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Effectiveness of Improving Performance with the Bigger Faster Stronger In-Season Training Program

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EFFECTIVENESS OF IMPROVING PERFORMANCE WITH THE BIGGER FASTER STRONGER IN-SEASON TRAINING PROGRAM

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This study investigated the effectiveness of improving performance of adolescents with the in-season Bigger Faster Stronger (BFS) program. Thirty seven high school athletes were divided into three groups; BFS (n=14), traditional weight training (n=10), and control (n=13). Each participant went through a battery of seven performance pre-tests and post-tests (estimated 10RM incline bench, broad jump, one minute sit-up test, t-test, line drill, 40 yard sprint, 1.5 mile run). Following the pre-testing, the control group continued to participate in their sport. The BFS group participated in the in-season BFS program (30 minute supervised session consisting of a warm up; agility, plyometric, sprints, core lifts; squats, hang cleans, bench presses, deadlifts, and stretches) conducted twice a week. The components of the traditional weight training program performed twice a week included; a cardiovascular warm-up, followed by dynamic stretches and footwork exercises, various resistance training exercises in the weight room using a circuit training system, and a 5 minute cool-down followed by static stretches. After four weeks, the seven performance tests were conducted again for all subjects.

Subjects in the BFS group were unable to improve their performance significantly in most tests (except the one minute sit up for males) in four weeks. The athletes in the study may not have improved in the performance tests for various reasons; possibility of overtraining, fatigue on day of testing, insufficient load, length of program being too short to produce strength gains for large muscle groups, less potential for neurological adaptations, and the validity of the performance tests in assessing BFS improvements. Although slight improvements were found in this study, future investigations should examine continuing the training protocol for an additional period to determine if a longer in-season training program would produce significant performance improvements.

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INTRODUCTION

Resistance training uses various training methods in an attempt to improve muscle strength, muscle power, and/or muscle endurance (8). Resistance training programs, along with the physiological improvements (increase in strength, flexibility, and lean body mass), strengthen bones, assist with weight management, improve mental health, and decrease cardiovascular risks (4, 7, 9). Research has also demonstrated the benefits of resistance training for children and adolescents (3, 8, 12, 29, 41).

Strength training has been proven to be safe and not to negatively impact growth and maturation of youth (10, 16, 23). Studies suggest that training the musculoskeletal system of adolescents may prevent injuries and enhance recovery time from sprains, strains, and fractures (11, 29, 33, 35, 38). Furthermore, regular participation in resistance training programs may also improve performance for these athletes in sport-specific skills (38).

Research has still not confirmed which resistance training program is the most effective for young athletes. Studies have been conducted on plyometric programs (21, 26), heavy resistance training programs (15), concurrent strength and endurance training (22), agility programs (14), and neuromuscular training programs (31). These programs have been effective in their respective areas and all provide unique benefits, however, one is not better than the other. Another strength training program, which utilizes many of the aforementioned training regimens, used across the United States in more than 9,000 high schools, is the Bigger Faster Stronger (BFS) program (37).

The BFS program combines a variety of conditioning techniques (strength, power, speed, agility, and flexibility) into one comprehensive training program to reduce teaching technique time, improve team spirit, and enhance athletic performance (37). The BFS program consists of a readiness program, an in-season program, and an out of season program throughout the entire school year organized into four-week cycles (37). During the off-season, core lifts (squats, bench, power clean, and deadlifts) are performed on specific days with different parameters (sets and reps) assigned each week. Flexibility and agility exercises are executed every day of training, while plyometrics, auxiliary lifts, and sprint work are completed every other day. In-season training consists of performing the core lifts, which include some Olympic lifts, flexibility, agility, plyometrics, and sprint work for two-30 minute sessions a week while participating in regular sport activity.

Despite its popularity, there are no published scientific studies on the BFS program and athletic performance, particularly with adolescent athletes. The purpose of this study was to evaluate the effectiveness of the in-season BFS training program during a four week training period to improve individual performance for adolescent student-athletes.

METHODS

Experimental Approach to the Problem

The study was designed to determine the effectiveness of a four week in-season resistance training program for high school athletes. Three groups, two experimental groups (BFS group and traditional weight training (TWT) group) and a control group were selected for this purpose. Both experimental groups performed resistance training, twice weekly, along with regular sport participation; the control group did not partake in resistance training while participating in their respective sport. All the athletes were tested in upper body muscle strength, lower body muscle power, core muscle endurance, agility, anaerobic endurance, speed, and aerobic endurance before and after the four week training program. Descriptive analysis was used to analyze test data and create physiological-based data.

