

Division of Diabetes Treatment and Prevention

Clinical Exercise Update: Six Important Findings Regarding Physical Activity Recommendations for Individuals in All Age Groups

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Most of what I do is in clinical lipidology. That is cholesterol disorders. Yes, that includes drugs and medicines but it also includes, first and foremost, lifestyle changes. And then for the last 15 years I've worked with the IHS Diabetes Division, helping conduct various CME programs on lifestyle and of course clinical exercise science.

On this first slide, I did put my email address for those of you that want to email me separately. I don't think it's any place else you'll get a copy of the slides as I understand, so I put that there for your convenience. The overall objective here is to review and practically apply recent exercise clinical trial research in a variety of settings. In almost every case, I've taken research that is published in the last seven months, so it is current. And in many cases, this is going to overlap with what you already know. But by reinforcement, I think that's very important. And some of the new clinical pathways with exercise are new and we'll discuss those as we go through this.

I've done this before for the American College of Sports Medicine and the American Council on Exercise. When I'm given a limited amount of time, I tend to pick six or seven key trends over the last year that apply to the utility of using physical activity for reducing chronic disease risk.

- We'll talk about that, we'll talk about fitness versus metabolic fitness. That might be new to some of you but it is very real.
- We'll talk about sitting or sedentary time, and all-cause mortality, and some things you can do about that.
- Single versus multiple steps of resistance exercise. That has come full circle. That is to get the most strength in a given amount of time or a limited amount of time. You're in the gym using resistance training, how many sets and reps do you do to get at least minimal effect versus maximum effect? That's quite well worked-out now. It has taken about three decades to do that, but we have that information.
- Evidence-based yoga benefits, everybody has questions about Hatha Yoga and Pilates, et cetera, et cetera. I spoke on this, and then part of the faculty of University of North Carolina Chapel Hill for complementary and alternative medicine. I teach a course called "The Psychobiology of Mindful Exercise." A bit of that is some of the utility of using yoga to improve overall health. We'll talk about that.
- Intensive versus moderate exercise and obesity - the bottom line is it probably doesn't make any difference how hard you exercise as long as, whether you workout hard or moderately, if the total caloric value is equivalent in both of those comparators, then you're going to lose just about as much fat weight regardless of the intensity that you work out. Now, there's a caveat to that. And if



you are fit enough to exercise with a little higher intensity with a greater load you'll reach some additional benefits. We'll talk about that.

- Finally, most of you that have looked at the quick guide cards on the IHS DDTP website, you've seen a number of quick guide cards on the diverse forms of physical activity to replace planned workouts that are like household chores, utilitarian tasks, et cetera, and a lot of research in that area.

Let's start. Most of us know what aerobic fitness is and cardiorespiratory fitness. How about metabolic fitness? Jean-Claude Duprés coined this term 20 years ago. Basically what it says is, let's say you work out at such a low level intensity-wise, which you endure for an hour or even longer, like a long slow walk on the beach, would that bring any benefits from that versus a much shorter period of time at much higher intensity? And absolutely, there is. We'll show you some of that research which occurred in the last couple of years.

So we know what cardiorespiratory fitness is. That is the capacity of the heart and lungs to supply blood and nutrients to the rest of the body. Metabolic fitness is the peripheral adaptations at the muscular level. And I'm not talking about muscular size or muscular strength now, the metabolic quantum effects at the muscle cell site.

The good news here, the bottom line, is whether you increase aerobic fitness or aerobic capacity, or not, perhaps because a patient of yours or you cannot exercise at a higher intensity, you still reap benefits in the periphery that relate to all-cause mortality and health. Those mechanisms that generate the metabolic fitness include changes in muscle mitochondria content, fuel storage at the muscle cell site; PPAR activation, that's going to be a new one for all of you, but would you believe that almost every diabetes drug you use is a PPAR activator in some way? And guess what? Exercise, regardless of how hard you work, you also activate those same nuclear receptors. We'll talk about that briefly.

Okay. So here is Pandey and Tim Church's paper just a couple of months ago from the University of Texas Southwestern Medical Center in Dallas. Long story short, I'm not going into great detail here. Two hundred-plus patients -- most were women -- exercising for nine months, three to five days a week at 50% to 80% of aerobic capacity. The long and short of their paper was exercise training in this study was associated with significant improvements in metabolic parameters irrespective if they had a higher VO₂ max or a higher cardiorespiratory capacity.

That's important for those of us that are measuring fitness, i.e., treadmill test times or model run times or whatever else. Someone may not enhance their mile run time or aerobic fitness, per se, but they can certainly increase metabolic fitness. That's something we generally don't measure, but it certainly can be assumed that they're benefiting there.

In Pandey's study, you can see here when you graph just A1C in this group of 200-plus patients, the red and the green lines show the people who did not respond to increasing VO₂ max, the fitness non-responders, versus the people in the study who actually improved aerobic fitness, both those groups had the same diminution in A1C irrespective of how hard they worked.

So basically what we're saying here, to sum this up, is that in their analysis they found that hemoglobin A1C, even waist circumference and percent body fat -- I didn't say body weight, I said body fat -- all improved in groups that exercised regardless of whether they increase VO₂ max or aerobic capacity or cardiorespiratory fitness or not. And they do this via mechanisms that we'll talk briefly about in a minute. And not to get too complicated, but if you want new information we'll give it to you.

The classic paper 20 years ago by Jean-Claude Duprés in Ontario was the first to show these peripheral changes. Basically what John had said in that initial paper on metabolic fitness, he coined the term "metabolic fitness" -- from a practical standpoint, although an hour daily walk at any speed

may not have marked effects on cardiorespiratory fitness, it probably represents an exercise prescription that has likely substantially improved metabolic fitness, thereby reducing the risk of coronary heart disease. Of course, he said that back 20 years ago in 1995, 1994-1995. And of course, since then there has been a whole wealth of papers to substantiate that claim of these peripheral benefits.

