Maximizing Performance in the Recreational and Competitive Endurance Athlete Over 50

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- [Calista] Today's course is titled "Maximizing Performance in the Recreational "and Competitive Endurance Athlete Over 50." And it is my pleasure to welcome back to physicaltherapy.com Mike Studer. Mike is the owner and lead therapist at Northwest Rehabilitation Associates. He has been a PT since 1991 and a clinical specialist in neurologic physical therapy since 1995. Mike is the only therapist in the nation to be awarded Clinician of the Year by two different national academies in the American Physical Therapy Association, and that being neurology and geriatrics. He has also authored over 30 journal articles and contributed to or primary authored six book chapters. He is a recognized national and international speaker on topics including aging, stroke, motor learning, motivation and rehabilitation, cognition, balance, dizziness, and Parkinson's disease, having presented in 48 states and nine countries. Mike has also presented a TED talk this year on neuroplasticity that has been viewed by thousands, so if any of you have not watched and listened to that, I would recommend go ahead and doing that. And he is one of 250 therapists in the nation to be designated as a fellow of the APTA for a lifetime and diverse contributions to the profession in clinical, research, and educational fields. So thank you so much, Mike, for helping us organize this virtual conference week and kicking it off. And at this time, I'm gonna turn the microphone over to you.

- [Mike] Thanks so much, Calista, and Kathleen and everyone at Continued in the background. My pleasure to organize this week's submission and symposiums on the GeriAthlete and the athlete over 50 years old, which I continue to aspire to be. Yes, I'm over 50 and I'll continue to call myself an athlete. So I am speaking from a little bit of experience, and also from the professional realm as a physical therapist and bringing to you the evidence and the science therein as well. We're gonna spend particular focus today on the competitive and recreational athlete over 50. My colleagues will be looking at strength, psychology, injury prevention, and performance along the way too,

and so I'm looking forward to heading this off for you. Let's get started by taking care of one housekeeping item and the one and only slide that I will actually read to you verbatim. With that exception, we're gonna be moving fast and doing a lot of interaction today through the chat room and through the slides that I have presented for you. So first and foremost, I do not have any disclosures, financial relationships, et cetera, in presenting this to you, and the learning outcomes I'll read to you verbatim. So as a result of this course, participants, you, will be able to "Identify at least three myths "regarding endurance in aging. "Independently list at least three interventions "that have an evidence basis for improving endurance "in individuals over 50. "Cite at least four references "supporting physiologic rationales for the recent trends "in endurance records for swimming and distance running, "and identify at least three of the most common injuries "experienced in endurance Geriathlete training." So with that said, let's move on into our course timeline.

You signed up for this course, you know exactly what you are up for, and this is the order in which we're going to tackle things. So along the way, I want you to watch for these gray slides. The gray slides will help you participate in the course, test your knowledge during the course, and, perhaps to you most importantly, pass that all important post-course quiz. So watch for the gray slides, there'll be about 10 to 14 of them throughout the course. I'll let you guys count them. I'm going to give you the current evidence and best answer and I'll identify that during the course as well to help you assimilate your knowledge along the way.

So you'll always see the best answer according to the information we've got right now in green before we leave the gray slides. So here we are at the lead of the Boston Marathon. This was actually the 2016 Boston Marathon start. I wasn't at this starting line. I have been there before. And most importantly, everything was virtual. I was supposed to be there again this year. Hope to be in April next year. But it's time for us to, "GO, The GeriAthlete Generation." So this may be the picture of what you envision

when we talk about the term that I coined back in 2006, the GeriAthlete, and wow, this has been a boom in the generation. This is very incredible in terms of the accomplishments that the aging athlete has been able to achieve. Just look at the times here. You'll see on the left-hand portion of your slides here, the 100-meter time for the world records and actually even citations here in the 1896 Olympics, 12 flat, and the current, and now that's the, that was the Olympic performance. That was the gold mark actually at that point. And in fact that was what was the mark to get a gold. And now age 61 has been able to beat that at 11.7. Look at the 200 meter, running again. The gold was achieved in 22.2 seconds in 1896, and now there's a 46-year-old who has bested that. 400 meters, you can look on down the line here and look at what is happening with age performance besting performance that was Olympic level in 1896. Certainly you can talk about equipment a little bit, surfaces. You can talk about conditioning training and knowledge.

And we certainly understand those things are the things that you and I can learn from today how to help our aging athletes perform better, achieve better with health. Now, keeping in mind that all of these things are quantified to an individual. We'll talk more about that in just a little bit. So we're going to look at things that are relevant to kind of the extremes. Dan King, a 61-year-old hitting a 4:49 mile, Julia Hawkins, 103-year-old hitting a world record in the 40-meter dash, and Ruth Frist, 104-year-old with a world record in the shot put. Those are the lifters and the sprinters. Those are the extremes out there. And then also the extremes in the endurance athletes. These are three very recent citations here, probably one of which would be a familiar name to you. Jeannie Rice, a 71-year-old female hitting a 1:37 half, Ed Whitlock, an 85-year-old hitting a 3:56 marathon, and then Gene Dykes most recently, two years ago, a 70-year-old hitting a 2:54 marathon. Now, Ed Whitlock's probably the most likely recognizable name to you there who was actually even hitting sub threes in his later years as well. But to hit an 85-year-old mark at 3:56, absolutely phenomenal. How are these people doing it? We're gonna find out today. So let's define the GeriATHletes now that we've kinda

looked at what's the possible and the plausible. We're looking at competitive, recreational, vocational. So individuals that are working longer, performing at physically demanding jobs for longer, and then also voluntary and community. With that said, let's talk about and debunk some of the myths that occur actually in performance training as regarding endurance. So when we work on these things, we tend to propagate some of these myths and we understand that science can help us debunk some, but do we help to further the cause of science and go out and educate and debunk more of the myths? So I'm gonna pause for a second. I'm gonna let you read the six bullet points there, and I want you to consider as you are reading these have you actually propagated some of these myths yourself?

If you haven't propagated them and spread them yourselves, have you heard other individuals, lay persons or persons in the medical community spread these myths and have you heard that in social media, in pop culture, or actually in medical settings? So take a look at those. So how many of those are actually myths? How many of those are actually true? And in fact, you know that from the title there every single one of those are myths. Now there are some that are easier to debunk than others. We're going to take our time throughout the course today to be able to explain the physiology and debunking the myths behind some of those that are very appealing to spread ourselves, but all, every single one of these are false.

So one of the things that we have to think about is, the final myth there, is that endurance athletes should not participate in strength training. And the research to debunk this, one of the first ones that I'm gonna cite here, not the very first article, but you look at the Jung article in "Sports Medicine" and many to follow this, starting in 2003, looks at strength training as being the avenue in which and the conduit that you can improve running economy, kinetics, kinematics, and also be able to keep your speed, keep your endurance and your speed for longer even though it does not show an increase in the VO2 max, which we learned later by Sedano and colleagues in 2013.

So there is a role for strength training and runners, and we're gonna underline that and explain it throughout the course. It doesn't have a negative effect on lactate threshold. That's the LT that I've placed there, and does have a role in power, which we're gonna learn about. Running economy, kinetics, kinematics if you will, as well, does not seem to change your speed over time though. So that endurance athlete and the endurance runner can and should participate. So moving to the other side of the pendulum, swinging over from myths to debunk, let's talk a little bit about facts.

And we understand that each one of these five bullet points are salient for us in our practice. We understand that with strength training and in endurance athletes we can have greater longevity, and it's very similar to having, you know, a fasting type diet, an intermittent or longterm fasting diet, the effects of regular exercise. We understand that our insulin sensitivity at the systemic and the organ level as well as, and most importantly here, the muscular level improves. And we understand, and this is a key point at the very top. We talk about the amount of losses to be expected per year per decade. And you've all seen those statistics in the '70s and '80s. You've seen it in relationship to walking speed.

You've seen it in relationship to endurance performance. You've also seen it most commonly expressed in terms of strength. And we're now coming to understand that these are not necessarily the obligatory amount of losses to be expected with aging, when in fact much of the percentage or volume losses can actually be attributed to inactivity that is expected of the individual as they age, and the environmental demands that have been reduced on the individual as they age. Higher chair heights, an easy lift chair, no access to stairs, those types of things may end up increasing the likelihood of some of these losses, inactivity. So we're ready to move into the physiology of human aging and really take a look at this with particular consideration in the endurance and performance attributes. So as I suggested earlier, we have to question ourselves what truly is the aging process. We have some trends, we also

understand truly what's gonna happen physiologically, and then we can extend those into what happens for competitive and for recreational athletes in terms of both performance and training. Now, tying back to that very I guess significant slide that I gave to you earlier, the 1896 Olympics versus the capacities for people over 50 today to beat all of those levels. We look at the epidemics of aging, if you will, in quotes. And we see that aging has progressed along several lines, not only the total lifespan but also the quality of life, and then a third fold, the number of individuals we have that are in that aged category. What we even defined as old back in the 1900s obviously was much different. So the average lifespan in 1900 itself, and these are United States statistics that I could gather only, was 47 years old. And now in 1988, that was 75 years old. So we're talking about increasing by nearly 80% right there. And then at this point that has tended to level a little bit which is why I didn't move in toward the 2015 data. We are in the neighborhood of 77 years old or so.

