

The Science of Reps: The Strength Training Contributions of Dr. Richard A. Berger

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One set of ten or ten sets of one? Five sets of four or four sets of five? One hundred percent of 1RM or ninety percent? Or fifty percent? Dynamic or isometric? Slow or fast? Free weights or machines? One day per week or five times per day? Before practice or after practice? Out of season only or out of season and in season, too? Full moon or quarter? Boxers or briefs? These and related questions have been asked for as long as we have had written records, and they will no doubt persist as long as there are human beings to debate them. Training theories are a bit like certain body parts—everybody seems to have one. Some theories are preposterous, of course, some are commercially driven, and some are accepted simply—and simplistically—because the person recommending them is: 1) heavily muscled, 2) a good athlete, or 3) speaking with an Eastern European accent.

What we need in order to find our way through this briar-patch of conflicting information is research—fact-based, carefully designed research. Even though resistance training is hardly new (We have evidence from as far back as forty-five hundred years ago of men lifting heavy objects over their heads), systematic research into how best to train to build strength and athletic power only began within the last fifty years.¹ One of the first men to apply modern testing procedures and statistical analysis to some of the above questions was Richard A. Berger, now Professor Emeritus at Temple University. Beginning in the late 1950s Berger turned his agile mind to several of these questions, but he is remembered most for his probing analysis of the effect of varying sets, loads, and repetitions on the development of strength.

Berger grew up in Chicago, and as a boy he loved sports, particularly football. He played throughout

high school and started at running back. Following high school Berger served a hitch in the Marines, and then returned home where he got together with John Hagen, a high school pal who had just finished his own tour of Marine Corps duty. Both young men had done a lot of exercise during their time in uniform, of course, but only Hagen had been introduced to something revolutionary—weight training. Hagen, in turn, made a revolutionary of Berger. Together, they built a place to train on the Hagen family farm, in an abandoned 6'6" x 6'6" chicken coop just barely large enough to accommodate their six-foot exercise bar. The coop was unheated, and that winter the two young men began every session dressed in many layers of clothing. "We took off more and more clothes as the training progressed and we gradually got warmer," Berger recalled with a laugh. "We trained hard, too—five days a week—because we were getting ready to try to make the Michigan State football team. We trained for about a year, and we actually over-trained because we just didn't know what we were doing."²

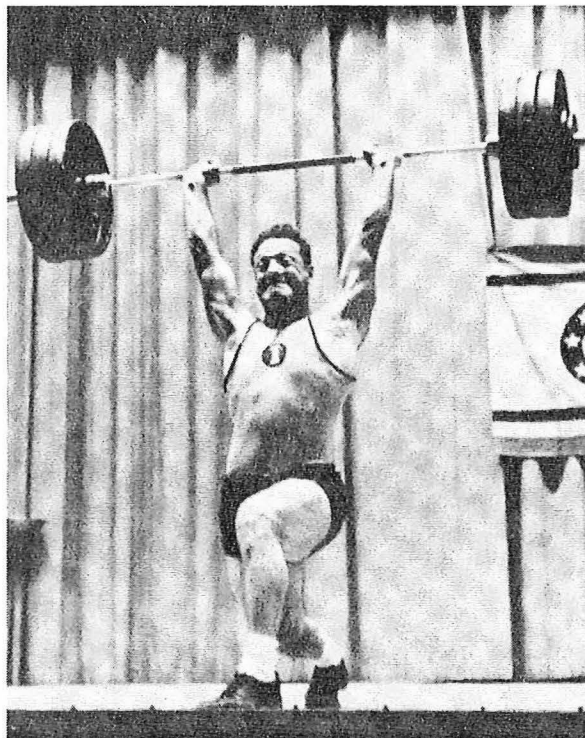
Over-trained or not, once at Michigan State, Berger made the team and, as he had done in high school, played as a running back. He continued to lift on his own in the off-season during his playing days at Michigan State, and even a bit during the season itself. He had to do it on the sly, however, in much the same way most other weight-trained athletes did back in the day when the myth of musclebinding held sway throughout the land.³ In fact, he recounted an incident in which Biggie Munn, the legendary Michigan State coach, having heard that Berger was seen lifting weights, told him, "Berger, I don't want to hear about you doing any of that lifting. It's bad for you. I want you to get a summer job doing heavy construction work. That's what you need, not those weights."⁴