So let me graphically just say what I just said. Intensity-driven activity, that is walking very fast, swimming very hard, cycling up steep hills; that higher intensity that is above 65% of max, generate increased capacity, dimensions, heart size, and of course, performance. Duration-driven activity, okay, let's say we slow down to maybe only 30% of max effort, there are peripheral adaptations that also although you mobilize and use fat, it may take a little longer to use the same amount of fat you would use at a higher intensity. You certainly can drop A1C. You tend to have a blood-thinning effect with long slow distance. And of course, you increase the capacity of the peripheral muscle cells to metabolize oxygen, of course. So there are clear benefits from duration-driven activities, especially someone who is compromised in health where they cannot exercise very intensively.

Okay, next slide here. That's where I get in to the term long slow distance or LSD training, if you will. These are the forms of activities. Even though here is someone walking Squaw Peak just a month ago in Phoenix. Yes when she's going up a steeper grade it could be deemed as an intensive activity above 60% to 65% of aerobic capacity. But when you average all the ups and downs of Squaw Peak or Camelback Mountain, it actually is something lower than intensive exercise when you summate the entire workout. And that's what I'm saying here. You don't necessarily have to sustain high intensive activities to generate metabolic benefits.

Now, this is a new term for many of you. PPARs or what we would call peroxisome proliferator-activated receptors. These are nuclear proteins; it's something you cannot see. They are numerous in fat cells and muscle cells, et cetera. Activating these particular cells, proteins actually turn on and off DNA transcription. But what that really means is PPAR activators or PPAR cells come in about nine different forms characterized by the Greek alphabet like PPAR-alpha, PPAR-delta, PPAR-beta. But the new PPAR on the block which was just discovered up to a few years ago by Ron Evans at the Salk Institute, this is Ron right here, that's Ron Evans, he found a proliferation of PPAR-delta receptors in muscle tissue more so than in the heart, in the arteries, in the liver, elsewhere. Since then, a strong hypothesis is if you just move, just walk, just move at any level in terms of a continual muscle contractions at any level, you're going to stimulate PPAR delta proteins, which directly relate to oxidation in the muscle, directly relate to insulin sensitization and directly relate to reducing cholesterol, irrespective of the intensity of exercise.

And this has been shown in numerous studies since Dr. Evans at the Salk Institute discovered PPAR-delta. For instance, researchers just a couple of years ago at Texas A&M also showed the stimulation of PPAR-delta in people who did intensive versus moderate exercise. There was really no difference in the stimulation of PPAR-delta. Again, I know that's a little exotic, but here's a pathway that likely explains why we reduce risk of diabetes and coronary disease unrelated to weight loss, unrelated to fitness changes, unrelated to blood pressure reduction, unrelated to LDL cholesterol reduction. If you look at all the risk factors that exercise improves, that only explains about 60% of the reason why exercise reduced all-cause mortality in these chronic diseases. We've always wondered what the other secret factor was, if you will, that contributes further to the risk reduction of diabetes and coronary disease, and we think that at least half of the difference and the remnant reason why people reduce the risk is PPAR activation especially PPAR-delta.

So don't get too worried about measuring this. There's no way you're going to measure, at least inexpensively. Leave that for the scientists at Johns Hopkins and San Francisco, et cetera. We just know this is beginning to explain some of the reasons why to just move and move frequently and move as often as you can, you can help reduce risk.

This comes back to something practical. As you probably can realize, if you've heard any of my earlier discussions, I like to use simple gauges of activity like simple pedometers, well-engineered simple pedometers. This happens to be an elementary school in Barrow, Alaska, a couple of years ago. It was about 34 below zero at the elementary school there and we were able to go around the hallway like nine laps per mile. But what I'm saying here is that pedometers, if they work well, they tend to measure muscle contractions. We don't worry about how far you walked or how many calories you've burned for every step that reads out on the pedometer represents a PPAR-delta activator, if you will. That's really what I'm most interested in. It's a simple metric to put into your best practices outcomes measures.

Speaking of best practice outcomes measures, Let's Move in Indian Country, which I know best practices kind of evolved from. In the last year and a half I've had a research project with elementary schools around the Southwest, unfortunately, not in the IHS. We were using very inexpensive ACCUSPLIT pedometers. These averaged about five dollars apiece but they're smaller, they're less obtrusive and easy to clip on a child. And of course, we use this for a variety of children's programs. One of the most fun programs we do with a child, how many counts they could generate in four minutes of movement. You can imagine a child, if you said, "Go!" and "Get as many counts as you possibly can," they would move as fast as they could. That has been a real winner in many of the programs we have around the country for getting kids in elementary school grades to exercise.

But really what I'm speaking to here is using such pedometers to gauge how active the kid is at home and at school. We have a device now where the children will wear and record two school days of activities versus two weekend days at home. And we want to see the difference in how they active in their school and home and the differential. We add them up, but the differential, we try to close the gaps such that they're at least as active at home as they are at school.

With that, let me just add a couple of things. If I can do this right, there are new metrics and standards now for how many steps a child, adult, and a very young child should get. Rachel Colley at the American College of Sports Medicine finalized a huge research database project that she finished several years ago. Of course, we've heard for years that adults should get at least 10,000 steps per day. And that still holds true, 10,000 steps a day. Children three to five years of age, according to the latest CDC goals, should be around 6,000 steps with a reliable pedometer; like the one I just showed you but there are others, it's not just complying with that ACCUSPLIT pedometer. Those between six and 19 years of age should get 12,000 or more steps per day. That's a lot of steps; that's an average of five to six miles a day of walking. What we're saying with these actually step count thresholds, is by doing this in these age groups, one would not gain any further weight than they normally would be for that age.

Right now, 6-year-olds to 19-year-olds get an average of about 8 - 9,000 steps per day. So they need to be doing at least 3,000 to 4,000 more per day. And of course, most adults, depending on who you are and where you are and what you do, get less than 6,000 steps per day. So they have a long way to go there. Children three to five years of age actually probably do the best. Most children, whether they're underprivileged or not, get anywhere from 5,000 to 7,000 steps per day. This is new data. We just want to keep it that way and increase it as they get older and more fit, male or female. So those are the new goals for those age groups based on Rachel Colley's work a couple of years ago.

