Discussion

Leader: Christine Steele, PhD, Abbott Nutrition, Columbus, OH

Dr Wheeler: Dr Phillips, a lot of the information you shared about the benefits of resistance training and nutrient timing and so forth seems to be relevant for young and middle-aged fit people. What kind of exercises can the elderly do? Can they do enough to see the same benefits? If, in fact, they can benefit, how do we begin to educate people about it?

Dr Phillips: We are sure that with exercise older people can make gains, sustain function, and do very well, but older people have to consider the combination of exercise and nutrition. Older people start off at a lower baseline than younger people. They also may have some underlying pathologies such as insulin resistance that would be barriers to maximizing the full potential of their nutrition. One understudied population that we know can make gains is older women. We have a hard time discerning how postmenopausal women gain any lean mass at all. It is difficult. We have underestimated the ability of estrogen and progesterone, which older women lose, to act as anabolic stimuli. But older men retain some of that, and circulating testosterone.

However, they can all make gains. I think that the timing of the nutrition is important, probably more important than in younger people. I also think we have opportunities to develop exercise strategies that may be more broadly applicable. If you can stand up and lower yourself to about 90° with a bent-knee squat and then stand up, that is about 30%

of single repetition maximum (1RM). Try doing that to failure. Everybody in this room could do that, and you would find that their knees kind of burned afterward. Why not ask elderly people to do that? They do not need to go to the gym to do it.

Dr Suetta: I disagree with Dr Phillips about the intensity of resistance training for elderly people. Robust data—solid evidence—exists that shows we should advise elderly people to aim for at least 80% of 1RM, because that level increases muscle mass and achieves muscular gains most effectively. There is a statement about this from the American College of Sports Medicine (ACSM). Some studies have shown this even in frail elderly and very elderly people. So we have enough evidence to say that 30% of 1RM might increase muscle mass a little, but not as much as fairly heavy resistance training intensities.

Dr Phillips, you showed that the muscle protein synthesis rate increased with both 90% and 30% of 1RM, and you stated that neither of those intensities increased muscle mass much.

Dr Phillips: Oh, but they did.

Dr Suetta: Not as much as training with around 70% to 80% of 1RM. Could you speculate on what the synthesis rate would have been if you had tested at 80% of 1RM?

Dr Phllips: We tested at 90% of 1RM, which is only 10% higher, so you would expect that the response at 90% would mirror that at 80%. There is nothing magic about 80%. In fact, studies using lower intensities have never taken the intensity to fatigue. That is the whole point of 30% of 1RM to fatigue. If you consider the size principle, 30% of 1RM to fatigue begins to recruit type II fibers in an orderly manner, much the same way that 90% does. So the ACSM position aside, which I think is based on poorly reviewed evidence, no one has compared studies using lower intensities performed to fatigue. However, a large body of literature exists describing research that used intensities of around 20% of 1RM and used, for example, vascular occlusion to show that they could induce fatigue that achieved substantial hypertrophy. In fact, some colleagues of yours did a study in which they exercised young men at 16% of 1RM and got a 2.5% increase in hypertrophy.

Dr Suetta: I am aware of that study, and it is interesting. But I would always advise elderly and frail people, who have only a certain amount of energy to train, to do the optimal thing. I would never advise them to train at an intensity of 30% of 1RM. Later, I will present data showing that one of the side effects of resistance training is gains in muscle function and power, but not with an intensity of 30% of 1RM. There are good reasons to go to the gym and not just do stand-ups.

Dr Phillips: You do not gain at 30% of 1RM if you only do 10 reps, but our subjects are failing after 23 reps. So the onus is on me to prove to you that 30% to failure is enough to increase strength.

Dr Suetta: Do you think they increase muscle power?

Dr Phillips: Not power. Even exercising at 80% of 1RM will not increase power. You have to perform fast and train powerfully to increase power.

Dr Suetta: I disagree. A lot of evidence has demonstrated that older individuals gain power and explosive muscle strength (rate of force development) by training at intensitities of 60%-80% 1RM, including several studies from our own lab [Caserotti P et al: *Scand J Med Sci Sports* 2008;18:773-782; Suetta C et al: *J Appl Physiol* 2004;97:1954-1961; de Vos NJ et al: *J Gerontol A Biol Sci Med Sci* 2005;60:638-647]. An interesting study by de Vos et al compared different training intensities in old individuals and clearly showed that training at around 80% of 1RM increases muscle power much more effectively than any other intensity [*J Gerontol A Biol Sci Med Sci* 2005;60:638-647].

Dr Phillips: If they trained at 30% of 1RM but did it fast, then I would argue that they would increase power. That is the definition of power—force developed rapidly. So if someone trains at 80% doing slow repetitions up and down, they do not increase power as much as if they trained specifically for power at lower percentages of 1RM so they could move the weight rapidly (ie, developing maximal power). The proliferation of mitochondria might actually be greater when exercising at 30% of 1RM rather than at

80%, and thus the aerobic stimulus is greater at 30%. So exercise at 30% 1RM produces two benefits—increased strength and muscle mass, and increased mitochondrial content.

Dr Suetta: Again, I disagree with you. I think this point is very crucial, because there many people seem to misunderstand how you get improvements in muscle power and rate of force development. As I just mentioned, several studies have demonstrated that heavy-resistance training improves muscle power and explosive muscle strength (rate of force development [RFD]).

