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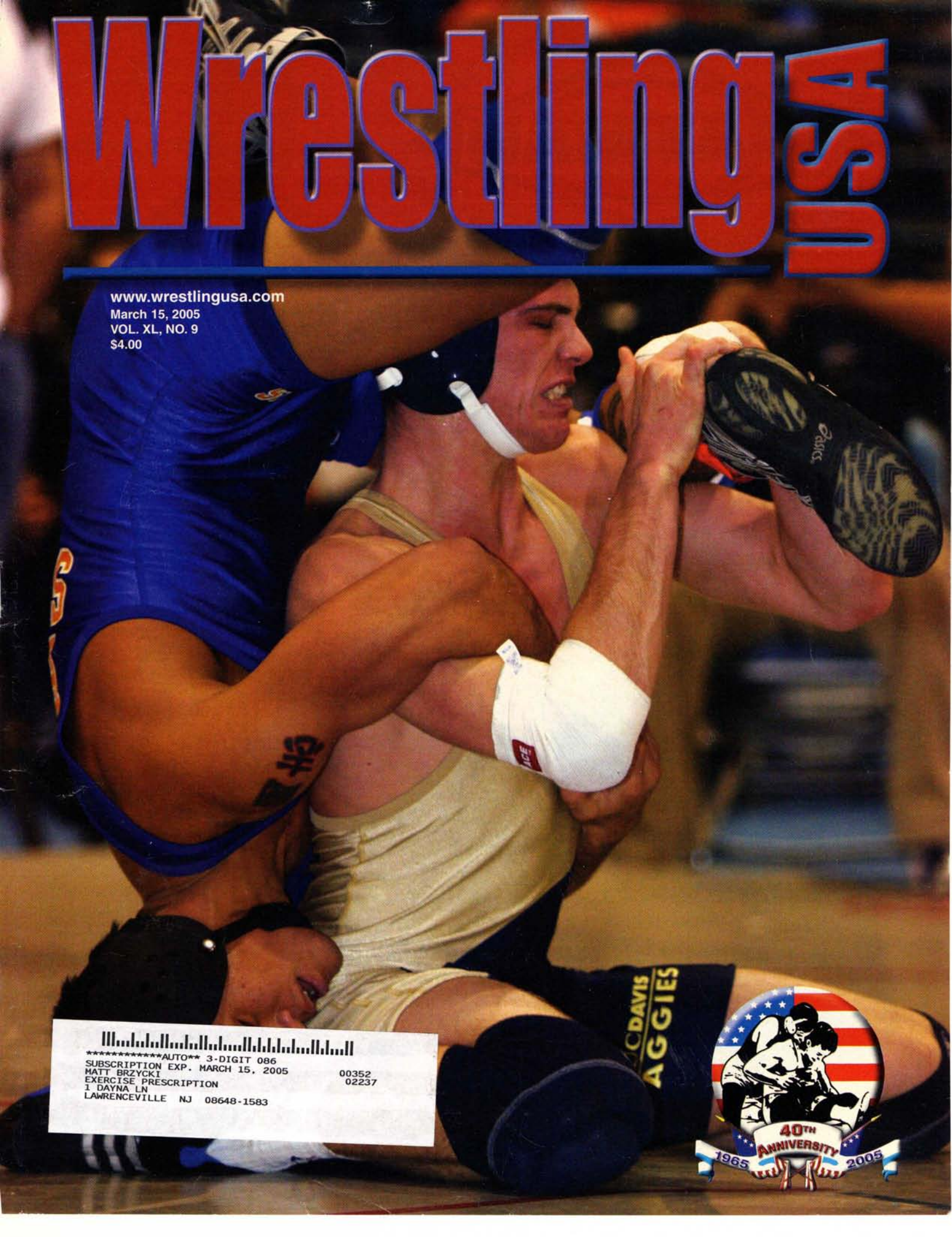
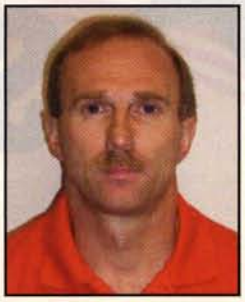


Estimating Maximal Strength



By Matt Brzycki

Over the years, two basic types of strength tests have evolved: static and dynamic. Static (or isometric) tests are those in which a force is exerted against a resistance that is fixed and does not move; dynamic (or isotonic) tests are those in which a force is exerted against a resistance that results in movement.

