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Pilot Study

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Effects of a Six-Week Randomized Training Program on Speed and Agility in Previously Trained Adolescent Males

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ABSTRACT

Athletes are constantly searching for training regimens to gain performance advantages for competition. Protocols are designed to promote increases in performance over short- and long-term periods but, most of these protocols improve only specific variables such as strength or running speed but not overall performance. The purpose of this study was to determine if increases in speed performance could be seen using a randomized style of sports performance training on adolescents who were familiar with, and had previously trained, using this style. Eight-male subjects, mean age of 14.6±0.9 years, participated in this training study. Mean height and weight were 1.7 m±0.12 m and 77.6 kg±15.3 kg, respectively. The study consisted of 6 weeks of randomized sports performance training. Subjects participating in the study had at least 12 weeks of previous randomized sports performance training. Three performance assessments (Russian box, plank, and timed ladder) were conducted prior to the 1st week of training and after the 6th week. Girth measurements (arm, thigh, and chest) and weight were also assessed pre- and post-training. Following the 6 weeks of training, significant differences (p<0.05 two-tailed, paired t-test) were observed in all three performance assessments. Pre/post measurements for the Russian box, plank, and timed ladder were 72.13±20.27 touches/91.13±30.99 touches, 239.86±194.67 seconds/346.57±272.09 seconds, and 281±39.62 seconds/255.75±33.23 seconds, respectively. No significant differences were seen in pre- and post-training subject weight or girth measurements (arm, thigh, and chest). Results support that randomized sports performance training can continue to increase performance in adolescents with previous training experience.

KEYWORDS: Anaerobic capacity; Sports performance; Randomization.

ABBREVIATIONS: RSPT: Randomized Sports Performance Training; IRB: Institutional Review Board.

INTRODUCTION

With the ever changing face of athletics in America, improving sports performance is the primary focus of most athletes. This, however, can be a complicated issue with many conflicting ideas surrounding the best way to improve performance. Obviously, sport selection is the determining factor when shaping a training program. For example, sports that emphasize power, whether anaerobic alactic (baseball, weight lifting) or anaerobic lactic (football, basketball, soccer), are often hindered by training programs that seek to improve aerobic fitness.[1] Most sports require unplanned movements or reactions that require a quick burst of energy intermittently dispersed between bouts of running or sprinting. However, for performance to improve, physiological adaptations must occur to the nervous, muscular, and cardiovascular systems.[2]

This has led to the development of many different modes of training from plyometrics to more systematic approaches like modified resistance training programs, both of which have shown to transfer to certain activities such as sprinting.[3] Because, sports performance is close-

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ly associated with intermuscular coordination (the interaction of many muscles to control a movement[4]); training programs designed to promote intramuscular coordination (neural adaptations within a single muscle) may not be as promising when discussing training and performance transfer.[5] Baker[6] however, demonstrated that beginning athletes could achieve transfer benefits from a more general training program but as they become more adapted to that program, specificity played an increasingly important role in performance. Because neural adaptations to resistance training are the primary contributor during the first 8 to 10 weeks of a training program[7] many beginning athletes will see plateaus in performance shortly after this period. Plateaus can also be traced to other factors such as overtraining, inadequate recovery, lack of nutrition and imagination.[8] These factors have led to the development of programs that manipulate the different variables of training (periodization) in order to continually improve.

Buford et al[9] demonstrated that if volume is kept consistent then different models of periodization (linear, weekly undulating, daily undulating) are all equally effective in improving strength. Because general training programs can improve performance early in training[6] and more variation is needed to continue to elicit gains in long-term performance,[2] can training programs be developed to address both of these needs as well as the need to incorporate variables such as intermuscular coordination while not ignoring other components like anaerobic capacity, power and core strength all while avoiding situations that lead to overtraining? The purpose of this study was to determine if a randomized style of sports performance training could continue to improve performance in previously trained male adolescents. "Randomized" training can best be described as a method of training that has no set training regimen for a given day but looks to improve variables of performance by complex power movements interspersed with traditional and nontraditional strength training, agility and foot work drills, increasing anaerobic capacity, improving balance and core strength all of which play a vital role in "on field" performance. It was hypothesized that randomized sports performance training would continue to improve performance in subjects who were previously trained and familiar with this style of training.

