Physical Activity Guidelines for Diabetes and Prediabetes

A Web-based Training

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Hello, my name is Ralph La Forge from Duke University Endocrine Division in Durham, North Carolina. This webinar is entitled Exercise and Physical Activity for All Ages: The 2012 Research and ACSM/ADA Prediabetes & Diabetes Exercise Guidelines.

This webinar was originally recorded in May of 2012. This version is an updated version split into four parts. These four parts are as follows: overview and key concepts, recent important clinical exercise trials, ACSM and ADA physical activity guidelines and practical physical activity strategies. Each of these parts approximate 15 minutes, although several may be as long as 20 minutes.

Part One: Overview and Key Concepts.

Throughout this entire session, there is one underlying theme that is most important and that is, just get your patients to move and move often including you, the provider. This is a common theme that is supported by many clinical trials regardless of the mode, duration, or the intensity of exercise. There is a lot of risk reduction that can be generated from just moving and moving often.

A large amount of evidence, especially recently, shows that exercise provides the best prevention and treatment for insulin resistance in Type 2 diabetes, in comparison even with dietary management. This is not to say that dietary management and weight loss don't provide very important benefits, but exercise by itself has very important insulin-sensitizing effects that can reduce the risk of not only diabetes but much of the morbidity that we see with diabetes.

Here on the left, are a number of major trials over the last decade that do support this. Now, when we ask how much weekly physical activity is required to reduce the risk of both diabetes and cardiovascular disease?

On this graphic, as you go from left to right, if you look at the centerline arrow, that’s white from left to right, starting with 500 calories of exercise a week, a 1,000 calories of exercise a week all the way through 25,000 -- or I’m sorry -- 2,500 calories of exercise a week, as you increase the volume of activity, you accrue various additional benefits.

But, note that even at the lower energy expenditures, that is 500 to a 1,000 calories of exercise a week, this would be tantamount to walking 5 to 10, or 11 miles a week, that you generate very important metabolic benefits that include glucose transport and a variety of metabolic benefits that can help delay the onset of diabetes.

If we look at the very center of this graphic in orange from about 1,500 calories plus, we begin to generate enough energy expenditure over the course of the week to begin to lose weight, to decrease total and LDL cholesterol and other benefits.

And if we look all the way to the right of this graphic in red, it is fairly clear now, that about 2,500 calories of exercise a week and beyond is required to maintain a new-found weight after having lost significant body weight.

So, for weight maintenance, if that’s your focus, the energy expenditure required per week is fairly large may be on the order of around two hours or more of exercise a week.

Now, in this section, I am going to show several slides that are fairly complex but that portray a very important part that we all need to understand, not so much to teach our patients these metabolic concepts but to understand these as providers.

On this slide, you will see a sequence of events starting in the upper left where you have muscle contraction, the little parallel lines are muscle contraction dynamic and as you go from left to right along the top, and down on the right border then back across from right to left in the bottom border of this slide, you have what occurs after one or two muscle contractions.

So, what we're really trying to say with this slide is in the very beginning, and the first thing that happens in just a fraction of a second, well before we begin to oxidize fat calories or you know, weight-loss, many things happen in terms of a AMPK activation.

This is a process that's almost identical to how Metformin works, glucose transport, we begin to have insulin signaling and PPAR gamma and delta activation and insulin sensitization even before, we began to fully oxidize a gram of fat, and my point here is that these early mechanisms in the very beginning stages of walking, for instance, would begin to improve our risk scores even before we begin to lose much weight. Of course, if we activate muscle contractions enough and oxidize enough fat calories, we obviously are going to be decreasing body weight and decreasing total fat volume.

But the early processes in exercise, in the first few seconds of any exercise program and throughout that exercise session or program, there are mechanisms that are independent of fat oxidation and weight loss that actually are responsible at least in part for reducing our risk of diabetes and of course, cardiometabolic disease.

Now, here is another fairly complex slide, but its purpose is very important for providers. What it does is, it explains the various differences metabolically between higher intensity exercise, that is, let's say, aerobic exercise that exceed 60% of VO2 max or aerobic capacity versus low to moderate exercise. That is exercise that's done at a much lower intensity, perhaps 30% to 50% of VO2 max or 30% to 50% of just your effort max.

Now, understand the energy that produces the calories that we so frequently talk about comes from the splitting of Adenosine Triphosphate. The most immediate source of energy for a muscle contraction is ATP or Adenosine Triphosphate. You see the molecular formula for this in the upper left-hand corner. Many of you have actually seen this in early studies that maybe you've gone through in exercise physiology, but as soon as you split the terminal phosphate group off of each ATP molecule, it generates 7 calories, OK. And that's the immediate source of energy for muscle contraction.

So, in many ways, rather than saying how many calories is a 2 mile walk equivalent to, from an energetic standpoint, it might be more specific to say how many ATP molecules can I split or hydrolyze to generate those muscle contractions for that mile walk or whatever.
Okay, now my real point here is extremely important and that is, whether you do high or low intensity exercise, it's total volume of ATP splitting that really is mostly responsible for deferring your risk of diabetes or to generate the cardiometabolic benefits from the exercise session. If you look at the bottom of this slide where it says exercise and comparing high and low intensity as an example, we have 15 minutes of higher intensity exercise, perhaps jogging. For 15 minutes, jogging at maybe 7 or 8 miles per hour would generate around 300 calories of heat. That's equivalent to about 43 moles of ATP.

However, we have another choice. If we slow down and walk that mile or two, that is, it takes us 30 to 35 minutes to walk that same distance, we would have run in the high intensity example, then that 30 to 35 minute walk would generate about the same number of total calories. That is 300 calories.

But, note the important message here is that both these workouts, the high-intensity run or the low to moderate intensity walk are equivalent in ATP molecule splitting and that is the basic stimulus for insulin sensitization and the early cardiometabolic benefit.

So, you would say that both individuals, the one that did high-intensity exercise and the one that did low to moderate intensity exercise for the most part; there are a few differences here, but for the most part generate identical risk reduction benefits, especially from a diabetes prevention benefit.

Okay, now let's just summarize the points I'm trying to make here early on with this webinar. From a risk reduction and cardiometabolic risk perspective, when I say cardiometabolic risk, I am talking about both, heart disease risk and diabetes or metabolic risk, Total Energy Expenditure of the workout, or the exercise session or the physical activity is the key prescriptive parameter. And of course Total Energy Expenditure is fundamentally a product of how hard you work, that is, exercise intensity times the exercise duration, or how long you do it.

Now, there are added benefits of higher intensity exercise, but these come with higher risk for someone who might be overweight with the metabolic syndrome, maybe they're pre-diabetic or especially diabetes when you start pushing these patients or they push themselves beyond 60%, 70% of aerobic capacity, then you run some injury risk, and even potentially cardio event risk, that is, even the risk of potentially having a heart attack because they are already at high risk, and they are doing a lot of exercise.

So, we're not saying that patients, even diabetic patients cannot do higher intensity exercise, but it should always be preceded with weeks if not months of moderate or lower intensity of exercise.

Okay, now here is my last physiology slide. And again, I am trying to make a metabolic point here that's very important. It's called Comparative Outcome Indicators.

You have two methods to measure outcomes from physical activity. In most cases, we use both of these. But, many of us can many times exclusively use body weight changes as our sole Tier 1 outcomes measure. Muscle contractions or the behavior of movement itself is an independent factor that can provide benefits for reducing metabolic risk.

Okay, let's graphically explain what I just said. On the left you have here are just changes in body weight, that is, scale weight. We let the BMI or scale weight sort of drive all of our outcomes from a diabetes prevention perspective or a diabetes treatment perspective.

Know what body weight tells you. Body weight is comprised of fat, bone, water, and muscle protein, and of course, body weight is loosely tied to certain adipokines, A1C, glucose, and lipid parameters that you can measure in the blood. But, it's not a direct relationship with body weight changes in these particular outcomes; it's fairly loosely tied to it.