This is a form. It's the Youth Stepcount Activity Log. The reason I'm putting this with metabolic fitness, remember I talked about PPAR-delta stimulation? Well, steps are representations of PPAR-delta activation, increasing metabolic fitness. One way to measure that is with pedometry. What we've done here, as I've said earlier, is an instruction given to a child, let's say a middle school child, to measure their step count on two school days and two weekend days at home. It gives the instructions on how to do that and any comments, and to report that back for their teacher to begin a discussion about what the total count is, what it should be based on their age, and looking at if they're more active at home than at school. We're not saying one or the other would be better, but a big differential might mean

something. So this is one gauge we're using now to inform the teacher if they do need to have more daily activity.

So to wrap that point one up, as little as 20 to 30 minutes, three times work of low to moderate intensity activity is beneficial in helping reduce cardiovascular disease and diabetes through metabolic pathways that are not entirely related to aerobic capacity or even weight loss, for that matter.

Let's talk about sitting time. In the last six years there have been just under 400 papers published in the peer-reviewed literature on the metabolic and health detriments of too many hours sitting. I'm going to give you the gestalt of these studies. If you sit more than seven or eight hours a day, it is not good news - even if you are fit, even if you are aerobically fit. Sitting time in excess of seven or eight hours a day is, from a cardio-metabolic standpoint, not good.

Several of the latest papers that have come out. This is Parks and others in Bethesda, Maryland, basically looking at 150-plus thousand older adults between 60 and 82 years of age. They've looked at among the less active of these older adults, replacement of one hour a day of sitting, just taking one hour of the day that they were sitting, and installing an equal amount of either exercise or non-exercise activity like standing that's associated with lower all-cause mortality. Let me say that again. Replacing one hour of sitting in older adults with an equal amount of either walking or movement or even standing -- the later data will show you even standing is better than sitting from a metabolic fitness perspective. That's basically what this group found in Bethesda, Maryland. Just about three months ago, they published that work.

And this is just another graphic representation of another study, the 222,000 Australian adult study, just showing again looking at the hazard ratio of all-cause mortality and relating all-cause mortality to sitting time. Once they exceeded about eight hours a day of sitting, all-cause mortality began to increase; this from all causes, and we've seen this over and over and over again in big epidemiologic studies.

One of my favorite studies is Toby Pavey's study; he just published this just a month ago from Brisbane, Australia. This is the Australian Longitudinal Study on Women's Health. Basically, when again looking at sitting hours over the day, noticed that after about six to seven hours a day, sitting longer than that cumulatively over the total course of the day, the hazard ratio of all-cause mortality also went up quite markedly. Prolonged sitting time was positively associated with mortality. This is in women now. Women reported sitting for more than eight hours and did not meet the physical activity guidelines had increased risk of dying within the next nine years.

There's another paper by Genevieve Healy, again in Australia, showing sitting-reduction strategies targeting increase in standing or stepping or both may benefit cardio-metabolic health, including just standing, even standing at your desk. Many of you probably by now have seen online or heard about people or perhaps yourself having standing desks, they're not sitting but they're standing. Standing takes ATP splitting that means you burn a few calories. It's about a one and a half to two MET activity. That is one and a half to two times resting metabolic rate. If you stand at your desk for five or six hours, that's very substantial.

Here is another paper that is more of a practical nature. This paper looked at the utility of using various strategies to keep people from sitting too long like wearing a pedometer, a pedal machine, self-monitoring daily steps, the more influential of which were using pedometers and a pedal machine bio-feedback display that you would have at your desk. I fully realize that most of us aren't going to be able to afford that, but most of us can afford the pedometer. But these are all effective strategies to reduce sitting time.

So each hour a day spent sitting is associated in two other studies with a 14% increase in coronary artery calcium score independent to traditional risk factors including physical activity, fitness activities, and a study of middle-age subjects without cardiovascular disease. This is from the Dallas Heart

Study. Again, you see increasing support. Just about every month that goes by there's another trial showing this.

Now, one of the reasons people do tend to improve reducing the risk of all-cause mortality and chronic disease with movement is the reciprocal of that, that is inactivity. So sitting time, prolonged sitting for more than an hour at a set, if you will, increases platelet stickiness. That means it decreases fibrinolytic capacity of the blood. Blood gets a little thicker, little stickier as you can imagine. We also have enormous amount of data on lipoprotein lipase, an enzyme that's responsible for hydrolyzing and splitting fat including cholesterol and its component parts to be metabolized. Well, you reduce LPL for prolonged sitting time. So we think lipoprotein lipase and platelet stickiness are the two common factors that predispose us to early mortality due to too much inactivity, especially sitting.

So those are the basic reasons. What can we do about it to be more practical? Right now just based on the last six months of data that looked at interventions where someone would get up five minutes on the hour. This is what I call "workplace energy expenditure." Every hour on the hour, five minutes of walking anywhere, upstairs, around the desk, down the street, down the hallway. If you multiply five minutes times seven, it would be 35 minutes, at three to four calories per minute, that would be about 100 to 140 calories that you would not have expended otherwise. And over the course of one year, that's about 10 pounds of adipose tissue loss just from getting up on the hour and moving five minutes. Some papers suggest more like nine or ten minutes on the hour.

And of course, we've looked at the insulin sensitization of that as well, getting up. So you notice here, a standing desk as I talked about, using the stairs, sidewalks, et cetera. I think you probably get the message that there's a way to keep moving, you just have to remind yourself to do it. Microsoft WORD and Office has timers on all of their platforms, their word documents, their word processing software, their Excel spreadsheet. You can put a timer to ring an alarm at any interval that you want, once an hour, twice an hour for any length of time. So we have at our desk a provision to remind us to get up and move.

Okay. The third trend I'd like to talk about is the preponderance of evidence suggesting that performing multiple sets of resistance training or weight-training exercises confers muscle hypertrophic and/or strength gains advantage over single set. In other words, if overall muscular strength is your goal, two to three sets of eight to twelve exercise repetitions for the major muscle groups may be all that is necessary. Now, this will be old hat for some of you. This sounds like something right out of the ACSM or ACE Manual, right? Not so. Because up until about four years ago, the preponderance of evidence was that there was very little difference in strength gain from doing one set of so many repetitions versus adding a second or third set, okay?

