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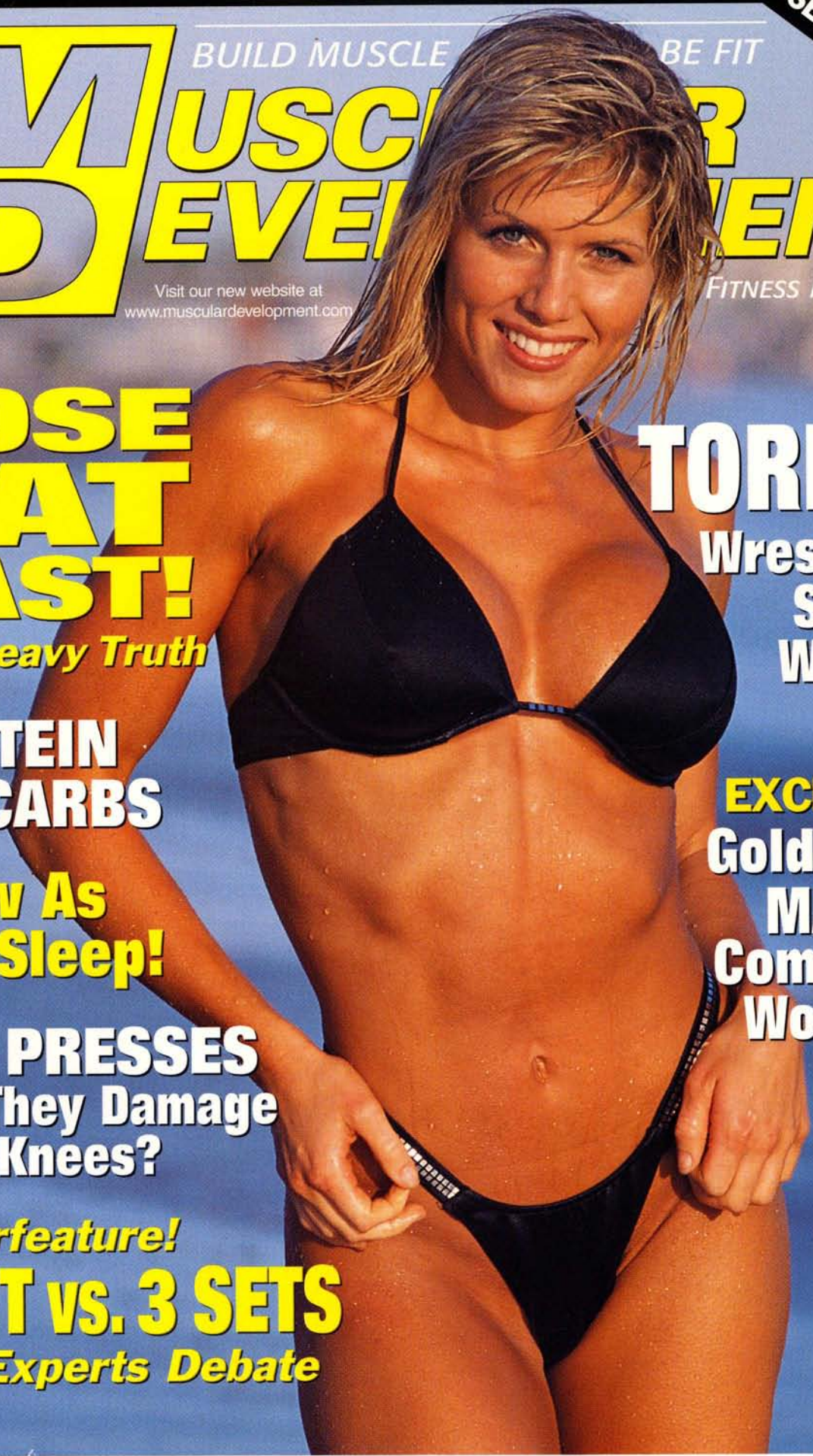
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# HIGH INTENSITY TRAINING 1 SET VS 3 SETS

*The Experts Debate—No Holds Barred!*

By Richard B. Kreider, PhD, FACSM

## **Introduction**

In order to optimize health benefits from exercise and/or performance, individuals have to train. Individuals who do not train enough may not experience optimal training adaptations and/or peak performance, while individuals who train too much may experience negative training adaptations. For this reason, there has been interest in determining the optimal amount of training necessary to improve health and optimize performance. As various forms of training developed, there has been considerable debate regarding which training techniques may offer the best training stimulus for various populations. One such debate is the controversy over the appropriate number of sets, repetitions, intensity and training volume necessary to optimize gains from resistance training.

