REST INTERVALS FOR HYPERTROPHY

YOUR COMPLETE EVIDENCE-BASED GUIDE

WEIGHTOLOGY

THE SCIENCE OF BODY METAMORPHOSIS

Learn how to structure your rest intervals to maximize muscle size

by James Krieger

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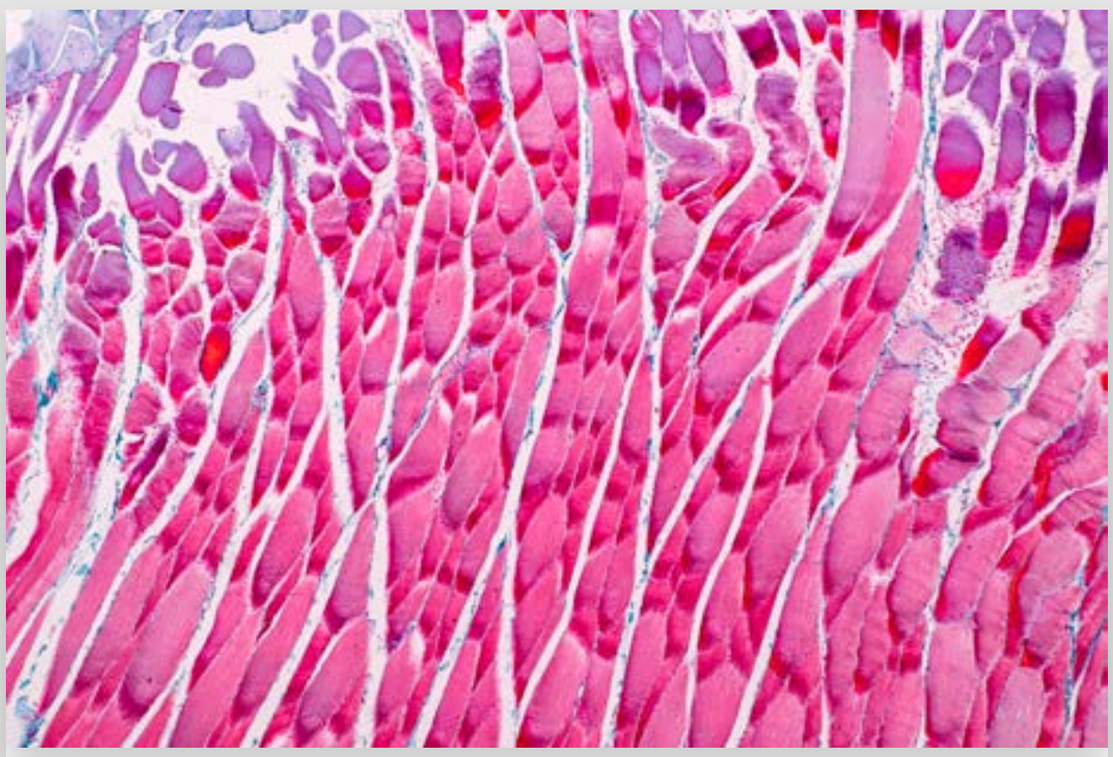
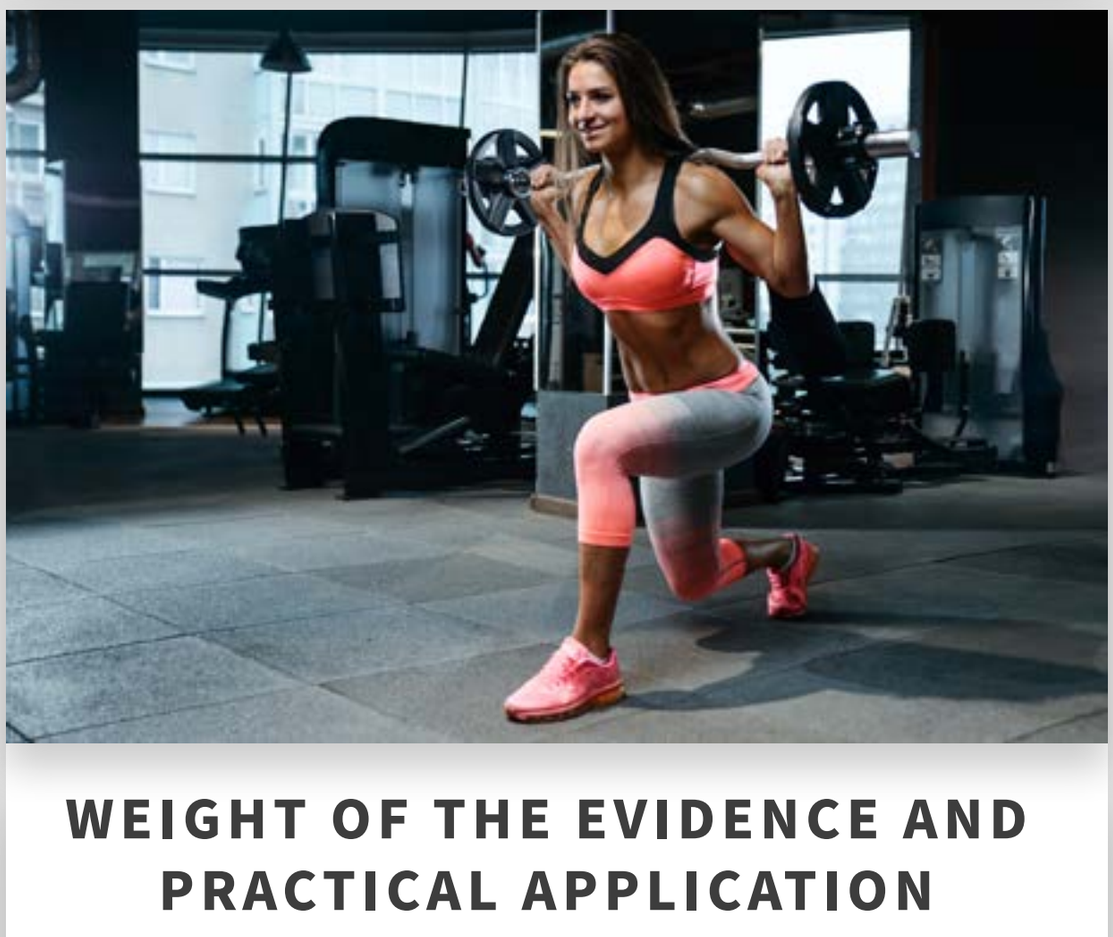