Strength testing has gradually become more sophisticated. Nowadays, the tests can be done in a formal, scientific setting – such as a laboratory or sports medical facility – using a variety of equipment ranging from relatively simple dynamometers and tensiometers to much more elaborate testing devices. Some equipment can even provide both static and dynamic tests that measure strength at different joint angles over a full range of motion. This information can be used to plot a computerized "strength curve" with an incredible degree of accuracy and repeatability. Unfortunately, such scientific testing – if it is even accessible – can be rather expensive and involve a considerable amount of time. In addition, sophisticated scientific tests are usually not practical for assessing a large number of athletes.

Fortunately, there is a more convenient way of assessing muscular strength without the inherent drawbacks of high-tech scientific testing. Since these assessments are performed outside of a formal, scientific setting, they are referred to as "field tests." These tests represent simple, convenient and easy-to-administer methods of measurement that require a minimum amount of time, cost and equipment. For these reasons, many coaches rely on various field tests to assess muscular strength.

The most popular (and traditional) way to assess muscular strength has been to determine how much weight an athlete can lift for one repetition. (The most weight that can be lifted for one repetition is referred to as a "one-repetition maximum" or "1-RM"; the most weight that can be lifted for 10 repetitions is referred to as a "10-repetition maximum" or "10-RM.") Such tests are usually performed using three or four exercises that are representative of the major muscle groups. For example, a bench press or an incline press is typically used to assess the strength of the chest, shoulders and triceps while a squat or a leg press is often used to measure the strength of the hips and legs.

The 1-RM is also used as a measuring stick in strength programs that are based upon periodized or pre-planned workouts. In this type of program, athletes are asked periodically to "max out" to obtain a 1-RM and then incorporate various percentages of it during different phases or "cycles" of training. Here is a simple example: In the first three weeks of each cycle, athletes might do 2 - 3 sets of 8 - 10 repetitions in each exercise with 50 - 70% of their 1-RMs; in the fourth and fifth weeks of each cycle, they might do 3 - 4 sets of 6 repetitions in each exercise with 70 - 85% of their 1-RMs; and in the sixth and seventh weeks of each cycle, they might do 3 - 5 sets of 1 - 4 repetitions in each exercise with 85 - 95% of their 1-RMs.

CONCERNS

There are a number of concerns with the traditional way of testing for a 1-RM. One is that performing a 1-RM is a highly specialized skill that requires proper warm-up, instruction, supervision and practice. Wrestlers could use this time better by practicing and perfecting specific skills that they would use on the mat. In addition, traditional 1-RM testing can be time-consuming due to the number of warm-up sets that are required to prepare for the maximal attempt. These problems are magnified when evaluating a large group of athletes. Again, this valuable time could be invested better by engaging in sport-specific activities.

But the main concern with traditional 1-

RM testing is an increased risk of musculoskeletal injury. Attempting a 1-RM can place an inordinate and unreasonable amount of stress on the muscles, bones and connective tissues. An injury occurs when this stress exceeds the structural integrity of those components. The concern for safety is even greater when testing younger adolescents who are at a higher risk for incurring musculoskeletal injuries. Needless to say, any injury that occurs from attempting a 1-RM in the weight room is simply inexcusable.

So, using the 1-RM – either as a testing method or a training protocol – is inefficient and unsafe. Clearly, then, coaches who choose to test the muscular strength of their wrestlers must identify a means of doing so that is efficient and safe as well as inexpensive, practical and reasonably accurate.

STRENGTH AND ENDURANCE

At this point, it is necessary to distinguish between two terms: strength and anaerobic endurance. For the purposes of this discussion, strength can be defined as "the ability to exert force." Furthermore, maximal strength is the ability to exert force during a single muscular contraction with a maximal load. In contrast, anaerobic endurance is the ability to exert force during successive muscular contractions with a sub-maximal load. (It is important that anaerobic endurance is not confused with cardiovascular endurance. Anaerobic endurance is a short-term, high-intensity muscular effort – less than about two minutes; cardiovascular endurance involves muscular effort for a much longer duration.)

Maximal strength and anaerobic endurance are highly related. There is a direct correlation between the maximal number of repetitions that can be done (that is, the repetitions to fatigue) and the percentage of maximal weight: As the percentage of maximal weight increases, the number of repetitions decreases in an almost linear fashion (at least up to a certain number of repetitions).