I'll give you the consummate paper that was written by Tom Berger several years ago. Let me go back. Before I get to that, when I say "muscular strength" I'm really talking here about muscular strength versus muscular power or muscular endurance. I'm just talking about sheer muscular strength like low back strength, torso strength, upper extremity strength, et cetera. That's really I'm alluding to when I say "strength" here.

And of course, there are many ways to do this. We know clearly that the benefits of keeping basic strength up is going to be increased bone mineral content because any resistance exercise is going to stimulate osteoclast formation. You increase your functional strength, ability to perform activities of daily living. We now know and there is plenty of data supports that insulin sensitization from resistance exercise. And we actually have shown that even higher-intensity resistance exercise actually enhances insulin sensitization even more, which would be good for type 2 diabetes and prediabetes. And of course, metabolic and body composition changes that are very positively associated with strength training.

So this is the study by Tom Berger way back at Texas Tech University in 1962. It has been talked about every which way there can be in the literature. In fact, it's the most cited single strength study ever even though it was a very simple study. The first column is sets, one set of two repetition. And this is percent of strength gain, 1RM max. Just the percent increase and strength gain, doing this for a week, one set of two repetitions every other day increased strength 20%. He changed the permutation all the way to two sets of two repetitions, two sets of six repetitions, two sets of ten repetitions, three sets of six repetitions and three sets of ten repetitions.

The one that won out, and this was replicated in numerous studies shortly after in the early '70s, actually, it became gospel that all you need to do is three sets of six repetitions. But keep in mind the repetitions would be set such that you would have so much load on the resistance arm or the barbell that you could not do a seventh or eighth rep. It would be nearly maxed. So three times six reps was, for years, the standard for enhancing not muscular endurance but muscular strength.

But since then, there have been many, many papers. Hundreds, if not, probably close to the 700 or 800 papers, showing, especially when you look at huge groups of studies, the data support the use of multiple-set programs for trained individuals and single-set programs for untrained individuals. True, someone just starting strength training that is a novice to it, especially an older person, four or five exercises with a single set to start with, but over time, at least two sets to have the most favorable benefit in terms of strength gain.

We have another study where we looked at training in elderly women. We found the same thing. This was a São Paulo, Brazil study done a year ago looking at knee extensor strength, which is pretty important if you're going to reduce falls in seniors, and these were older women. And they looked at one or three sets twice a week for six weeks of knee extensor resistance training. Their results suggest that during the initial stages of strength training, single- and multiple-set training demonstrate similar capacity for increase in dynamic strength of the knee extensors in elderly women. So in elderly women, we're just talking about women that were between 60 and 74 years of age, it really didn't make much difference in terms of enhancing strength whether they did one or three sets. Just keep that in mind. That would be not necessarily the truth in a younger individual, let's say 30 to 40 years of age, they're going to show that two to three sets would have actually enhanced measurable strength gain.

Here's a study in Colorado Springs, actually at the Olympic Training Center, done a couple of years ago where they showed that multiple sets are associated with 40% greater muscle size -- that's what we call hypertrophy-- than one set in both trained and untrained subjects. But in this case, we're talking about where the median age was in the 30s, not older women 60 years of age or later.

So multiple sets, and we'll come back to this, but at least two sets is really what we're talking about if you're trying to at least optimize strength gain. And again, you can see here when we say "hypertrophy" that means muscle size which is correlated very closely with muscle strength whether it be lower back muscles, leg extensor muscles or upper extremity muscles, going from one set to two or three sets, there's about 35% increase in strength. However, optimally, spending more time in a gym, I hate to say, four to six sets generated another 25% to 30% increased strength, at least in this group that they did at Colorado Springs.

Here's the final analysis here. This is the official American College of Sports Medicine guidelines on strength training based on 1,100 studies, most of which were done in the last decade. The thing I want to show you here, and you can print this out on your own later, is that for ideal strength gain, you set the resistance on the bar such that 60% to 70% of the weight that you can lift one time is set on the bar, 60% to 70% of 1RM max. And then in terms of repetition, 8 to 12 reps; and in terms of sets, two to four sets. That's for those up to about 60, 65 years of age who are trying to enhance strength. Multiple sets, 8 to 12 repetitions, maybe 6 to 15 repetitions is not too far off of that, but that's what we now see as the guideline. That is in the guideline you'd be responsible for if you were taking a personal trainer exam or a clinical exercise specialist competency exam.

Said another way? What I just told you said another way, moderate intensity, that is 60% to 70% of one RM max, 8 to 15 reps, is ideal for a balance between strength and muscle endurance gain. True, if you take the Berger study we showed you at the beginning, if you increase the weight on the bar to, let's say, 85% to 90% of maximum ability to move that weight one time and you increase that weight on the bar where can only do five or six reps at the most, you will enhance strength the most versus, let's say, eight to 15 reps. Whereas over 15 reps, you don't increase strength that much but you increase the ability of the muscle to repetitively consistently contract over and over again. And what the American College of Sports Medicine is saying is a happy median would be eight to 15 reps would gain benefits in both strength and muscular endurance.

One last thing, this is an Arizona State University study a few years back. This is about the fourth study that year that showed if you take patients with impaired fasting glucose or pre-diabetes, they found that high-intensity strength training had greater insulin sensitization with multiple sets than single sets. When I say "high-intensity" I mean 85% of 1RM max. Let me just say, though, if you're starting a patient that has metabolic syndrome or prediabetes or impaired fasting glucose, I would start them on a single set. But many universities have shown that higher-intensity multiple set resistance training further enhances insulin sensitivity by 20% to 30% which is pretty impressive. So, yes, if the patient is healthy enough as a prediabetes patient, even several studies recently had been done and shown the same results with type 2 diabetes patients.