Obviously some influences statistically will occur over the year 2020 though, as well. Now in the 1960s through 1990s, we had that population growth. I don't need to go over that too much. We talked about the Baby Boomer generation, you know, leading into this entire, you know, week long series. And that's one of the reasons why it's so significant for us to do this, I won't belabor that point. But let's take a look at the 2021 bullet. 31% of the United States will be eight years older than the lifespan average was just 120 years old earlier. Nearly a third of the population is gonna be older, eight years older, than the lifespan was 120 years ago. That's a dramatic gain. Imagine what I'm saying to you right now is if that were to extrapolate out another 120 years and go to the year 2140, then that would mean a third of the population at that point would be over our current life span by eight more years. So 83 years old to 85 years old, a third of the population. And guess what? We've nearly achieved that at this point because of the Baby Boomer generation. So that's pretty dramatic as well. So we understand that healthy aging is to be encouraged. You could almost consider aging as his own little column of disease, according to the medical systems. And what do we want to do to

try to mitigate the effects of that disease? And I'm not gonna list all seven of those first four bullet points or the final two. I want you to understand that there is a commonality between all of these that are listed on the left-hand side of your slide, and that is inflammation. And we know that we can mitigate a great deal of that with exercise. So whether you're talking about a recreational athlete, a competitive athlete, or an individual that is vocationally or advocationally or volunteer engaged, we know that to be able to extend their capacities, performance, and contributions, we can use exercise to mitigate at least these top nine conditions.

So I'll have to ask you then what is your perspective? When you look at the physiology of endurance, what would you fill the blank in with when I say to you, "This is the percentage of endurance "that's lost, secondary to aging "and this percentage of endurance performance loss "secondary to disuse?" And after what age would you say, insert a number of years there, would you say that one can maintain but not gain strength? What is your perspective as we lead in here? And I want you to be able to answer that question as we move on throughout the day. And I'll certainly be available to you by my email to continue the learning experience for you after we're all finished today and to dialogue on many of these points as well.

So the sedentary individuals show a linear decline in their 20s and 30s throughout the rest of their life. So we're talking now about answering that first part of the question. If you're sedentary, age will actually take its effects upon you and show a linear decline in the 20s and 30s. But then it will show a non-linear loss after 70 years old. Okay, so that's pretty clear that your precipitous reduction in your endurance capacity will increase at the age of 70, all right. But active individuals can mitigate that throughout their 20s and 30s all the way until they hit 70, and there'll be some caveats on that. What we can expect is that age-related losses will include a reduction in VO2 max. So that will be occurring with aging on a couple of different properties. So your heart rate maximum is not something that we know at this point how to change through exercise.

We don't know how to actually slow that process down. And your VO2 max will be influenced by your lean body mass. However, that variable can be influenced by your level of activity, prescriptive, dosed well according to age and capacity. So underscoring the final bullet point there, exercise training absolutely influences a lean body mass, you see abbreviated there as LBM. And that's one of the main variables in your efficiency of moving and contributes to your VO2 max. We can't influence the heart rate. We can influence the lean body. The active individuals as they age influence their endurance performance, largely through lean body mass and a few other physiologic aptitudes that we're gonna talk about today that are also being revealed on this slide.

So if you take a look at the lungs, your maximal oxygen consumption, so it's your total capacity to burn mobilized and energized, energy storages, systems. So I've consumed something, I can mobilize it. I've got a available carbohydrate. It's going to be available if there's enough oxygen to help me through that Krebs cycle to burn it, right? And then in addition, we can have local energies that are stored, right? And that can happen at the muscular level. And people have different genetic capacities to do that, but that's an extremely trainable component to train your muscles to be able to have some local glycogen available because you're now exposed to that stimulus on a regular basis because of your training.

Oh, we're probably gonna go out for a three-mile run again tomorrow. Let's learn how to store some local energy at the muscular level. Let's learn how to be more efficient in that process. Well, you still need oxygen to make that happen. So your one-rate limiter could be your capacities at the pulmonary level. In addition, we know that lactate threshold has a couple of different purviews there. We have circulatory and cellular lactate thresholds and it's your tolerance for your near maximum sustained performance level. You can measure the lactate threshold for an individual. And then finally, which I alluded to earlier, we take a look at your exercise economy, which can

be influenced by your strength training, your kinematics, and potentially even some coaching but will additionally be influenced by things that you cannot control at the neurologic level, and some things you can and cannot control at the cardiopulmonary. So let's review then. Physiologic determinants of endurance performance can come centrally at the cardiopulmonary, can come metabolically at the lactate threshold, and can be influenced by your exercise economy, your movement attributes, your lean body mass, and your overall ability to be able to move through that motion because of your neurologic familiarity, motor control, and otherwise. So I won't spend a lot of time to belabor this point. This is something you probably could have put into the repositories of your mind when you were going through your professional school. But we look at the Fick equation with VO2 max, and what does it actually mean?

Well, there's that heart rate max that's sitting down there at the bottom that we don't know a mechanism to improve just yet. And then we have our stroke volume max and we have our arterio-venous differential there. So that's that efficiency of exchange happening across the surfaces of the lung, if you will, so the diffusion maximum. So that Fick equation helps us with our VO2 max. Your stroke volume can be influenced somewhat with training and your arterio-venous O2, which we'll talk about a little bit later, has some different attributes that can be trained as well.

So your lean body mass, your capacities in terms of regular stimulus for endurance can influence the final two variables, cannot influence the heart rate maximum. So here again, we circle back to exercise economy. This ties together. What did we already say? We said that evidence tells us that, again starting back in 2003 and earlier with a Jung article that I cited for you and then continuing into the 2013 article and many since, here again, Tanaka and Seals in 2008, metabolic cost of sustained exercise can be affected by strength training, by correct stimulus and dosage. There's responsiveness that does not decline with age. So now if you were to go back to that slide, you're already ready to answer some of these blanks, right? So it does not

appear as though the third question there can be filled in. There doesn't appear to be an age that you can say after this, you cannot gain strength. And we're starting to be able to answer these two right here, and we're understanding that in fact we don't have perfect answers here. But a greater percentage of performance in endurance is actually lost due to disuse than we previously thought. We'll continue to answer these as we go along though, as well. All right, so we'll get you caught right back up to where you were. And now it's time to talk about lifelong exercise and the effects of lifelong exercise, which is the LLE there. So we have some benefits locally at the muscular and cardiovascular level, and then also systemically.

And this is exactly where we tie in to that ability to be able to change diabetes, osteoarthritis, some forms and not all forms of cancer, as well as many other things that we associate with but are not directly results of aging. Remember that slide where I said all of these are responsive to, or they have a commonality, through inflammatory properties. Well, lifelong exercise has significantly reduced the inflammatory tendencies systemically and can directly be tied to a more successful outcome with these comorbidities on board.

And I've got citations for you that you'll see in your bibliography for that, that would be the systemic. I'm gonna take just a moment though to also talk about extracellular superoxide dismutase. Now, obviously this is a mouthful that you wouldn't necessarily need to be able to explain to all of your patients. But briefly, I want to tell you that with strength training, especially for the endurance athlete who is participating in some endurance engagement as stimulus on a regular basis that this protein will actually help to reduce the effects of those free radicals that you've consumed in your environment or your diet by taking that free radical and pairing it up so it does not attack your DNA and the rest of your cellular structures. So superoxide dismutase is an antioxidant protein. So again, takes the free radicals missing an electron, wants to be able to grab on and create, let's ascribe a little bit of a personality to it, if you will, wants to destroy

other cells and keeps it from happening. So what do we know for sure? I've given you a really good opportunity to understand what is myths and I've shared with you already some of the facts of aging. Let's get down to the science of the facts of what's included. So we, first and foremost, we know we've got cardiac changes and I've separated these into columns for clarity for you. We have a known decreasing, a known increasing, and then the functional effect that we've got here. So I'll take an opportunity then for you to be able to go through the decreasing yourself. And I'm gonna pause and let you just read this slide for a second, and then we'll just summarize a little bit of it. So as you look at some of those things there, you'll see the reductions that happen with aging. We already talked about VO2 max, and one of the functions of VO2 max going down is heart rate maximum, right? And one of the functions that happens with aging but has some responsiveness to exercise is stroke volume.

