Journal of Strength and Conditioning Research, 1995, 9(1), 37-42

Precompetition Training Sessions Enhance Competitive Performance of High Anxiety Junior Weightlifters

Andrew C. Fry[1], Michael H. Stone[2], John T. Thrush [3], and Steven J. Fleck[4]

[1]*Dept. of Human Movement Sciences & Education, University of Memphis, Memphis, Tennessee 38152;* [2]*Dept. of Health, Leisure & Exercise Science, Appalachian State University, Boone, North Carolina 28608;* [3]*U.S. Weightlifting Federation, Northwest Regional Training Center, Sumner, Washington 98390;* [4]*Sports Science & Technology Div., U.S. Olympic Committee, Colorado Springs, CO 80909.*

Reference Data

Fry, A.C., M.H. Stone, J.T. Thrush, and S.J. Fleck. Precompetition training sessions enhance competitive performance of high anxiety junior weightlifters. *J. Strength and Cond. Res. 9(1):37-42. 1995.*

ABSTRACT

The effect of a precompetition training session on competitive performance was studied in 19 male Olympic-style weightlifters (mean age 17.3 yrs). Using a randomly assigned crossover experimental design, all subjects performed a low volume, moderate intensity (85% 1-RM) training session at 10:30 a.m. one test day, or no training at this time on the other test day. A simulated weightlifting contest was performed at 4 p.m. on both test days to determine maximal performance on the snatch and the clean and jerk, as well as maximal vertical jump performance. An abridged profile of mood states (POMS) was administered prior to all lifting sessions. A subgroup of 6 subjects, labeled responders, demonstrated significantly greater lifting and jumping performance on the test day that included the morning training session. The other 13 subjects were labeled nonresponders. No differences were observed between the responders and nonresponders on any other variables except for anxiety levels reported on the POMS, with the responders reporting significantly greater perceptions of anxiety. This suggests that weightlifters who exhibit high levels of perceived anxiety may enhance competitive performance by performing a low volume, moderate intensity training session 5 to 6 hrs prior to competition.

Key Words: strength, snatch, clean and jerk, vertical jump, mood states

Introduction

As with all serious athletic competition, optimal performance is a primary goal for the sport of Olympic-style weightlifting. As a result there is considerable interest in any factors that may enhance performance. A preliminary study by Stone et al. has indicated that high power physical performance is augmented following a moderately heavy strength training session (19). Specific to the high power sport of weightlifting, Volkov et al. (22) have reported similar responses after various weightlifting training sessions. At this time, however, no previous investigation has directly examined competitive weightlifting performance following a moderately heavy weightlifting training session.

It is most likely that competitive weightlifting performance is dependent not only on physiological variables but on psychological characteristics as well. This has been demonstrated for high power track and field athletes, with performance being related to both physiological and psychological factors (20). This psychological (i.e., state-anxiety) influence on competitive performance has also been demonstrated for weightlifters (11) and power lifters (5). Thus it appears that successful performance is not only dependent on proper physiological conditioning but also on appropriate management of athlete anxiety levels (7). It has been suggested that performance of gross motor tasks, such as high strength activities, may require greater arousal than tasks requiring finer motor control and technique mastery (15). In this manner, optimal weightlifting performance, which requires maximal power output as well as fine motor control, is dependent in part on the psychological status of the athlete.

Therefore, the purpose of the present investigation was to determine the effects of a moderately heavy morning weightlifting training session on competitive performance (i.e., 1-RM snatch, 1-RM clean and jerk) and maximal vertical jump efforts. In addition, the effect of psychological status on these same physical performances was investigated.

Methods

Nineteen male participants at a 1-week junior-age-group U.S. national weightlifting camp served as subjects for this investigation (mean age 17.3 ± 1.9 yrs, height 170.9 ± 6.8 cm, body weight 72.8 ± 14.1 kg). All subjects placed

1 to 3 in drug tested U.S. Weightlifting Federation national championships according to their age group and weight class, and were subsequently selected to participate in this training camp. Six of the subjects had previously represented the U.S. in international age-group competition. None had ever tested positive for drug use. Prior to the study, each subject and a parent/guardian signed an informed consent document approved by the Sport Science and Medical Committee of the U.S. Weightlifting Federation.