Historically, exercise prescription guidelines for resistance training have been to perform two to three sets of 8–12 repetitions, two to three days per week. Additionally, that training should be structured in a progressive, systematic and periodized manner in order to optimize training adaptations, particularly in athletes. However, over the years, high intensity training (HIT) has been proposed as an effective alternative to multiple set/periodized

training (MS/PT). Although a number of variations of HIT have been proposed, HIT has typically consisted of performing one set of controlled concentric and eccentric contractions to failure. While debating whether to perform one or more sets of resistance training may not sound like a big issue, there has been a contentious divide in the strength community among HIT and MS/PT proponents. Proponents on each side have been firmly entrenched in the principles of training they feel support their view. Because of this, the debate regarding HIT versus MS/PT has often degraded into volleys of negative and personal comments.

Over the last several months, two papers have been published that have refueled this debate. One is a study from the University of Florida that indicates that increasing training volume from one to three sets in middle-aged, recreational weight lifters did not result in statistically significant improvements in muscular strength or endurance. The second presents new guidelines on resistance-training from the American Heart Association indicating that one set of 8-12 repetitions performed to failure for two to three times per week is sufficient to promote gains in strength and endurance and that adding sets does not sig-

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nificantly promote additional gains. Obviously, these new data and guidelines have been heralded by proponents of HIT while met with skepticism by proponents of MS/PT.

In response, MD formed a roundtable to present both sides of this issue in a no-holds-barred format. The goal is to provide readers insight into the rationale and scientific support of each side of this debate so they can make an informed decision about which types of training may be best for them. What follows is a provocative, frank, entertaining and at times contentious debate. So kick back, tighten up your weight belt, and let's get ready to rumble!

### Ground Rules

Several known proponents on both sides of this debate were invited to respond to a set of questions I prepared regarding HIT and multiple set/periodized training. Panelists were asked to provide supportive scientific evidence of their views. Once answers were obtained, panelists had an opportunity to verify their quotes but were not allowed to get into a point-counterpoint argument with other panelists based on their responses.

Answers are presented as quoted and in their entirety. There was no sharing of answers among panelists prior to submitting their responses. At times, comments are frank and pointed in support or against various individuals or organizations that have published research in this area and/or developed position stands regarding this issue, and even myself for asking "irrelevant" and/or "redundant" questions. It should be noted that MD neither endorses the views or opinions expressed in this roundtable, nor does it have an established position regarding this issue.

### The Panel

#### PRO HIT:

**Matt Brzycki, BS**

*Coordinator of Health Fitness, Strength and Conditioning Programs, Princeton University*

**Ken Mannie, MS**

*Head Strength/Conditioning Coach, Michigan State University*

**Richard A. Winett, PhD**

*Heilig-Meyers Professor of Psychology and Director, Center for Research in Health Behavior Virginia Tech University*

#### PRO MS/PT:

**Michael Barnes, M.Ed., CSCS,**  
Certified Club Coach-USWF  
Strength Development  
Coordinator, San Francisco  
Forty-Niners

**Mike Greenwood PhD,**  
CSCS \*D

*Associate Professor and Graduate Coordinator, Arkansas State University*

**Steven Scott Plisk, M.S.,**  
C.S.C.S.

*Director of Sports Conditioning, Yale University*  
*Vice President at Large, National Strength & Conditioning Association*  
*Associate Editor, Strength & Conditioning Journal*

### Roundtable Questions

**Q: Over the last number of years there has been considerable debate regarding the validity and effectiveness of HIT training. Do you recommend HIT training?**

#### PRO HIT:

**Brzycki:** I've advocated HIT since 1980. Considering the ever-growing popularity of HIT and the legions of strength and fitness professionals who have found it to be an extremely productive method of training their athletes "in the trenches," it's incredible that there's even a debate.

**Mannie:** I have been working with the HIT methodology, in all of its various forms, for over 25 years. Having applied it in numerous settings with heterogeneous populations, I can recommend it without equivocation. Scientific and empirical evidence supports the effectiveness of the HIT protocol. I have seen no compelling data to refute this statement or

my adamant conviction regarding the effectiveness of HIT.

**Winett:** Yes. However, it's important to understand that we are talking about a theory and set of principles of training and not one specific training routine. There are many variants of high-intensity training and to lump them all together takes away from discussing specific training variables, such as volume and frequency of training, and the degree of intensity that may be required in training to produce meaningful changes.

#### PRO MS/PT:

**Barnes:** One set to failure seems to be the only common dominator in HIT training. The HIT programs I have seen don't account for volume, relative intensity, power output or significantly address neural patterning. Because I deal with an athletic population, I don't consider HIT training to be the most effective for my population.