The amount of blood your heart can kick out of the left ventricle with one powerful flow. Your tolerance for carbon monoxide, maximum tolerance for that CO. And that should actually be carbon dioxide. I'm not sure why that is not on there. That should be a subscript 2 on there, carbon dioxide. And then also your skeletal muscle arterial flow and capillary density, those should make sense to you. Those would be reducing as a function of aging.

Doesn't mean that all of them are aresponsive, unresponsive to aging, but these would naturally decline. And then similarly increasing in the middle column there and these are negative to increase. And I'll let you read those for yourself, which you may already have. And then what is the result, the net effect. So not able to perform as long, not able to be able to deliver as much oxygen by volume by way of blood flow to the muscles, and that should be the effect. But there are some trainabilities that can mitigate that. On a pulmonary strictly lung level, similar organization to this slide. What does reduce, and I want you to pay particular attention to the elasticity of the lungs

there. What does increase, and this is negative that increases and what's the net effect. So tidal volume of lungs, threshold for being short of breath, and then overall total exercise capacity. Now let's take it to the third level. Logically, let's look at what happens at the muscles. So we did cardiac, we did pulmonary, and now we're going to do muscular. Now, muscular again, these are, many of them, responsive to training, but what is decreasing? Capacity of mitochondria, type 1 and type 2 muscle fibers. Important for your quiz coming up. Increasing, negative that they are increasing, the body fat not the lean body mass, right?

And then what's the effect? And we tied this directly to what you heard earlier, the movement economy, the efficiency, one of the main reasons, this slide, that we know that it's okay and suggested and indicated that we do strength training for runners then as well. So here we are, first gray slide. Everybody's ready to actually look at something that represents not quite verbatim of one of the questions that you are going to be answering at the end of the course, just to help us summarize some of our learning. When you look at the physiologic effects of aging that impact endurance, the correct answer really is all of the above. We talked about type 2 muscle fibers. We just covered that.

We talked about maximum heart rate and that being really an untouchable variable, and then also stroke volume happens naturally and normally with aging, but has some trainability. And then mitochondrial capacity, I'm gonna add on to that and truly even the efficiency of the mitochondrial system, the ability to mobilize and make energy out of metabolites, okay? So now let's move on to an arena that's not often discussed with regard to aging in athletics, but maybe just aging for the geriatric physical therapist and other health professional and that would be the neurologic system. Now I'm not gonna read these for you. I think they're very straightforward, but all of them are salient to the performance athlete, right? The ability to see that racquet, that pickle ball, come up out of the air and to be able to react quickly. The ability to have cognitive processing out

on the basketball court for the state senior games. And these things happen naturally, and we have some ability to impact a few of these. Not all of these will be responsive to exercise. And we'll have a question on that one as well. At this point, I want you to be very clear on this gray slide now. Three of these are not responsive to exercise. Take a moment to see if you can test your knowledge and assumptions on which of the three are not responsive to exercise, and then I'll reveal it for you. And that's right. So three of them are not responsive to exercise. Conduction velocity of the nerves, denervation of the nerves, and visual acuity. So that is correct to say that cognitive processing and reaction speed have some trainability effect. And more than anything, they have even greater losses in learned non-use or disuse capacities. So when we add up the cardiac and the pulmonary that we talked about earlier, we know that this slide summarizes exactly what I told you earlier in two separate slides, Fick equation, and subsequent, right? And we know that 80% of that cardiac output is to be assumed at 60 versus your 20-year-old capacity.

Largely we lose that 20% because of atherosclerosis, and we lose some of that in terms of pulmonary resistance. And we'll talk more about that. So that reduced cardiopulmonary performance reducing from your potential maximum at 20 down to an 80% value at 60 comes from those two variables. In the cardiopulmonary realm, diving just a little bit deeper, how do we get to the heart rate maximum? Certainly we can look at Karvonen on that. And we also have to understand that a heart rate maximum does have some individuality that has some psychogenic properties to it, that being an individual's psychologic tolerance for maximum that sometimes can be a rate limiter even before the heart rate maximum is achieved. But what do we know by fact, and by science? Let's come back to your third gray slide now. So the additional mechanisms of losses in endurance with age include, which of these? And these should all look pretty familiar to you, because in fact, the correct answer is all of those. Now you might ask yourself a secondary question. Which of these show responsiveness to training? So we'll talk more about that, and you might be able to answer that already. So again,

looking at the musculoskeletal system these are the summaries of what we've talked about so far in the first four bullet points. And I'm gonna to add two new bullet points for you as well. So we talked already about denervation and we talked about reduction in type 1 and type 2, both the slower and the fast twitch fibers. We talked a little bit about fiber size and tensile strength back on that slide. And we also talked and mentioned very clearly would be the blood flow to get to these areas. Flexibility we didn't talk about so much, but we look at the water properties, the tissue in terms of the collagen properties, and we see that there's a collagen maturation that kind of stabilizes and limits our capacity to gain a lot more flexibility. Doesn't mean it's not trainable with age, but it does limit us to some degree. And we do have a natural level of bone demineralization which is probably also increased more than it needs to be in aging with disuse as well.

So a very interesting slide for you here that really takes a look at critical speed in aging as compared to distance capacity. I want to guide you through this one a little bit and say that critical speed, and I'll give you a citation for this as well, reduces linearly after age 35 by about 2 1/2%, you see that. And you see that that 2 1/2% increases as we age from 55 to 80. Now you also understand, here's the interesting part, that the capacity for distance changes in a curvilinear manner between 35 and 70 at that same 2.5%. But for many individuals, the masters athletes is what we're talking about here, that can reverse during the decade of 70 to 80 and actually show improvement at that point.

The physiology behind this is actually not known yet, but this is a very intriguing finding. We'll go on a little bit further looking at the citation for this as well. So we're gonna move to our next question though, right? And that question with your fourth gray slide. So let's look at this. What are those mechanisms of loss that can be ascribed to aging? Take a look at that and see what your thoughts are. That's correct, you've got that again, and this is very similar to what you've seen before. Now you

know exercise economy, how do you impact that with your patients? Strength training, endurance training? How do you educate them on that? Where can they make gains? Stroke volume, mitochondrial efficiency, also efficiency in kinematics, and look at that ability psychologically as well to make some impact changes and also that entire capacity to be able to store energy locally, right? So D, you're right, Christie, thanks for answering there. And your lactate threshold and maximal oxygen consumption. These are truly going to be influenced with aging but we can mitigate some of those. Now gray slide, I believe this is number five for you here. Let's take a look at this one. I'll read the question, and then I want you to think about what you've heard already. Age-related changes outside of the cardiopulmonary system include what? A, did we talk about that one? B, fiber size and tensile tendon strength, nerve conduction velocity. Any thoughts there? So these are age-related changes outside of the cardiopulmonary system.

Christiane, you're exactly right. It is E, it's all of the above on that one too. So I hope that you're gaining some confidence in your knowledge, gaining some confidence in the amount of volume of information I'm throwing at you, but you're consuming it and we're testing it along the way. And then for a third slide in a row here, we'll end up doing one more question before we move on to help to summarize. Mechanisms mediating age-based reductions in maximal cardiac output. So what can we do for ourselves? What can we do for our patients? Which one of these or which of these are plausible and which are not? So which one cannot be changed? Mechanisms mediating age-based reductions in maximal cardiac output. Now remember, you're looking at what's going to impact and Serena, you've got it, it's C. And Karima, you do as well. So maximal heart rate, can we change that? Maximal stroke volume, can we change that? Well, age-related atelectasis is the one area right there that was not named as a mechanism, okay? So the others, definitely mechanisms, and two of those don't seem to have responsiveness but the maximum stroke volume does, so a second level to that slide then as well. So let's move on and let's understand some of the really

competitive performance attributes and how do we change those for individuals over 50 years old? So this is what we're gonna talk about, and these are some of the advances that have been made and continue to be made for our patients. And we'll understand a little bit more about this as we go throughout the day. A few of them I've already alluded to, and some of which maybe you're already practicing. So as we move on here and we understand what we're looking at on these, I want you to take a moment to think first about these training cycles and principles, and think about things that you're already doing in your life to apply these things, and perhaps how you're already advising your patients. So we know that if we just put into the column of benefits for training cycles and principles advances that can be made, you're looking at these four things, okay?

And many of them can be subcategorized as cross training, variability, adaptability, periodization. A lot of those things can be discussed on this slide. So we talk about behavioral economics, setting goals, changing events, and keeping individuals from being injury-free because of that multi-sport athlete that you are training in their aged years. Remember, this is exactly the science that we're talking about for our youth as well.