So, when you lose body weight, you're fairly assured that the majority of that is fat weight, but not always, it can be a good bit of water weight and of course, we can also see many patients actually gain a kilogram or two of lean muscle weight when they measure body weight.

Now, on the right, if you measured just muscle contractions, i.e. step counts. Now, if you notice on the right, this graphic, where it's muscle contractions, consider this side of the slide graphic as the behavior of stepping or walking.

With each walking step, there's a series of muscle contractions, and each muscle contraction is an AMP kinase or PPAR-delta or gamma activator. These are activation mechanics that work very similar to diabetes drugs, and each step is an insulin sensitization step.

So, the actual walking, or bike riding, or swimming or running or dancing or whatever you're doing represents a muscle contraction which is a direct insulin sensitizer unlike the body weight changes that I showed you on the left side of this slide.

So, the point really is for outcomes indicators purposes, body weight is important but the behavior of stepping or muscle contracting or exercise itself is really the more important outcomes measure, and anything we can do, any process we can use to actually measure the activity is a direct relationship to insulin sensitization even compared to body weight changes.

Now, this is another key concept that is very important; it's called adiposity reduction versus weight reduction. Adiposity is all stored body fat, or in other words, total body fat.

Body weight includes body fat but it also includes muscle protein, bone, and water etcetera. So, changes in adiposity or total body fat are probably more relevant in terms of risk reduction than just plain body weight reduction.

That's one reason why we like to measure waist circumference or skinfold changes assuming that they are measured proficiently and correctly and skillfully. That those changes and actual fat measures as in waist circumference or skinfold measures are more direct measures of risk than just body weight. We need to measure both is my point here.

And as you can imagine, many individuals when starting an exercise program will lose body fat from the deep tissue visceral fat near and in the abdomen as you see in red on the left graphic at this slide and even in subcutaneous spaces just under the skin on the outside circumference of the left graphic of this slide. You can see changes there in patients, but those patients also may increase by several pounds lean muscle weight and in that case, it would be very little, if any, body weight change although they actually did reduce adiposity.

So again, another rationale for why direct measures of body fat are as if not more important than just tracking body weight by using the scale.

Okay, now let's summarize key points from this Section 1 of this webinar. Recording the actual behavior of muscle contraction, for instance walking or walking steps is more directly linked to insulin sensitization and another cardiometabolic risk reduction mechanisms compared with assessing only body weight changes.

Body weight changes do not entirely tell the story of fat weight changes, i.e. adiposity versus body weight. And finally, total physical activity energy expenditure is the most important

cardiometabolic risk reduction parameter regardless of how you increase total physical activity energy expenditure whether it be with softball, circuit weight training, resistance training of various modes, or aerobic activity. It's the total energy expenditure over the course of the session in the day that is really most linked to cardiometabolic risk reduction.

Now, as we conclude Section 1, I just want to give you a head up on how much physical activity that is the physical activity amount or volume at least per week is required for diabetes and prediabetes including adult and pediatric. So what I'm doing here is sort of over viewing what is to come in the next few sections of this webinar.

If you look at the current guidelines on the weekly energy expenditure in calories for diabetes, that we want at least to add a thousand calories of exercise a week to reduce cardiometabolic risk. That is the risk of cardiometabolic disease.

When we ask the question how about weight loss, what is the minimum weekly energy expenditure that is required for significant weight loss, now we've got a higher order of volume of exercise as you'll see on the right under weight loss for diabetes, it's at least 2,000 calories of exercise per week.

To give you a rough idea how much a 1,000 and 2,000 calories is for a particular individual, that let's say is borderline overweight, a 1,000 calories would be about 10 or 11 miles of walking a week whereas for weight loss it might be closer to 20 miles of walking a week or about 2,000 calories.

For prediabetes, it's the same threshold for how much physical activity. 1,000 calories of exercise a week to reduce the risk of diabetes and 2,000 calories a week or more for patients to lose weight.

Then under pediatric, although we don't have firm consensus guidelines on the volume of exercise to reduce cardiometabolic risk, the latest and greatest from a number of organizations are advising that seven hours of exercise per week, split between moderate and higher-level exercise or the equivalent of 12,000 walking steps or moving steps per week as measured by a pedometer is the threshold for pediatric cardiometabolic risk reduction.

So let me just say once again I'll conclude this part 1 by “Just Move and Move Often!”, is the message.

Part Two: Recent Important Clinical Exercise Trials

In this part of the webinar, we will be discussing what’s new. That is what’s new in recent, important publications and research trials between 2011 but mostly in 2012. So, all the trials in this section are very new.

Please note that some of these trial outcomes are not completely congruent with the physical activity recommendation guidelines for weight loss and diabetes risk reduction stated and depicted in both the *physical quick guide “how to” cards* on the DDTP website and the *2011 IHS Adult Weight Management and Cardiometabolic Risk Management and Diabetes Best Practice* guidelines. Those guidelines are more of a consensus and summation of individual studies published over the last 4-5 years.

Also, note that the trial outcomes in this section will be supportive of what you already know and some of these trials will actually garner new information that you can apply to your exercise programming skills.

Let's start with John Dube's paper that was published earlier this year, this is from Switzerland and basically this trial showed the minimum amount of exercise in order to reduce risk. It took 55 healthy volunteers, BMI was just in the obesity range a little over 30, and put them through a 16 week stationary bicycle treadmill walking program four days a week, and looked at a variety of parameters including insulin sensitivity and a variety of other cardio metabolic risk factors.

And the bottom line with this paper as we've seen recently in other papers over the last few years, even an exercise dose of adding just 400 calories of exercise a week at about 40% to 50% which is about 40% of what the guidelines for physical activity are recommended, at least a 1000 calories, was associated with a significant improvement in insulin sensitization.

So, 400 calories here for most of our patients considering a body weight that's the upper limit of overweightedness or maybe the very minimum limit for obesity, 400 calories would be about a 4 mile walk per week. Even adding 4 miles per week in this case would improve insulin sensitization, not much for weight loss but at least beginning to reduce risk.

Now in this paper by Amanda Fretts and Barbara Howard and others, they looked at the Strong Heart Study data and found a very similar outcome as the previous study. And they looked at the physical activity patterns in Strong Heart and found that as little as 2,500 steps per day, about 1.3 miles of walking per day, was enough to begin to reduce cardio metabolic risk benefits including blood pressure, insulin sensitization, and delaying the onset of diabetes.

So, here again is a paper that shows there is benefit at lower levels of physical activity volume that is not quite enough to reduce body weight but enough to begin to reduce risk and in this case risk of diabetes.

Now, this paper actually shows what can be gained by exercising at a little higher intensity level. I know, I said intensity doesn't matter by and large, if you spent enough calories but there are instances where exercising at a higher level or higher rate can improve risk a little bit more. So, here is a paper from Sweden, 22 women with Type 2 diabetes participated in a supervised group exercise program for six months, and of course, this program included both aerobic exercise and resistance exercise and what they found is that improvements of insulin sensitivity after six months was little bit more related to the speed or the intensity of exercise than the volume or just the total energy expenditure. Whereas the reduction in A1C was a little bit more related to the training volume or just the **total energy expenditure**.

So, the metabolic effects of training may be seen in the absence of improved exercise capacity was another finding in this study. So it is true, we've seen this without other studies, if the patient is healthy enough to exercise at a higher heart rate or a higher speed or a higher workload as long as it's not contraindicated, then there is little bit more insulin sensitization, given the same number of total calories as compared to a longer, slower exercise bout.
Okay. So let's just summarize the key point of what we just said, so the point is clear. Most of the metabolic benefits of exercise particularly for those with diabetes and prediabetes are generated by **total energy expenditure** of each exercise session as compared to what they're doing, that is the mode of exercise, or the speed or the intensity of exercise. However, if they're

healthy enough exercising at a higher intensity at least modestly higher can actually bring slightly higher benefits from a metabolic standpoint.