Body density was anthropometrically estimated via the Jackson and Pollock equation (9) while body composition was calculated via the Siri equation (17). One repetition maximum (RM) values for the two competitive lifts (i.e., snatch, clean and jerk) were determined from their best previous competitive performances; 1-RM back squat values were determined from recent training sessions.

The subjects were randomly divided into two groups: A (n = 9) and B (n = 10). On Test Day 1 of the study, each subject in Group A performed a moderately heavy training session at 10:30 a.m. which included clean pulls and snatch pulls at 85% of 1-RM for the clean and snatch lifts. Group B did not train at this time, which is typical for weightlifters on actual competition days. At 4 p.m. both groups took part in a simulated weightlifting contest. After an appropriate controlled warm-up, the subjects executed three official attempted lifts for both the snatch and the clean and jerk, consistent with official competition protocol. Successful execution of each attempted lift was verified by one or more members of the coaching staff using competition criteria stipulated by the U.S. Weightlifting Federation (21).

Coaches verifying the lifts had not been present during the morning sessions and therefore were blinded as to which group each subject was in. Maximal efforts in the snatch lift before and after a 1-week period have previously demonstrated no significant changes among a similar group of subjects (6). Furthermore, 1-RM maximum tests of large muscle group exercises (barbell squats and bench presses) repeated after a 6-hr period also have exhibited no significant changes (16), thus indicating the short-term stability of these strength measures.

Following 2 days of normal training, the same test protocol was repeated on Test Day 2 during normal training. Two training sessions per day consisted of various combinations of snatches, snatch pulls, cleans, clean pulls, jerks, front squats, and back squats at 70 to 95% of 1-RM. This protocol is representative of typical training sessions for weightlifting (1). Using a crossover design, all subjects in Group B performed a moderately heavy training session at 10:30 a.m., which was identical to the morning training session performed 2 days earlier by Group A. Subjects in Group A did not train at this time. Other than the change in training group for the morning session, Test Days 1 and 2 were identical. This crossover design test protocol is illustrated in Figure 1.

Immediately prior to each simulated contest on Test Days 1 and 2, all subjects were tested for maximal vertical jump performance as a measure of power capacity. A two-footed takeoff with no approach steps was used and employed a Vertec vertical jump tester (Sport Imports, Columbus, OH) and previously described procedures (10). In addition, questionnaires were administered prior to each training session and simulated contest, including an abridged form of the profile of mood states (POMS) (3) and a training questionnaire.

Based on physical performances on Test Days 1 and 2, two subgroups of subjects were identified. Those who improved in vertical jump performance, in the snatch, and in clean and jerk lifts on the test day that including a morning training session were classified as responders (n = 6). Two subjects from Group A and 4 from Group B constituted the responders group. All subjects who did not improve in all three measures were classified as nonresponders (n = 13). Statistical comparisons were made between the responder and nonresponder groups. Independent t tests were used

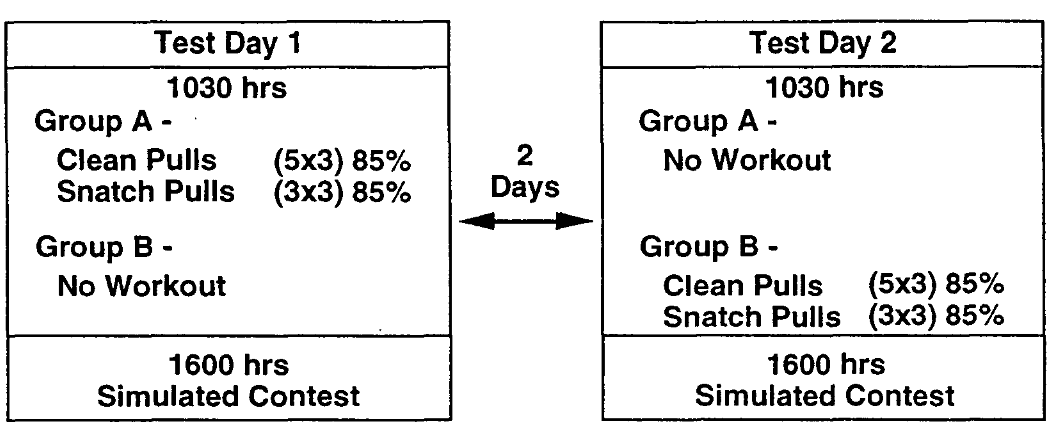

Figure 1. Crossover design experimental protocol for Groups A and B.

to compare descriptive characteristics. Two-way repeated measures analyses of variance (group × time) were used to analyze jumping and lifting performances. Multivariate analyses of variance were used to analyze two clusters of data consisting of POMS or questionnaire responses (2). A significant Wilks' lambda was followed by two-way repeated measures analyses of variance. All results are reported as means ± *SD*. Significance throughout the investigation was $p < 0.05$.