METHODS

Experimental Approach to the Problem

The goal of this investigation was to evaluate the effects of randomized training on performance variables during the time frame when improvement would normally tend to plateau and determine if randomized sports performance training could elicit gains in strength and performance after the neuromuscular adaptation phase of training. In this setting, "randomized training" referred to the inclusion of components of performance: aerobic endurance, speed, agility, explosiveness, flexibility for upper and lower body as well as core. For example, the workouts during any 1 week would include all of the previously listed components as well as 1 day when the volume of work might range from 10,000 to 40,000 lbs during a 1 hour workout.

Each of the participants had already been clients at a sports performance center (RepsUSA) and had a minimum of 12 weeks training experience. Thus, they were familiar with the style of randomized training and may have been getting close to the point where a plateau often occurs. Thus, the beginning of the 6 weeks when measurements were taken was used as the control point for the study.

Subjects

Eight male participants, between the ages of 13 and 16 years, included athletes from high school varsity and junior varsity football, basketball, and baseball teams. Each participant took part in their respective sport-specific training at their high schools and then attended 2 to 3 sessions per week at REPS. This study was reviewed and approved by the Institutional Review Board (IRB) and all potential risks and procedures involved in the study were explained to the subjects. Written informed consent to participate in the study was obtained from the parents along with assent from the adolescents. Participants were disqualified from the study if they failed to train at REPS at least 2 days per week. The training program was performed over a 6 week period and participants underwent benchmark assessments prior to week 1 and after the 6th week. Benchmark assessments included timed ladder drill, Russian box, and plank. (See Appendix A for an explanation of the assessments).

Procedures

Assessment tests were performed after a regular REPS warm-up but prior to training. Participant's body weight was taken during week 1 and 6 using a dial floor scale. Girth measurements of the upper arm, thigh and chest were also taken at week one and six using a Gulick measuring tape (Creative Health Products, Ann Arbor, Michigan, USA). The training protocol consisted of 6 weeks of a randomized style of sports performance training already familiar to the subjects. Because of the nature and style of REPS training the specific daily protocol over the course of the 6 weeks could not be documented as with a standard resistance or other performance-based training styles. Training sessions lasted one-hour per day and on any given day subjects would have been asked to perform simple exercises such as push presses, hurricane squats, log bench presses, isokinetic knee flexion/extension, isokinetic squats, isokinetic hip flexion and extension, deadlifts, lunges, or core work in various sets and repetition schemes. Subjects would have also been asked to participate in performance-based tasks such as slideboard, shuttle runs, sprints, step-ups, footwork drills, complex power movements, etc. Within a given week, however, all major components of performance were addressed (as mentioned previously) but never in the same fashion.

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Statistical Analysis

Descriptive data are reported as means and standard deviations (SD). Data were analyzed using Microsoft Excel and two-tailed, paired *t*-tests were used to determine if there were significant differences between week 1 and 6 in the bench mark assessments as well as girth measurements. Alpha level for significance was set a priori at $p \leq 0.05$.

RESULTS

A total of eight male participants, with a mean age of 14.6±0.9 years participated in this randomized sports performance training study. The means and SD values for age, height and weight are summarized in Table 1. The analysis, using the paired *t*-tests, determined that there were significant differences ($p \leq 0.05$) between pre- and post-training performance assessments (Russian box, plank, and timed ladder), but not for the girth measurements (arm, thigh, chest) and body weight ($p \geq 0.05$). Subjects averaged an increase of 19 touches per minute on the Russian box. A mean decrease of 25 seconds was seen on the timed ladder drill and an average increase of 107 seconds was seen in the plank. Table 2 summarizes the data from the performance assessments.

Figures 1, 2, and 3 graphically depict increases in performance assessments between week 1 and week 6.

	Mean	SD	Max	Min
Height (m)	1.7	0.12	1.96	1.63
Weight (kg)	77.6	15.3	100	55.9
Age (years)	14.6	0.9	16	13

Table 1: Subject data.
Demographic data for the 8 adolescent males who participated in this study.

	Mean	SD	*p*-value
Russian box (number of touches)			0.012
-pre	72.13	20.27	
-post	91.13	30.99	
Plank (seconds)			0.044
-pre	239.86	194.67	
-post	346.57	272.09	
Ladder drill (seconds)			0.008
-pre	281	39.62	
-post	255.75	33.23	

Table 2: Pre- and post-test performance assessment data.
Results of the pre- and post-testing for the measures of strength, agility and speed for the 8 participants.

