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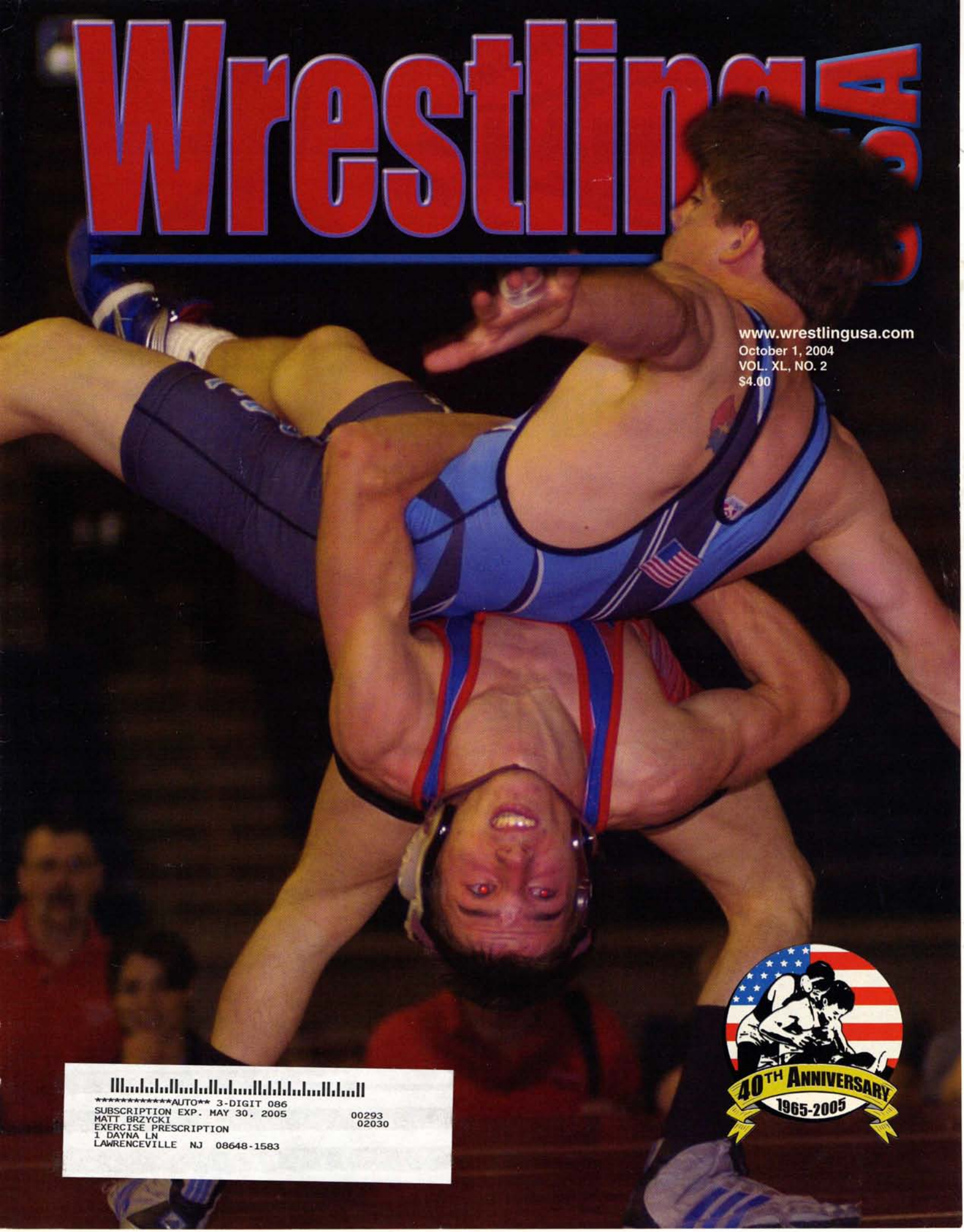
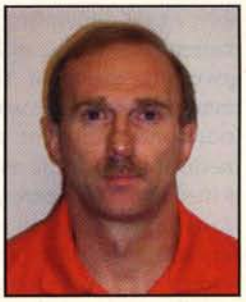


40TH ANNIVERSARY
1965-2005

Not So Fast!!