The single sport athlete likelihood for injury versus the multi-sport athlete. So all four of these principles, I want you to transfer onto the aging and the GeriAthlete then as well. Now I want to look at the exercise principles and the things that we can do in a treatment session and in a treatment planning and a plan of care for our individuals, whether we're coaching them or whether we're in a skilled therapy plan of care for them. The principles should be very clear to you and you should be using them, and I'm gonna go over each of them. So I'm not gonna spend time on this slide just trying to define each of them. Let's get ready to move in. What is overload? Well, overload should be very straightforward for you. We see overload in almost every capacity in skilled rehabilitation, in personal training, athletic training, because we take higher than

normal stressors in any one of these categories and we try to help the body become adaptable and tolerant of over periods of time, or sometimes just for brief exposures. In this presentation, what are we talking about? We're talking about the endurance athlete. So we want them to be able to sustain and endure at a level of performance that does not have significant decrement. So we load them beyond it for brief periods of time. Now, when we do an overload principle and we're including some resistance training, running with a weighted vest, running with hand weights, ankle weights, running with resistance from behind, jumping, consecutive numbers of jumps, and all sorts of overload principles, running against the resistance of water, et cetera. All of these things have to be considered in terms of efficacy being as closely related to the end goal as possible.

Am I working on running? Am I working on swimming? So now I'm going to swim with a suit that creates extra drag or with clothes on, that's actually done. Am I going to tie my feet together and create overload so that I have to do all of the work with my upper body and torso, et cetera. You have to make certain that the task specificity occurs because we have to be obeyant of the said principle. Now, again, we only have two hours today.

So I'm giving you just a brief primer on each one of these main parameters. We're gonna move into the progression concept. Remember the principles being overload, progression, and then next we'll do adaptation, use disuse, and specificity. At progression, we know that we want to load the individual at a dose response level that they're capable of tolerating systemically and locally and not going above and beyond that in order to prevent breakdown. So we think about the numbers of repetitions, the amount of time and the overall amount of workload that's being carried. That has to be considered from a nutritional hydration standpoint, from an energy efficiency standpoint, and from a tissue standpoint, both pulmonary cardiac as well as local tissue, especially musculotendinous, right? So with that time and workload

progression, and you've heard things like don't add more than 10% mileage per week, and some of those types of considerations, then we have to look at recovery and response. Now recovery and response does have some effect that needs to be considered with regard to age, right? And that's where we land at a therapeutic dosage is personalized for this individual's age, for their current level, their baseline level at which they came to you, and in addition to that, it's personalized toward them psychologically and preferentially. How much time do they have in their week? How hard are they willing to work? What is threshold for this individual? So we take a look at all of these things when we look at progression.

Now I don't want you to be misled here by the next slide. I want you to look at use and disuse. I want you to look at this in consideration to what happens as a tissue unwinds when it has not had forces in stimuli, and what happens as we begin to gradually wind that tissue back up or to load that tissue. Remember with regard to the exercise principles, we have to have some use and disuse considerations. Now, when you are building someone up from a baseline level, if they've had a recent significant disuse, perhaps due to, you know, a prolonged illness or to a surgery, on bedrest, we have to be really careful with disuse in terms of loading bone back up, loading tendon back up when we consider impact absorption and fatigueability, right?

And all of those tissues that I've got listed for you at the top are responsive to use and disuse considerations. You can read that for yourself, but we have to take particular attention to the very frail individual as we start them back up. Now, I also want to talk to you about a very closely related element, and that would be adaptation. So adaptation's closely related to progression, closely related to overload, but adaptation really talks about habituating the tissue, right? So asking the tissue to be able to continue to gradually and logically improve its tensile capacities through increased resistance, and remember force and resistance is not the same. Forces being a consideration of power, consideration of time and explosive use, whereas resistance

would just be in terms of strength and load. Repetitions, how many repetitions do we actually ask that tendon, muscle, bone to be able to endure? And that is where we begin that progression. And we use adaptation to habituate that tissue in that regard. So remembering that as we continue to load over a period of time, if we don't periodize and allow for rest and recovery, we will not get the adaptation effect. And the main point here is that with aging, we have to be very careful of the adaptation so that we're allowing for recovery. Now we tend to, myself included, err on a more conservative side because of the aging athlete. And you don't have to guess work about this. You look at performance attributes to see if when you've brought the individual back to loading, if their performance has come back up or not.

Did we give them enough rest, temporally, hydration-wise, nutritionally, quality of sleep, and all those things so that our dosage and a prescription is complemented and given the best opportunity to allow that person to adapt when we have given them all the rest of those other variables. So you don't have to guess, you see what the performance is like, you load the tissue, and you give them rest time and recovery, and you see if they've recovered.

And if they've recovered back fully to their maximal time or to their training peak effect, then you know that you, they have adapted. If they continue to falter and fail and not be able to meet a previous standard that they could, then we have a decreasing effect that there's too much loading or ineffective recovery. Again, main factors, which we'll go over later, sleep, hydration, nutrition. And then obviously there are some metabolic and systemic considerations there too. Moving forward, as I've already touched on, and you don't need me to reiterate too much, and we have to keep in mind when we are loading, our overload, our progression, considering our use and disuse, we have to be very specific with the imposed demands toward the adaptations that we prefer. Okay, so the one myth that I want you to look for, the bottom bullet point there, is that if you're an endurance athlete, just train endurance! Hey, you know, as a baseball player

in the 1970s and 1980s growing up especially, we did not do any strength training because we thought that strength training was not within the realms and needs for a baseball player. And so we worked on footwork, we worked on agility, we worked on eye hand coordination, we worked on technique. We did not go out and run, we did not weight lift because we thought that the specificity would not be there for us. And that's where we got it wrong. So strength training carries over into specificity more than we previously thought. So we debunked that. Now, what are the mechanisms directly for strength training to help individuals that are endurance athletes actually improve? Well, I'm excited to share this with you because these are some of the most significant changes that you can actually carry over to your clients and your athletes and yourself.

And as you see here, economy and running form and performance at higher velocities, and if it takes me nearly 90% of my maximal capacity to drive up a hill at six minutes and 42 seconds running, if I'm stronger, it's going to take a smaller percentage of that. So that economy of running at maximal and higher submaximal levels is one thing to consider there. So we look at that, and that's what this Denadai study helps us to understand. So, and this has been replicated in swimming and cycling in the same methodology.

So what are the other mechanisms for endurance gains that are related to strength training, what else happens? When you look at mesocycles, a form of periodization, if you will, across many different endurance athletic performance, we see the middle and long distance performers benefit the most with strength training, which you might've actually suggested would be the opposite that perhaps the short distance sprint athletes would be the ones that would improve the most. And the reason why is that ability to be able to reduce your energy costs over a period of time is what can make those percentages of gains even greater. So now let's take a look at what happens when someone at any age increases strength, and I'm not going to read these to you because I think you can consume them for yourselves, and some of these you would

have actually already known. But I want to actually lead this into the combination, the combination of strength with endurance training. And this is one study here, a collection of them have been replicated since, but one of the initial seminal studies from Wood and colleagues in 2001 shows concurrent training, endurance training ET, resistance training RT, to be superior over either one. So they did a great job of looking at different outcome measures that were performance based. They did a great job of taking aged athletes at 68.4 years old average and they gave us their dosage with three times per week. And they tried to do either endurance training or resistance training or both, and compared those to a control. And you see the summary points down there at the bottom.

The both groups were more effective than either of the singular endurance training or resistance training alone in all of the outcome measures. So very seminal and important to understand there too. So what actually do we look at when runners in specific are doing strength training? Very consistent with what I've talked with you, but now a slightly deeper dive here with resistance training, really especially at the core and hip focus being very essential here. And what you're gonna hear from my colleague tomorrow Chris Johnson is really some of the even greater deeper dives here into an area of the body not touched on by the 2004 study here by Chtara.

But you're going to look away from the core and the hip and see some great benefits in Chris's information. I'll encourage you to listen in to that as well. So let's talk about cycling now. Where do you think the cyclists need to hit their strengthening? Well, you look at their capacity to do training at 70% of their one repetition maximum. Can be very sport specific in that in terms of the, you know, power output, their wattage performed on the bike. And then train at 70% of that with high-intensity interval training and actually even noticing gains in the studies of 2012 and 2010 of even continuing one time per week strength training during the competitive cycling season helps to preserve that strength rather than being something that we would have, and potentially

even still would have considered of never doing strength training when you are quote in season. So we take that study and learn and gain from that as well. And then in addition, we take a look at another study that advances us one step closer to today's evidence. And this is a Mikkola article that takes a look at strength training and endurance training and also helps to focus the muscle groups that were performed there too. and I'll encourage you to again take a look at this evidence from 2011 and see where Chris takes you tomorrow. Here we move now away from the hips and the core, beneficial, absolutely. It's not like the human body has changed since that study that we just cited then previously, but it's in fact understanding that, and that was really the Chtara study, we're looking at the core and hip. Now here, we're looking at leg extensors. We're looking actually at the abductors when we're doing counter movement jumps, and also looking at the calves that are contributing to max speed and jump power, et cetera.