When we say strength training, we're not just relegating that to what you do in the gym. All of these are strength training. Not just using gravity-dependent weights. A downward facing dog and the core strength of the core of the body with yoga, Thera-Bands work, certainly wind resistance with these parachute runs we see runners do, or Pilates. So we're not just talking about strength gains only in the gym or with free weights. We're also talking about the multiplicity of ways you can enhance muscular strength.

There's another example using Thera-Bands or the equivalent. And of course, we'll come to yoga in just a moment, but it takes many years to do a tree pose. It not only takes flexibility, but it takes lateral abdominal and hip flexor strength to hold that pose that Jennifer is holding. That is what I would consider a strength exercise but also a flexibility exercise and also a mindful exercise.

One last thing, I think probably most of you that are personal trainers or healthcare providers know that there are three different types of muscle contractions. Concentric where the muscle shortens; isometric where you just hold the length of the muscle holding your weight, like horizontal bar, for instance; and eccentric exercise when you let yourself back down when the muscle is contracting but it is elongated. The reason I show this is that eccentric phase when the muscle is elongated like when you're letting a dumbbell back to the resting position where the bicep is starting to lengthen out, but still holding some tensile tension on it, that phase of muscle contraction, the eccentric phase is clearly the most important phase for developing muscle strength.

But it comes with a double-edged sword. It's also the most important phase for stimulating delayed-onset muscle soreness. Any activity that has an eccentric muscle movement, even downhill running, if you can imagine, the quads are breaking and lengthening and keeping you from falling on your face running down a ski slope, for instance, versus running up a ski slope. That was a study done years ago on muscle soreness. Running up a very steep slope, the patients were exhausted, the subjects were exhausted. But they weren't that sore the next day. But jogging very slow down the hill, they couldn't get out of bed for a day or two. That's because of the lengthening muscle contraction.

What I'm really saying here is if you're in the gym, are doing a device exercise, if there's an eccentric component that's going to help with providing further increases in strength versus isokinetic devices that eliminate the eccentric component -- we see those types of devices in physical therapy laboratories. Patients or athletes that have been injured who want to eliminate or at least reduce the

eccentric phase because that is the most strenuous phase of muscle contraction. And then in time, let them eccentrically overload the muscle.

Just a word on Pilates. Pilates, as you've probably realized, is a system of exercises that can be done on a mat, but most often is done on a reformer, one of eight or nine different types of reformers. It takes concentration, breath centering, control of breathing, precision and flow, because there's a slow movement. It's largely eccentric on the core abdominal regions of the body for the most part. And there is no better way now that we have fairly decent data and research laboratories on Pilates, to improve low back health, core strength, and posture. Pilates clearly is both a concentric but mostly eccentric exercise done with a mild resistance of spring-loaded handheld devices. You can see here this particular subject is holding this position. The low back lumbar muscles are isometrically being contracted now. But she will let her legs back down to be almost horizontal, by doing that, these muscles in the posterior become eccentrically overloaded. Thereby, if it's done correctly and progressively and gradually, it is enhancing core strength especially on the low back. I guess my point there in the last couple of slides is Pilates went for like 20 years with hardly any research. And in the last five or six years there has been a burgeoning of Pilates research published studies in the refereed literature.

I'm going to answer a question or two before we go to the next slide just to save a little time at the end. Joe Talley had asked, "Does lifting to complete muscle failure add to the benefit?" Joe, that is a great question. You would think so if you talked to some trainers. Going to complete failure definitely enhances your ability to tolerate pain and strength, and that can be important in athletic endeavors. But you risk straining the muscle. And from a health standpoint, as far as we know, it doesn't add anything. It actually may subtract from dynamic lower-intensity muscle movements and muscle contractions. So from a health perspective, no, going to failure does not. However it's done quite often. If you have a personal trainer and you're really into strength training, with most trainers, after you've graduated your training program, you will go at the end of each set to near or abject failure. That does not need to happen. And the older you are, the greater the risk. I can tell you personally, the greater the risk. I've had two hernias from college when I ran track for the University of Texas. I had a leg press machine and our athletic trainer -- I can't tell you how many decades ago -- had me go to failure so many times. I've had a bilateral inguinal hernia, had that be repaired. I never did get back to track that year. So I can speak personally, there are some cases it doesn't work out.

All right, let me go to the next slide or the next point. Okay. So let's talk a little bit about practical hatha-based yoga exercise. Let's understand what we mean by yoga. If you say you do yoga. That has very little to do with exercise. I've written seven book chapters on the science of hatha-based yoga. Hatha yoga is a branch that includes exercise. But these branches here include a variety of observances that have very little to do with the actual asana or a yoga pose that you would see in a fitness center or a yoga ashram.

Most yoga originally evolved to include moral observances, breath control, meditation, posture, spiritual integration. When you say you do yoga, for me it sounds like tantamount to saying, "I do Catholicism." That's really what it sounds like to me. But really, what we're really saying is yoga refers to of course a complex system of physical and spiritual disciplines. And we must differentiate the word "yoga" from the participation in hatha yoga, which is the physical form of yoga, which originally was the form of yoga to prepare the mind for meditation. That's why we do the pose or series of poses, to prepare the mind for meditation. Hatha yoga comes in many, many, many, many styles and forms. We won't get into all the styles but what we'll say is there is a growing body of research and there has been for two decades on the utility of engaging in two or more times a week of various hatha yoga styles to improve health.

Again, you have to remember that hatha yoga must include all three of these to get the full health-related benefits. The actual pose itself, the muscular contraction or the asana, as they say. Breath work or our pranayama component, as we say, and some type of internal meditation function or cognitive function. Jay Dunbar calls that "mentation," some type of relaxation from a mindset

standpoint. In other words it's done non-judgmentally other than just listening to the kinesthetic feel of the actual pose itself. When all three are combined, not just two of the three but all three, there are enormous benefits that we've seen in many, many, many studies. The biggest review of yoga literature ever done was 900 studies reviewed by Ospina and others, and basically, out of the hundreds or so claims of what yoga could do for someone, five stood out very clearly to be evidence-based. That is stress-related symptom reduction, pain symptom reduction, reduction in systolic blood pressure, addictive behaviors improvement, and improvement in muscular balance. Those stand out and has stood out in the research for many years. Going beyond that, there are other benefits but not as well researched and not quite as robust in the terms of the findings.