Subjects

Thirty seven high school athletes (16 girls, 21 boys, age, 15.9 ± 1.0 years; weight, 65.0 ± 12.7 kg; height, 171.6 ± 6.1 cm) from Hopkins High School in Hopkins, Michigan volunteered to participate in this study. These volunteers were healthy athletes who had not participated in the BFS program in the past month. The subjects had all participated in high school athletics since their freshman year and were all currently playing a sport at their high school; five were playing softball, 12 were on the track team, seven were playing soccer, one was playing volleyball, nine were playing baseball, and three were on the cross-country running team. All subjects had their mandatory medical examination completed prior to their involvement with the study. Parents or guardians signed parental consent and the athletes signed informed consent prior to participation in the study. The experimental protocol was approved by the Human Subjects Institutional Review Board. The subjects were divided into three groups; BFS; n=14, TWT; n=10, and control (C); n=13.

Testing Procedure

In order to evaluate the effects of the BFS in-season resistance training program on performance, a testing procedure that included measurements of seven specific motor qualities; upper body muscle strength, lower body muscle power, core muscle endurance, agility, anaerobic endurance, speed, and aerobic endurance was used. The tests applied are used routinely for the assessment of human muscle function and dynamic athletic performance by both researchers and practitioners in various human movement-related areas, particularly in sport (1, 27, 32, 44). The pre tests were conducted once on two separate days in a counterbalanced order. This allowed the athletes to become familiar with the tests. Performance tests were conducted in the week before and the week after the four week training period.

Upper Body Muscle Strength. A 10 repetition maximum load for an incline bench press was used to measure upper body muscle strength. Maximal strength testing is not warranted in a younger, less experienced population (3) and studies by Kravitz et al. (18) and Reynolds et al. (36) demonstrated that estimated one-repetition maximum testing provide acceptable levels of accuracy. Therefore, the maximum load for 10 repetitions of the incline bench was used to estimate one-repetition maximum strength. Before testing, the athlete was instructed on the proper form for the incline bench press exercise and followed standard RM testing procedures (1). The load for the 10 repetitions was recorded and used for analysis.

Lower Body Muscle Power. The broad jump was used to assess horizontal leg power, which has been shown to be reliable and valid (25). The subject stood on two feet, and jumped as far as possible, landing on two feet. The distance (from toes to heel contact) was recorded in centimeters.

Core Muscle Endurance. A one minute sit-up test was used to evaluate core muscle endurance. The subject had their fingers interlocked behind their neck, and their feet secured to the ground. When the time started, the subject raised their upper body until their elbows touched their thighs and lowered until their upper back touched the ground. This was repeated as fast as they could for one minute. The number of repetitions in proper form was counted and used for analysis.

Agility. Agility performance was assessed using a t-test. A t-test is an accepted measure of agility (1). From a center cone, five yards was measured in both directions and cones were placed at these spots. From the center cone, 10 yards was measured perpendicularly from the line of cones already placed and another cone was set down at this spot forming a "t". Time was measured with a manual stopwatch (0.1s).

Anaerobic Endurance. Anaerobic capacity was measured using the line drill as described by Baechle et al. (1). A standard basketball court was used for the test. The subject was instructed to touch the lines with their foot. The subject started at the baseline, sprinted to the foul line and back, sprinted to the center line and back, sprinted to the foul line on the other side and back, and sprinted to the far baseline and back. The subject was given a two minute rest between tests, and performed the line drill four times total. The average of the four trials was used for analysis. Time was measured with a manual stopwatch (0.1s).

Speed. Sprinting performance was assessed using a sprint over a distance of 40 yards. The subject was initially standing and instructed to accelerate as quickly as possible through the 40 yards. The drill was over when the subject crossed the line with their body, 40 yards away. Time was measured with a manual stopwatch (0.1s).

Aerobic Endurance. Aerobic endurance was assessed using a timed 1.5 mile run around an outdoor track. Subjects ran as fast as they could for 1.5 miles. Time was measured with a manual stopwatch (0.1s).