So there's a lot of benefits to be had there as well. So as a summary, we know that strength with endurance training is beneficial both in season, both in combination with the endurance training. It had been previously thought that strength training would mitigate the beneficial effects of endurance training. And that if you were doing strength training, that you would lose some of the potential benefits from endurance training as well.

And that does not seem to be wholly the case, even in the runner. The other thing to take a look at there in terms of apoptosis and cellular death is that strength training for the endurance athlete helps to reduce telomere, sorry, helps to sustain the telomere length and the life of many cells then as well. And again, we take that through that chronic inflammation cycle and being able to reduce the effects of systemic inflammation then too. So we look at the three paragraphs that are cited for you here, and then obviously the citation down at the end. We understand that with endurance training, power training across these master athletes, that their overall body type,

adiposity, their performance, oxidative stress, inflammation systemically are all showing good biomarkers there as well. Continuing into the more contemporary studies for this, interleukin 6 and 10. I don't pretend to be an expert in these levels, or in these understandings, but we know that at the hormone level that strength training is also improving our endurance athletes. The telomere length, that's the TL again, of the MA, masters athletes, associated with resistant performance is actually improved as well. Adiposity, so your level of lean body mass is improved as well. And this is a very recent study here this year by Sousa and colleagues. So so many things to be gained for the endurance athletes, not only straight performance but also quality and longevity of life and ability to be able to mitigate potential comorbid diseases that would be programmed into their DNA as well.

So when we look at the overall benefits of higher strength in runners, I think that this slide has four great bullet points for you to reiterate and learn from, and summary points inclusive there for that competitive athlete. So let's move into your next slide and let's understand some of the, I guess summary points for our questions then.

So what do we know? We know that exercise has actually been proven to moderate some of these age-related losses, which ones? And which ones are left on the table that exercise does not seem to be able to influence. What are your thoughts there? And I've really enjoyed reading your quick answers come up in the Q&A. So Anita, you're gonna guess C and you were the first one to pop up with that. And I'm gonna say absolutely, that's correct. So that means that the remainder on the list here cannot be scientifically proven to be responsive to exercise. Nerve conduction velocity, visual acuity, and maximum heart rate. That's consistent with everything you've learned so far today along the way. So that physiologic effect that we are noticing for the endurance athlete across the board, not just runners, it can be summarized with these seven bullet points that you see here too. And that is that physiologic effect that are systemic. You take a look at osteoporosis, that's addressed here. You take a look at sarcopenia,

that's addressed here. You take a look at diabetes and then some of the osteoarthritic conditions, all of them addressed here in terms of physiologic effects. So what's the dosage that you should actually be giving and assigning to your athletes? And that's spoken to to some degree here. Coupling information from the American College of Sports Medicine, as well as many other studies that have helped us to reiterate this. These can be, these are a few slides that can be consumed now and then also reflected back on later. So I think this is very straightforward. I'm certainly available to explain more on this, but this should be not only something given a nod to but something we give a prescription to. Because too often, we do not utilize the science and use that 80% of one repetition maximum because now we have, with high-intensity interval training, a way to be able to parlay and to dose and to pull it into the realms of the endurance athlete.

So when you're talking about strength training for the endurance athlete, you can use their 80% maximum within your brief high-intensity intervals. You can make it sport-specific or you can bring it out into machine-based, if you like depending on the specificity and adaptation expected. Why did we use high-intensity interval training? Well, you certainly have some very sport-specific applications that are listed for you here in terms of the rationale. And these are four of the main rationales by which we use high-intensity interval training, which for the rest of today's effort, we will abbreviate as HIIT. So I'll ask you a question now at the bottom there. Are these actually the same benefits from HIIT as what you would expect with moderate-intensity continuous exercise? And in fact, in most citations, you will see that the benefits in HIIT, even with a shorter period interval of exercise, so sometimes eight minutes, 12 minutes of HIIT compared to maybe 30 minutes of moderate intensity continuous, HIIT seems to win on most of those extrapolations then too. And now what are the ratios by which, and now we populated that forward for you as well. Typically it's an off ratio of three to four times the amount that you see of off versus on, okay? All right, now high-intensity interval training has been studied in many different applications and we

see it purely in weight training. That's probably where we have a greatest volume of the studies, but we also see it directly parlayed into the actual athletics as well in terms of a prescription for running, swimming, cycling, and ergometry, okay. Now I've got yet another gray slide for you here, and I'll ask for your input, see what you think. So evidence that you've heard of today supports moderating the effects on endurance performance through, and I'll let you read those for yourself. Serena, you already have it. Very good, and that is correct. High-intensity interval training, as we just went through. So moderating the effects of age through this, and the others should be debunked and unfortunately can be advertised to some degree on our well-meaning athletes.

Let's do another gray slide for you here. How about endurance specific running training in aging? I'll give you a moment to actually look through all four of your options there, and I'll be looking forward to that first answer coming up front. So, in fact, there we go.

And we've got some first responders again, right there. Yasmin, Karima, Kristen, you're absolutely right. James, you're right, and James, I'm sorry. I see yours is listed there first. So that is correct, it is C. People over 65 can make improvements that translate into running through muscular, we've talked about that efficiency, strength, higher workload economies, cardiovascular, stroke volume, and we talked about efficiencies at the pulmonary exchange, as well as energy transport and storage mechanisms, mitochondrial efficiencies, right? So all of those things are absolutely true, and are not age-specific. So as we move on here today and we look at the Peloton, and we're kinda breaking away from the pack and advancing your education here today, we're ready to talk about recovery time for the aging endurance athlete. And the recovery time, which I've alluded to so far a couple of times in the presentation when we talked about adaptation, right? And how do we know that our athlete is actually thriving and benefiting from the training schedule and the periodization? We look at the longer period of recovery time necessary for the aging athlete. We look at what their

preferences are, what works for them. We talked about one of the earliest slides at the very start of the effort here today and cross training and having the multi-sport athlete and looking at in-season and out of season training. And we also look at thermal effects and responsiveness. And so we'll look at all of those things really here today as well. And I want you to take a look at the citations of the literature and understand that this is a very small part of the presentation that I have here today, but we'll talk about it more. Pete Barusic, my colleague, is gonna talk about injury prevention and some of the training that happens in there.

And I want you to take a look at this and know that thermal effects appear to be among the most well-studied and well-evidenced variables that we can use to help the endurance athlete recover. So there are different camps and schools of thought for almost everything, but the evidence helps us understand that cross training will help to reduce the overall load-based reduction and return to performance. We talk about continuing to move to some degree rather than a complete rest, so that stiffness does not ensue. And so that the, you know, really the collagen adaptation continues to be able to reduce inflammation that naturally should occur with training, but to be able to reduce the negative effects of inflammation, we want to continue blood flow going through.

Active recovery seems to be superior. Submersion in cold, which I alluded to, superior to that nice, hot, hot tub after the marathon. Probably not a good idea, but some people would go that direction. And then massage also being an attribute that may help on both the physiologic properties, mobilization of waste products, improvement of vascular flow then as well on the arterial but even moreso on the venous side of things. So we're ready to move actually on now to the applications of our evidence in the recreational athlete, not just the competitive athlete. And when we look at these things, we understand the recreational athlete might have aspirations in some things that would actually have some overlap with the competitive athlete, especially tennis

and golf, or competitive speed walking as well. Now, when this is defined, it is very important to look at the opinions of the recreational athlete. What do you perceive when you say you are physically fit or not? A lot of times we as a culture take a look at the physical appearance of someone, the overall lean body mass or not. Is that your definition of fitness? So I intentionally left the quotes open to be filled in at the end. Now is your opinion of fitness that you can do a daily walk? Do you feel like your self or your father or your grandfather or mother for that sake, do you feel like the definition of the recreational fit 80-year-old is someone that can do a half hour walk daily, or are they missing on certain attributes of fitness if that's all they do is walking? And I'm asking a rhetorical question there, obviously too.

What else can be defined as fitness? As you see here, someone who is active and has a lot of optimism and energy? Or do you look at the comprehensive nature of fitness, the seven categories that are classically listed there? Or do we consider fitness as longevity? No one can actually say that for an individual, that your definition of fitness is absolutely wrong, but maybe that some of them are just incomplete. So when we think about what's naturally discussed across really the lay considerations of fitness, a lot of times it falls into lean body mass and that natural ability to look at step per day counting that we all kind of gravitate to now. And we say that everything can be ascribed in fitness by your number of steps per day.