KEY TAKEAWAYS

Short Rest Intervals (1 Minute or Less) Impair Muscle Protein Synthesis in Compound Moves Compared to Longer Rests (2+ Minutes)

Muscle protein synthesis studies indicate **little difference between 2 minute and 4 minute rest intervals when a mixture of compound and isolation movements are used**. However, **when rest intervals decrease down to 1 minute, muscle protein synthesis is impaired** compared to long rest intervals.

Short Rest Intervals (1 Minute or Less) May Impair Hypertrophy in Compound Moves Compared to Longer Rests (2+ Minutes)

In studies that use a mixture of compound and isolation movements, **no differences in hypertrophy are observed when 2 minute rest intervals are compared to longer rest intervals**. When **rest intervals of 30 seconds to 1 minute are compared to longer rests, then 3 out of 5 studies favor longer rests**.

Short Rest Intervals (1 Minute or Less) May Not Adversely Impact Hypertrophy With Single Joint Isolation Movements

A few studies suggest that **short rest intervals of 1 minute or less do not impair hypertrophy when single joint isolation movements are used in the upper body** (such as with direct arm work).

MAKING MUSCLE: EFFECTS OF REST INTERVALS ON MUSCLE PROTEIN SYNTHESIS

In the early days of bodybuilding, it was believed you needed to train with short rests if you wanted to get your muscles as big as possible. This was mainly due to the massive pump you would get from short rest training, and the belief that the pump was related to muscle growth. This belief was further cemented when scientists such as Bill Kraemer published research showing

that short 1-minute rest intervals produced greater growth hormone and testosterone responses compared to longer 3-minute rest intervals. This idea was based on the assumption that the elevation in anabolic hormones that you get in the 15-30 minutes after a training session were related to muscle growth. Since bodybuilders tended to train with short rests, short rests created large anabolic hormone responses, and bodybuilders has large muscles, it was believed that

" THE IDEA OF 'TRAIN WITH SHORT REST = MAXIMAL ANABOLIC HORMONE STIMULUS = MAXIMAL HYPERTROPHY' CAN BE SAFELY FLUSHED DOWN THE TOILET "

there was a causal relationship. We know now, however, that post-training hormone responses are not related to muscle growth. Thus, the idea of "train with short rest = maximal anabolic hormone stimulus = maximal hypertrophy" can safely be flushed down the toilet.

To understand the potential impact of rest interval length on hypertrophy, we can first look at how rest intervals impact muscle protein synthesis (the process by which your muscles make new protein). In the hours after a training session, muscle protein synthesis is elevated, meaning your muscles are already building new protein and going through the process of hypertrophy. If there is a difference in muscle protein synthesis with different rest intervals, then it suggests