After the pre-tests were conducted, the subjects were ranked by performance in three tests; the 10RM incline bench, the 40 yard sprint, and the 1.5 mile. In order to divide the subjects into similar groups, females and males were ranked separately. The three ranking numbers of each test for each individual were added together, resulting in an overall ranking. The athletes were then assigned into a group, ensuring that all three groups were similar based on performance and gender. The athlete that ranked first overall was placed in the same group as the athlete that had the lowest overall ranking. The second highest ranked athlete was placed with the second lowest ranked athlete and so on to ensure that groups had equal amounts of high and low ranking performances.

Training Procedure

All subjects continued participation in their sport throughout the study. The BFS and the TWT were required to perform a supervised training session twice a week for four weeks. Thus, the program entailed eight training workouts for each subject in both experimental groups. Training sessions in both experimental groups lasted 30 minutes.

The Bigger Faster Stronger in-season program used in this study was obtained from Shepard's Bigger Faster Stronger in-season training program (37). The BFS in-season program consisted of a warm up; agility, plyometric, sprints, core lifts; squats, hang cleans, bench presses, deadlifts, and stretches. The intensity for lifting for the athletes was based on their 10RM incline bench score (which is 75% of their 1RM). Athletes started their first set of each rep with this load, and they increased their load every subsequent set. The load continued to increase from session to session. The BFS in-season training program is outlined in Table 1.

Table 1: Bigger Faster Stronger In-Season Program

Pre-weight room:	Dot drill:	5 directions	6 x
	Plyometrics:	Vertical jumps	10 x (15s rest)
		Long jumps	9 x
		Depth jumps from 20-inch box	5 x
		Depth jumps from 20-inch box with a jump after landing	5 x
		Depth jumps from a 20-inch box with a jump on to another 20-inch box	5 x
		Box jumps on to a 20-inch box	5 x
		Alternate leg bounds	3 x width of basketball court
	Speed:	10-50 yards sprints	10 x (30s rest)
Week 1:	Day 1:	Straight leg deadlift	3 sets x 3 reps
		Towel bench	3 sets x 3 reps
		Box squat	3 sets x 3 reps
	Day 2:	Hang clean	3 sets x 3 reps
		Towel bench	3 sets x 3 reps
		Straight leg deadlift	3 sets x 3 reps
Week 2:	Day 1:	Hang power snatch	2 sets x 5 reps, 1 set x 10 reps
		Incline bench	2 sets x 5 reps, 1 set x 10 reps
		Box squat	2 sets x 5 reps, 1 set x 10 reps
	Day 2:	Straight leg deadlift	2 sets x 5 reps, 1 set x 10 reps
		Towel bench	2 sets x 5 reps, 1 set x 10 reps
		Parallel box squat	2 sets x 5 reps, 1 set x 10 reps

Table 1-Continued

Week 3:	Day 1:	Straight leg deadlift	5 reps-3 reps-1 rep
		Towel bench	5 reps-3 reps-1 rep
		Box squat	5 reps-3 reps-1 rep
	Day 2:	Hang clean	5 reps-3 reps-1 rep
		Towel bench	5 reps-3 reps-1 rep
		Straight leg deadlift	5 reps-3 reps-1 rep
Week 4:	Day 1:	Hang power snatch	4 reps-2 reps-2 reps
		Incline bench	10 reps-8 reps-6 reps
		Box squat	10 reps-8 reps-6 reps
	Day 2:	Straight leg deadlift	4 reps-2 reps-2 reps
		Towel bench	10 reps-8 reps-6 reps
		Parallel box squat	10 reps-8 reps-6 reps
Post-weight room:	Flexibility:	Hamstring stretch	hold for 30 s
		Latissimus stretch	hold for 30 s
		Pectoral stretch	hold for 30 s
		Backleg stretch	hold for 30 s
		Achilles stretch	hold for 30 s
		Quadriceps stretch	hold for 30 s
		Abdominal stretch	hold for 30 s
		Adductor stretch	hold for 30 s
		Gluteus maximus stretch	hold for 30 s
		Groin stretch	hold for 30 s
		Hip flexor stretch	hold for 30 s

The traditional weight training program used was a synthesis of findings derived from Faigenbaum's recommendations for adolescent weight training (8). The components of the traditional weight training program included: a cardiovascular warm-up, followed by dynamic stretches and footwork exercises, various resistance training exercises in the weight room using a circuit training system, and a five minute cool-down followed by static stretches. Any lifts involving extra weight used the same protocol for determining intensity as the BFS program. The intensity for lifting for the athletes was based on their 10RM incline bench score (which is 75% of their 1RM). Athletes started their first set of each rep with this load, and they increased their load every subsequent set. The load continued to increase from session to session. The details of the traditional weight training program used are outlined in Table 2.