And we know that that is a pendulum that's probably swung a little bit too far, right? We do know that as a country, the United States is among the lowest for individual steps per day. And I've got statistics for you on that as well if you should need them for educational componentry. And we also take a misnomer again thinking that walking is actually a definition of fitness and sufficient for your full complement of what might be, in tongue in cheek, considered a balanced breakfast of fitness, if you will. So the recreational athlete, because of the infrequency of tissue loading, they're not in a training program per se, may actually be at greater risk when they do try to move that

heavy wheelbarrow, get ready to dig up the garden in the spring, lift a heavy suitcase because now they're going on vacation and they had not been loading that tissue for previous training leading up to this. So when we look at the recreational GeriAthlete, again, we go back to the American College of Sports Medicine again. We understand that to be able to reduce some of those effects that we thought were absolutely obligatory with aging, we need to knock down the volume of sedentary lifestyle for an individual and for a population. And we have to also take that recreational GeriAthlete and help them modify some of the chronic diseases through inflammation that we talked about. We also give and offer a very consumable package of a dosage through higher-intensity training, especially high-intensity interval training, to make it more consumable and perceivably doable throughout my, quote, busy life, five to eight minutes of HIIT training because you can't afford to do 30 to 40 minutes of moderate-intensity training.

And we also educate and consider, again, one of the main bullet points out of the ACSM summary information that came out in 2016, '17 is that just doing exercise very infrequently and periodically has very little cumulative effect to be able to make physiologic loading base changes. And while that may seem very straightforward to you, it may not be something that is so consistent with the opinions of our clients and our patients. Oh, every once in a while, I'll, you know, go out for a run or I'll lift weights a few times per month and there's not much to be gained if you are so sporadic in those and unintentional in those dosages.

So now let's move on to some of the very specific recreational athletics, and let's look at golf. And I'll summarize for you here on the next few slides that we understand that golf benefits from strength training across a few different aspects specifically and preferentially of the body, and explosive trainings that require some power seem to be superior to those that require strength. So strength training, physiologic and systemic effects. I want to reiterate this to you and just add on a little bit more as we move into

the recreational athlete, because we have to understand that the recreational athlete who just walks, why do they also need to do strength training? Here's exactly why, and so I bring that back to you at this point. And a lot of times we forget about the fourth bullet point down is that strength training, more so than, and sometimes even depending on what type of endurance training you do, stationary biking or swimming, sometimes those will have, if that's your choice then to do especially a seated resisted, or sorry, a seated cycling for endurance training will have very little to no true impact, with no pun intended, on bone density. And swimming can actually be, if that's your form of endurance athletics, as compared to, and replacing time you would be spent in walking, can actually reduce bone mineral density for age-related and gender-related matches. So strength training here in the recreational athlete is absolutely important to maintain that bone density. Now again, I bring to you the same slide, not to fear the dosage even in the recreational athlete.

And I won't belabor the point here, but you have to understand, we must still again apply the science to be able to get the benefit. Now I want to move into, just like I did with golf, and give you a study here on aquatics and understand that with a 24-week aquatic training program with resistance training, we see that the participants were able to actually increase each one of these aspects of performance: knee flexor strength, extensor peak torque, et cetera that you can read for yourselves, with the endurance training.

And they did so while undergoing the aquatic-based performance then as well. So we're talking about aquatics and doing strength-based aquatics in a chest high shoulder high program here. So to reduce impact for those who have maybe joint considerations, who have lean body mass considerations, or who just prefer the aquatic-based environment. Absolutely strength training can be carried out in that environment as well. HIIT training can also be carried out in the aquatic application, whether that be, you know, working on the standing-based aquatic programs, or

actually HIIT training in truly a swimming and a forward, you know, or Australian or freestyle motion as well. In this study, they were actually looking at a few different things. And it also included in this 2014 study the underwater treadmill application and looked at that for people that already had in effect osteoarthritis. So now let's take a look again at the science. Optimal strength exercise dosage very clearly set right here. So when you look at the optimal strength exercise dosage in the recreational athlete, if it can be consumed, we want to try to get consistency. We don't want to have that intermittent or infrequent dosage. We want to have potentially up to 20 repetitions in a set when we're looking at for muscular endurance applications, okay?

And we do that with consideration of their medical history and tolerance for exercise. So now, remember we sometimes make it more consumable to use a lower weight, 60% or so, 20 repetitions in a set or so, for muscular endurance, not muscular strength purely by itself. And the reasons that we do this to make it more palatable is something that I've actually again coined myself. And that is to say that the difference between zero and one, not doing something and doing something one time per week is much greater than the difference between one time a week and three. So at least giving a palatable dosage that can be accepted and participated in on a regular basis is much better than doing something that's overwhelming, then it will be more often not performed than performed.

So the difference between zero and one is much greater than the difference between one and three. And it doesn't matter if you're talking about mileage per week, number of exercise routines that you've done per week, number of times you've traveled outside of your home per week. So now let's take a look at high intensity and also low, let's look at a low-volume high intensity and a moderate intensity continuous versus high-intensity interval training when we study the comparisons on, really you look at glucose control, you look at cardiovascular strength, and you look at the compliance, the likelihood of actually continuing to participate. The effect size, and there should be

actually a reducing arrow here. Sorry, as this one got transferred forward is looked like we lost our arrow. The effect size of low-volume high-intensity interval training should have a downward arrow there. So it is not as effective, but the compliance goes up which is exactly what I suggested to you on that last slide. Sometimes bringing intensity down, you can get compliance up. Cardiovascular and strength training on a high-intensity interval segment is absolutely going to be the most superior, but remember some people would prefer the moderate intensity continuous, which has its benefits as compared to the others in terms of glucose control. So I'm showing you that each one of these have their own beneficial attributes.

Overall, if you're looking at performance, you look at HIIT. If you're looking at compliance, you do low-volume HIIT. And if you're looking at glucose control, you do moderate-intensity continuous. So with that said, let's go to another gray slide for yourself. And I'll ask you to be successful in debunking some of the myths that you have heard debunked scientifically throughout the efforts today. I'll watch for the first person to answer here. And Anita right there with the E. Everybody's answering it correctly, you're absolutely correct.

So which one of these myths is actually true? So none of these above are actually true. You cannot walk daily to maintain strength. People can get stronger after age 85. "If I keep my body fat down," I'm absolutely the, and that's everything I need to do to be fit. And you all have seen frail thin 85-year-old men and women who are not fit just by keeping their body fat down. "Most of my abilities are fixed based on my genes." That's absolutely not true as well. So you've done an exceptional job in recognizing that answer E is in fact, the case. Let's move into the segment briefly today that we're gonna talk about that is objective testing now. And objective testing, really when we take a look at it throughout geriatrics in specific, can be done in a number of different ways. We look at Rikli and Jones, especially when we take a look at a one-repetition maximum in isokinetic performance. Again, Rikli and Jones, more than one-repetition

maximum. You can define absolutely objective testing on performance in isokinetics and function, function based on speed in terms of, you know, your 100-meter time, be that running or swimming. You know, there are timed trials for cycling then as well. You can look at objective testing that's broken down by endurance and when an individual's wattage on cycling begins to reduce, or when they're running economy and ability to maintain a pace begins to reduce. You can also look at objective testing with regard to flexibility and probably most obvious to many of you would be different objective testing measures for balance. Let's take a look at the first one I referred to right now and that would be Rikli and Jones. Rikli and Jones, I won't take the time to completely comprehensively cover here today, but a adequate summary would be the five bullet points, sorry, six bullet points that you see in front of you here. Obviously this is easily researchable. Something that you can look up on your own after the course, but hopefully I've led you to something that you were either not familiar with or something that you needed to be reminded of.

In addition, as I've suggested, objective testing in geriatrics can be conducted with tools that we have in other aspects of rehabilitation and performance training. And that could include the bulky treadmill, which is explained here, in terms of how to conduct it. And these are non age specific, these are actually gender specific in the standard performance of the bulky treadmill. But a geriatric specific examination could actually be done in a similar fashion depending on what the sport would be of choice. And so you could actually adjust some of these to some degree, depending on the individual's baseline. So in addition, you can do a testing objective in sport to take a look at the capacities for absolutely sport performance testing or submaximal performance as well. Even if you're looking at an endurance athlete, and maybe they're gonna be participating in the state senior games and running a longer distance, you can still utilize a 400-meter run for objective testing then, too. We can additionally start to move toward some flexibility, agility, reaction, speed, and endurance if we were to use some sort of timed agility course that included a shuttle test or something of that nature as

well. So all of those are testable on the track and off. And here is one example of a senior agility test, so named. And you can again take a look at that, look that up for yourself, but hopefully I've at least led you to something that you either had not known or something that you are benefited by being reminded of. The conduction of that test looks like this, with the sitting and moving around the cones, returning to sitting, and there are age norms available for that additionally. Now with that said, we also can benefit, our athletes, consumers, clients with a speed endurance test and these fashions would just be some of those possibilities.