**Greenwood:** The HIT training system (single set system) is a traditional resistance training system that, in my view, is very individual and situational specific. Personally, I would only recommend HIT training to beginners (untrained) who are interested in establishing a muscular base and/or individuals who are interested in general fitness. Various untrained populations might include groups who have been sedentary for some time (i.e., general population, after completing a given rehabilitation protocol, after a detraining period, older adults). In relation to special populations, I may recommend the HIT system of training to a variety of individuals based on their current level of functioning and the pathophysiology of their disability/condition (i.e., neuromuscular, orthopedic, cardiac, pregnant). Depending upon sport specific demands and individual needs, I might recommend the HIT training system to certain athletes during the maintenance phase in their competitive season.

**Plisk:** First let me preface my

comments by stating that "High Intensity Training" is a misnomer. It may be classified as a type of "repeated submaximal effort" training. Due to the extreme emphasis placed on fatigue, however, it is actually a low- to moderate-intensity type of training which provides a metabolic conditioning stimulus more so than a strength training effect. I do not recommend HIT for strength development.

**Q: HIT training has evolved over years. What do you consider to be the most effective type of HIT training?**

**PRO HIT:**

**Brzycki:** While HIT may have evolved since first becoming popular in the early 1970s, the fundamental principles have remained the same. That said, HIT is not and has never been "one set of 8-12 reps on a Nautilus machine." There are countless interpretations, variations and applications of HIT, with many strength and fitness professionals incorporating their own personal twists and perspectives. Any type of weight training— including HIT— will be effective provided it encourages progressive overload of the muscles and provides for adequate recovery.

**Mannie:** HIT has as many variations in program design, reps, sets, total volume, etc., as any of the myriad multiple-set and periodized strategies currently employed. Traditional HIT— which usually involves one set per exercise executed to the point momentary muscular fatigue via varying rep ranges, maintaining a controlled movement speed, implementing two to three exercises per muscle compartment, and performed two to three times per week— is the most often described and studied variation. However, it is but one version of the HIT construct. All the variations in our scheme are effective. We believe in variety and have insured that it underpins our program.

**Winett:** There is no one inter-

pretation or routine or set of procedures that has been shown in research to be more effective than any other. For example, there's really only preliminary data on the effectiveness of using slower repetitions compared to training using a more conventional cadence.

**PRO S/PT:**

**Barnes:** If there is a most effective type of HIT training it would be a multi-joint exercise using free weights and it would have some type of systematic increase in intensity.

**Greenwood:** The type of HIT training I would consider to be the most effective would be the training system that meets the specific individual and situational needs of the populations previously mentioned (i.e., untrained, general fitness, disabled, older adults). The original HIT system (Liederman, *Secrets of Strength* 1925) emphasized a heavy load, minimal repetitions and extensive recovery periods (five minutes) before moving on to the next exercise and a different muscle group. More recently, proponents of the HIT system recommend higher repetitions and lighter resistances (Pollock et al., *Circulation*. 101:828-833, 2000). Here again, the HIT system would select, if I used HIT, would be strongly dependent upon the specific needs of the population requesting/receiving the training.

**Plisk:** In my opinion there is no such thing. All of the HIT variations I'm familiar with are essentially second generation Nautilus theory. There are a few different spins on this theme, but the basic premises are the same: single sets of moderate to high repetitions to failure; slow, controlled movements (usually accompanied by an anti-acceleration philosophy); and inordinate emphasis on machines (probably to minimize some of the technique problems associated with training to exhaustion).

**Q: When you develop training programs, do you exclusively**

**use HIT training methods, some combination of single and multiple set training, or exclusively multiple set/periodized training?**

**PRO HIT:**

**Brzycki:** One of the many misconceptions about HIT is that it is "one set and only one set." While most versions of HIT involve one set of each exercise, there are multiple-set applications (although the multiple sets are of much lower volume than found in traditional programming). Since 1982, I've had the opportunity to oversee the training of thousands of Division I collegiate athletes who competed in almost every sport imaginable from football and basketball to lacrosse and squash. Without exception, the programs I prescribed for all of them involved HIT methods.

**Mannie:** All of our strength training activities incorporate the HIT methodology as the mainstay.

**Winett:** I do not recommend multiple sets or a periodized program because there's limited data to support their efficacy and limited data to support the idea that the volume of training is the key stimulus causing adaptations. I emphasize, however, that training is a very dynamic process and a person must pay close attention to how they are responding and recovering from training. For example, during periods when there are other significant stressors in a person's life, or a time of particularly intense training, more rest days are typically needed. That can be seen as a form of periodization, or frankly, common sense. If you do studies where you're comparing a training approach that is more dynamic to one that is relentless in intensity and the number of rest days between training sessions— in other words, a very poor example of higher intensity training— then we shouldn't be surprised that a more dynamic approach shows better results. So, we're talking about the intelligent application of principles and not their blind application.