Statistical Analysis

Statistical analysis consisted of standard descriptive data (mean ± SD), and percent improvement for all performance tests. A 3 x 2 x 2 (group x test x gender) repeated-measures analysis of variance (ANOVA) was conducted to examine the differences with the dependent variables with Tukey's honest significant difference post hoc tests. The alpha level was set at 0.05 for all analyses. Statistical analysis were computed using Statistical Package for Social Sciences 15.0 (SPSS, Chicago, IL) Software.

Table 2: Traditional Weight Training Program

Pre-weight room:	Warm-up:	Stationary bike	5 min
	Dynamic stretches:	Walking with knees up	3 x width of basketball court
		Walking with swinging leg forward and backwards	3 x width of basketball court
		Walking lunges with arm swings	3 x width of basketball court
		Long stride jogs	3 x width of basketball court
	Footwork:	Stationary fast feet	3 x 30s
		Shuffling left and right	3 x 30s
Weight room:	Week 1:	Ball wall squats	3 x 10
		Bridge (supine, hold for 10s)	3 x 10
		Push-ups	3 x 10
	Week 2:	Incline bench	3 x 10
		Back extension	3 x 10
		Leg press machine	3 x 10
	Week 3:	Lat. pulldown	3 x 10
		Bridge (lift leg and hold, 5x)	3 x 10
		Ball wall squats with ball between knees	3 x 10
	Week 4:	Incline bench	3 x 10
		Back extension	3 x 10
		Leg press machine	3 x 10
Post-weight room:	Cool-down:	Stationary bike	5 min
	Static stretches:	Pectorals	3 x 30s
		Low back	3 x 30s
		Hamstrings	3 x 30s
		Quadriceps	3 x 30s
		Calves	3 x 30s

RESULTS

The effects of the four-week in-season training programs on the performance variables are presented in Table 3. The interaction was significant ($p < 0.05$) for the sit up test for males in the BFS group (pre-test: 42 ± 11 sit-ups, post test: 48 ± 12 sit-ups, 7 ± 5.9 % improvement). There were no significant main effects for gender or group. Given the relatively small sample size and the practical nature of the study, differences between the magnitude of the performance tests were calculated by using Cohen's effect size statistic (40), which is presented in Table 4.