In any event, Berger left the team after two years as he had gotten married; he was working full-time, too. But he stayed in school and took a BA in Social Work in 1951. He remained at Michigan State through his Mas-

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ter's degree, awarded in 1956, but he switched to the department of Physical Education. During most of those years he worked forty hours a week on a night shift job and also had a graduate assistantship in his department. Even with his job, his academic work, his assistantship, and a growing family that eventually totaled eight children, Berger somehow managed to get to the gym fairly regularly and lift weights. By that time he had been introduced to the strength sport that helped to shape his life—competitive weightlifting. As he said, "Olympic weightlifting added greatly to my interest in strength research."⁵

When asked who might have influenced him as a researcher in this "new" field, Berger hesitated, then said that several of his professors at Michigan State and at the University of Illinois, where in 1960 he took his Ph.D., had influenced him through their work ethic, knowledge, and professional dedication. "They didn't share my enthusiasm for research into progressive resistance, however," he added. Then, almost as an afterthought, he said, "you know, the man who had by far the biggest influence on me in the field of strength research wasn't an academic. That person was Bob Hoffman, who owned the York Barbell Company, published *Strength & Health* magazine, and sponsored the York Barbell Club, the top weightlifting team in the U.S. I read every article Bob wrote in *S&H*, because he usually wrote either about competitive lifting or about how weight training would make you better at your chosen sport—my two main interests. Bob wasn't a scientist, but he had a remarkable memory and knew thousands of anecdotes about athletes who lifted weights, and I was a great admirer of his. There weren't many academics working in my field of study, and so I think I appreciated Bob even more,



Professor Richard Berger came to the field of exercise physiology after having learned by personal experience during the 1950s and 1960s that progressive resistance exercise, done correctly, would increase a person's power and athletic ability. Berger came by these insights in the weight room and on the platform as an elite weightlifter, and this knowledge inspired him to focus on strength-related research.

although with his non-stop talking and with those lifting medals all over his coat he was quite a character. I'd lifted weights myself to improve athletically, so I knew that what he was saying was correct, but it was always a big help to get new ammunition every month from his articles or from listening to him tell his stories at the lifting meets."⁶

By the time Berger was well into his doctoral work at the University of Illinois, he was a nationally ranked weightlifter, and he continued this pursuit after he graduated, did some post-doctoral work there, and took an Assistant Professorship at Texas Technological Institute in Lubbock, Texas, in 1962. At 5'8" and weighing in the 175 to 185 pound range, Berger's best lifts in competition were 300 pounds in the press, 275 pounds in the snatch, and 360 pounds in the clean and jerk. In

practice, he managed a 375-pound clean and jerk and a 325-pound press off the rack. In the late 1950s and early 1960s, Berger was often a competitor in the National Weightlifting Championships. He tied for third place on two occasions in the 181-pound class to such elite lifters as Tommy Kono, nine-time world champion and Louis Riecke, one of the last American lifters to hold a world record in the sport.⁷ Riecke, in fact, is connected to Berger in another way, as the Louisiana lifter was one of the first U.S. athletes to use anabolic steroids to enhance his performance. Under the tutelage of Dr. John Ziegler, Riecke began doing isometric contraction and taking methandrostenedione (Dianabol) in 1960 and made astonishing progress in the following months.⁸ Competitive by nature, Berger was curious about this new wonder drug and hungry for the gains it promised. Thus it was that after much deliberation, he began taking Dianabol. But he only took it for a week. He says now that the more he thought about it the more it bothered him to be taking

it, and so he just stopped. "I'm glad I stopped, because I don't think I took enough to have hurt myself like some have done. I did seem to get a boost from it, but from what I've read I imagine the gains may've come from a placebo effect since all the guys in the gym had made such big gains by using it. I guess I'd have to say that those kinds of drugs didn't fit my views as a Christian. I just know that I felt a lot better about myself once I stopped."⁹