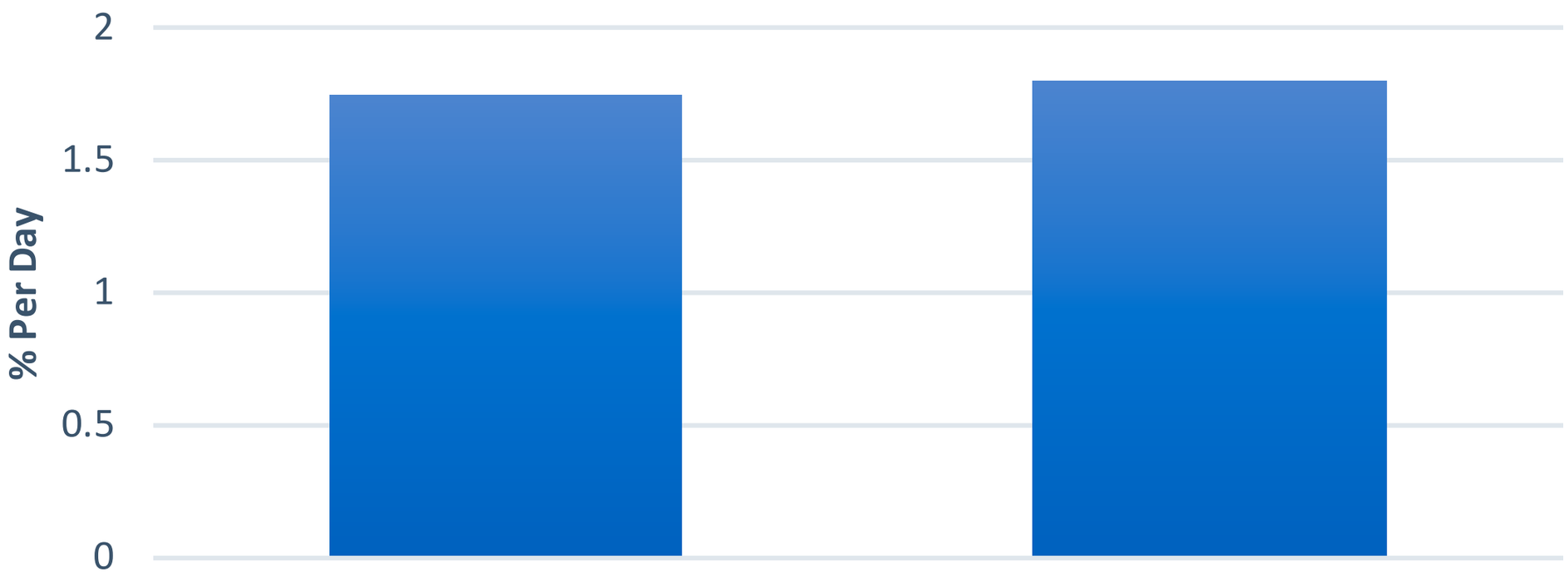
" IF THERE IS A DIFFERENCE IN MUSCLE PROTEIN SYNTHESIS WITH DIFFERENT REST INTERVALS, THEN IT SUGGESTS THERE COULD BE A DIFFERENCE IN HYPERTROPHY "

that there could be a difference in hypertrophy.

A study by Damas and colleagues compared the muscle protein synthesis response between 2 minute and 4 minute rest intervals. The subjects did 4 sets of leg press and 4 sets of leg extensions with one leg, and the same sequence with the other leg, but

with the longer rest intervals. Thus, this was a **within-subjects design**; since each subject was compared to himself, it removes the impact of genetic variability in the training response. There was no significant difference in the muscle protein synthesis response between 2 and 4 minute rests (**Figure 1**). This would suggest that there would be no difference in hypertrophy between 2 and 4 minute rest intervals.

Figure 1: Impact of 2 vs. 4 Minute Rest Intervals on Muscle Protein Synthesis

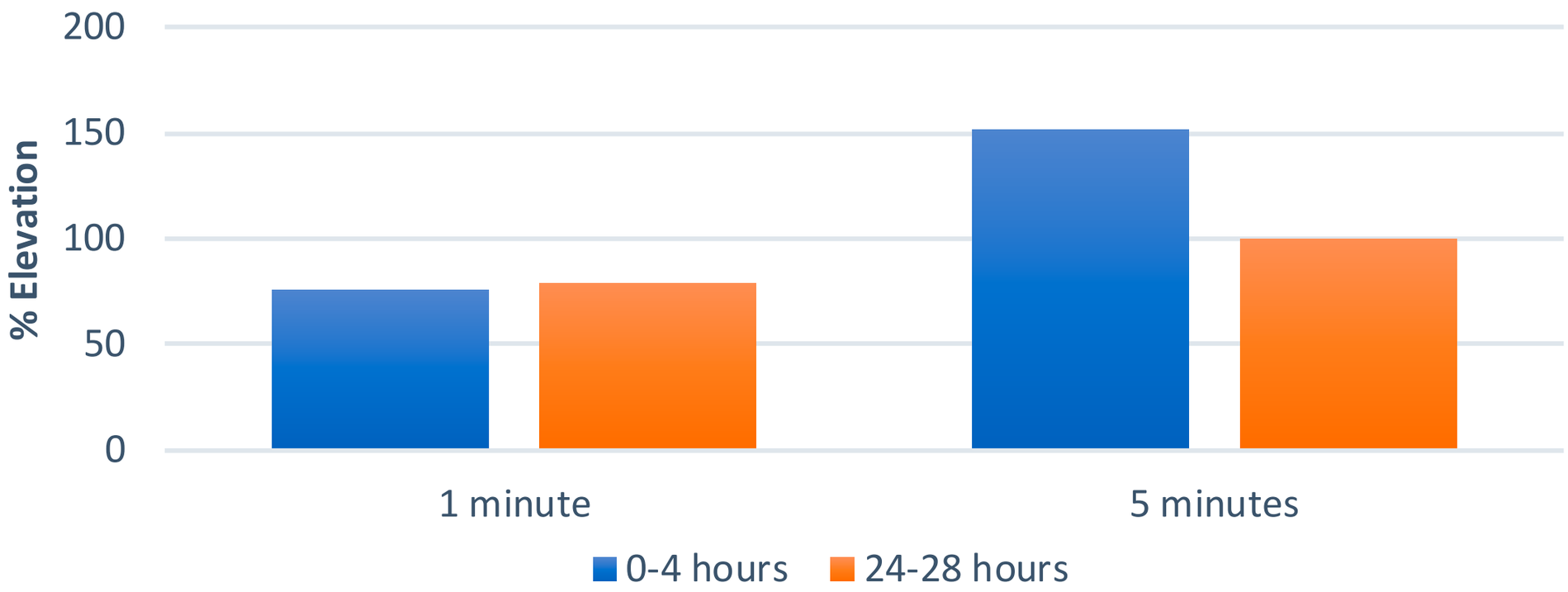


From Damas et al. (2019)