Now, here is a somewhat similar study from Arizona State University, Larry Black and others are published actually a little more than a year-and-a-half ago, on the effects of intensity and volume of insulin sensitization during acute bouts of resistance training.

So, this is a resistance training study comparing moderate intensity resistance training as defined by 65% of 1 RM max versus higher intensity strength training as defined by 85% or more of 1 RM max.

And, so, what they found here is that the higher intensity protocol resulted in greater insulin sensitization as compared with the moderate intensity protocol. The higher intensity protocol multiple set bout yielded the greatest effect in both fasting glucose and insulin sensitization, although the lower intensity exercise, the moderate intensity exercise still showed improvement in insulin sensitization, but there was about 30% more improvement with a higher intensity resistance training protocol.

So, here's a case if the patient can handle the higher workloads of higher resistive forces and they preceded this with warm-up and a week or two of lower resistive forces, then this could be a priority for patients, again that can handle it.

Now, this graphic is just suggesting that there are many forms and perception of resistive exercise training. We tend to think of free weights or weight machines, but anytime you're working with body weight resistive forces like in some of the Hatha yoga poses and Thera-Bands or even running with these resistive shoots that you see on the left or even variable terrain hiking where you have body weight against gravity can all be considered borderline, if not outright, resistive exercise training.

So, I didn’t want us to think myopically just as resistance training being three sets of ten reps in a gym on a weight stack machine. There are many different ways to apply resistive exercise of loads and this can give you some ideas.

Now, here's a paper published earlier this year that was a study done on both prediabetic and diabetic patients looking at both resistance and aerobic type exercises to reduce the prevalence of hyperglycemia in these two populations. It wasn’t a large study but there were 15 patients with prediabetes and 15 patients with diabetes. And they looked at both aerobic exercise that is cycling at 50% of cycling resistive max or resistance exercise equivalent of 45 minutes of lat pulls, chest press, leg press, and leg extensions 3 to 5 sets of 10 reps.

And, what they basically found is that a single session of either, the endurance exercise, the aerobic exercise, or a single 45 minute session of resistance exercise had the same benefits in terms of reducing the prevalence of hyperglycemia and improving glycemic control.

Now, let me just say one thing about this paper. It brings forth a very cogent point and that is as long as the resistive exercise and the aerobic exercise are equivalent in total energy expenditure that's probably showing why they both are equivalent in reducing hyperglycemia.

I don't think there was anything particularly sacrosanct special about the resistance exercise as compared to the aerobic exercise with the exception that both were the same relative energy

expenditure and that's why you saw the equivalent of both of those regimens reducing the prevalence of hyperglycemia.

Now, here's a very important paper from Ontario Canada. Mark Tremblay and others who have been doing work with pediatric, prediabetic, and diabetic kids for many years. They studied 1,600 plus, 6 to 19-year-olds, and they studied these individual kids and youth with an accelerometer.

An accelerometer of course, measures not just steps, but forces behind each of the steps and they concluded that 12,000 steps per day for this age group is a target to determine whether children between 6 and 19 years of age are meeting the current physical activity guidelines of 60 minutes of daily moderate to vigorous physical activity.

The MVPA means Moderate to Vigorous Physical Activity. And, as you know, as we will see later, that is the guideline for a cardiometabolic risk reduction for all children for physical activity, 60 minutes of moderate to vigorous physical activity per day, which in this case is equivalent on a pedometer to be around 12,000 steps per day. Of course, not all at one time but throughout the entire wakeful day.

Now, let's look at a similar study, but for adults in terms of step counts. This study was published just about a year ago by Catrine Tudor-Locke, who is probably the most esteemed expert on walking and walking and health, than anyone in the world really. She's at the Pennington Biomedical Research Institute in Baton Rouge, Louisiana. And, she took NHANES data from 2005/2006 about 3,500 adults, and her mission was to, how many steps per day is equivalent to 30 minutes a day of moderate to vigorous physical activity for adults?

And, found that about 7,900 steps per day for males and 8,300 steps per day for females, remember, women are little shorter and take more steps per unit distance, is the equivalent of about 30 minutes per day of moderate to vigorous physical activity. Now, in a sub-sample of participants in Catrine's study here, about 1,197 patients, they found that 150 minutes per week of moderate to vigorous physical activity translated to about 7,000 steps per day, or about 49,000 steps per week.

So, the upshot of this paper, you kind of have to average all of this out, is that accumulating 8,000 steps per day, is a good proxy for 30 minutes of daily moderate to vigorous physical activity, male or female, while accumulating 7,000 steps per day, or every other day -- I'm sorry -- while accumulating 7000 steps per day every day, is consistent with obtaining 150 minutes of weekly moderate to vigorous physical activity.

Now, I know we've all heard of 10,000 steps per day, which was an original threshold set almost 30 years ago in Japan, but we are just talking here for the proxy of 30 minutes per day. We are not saying 30 minutes per day is adequate, it should be probably more than that, but just to give you a pedometer step count equivalent, which would be again, about 8,000 steps per day would be fairly closely associated with a half an hour day of moderate exercise.

Note that this 8,000 steps includes <u>all</u> daily physical activity and should not be confused with the number of daily walking steps that should be <u>added</u> to the activities of daily living required for weight loss and diabetes risk reduction that is depicted in the DDTP physical activity quick guide card and IHS Best Practice guideline tables.

Now, here is a seminal paper by Kevin Hall and others, at again the Pennington Biomedical Research Institute in Baton Rouge, Louisiana. On energy balance, especially energy balance and exercise. And, of course, Kevin and his colleagues looked at well over 100 trials, not any one particular trial, and what he found, he found many things, but the two important trends that I would like to convey to you are these:

That a popular belief is that exercise training results in body compositional changes that generate an additional energy benefit, mediated through Resting Energy Expenditure or Resting Metabolic Rate. So, what they found by looking at all of these studies that measurements that are not so confounded by various research procedures that were not the same in all of these comparative studies, what they found is that the impact of exercise training, be it resistance training or in most cases, it was aerobic training on Resting Energy Expenditure was negligible.

You hear so much about what exercise is doing to reset my resting metabolic rate or my resting energy expenditure. And, some papers show that it's slightly elevated, many papers show that it's slightly decreased, and many papers show it's not changed at all.

So, Resting Energy Expenditure changes with exercise training is probably quite negligible and should not be used to justify further weight loss.

Number two: the origin of what we've heard for years is the "3,500 calories per pound" of fat rule is based on the calculated energy content of body weight change, and is often misapplied to predict the weight change, time course after a given intervention of diet or exercise. This is a fundamental error because no time period is specified for that intervention when you look at all of these studies.

The bottom-line with this number two finding is that it's probably erroneous to apply 3,500 calories per pound of fat. If you just extrapolate and you said that, that would be 100 calories per mile of walking that you would have to walk 35 miles to generate 3,500 oxidized fat calories, that would be an error, anybody who walks 35 miles is going to lose more than 1 pound of body weight, and that's another reason you cannot really use 3,500 calories per pound of body fat as an example.

So, that these are two misconceptions I think that are well founded by this paper, and I think that can go a long way for avoiding, misconstruing that with patients.

Now, here is a very recent paper by investigators both at Pennington and at Duke University, that looked 15 controlled trials on weight loss and exercise, and what Chris Lantz and Dave Thomas and others titled this review paper in Obesity Reviews is, why do individuals not lose more weight from an exercise intervention at a defined dose of exercise? And boy, is this a telling question.

I think we could all ask this question, certainly our patients could. And they concluded that a small magnitude of weight loss observed from the majority of their studies that they evaluated is primarily due to the low doses of prescribed exercise energy expenditures.

I mean you may think, or the patient may think that he is exercising a lot, but what has been found in so many studies that many if not most patients especially female patients tend to

compensate by adding more energy intake, that is, increasing the caloric intake as result of the exercise program, we call that energy compensation. That is, they may exercise 300 or 400 calories a day, but then they add back 100-150 calories per day of food that they would not have eaten otherwise had they not exercised, and that's one of the contaminants of trying to predict weight loss, and that is, energy compensation or controlling for the increase in appetite that we see with many, many patients.