As a sport scientist, Berger understood that such things as anabolic steroids could confound the results of a training study, and so he was pleased to have gathered his data prior to the steroid era for the research that made him famous. The research was done at the University of Illinois and was the basis for his dissertation, "The Effect of Varied Weight Training Programs on Strength and Endurance." The research that fed the dissertation was important for several reasons. By the 1950s, it was of course common knowledge that the lifting of heavy weights would increase muscle strength, especially if the training loads were increased as strength increased. Prior to Berger's study, however, which hit the professional big-time in 1962 via an article in the *Research Quarterly* entitled "Effect of Varied Weight Training Programs on Strength," research designs did not clearly identify the independent contribution of sets or repetitions to increases in strength.¹⁰ In contrast, Berger's study systematically varied the sets and repetitions in order to determine their effect, if any, on strength increases. What is more, previous studies failed to include statistical designs appropriate for the examination of the independent effects of sets and repetitions, as well as their interacting effects. Berger applied a factorial ANOVA to determine the effects of one, two and three sets, and two, six and ten repetitions (and their interacting effects) on strength increases (N=177).¹¹

The statistical results showed that three sets and six repetitions were closer to the optimum combination than were the other variations studied in the development of strength over a twelve-week period among college males. The lift used was the free weight bench press because it was easy to standardize and simple to learn. The 177 subjects were freshmen and sophomores in nine weight training classes at the University of Illinois. The subjects were divided into nine groups and were designated both by Roman numerals (signifying sets) and Arabic numerals (signifying repetitions), so that the nine groups were: I-2, I-6, I-10, II-2, II-6, II-10, III-2, III-6,

and III-10. Whenever a subject was able to perform one more rep than the number designated for his group, the training load was increased accordingly. Conversely, if a subject could not perform the required number of reps he would be assisted just enough by a spotter so that the appropriate number of reps could be done. Also, as Berger says in the article, "The loads were always intended to elicit maximum effort for a given number of repetitions." The subjects worked up to a 1RM effort once every three weeks.¹²

All nine of the groups made statistically significant gains in the 1RM bench press, and all nine made significant gains in all four testing phases. However, by using analysis of covariance to test for significant interaction between sets and repetitions, Berger was able to demonstrate that the III-6 group, using three sets of six reps, "was more effective in improving strength than any other combination of sets and repetitions per set."¹³ Berger continued to mine this particular field for several more years, and to publish his results in *Research Quarterly*.¹⁴ His efforts increased our understanding of this increasingly important methodology in ways that were, we might be forgiven for saying, statistically significant.

Berger also made important and early contributions to the battle against the myth of the "musclebound lifter." His studies provided insight into the effects of strength training on performance, or showed the importance of strength as a component of physical prowess. In one study, college students in a beginning basketball course resistance-trained the muscles used to extend the arms in shooting baskets. After ten weeks, shooting accuracy at fifteen feet was significantly improved compared to a control group of students.¹⁵ In another study of sixty-six college males, both static and dynamic tests of leg strength were significantly related to leg power with correlation coefficients, respectively, of $R=.61$ and $R=.71$.¹⁶ In yet another study, when forty-nine college males did barbell squats three times weekly for seven weeks, significant improvements occurred in vertical jumping.¹⁷ Other studies by Berger have reported significant relationships between general body strength and the AAHPER youth fitness test, and Barrow's test of motor ability, which contains events such as sprinting, softball throw or medicine ball put, and agility run.¹⁸ The logical implication provided by these studies is that an increase in strength should improve athletic performance.

Berger left Texas Tech in 1968 and assumed

similar duties at Temple University, where he taught for twenty-five years, retiring in 1993. During his teaching career at these two institutions, he was the main advisor for more than a hundred master's theses and doctoral dissertations. When Berger left Lubbock, where he could drive to the university weight room in less than ten minutes, and moved to Philadelphia, where it took him at least forty-five minutes to make the drive, he retired as a competitive weightlifter. This decision was also influenced by his growing responsibilities as a father of eight young, active children. He still trained with weights, lifting three times each week on seven exercises chosen from a group of fifteen that make up his basic program. Number of sets? Three, of course. His reps? Five or, usually, six, and occasionally as many as ten. For many years Dick also played a lot of handball and he won the intramural championship at both Texas Tech and Temple. He also went through a period when he ran ten miles twice per week, but then moved to fast walking in his neighborhood in order to stay fit for hiking trips.¹⁹