Results

Physical characteristics and competitive performances for the responders and nonresponders are listed in Table 1. No significant differences between the groups or from Test Day 1 to Test Day 2 were observed for any of these variables. The improved performances demonstrated by the responders were significantly greater on the test day that included a morning training session (see Figures 2, 3, and 4). These improvements included the following mean absolute increases: vertical jump = 3.0 cm, snatch = 5.8 kg, and clean and jerk = 6.2 kg.

Results of the questionnaires completed before the simulated weightlifting contests identified only one significant difference between responders and nonresponders. Greater levels of anxiety on the abridged POMS were indicated at all times for the responders, with similar patterns for both test days. No differences were observed between responders and nonresponders for the training questionnaire. Tables 2 and 3 list the responses to these questionnaires.

Table 1
Descriptive Characteristics of the Responder (n = 6) and Nonresponder (n = 13) Groups

Variable	Responders *M*	Responders *SD*	Nonresponders *M*	Nonresponders *SD*
Age (yrs)	16.5	2.0	17.6	1.8
Body weight (kg)	74.1	20.6	72.2	10.9
Height (cm)	170.3	5.4	171.2	7.6
Body density (g·mL^{-1})	1.079	0.006	1.078	0.009
Relative fat (%)	8.9	2.4	9.2	4.0
Fat weight (kg)	7.0	3.9	6.9	3.7
Fat free mass (kg)	67.1	16.8	65.3	8.4
Years trained	3.2	2.5	3.9	2.2
Competitive 1-RM snatch (kg)	98.8	22.3	96.9	15.5
Competitive 1-RM clean & jerk (kg)	123.8	27.5	123.7	18.2
Best competitive total (kg) (snatch + clean & jerk)	221.7	50.3	218.3	33.4
1-RM back squat (kg)	153.8	31.8	168.3	27.0

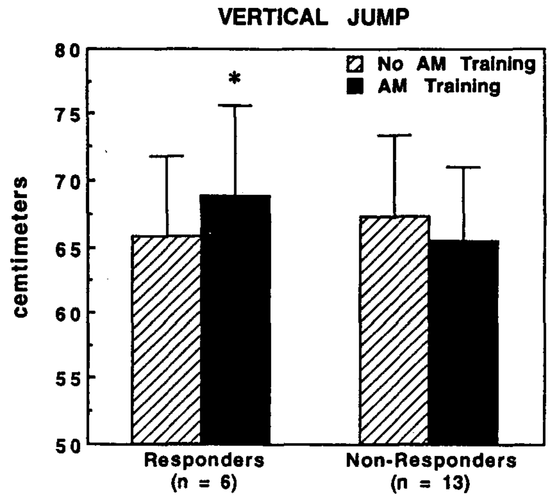

Figure 2. Vertical jump performances (mean ± *SD*) of responder and nonresponder groups for both training conditions (a.m. training or no a.m. training). *Different from no a.m. training, $p < 0.05$.

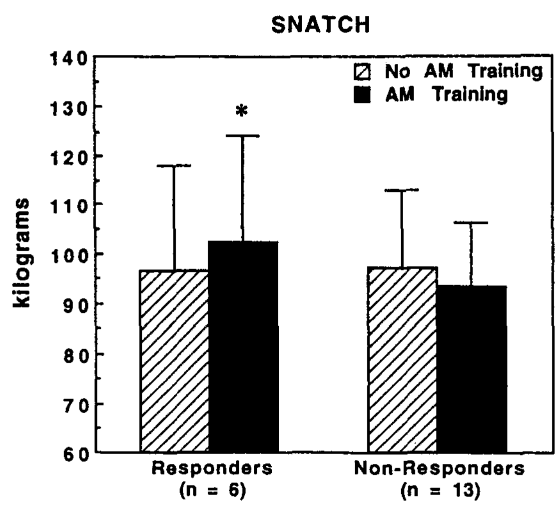

Figure 3. Snatch lift performances (mean ± *SD*) of responder and nonresponder groups for both training conditions (a.m. training or no a.m. training). *Different from no a.m. training, $p < 0.05$.