Now, the other findings in this study, I think are quite provocative. The results of looking at these 15 trials that Thomas and others looked at in this paper, showed that their findings indicated that resting metabolic rate is in fact reduced slightly when exercise is increased. And, energy intake is held constant, particularly among individuals with lower levels of muscle mass and hence lower resting metabolic rate.

Now, I know I've said earlier in general, resting energy expenditure and resting metabolic rate doesn't seem to change when you look at all the studies globally, all the studies published as a result of exercise training.

However, in the 15 trials that this group looked at, when those people did not change either way their energy intake, and they increased their energy expenditure with an exercise program and they had just a very -- in other words they had average or less than average muscle mass, then they had a slightly lower resting metabolic rate, and of course that then would contaminate any significant weight loss.

So, what they concluded there is this metabolic adaptation reduces the size of the exercise-induced energy deficit and preserves body mass primarily for leaner individuals.

So, some slight changes in resting metabolic rate that can actually cause someone to lose less body weight than they would liked to have lost with the given dose of exercise. Know also we are just talking body weight here. What they didn't measure in these 15 studies, at least most of them, they didn't measure adiposity changes. It could very well be that these individuals did lose significant total body fat but was not completely reflected in decreased body weight.

Now, here's a paper at St. Louis University, Murphy and others that actually took 16 men and women in 1 year of exercise-induced weight loss is what their objective here and they were looking here to see what would happen if you compared caloric restriction. These are the bars in white on the graphic on the right, versus exercise only which are the black vertical bars on the right in the graphic on the right, versus a controlled group over one year of exercise training versus caloric restriction, and what they found is 1 year of exercise induced weight-loss results in greater reductions in a intramuscular adipose tissue and visceral adipose tissue found in the abdomen than compared to weight loss induced by caloric restriction.

In other words, what this is saying is that when you add exercise to diet or caloric restriction that you have further reductions and significant reductions in visceral adipose tissue which is very important because of its relationship to dyslipidemia and hypertension and insulin resistance and you also have a more significant reduction in intramuscular stores of adipose tissue.

Believe it or not, fatty acids find their way into muscle tissue as well. It doesn't make you have fat muscles but the slight increase in fatty acid composition of muscles actually increase glucose intolerance and insulin resistance and exercise can very quickly help that process and that is a benefit of adding exercise to caloric restriction.

Now, the next couple of studies are very interesting studies and there's been a whole barrage of papers in the last 3 or 4 years on sitting time and diabetes in CVD risk. So, sitting time or sedentary time is basically measured by how many hours of the wakeful day or what percentage of the wakeful day are you completely inactive, mostly at the work location.

Now, we will start with the paper by Cooper and others from the University of Bristol in the UK, looking at 528 adults with newly diagnosed Type 2 diabetes who ran a diet and physical activity intervention program. And when he looked at these investigators, looked at this paper and cross-sectional analysis, each hour of sedentary time was associated with larger waist circumference, a lower insulin sensitization or greater glucose intolerance and lower HDL cholesterol, of course HDL cholesterol is the good cholesterol, you want to actually go up certainly not decrease which it did in direct proportion to the number of hours you were sitting or inactive per day.

So, the conclusion here by Cooper, and others was higher sedentary time is associated with the poor metabolic profile in people with Type 2 diabetes.

Now, what you do about those individuals that spend a lot of time at the workstation with minimal break time? Well, Genevieve Healy and others published and she has done this for several years. This is just her most recent paper from Australia in Diabetes Care last year looked at a 168 men and women, and they did an accelerometer study. And their basic findings were that the greater number of breaks an individual takes in the workday especially, breaks from sedentary behavior, the lower the waist circumference, body mass index as well as blood lipids and glucose intolerance.

So what they found with Dr. Healy's paper was if the person got up at least five minutes on the hour, these diminutions in risk factors would, or these improvements or increases in metabolic risk factors would be held constant, that is, they would not have a worse metabolic profile, if they would just move five or more minutes on the hour is really what she came up with.

Now we're going to come back to this, when we get to the practical strategies segment of this webinar on what could be possibly be a good prescription for the workplace to minimize deterioration of metabolic risk? And as I said, we'll get back to this.

Now let's conclude the recent clinical trials section with just a quick summary of what we have found in this particular section of the webinar. Let's start with moderate levels of physical activity by any measure can reduce Type 2 diabetes risk and increase insulin sensitization. I think we now have seen that, whether it be resistance training, combined resistance training and aerobic training or either one by itself. But the total energy expenditure from either of those two modalities is really what drives reduced risk and reduced risk of Type 2 diabetes.

The second point is higher intensity exercise generates somewhat greater insulin sensitization than moderate intensity exercise but it can be risky for some patients, especially patients that do not have adequately controlled glucose or they have stage 2 hypertension or they are morbidly obese. Of course, there are predisposing factors for some patients where you would not want to go to higher intensity exercise as defined as 60% or greater of VO2 max.

The step count target, the walking step count target for, would be equivalent to moderate to vigorous physical activity for all children would be about 12,000 steps per day. 8,000 steps per

day is a good proxy for 30 minutes for moderate to vigorous physical activity for adults. We're not saying that 8,000 steps would be the ideal; we're just saying that that would be a minimum proxy for how active an adult should be, the same for the point above 12,000 per day for children.

From a practical point of view, the benefit of acute exercise on resting energy expenditure is negligible. I would not try to factor in what Resting Metabolic Rate might have done to a particular exercise training program. In most cases, when you average all the literature, it's negligible, and Dr. Hall discovered that and printed that up in the paper we showed you earlier

Aerobic exercise training may in fact reduce resting metabolic rate when energy intake is held constant or unchanged. So again, there are some papers and patients especially that have been very previously sedentary have not done anything for the previous year other than just minimum activities of daily living. That when adding, let's say a five or six day a week walking program, can in fact reduce their resting metabolic rate very slightly, and that can actually reduce the prediction of how much weight they are going to lose.

So, here's a case for those patients. I would rather you measure the actual behavior of exercise than the weight loss itself. The step count or the minutes of exercise or the performance measures of exercise are probably a better measure than just body weight changes by themselves.

The next point is that it appears that exercise intensity is more related to insulin sensitization whereas total exercise volume that is the total daily energy expenditure is related to A1C.

So, as we've said earlier that total energy expenditure over the day or the week or the month or the year for that matter, really is the most important variable for predicting metabolic risk.

That said when we split hairs and look more specifically if the patient can safely exercise at a higher energy expenditure, let's say 65%-70% of their aerobic capacity versus 50% then they are going to get a fair amount, greater insulin sensitization for the same amount of time exercising.

A single 45 minute dose of exercise, whether it be aerobic endurance or resistance training can decrease hyperglycemia, up to 30 to 35% reduced glucose for the 24 hour period following the exercise, and that's probably because when you, when aerobic endurance exercise or resistance training exercise is equivalent in energy expenditure, that's the case. It's the energy expenditure that’s driving down the hyperglycemia, not the particular mode of exercise.

The addition of exercise training to dietary weight loss, preferentially reduces subcutaneous abdominal adipocyte size reduces intramuscular stores of adipose tissue and fatty acids and decreases visceral fat, is one advantage that exercise has when you combine it with dietary restriction.

Sedentary time can significantly increase waist circumference, decreased insulin sensitization, decrease the good cholesterol which we call HDL-cholesterol. This trend can be reversed by taking regular work breaks which is approximately equivalent to five or more minutes of walking on the hour.

Part Three: Physical Activity Guidelines - Adults

American College of Sports Medicine and the American Diabetes Association, Physical Activity Guidelines. So, these are consensus guidelines on physical activity that I thought would be good to update for those of us who may not have read the literature on this subject in the last few years. If you take the most recent guidelines by the American Diabetes Association, which I believe the IHS/DDTP also agrees with and has put into their standards.