I'm just going to show you two slides here of two more recent reviews. This is Pascoe and others from the University of Texas at Houston and Sweden that looked at 25 randomized controlled trial studies using hatha yoga, and that's hard to find, a randomized controlled hatha yoga trial, showing again a decrease in systolic blood pressure, heart rate, stress hormones, and cytokine expression. Most studies were done two or three times a week for about 20 minutes on average, these particular yoga exercises that we'll explore in just a second.

Here's another review study that was just again published at University of Toronto, 2015, by Desveaux and others. But the ten studies of almost 430 individuals mean age 56 years of age compared with the usual care yoga, resulted in significant improvements in exercise capacity and mean improvement in health-related quality of life. So this may sound a little rote to a lot of you, but when someone challenges a yoga teacher or someone beginning to teach yoga that there's no evidence base, there is a robust evidence base, especially in very well-refereed medical journals.

I'm going to end with this, with yoga. The beginning yoga style that everyone should start if we're going to start hatha yoga, would be restorative yoga. Restorative yoga is hatha yoga using props, props that make it easier at least at the beginning stages. Restorative yoga has lots of research. Judith Lasater coined the phrase "restorative yoga" many years ago. And then as time goes on, you can begin to withdraw the props, the pillows, the bolsters, the blankets, so you rely more and more on your body's flexibility and strength.

This is actually a sarvangasana or a supported bridge pose, helping lower back. Yes, they're not burning many calories but they're certainly helping lower back flexibility and they certainly are in a relaxation pose to help reduce systolic blood pressure, et cetera. Legs-up-the-wall pose, probably the most famous hamstring stretch for men ever recorded. I did many studies and most men have very tight hamstring strengths. Most people do but most men do. To make it easy in the beginning, you put bolsters under the buttocks and then you try to get the buttocks as close to the wall as possible. And in time, you withdraw the thickness of the blanket such that the buttocks sit square on into the right angle of the wall, putting maximum stretch on the hamstring. That's probably the best overall hamstring stretch of all time. Of course, flexible hamstrings improve low-back health.

This is one of the resources, Judith Lasater's restorative yoga text, "Relax and Renew." Probably the best single yoga how-to text. She's a doctor of physical therapy. She's been around for 30 years. She knows her stuff. Other restorative poses.

Kim Schwartz, High Desert Yoga in Albuquerque. Years ago, I did a cardiology conference in Santa Fe and I had Kim come up and placed 400 yoga mats in this huge auditorium and had all of these cardiologists that were listening to two days' worth of heavy-duty cardiology investigation and research. And then I said, "We're going to do a very special research, one that's new data. If you'll all be routed into this one room." They all looked at me like, "What are we doing with this now?" They got into this room. And this is not an auditorium, there's not slides or anything, nothing but mats on the floor. I routed them all in there and I shut the door, locked the door, and had Kim go through nine restorative poses. You're talking about making believers out of these -- for the most part -- male, stiff, unflexible cardiologists. It just worked wonders. And of course, when they left the room many of them were

saying, "Well, I would like your book. I'd like to know more about it because I want to give this to my wife." What I really meant for them was for them to use it for themselves. But, again, restorative yoga is the best beginning stage of hatha yoga.

The breath work part of yoga is probably the most important. I mean there's the physical part, the resistance part, the holding the pose part. But what probably transcends all of the benefits is the breath work component. We know enough now about breath work physiology that when someone purposely inhales for a two-count, and exhales for a two-count and increases that count over time, especially on prolonged expirations of the breath, they have an impressive robust stimulation of the parasympathetic vagal nerve. That just means that it generates a very immediate real-time relaxation response. You can do it in just one minute. A couple of deep inspirations and prolonged expirations would immediately stimulate parasympathetic response such that you relax almost immediately. There is no anxiolytic medicine that will ever do that in real time and it's great.

We've seen data over the years of even when you have a conscious inhalation, taking a breath in, your sympathetic nervous system tends to be slightly activated then, slight pupil dilatation. On prolonged exhalation, you actually stimulate the parasympathetic nervous system, more the relaxation response. One of the simple tools we use for people just using the breath work part of yoga by itself without the meditation or the asana or pose along with it, is an exercise where a client or a patient will inhale to the count of two, exhale to the count of two, inhale to the count of two, exhale to the count of three, inhale count of two, exhale to the count of four, inhale count two, exhale to the count of five. So they're doing longer and longer exhalations. This technique by itself is probably the most evidenced-based, at least physiologically, in terms of the benefits that are reaped from just the breath work part of yoga. And I've seen so many yoga classes that avoid or have complete absence of the breath work component. It has to be fundamental to the hatha yoga exercise.

Luciano Bernardi and others in Italy and now in London have done the consummate work on breath work. Not breath work you would do in a meditative sense, but in singing and chanting. In singing the Ave Maria, choirs who have prolonged notes on expiration, and you can identify with this if you sing much, has shown very clearly when they did electromyographic and electroencephalographic studies showing that cardiac vagal activity -- that means parasympathetic slowing heart rate, increasing heart rate variability which is very correlated with reducing risk of coronary disease -- was the first to show that singing on a regular basis, especially holding notes for as long as you can, is a pranayamic yoga technique and is extremely healthy. I couldn't let that pass without talking about Bernardi's work.

We saw one recent paper -- and I won't go into any details because we're short on time here -- on reducing atrial fibrillation. About 30% of population over 50 have a fib, which can be concerning. In two studies in the University of Kansas, the first study in 2013 and one just about three weeks ago, came back to this looking at 50 patients or so in three months twice a week of doing a three times a week 45 minutes of hatha yoga. It reduced the number of episodes of these very rapid heartbeats with shortness of breath. It was reduced from three-point episodes a day to 2.1 a day. In the more recent paper, it dropped it to one a day from about four. But it had to be regular yoga. They couldn't skip it for two weeks and come back once a week. They had to do it on a regular basis.