One limitation here is that 2 minutes rest isn't a very short rest interval. What happens when we compare very short rest intervals (like 1 minute) to longer ones? In a study by McKendry and colleagues, researchers compared the impact of 1 minute versus 5 minute rests on muscle protein synthesis in the

legs. The subjects did 4 sets of leg press and 4 sets of leg extensions at 75% 1-RM to failure. Muscle protein synthesis at 4 hours was approximately double the magnitude in the long rest group compared to the short rest group (**Figure 2**). By 24 hours, the responses were no longer significantly different, although the percentage change still slightly favored the longer rest. Intracellular anabolic signaling was increased by 4.2 fold in the

Figure 2: Impact of 1 vs. 5 Minute Rest Intervals on Muscle Protein Synthesis



From McKendry et al. (2016)

long rest group, but was not elevated in the short rest group. The inferior muscle protein synthesis and anabolic signaling response would suggest that very short rests (1 minute) may be detrimental for hypertrophy, at least if you're using a mixture of compound and isolation movements on large muscle groups like the legs.

Taking these two protein synthesis studies together, it appears that there is little difference between rest intervals of 2 minutes or more, but when the rest intervals decrease to around 1 minute, then muscle protein synthesis (and thus hypertrophy) may be impaired when you're using a combination of compound and isolation movements to failure.

" WHEN THE REST INTERVALS DECREASE TO AROUND 1 MINUTE, THEN MUSCLE PROTEIN SYNTHESIS MAY BE IMPAIRED WHEN YOU'RE USING A COMBINATION OF COMPOUND AND ISOLATION MOVEMENTS TO FAILURE "