All in all, Dick Berger has had an enviable career. President of the Physical Fitness Council of the American Alliance for Health Physical Education and Recreation from 1973 to 1974 and an associate editor of the *Research Quarterly* from 1965 through 1968, he has published more than one hundred articles in strength research and its application to sports training, testing and measurement of physical performance, statistics, physical rehabilitation, personality, and work physiology. He also published three books—*Conditioning for Men* (Allyn & Bacon, 1970), *Applied Exercise Physiology* (Lea & Feibiger, 1982), and *Introduction to Weight Training* (Prentice-Hall, 1984). Berger is one of those lucky men who found a thing he loved to do and then found a way to make a living doing it. He loved strength training and he loved to think about it, and this combination forged his life's work. As he put it, "What I really like is to have the data in front of me and then to analyze them. I get a little high that way—to see what the data tell me. I have in my mind a hypothesis, and the data tell me if my hypothesis is correct, or incorrect, or if it needs to be modified. The answers are all in these numbers. That process has always been fun for me; the fun was part of the job I had."²⁰

NOTES:

Portions of this article appeared previously in the *Journal of Strength and Conditioning Research*, 15, no. 3 (2001): 275–278.

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2. Richard Berger, interview by Jan and Terry Todd, 24 June 2001.
3. Terry Todd, "Al Roy: Myth Breaker," *Iron Game History* 2, no. 1 (January 1992): 12-16; Terry Todd, "Myth of the Musclebound Athlete," *Strength and Conditioning Journal* 7, no. 3 (June 1985): 4-9.
4. Berger interview.
5. Ibid.
6. Ibid.
7. Bob Hoffman, "Best Seniors Ever," *Strength & Health* (18 October 1963): 13-16, 63-64; Bob Hoffman, "1962 Senior National AAU Championship," *Strength & Health* (13 September 1962): 13-16, 56; Peary Rader, "Contest Results," *Iron Man Lifting News* 6, no. 8 (6 April 1960): 22.
8. Jan Todd and Terry Todd, "Significant Events in the History of Drug Testing and the Olympic Movement: 1960-1999," in Wayne Wilson ed., *Doping in Elite Sport: The Politics of Drugs and the Olympic Games* (Champaign: Human Kinetics, 2001), 65-128.
9. Berger interview.
10. Richard A. Berger, "The Effect of Varied Weight Training Programs on Strength and Endurance," (Ph.D. diss., University of Illinois, 1960); and Richard A. Berger, "Effect of Varied Weight Training Programs on Strength," *Research Quarterly* 33, no. 2 (1962): 168-181.
11. Richard Berger, personal communication to Jan and Terry Todd. October 2000.
12. Berger, "Effect of Varied Weight Training," 180.
13. Ibid.
14. Ibid; Richard Berger, "Optimum Repetitions for Developing Strength," *Research Quarterly* 33, no. 3 (1962): 334-338; Richard Berger, "Comparative Effects of Three Weight Training Programs," *Research Quarterly* 34, no. 3 (1963): 396-398; Richard Berger, "Effect of Maximum Loads for each of Ten Repetitions on Strength Improvement," *Research Quarterly* 38, no. 4 (1967): 715-718; Richard Berger, "Comparison Between Resistance Load and Strength Improvement," *Research Quarterly* 33 no. 4 (1962): 637.
15. Richard Berger, "Effects of Strength Improvement on Accuracy in a Gross Motor Task," *American Corrective Therapy*, 27 (March-April 1973): 57-58.
16. Richard Berger, "Relationship of Power to Static and Dynamic Strength," *Research Quarterly*, 37 no.1 (1966): 9-13 .
17. Richard Berger, "Effects of Dynamic and Static Training on vertical jumping ability," *Research Quarterly* 34 no. 4 (1963): 419-425.
18. Richard Berger, "Comparison between the Strength Index Test and the Predicted Dynamic Strength Test in predicting Motor Performance," *Research Quarterly* 38 no. 3 (1967): 507-509.
19. Berger Interview.
20. Ibid.