## **PRO MS/PT:**

**Barnes:** Exclusively multiple set and a progression/periodization model. I would like to also mention that I use many different training techniques depending on the individual needs of an athlete. It takes a tremendous amount of muscle mass to compete in professional football, specifically at the line positions. This varies a great degree from a quarterback; therefore, I would not apply the same training program. Regardless, all of my programming uses systematic increases in training variables to elicit the greatest training response.

**Greenwood:** The strength and conditioning training programs I develop are primarily centered on collegiate athletes (i.e., baseball, basketball, football, track & field) and power lifters. Therefore, the majority of my training protocols encompass multiple set and multiple set/periodized systems. Here again, for rehabilitating athletes, untrained athletes, and/or de-trained athletes, emphasis would be placed on HIT system protocols initially to establish basic physiological adaptations. After establishing sport specific physiological adaptations through appropriate assessment procedures, periodized training principles with a multi-set emphasis would be infused. Additionally, the HIT system might be utilized during the maintenance phase of the athlete's competitive season. The inclusion of the HIT system would be dependent upon the demands of the sport, the athlete's specific needs, and the time constraints involved in the training process. In the health club setting, the HIT system would be my initial selection for the untrained individual after determining their current level of functioning with relevant exercise assessments. The bottom line— I believe the resistance system you select is relative to the population and specific activity demands you are training.

**Plisk:** Our programs include a combination of "brief maximal efforts," "repeated submaximal

efforts," "submaximal accelerative efforts," and "reactive-ballistic efforts." Emphasis is placed on skillful, athletic movements where the type of concentric or eccentric failure associated with HIT would be inappropriate. On the contrary, we have a standing rule in our program: Rest-pause as needed to execute each rep at full power. In all cases, exercise range of motion is considered an acceleration path. The only distinction is whether the athlete accelerates through the sticking region (e.g. when executing standard barbell exercises like the squat and deadlift) or the entire movement (e.g. in order to launch the object or body ballistically). The reason for this is that adaptation is a function of activation, and maximal effort at a given resistance is the means toward achieving it. Adaptive tissue remodeling is as much a response to motoneural signals as it is a simple cellular repair process. (Case in point: Graft the nerve of a type I [slow-twitch] motor unit onto a type II [fast-twitch] muscle fiber, or vice-versa, and that fiber's properties proceed to reverse themselves). Indeed, to quote Drs. Mel Siff & Yuri Verkhoshansky from their *Supertraining* textbook (p. 4), "The fundamental principle of strength training, then, is that all strength increase is initiated by neuromuscular stimulation."

**Q: In your view, what is the greatest advantage of HIT training?**

## **PRO HIT:**

**Brzycki:** The greatest advantage of HIT is that it represents a practical approach to strength training in that it can produce excellent results in a relatively brief amount of time without being unnecessarily burdened by the undue complexity, relative inflexibility and pseudo-scientific terminology that are characteristic of periodized training.

**Mannie:** HIT provides the trainee with a scientifically sound approach to progressive overload

in a structured, comprehensive, time-efficient and extremely productive manner. In my opinion, it also offers a safer alternative relative to risk/benefit considerations as compared to certain other approaches.

**Winett:** It is an extremely time limited, and hence "cost-effective," way to train.

## **PRO MS/PT:**

**Barnes:** I believe HIT training to have some application for general health and fitness.

**Greenwood:** I believe the greatest advantage(s) of HIT training systems would include two factors: 1) great for general fitness/untrained/special populations, and 2) limited training time required for general fitness parameters to be attained.

**Plisk:** It's easy to administer and requires little knowledge, planning or skill. All that's needed is the ability to count reps.

**Q: In your view, what is the greatest weakness of HIT training?**

## **PRO HIT:**

**Brzycki:** The greatest weakness of HIT is the unfortunate and inaccurate perception and portrayal of it along with the unjustified and unending criticism that it has received from certain individuals who have clearly placed their own personal agendas ahead of the strength and fitness profession.

**Mannie:** I doubt any system of resistance training can claim perfection across the board. The HIT methodology has fared quite admirably in the currently available research data when compared to the compendium of multi-set schematics (Carpinelli, 1999). HIT has no glaring weakness that isn't as readily apparent in the vast agglomeration of multi-set/periodized programs. If definitive, unbiased research data exist to refute this comment, I have not seen it.

**Winett:** The supposition by some people is that it is vastly superior and the only way to

train. HIT has not been demonstrated to be better than other methods; it's simply that other methods have not consistently been shown to be better than derivatives of HIT.