By Matt Brzycki

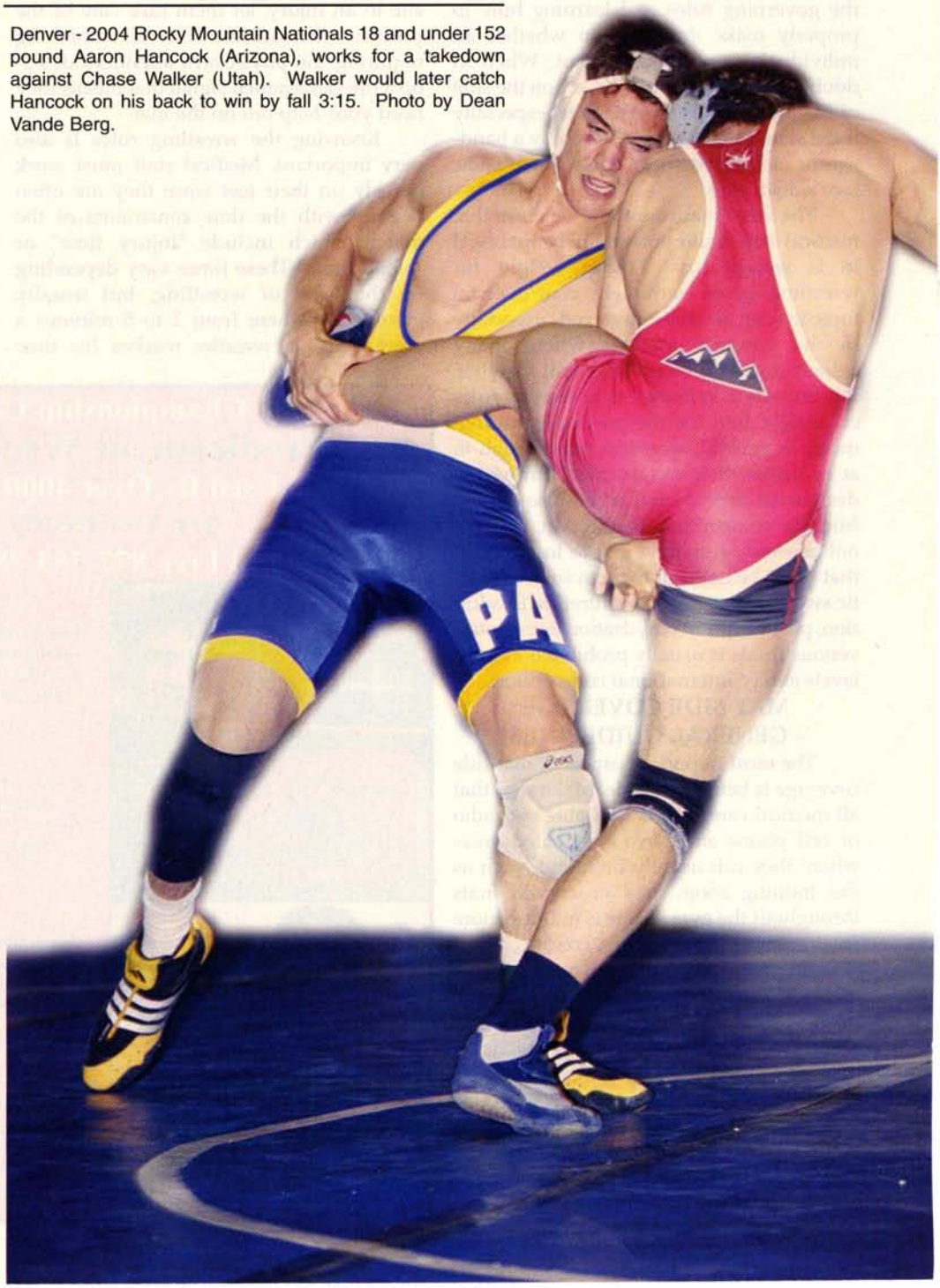
One of the biggest battles in the field of strength and fitness concerns the speed at which repetitions should be performed. Essentially, strength coaches have enlisted as soldiers in one of two armies: Those who advocate high-speed/explosive repetitions that are performed in a ballistic manner and those who advocate slow-speed/deliberate repetitions that are performed in a controlled manner.