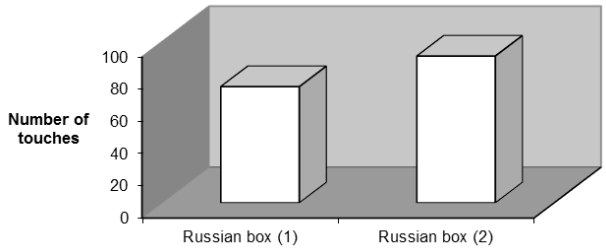

Figure 1: Pre- and post-training Russian box.
These data show the increased number of touches during the Russian box drill that the participants were able to perform following 6 weeks of "randomized" training.

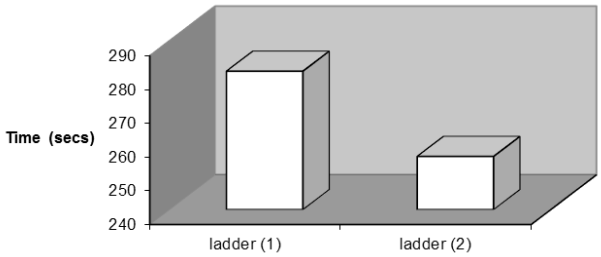

Figure 2: Pre- and post-training timed ladder.
These date indicate the increased speed that occurred in the timed ladder drill following the six weeks of "randomized" training.

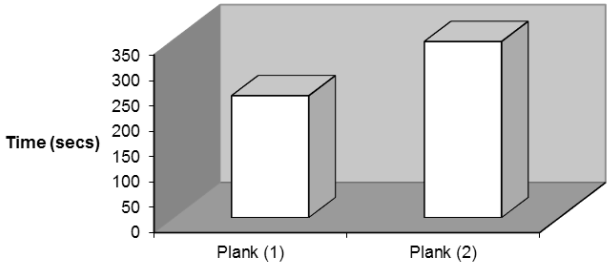

Figure 3: Pre- and post-training plank.
These data show the increase in the number of seconds that the participants were able to hold in the Plank position indicating an increase in strength following "randomized" training.

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	Mean	SD	*p*-value
Weight (kg)			0.945
-pre	77.6	15.3	
-post	78.2	15.6	
Girth Measurements			
Arm (cm)			1.0
-pre	29.9	4.1	
-post	29.9	3.4	
Thigh (cm)			0.118
-pre	50.9	8.0	
-post	50.3	7.6	
Chest (cm)			0.111
-pre	91.9	8.3	
-post	92.8	9.2	

Table 3. Pre- and post-training weight and girth measurements.
The means and standard deviations for the participants prior to and following the 6 weeks of "randomized" training.

The pre- and post-training results from the weight and girth measurements are listed in Table 3.

DISCUSSION

The purpose of this study was to determine if randomized sports performance training (RSPT) could continue to produce significant gains in performance assessments in previously trained children. The significant differences in the pre- and post-training performance assessments were consistent with the predicted hypothesis. Similar to other models of periodization,[2,5,6,9] RSPT did result in increased gains in performance assessments in previously trained male adolescents as seen with faster times (timed ladder, Russian box) and strength (plank). One factor that plays a role in the continued increase in performance is the fact that RSPT addresses both general training (resistance training) and performance specific training (plyometrics, agilities, etc.) either during the same training session or separate sessions. General resistance training has been shown to increase performance in untrained individuals[6] whereas variation and progression has been shown to contribute to further improvements in performance in previously trained athletes.[2] This style of training allows athletes to properly recover from working one group of muscles in a specific way while continuing to train other areas on subsequent days. Since the RSPT practiced at RepsUSA is truly randomized, the nervous system as well as the musculoskeletal system is constantly taxed not allowing the body to fall into specific patterns of movement or joint angles during lifting and drills. This has the potential to constantly alter muscle-firing patterns, increase recruitment and force production because as new movements and exercises are being learned, activity in the primary motor cortex increases, which is where motor unit activation begins.[2] Ideally, electromyography of muscles, determination of any changes in percent body fat as well as levels of blood lactate would have been helpful in documenting intensity of effort had they been available.

A part of the warm up during each session were the ladder drills. Participants were already very familiar with the sequence and the increased motivation that occurs when knowing that they are being timed and tested may have contributed to the decrease in time.