These guidelines that were just revised in February of 2012, regarding physical activity and the patient with diabetes are these: At least 150 minutes of moderate intensity exercise, mostly aerobic exercise per week. And what they mean by moderate intensity, moderate intensity is defined as anything between 40% and 60% of VO2 max.

In this particular statement, they say 50% to 70% of maximum heart rate. So understand the percentage range of maximum heart rate is higher than the percentage of maximum aerobic capacity or VO 2 max. So 50% to 70% of maximum heart rate is equivalent to 40% to 60% of effort max or percentage of maximum aerobic capacity.

Okay, so 150 minutes or 2½ hours of this level of activity spread over at least three days per week with no more than two consecutive days without exercise. In other words, you could do 2½ hours of exercise on Saturday afternoon, and do nothing for the rest of the week, that would not be good and certainly, for the majority of the week, would not help to reduce cardio metabolic risk at all.

Going further, the ADA does say in the absence of contraindications, perform resistance training at least twice per week, at least once set of at least 5 different resistance training exercises. Now we've said before in Part 1, resistance training can be perceived in many different fashions. You can even use your body weight as resistive forces if you're walking up a steep enough incline. However, in most cases we are talking about resistance weight training that you would see in the gym. But again, the perception of what constitutes and defines resistance training is more than just gym resistive forces that there is many ways to add resistance to particular movement pattern.

Now, let's go on and define the guideline threshold for how much exercise per week, to reduce risk of diabetes and coronary disease which we call cardio metabolic risk, versus, how much weekly exercise to reduce weight. Now, if you have heard me present in any time over the last six or eight years, you've heard this point that I've tried to make so many times, and that is the level and volume of exercise to reduce cardiometabolic risk is commensurate with what the NIH and the CDC and the ADA and ACSM etcetera advise for public health.

That is 150 minutes per week or 30 minutes a day, 5 days a week, which would be equivalent of 1,000 to 1,500 calories of exercise a week, which is roughly 20,000 to 30,000 walking step counts per week. Okay, so for overall health, especially cardio metabolic health, 2 ½ hours or more of exercise a week is required, but if you ask the question, how much for weight loss? And they do overlap. It would be 250 to 300 minutes per week or about 60 minutes or more per day, 5 or more days per week, which would be equivalent to 2,000 to 3,000 calories of exercise a week, or adding 40,000 to 60,000 step counts per week on a reliable pedometer.

So public health, cardiometabolic risk is about 60% less total energy expenditure requirement, than for weight loss. I think we all know by now that that is the case, but the real bottom line here is that patients who do not lose weight or very little weight, but still are exercising two, to 2

½ hours a week, we should give them credit for reducing their cardiometabolic risk. That's one reason we need to have objective measures of exercise.

Now regarding weight loss, this data here, resistance training and weight loss is a consensus position statement by the American College of Sports Medicine on Resistance Training and Weight Loss. And I'll read it straight verbatim, because each line here is very important.

Resistance training for example, free weights or machines will not promote clinically significant weight loss. It doesn't mean that there won't be some weight loss, but it's not clinically significant compared to say aerobic exercise. Resistance training was not assigned a major role by the authors of this consensus document, because it was believed that evidence for the efficacy of weight training, for weight loss and maintenance was insufficient. Although the energy expenditure associated with resistance training is not large, resistance training may increase muscle mass, which may in turn increase 24-hour energy expenditure. And that's true, and they're certainly other benefits not related to weight loss from increasing the strength and resistance training.

Now, also understand that when we say there's not a huge amount of energy expenditure with the typical resistance training workout, there are exceptions to that. High repetition low weight, circuit weight training, you can spend an hour and a half in the gym, doing 10 to 30 reps on very low resistance devices and doing a circuit of these over the course of an hour or more and spend 300, 400, 500 calories, but we are talking here about the typical 3 sets of 10 reps, 5 or 6 or 7 exercises and with resistance training weights or weight machines, that’s what we are really speaking to in this slide.

Now if you permit me to use a quote that I think is apropos for what we are doing in the DDTP and exercise in pre-diabetes and diabetes, and that is what David Katz said from Yale, some years ago, “The modern world makes it very easy to out-eat exercise, and nearly impossible to out-exercise excessive eating.” Therein lays our challenge. As healthcare specialist, exercise specialist, dietitian, CDE’s physicians, this is our challenge. This next slide illustrates the point.

For instance, let’s just take a scone. I think most of us know what a scone looks like. And scones range from about 140 calories to over 500 calories, depending on the size and composition of the scone. How long does it take to eat a scone? 5 to 10 minutes. Now let’s take that energy in kilocalories of 140 to 500 calories and apply it to exercise.

Okay, so that 140 to 500 calories scone is equivalent in exercise at least walking to between 1.4 mile walk to 5 or more mile walk. So 1.4 mile walk about a 140 calories, give or take. A 5 mile or more walk, 500 and more calories, okay.

In the 1.4 mile walk, it would take you at least 25 minutes depending on your speed and your fitness to generate the minimum caloric density of a fairly small, not fat or sugar enriched scone. Can you see now how you can undo an entire weekly energy expenditure from an exercise program by a 500 or 600 calorie scone, all in one 10 minute session?

So, I have to say as much as I have a favor towards exercise to reduce cardiometabolic risk in preference to dietary strategies, at the same time it is crucial that we understand that dietary or eating behavior perhaps is the most important single behavior than can compromise the benefits of exercise, in terms of glucose intolerance, fat weight gain, insulin sensitization, and all the

other benefits of exercise. 1 or 2 mistakes throughout the week in dietary behavior can unwrap the benefit for what we have procured with a decent exercise program.

Now -- and perhaps the most important combined consensus guideline was between the American College of Sports Medicine and American Diabetes Association on exercise and Type 2 Diabetes, and this was a consensus statement published a little less than 2 years ago.

In randomized control trials, about one hour of daily moderate aerobic exercise produces at least as much **fat loss** as the equivalent caloric restriction, which results in greater insulin action. So what we are saying is **both are important, caloric restriction and exercise**. However, the exercise as you have seen from Part 1 has an immediate insulin sensitization effect, even unrelated to changes in body weight.

Another statement made by this consensus paper is that the optimal volume of exercise to achieve sustained major weight loss is probably much larger than the amount required to achieve improved blood glucose control and cardiovascular health.

Going further another statement made by this consensus document, a combination of aerobic and resistance exercise training may be more effective in improving blood glucose control, than either alone, as we've evidenced earlier from one or two papers we talked about earlier in this webinar. However, more studies are still needed to determine the total caloric energy expenditure requirement, exercise duration requirement, and/or exercise mode to be responsible for this.

So, still have work to do on adjusting what is the ideal total caloric energy expenditure for the average diabetic patient. But at least we have these clear trends to report.

This consensus paper also reported that exercise intervention studies showing the greatest effect on blood glucose control have all involved supervision of exercise sessions by qualified exercise trainers. The most direct test of the incremental benefits of supervised training was in the Italian Diabetes and Exercise Study. So what they're saying here is that supervised exercise, you can be reasonably confident that the patient is complying with the total energy expenditure of what your prescription is. Whereas, home exercise often times you might prescribe 300 calories a day, every other day of exercise, the patient may skip a day or may give you 200 calories, you don't really know this. Self report often over embellishes or over reports the energy expenditure just like the under report caloric intake.

Another evidence statement from this report, in addition to aerobic training, persons with Type 2 diabetes should undertake moderate to rigorous resistance training at least two to three days a week. We have said this before, but understand that is full blown supported by ACSM and the ADA.

Finally, when we look at those prescribing exercise they give several cautions about working with patients that have had diabetes, especially diabetes longer than 5 or 6 years.

And they remind us of some of the cautions, considerations we need to keep in mind when working with diabetic patients that we would not have to use with age match, gender match individuals without diabetes.

So, what the ACSM and ADA are saying here is that those providers that prescribe exercise are required to understand that those with diabetes for more than 5 years tend to exhibit these exercise responses; chronotropic incompetence, that just simply means for any given intensity of exercise, the longer you've had diabetes, the more blunted the heart rate response, okay.