Unless a wrestler has (or had) an injury or other musculoskeletal disorder, the relationship between maximal strength and anaerobic endurance remains relatively constant. Therefore, regardless of whether maximal strength increases or decreases, athletes should always be able to perform the same number of repetitions with a given percentage of their 1-RMs. If maximal strength increases, then anaerobic endurance increases. So if the 1-RM improves by 20%, for example, then the 10-RM should also improve by 20%. And if anaerobic endurance increases, then maximal strength increases. So if the 10-RM improves by 20%, then the 1-RM should also improve by 20%. (There is one caveat, though: The actual improvement in a 1-RM may be less if an athlete has not practiced the requisite skill in performing a 1-RM.)

IMPLICATIONS FOR TESTING

Since there is a direct relationship between anaerobic endurance and maximal strength, you can determine anaerobic endurance by measuring maximal strength. You can also determine maximal strength by measuring anaerobic endurance.

A test of anaerobic endurance is not a direct measure of maximal strength. However, a test of anaerobic endurance is much safer than a test of maximal strength because it involves a sub-maximal load. But how can you assess anaerobic endurance and relate this information to maximal strength?

PREDICTION EQUATIONS

Over the years, a number of prediction equations have been developed and used to estimate a 1-RM based upon the relationship between maximal strength and anaerobic endurance. The following equation can be used to predict a 1-RM based upon repetitions to fatigue (where "X" equals the number of repetitions performed):

weight lifted ÷ (1.0278 - 0.0278X)

To illustrate the equation, suppose that a male wrestler reached muscular fatigue after 10 repetitions with 150 pounds. Inserting these values into the equation yields a predicted 1-RM of about 200 pounds [0.0278 x 10 = 0.278; 1.0278 – 0.278 = 0.7498; 150 ÷ 0.7498 = 200.05].

In a study that involved 48 subjects, researchers found that this equation had a high correlation for predicting a 1-RM in the bench press and squat; in a study that involved 67 subjects, researchers showed that this equation had a high correlation for predicting a 1-RM in all three of the competitive powerlifts: the bench press, squat and deadlift.

It appears as if the relationship between maximal strength and anaerobic endurance becomes less linear beyond about 10 repetitions. Therefore, this equation is most accurate for predicting a 1-RM when the number of repetitions to fatigue is 10 or less. In a study that involved 220 subjects,

researchers compared six different equations and found that the aforementioned equation was the only one of the six in which the predicted bench press did not differ significantly from the actual bench press when 10 or fewer repetitions were completed. It should also be noted that if the repetitions exceed about 10, then the test becomes less accurate for evaluating anaerobic endurance as well as for estimating a 1-RM.

GENETIC INFLUENCES

Each individual inherits a different potential for increasing various physical attributes such as muscular size, muscular strength, cardiovascular endurance and anaerobic endurance. Indeed, a wrestler's physical profile is largely determined by several genetic (or inherited) characteristics including predominant muscle-fiber type, muscle-to-tendon ratio, limb length and neurological ability. So if predicting a 1-RM from a test of anaerobic endurance is to be more precise, then individual differences – that is, genetic influences – should be considered. However, the equation that has been mentioned previously will still be fairly accurate for predicting a 1-RM for most wrestlers.

PERSPECTIVES ON TESTING

Attempting a 1-RM is not really necessary to monitor the progress of an athlete. If wrestlers are recording their workout data – and they should – a coach can simply check the athletes' workout cards to evaluate their levels of strength.

Unless you happen to be a competitive weightlifter, there is no need for you to "max out" to determine how much weight you can lift for one repetition. Even the National Football League – an organization whose athletes must possess an extraordinary degree of muscular strength – has gotten away from using the 1-RM to test college players at their annual combines. (All players – except for quarterbacks and wide receivers – perform repetitions to fatigue with 225 pounds.) And even if you are a competitive weightlifter, you do not have to perform low-repetition sets until you get close to a contest.

The purpose of strength testing – and strength training – should not be to compare the strength of one wrestler to another. It is unfair to make comparisons between wrestlers because each athlete has a different genetic potential for achieving muscular strength. Testing and training are much more meaningful and fair when a wrestler's performance is compared to his/her previous performance – not the performance of others. Lastly, strength testing should not be used as a barometer for predicting athletic performance: Simply because one wrestler can lift more weight than another wrestler does not mean that he or she is a better athlete. Remember, the winner of a wrestling match has never been decided by a bench-press contest.

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).