It appears that another advantage to the randomized style of training and its effect on performance might be the potential to continue to train at high intensity and volume levels while avoiding training staleness and subsequent decreases in performance. This could be more of a psychological factor because many athletes become bored with their training regimen and frequently experience performance losses due to the fact that their training intensity is lowered because of lack of motivation.[8] Randomization constantly provides fresh workouts so athletes can look forward to training and continue to train at high intensities and volumes. Training intensity and volume both play roles in performance gains.[2]

One reason why the continued gains in performance might have been seen is that most athletes participating in the study trained at the same time with one another. The competitiveness among the athletes could be considered extra motivation and allow them to produce greater gains in performance.[2,10] A drawback of the study was that these subjects were also in high school and their training there was not controlled. It was also not possible to include a control group, therefore, each participant acted as his own control.

Future considerations in research using RSPT could be to compare other types of training protocols to RSPT and measure improvements in performance between the style or using RSPT over longer periods of time to distinguish if gains in performance can be continued. Also, devising further performance assessments to test all performance variables should be considered.

CONCLUSION

It was concluded from these results that randomized sports performance training can continue to increase gains in performance

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assessments in previously trained adolescent males. These findings support the research hypothesis that stated gains in performance would be seen over a 6 week training period in participants that were previously trained in the randomized style of training.

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AUTHORS CONTRIBUTIONS

Both authors have contributed to the data collection and writing of this manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to declare.

PARTICIPANTS CONSENT

Statement was approved by the Institutional Review Board for the Protection of Human Subjects at our university.

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APPENDIX A: Explanation of performance assessments

1. **Timed ladder drill:** This drill tests the subject's foot speed and conditioning. With this test the subjects will be asked to perform nine separate footwork sequences in succession in little time as possible the length of a floor agility ladder (approximately 10 yards) and back. The nine drills include: A) Two-feet per space facing forward the entire length and back. B) Two-feet per space facing sideways the entire length of the ladder and back. C) Icky shuffle, which is a pattern of right foot in, followed by the left foot in, followed by the right foot out and then the left foot up one space. D) Single machine gun which is another drill where the shoulders run parallel to the ladder and the pattern is such that if you are going to your left the left foot goes in the first space followed by the right foot in the same space then the left foot out of the space followed by the right all the way down the ladder and back. E) Double machine guns are next in sequence with the subject standing in the first box, shoulders parallel to the ladder. If they are going to their left they will start by moving the left foot out of the box followed by the right and then move the left back into the starting space followed by the right. Once this is achieved the left foot will lead to the next space followed by the right and the L pattern will continue the length of the ladder and back. F) Triple machine guns follow the doubles. With this one the subject will again start in the first space with shoulders running parallel with the ladder. The subject, if moving to their left will start with the left foot out of the space forward followed by the right. The left foot will then return to the starting space followed by the right and then the left foot will step backwards followed by the right. The left foot will again move back to the starting space followed by the right and finally the left foot will move to the next space followed by the right and the pattern will be performed the length of the ladder and back. G) S-drill is next. With this pattern the subject will start with either foot in the first space and just like skipping rope will keep their pivot foot in the space for two small hops until the foot that is moving reaches the space in front of the pivot foot thus becoming the new pivot foot. This pattern is repeated both the length of the ladder and back. H) Eggbeaters are the next drill in the sequence. This one requires the subject to stand sideways and alternate feet with a hop leading with the foot in the direction the subject is traveling. It will be performed the length of the ladder and back. I) Straddle step is the final drill. In straddle step, the subject begins the drill with both feet in the first space facing the long end of the ladder. The subject will then step out of the ladder with one foot and the next foot will step out the other side. After this, the foot that stepped out first will return to the starting space followed by the other foot. The lead foot will then step forward to the next space followed by the other foot. This drill will be performed the length of the ladder and back.

2. **One minute Russian box:** The Russian box is a platform six-inches off the ground and approximately six-feet long and two-feet wide with two-foot panels at both sides angled at 45 degrees. The Russian box test explosiveness laterally as well as balance and endurance. Subjects will be asked to start on one angled panel with the outside leg on the panel and the other leg off the panel with the knee raised and the foot slightly behind the body much like a slide board or speed skater. On go, the subject will push off the angled panel clear the three cones stationed in the center of the apparatus and land with the opposite foot on the other panel clearing the cone center line with the complete body before reversing the motion. The subject will be asked to complete as many passes as possible in the one-minute time limit.

3. **Pushup plank hold:** This assessment will test the subject's core and shoulder strength and stability. Subjects will be instructed to get into the up phase of a pushup and hold as long as possible.