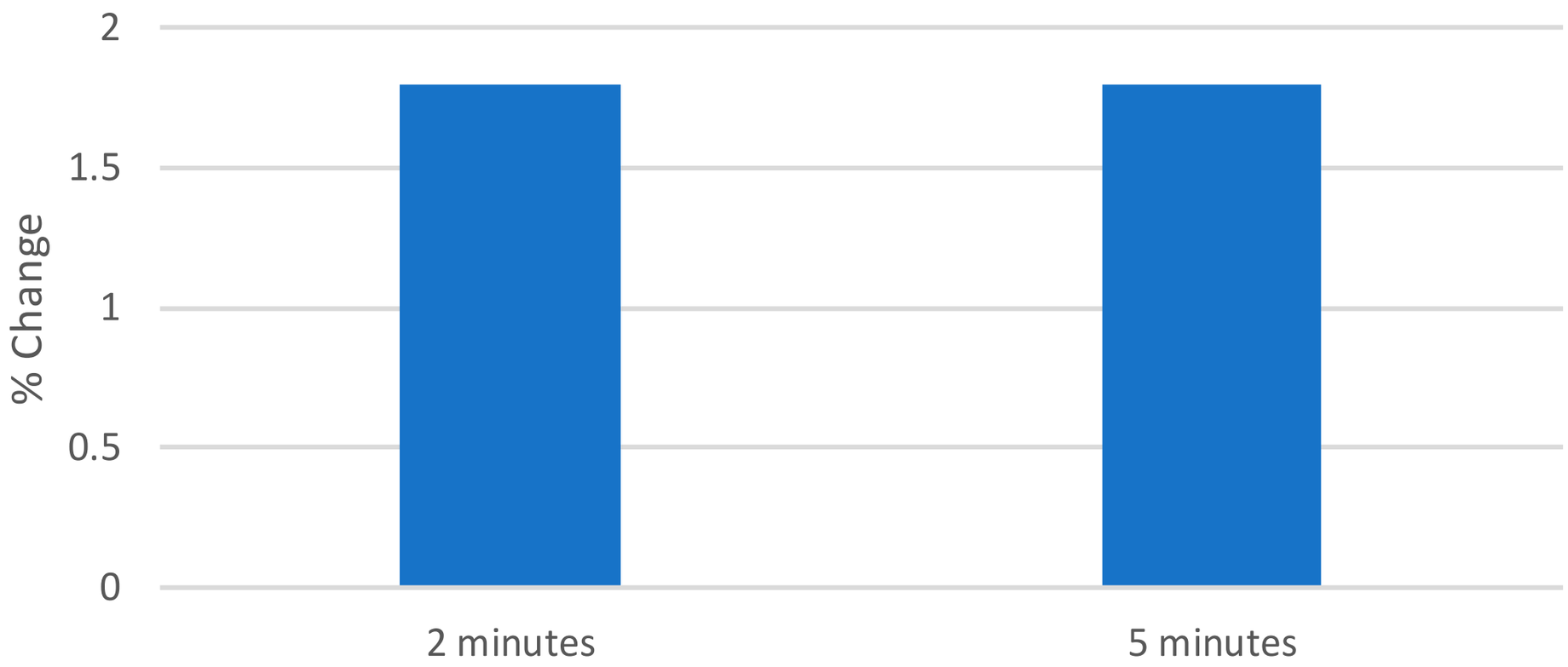
REST INTERVALS AND MUSCLE SIZE: TRAINING STUDIES

The muscle protein synthesis data suggests that very short rests may not be ideal if you want to maximize hypertrophy. However, muscle protein synthesis does not always correlate with long-term gains in muscle size. While the muscle protein synthesis data gives us some hints, we need to look at long-term training studies that compare the effects of different rest interval

lengths on muscle size. Let's take a look at the existing studies, and see if we can detect any sort of pattern.

- In the first study to investigate the impacts of rest intervals on size, researchers compared 2 minute rest intervals to 5 minute rest intervals on quadriceps muscle size. While the researchers tried to equate training volume (sets * reps * load), it was 7%

Figure 3: Impact of 2 vs. 5 Minute Rest Intervals on Muscle Size

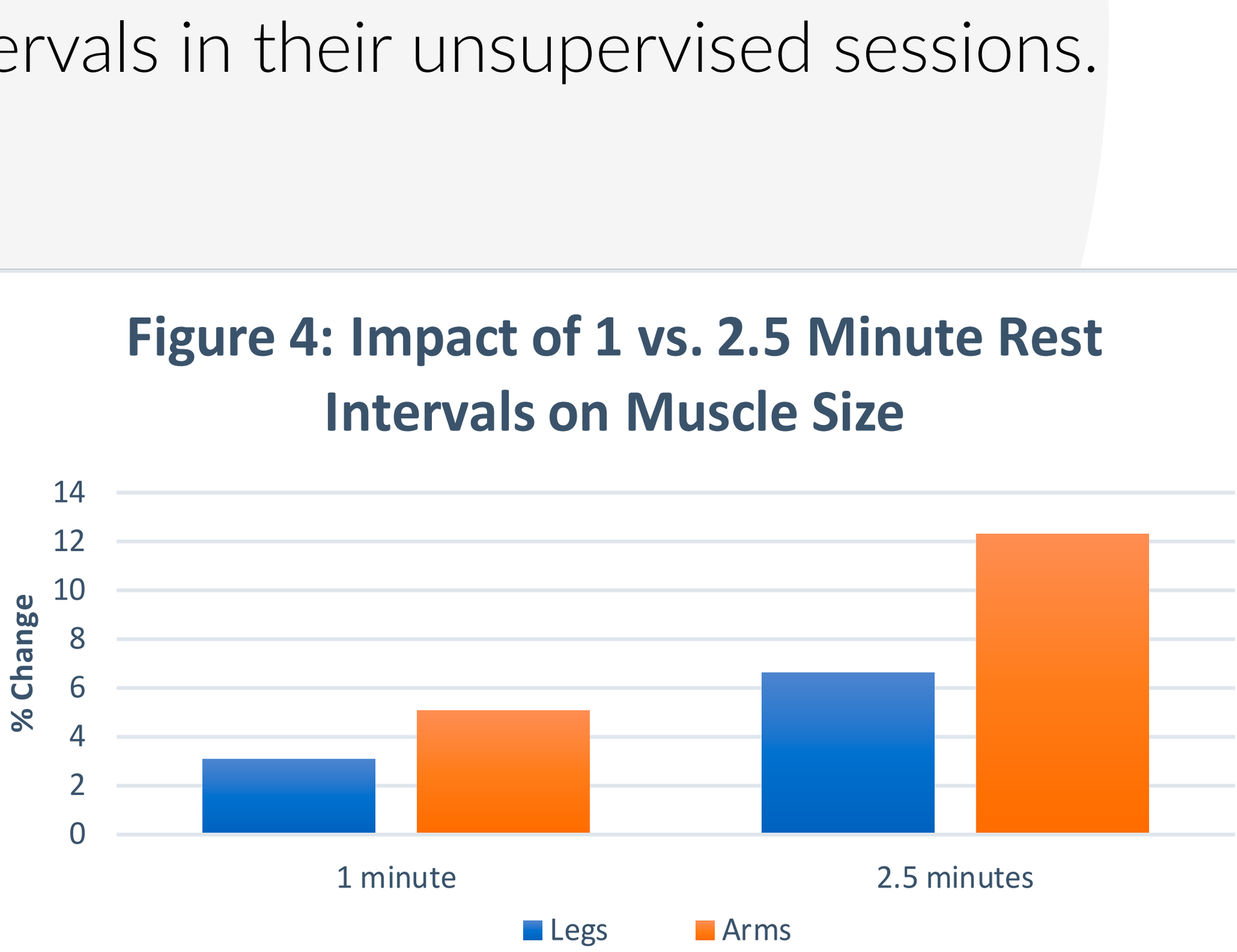


From Ahtiainen et al. (2005)

higher in the short rest condition (the short rest condition did 9 total sets per session on legs, while the long rest condition did 7 total sets as they could do more weight per set). Gains in muscle size were identical (**Figure 3**). These results are supported by the muscle protein synthesis research which

suggested there would be no difference in hypertrophy between a 2 minute rest and 5 minute rest. Similar to the protein synthesis study, a limitation is that a 2 minute rest interval is not very short. Also, training was only partly supervised, so we cannot be certain that the subjects adhered to the rest intervals in their unsupervised sessions.