Table 3: Descriptive Statistics

Test / Group	MALES			FEMALES			TOTAL		
Sit-Ups (#)	Pre (M ± SD)	Post (M ± SD)	% improvement	Pre (M ± SD)	Post (M ± SD)	% improvement	Pre (M ± SD)	Post (M ± SD)	% improvement
BFS	42 ± 11	48 ± 12	7 ± 5.9	35 ± 4	32 ± 5	-3.8 ± 6.2	39 ± 10	42 ± 12	2.7 ± 8
TWT	37 ± 7	38 ± 7	1.1 ± 2.5	35 ± 9	38 ± 9	4.1 ± 4.7	36 ± 7	38 ± 7	2.4 ± 3.7
C	45 ± 8	45 ± 8	1.2 ± 3.6	31 ± 10	35 ± 7	6 ± 7.6	39 ± 10	41 ± 9	2.6 ± 5.2
10 RM (kg)									
BFS	42.5 ± 17.5	44 ± 16	2 ± 3.5	20 ± 4.5	22 ± 3.5	6.1 ± 9.5	33.5 ± 18	35 ± 16.5	3.6 ± 6.4
TWT	40.5 ± 6	41.5 ± 4	1.4 ± 3.2	22.5 ± 2.5	25.5 ± 1	6.1 ± 4.8	32.5 ± 10.5	34.5 ± 9	3.5 ± 4.4
C	37 ± 15.5	36.5 ± 10.5	0.7 ± 11.9	22 ± 1.5	22.5 ± 2.5	1.5 ± 2.7	32 ± 13.5	32 ± 10.5	1 ± 9.8
40-yd (sec)									
BFS	5.4 ± 0.2	5.3 ± 0.3	1.1 ± 3.2	6.2 ± 0.4	6 ± 0.3	1.2 ± 4.9	5.7 ± 0.5	5.6 ± 0.5	1.1 ± 3.7
TWT	5.4 ± 0.5	5.3 ± 0.4	0.9 ± 1.2	6 ± 0.2	5.9 ± 0.3	0.5 ± 1.1	5.6 ± 0.5	5.5 ± 0.5	0.7 ± 1.1
C	5.7 ± 0.6	5.4 ± 0.3	2.9 ± 4	5.9 ± 0.6	5.7 ± 0.2	1 ± 3.3	5.7 ± 0.5	5.5 ± 0.3	2.3 ± 3.7
T-test (sec)									
BFS	11.3 ± 1.2	11 ± 0.9	1.3 ± 4.4	12.5 ± 1.3	12.9 ± 0.9	-1.4 ± 7.6	11.8 ± 1.3	11.7 ± 1.3	0.2 ± 5.6
TWT	10.6 ± 0.6	10.7 ± 0.7	-0.8 ± 2.4	12.9 ± 0.9	12.2 ± 0.4	2.6 ± 2.3	11.6 ± 1.4	11.4 ± 0.9	0.7 ± 2.9
C	11.2 ± 0.2	11.1 ± 0.3	0.2 ± 1.6	12.4 ± 0.2	12 ± 0.3	1.8 ± 0.5	11.5 ± 0.7	11.4 ± 0.5	0.7 ± 1.5
Broad jump (cm)									
BFS	204 ± 19.5	217.5 ± 14.5	3.4 ± 3	158.5 ± 23.5	162 ± 14.5	1.4 ± 5.9	185.5 ± 30.5	195.5 ± 32	2.6 ± 4.2
TWT	219 ± 26.5	211 ± 27	-1.8 ± 1.2	180.5 ± 12	185 ± 7.5	1.2 ± 1.9	202 ± 28.5	199.5 ± 24	-0.5 ± 2.2
C	205.5 ± 17.5	211 ± 21.5	0.7 ± 5.1	180 ± 10	178 ± 9	-0.5 ± 0.5	199.5 ± 20	201 ± 23	0.4 ± 4.2

Table 3-Continued

Test / Group	MALES			FEMALES			TOTAL		
Line drill (sec)	Pre (M ± SD)	Post (M ± SD)	% improvement	Pre (M ± SD)	Post (M ± SD)	% improvement	Pre (M ± SD)	Post (M ± SD)	% improvement
BFS	35 ± 2.7	35.4 ± 2.5	-0.6 ± 1.7	39.1 ± 1.7	39 ± 2.3	0.2 ± 2.2	36.6 ± 3.1	36.8 ± 3	-0.3 ± 1.8
TWT	33.3 ± 2.3	34.2 ± 3.2	-1.2 ± 3	38.1 ± 2.5	38.7 ± 2.1	-0.7 ± 3.9	35.4 ± 3.4	36.2 ± 3.5	-1 ± 3.2
C	33.5 ± 1.6	34.9 ± 1.8	-2 ± 3.6	36.6 ± 2.7	27.8 ± 18.6	24.1 ± 50.7	34.7 ± 2.5	32.1 ± 11.4	8.4 ± 32.4
1.5 mile (sec)									
BFS	748.1 ± 155.8	688.6 ± 109	3.8 ± 3.3	853.1 ± 47.8	910.9 ± 93.5	-3.1 ± 3.3	790.1 ± 131.1	777.5 ± 150.7	1 ± 4.7
TWT	852 ± 249.3	750.1 ± 62.3	4.9 ± 12.1	816.7 ± 151.1	882.6 ± 182.9	-3.8 ± 2.1	836.3 ± 200	809 ± 139.2	1.1 ± 9.8
C	651.5 ± 64.8	684.2 ± 120.8	-2.1 ± 4	886 ± 129.2	949.6 ± 290.1	-2.4 ± 8.5	729.6 ± 143.4	772.6 ± 218.6	-2.2 ± 5.3

Table 4: Cohen Effect Sizes

Test	TWT	BFS
Sit-Ups	-0.13	0.02
10 RM	0.07	0.07
40-yd	0.06	0.06
t-test	0.01	0.12
Broad jump	-0.02	-0.06
Line drill	0.14	0.17
1.5 mile	0.06	0.01