#### **PRO MS/PT:**

**Barnes:** It doesn't address strength, endurance or the ability to repeat high intensity bouts with no significant loss in performance. There is a SAID (Specific Adaptations to Imposed Demands) Principal that applies to all physical training. If the body is asked to adapt to one set to failure, that is what happens. Most athletic competitions, specifically team sports, involve repeated bouts of maximal effort. This is one of the reasons why I use multiple sets in my programs.

**Greenwood:** I believe the greatest weakness of the HIT training system is that it does not effectively accommodate all the training adaptations required for advanced weight lifters, body-builders, or well-trained athletes!

**Plisk:** The weaknesses of HIT are threefold:

1. It violates the principle of dynamic correspondence (also referred to as specificity or transfer of training effect). Simply stated, training tasks should be selected and prioritized according to the demands of performance. Their basic biomechanics— but not necessarily outward appearance— should be specific to those occurring in competition. Power production and rate and time of peak force application (impulse) are especially important criteria. Other practical considerations include amplitude and direction of movement, accentuated region of force application and regime of muscular work.

2. Optimal training volumes cannot be performed. Strength gains and body composition alterations are related to training volume, at least up to a certain point. However, an optimal threshold of work cannot be achieved when fatigue is overemphasized and training quality and recoverability are compromised,

as is the case with HIT methods.

3. It violates the principle of cyclic workload variation. The concept of progressive overload is misinterpreted in most HIT programs, where training intensity is increased simplistically (i.e., in a constant linear fashion). Much more profound training effects are realized— and accommodation/stagnation is avoided— via fluctuation rather than linear progression in workload. A three to four-week period seems to be an optimal biological window within which to organize such training.

**Q: Critics of HIT training often suggest there is too little peer-reviewed scientific evidence to suggest that HIT is as effective, or more effective, than traditional periodized, multiple set resistance training. If you are a proponent of HIT, what is your view of this criticism and what research data do you cite to support your view?**

**Brzycki:** First, legitimate scientific evidence should be peer-reviewed, not pal-reviewed. Indeed, some studies have design flaws that would not be worthy of a passing grade in a high school science project, yet they somehow passed the supposed peer-review process of a scientific journal. Second, I don't know of any HIT proponent who has said HIT is "more effective" than traditional methods of training. Any study that has been conducted in a scientifically acceptable manner and is void of any researcher bias has shown that— without exception— there are no significant differences between single-set (or low-volume) training and multiple-set (or high-volume) training.

**Mannie:** I would recommend that these critics take a close, objective look at the data. Forty-seven refereed studies were done comparing a SS (single set) protocol to a MS protocol; 45 showed no significant difference between the two in strength and/or hypertrophy. These results are a clear indication to me that HIT is

at least as effective as any MS/periodized approach. Until I see compelling evidence to indicate otherwise, I will maintain this view. It is interesting to note the knee-jerk response of HIT critics when their proclamations of MS/periodization superiority are challenged. I refer MD readers to the response of a group of scientists/practitioners (Byrd, et al., 1998) to an incisive review of the literature (Carpinelli and Otto, 1999) and the subsequent reply by the review authors for an illuminating and thought-provoking exchange.

**Winett:** It is as effective by default, because most studies during the last 40 years do not show the superiority of multiple set or periodized programs to single set training. HIT training has not been shown to be more effective, but it is more cost-effective.

**Q: A recent paper published by Hass et al. (Medicine and Science in Sport and Exercise. 32:235-242, 2000) evaluated the effects of single versus multiple set resistance training in a group of middle-aged, recreationally-trained adults. Results revealed that in a group of subjects who had previously trained with one set to failure, increasing training volume to three sets did not promote greater gains in muscular strength, muscular endurance, and/or body composition. What is your general impression of the quality and significance of this study?**

#### **PRO HIT:**

**Brzycki:** Like other studies done at the University of Florida, the quality of this research is exceptional. In terms of importance, this 13-week study— using subjects who had been performing single-set training for at least 12 months— shows that single-set training continues to be effective beyond one year. Further, increasing the training volume by 200 percent did not produce significantly

greater results in experienced subjects after 13 weeks of training. In fact, the one-set group increased their muscular strength in the leg extension and 1-RM bench press more than the three-set group during the last six weeks of the study. It is also interesting to note that seven subjects did not complete the study— all from the multiple-set group. This includes two subjects who experienced tendonitis— an overuse injury— in their shoulders and knees.