It doesn't mean it would just barely go up in response to graded increase in workload, it just remains about 10-15% less heart rate for any given intensity mode or duration of exercise.

So, if you're using heart rate charts to determine someone's intensity, you probably cannot use those charts with any real validity with longstanding diabetes.

Those patients also likewise tend to have a blunted systolic blood pressure response to exercise. That includes resistance training.

We also know that diabetic patients have slightly reduced peak VO2 max. Their aerobic capacity, although it certainly can be improved, probably falls short 5%-10% than would be otherwise, had they not had longer standing diabetes. That does not mean that just because they don't have this incredible peak aerobic power that they don't benefit from managing their diabetes not at all.

And finally, anhydrosis patients with 5 or more years of diabetes tend to have an inadequate sweat response that tends to mean they overheat even with modest heat loads. That's why having convective cooling, why they should be hydrated continually and hot/dry or hot/humid weather is vital.

So, monitor the signs and symptoms of hypoglycemia of course, ratings of perceived exertion or as if not more important for diabetes, than it is for healthy normals.

And, in terms of RPE scales, Rating Perceived Exertion, you certainly can benefit from just using the 0 to 10 revised board scale for gauging intensity of exercise.

Now, of all these cautions and considerations, I think active convective cooling is the most important, especially for gym exercise or supervised aerobic exercise, can't tell you how many gyms and even diabetes exercise programs, even cardiac rehab programs that do indoor aerobic exercise on Stairmasters, and Ellipticals, and Rowing machines, and Bicycles, and Treadmills at minimum access to convective cooling. Keep in mind, when you sweat, one of the key ways you can keep from overheating is evaporative heat loss. Unless that sweat is in contact with some moving drier air, you are not going to reduce your body temperature.

You need to have moving air around the sweat and this is so true in those patients that have the metabolic syndrome, pre-diabetes, but particularly diabetes. So, once again, I'm going to conclude this part of the webinar, just **get your patients to move and move often**.

Part Three: Physical Activity Guidelines - Children

Now, let's discuss Pediatric Exercise Guidelines. To some extent we've discussed this in terms of 12,000 steps per day for most children, but this includes diabetic children, it is the ultimate goal in terms of total step count per day, as we've talked about earlier in this section.

Now, the CDC guidelines for pediatric diabetic exercise guidelines including aerobic, muscle strengthening, and bone strengthening activities are all found on the CDC website. But

basically, what these guidelines suggest is one hour or more of physical activity per day, which is going to include muscle strengthening activities, which include sports and calisthenics and various forms of strength exercises as well as aerobic activities.

And of course, aerobic activities is the priority for kids. The CDC goes on to give examples of what would they would consider for children as vigorous activity versus non-vigorous activity, as well as muscle strengthening and bone strengthening activities, as you can see on this slide. So they are fairly helpful, this particular set of guidelines from the Centers for Disease Control.

However, the highest authority on actually working with diabetic children is from the International Society of Pediatric and Adolescent Diabetes. ISPAD is the acronym for this group, and let me go through some of their recommendations for working, especially advising one-on-one activity for pediatric Type 1 or Type 2 diabetes.

It is especially important to plan for long duration or intense aerobic exercise or else hypoglycemia is almost inevitable. So these things have to be thought of proactively about how long a child is going to exercise and at what level. Nearly all forms of activity lasting over a ½ hour will be likely to require some adjustment to food and/or insulin.

The second thing you need to remember is young people with Type 1 diabetes have been found to have decreased aerobic capacity as measured by VO2 max compared to non-diabetic control subjects, very similar to adult Type 2 diabetes.

When regular soluble insulin has been injected prior to exercise, the most likely time for hypoglycemia will be 2 to 3 hours after the injection. In contrast to the high-risk time for hypoglycemia after rapid acting analogue insulin is between 40 and 90 minutes. The key exercise recommendations then for pediatric Type 1 diabetes is avoid exercise; you have blood glucose that's lower than 100 mg per deciliter or greater than 300 mg per deciliter. Check ketones if blood glucose is greater than 250 mg per deciliter and take 15 grams or so of carbohydrates every 30 minutes or so, which would be like a piece of fruit.

Check blood glucose every 30 to 60 minutes during exercise and finally avoid using legs for injections. For example running, which increases the absorption, the abdomen would be a better site of injection. I will conclude this section as I've said in the other sections to just get your adult or pediatric patients to move and move very frequently.

Part Four: Practical Physical Activity Strategies

Okay, the last part of this webinar are practical physical activity strategies for pre-diabetes and diabetic patients. So, again, these are practical strategies just to get patients to move on a regular basis. To start with, the simplest thing I could say if someone said you only have 30 minutes to give this program, I would just say use this slide, add at least 1,000 calories of physical activity per week. This is equivalent to 9 to 10 miles of walking per week or adding 20,000 pedometer step counts on a reliable pedometer.

Now, what is 1000 calories equivalent to? Well, if you assume someone is between about 150 to 170 or so pounds of body weight, this holds true. Of course, heavier individuals, generate higher caloric expenditures for any one of these particular activities. But 1,000 calories in general is equivalent to 10 miles of walking at about 3 miles an hour which is a moderate to fast pace walk. 2 ½ to 3 hours of continuous exercise at 55 to 65% of maximum effort level, or

maximal walking speed. Three 45 to 50 minute aerobics classes, aerobics dance, stair stepping, such classes would be examples. A 3 hour hike over variable terrain with a ten pound backpack, 3 hours of cycling at 10-12 miles per hour, assuming outdoors that does not equivocate to indoor stationary cycling.

Three miles of freestyle swimming, especially women, 2 ½ miles of freestyle swimming in men. Note you don't have to do the above activities all at once, but you can spread them out over the course of the week, of course, we wouldn't do these all in one day and they become sedentary for the remainder of the week, of course.

Now, in terms of being practical, I think this statement by Tim Church at Pennington Research Institute in Baton Rouge, states it very well. “What is 100 calories equivalent to about a mile a day of walking for most people?” Over the last 50 years in United States we estimate that daily occupational related physical activity energy expenditure has decreased by more than 100 calories.

And, this reduction in energy expenditure accounts for a significant portion of the increase in mean United States body weights for most women and men. In other words, by adding a mile per day of energy expenditure, which is about 100 calories, would help offset this deficit, such that most people would gain very little weight over the next few years.

Now, here is what I would consider a very time efficient 1,600 or more calories per week physical activity program for those of us that just do not have very much time throughout the work week to exercise. However, even with minimum time to exercise throughout the work week, on Monday, Wednesday and Friday 20 minutes of walking, and I don't mean at one time, like Monday a five or six times walking for 4 minutes each would be what we're talking about here, the same for Wednesday and Friday. So multiple work breaks where you're taking 5 or 6 minutes per work break to take a walk.

However, when you add these three days up, you're only talking about 300 or 400 total calories at the very, very most. One weekend day, Saturday or Sunday, a 2 hour what we call long slow distance exercise session would really bring your caloric expenditure for the week up to well above 1,000 calories per week. And one way to do that is have someone in your family, as we've done in several different programs that we've recommended, have someone in your family take you about an hour from home and drop you off and you have no way, but one way to get back home that is walking, and at increasing distances let them each successive Sunday or Saturday drop you off further and further from home.

Now, that's sort of a more aggressive way to do this, but what we're really saying here is an 1 ½ to 2, 2 ½ hour hike over the weekend, especially if you add variable terrain hiking where there is multiple hills or stair steps that can help boost energy expenditure for that one day where you're exercising 800 or 900, even 1,000 calories that one day a week.

But, keep in mind, we're not advocating one weekend day where you do 1,000 or more exercise in one session, you have to have done something, however slight, throughout the workweek.

So, when you add those four sessions up, you are talking about at least 1,500, if not close to 2,000 calories of exercise a week, which certainly would be the beginning threshold for significant body weight reduction.