DISCUSSION

This study is the first to investigate the BFS program's effectiveness of improving performance for adolescent in-season athletes. After four weeks, subjects in all groups improved in different variables, as seen in Table 3. Although the means ± SD of all the subjects in the BFS group improved in all performance tests, except for the line drill, the only change that was statistically significant was the one-minute sit-up tests for males in the BFS group. Previous studies have also found significant improvements in muscular endurance, and sit up tests in particular, following an intervention (2, 34). Bracko et al. (5) found no significant difference between genders in a sit-up test. In the current study, males might have improved in the muscle endurance test because of physical differences (more type II, anaerobic core muscles versus females), or they tended to use these muscles more while participating in their sport (1). Also, more complex movements may require a relatively longer neural adaptation period for females (1). Therefore, females may require more time to demonstrate neural adaptations from weightlifting (31). This may account for the lack of significant improvements for the females in the current study. Further research should investigate these findings.

The chosen performance tests may not have been valid in evaluating the training programs. The seven performance tests were chosen to encompass a wide scope of athletic ability. However, in-season athletes should concentrate on improving their sport-specific skills. The tests chosen to evaluate performance may not directly relate to their performance in their respective sport during their season. Also, though the BFS program does not claim to improve aerobic capacity, the 1.5 mile test was included in order to test athletes in a wide range of performance variables. Perhaps the lack of specificity of training the mechanics of the chosen performance tests resulted in limited improvement in these tests. Even though the seven tests used in the current study evaluated a wide range of ability, they were not sport-specific.

The lack of significant differences between pre- and post- tests observed in the current study does not confirm the findings of some other studies on resistance training using adolescents. Concurrent strength and endurance training programs (22), agility programs (14), and neuromuscular training programs (31) have all shown positive effects on athletic performance. Christou et al. (6) found that soccer training combined with resistance training improves upper and lower body strength and speed. Sprint running has also been shown to be an effective training method to improve leg power and athletic performance (24). As well, heavy resistance training programs improve maximal strength and throwing velocity in adolescents (15). Therefore, there are many studies that have tested different adolescent training protocols and found significant improvements.

The BFS program uses a combination of these different training methods, which were successful in improving performance individually. However, the current study suggests that four weeks of in-season resistance training is not effective in significantly improving individual performance. Although four weeks is a fairly short exercise period, strength gains have been reported previously (19, 39) and with adolescents (28, 42). However, Landin et al. (19) only tested and trained single joint muscles of the upper body. Significant strength gains were found because single joint muscle groups were isolated and trained (19). The current study focuses on multi-joint muscles and for this reason four weeks may not have been enough time. The BFS program is a year-long process and the current study only investigated in-season athletes that had not participated in the program in the last month. The four week experimental training period was selected because neurological improvements are thought to occur during the initial stages of training (30). These neurological aspects are thought to include motor unit recruitment and firing involved in motor learning (19). However, it has been proposed that the magnitude of these improvements depends on prior physical activity level and experience in the specific task (13). This would suggest that trained athletes would exhibit less neurological adaptations in response to resistance training (3). Other research has shown that neuromuscular adaptations occur after four weeks of training in trained high school athletes (17). It may be possible that the training stimulus in the current study was not adequate to produce neurological improvements. In order to stimulate both neurological and muscular change in trained athletes, the training techniques must overload these systems. It is possible that the current study did not overload the athletes, and therefore did not train neural adaptations.

The focus on proper technique may not have produced adequate loads for strength gains (43). The BFS program utilizes Olympic lifts (cleans, snatches) as compared to the traditional training group. For most of the subjects, Olympic lifts were a new training technique. Therefore, form and technique were emphasized using light weight. This light load may be one of the reasons that strength gains (due to neurological or muscular changes) did not occur after the four weeks of BFS training. Despite some controversy in the past, the use of Olympic style weightlifting is supported for younger athletes if proper technique is emphasized. Olympic weightlifting has shown positive effects on power, balance, coordination, timing, and physiological effects (41). Time allotted to learn the proper technique before the study would have allowed for more intensity for each lift, which would have overloaded the neuromuscular adaptations resulting in more improvement on the tests.