Figure 4: Impact of 1 vs. 2.5 Minute Rest Intervals on Muscle Size



From Buresh et al. (2009)

- In a study on untrained subjects, researchers compared 1 minute to 2.5 minute rests. Statistically, there were no differences in leg size gains between the groups, but the percentage gains favored the long rest group (**Figure 4**). Gains were statistically greater in the arms in the long rest group (**Figure 4**). Essentially, gains were twice as

high with a 2.5 minute rest versus 1 minute rest, despite greater anabolic hormone responses in the short rest group (again falsifying the "hormone hypothesis" of muscle gain). The greater gains in the long rest group are supported by the protein synthesis data showing inferior muscle protein synthesis responses with 1 minute rest. One major limitation of this study is that subjects were not supervised during training, so we cannot be certain that the subjects ad-

" GAINS WERE TWICE AS HIGH WITH A 2.5 MINUTE REST VERSUS 1 MINUTE REST, DESPITE GREATER ANABOLIC HORMONE RESPONSES IN THE SHORT REST GROUP "

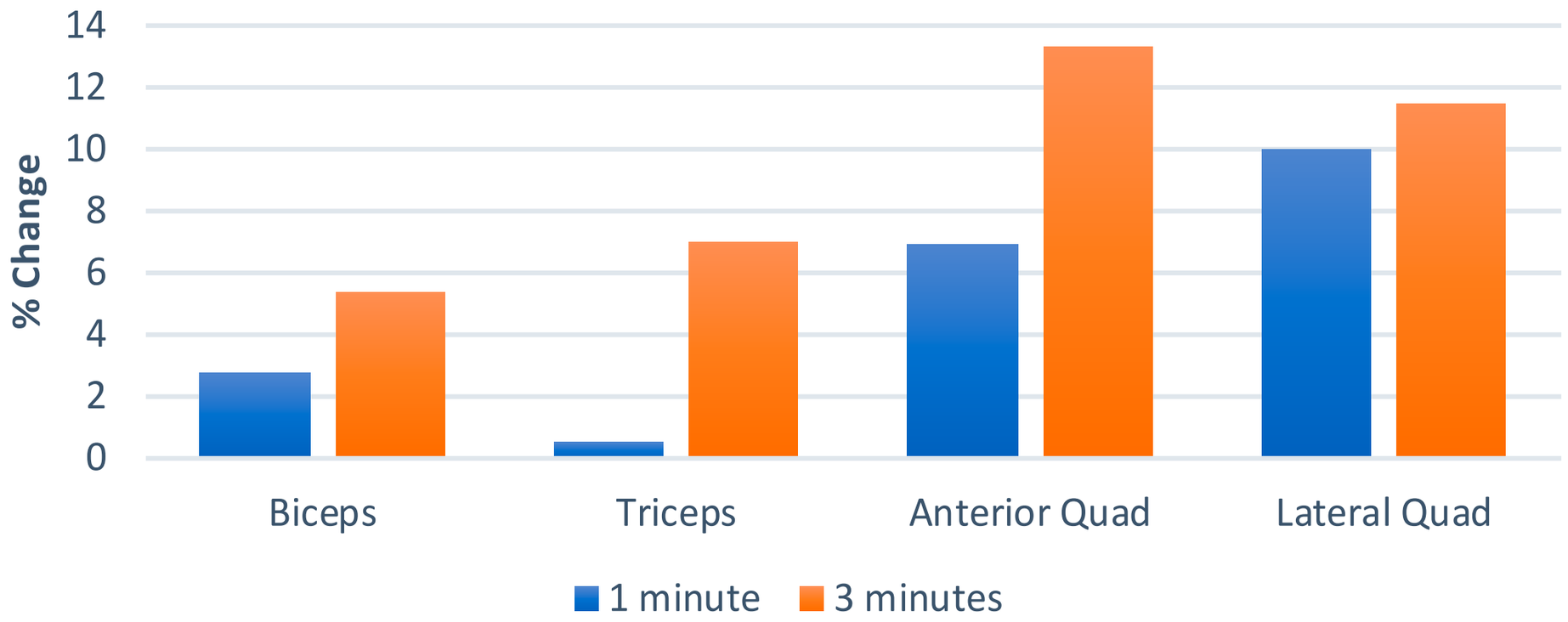
hered to the rest intervals. Another limitation is that muscle size was estimated using circumference measurements and skinfold thickness, which is not as accurate as a direct measurement like magnetic resonance imaging (MRI).