**Mannie:** My impression is that the Hass et al. study is but another one indicating the effectiveness of HIT, and that MS training failed to produce greater gains in strength, muscular endurance and/or body composition when compared to this particular SS protocol. The question takes to task the quality and significance of this study. If there are questions about confounding/extraneous variables, or possible design flaws/contamination in this or any other study that supports either HIT or MS/periodized approaches, they are certainly dutiful and understandable. Within that framework of fairness, if we are going to [discuss] this or any other "pro-HIT" research data, we should be afforded the opportunity to do the same with specific "anti-HIT" data in this same forum. It is interesting that no studies supporting MS/periodization as being superior to HIT are presented for review in this roundtable format.

**Winett:** This is a well-conducted study in a scientifically rigorous journal. It was conducted to address one major and important issue in the field. The issue is that most of the work comparing single vs. multiple sets focused on previously untrained men and women. It was possible, though the mechanisms were not clear, that further adaptations for advanced trainers require more volume. The results of this study suggest volume is not critical for further adaptations in advanced trainers.

#### **PRO MS/PT:**

**Barnes:** The research is of the highest quality and is not in question. But it applies to middle-aged recreationally trained adults. It leads me to conclude that for general health and fitness HIT training is what I consider a crude but viable solution to that population. Collectively, we as physical educators are responsible for advancing the field. This means using peer reviewed research and science as a foundation to our methods, not cookie cutter recipes.

**Greenwood:** The results of this study might prove relevant and/or significant to middle-aged recreationally trained adults but cannot be generalized to all populations. Personally, I have several concerns about the findings presented in this study. First, the investigators report that the results of this study are similar to other studies using untrained subjects, yet their subjects had a year of training prior to the start of the study. I assume it depends on how you define "untrained." Second, even though no significant muscular strength and endurance differences were reported between groups, the multiple set group did display greater gains than the single set group during the pre-, mid- and post- training assessments (no Effect Size reported in the article). These strength trends were not reported in the text but were evident in the figures that were displayed in the manuscript. Additionally, after evaluating the figures, the multi-set group was higher on just about every pre-test measure. Obviously, with greater strength displayed in the pre-test results, the multi-set group would not exhibit the strength improvements in a 13-week period that the single-set group could accomplish since there was more room for improvement. Further, the investigators did not analyze the post-test values between groups, but rather analyzed the differences between the pre- and post-test values. This is generally acceptable, except for

the fact that the multi-set group started off at higher strength levels (although not significant) which probably accounts for no significant differences in the study. Finally, the investigators combined males and females in both groups but failed to address absolute and relative strength differences regarding gender (actually only report relative strength differences and not absolute differences between groups). Considering the attrition rate, the final number of subjects included 12 males and 30 females (N=42), but the number of males and females within each group were not reported. The investigators indicated that through statistical analysis both genders progressed at a similar rate and therefore were presented together. Personally, I would like to know if male representation in both groups was equal or dominant in one group. Even if the males and females progressed at similar rates initially, what were the strength differences between genders by the end of the study? A dominant male representation in either group would skew the final results. However, it is difficult to make this claim when you don't have equal gender representation to begin with. Increases relative to gender differences are unknown based on the research design of this study. In my opinion, the previous concerns addressed are major limitations of the study and therefore difficult to generalize to any population.

**Plisk:** This study was presented at the ACSM conference the previous year, where circuit training methods were reportedly used. That fact has been omitted here. Additionally, the authors have dismissed several factors in their conclusions:

- The training program consisted of intentionally slow movements, which are known to reduce gains in strength.

- The multi-set group showed the only significant difference between groups (1RM leg curl/kg body mass), as well as several within-group differences not

shown by the single-set group. For example, the former group improved at more angles in the isometric testing and— very importantly— achieved a statistically significant reduction in body fat percentage. The latter group did not.

• Furthermore, although not statistically significant, the multi-set group showed greater gains in the endurance tests (about 25-45%) than the single-set group.

**Q: In your view, can the results of this study be generalized to serious weightlifters, bodybuilders, or well-trained athletes?**

**PRO HIT:**

**Brzycki:** Having trained individuals ranging from neophyte to elite, I am not convinced there are any physiological reasons why the aforementioned populations would not experience results similar to those produced in the study by Hass and his colleagues. The fundamental concept of progressive overload applies to everyone.

**Mannie:** I see no reason why the results of this study could not be extrapolated to any population. Critics of HIT claim a mysterious "point of diminishing returns" will surface in the case of "well-trained" athletes. I pose the following questions relative to this proposed hypothesis: (1) What exactly constitutes a well-trained athlete: is it six months, one year, two years, three years, ad infinitum? (2) At what point in this continuum does HIT no longer produce the sought-after results— and what are the physiological mechanisms responsible for this occurrence? (3) What are the physiological mechanisms responsible for the superiority of a MS/periodized model in well-trained individuals and why doesn't HIT provide the same benefits? HIT critics should be able to answer these questions with clarity before pounding the podium with declarations of MS/periodized superiority. Common sense dictates that it is specious

to make a blanket statement that a particular routine or set of guidelines is all-inclusive for every individual in all situations. This is true on both sides of this issue. Competitive weightlifters, for instance, need to develop the congruent neural pathways necessary for the encoding of the skill patterns for the lift(s) in question. As with any skill, repetitive bouts of the specific movements are paramount for these neural and cognitive adaptations.