Now, the higher the BMI, the heavier your patient may be, the more caloric expenditure he would generate for each of these sessions. So this 1,600 calorie a week is very likely to be well in excess of 2,000 calories per week for someone that has a BMI of 32, 33, or greater.

And, this is merely a picture of just various trail shots of variable terrain. If you're in an environment where you have, especially outdoors, where you have multiple terrain to walk over, where you get full spectrum light, a lot of vitamin D synthesis, as well as a variant environment to walk in, and maybe there's a few hills to add caloric expenditure.

Now, this is an example schematic of a program that might work for you in your neighborhood, where you start from home and you might walk a mile to a set of bleachers or stair steps, maybe a junior high school or high school soccer or football stadium, where you might walk figure eights or 5 or 10 minutes in the stands where you walk up an aisle over, and back down an aisle and up an aisle for maybe 5 to 10 minutes, using gravity to increase the energy expenditure, and then walk a mile back home.

Understand that anytime you have hills or stair steps, you add about 30-35% caloric expenditure for a given speed and distance. So, this would be sort of a circuit, walk from home, and the middle of that circuit would be some either stair steps or hilly terrain to walk through, but always cooling down by coming back on relatively level ground.

Now, here is a graphic of a program that is a multi-intensity continuous aerobic exercise session, not completely unlike what we said in the previous workout. This would be a session for a 30-45 minute workout, where you would actually, let's say, you are walking and the first 5 or 10 minutes of the walk you are walking at a very nominal pace, maybe moderate intensity.

And, then about every 2 to 3 minutes you pick up the pace quite significantly, or maybe even you jog for maybe a minute or two and then walk for a minute or 2. In other words, in the middle 70% of this 45 minute session you are speeding up and slowing down. And in this case you are satisfying some of the requirements for higher intensity of activities, especially intensity that exceeds maybe 55%, 60% of your aerobic capacity, interspersed by lower intensity, maybe only 30%-40% of aerobic capacities, slower walking, for instance.

And you can apply this to cycling or swimming or aerobic movement types of activities. But again, what it says is you always start off at a very nominal pace, in a rhythmic fashion, like walking or cycling, and then do intervals of higher intensity activities. But I am not talking about exhaustive intensities; I am just talking about intensities where you may be peaking out around 80% of your maximum aerobic power of your maximum effort level. So, in this case you would satisfy both moderate and higher intensity activity in one particular 45 minute workout.

Now, it's very important to understand that those individuals that are obese expend far more calories than those of us that are normal BMI or normal body weight for a given workout.

So, the point here is overweight and obese pre-diabetes and diabetes patients expend many more calories for a given workout, especially walking or weight-bearing types of exercise.

Here is a paper that’s gosh, almost 15 years old that illustrates this point, showing that as much as 50% of VO_2 max, 50% of aerobic capacity of an obese patient is required for a particular walking workout, compared to someone that is normal weight, requiring only 35% of VO_2 max.

In fact, some BMIs require for a particular nominal walking workout, like a BMI over 40 may use as much as 98% of their aerobic capacity just to walk two miles an hour.

So, of course it has to be understood that the heavier the individual, of course the more caloric burn for any particular given distance or speed, but it's also costing them more in terms of cardiorespiratory capacity or endurance. It's costing them more heart rate work, more blood pressure work. So obviously you have to correct the intensity of exercise and the distance of exercise to their body mass.

This workout is something that we spoke to earlier, but perhaps more specifically, workplace energy expenditure.

For example, let's say you have a 7 hour work shift and 5 minutes on the hour you walk at 2.5-3 miles an hour, as a work break, that would total 35 minutes at 3 or 4 calories per minute, which would be about 2,000-2,500 steps over the entire seven hour workday, which would be the equivalent of 100-140 calorie energy expenditure. Or even more if the individual has a BMI greater than 30.

And, it's also important to know that this 100-140 calorie workout is roughly equivalent to 10-15, 20 milligrams of metformin, since the modest level of exercise works very similar to how metformin works in terms of insulin sensitization.

Let's talk for a bit about my favorite means of managing patient's exercise, and that is what we call systematic pedometry, that means a systematic use of reliable pedometers, and how we prescribe the pedometer.

If you go to the DDTP website and under Quick Guide Cards you will see a tab called Physical Activity; in this slide it's in the back of this graphic, it says Physical Activity. And, if you click on that Physical Activity tab, you will come up with this particular graphic and tab, which is a whole host of subordinate links under Physical Activity.

And, under these tabs if you click Pedometer Instructions or Native Pedometer Trekking, you will get some of the information I am going to provide you now, including an audio of exactly how to prescribe various pedometers.

Let's talk briefly about systematic clinical pedometry. The only reason I insert clinical here is because we are using the pedometers as a medical device, to score patient activity and patient movement as an outcomes measure to put into the chart on return visits.

So, the application of systematic use of well-engineered pedometers is a very objective activity to put as outcomes measures into the clinic chart.

Also, in this site you have a Pediatric 7-Day Step Activity Assessment Form, just an example of having a child over the course of one week measure activity, both at home, during school hours, during sports, and recording the total step count over the course of school and home days, including weekends, and to bring this back to you as baseline activity to see what they are generating in terms of daily and weekly physical activity.

Now, as we said much earlier in the webinar, 12,000 steps per day on average is the goal for youth, including teens. We will see though when you use this form how your pediatric patients

stack up, and we are talking about both pre-diabetic pediatric individuals, as well as diabetic pediatric patients.

Also, on the DDTP website are several forms; this is from Lancaster County in Nebraska, an example Pedometer Report Form called Walk Your Way to Health, which is an excellent form; there are others as well.

I would advise strongly that if you advise walking and you are using a pedometer to design a form that looks very similar, if not identical, to a medication prescription form. Except this form would be a prescription (Rx) for outpatient exercise pedometry. Patient name, date, the therapeutic code; that would just be the reason you are prescribing the pedometer, for weight loss, just to become more active.

For fitness purposes, to reduce the risk of diabetes, whatever the code is; the reason for actually prescribing the walking program. And then further down you would check a box that would signify or at least designate the type of pedometer model that you're going to actually prescribe, you may be given in this pedometer. This is just an example of an ACCUSPLIT Eagle 2720 Pedometer, but there are many others. You would put that in, you'd be very specific to record that, and then give them a prescription for the number of steps per day and maybe grade that where they might be increasing their steps per day, like 2,000 steps per day, increase over what they're doing now and then over time they would increase that step count to maybe 8,000, 10,000, 12,000 steps per day.

Again, that's an **individualized prescription.** You would have to treat them as an individual and what their baseline is before you actually prescribe what their end goal is for total step count. Then, sign it like you would for an outpatient drug prescription. Of course, you may not be the MD. You might be the CDE or the exercise specialist or the nutritionist or RD, you would again sign it and make it official and the patient would take this form in theory to the pharmacy to get the outpatient device, which would be the pedometer.

But, in this case you would actually be given a pedometer yourself, but I think we would go a lot farther in terms of being serious about the use of a pedometer for a clinical device, as if you gave them this prescription form along with the pedometer in the clinic visit.

Now, a form of pedometer use is called pedometry trekking and that's where you actually prescribe a tek or circuit or a trail or a distance that's pre-measured and you actually prescribe the exercise or the walking by the trail or the trek, after having premeasured the track, and I learned this from the University of Nevada, Reno. Dr. Mary Sanders had been using this device for her diabetic patients for, gee, 6 or 7 years where she was having her patients do various treks per week.

These are pre-designed, pre-measured trails and she would always start with a low-level trail, maybe a half a mile, and she'd have other pre-measured trails that might go all the way up to 5 or 6 miles.

So, this takes time to develop, but it's a lot more creative than just saying go out and just walk 4,000 or 5,000 steps each exercise bout. So, let me just summarize what Pedometer Trekking is. It's 3 to 10 customized paths or trails that you would prescribe such that on this graphic slide you might have at least 4 levels. One circuit or track would be what we call Level 1; that would

be the equivalent of 1,000 to 3,000 steps that would be about ½ a mile to a mile-and-a-half course. This could be through a park or through town or out in the country.