Okay, these are just some hatha yoga poses for low back exercise. These are proven asanas or poses for low back pain and have been used in many, many, many, many studies.

Okay, as we wind down now, in another five or six minutes we'll go through just one point that you've probably heard me speak about before, there is more recent data on it. Increasing exercise intensity provides additional benefit depending on the target health outcome in insulin-resistant obese persons including type 2 diabetes. You've heard me say for years that any exercise is good to reduce risk. But if you're healthy enough, if you exercise a little bit more intensively you do reap some more benefit. There's no question about it. But Bob Ross has done more than anybody in the world on this in Ontario, Canada, just published a study four or five months ago. So, that a fixed amount of exercise

independent of the intensity resulted in similar reductions in abdominal fats. As long as intensive exercise is the same amount of calorie expenditure as the lower-intensity exercise, you lose the same amount of fat weight. However, those who exercise more intensively had a further reduction in two-hour glucose level and had greater insulin sensitization. So there are utilities for exercising a little harder to reduce complications of diabetes. But the patient has to graduate to it. You cannot start with intensive exercise. We've seen this in many studies.

Here is a non-deniable fact, IM Lee at Harvard. IM Lee is an exercise epidemiologist. She is probably the best known exercise epidemiologist in the world. She was one of the first to show in the Harvard alumni study that, yes, if you exercise every other day at maybe 60% of maximum, you can reduce your risk of coronary heart disease by at least 10%. However, if you exercise to about 70% to 75% of max or above six metabolic levels for the same period of time you reduce your risk considerably more. So, again, although any movement is good, more intensive movement after a graduated-start exercise program would probably definitely be in order.

Finally, you've probably heard about this style of training, it's called "30-20-10." It's a fun training methodology. It's a dynamic walking, running, swimming, bike riding type of methodology. What we mean by "30-20-10" is 30 seconds of very slow activity, easy pedaling on the bike, followed immediately by 20 seconds of about 50% of max, followed by 10 seconds of near all-out max. Repeat that five times, two-minute breaths between each circle set, three or four times a week. And guess what? You've saved time. And what they've been able to show in numerous studies including the originator of this technique years ago, Gunnarsson from Denmark, back in 2012 -- actually in 1995 was when he did his first study, but his recent is 2012, doing his 30-20-10 technique whether it be in a pool, on a bike, on a treadmill, or outside, reduced training volume by 54%. That means it reduced the total training time but the total energy expenditure was the same. However, I would not advise doing this without maybe a week or two in someone with prediabetes or diabetes undergoing a very graduated moderate moderate-level exercise program where they suddenly get on a StairMaster and go near maximum even for ten seconds.

So the 30-20-10 or 10-20-30, if you will, is a training technique that adds a lot of interest and a lot of fun to an otherwise boring exercise program. Essentially, you do that when you go out hiking variable -- here again is Camelback Mountain, it's great for a while then it's hard for a while. That's sort of doing the same thing; only the 30-20-10 is even more intense and more dynamic, if you will.

So what I would suggest from a practical standpoint here is those of you that go out for maybe a 45-minute walk, maybe the little eight or nine minutes of that walk pick up the pace to maybe 65%, 70% of your max walking pace and ease back down. That's really what we're saying. Another way of seeing that is to take a walk, a mile walk or a high school track, let's say, walk the bleachers, figure eights in the bleachers, or jog on the track for maybe ten minutes and then walk back home. Sounds simple, but that's in fact what we're talking about in interspersing some higher intensity activity throughout a particular workout rather than doing just LSD only, long-slow distance.

Finally diverse types of moderate exercise are also associated with cardiovascular disease mortality risk reduction. So you don't even have to go to the gym if you do enough gardening, that's what we're saying here, or other household chores. Just think of it this way. An active outdoor lifestyle, let's say in your yard, that expended a thousand calories would have just as much and maybe in some cases even more ability to reduce cardio-metabolic disease risk, than the same amount of energy expenditure with formalized planned workouts. And from a utilitarian perspective, this has a lot of meaning. This one million women study that was just published. Miranda Armstrong just published the 1.1 million women in the UK study and what they found is that anywhere from 120 to 150 minutes per week of moderate physical activity -- especially, they actually had an advantage if they did it through household chores and utilitarian tasks. And we're seeing that over and over again with these utilitarian activities.

I created a Facebook page website called “The Gym Inside Your Door” and that was inspired by the Alaska Tribal Health Consortium that has a ten-year running website called, “The Store Outside Your Door,” Native foods. The Gym Inside Your Door is basically a systematic approach to actually a circuit of household chore exercises that could be done in the yard as well. Painting, activities of daily living, yard work, et cetera. And you have the instructions for this circuit of household chores on the quick guide card section of the DDTP website under “Physical Activity.” Go to “Resources” and then go to “Household Circuit Training Activity Program.” It’s a video, a schematic video of how this might work. This is one way to get things done and accomplish tasks as well and stay reasonably metabolically fit.

This is the form we use for the five or six activities we have a patient do with one-minute rests in between. It could be hanging clothes out, ironing, scrubbing the floor, taking out the trash, digging up something in the backyard, and coming back to a resting position. That’s basically what we mean by “Household Circuit Training Activity.” There are many resources for this I can share with you later.

Let me conclude by saying one of the SDPI program’s best practices programs is always looking for metrics to show results and outcomes and measures. Please do not forget about using simple, inexpensive but standardized, well-engineered pedometers. They probably represent the best single utilitarian mode of outcomes measures. Yes, a patient can cheat. A patient can put that pedometer on their dog's collar and have their dog run wild. But one thing we know, that somebody is moving. You can't fool it, somebody is moving.

I will say a single bout of exercise generates more real-time favorable metabolic arterial and psychobiologic changes than any single medical therapy. I'll give you two resources for those of you that -- really, this is a brand-new certification by the American Council on Exercise. The core text is called “Medical Exercise Specialist Manual.” These are for fitness instructors and nurses and mid-levels that really want a clinical version of how to appropriate exercise with chronic disease. This is a new certification by the American Council on Exercise. And this last document here is a patient community guidebook on exercise with all those guidelines I spoke to you about but this is entirely for the patient and for the public, not necessarily written for science-speak or those of us in the clinical exercise sciences.