Therefore, a competitive weight lifter must practice the skills of his sport with regularity— just as a competitor in any other sport must practice his/her skills. However, if the goal is to develop strength and muscular size for general fitness enthusiasts or specific sports, the HIT methodology will garner results as well as any other in this discussion. The issue with competitive lifters is more about skill acquisition than it is with strength or morphological adaptations.

**Winett:** Yes. Seriousness should not be equated with some willingness to use multiple set training. Rather, seriousness has more to do with how consistently and how hard a person trains and the priority they give to training compared to other life pursuits and obligations.

**PRO MS/PT:**

**Barnes:** For a highly weight trained athlete, HIT training has little substantiation. For a well-trained athlete who has no lifting experience, any type of resistance training will assist in bettering his performance. I would contend that I could have players move weights from one side of the weight room to the other and they would get stronger. I want to maximize athletic performance so I systematically control as many training variables as possible.

**Greenwood:** No, absolutely not! The results possibly can be generalized to middle-aged recreational trained adults minus my concerns mentioned in the previous Q & A.

**Plisk:** For the reasons dis-

cussed above, it is difficult to generalize the authors' conclusions to any population.

**Q: Do you feel serious weightlifters, bodybuilders, or well-trained athletes can optimize strength, muscle mass and/or performance to a greater degree using HIT training than traditional multiple set/periodized training?**

**PRO HIT:**

**Brzycki:** As I've said, HIT is at least as effective as any other method of resistance training in terms of increasing muscular size and strength. There is no reason to believe "serious" athletes would require different stimuli than others in order to produce optimal physiological adaptations. While on the subject, categorizing lifters with terms such as "serious" or "recreational" can be deceiving. For example, I consider myself to be a recreational lifter since I am no longer training for any type of competition. Nevertheless, as a long-time lifter— and former competitive powerlifter and bodybuilder— I also characterize myself as serious, experienced and highly trained.

**Mannie:** Again, I refer to the currently available data. If the claim is that a MS/periodized model is superior to HIT, then the [essential element] rests with the claimant to produce the burden of proof to validate the claim. Currently, the preponderance of available data do not support the claim.

**Winett:** There's no research showing the superiority of HIT. It's not a question of producing better outcomes, but there is the issue of producing similar outcomes with much less training time. Overall, the outcomes people achieve through resistance training are largely genetically mediated, with consistency and intensity of training then influencing the degree of genetic potential that is realized.



## **PRO MS/PT:**

**Barnes:** No, because it doesn't apply enough training stimulus in reference to variation, intensity and volume.

**Greenwood:** No, absolutely not! HIT does not meet the specific physiological demands associated with these populations or training protocols. Additional points that I have not addressed yet include increases in bone mineral density and neuroendocrine responses to resistance training. The Minimal Essential Strain (MES) is the necessary force required to initiate new bone formation. Highly trained athletes must undergo significant structural adaptations to increase bone mineral content which is difficult to attain with single-set protocols that promote higher repetitions and light to moderate work loads. Conroy and Earle (1994) recommend three to six sets of up to 10 repetitions with loads of 1-10 RM to accomplish this physiological adaptation. In relation to neuroendocrine responses (i.e., testosterone, insulin growth like factors, growth hormone), heavy resistance training (85-95% of 1RM) with moderate to high volume and short rest periods is the recommendation to stimulate this physiological response during training (Kraemer 1994; Fleck & Kraemer 1997). These factors should be considered when developing resistance training systems that meet the individual and situational specific demands of select sport/exercise populations.

**Plisk:** On the contrary, they can expect inferior results from HIT.

## **Final Comments?**

### **PRO HIT:**

**Bryzcki:** I appreciate the courage and willingness of MD magazine to tackle an emotionally charged subject while allowing the panelists to discuss the subject in a no-holds-barred format. Finally, I'd like to thank Dr.

Kreider for coordinating the roundtable.

**Mannie:** The scientific method dictates that an extraordinary claim requires extraordinary evidence. The claim that MS/periodized strength training procedures are superior to the HIT methodology has been promulgated by a variety of individuals/organizations for many years. The ascendant scientific literature, however, fails to support this claim. In conclusion, the extraordinary evidence required to support the notion that MS/periodized strength training is superior to HIT does not exist.

