when you talk about weight training, if you're really trying to improve, you're talking about weight training three to four times a week, if you're trying to increase strength. You can maintain with twice a week. I remember reading some of the articles on some of the champion power lifters. These are the guys who do the bench press and deadlifts, some huge weight. And a lot of them, the key for them to keeping up their status was maintaining their strength without getting hurt.

So a lot of them would only workout twice a week. And one day would be heavy, and one day would be light. They would only do heavy lifting once a week. They would do light lifting once a week. And this way, they can maintain their strength, maybe improve a little bit, but they



wouldn't get hurt. A lot of the elite athletes, the big thing is no longer conditioning to a certain point, just making sure you can perform without being injured. So you have the split routine.

You'll also have something that you'll see called super setting or giant setting, or giant setting. And that's where you combine exercises. And one of things-- but, basically, it's the idea of using two or three sets for one thing.

So, for example, an example of super setting might be where you do a bench press, and then you might follow it up with dumbbell flies. The idea being, as you work the chest muscle, and you work with slightly lighter weight, maybe do an increased range of motion, and that's what we call agonistic, where you're working the groups together. Some people do super setting antagonistic, where maybe they'll do a bicep curl, followed by, let's say, a tricep pushdown. The idea being there is you do the bicep curls. The blood is already in those compartments in that aspect of the body, so then you would do the reverse.


When you do the reverse, now you already have the blood going through there to help provide the oxygen. But as you're doing it, you get antagonistic inhibition, so now you can get the bicep to relax and get it ready for the next workout because you're using the tricep. So that'd be another example.

There are so many different ways. So I think the common bond here is, first of all, overload. You're always overloading the muscle. The second concept behind it is there's probably some neural stimulation going on when you're using all these different type of methods. Often, if we look at something like a bench press, for example, let's take a bench press and see if we could bring it into the sport.

And a lot of people say bench presses, it's like a useless-- all the men want to do bench press. Everything is measured-- how much can you bench? But how applicable is it to most of the sport things that we do?

Well, you know what? If you're talking about a wrestler, trying to keep a guy off you, talk about a football player pushing off, you can see, it actually is used in sports. Now the thing about using all these different weight training, I mean, the bench, flat bench, incline bench, decline bench, does it make that much of a difference on the muscle? Biomechanical studies, it doesn't make a huge difference in the stimulation of the muscle, so it might be more the motor pattern. Because if you're talking about wrestling or football, when they come up, because you're working against an opponent, the angle is not always the same.

So the football player might be pushing up slightly at one point. He might be pushing down. So it's those different angles. I think sometimes when you do the weight training at different angles, you kind, of stimulate that. Every time you put a motor pattern into the body, it is an experience, a motor pattern, you can draw on, again, when you need it. So I think that might Be some of the real benefits when we look at the different angles.



OK. That's kind of just a brief introduction to the muscle strength. So if we look at PNF, Proprioceptive Neuromuscular Facilitation, now how many of you are using this? PNF? OK, are you using hold-relax? Contract-relax? Rhythmic initiation? Rhythmic stabilization? Any of those?

OK. Because PNF, it's about 12 different techniques that you can use, based on what you want to do. So if we were to do it now-- now, PNF, if I'm going to kind of relax this hamstring and loosen up this hamstring, first of all, I wouldn't even call it a hamstring. In PNF, you never stretch muscles, you always stretch patterns.

Traditional PNF, you would never think of loosening up a hamstring. What you would think of is, well, this is the extensive pattern. If that's starting to pull, I need to loosen up the extensive pattern. Or let's do the same thing.

A PNF pattern always involves three different dimensions. A PNF pattern involves flex and extension, ab and adduction, and internal and external rotation. So that is working on the spindle reflex and the Golgi tendon organ together. It's not just both.

You're also getting some of that tension change. What you would do is, by facilitating both, a lot of people just do it at the heel. If you press down at the heel, that's a different movement pattern than if you press down on the foot and proximal to the knee. PNF often teaches us that we actually use two hands. You want two contacts, because you get a greater stimulus with the two contexts. So that would be an example of the PNF technique.

So you can do hold relax, contract relax. I generally will not use contract relax. I use hold relax. Now many people use this term interchangeably. The difference is, in a contract relax, the patient is that it's trying to push down as hard as they can. In a hold relax, you start pushing up, and they match your force.

The reason why I like hold relax better is when on a contract relax, sometimes the patient is pushed down so hard, you'll see the hips start coming up. And they're not just getting that contraction. Also, I get a guy who's way too big for me, a 300 pound lineman, I don't want him pushing down on me. I can't stabilize that.

But if I do the hold relax, they match my force. So if you're working with someone who's bigger and stronger, it's a way of using PNF without losing any stability. So you start pushing. You say, just match my force. So you can control-- so you gently ramp the force up, and you can control the force.

And that would be an example of using a traditional PNF pattern. It's what we would call the lower extremity patterns. The one I just used on you would be D1 flexion and extension. And all that means is D stands for diagonal, and there are two different patterns. The one I used for you was the combination of external rotation, abduction, and flexion.