- In a study on recreationally trained men, researchers compared constant 2 minute rest intervals to rest intervals that were progressively decreased by 15 seconds each week from 2 minutes down to 30 seconds. The short rest training impaired load volume, but changes in arm and leg muscle size were similar. A follow up study by the same group showed similar results; in fact, percentage gains favored the short rest group in that study. These studies don't show any detriment to the use of very short rest intervals. However, in these studies, both training groups used 2 minute rest intervals in the first two weeks. Rest intervals did not begin to decrease in the short rest group until week 3. The rest intervals were still moderate at 90 seconds at week 4, and did not hit one minute until week 6. Since half of the study involved moderate rest intervals, it's possible that the decreasing rest group did not spend enough time using short rests to impact gains. Another possibility is that the gradual decrease in rest intervals allowed the group to slowly adapt to very short rest intervals, and thus did not impact hypertrophy. A third possibility is that both groups were supplemented with

creatine; since creatine may improve recovery between sets, it may have negated any potential detriment to very short rests.

- Dr. Brad Schoenfeld carried out a well-supervised study comparing 1 and 3 minute rest intervals in trained subjects. Both groups did 3 whole body workouts per week, doing 3 sets of 8-12 RM of 7 exercises (mostly compound) each session. Muscle

Figure 5: Impact of 1 vs. 3 Minute Rest Intervals on Muscle Thickness

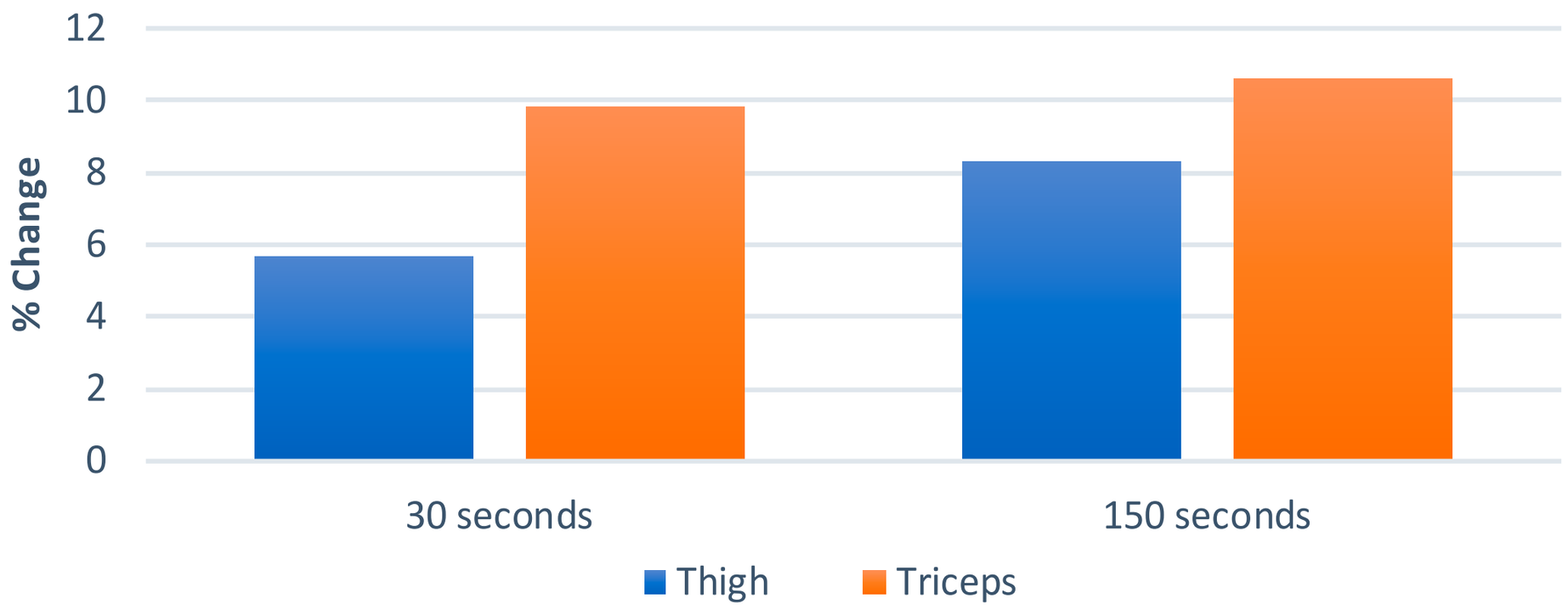


From Schoenfeld et al. (2016)

gains favored the long rest group in all outcomes, with nearly twice the gains in some measurements (**Figure 5**). These results are similar to the results of the 1 vs. 2.5 minute study by Buresh and colleagues discussed earlier, and are supported by the protein synthesis data showing inferior protein synthesis with 1 minute rests.

- Fink and colleagues compared 30 second rest to 150 second rest in untrained subjects using light weights (40% 1-RM) to failure. The exercises were squat and bench press. Muscle gains tended to favor the long rest group for legs, although the difference was not statistically significant (**Figure 6**). Gains were similar between groups for triceps (**Figure 6**). This study is tilted in favor of 2+ minute rests, although not to the same extent as other studies previously discussed.