**Winett:** There are many exciting developments in resistance training that should be discussed as it becomes a centerpiece of disease prevention and health promotion programs. Applications to athletes in the grand scheme of things are of really minor concern compared to applications that can get substantial segments of the population to do some form of resistance training.

### **PRO MS/PT:**

**Barnes:** To me, the term HIT is an enigma. HIT is so loosely defined that the only common denominator is one set to failure, so that is what I based my responses on. There are numerous ways to define "Intensity" in HIT. Not as a 1 RM, because most of their programs don't go below six reps (about 85% of 100%). The term they like to use is "maximal momentary effort"— nothing definitive or that can be quantified biomechanically— velocity, power output, percent 1 RM, distance, total work per unit time, force, etc. The coaches who train HIT like to use machines but not all the time, so the argument for neural patterning is a draw. No HIT coaches I know use any Olympic movements, so mark one up for power output and intermuscular synchronization. Their response to the Olympic movements is that they are too dangerous. There is an inherent risk in lifting weights so it is a matter of not training to get hurt

or maximizing athletic performance. It is all about what the coach perceives as acceptable risk. They also like to say, "Why should I take the time to teach the Olympic movements when I can be getting an athlete stronger right now?" In the immediate future they may show relatively greater improvements because of the rudimentary neural patterns, but in the long term (eight weeks +) their theory falls apart. The development of a powerful athlete comes by training power. In light of adapting the central nervous system and metabolism, for the athlete who wants to develop some kind of strength endurance and metabolic condition, multiple sets need to be used. Also, with multiple set training, the athlete develops a resistance (and adapts morphologically) to training stimulus/volume.

**Plisk:** The concepts I am proposing are nothing new. They have been a way of life in the training of international athletes for decades, with obvious success. They are now generally well understood and accepted in the U.S., largely due to the educational resources and programs offered through the National Strength & Conditioning Association. HIT proponents frequently criticize the NSCA for its "party line," as if there is some grand conspiracy at work. If a professional organization of 18,000+ members with a common interest in exchanging and applying sound principles constitutes a conspiracy, then I accept this definition. I often think European coaches and sport scientists must find all of this very amusing. A new millennium has arrived and we still can't agree on basic issues regarding free weights vs. machines, multiple vs. single sets, or explosive vs. slow movements. The central question is: Should we be satisfied with something that is marginally effective, or is it our mission to find what works best? Searching for a better way requires a willingness to redraw

the line between the fundamental principles and individual preferences that each of us bases our priorities on. This can be a wake-up call for those who associate weight training productivity with struggling to move the bar, or with the easily demonstrable burn and pump. It's easy to assume these are the stimuli for adaptation, when in fact they are merely signs and symptoms of one type of work. Adopt a principle-based approach, and accept the challenge to think— instead of feel— your way through training.

## Summary

So, what have we learned from this roundtable? In my view, the following can be said regarding the HIT versus MS/PT debate:

- There remains a strong disagreement among HIT and MS/PT proponents regarding the value of single and multiple set training and interpretation of available literature.

- Exercise prescription is an art of applying scientific training principles and methods to conditioning programs. As with anything in life, there is no one method that will work for all populations and all individuals within that population. The volume and intensity of training that may optimize performance in some individuals may undertrain or overtrain others.

- The vast majority of resistance training research studies have employed multiple set training methods particularly in athletic populations. This has yielded a significant body of knowledge to understand how the body adapts to training and should therefore serve as the basis of developing resistance-training programs.

- There is scientific evidence that single set training in adult fitness populations can increase strength and endurance to at least 70–80 percent of the gains experienced from multiple set training. Therefore, single set training may serve as a time-efficient means of increasing and/or

maintaining strength in adult fitness type populations. Whether single set training is as effective or more effective than multiple set training in athletes remains to be determined.

- There are many variations of HIT and MS/PT, which make research design challenging and interpretation of results difficult to apply to general populations. Therefore, results of studies should be considered in light of the populations evaluated and methods employed.

- Several studies indicate that multiple set training promotes significantly greater gains in strength and endurance while no study indicates that single set training promotes greater gains in strength and endurance than multiple set training.

- Interestingly, none of the individuals interviewed in this roundtable felt that HIT training was more effective than MS/PT training although the HIT proponents strongly felt that HIT may be as effective as MS/PT training.

- Additional well-controlled research is necessary in a variety of populations to determine the effectiveness of HIT and MS/PT at various training phases.

- Regardless of which training method is used, coaches and athletes should monitor training adaptations and progress as tolerated depending on their individual goals of training. ■

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