Discussion

Results of the present investigation suggest that weightlifters with high anxiety profiles experience improved 1-RM weightlifting performance, as well as vertical jump performance, when a morning training session precedes afternoon competition. However, this pattern was not evident for those subjects with lower levels of anxiety. Although it is likely that some physiological mechanism also contributed to the enhanced performance of the responders (20), the lack of improved performance for the nonresponders suggests that the adaptation does not occur in all individuals. It should be noted that the physical and performance characteristics of the responders and nonresponders

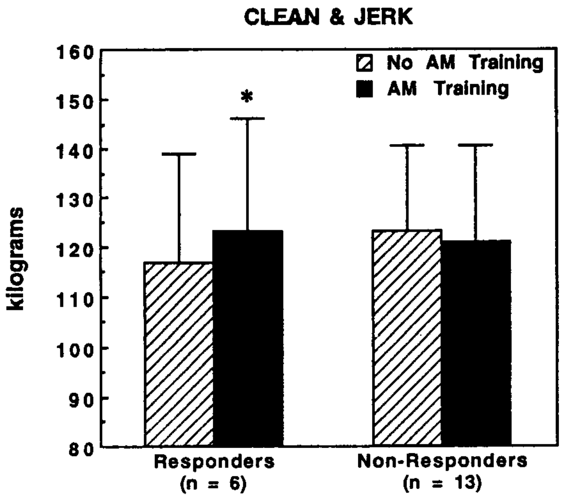

Figure 4. Clean and jerk lift performances (mean ± *SD*) of responder and nonresponder groups for both training conditions (a.m. training or no a.m. training). *Different from no a.m. training, $p < 0.05$.

Table 2
Responses of Responder (n = 6) and Nonresponder (n = 13) Groups to Abridged POMS Questionnaire

Question	No a.m. training *M*	No a.m. training *SD*	a.m. training *M*	a.m. training *SD*
How anxious did you feel?				
Responders	2.67	0.80*	3.17	0.98*
Nonresponders	1.85	1.07	1.69	1.11
How sad or depressed did you feel?				
Responders	0.50	0.55	0.17	0.41
Nonresponders	0.39	0.65	0.23	0.44
How confused did you feel?				
Responders	0.17	0.41	0.33	0.52
Nonresponders	0.31	0.63	0.23	0.44
How angry did you feel?				
Responders	0.17	0.41	0.50	0.84
Nonresponders	0.31	0.63	0.23	0.44
How energetic did you feel?				
Responders	2.67	0.82	2.50	0.84
Nonresponders	2.31	0.75	2.00	0.91
How fatigued did you feel?				
Responders	1.00	0.89	1.50	1.38
Nonresponders	1.15	1.14	0.85	0.80

Note. Results of questionnaire administered prior to simulated weightlifting contests. 0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, 4 = extremely.
*Different from nonresponders, $p < 0.05$.

were similar, as were years of training experience (see Table 1). In addition, assignment to training group did not influence competitive performance, since 2 responders were from Group A and 4 were from Group B.

Table 3
Responses of Responder (n = 6) and Nonresponder (n = 13) Groups to a Training Questionnaire

Question	No a.m. training *M*	No a.m. training *SD*	a.m. training *M*	a.m. training *SD*
Are you looking forward to this workout?				
Responders	3.00	0.63	3.50	0.84
Nonresponders	2.92	1.04	3.00	0.91
Do you feel strong?				
Responders	2.83	0.41	3.00	0.89
Nonresponders	2.23	1.09	2.31	0.75
Do you feel recovered from your last workout?				
Responders	3.17	1.17	2.50	1.23
Nonresponders	3.15	0.99	2.77	1.17
Are your leg muscles sore?				
Responders	0.83	1.17	1.17	1.17
Nonresponders	0.62	0.96	0.62	0.87
Do your knees hurt?				
Responders	0.17	0.41	0.50	0.55
Nonresponders	0.39	0.77	0.39	0.77
Is your lower back sore?				
Responders	1.17	1.17	1.50	1.64
Nonresponders	0.62	1.12	1.15	1.41

Note. Results of questionnaire administered prior to simulated weightlifting contests. 0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, 4 = extremely.