THE BIRTH OF A CONTROVERSY

In 1970, Nautilus Sports/Medical Industries - at the time, a newcomer to the business of manufacturing exercise equipment - began educating fitness enthusiasts by providing guidelines for safe and efficient strength training. In retrospect, this was a critical time to disseminate training advice since the so-called "fitness boom" was just entering its embryonic stage. Included among this new information was the suggestion that each repetition should be done in a deliberate fashion by raising a weight in two seconds and lowering it in four seconds. (This was sometimes referred to as simply "up two, down four" or "2/4.")

During that era of resistance exercise, protocols were heavily influenced by the opinions and training methods of the competitive Olympic style weightlifters who perform their repetitions in a rapid, explosive fashion. The advancement of the idea that repetitions should be done with a controlled speed of movement went against the prevailing train of thought thereby sparking the fiery controversy that continues to rage with heated passion more than 30 years later.

Since the early 1970s, recommendations to perform high-speed repetitions and certain explosive movements - including the so-called "quick lifts" and plyometrics - have been force-fed to the athletic community with a religious zeal. Many who promote high-speed repetitions would have you believe that their philosophy represents the only approach and that anyone who believes otherwise is misinformed, misguided and/or not very knowledgeable about strength training. Those with different views are quickly and feverishly attacked for their irreverent non-acceptance of the traditional "party-line" thinking. Nonetheless, there are legions of highly qualified and completely competent strength coaches at the scholastic, collegiate and professional levels who do not recommend high-speed repetitions. Does their advice have any merit?



Denver - 2004 Rocky Mountain Nationals 18 and under 152 pound Aaron Hancock (Arizona), works for a takedown against Chase Walker (Utah). Walker would later catch Hancock on his back to win by fall 3:15. Photo by Dean Vande Berg.

MUSCLE FIBERS

It is believed that in order to become "explosive," you must train "explosive." The assumption is that by lifting explosively in the weight room, the fast speed of movement will somehow change the chemical composition of slow-twitch (ST) fibers and/or selectively recruit fast-twitch (FT) fibers.

Fiber Conversion

There is no conclusive evidence in the scientific literature that consistently and convincingly supports the belief that muscle fibers can be converted from one type to another. It appears as if one type of muscle fiber may take on certain metabolic characteristics of another type but actual conversion does not occur.

Fiber Recruitment

Likewise, there is no conclusive evidence in the scientific literature that consistently and convincingly supports the belief that muscle fibers can be selectively recruited. Muscle fibers are recruited - or "innervated" - by the nervous system in an orderly fashion based upon the intensity or force requirements and not by the speed of movement. Demands of low muscular intensity are met by ST fibers. Intermediate fibers are recruited once the ST fibers are no longer able to continue the task. FT fibers are finally recruited only when the other fatigue-resistant fibers have severely depleted their energy stores and cannot meet the force requirements. All fibers are working when the FT fibers are being used. The orderly recruitment pattern remains the same regardless of whether the repetition speed was fast or slow. In sum, the selective recruitment of muscle fibers is physiologically impossible.

This pattern is consistent with the "size principle" of recruitment that was proposed by Dr. Elwood Henneman in the 1950s. He described the experimental basis of his principle in 18 related articles that were published in the Journal of Neurophysiology over the course of 25 years. According to this principle - which is widely accepted by neurophysiologists and regarded by them as one of the most important advances ever in the field of motor control - motoneurons are recruited based upon increasing size: The motor unit with the smallest motoneuron is recruited first and the motor unit with the largest motoneuron is recruited last. (A motor unit consists of a motoneuron and all the muscle fibers that it innervates.) In general, the smallest motoneurons innervate ST fibers and the largest motoneurons innervate FT fibers. Therefore, ST fibers are recruited first and FT fibers are recruited last.

Incidentally, the orderly pattern of recruitment has another significant implication for training: When lifting weights, it is important for you to engage as many FT fibers as possible. In the weight room, then, you should perform each exercise to the point of muscular fatigue.