I can give you some age norms for those as well, and those are commonly found obviously online in addition, though. Those are available in running and in swimming and in cycling for age norms on time trials, as I alluded to earlier. In addition, there are some standards that are available for your longer distance running attributes, as well as swimming, all with age and gender data that are available. So be on the lookout there as well, and we'll look at some of those later on in the course additionally. Remembering that we can move from some of our more clinical tests and we can actually also apply these as cited in 2018 by Buckley et al, and really look at some of the research that comes from the clinic.

Maybe even out onto that competitive GeriAthletes effort to be able to test themselves for readiness in their specific sport. You don't need me to read through those for you as well. You should be familiar with a number of these. Some people are leaning more now to, and some of you even listening in on this had not been familiar with this one-minute sit-to-stand test. It's where I tend to gravitate a little bit more to, aware that the five times that sit-to-stand has more clinical applications for the recovering patient from frailty in surgery. The 30-second sit-to-stand certainly can be a little bit more palatable, but when we're talking about muscular endurance and the performance athlete and GeriAthlete, we can move into the full one-minute or 60 second sit-to-stand. So summary points of a couple of things here for you to be able to, wow,

Mary's already answered here. Look at that, so, so you're exactly right, Mary. That is one of the endurance fitness. Anita, William, Karima, you're absolutely correct on that. That all of these that are listed out here are usable and they have validity for screening endurance measures. Six-minute walk test, two-minute step test. So absolutely the answer is E, all of the above, and Whitney thanks for even correcting. I'm gonna go to Tracy's question here. And Tracy said, "What is the 30-second wall press?" And so that actually is a standing effort to be able to do rather than pushups. It's basically wall pushups. So Tracy, thanks for your question there, and that's what that looks at. All right, so let's move to your next slide here. So yes, sir, in fact, you're right, the answer is E. I'm gonna briefly introduce to you the Senior Athlete Fitness Examination. Some of you will already be familiar to that.

And I want to do a small plug for the virtual event of Combined Sections meeting. Again, you're probably very familiar with Combined Sections meeting, but the American Physical Therapy Association meeting in February of 2021 has already been determined to be virtual. Myself and many of the colleagues that you'll be listening to this week, as well as my colleague, Rebecca or Becca Jordre from the University of South Dakota, who is actually the primary author of the Senior Athlete Fitness Examination will be presenting a two-day pre-conference course which will actually be post-conference this year.

And you'll be able to hear what I'm saying today in much greater detail, as well as my colleagues Chris Johnson, Pete Barusic, Joel Sattgast, and Becca Jordre on that as well. So we'll have two full days, and I would encourage you to take a look at that. The exact details of Combined Sections post-conference are yet to be determined, but that's as it had been. So that's a lot of great time if you're interested in engaging in what we did today. I don't benefit financially from you attending that at all. So just as a disclosure, we're looking forward to that as well. So the Senior Athlete Fitness Examination, as you saw on that slide, has a very comprehensive view. This is actually

a scoring chart for the Senior Athlete Fitness Examination and looks at gait speed and balance and flexibility as well as anthropometrics, flexibility, strength, and everything listed there. So the Senior Athlete Fitness Examination has literally thousands of data points for individuals tested at state games as well as national games and really shows very good rigor, helps to educate athletes, is easy to conduct. And those athletes that participate in that walk away with some sense of their benchmarks and oftentimes come back year after year and have something that they want to actually show us in how they've improved on those. So the injury prevention aspect of endurance training, I'll spend very little amount of time on because we certainly understand that Pete Barusic's effort on this is going to be much more comprehensive. But I wanted to give you a complement of this in the effort today because we've spoken to these points and I want to consolidate the information up for you there.

And I'm sorry as the slide was translated, it looks like the respect F and the O-R got a little bit separated there, but I'm sure you will provide some latitude for that too. What have we said so far is absolutely critical in endurance training and aging athletes? Well, we've talked about the need for strength. We've talked about the variability cross training periodization mesocycles. We talked about the multi-directional nature and training, not just in sport and in direction, but out of. We talked about staging loading when we talked about both, you know, use and disuse, as well as overload and the actual ramping up of that load.

And we talked about biomechanics and appreciating that the kinematically superior athlete would be the one that could stay more injury-free, and that again tied us back into strength. So all of these have science behind them, and we look at the recovery in the aging athlete being a little bit different than the recovery in the younger athlete with a movement toward thermal, a movement toward an active rest and recovery, not an inactive, and utilizing massage as well. So with that said, what can be done truly from stretching and injury prevention? We certainly understand that the literature on static

stretching as a warmup has not been upheld and something that has been debunked. And we know that the dynamic warmup seems to be superior as long as it's very sport specific, both for the cardiovascular primer as well as for the dynamics of what it does for the tissue and vascularization before we begin an effort to train. With regard to injury prevention, again in the endurance athlete, we have to understand that there is a role maybe for the dynamics of stretching. We use certainly in a rehabilitative fashion we use stretching, but from an injury prevention standpoint static stretching has not actually showed that it has superiority then to. We absolutely use strength training and deep tissue massage as well as warmup.

And I've already talked with you a lot about the final three bullet points there as well in the science that we've looked at so far today. Where do the senior athletes tend to break down and where do we want to watch for injury tendencies and help these individuals? We know that at the musculotendinous junction occurring with tendinosis and osteoarthritis at the bone level, we know that these individuals will have a greater likelihood because of the years and repetitions that they have pre-competition and pre-training to have a greater tendency toward cumulative overuse. And remember, if we want to mitigate that, we use periodization and strength training to be able to reduce the overload on a tissue that has recognized some load and had some specific adaptation to the load that's already been performed.

And so we don't really have competitive traumatic losses when we've loaded that tissue in training then as well. With regard to injuries that would normally occur, it's rare for an aging or GeriAthlete to have a cardiac injury, and most of the times that's going to be the case if they already have a premorbid cardiac condition. Primarily we have to watch out for the athlete that is on beta blockers because they may not be able to be monitored as well with regard to their maximum heart rate for obvious reasons. And so their vital signs are not as reflective and accurate and show validity for us. The science for preventing cardiac injury is listed for you there. And the four bullet points that you

see are salient in that regard. One thing that I think is very important for us to understand when we move into the musculotendinous is that we really debunk the no pain, no gain notion, and we use the science. We use the science that says okay, endurance training with some strength training, we increase our tensile capacity. We look at our load progression that I spoke to earlier about 45 minutes ago. And we certainly understand and appreciate the warmup effect and the endurance training benefits of vascularization for that tissue, both locally and regionally there too. When we get to the load effect, it's important to respect the science behind this. And we understand that running between one and 20 miles per week at that range of six to seven miles an hour is a lower all cause mortality as compared to those individuals that run zero miles per week, or as compared to those individuals that run more than 20 miles per week.

So the sweet spot for your recreational and your competitive athlete, if you're just looking, just looking for longevity, will be that running one to 20 miles per week and not going a week without. So not necessarily gaining more, but not necessarily losing more with more mileage. Absolutely not gaining more with no mileage though at all. So some of the common injuries, truly actually common injuries that can be listed here when we consider the overall course of the geriatric or the aging athlete.

So what do we see? These common injuries occur, this should actually be a gray slide for you here, for the elderly endurance athlete include all but what? So Annemarie, you're first, and you're absolutely correct. And Deb, Serena, absolutely correct. So the bone stress injury can be common, especially if loading comes too soon or biomechanics are not well performed, right? So we use strength training, kinematics in training, et cetera. Tendonitis, absolutely, I cited that, can occur. Muscular tears, complete and incomplete. But the cardiac event incidence is very very low, especially for your senior athletes and a couple of good recent research articles citing that one, so that should be one of your gray slides for you there as well. So C, cardiac event.

And then as we talked about the science of recovery with aging, I thought I would give you a few summary points then here to be able to take a look at the ability to bounce back and the heart rate variability that happens with individuals after training can occur as much as 15 days after high-intensity training with fit and healthy adult women. A very nice intriguing study there, which is somewhat unique to actually just look at the fit and healthy adult women on that, so a nice study done there. And again, I don't want to read the rest of these slides to you, but it can take some period of time to be able to recover from a very large performance training effort then too. What did we allude to earlier and what are we gonna help you summarize here, and I told you we'd come around full circle to this is that if we want the best recovery time for our athlete, it is absolutely not just about getting a cold immersion, it's not just about massage, it's not just about active recovery.

But those features that I discussed with you earlier in terms of nutrition, hydration, and quality of sleep appear to be more salient than we might have once thought and never allowing yourself to get depleted in either of those top three. Imagine that, don't allow your tank to get depleted because it is very much harder to recover from a fully depleted state in any of those top three.