It is also possible that the athletes in the study did not improve in the performance tests because they were overtraining. These athletes were currently participating in a sport that practiced or competed at least five days a week. The BFS and traditional weight training group added two more exercise sessions to their schedule which could have resulted in overtraining. In another study, an excessive endocrine demand was evident in a group of 14-16 year olds who participated in seven to eight training sessions a week (15). As well, all performance tests were conducted on the same day. Therefore, even though recovery time was allotted, and their heart rate returned to their resting rate, athletes may not have scored their best on each performance test due to fatigue. Conducting the tests over four days would have decreased the impact of testing fatigue on their performance.

Further research needs to be conducted to determine if the BFS program can produce performance improvements. Also, more research needs to be conducted to evaluate athletes who use the BFS program, compared to athletes who use different sport-specific resistance training programs. It is important to evaluate if the multi-sport athlete approach that the BFS program preaches is more effective than different sport-specific programs. Further research that has athletes partake in the BFS in-season program should test athletes at the beginning of participation, and after every four weeks, until the end of their season. Evaluating the BFS in-season program over a longer season will be beneficial in determining its effectiveness in improving performance. It is important to determine the most effective program in improving performance for adolescent athletes.

PRACTICAL APPLICATIONS

The BFS in-season program for high school athletes does not appear to be a model training program over a four week period. In the current study, analyses may suggest that there is no interaction between performance improvements and four weeks of in-season resistance training for high school athletes; however, this may simply be due to insufficient statistical power. Therefore, even though the percent improvements are not statistically significant, slight improvements in sport may make a performance difference. After the four week intervention, some subjects were able to run faster, jump farther, and lift more weight. Although slight improvements were found in this study, future investigations should examine continuing the training protocol for an additional period to determine if a longer in-season training program would produce significant performance improvements.

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APPENDIX

Research Protocol Approval

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: February 19, 2007

To: Michael Miller, Principal Investigator
Alicia Crelinsten, Student Investigator for thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 07-01-01

This letter will serve as confirmation that your research project entitled "Effectiveness in Improving Performance with the Bigger Faster Stronger In-Season Training Program" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: January 17, 2008

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

WESTERN MICHIGAN UNIVERSITY
H. S. I. R. B.
Approved for use for one year from this date:

JAN 17 2007

HSIRB Chair

Western Michigan University
Department of Health, Physical Education, and Recreation
Parental Permission

1. **Study Title:** Effectiveness in Improving Performance with the Bigger Faster Stronger In-Season Training Program

2. **Investigators:** Alicia Crelinsten, CAT(C) and Michael G. Miller, EdD, ATC, CSCS

3. **Subjects:** Subjects must be healthy Hopkins High School baseball or softball players who have not participated in the Bigger Faster Stronger Program.

4. **Purpose of this study:** This study is for Alicia Crelinsten's masters thesis to determine the effectiveness in improving performance with the Bigger Faster Stronger in-season training program. Bigger Faster Stronger is a popular resistance training program for adolescents. Across the United States, more than 9 000 high schools have implemented this program (Shepard 2004). This program has grown in popularity due to its focus on the multi-sport athlete. Many high school students compete in a variety of different sports throughout their academic year. One resistance program, instead of choosing between different sports-specific training programs seems to be the answer. This has been the case for 250 000 student-athletes that have gone through the program (Shepard 2004). Despite its popularity, there are no published results on the Bigger Faster Program. It is important to evaluate the effectiveness of such a widespread concept.

   Resistance training for adolescents has been given more and more attention as the effects have been proven to be beneficial, rather than harmful. In the past, questions of weight training stunting growth kept young athletes out of the weight room. Nowadays, adolescent resistance training has become one of the most popular ways to enhance athletic performance. Researchers are now concentrating on discovering which program is the most effective for young athletes. Studies have been conducted on plyometric programs (Lephart et al., 2005), heavy resistance training programs (Gorostiaga et al., 1999), agility programs (Gambetta 2004), and neuromuscular training programs (Myer et al., 2005). The Bigger Faster Stronger program attempts to combine all of these programs into one comprehensive training program. This study will investigate the effectiveness in improving performance with the in-season Bigger Faster Stronger program. The purpose of this study is to evaluate a widespread training program and to test its validity. It is necessary to conduct this research due to the popularity of the program and the lack of published results.