With that, I am going to answer some questions starting with the last one. Rene said, “did he say he made a Facebook page? ‘The Gym Inside Your Door?’” Yes. Put it into your Facebook search engine, “Gym Inside Your Door.” But a good bit of that is a quick guide card on the DDTP website under “Physical Activity.”

Here is another question by Rick Frey. “I believe I heard you say that work at 40% to 60% of maximum effort that is moderate exercise is ideal to reduce the risk of diabetes.” I probably misspoke if I said that. Any movement at all would help reduce risk. 40% to 60% of maximum effort would be considered moderate. That is the definition of moderate intensity whether it be resistance training or aerobic exercise. And Rick goes on, he had two more questions. “Would you make the same statement about effort in regard to preventing CVD and diabetes risk?” Yes I would, only because with 40% to 60% of max effort you’re going to probably last longer, do more reps, spend more time in any activity versus if you were going to spend going 90% of max effort. Which would still have benefits but you’re likely to go farther with more time spent and perhaps more calories burned by slowing down to that moderate level and then prolonging the distance.

Okay, Ray had asked, “Anyone know of a good education and program in regards to the main type of resistance training a person can do at home?” The ACSM book, which is my last slide here, has a section on very basic resistance training exercises. Email me. If that doesn’t suit you, there’s a whole wealth, a very basic resistance training exercises that can be done at home without a lot of extra weight or a lot of formalized barbells and dumbbells and weight machines.

Here's one other question. How long of a break from sitting does it take to offset the negative impact of sitting? That's a good question. We saw that one paper that said the ideal is replacing -- let's say even as a fit person, you still probably sit six or seven or eight hours a day or more, replacing that with one hour of anything including standing seems to be right now nearly ideal. Let me go back. I should say walking during that one hour would probably be ideal more than standing.

Okay. With that, Jan, I'm going to back out and ask if anyone has further individual questions. They're more than welcome to email me and my email address is on an opening slide. Thank you so much for your time.

Jan:

Ralph, we really want to thank you. As usual, with your presentation you've just given us a lot of information and really inspired a lot of us too. I know I've watched your webinar with the group and we all stood up. I'm just envisioning, I'm envisioning all across the country we have lots of people standing up for your webinar. We did have a couple of other questions in the chat that came up and I can read those to you, Ralph.

Ralph:

I can read them. I have them right here.

Jan:

Okay, you got them?

Ralph:

Yeah.

Jan:

The start there about the devices, the Fitbit, smart watch, that kind of thing.

Ralph:

Oh, go ahead and read that one for me. Yeah, go ahead.

Jan:

Sure. Is there a device or app that's recommended to count steps that is not just a pedometer? Do you know about Fitbit or smartwatch or the Jawbone?

Ralph:

All three of those, smartwatch, Jawbone and Fitbit are all good. Compared to research that's just now being done, the Fitbit is in its third generation and it looks like it correlates pretty nicely with accelerometers which are high-end pedometers. My only thing is, as long as it makes you exercise it's good but I still think simple pedometers are the best because if you lose them -- you'd be surprised how many people accidentally flush their pedometers down the toilet -- you can replace them very inexpensively. But yes. In fact, as you probably know, there are about 40 different Apple apps and Android apps that you can download, I have them on my Android, that are surprisingly pretty close to what a high-end pedometer would show in steps.

What I do not recommend is putting the pedometer in your pocket. Even though I know you're going to have your cellphone in your pocket, it probably is a little better to have a cellphone in your pocket than a pedometer in your pocket. If you use a pedometer, always affix it tightly to the waist over one of the two legs. Fitbits and Jawbones, et cetera, are based on arm cadence. And that makes some assumption. There's a little bit of disconnect between arm cadence and leg cadence, especially in the sitting position. But all in all, the early research says that the Fitbit and the Jawbone, et cetera, are pretty darn accurate when you match them up against some of the accelerometers that they use in research.

Joe Tally had a question. Is there any benefit of super-slow repetitions? Yeah, super-slow repetitions activate more muscle neuro-synapses, there's no question about it. More motor units are activated. I don't know what that means. I don't know what that means, but yes, slower resistance movement -- and that includes Pilates -- activate more motor units. I'm not sure what that translates to in terms of health benefits but it definitely activates more. Go ahead, Jan, if you have another question.

Jan:

Sure. And I'm seeing that other folks out there in Indian country stood up for your presentation as well. We're also wondering. One of the questions is, is there is any benefit to sitting on the exercise balls.

Ralph:

Oh, from a postural standpoint, there is. There were some studies about ten years ago that showed that. Because your vertebral columns from your butt to your cervical spine has to balance. And it keeps you erect. From a postural and even a Pilates standpoint, sitting at a desk on a ball, you cannot beat it because you have to rely on balance. Now, do you burn any more calories doing that? I'm sure you do because there's a little wobble there, but I've not seen research on caloric expenditure. But from a postural muscular and skeletal health standpoint, you cannot beat sitting on a Resist-a-Ball.

Jan:

Okay. Another question about pedometers, Ralph - are pedometers sensitive? And to clarify that, are children able to just shake the pedometers to get it to count as their steps?

Ralph:

Absolutely. They can shake a thousand-dollar Accutrak 2. And this happens all the time. When they know they were supposed to put in 8,000 steps at home and they haven't, ten minutes before the class they're shaking it so the teacher will see that -- at least I know they're moving, okay? They're moving. The only time I've seen that they have a major disconnect was there in Santa Fe when you know the man -- the pharmacist Randy Burton tells the story about a Santo Domingo Native who would ride his horse every day and the horse was generating an incredible steps with four legs and the man riding the horse was generating about 6,000 steps every ten minutes, but it wasn't his steps.

As long as you are moving the little device, the pedometer, whether you're shaking it or I guess the only other times when you're riding on a bumpy road in a car and the pedometer is on your waist, they've been known to see high step counts because it's shaking on your belt line and you're really not doing much. All in all, though, I think that's okay.