Figure 6: Impact of 30 Second vs. 150 Second Rest Intervals on Muscle Size



From Fink et al. (2017)

- Finally, in another study on untrained subjects (see the Weightology review of this study here), scientists compared sets of 8 RM and 3 minute rests to sets of 20 RM and 30 second rests. There were no significant differences in muscle gains between

the groups. However, percentage gains in muscle cross-sectional area strongly favored the short rest/high rep group (9.9% increase in the short rest group versus 4.7% increase in the long rest group). Changes in triceps muscle thickess also favored the short rest group (35.2% versus 13.7%). These results are opposite to most of the other training studies previously discussed. They are also different from what is predicted by the protein synthesis data. A couple key characteristics of this study may explain the discrepancies. Unlike other studies, this study involved mostly single joint isolation movements in the arms. Also, repetition ranges varied between the groups.

" UNLIKE OTHER STUDIES, THIS STUDY INVOLVED MOSTLY SINGLE JOINT ISOLATION MOVEMENTS IN THE ARMS. ALSO, REPETITION RANGES VARIED BETWEEN THE GROUPS "

REST INTERVALS FOR HYPERTROPHY

Weight of the Evidence and Practical Application

The following table summarizes the available data on rest intervals, protein synthesis, and hypertrophy:

REST INTERVAL	TYPE OF EXERCISE	PROTEIN SYNTHESIS	HYPERTROPHY
2+ MINUTES (SUCH AS 2 VS. 4)	COMPOUND+ISOLATION	NO DIFFERENCE	NO DIFFERENCE
<=1 MINUTE VS. 2+ MINUTES	COMPOUND+ISOLATION	2+ MINUTES > 1 MINUTE	3 OUT OF 5 STUDIES SUGGEST BETTER HYPERTROPHY WITH 2+ MINUTES
<=1 MINUTE VS. 2+ MINUTES	UPPER BODY ISOLATION	?	ONE STUDY SHOWED BETTER HYPERTROPHY WITH SHORT REST, BUT WAS CONFOUNDED BY DIFFERENT REP RANGES BETWEEN GROUPS

The weight of the evidence suggests the following:

- There is no impact on protein synthesis or hypertrophy when rest intervals are at least 2 minutes.

- For a given number of sets of compound and isolation movements, protein synthesis and hypertrophy are lower when rest intervals are 1 minute or less as compared to 2+ minutes.
- For isolation movements in the upper body, short rests do not appear to adversely impact hypertrophy.

WEIGHT OF THE EVIDENCE

The data suggests that, if you're using compound movements, it's better to rest at least 2 minutes between sets. If you use shorter rests, you can make up for the potential decrease in hypertrophy by doing more sets. In a study that I reviewed in Weightology, subjects experienced similar hypertrophy when performing drop sets (which

are "no-rest" sets) compared to regular sets. The subjects performed enough drop sets until load volume was equivalent to that of the regular sets. Since it takes more sets with short rest to do the same load volume as long rests, this means you can nullify the impact of short rests with more sets. However, it may not save you time; it will take about the same amount of time to

" YOU CAN NULLIFY THE IMPACT OF SHORT RESTS WITH MORE SETS "

do 4-5 sets of an exercise with one minute rest compared to three sets with three minutes rest.

A possible explanation for why short rests may decrease hypertrophy is central fatigue. When you train with short rests on compound movements, the high aerobic demand and large increase in lactate may cause more fatigue in the cen-

tral nervous system. This can result in less signal going from the brain to muscle, and limit your ability to recruit the muscle fibers that have the greatest capacity for growth. This also explains why short rests don't adversely impact hypertrophy when using single joint isolation movements in the upper body. These movements don't cause as much central fatigue as compound

" A POSSIBLE EXPLANATION FOR WHY SHORT RESTS MAY DECREASE HYPERTROPHY IS CENTRAL FATIGUE "

movements, and thus short rests won't have the same negative impact. For more info on short rests, central fatigue, and hypertrophy, check out this Weightology research review article.

PRACTICAL APPLICATION

- For compound movements, most training should involve longer rest intervals of 2+ minutes. This is particularly true for movements that involve large muscle mass, like squats.
- **If you use shorter rest intervals on compound movements, you can make up for the potential de-crease in hypertrophy by doing more sets**, but it may not save you time.
- Short rest training and associated intensity techniques (drop sets or rest-pause) are best reserved for single joint isolation movements of smaller muscle groups, such as biceps, triceps, delts, and calves.
- **Don't turn your resistance train-ing session into a cardio session**. The high aerobic demand may lim-it your ability to recruit the muscle fibers that have the greatest ca-pacity for growth.

About the Author

James Krieger is the founder of Weightology and a published scientist, author, speaker, and coach in the field of exercise and nutrition. He has a M.S. in Nutrition from the University of Florida and a second M.S. in Exercise Science from Washington State University. He has published research in prestigious scientific journals, including the American Journal of Clinical Nutrition and the Journal of Applied Physiology, and has collaborated with notable scientists such as Dr. Brad Schoenfeld. He is the former research director for a corporate weight management program that treated over 400 people per year, with an average weight loss of 40 pounds in 3 months. He has been involved in the field for over 20 years and has written over 500 articles.

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