Previous studies of strength athletes have suggested that optimal performance is dependent, in part, on elevated arousal levels (11), although excessive anxiety may result in poorer performance (5). The present study suggests that the ability to manage anxiety levels is paramount, especially for athletes with high anxiety levels. Although gross motor tasks such as many weight training movements may benefit from high levels of arousal (15), the high precision of Olympic-style weightlifting technique may require that these anxiety and arousal levels be carefully regulated.

It has been suggested that elevated anxiety may be manifested somatically, thus affecting physical function. Physical exercise has been suggested to help alleviate this somatic type of anxiety (18). A potential physiological basis for this phenomenon has been previously reported. Elevated anxiety levels may be accompanied by increased electromyographic (EMG) activity, thus contributing to unnecessary fatigue (23). This type of fatigue may have occurred for subjects in the responders group when they did not perform a morning training session, although EMG activity was not monitored. It should be noted, however, that the responders' perceptions of anxiety did not change after a morning training session (data not shown), suggesting that the perceived anxiety may be manifested in many ways, not all of them detrimental to competitive weightlifting performance.

Additional neural, hormonal, and thermoregulatory factors may have contributed to the enhanced performance of the responders. Decreased strength and neural activity have been reported following a morning strength training session (8); however, the training protocol was of greater intensity and volume than in the present study. High intensity resistance exercise elicits dramatic acute endocrine responses (12, 13), but these responses return to normal by 6 hrs postexercise (13). Elevated muscle temperatures may influence physical performances, although any positive thermal effect following the morning training session would be unlikely to persist for 5-1/2 hrs (14). Low intensity exercise immediately prior to a test of short-term power has elicited augmented performances 6 min posttest (4), but this effect is also unlikely to be present after the 5-1/2-hr period between training sessions in the present study.

Despite evidence that a vigorous weight training session can enhance speed-strength performance for several hours postexercise (19, 22), this was not evident for all subjects in the present study. It is possible that the volume and intensity (% 1-RM) of the morning training session may not have been great enough to elicit such an improved performance for each individual. It is also possible that the 5-1/2-hr time period between the morning and afternoon lifting sessions may have been too long for beneficial physiological responses to be maintained.

Future study on this topic might manipulate the acute training variables (volume, intensity, etc.) and the timing of the precompetition training session. More in-depth analyses of the psychological profiles are also desirable and will require the use of more sensitive psychological instruments. Finally, the role of various physiological mechanisms, in particular neuromuscular, need to be investigated. Biomechanical analyses could also help determine alterations in this critical aspect of weightlifting performance.

Practical Applications

It appears that Olympic-style weightlifters or other high-power sport athletes who exhibit high levels of perceived anxiety may enhance competitive performance by using a low volume, moderate intensity training session prior to competition. Such individuals might be identified through evaluation with appropriate psychological assessments. It is also possible that through empirical observation, coaches may be able to identify athletes who demonstrate high precompetition anxiety levels. Although not part of the formal research protocol for the present investigation, 4 of the 6 members of the responders group were correctly identified by a coach who was familiar with all subjects but unfamiliar with the responder/nonresponder classification grouping. Further in-depth study would shed light on the role of anxiety management for these high-power athletes.