WHAT THE RESEARCH SAYS

While the warlike debate over the appropriate speed for repetitions in the weight room has stimulated quite a number of research studies, many of them have left much to be desired in terms of providing definitive conclusions. For one thing, some studies have design flaws that make their results scientifically unacceptable. A classic example of this is a study that appeared in the *Journal of the American Physical Therapy Association* in 1970. Authored by Mary Moffroid and Jack Whipple, the study has been referenced countless times as evidence that repetitions should be done at high speeds. The researchers concluded that a group that trained with a fast speed (108 degrees per second) produced gains at all seven speeds that were tested (0, 18, 36, 54, 72, 90 and 108 degrees per second) while a group that trained with a slow speed (36 degrees per second) produced gains at only the slow speeds. But the researchers violated a basic principle of statistical analysis and experimental design. As a result, their conclusions were unsupported by their data. In fact, the data showed that the group that trained with a slow speed had roughly twice the gains of the group that trained with fast speeds at 18 and 36 degrees per second. Moreover, there were no significant differences between the groups at the other five speeds.

Another issue relates to the type of equipment that is used in most of the research. The vast majority of studies that have examined high-speed versus low-speed repetitions - including the study by Moffroid and Whipple - have based their findings and measurements on the readings from isokinetic devices. For many years, the accuracy of this testing equipment has been heavily criticized for being wildly inaccurate and unreliable. As such, the results of these studies are questionable at best. But even if the data were accurate and reliable, demonstrating an improvement in performance on an isokinetic device is irrelevant since isokinetic contractions - those in which the angular velocity of a limb is constant - do not occur in sports (or in everyday life, for that matter).

A few studies did use conventional equipment (that is, barbells and machines). In one study that used selectorized machines, the subjects were divided into three groups: one group raised the weight in 0.75 seconds or less, another group raised the weight in 2.0 seconds or more and a third group raised the weight in 0.75 seconds or less for the first six weeks of the study and 2.0 seconds or more in the last four weeks. All three groups significantly increased their leg power during the vertical jump. There were no significant differences between the groups. In another study

that used the barbell squat, the subjects were divided into two groups: one group was to "explode upward as fast as possible" and the second group was to "raise the bar in a slow and controlled manner so that acceleration is minimized." Both groups were instructed to "lower the weight in a slow and controlled manner." After 7.5 weeks of training, both groups significantly increased their one-repetition maximum squat, vertical jump and muscular size (of the thigh). There were no significant differences between the groups. In short, research using conventional equipment has shown that slow-speed repetitions are at least as good as fast-speed repetitions for improving power (as well as muscular size and strength).

EFFICIENCY AND SAFETY

Besides all of the scientific facts that have been mentioned with respect to the speed at which repetitions are done, the laws of physics must also be considered. In order to overcome inertia and lift a weight, an external force must act upon it. In doing so, momentum is produced. Momentum can be defined as "mass times velocity." Assuming that the mass - or in this case, the weight - of the object stays the same, momentum is then a function of velocity: as the velocity increases, so does the momentum. Momentum affects the efficiency and safety of an exercise as follows:

Efficiency

High-speed repetitions that are performed in a ballistic manner are actually less productive than low-speed repetitions that are performed in a controlled manner. Here is why: When weights are lifted too quickly, an excessive amount of momentum is produced. As a result, the muscles generate tension during the initial part of the repetition . . . but not for the last part. In simple terms, the weight is practically moving by itself. In effect, the load on the muscles is decreased - or eliminated - and so are the potential gains in muscular strength (and size).

Unfortunately, the reduced muscular loading that occurs as a result of excessive momentum is demonstrated in weight rooms across the world on a daily basis - albeit, in most cases, unknowingly. Have you ever seen others raise the weight so quickly on a leg-extension machine that the pad left their lower legs partway through the repetition? Well, think about it: The pad is attached to the movement arm of the machine that, in turn, is connected to the resistance by some means (such as via a chain, cable or belt). If the pad is no longer in contact with the lower legs, there is no load on the muscles. If there is no load on the muscles, there is no stimulus - or reason - for them to adapt. Sure, the lifter will obtain some benefit when the muscles were loaded during the first part of the repetition (when the pad was in contact with the shins). However, the lifter will not obtain any benefit when the muscles were unloaded during the last part of the repetition (when the pad was not in contact with the shins). There is no question that the more momentum is used to raise the weight, the less productive will be the repetitions.