Notably, Macaluso and De Vito reported a load intensity of 60% maximal isometric voluntary contraction as the optimal load to produce the largest lower limbs' muscle power in older women [*Eur J Appl Physiol* 2003;90:458-463]. When optimal load for power development was assessed according to the 1RM method, one study reported that the greatest lower limbs' muscle power was achieved using a load intensity of 70% 1RM in elderly males [Izquierdo M et al: *Acta Physiol Scand* 1999;167:57-68]. Another advantage with this type of training is that you gain about three times more muscle mass and muscle strength compared to training at low intensities at about 30% of 1RM.

Dr Phillips: What if I told you we have the fractional synthetic rate of both mitochondria and myofibrillar?

Dr Suetta: I think you might get a small increase in muscle mass and an even smaller increase in muscle function.

Dr Phillips: No one has shown that, so I guess the onus is still on me to prove it to you. If you look at studies in which exercise at 30% of 1RM been done to failure or is done for a long time under tension, up and down, they show that people gain strength and gain mass. It is essentially the same mechanism as exercising at a higher intensity. It simply drives the protein synthetic process to be active in a type II fiber that normally would not be activated at that level. This will not happen if you do only 10 reps at 30%, but try doing 24 reps.

Dr Suzette Pereira [Abbott Nutrition]: Dr Holick, what is your take on providing vitamin D supplements to patients with end-stage renal disease? The kidney obviously is not functioning, and that is a main organ. You did mention that there are other tissues that can activate it.

Dr Holick: The clinical practice guidelines of the National Kidney Foundation recommend to all nephrologists that blood levels of 25-hydroxyvitamin D at all stages of chronic kidney disease need to be above 30 ng/mL, apart from those who need to get an active vitamin D analogue later in their disease. So we urge all nephrologists and primary care physicians to be alert to this and to confirm that their patients have at least 30 ng/mL, even if they have no kidney function. We believe that the parathyroid glands have 1-hydroxylase activity, and we will suppress some of the parathyroid hypertrophy by increasing 25-hydroxyvitamin D levels.

Dr Baracos: I have a question for Dr Phillips and Dr Volek. I am impressed by the elegance of the nutritional, metabolic, and physiological approaches you have taken, adjusting the composition of protein and other elements of the diet with the aim of increasing muscle mass and muscle function. You do that in people I see as having no medical need—recreationally active males and some categories of athletes. Is there a reason why you do not level your sights on the hosts of people who have consequential muscle wasting and loss of function? Is this because of resources or interests? I may be incorrect, but I perceive that if you look at the scope of literature you talked about this morning, that 95% of it would have been done in normal healthy young men, and 5% would have been done in other people.

Dr Volek: I think that is a great question, and a multifactorial one. Both resources and interests play a role. I am not in a medical school, so I have access to college students, staff, and faculty—generally a healthy population. I guess this access has dominated our work with resistance training and nutritional interventions. Having said that, we also have studied bone and muscle in adolescents, looking at milk consumption and vitamin D supplementation, focusing, probably mistakenly, on calcium. And we have done resistance training studies in elderly people, as well.

Dr Phillips: I concur with Dr Volek. A lot of these protocols take 7 or 8 hours to do, and young college men have the time to do them, and they are willing to do six or seven biopsies. We are doing some work in middle-aged women, and we have done some studies in elderly men and women employing the same principles as those used with

younger subjects. We can establish proof of principle concepts in young male populations in which we can be fairly invasive, and then use those principles in other populations.

Dr Volek: There also is a prevention aspect that does not get as much play as it should. Our medical system really focuses on treatment, and I guess my personal interests lie more in prevention, in this case, prevention of muscle atrophy and muscle wasting diseases. Certainly resistance training and nutrition in relatively healthy adults can help prevent and attenuate the decline in muscle mass as people age.

Dr Reid: Dr Volek, if your group has not studied creatine in patient populations, have others? If so, to what degree has creatine been beneficial for sick people?

Dr Volek: Creatine research took off in 1992, so there is nearly 2 decades of literature. During the first 10 years or so, the research was almost exclusively in the realm of sports nutrition in athletes and increasing performance. But because of its mechanism of action, creatine was attractive for researchers studying muscular and neurodegenerative disorders. So in the last 5 or 10 years, interest has grown in muscular dystrophies and a variety of other disorders that seem to have a dysfunction in creatine metabolism associated with them. The National Institutes of Health has funded several studies of creatine in Parkinson's disease, and there have been some recent animal studies on memory and brain function. Some work has been done on muscle function and strength in elderly people that shows a pretty positive effect. So literature on clinical therapeutic applications of creatine in patient populations has grown.

Dr Morley: Potentially, I think the best data on sick and older people will come from studies being done by Evans and Wolfe in Arkansas. They are studying bed rest, which, as you know, causes older people to lose muscle mass rapidly. They have some data showing that a balanced amino acid supplement can attenuate this to a large degree. As Dr Holick will tell you, a problem with these studies is that nobody ever measures vitamin D first. And if we just gave these older people vitamin D, maybe we would not have any of these problems. Still, the reality probably is that both play a role. Hospital meta-analysis data clearly show that giving protein supplements and/or caloric supplements can improve mortality and hospital length of stay in sick older people. I think these supplements are grossly underused because physicians have nearly no interest or training in nutrition. We have failed to fix this. Nutrition is still a minor part of any medical school curriculum, and I think this has to be changed.