5. **What your child will be asked if they participate in this study:** Your child will be asked to attend an information meeting where the study will be explained

in detail. At this meeting you will be informed of your roles and responsibilities along with the possible risks and benefits of this study. All athletes will have their mandatory medical examination completed prior to their involvement with the study. All subjects selected will participate in their sport as usual. Therefore, all participants will continue to practice and play games in their sport. If you give permission to your child to be in the study, they will randomly be assigned to one of the three groups (Bigger Faster Stronger program group, regular resistance training program group, or no additional training group which is the control group). Demographics (age, height, weight, and skinfold measurements) for every participant will be collected. Seven different performance tests will be used to evaluate athletic performance before and after treatment: estimated 1RM incline bench (upper body strength), broad jump (lower body strength and power), one minute sit-up test (muscular endurance), t-test (agility), line drill (anaerobic), 40 yard sprint (speed), and 1.5 mile run (aerobic). After this battery of tests, each group will begin their 4-week program. All baseball and softball players will continue to practice and play in games as their coach sees fit. One group will participate in the in-season Bigger Faster Stronger program, (supervised, twice a week, 30 minutes a day, core lifts, squat, hang clean, and bench). Another group will participate in a regular resistance training program, (supervised, three times a week, no power lifts). Prior to each training session, each exercise will be demonstrated and explained. Your child will also be given a chance to practice the exercise. The final group, the control group, will only participate in practices and games. After four weeks of this treatment, the performance tests will be conducted again. At the conclusion of the study, all participants will be given the opportunity to go through the resistance training programs. You nor your child will not be compensated for participation in this study. The study will last approximately five weeks (one week to pre test, 4 weeks of treatment, one day to post test). Therefore, participation will involve a time commitment.

6. Possible risks of your participation in this study: Resistance training may cause Delayed Onset Muscle Soreness (DOMS). DOMS will usually appear between 24-48 hours after exercise. As in any exercise program, muscle soreness will occur. The attached training programs are specifically designed to provide a gradual increase, to decrease the effects of DOMS. As in all research, there may be unforeseen risks to the participant. As with any physical activity, there is a risk of injury. Participants could injure themselves playing their sport, as well as in the weight room. However, studies have shown that resistance training with adolescents can be performed with no injuries (Faigenbaum 2004). If an injury occurs, appropriate emergency measures will be taken. If during the study your child develops an injury that prevents them from participating in the assigned group they will be excluded from the study. In the event of an injury, Alicia Crelinsten, an athletic therapist, will provide the necessary care. If further medical attention is needed, the participants will be referred to a physician.

7. Possible benefits of your child's participation in this study: Participants will gain all of the benefits of participating in an exercise program. Along with the

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physiological improvements (increase strength, flexibility, lean body mass), subjects will also improve their psychological well-being (decrease depression and anxiety) Subjects will gain knowledge on resistance training. Hopefully resistance training will become an important part in their athletic development. Resistance training for adolescents has shown to have positive effects on improving athletic performance. Therefore, taking part in this study will be beneficial to all subjects in both treatment groups. There are no benefits for the control group except that they will become aware of their athletic abilities through the pre and post testing sessions. All subjects will be informed of the results of the study.

8. Your child's rights concerning this study:

   a. Your child has the right not to participate in this study. Your child is able to withdraw at any time without prejudice or penalty. Refusal to participate will not affect your child's academic or athletic status. If your child discontinues, you have the right to remove your child's data.

   b. Your child's privacy will be protected. Only the investigators will have access to the information. All of the information collected is confidential. Your child's name will not appear on any papers on which information is recorded. The forms will all be coded, and there will be a separate master list with the names of participants and the corresponding code numbers. Once the data is collected and analyzed, the master list will be destroyed. All other forms will be retaired for at least three years in a locked file in the principal investigator's office.

As in all research, there may be unforeseen risks to the participant. If an injury occurs, appropriate emergency measures will be taken. If you or your child has any problems, questions, complications, or injury from this study, you are instructed to contact Alicia Crelinsten (269) 615-3098 or Dr. Mike Miller (269) 387-2728.

Your signature indicates that you have read the information provided above and have given your child permission to participate.

____
Child's Name (PRINT)

______________________________ _______________
Parent's Signature Date

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JAN 17 2007

HSIRB Chair

Western Michigan University
Department of Health, Physical Education, and Recreation
Written Informed Consent

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