References

1. Baker, G., H. Newton, B. Klemens, and B. Charniga. *The United States Weightlifting Federation Coaching Manual, Vol. III, Training Program Design.* Colorado Springs: U.S. Weightlifting Federation, 1987.
2. Borg, W.R., and M.D. Gall. *Educational Research.* New York: Longman.
3. Dean, J.E., J.P. Whelan, and A.W. Meyers. An incredibly quick way to assess mood states: The incredibly short POMS [abstract]. Association for the Advancement of Applied Sport Psychology Annual Conference, San Antonio, TX. 1990.
4. Dolan, P., and A.J. Sargeant. Effect of prior exercise on maximal short-term power output of human muscle [abstract]. *J. Physiol.* 343:108P-109P. 1983.
5. Fry, A.C. Heart rates and lifting performance of powerlifters during competition. *Nebraska Journal* 17(1):20-23. 1986.
6. Fry, A.C., W.J. Kraemer, M.H. Stone, B.J. Warren, J.T. Kearney, C.M. Maresh, C.A. Weseman, and S.J. Fleck. Endocrine and performance responses to high volume training and amino acid supplementation in elite junior weightlifters. *Int. J. Sports Nutr.* 3:306-322. 1993.
7. Gill, D.L. *Psychological Dynamics of Sport.* Champaign, IL: Human Kinetics, 1986.
8. Häkkinen, K., A. Pakarinen, M. Alén, and P.V. Komi. Neuromuscular and hormonal responses in elite athletes to two successive strength training sessions in one day. *Eur. J. Appl. Physiol.* 57:133-139. 1988.
9. Jackson, A.S., and M.L. Pollock. Generalized equations for predicting body density of men. *Br. J. Nutr.* 70:497-504. 1979.
10. Kennedy, D. The use of the Vertec to aid in the testing of the vertical jump. *American Fitness* 6(3):34. 1986.
11. Kopysov, V.S., and S.I. Lelikov. Success of competitive performance of weightlifters. *Theory Practice Phys. Culture* 7:22-24. 1981.
12. Kraemer, W.J., L. Marchitelli, S.E. Gordon, E.A. Harman, J.E. Dziados, R. Mello, P.N. Frykman, D. McCurry, and S.J. Fleck. Hormonal and growth factor responses to heavy resistance exercise. *J. Appl. Physiol.* 69:1442-1450. 1990.
13. McMillan, J.L., M.H. Stone, J. Sartin, R. Keith, D. Marple, Lt. C. Brown, and R.D. Lewis. 20-hour physiological responses to a single weight-training session. *J. Strength Cond. Res.* 7:9-21. 1993.
14. Nadel, E.R. Heat exchange in hot and cold environments. In: *Endurance in Sport.* R.J. Shephard and P.-O. Åstrand, eds. London: Blackwell Scientific, 1992. pp. 169-178.
15. Oxendine, J.B. Emotional arousal and motor performance. *Quest* 6:23-32. 1970.
16. Sewell, L.P., and J.E. Lander. The effects of rest on maximal efforts in the squat and bench press. *J. Appl. Sport Sci. Res.* 5:96-99. 1991.
17. Siri, W.E. Body composition from fluid spaces and density: Analysis of methods. In: *Techniques for Measuring Body Composition.* J. Brozek and A. Henschel, eds. Washington, DC: National Academy of Science and National Research Council, 1961. pp. 223-244.
18. Sonstroem, R.J. An overview of anxiety in sport. In: *Psychological Foundations of Sport.* J.M. Silva and R.S. Weinberg, eds. Champaign, IL: Human Kinetics, 1984. pp. 104-117.

19. Stone, M.H., B. Warren, J. Potteiger, and B. Bonner. Strength and vertical jump performance following varied recovery periods after high volume squatting [abstract]. North Carolina AAHPERD Conference, Greensboro. 1988.
20. Thomas, T.R., C.J. Zebas, M.S. Bahnke, J. Araujo, and G.L. Ethridge. Physiological and psychological correlates of success in track and field athletes. *Br. J. Sports Med.* 17:102-109. 1983.
21. United States Weightlifting Federation. *Official USWF Rulebook*. Colorado Springs: USWF, 1992.
22. Volkov, V.M., G.E. Milner, and G.V. Nosov. The after effects of training loads. *1975 Soviet Weightlifting Yearbook*. pp. 3-5. 1975.
23. Weinberg, R.S. Anxiety and motor behavior: A new direction. In: *Psychology of Motor Behavior and Sport–1976* R.W. Christina and D.M. Landers, eds. Champaign, IL: Human Kinetics, 1977. pp. 132-139.

Acknowledgments

The authors extend their appreciation to Sissel Anderssen and Tracey Palenshus for their valuable help with data analysis and with preparation of the manuscript. Appreciation is also extended to the staff of the Sports Science and Technology Division of the U.S. Olympic Committee for their assistance with data collection, and to the members of the Junior U.S. National Weightlifting Squad who graciously served as subjects.