Another way to see how speed impacts the efficiency of the repetition is to examine the relationship between force and velocity. Plotting those two variables on a graph - creating the so-called "force-velocity curve" - clearly shows that as the speed of muscular contraction increases, the force that a muscle can produce decreases.

Safety

More importantly, high-speed repetitions also carry a greater risk of injury than low-speed repetitions. Using an excessive amount of momentum to raise a weight increases the shearing forces encountered by a given joint; the faster a weight is raised, the higher these forces are amplified - especially at the point of explosion. In one study, a subject who squatted with 80% of his four-repetition maximum incurred a 225-pound peak shearing force during a repetition that took 4.5 seconds to complete and a 270-pound peak shearing force during a repetition that took 2.1 seconds to complete. This is clear evidence that a slower speed of movement reduces the shearing forces on joints. If the forces exceed the structural limits of a joint, an injury occurs to a muscle, bone and/or connective tissues.

Also consider this statement made by Dr. Fred Allman, a past president of the American College of Sports Medicine: "It is even possible that many injuries . . . may be the result of weakened connective tissue caused by explosive training in the weight room." In other words, explosive lifting that is done inside the weight room can predispose you to a future injury outside the weight room.

Occasionally, an attempt is made to counter these facts with this reasoning or something similar: "So what? Wrestling is dangerous. Does this mean that an athlete should not participate in wrestling?" Arguments like this miss the point entirely.

Nick Richardson (Pesotum, IL) decisioned Phillip Raynes (Virginia), 7-4 at the NHSCA National Open Wrestling Championships, June 27, 2004. Photo by Bob Case.

It is true that wrestling is inherently dangerous. For any athlete, in fact, injuries are an unforeseen, inevitable and unfortunate fact of life. But because wrestling is a dangerous sport, is it justifiable to perform dangerous activities in training? To paraphrase Ken Mannie, the Strength Coach at Michigan State, "Using potentially dangerous techniques in the weight room to prepare for potentially dangerous sports is like banging your head against the wall to prepare for a concussion."

SUGGESTED SPEED

So, how fast is too fast? Well, absolutely no one knows exactly how fast it should take to perform repetitions . . . nor is it likely that anyone will ever know. But one thing is certain: It is more efficient and much safer to perform repetitions with a controlled speed of movement. Regardless of whether you are using machines or barbells, the weight should be raised without any jerking or explosive movements and then lowered under control. Raising the weight in at least 1 - 2 seconds and lowering it in at least 3 - 4 seconds will ensure that the speed of movement is not ballistic in nature and that momentum does not play a significant role in the efficiency or safety of the exercise.

How effective is that speed of movement? A 16-week study demonstrated a 50% increase in upper-body strength and a 33% increase in lower-body strength in a group that performed each repetition by raising the weight in two seconds and lowering it in four seconds. Using the same six-second guideline for raising and lowering the weight, two different eight-week studies reported average increases in muscular strength of 55% in 17 subjects and 58.2% in 31 subjects.

THE LAST REP

When wrestlers are described as being "explosive" on the mat, essentially what is being said is that they perform, move and/or react quickly and forcefully. This is primarily due to the fact that the movement patterns for their skills are so firmly ingrained in their "motor memory" that there is little or no wasted effort. In other words, it is because the wrestlers are highly efficient at performing their skills - not because they did high-speed repetitions in the weight room.

Finally, understand that lifting weights at rapid speeds of movement is only a demonstration of power - not an adaptation. There is simply no scientific evidence to support the notion that explosive repetitions in the weight room will lead or contribute to explosive performances on the wrestling mat.

So when it comes to the speed at which repetitions should be done, follow this advice: Not so fast!

Editor Note: Matt Brzycki has authored, co-authored or edited 11 books on strength and fitness including Wrestling Strength: The Competitive Edge, Wrestling Strength: Prepare to Win and Wrestling Strength: Dare to Excel. The three wrestling books are available at all major bookstores or through Cardinal Publishers Group (800-296-0481).