Finally, when we take a look at age effects on training, we have to certainly understand that we have busy lives throughout the entireties of a lifespan, and sometimes people can get burned out. And if they don't see themselves improving, don't see themselves achieving, if we haven't used measurements to be able to help people see their capacities, or if we have tended to base their performance attributes and measurements on something that's unrealistic, on their ability to be able to compete against their times when they were 20 years old, all of those things can cause burnout, motivation losses, and et cetera. Remember we cannot train at 80 at the way that we might've trained when we were 20 in terms of volumes or in frequencies, and we have to appreciate periodization and also allow that recovery to happen so that we truly

have adaptation. Okay, so one of the things that I think is helpful to understand is that the behavioral economics behind the competitive and recreational athlete need to be integrated into our prescription and into our communication. So to me, I'm very, very much a fan of and an espouser of behavioral economics. And so I very briefly give you a primer on these things right here, and we certainly take a look at the main things being choice burden. If you give an athlete too many different choices just like, you know, going down the aisle of a grocery store and seeing 17 different choices for mustard, sometimes it can be overwhelming. So provide a program and reduce choice burden. And that is really a big thing is because again, the difference between zero and one is much bigger than the difference between one and three.

And if your athlete is inhibited or intimidated by trying to figure out, "Okay, what should my running plan "be for this marathon? "Ah, forget it, it's too much, I just won't do it." Provide a program. Test and retest, show an athlete that they're actually making improvements. Use the gamification effect. Other people are out there doing it your age, your gender, your performance, your sport. This can be done. Wow, they look good while they're doing that, they're staying safe, they're enjoying themselves. There's a halo effect that extends beyond that.

And so that makes training a little bit more palatable with another individual as well. Relay success stories of the 103-year-old that is able to set a record in the 40 meter. The 70-year-old that is able to actually go sub three in the marathon and look for optimism bias. Tie the training to past life successes as well. "You were able to achieve a successful level, you know, "as an executive in business, "and now you want to achieve that. "Additionally, you are capable of working hard, "thriving, and achieving goals." And then finally look at the nudge effect, and making it a little bit easier and consumable for your aging athlete to see themselves in this position. So as we wrap up, we think differently than we used to either at the start of this effort and even at the start of last decade. So I'll read this quote to you. Traditionally, peak muscle strength

was thought to occur at age 30 years, that was peak muscle strength, and then decline at 15% per decade between age 50 and 30. And then decline further by 30% per decade after age 70. But it's now evident that regular, intensive muscle training can minimize or reverse age-related declines in muscle mass well into the eighth decade of life. Absolutely science, this is where you see the hope. And then we also understand, that's the hope, and for me, this is the nope. So regardless of the frequency, duration, or intensity, a body in motion tends to stay in motion. And that reverse can also be said. A body in steady state, a body inactive tends to stay inactive.

So when we look at these things, we have arrived to our advanced finish line here. And I take this point really, with the last nine to 10 minutes to go, to field your questions, to also extrapolate a summary, if necessary, on any points that I have left either incomplete for you today or otherwise. So Dusty, I'm gonna take a look, and I'll let the Continued staff address that. Dusty, I hope you enjoyed yourself today. I do see that you need to move on. Margaret, thank you so much. I appreciate your comments. Karima, thank you, appreciate it. And I'll look for any other questions we've got here. Great participation along the way. You guys did, Rebecca, thank you. Sierra, thank you, Ryan, thank you. I recognize many of your names here and I appreciate your regular attendance.

Annemarie, thank you, I appreciate it, and Susan as well. And again, I want to turn a thank you back to all of you for your interaction, responsiveness, for your gray slides and questions, and hopefully all of you do extremely well on your post-course because of those. And thank you again for all of those that are now sending in your praise for the course already. I'm going to try to see if I can, let's see Karima, okay, good, thank you. And I'm gonna see, I think there was, I don't see any other questions that I need to address. Okay, I thought I had seen one. What is the, okay, here we go. Karima, "What is the best," and I'm just gonna page down and navigate this. "What's the best way to obtain VO2 max test?" And Karima, there are ways to estimate a VO2 max.

There are some subtests that I can help you with along the way, depending on what type of sport you're looking at. But the only way to actually obtain a VO2 max test is to go to a performance center that has the equipment. Usually that's going to be done on a stationary bike. There are performance setups that can do that on a treadmill as well. But there are ways to estimate a VO2 max test as well, depending on what sport. Those don't have nearly as much validity and fidelity to them as the actual performance. So VO2 max can be either estimated in certain ways, which I can share with you depending on what sport you're inquiring about.

But typically to answer your question, not even just typically, absolutely the only way to answer your question to get a VO2 max is to actually conduct it in a performance laboratory. Searching for any other questions then here. Okay, I'm not seeing any others. So Calista, I might have you take back over here unless there's any other questions that I have missed here 'cause it looks like everything else is just, not just but, your compliments of the course and I do appreciate those. Okay, hey, I've got one for William. I'm gonna explore it here. "For your home exercise, "how many exercises do you recommend?" And William, that's a great question.

So typically I will stay right within three to five, depending on the personality of the individual that I'm working with. And then Joseph, Joseph, "Sounds like you do," hold on. And these kind of float around just a little bit real quickly here. "It sounds like you do some training "for longer distance running. "What do you do on average for training?" Well, what am I, for myself, I average usually 57 to 62 miles per week. And that's usually to kinda keep me in shape for half marathons, if we were actually hosting actual half marathons. And then if I'm gonna be running a marathon, I like to be in the low 60s to low 70s. I actually run every single day. And again, as I've mentioned, I'm over 50 years old. I don't miss a day at all. We're here at October 19th and I haven't missed a day yet this year. Then to answer your question, Joseph, I will actually do variability training. So there'll be usually two days per week that I'm going to hit higher

tempo efforts. And I might do those within an eight to 10-mile run. And there are usually three days per week that I'm just gonna go for kind of a longer slow run and stay more, you know, in the neighborhood of about eight minutes or so, 8:15's per mile and try to hit 11 to 15 miles on that. And then there'll usually be a couple of days per week that I might do some strength-based running and carry five-pound hand weights with me, use a loaded backpack, et cetera. So hopefully that makes good sense as well. I do think that's all the rest of the questions here then as well. And then again, since we do have just a second here, I will tell you that there are some devices that are working on having VO2 max estimates as well. And I don't want to push any products on anybody here too, but those seem to have some viability. I haven't seen great studies looking at those, and in the same athlete comparing them to an end performance in-lab study. I'm missing one question here that I saw and now has disappeared, one second. Okay, there was a question about ellipticals. If I can get that repopulated-

- Sure, Mike.

- [Mike] And I'm gonna try to answer that.

- [Calista] Mike, the question on ellipticals is what is your thoughts on ellipticals for older populations?

- [Mike] Okay, so thank you for reiterating that, Calista. So ellipticals versus treadmill versus stationary bicycle. Now you have to take a look at an upright elliptical versus a recumbent or a semi-recumbent elliptical. And I will tell you that for individuals that have any compromise with regard to their balance, or are less likely to perform intensively because they're fearful about their balance so that they wouldn't push themselves to a good dosage on a treadmill but they would on a, especially a semi-recumbent elliptical, then I prefer those. So when you talk about things being

superior to or preferences, I would say a semi-recumbent elliptical is probably the safest and one that lends itself in a geriatric population to be used with the highest intensity because of the fear. Then next in line, and again, this is gonna have some personality. Some individuals will also like an upright elliptical, some individuals will like a stationary bike, whereas a lot of those same individuals wouldn't work themselves quite as hard on a treadmill. So I would say from a safety and intensity, that would be the reasons why I would choose to use a semi-recumbent elliptical, but only for those reasons. "What about a lower extremity restorator for seniors "that live in," looks like probably cold weather? And that would be fine too. The restorator doesn't tend to have as much resistance available for most of them. I actually own one that, again, not to push products it is actually quite good and has some resistance levels. Remember the overall excursion of movement for a restorator is very small, so it's harder to actually get the type of workout and also get the true range of motion benefits from that as well. So where it is not plausible to leave your room, and you need a endurance exercise there, absolutely an under the desk restorator could be plausible as well. Fabulous responsiveness and interaction with all of you. Calista, I'll turn it back over to you to summarize and good luck on your test, everyone.

- Well, thank you, once again, Mike. What a wonderful course. And before we close, I do want to reminder everybody that this was the first class of our GeriAthlete series and Mike did a wonderful job. And he had mentioned his colleagues throughout, so I hope that you guys join us the rest of the week. And if you're not able to, we will have those courses available recorded. Thank you so much, Mike, and thank you everyone for attending.

- [Mike] Take care.