Level 2 would be like 3,000 to 6,000. Level 6,000 to 10,000, and of course, Level 4; something 5 miles or longer. You can reserve that for patients who are fitter and they might do this once or twice a week at that level. Of course, each of these levels would be prescribed by not just their distance, but by their terrain difficulty, as you increase the level, you would increase the grade or any variable terrain that might be in your neighborhood. So, of course, you wouldn't start off with Level 1 being only a ½ mile, but it'd very steep terrain. It would be relatively flat.

So again, you can vary the track by distance and by the grade. For example, you might have a patient that's just starting out by doing Level 1 trekking several times a week. Two weeks later you might advance to Level 2, and then the Level 4. Again, this is outdoors. They are getting full spectrum sunlight, a lot of vitamin D synthesis, a lot of variety in terrain and a lot more interesting than walking on a motor driven treadmill, for example.

And, of course this graphic just further illustrates the circuitous route that you may have between the levels, from left to right, from that green trek, all the way to the right, where you have a real circuitous route that might be up to 5 or 6 miles in length.

I wanted to give you several web links that are very utilitarian for ordering pediatric physical activity kits that are extremely creative, one of which -- in fact, one of the most creative websites, it's very cost justified, is PE Central, Physical Education Central, http://www.pec@pecentral.org, and in this particular website you can order for any particular age group, from pre-K, all the way to high school, a variety of activities for children.

Now, the DDTP also has many examples of pediatric and family physical activity programs, one of which is the "Indian Health Service Physical Activity Kit". And as you have probably seen, and you can download this off the DDTP website, the Physical Activity Kit, which is a true kit, and actually, you can actually go through a training to enact the contents of this kit throughout many areas, West of the Mississippi, and you can look at the areas where you can actually undergo training, live training on this particular enactment of the programming in this kit. And all you have to do is just linkup with this website that I have in this slide graphic.

In the Physical Activity Kit, there are a variety of books for all ages. You see here there are 8 different books with a wide variety of activities. I can't emphasize enough of how creative and utilitarian these activities are.

Finally, I want, as I begin to close this webinar, I just want to make a few final points. Are there cardiometabolic risk reduction differences between formal workout in a gym or out in the track or outdoors, versus just being an active person in your job or otherwise? And, the answer is no.

Okay, here is an example of two different lifestyles called, "are there risk reduction differences between number one and number two here?" An individual, number 1, an active lifestyle, expending 1,500 calories per week from a variety of domestic, recreational, and work-related activities, and an individual number two, an inactive work and recreational lifestyle, but works out 3 or 5 days a week for a total of 1,500 calories of exercise a week.

Now, note that both of these lifestyles generate about 1,500 calories of energy expenditure, therefore they would derive just about the same cardiometabolic benefits. So, those people that

are active at work and at home, domestically, around the yard and the house and maybe play sports once or twice a week, they may not need to go to the gym, as long as their total volume of energy expenditure is the same as the individual that does go to the gym 3 or 5 days a week.

Diverse types of moderate exercise are also associated with lower incidence of diabetes and cardiovascular disease mortality. Now this includes such utilitarian activities as walking, gardening, climbing, household yard chores, those who expend a 1,000 or 1,500 calories of exercise a week in such utilitarian chores and activities may require very little additional exercise to lower diabetes and cardiovascular risk. And this can be done in a systematic fashion.

This graphic illustrates how to systematically use community and household domestic chores if it's done frequently in the right duration can be very fitness oriented. Now this graphic is also on the DDTP Quick Guide Card physical activity website under Household Chore Circuit Training.

This form is actually a form that the provider would write in, in each of the rectangles that circle around the center circle, each activity would be placed in each of these boxes starting when the 12 o'clock position where you might put stretching or some very light activity, and with each sequenced activity to the right as you go clockwise you might do 6 or 8 minutes of higher-level activities such as washing, scrubbing, yard work, clothes drying, ironing. Those types of things that require 2 to 3 to 4 METs of activity at higher intensities, such that there's only maybe 20 or 30 seconds between each chore, and after you have finished an entire circuit of maybe six or eight activities, it might be as much as 60-90 minutes later and you may have expended as much as 300 calories.

This idea about household chore physical activity done in a systematic way was generated years ago by several universities for their diabetic patients who couldn't afford, and didn't have the time to go to a gym, but could get a lot of the energy expenditure accomplished at home and also something accomplished.

Again, some of the activities as illustrated in this slide that you can put into that circuit, yard work, gardening, housework, painting, cleaning, shoveling, scrubbing, repair work, activities of daily living. To actually fit into that household circuit form, you probably need to do at least a five or six minute assessment of what the community and household and domestic needs are, and then you can begin to be creative and filling in the blank spaces on that circuit form of what they could actually do.

Now, as we begin to conclude this webinar, I wanted to leave you with several outcomes measures that are good to track physical activity, and these outcomes measures are actually laboratory values from a blood test. Triglycerides and non-HDL cholesterol tell us more about the patient's lifestyle, at least from a lab report perspective, and physical activity volume, than any other single laboratory measure. You can't fool these labs.

So triglycerides and non-HDL, you may not be familiar with non-HDL, it's simply you subtract the HDL-Cholesterol from total cholesterol which is reported on your lab report and what you have left over, is what we call non-HDL. I'll illustrate this in the next slide.
So, what I would recommend is to establish with your medical directors and the physicians you may work with a Lifestyle Lab Panel, and this could be just a subordinate panel to the typical lab report you already get. And, the primary measures on this Lifestyle Lab Panel would be again, triglycerides, non-HDL and you can actually include systolic blood pressure assuming that it's measured correctly.

Okay, now there are other optional labs you can use like fasting glucose A1c and skin-folds and waist circumference, but in terms of blood work, triglycerides and non-HDL are direct measures of fatty acid used with the walking, swimming, bike riding utilitarian activities that the patient is engaging in.

Again, at the bottom of this graphic you see the definition of non-HDL. It's simply, take the total cholesterol in the lab report, subtract the HDL value from it and you have a non-HDL.

And the magic behind non-HDL is these are all the bad lipid players in the lab report. When you subtract out HDL from total cholesterol, what you have left over are very atherogenic, triglyceride rich lipoproteins, LDL and total cholesterol, all the bad players.

And, the fact that non-HDL includes triglycerides, which are immediately used for exercise, unlike HDL, that will more reflect their exercise activity patterns, than total cholesterol or LDL cholesterol.

So, triglycerides, because they are used for exercise, and of course, triglycerides are also very responsive to dietary choices very significantly. And, non-HDL cholesterol are both impressive lab measures on visit to visit outcomes measures that would kind of be a scoring tool on how much volume of exercise they are engaging in on a monthly or bimonthly basis.

Finally, and again, this is on the DDTP Quick Guide Card website under Physical Activity and Physical Activity Readiness. If you are starting a patient that has diabetes on a moderate to high level exercise program, a moderate to vigorous exercise program, and they had been previously sedentary, you are strongly advised to have them be administered a stress test with EKG, usually that's a treadmill stress test done in an internal medicine office or a cardiology office, only rule out advanced coronary disease and untoward EKG abnormalities that you otherwise would not see or even know existed in a patient that's just starting to exercise.

So, the American College of Sports Medicine and the American Heart Association Guidelines are for those patients that have two or more major cardiovascular risk factors, including diabetes, that are going to be sustaining moderate exercise on a regular basis, or certainly vigorous exercise on a regular basis, have a baseline Graded Exercise Testing (GXT) with the electrocardiogram prior to engaging in this program.

Again, the instructions for this is much more specific on the Quick Guide Cards section, under Physical Activity and Exercise Readiness.

As I have done with previous sections of this webinar, I will close with just get your patients to move and move often, and you should be the first example.

If you have questions on any of the clinical trials or the guidelines or the examples of physical activity program sessions, I will be glad to answer them by email. My email address is on the slide, rlaforge@nc.rr.com.