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Effects of a Periodized Training Program and a Traditional Military Training Program on Functional Movement and Y-Balance Tests in ROTC Cadets

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ABSTRACT

Background: Functional movement screening (FMS) and Y-balance test (YBT) are assessment procedures used to examine the 'quality' of movement patterns and identify individuals that might have specific limitations or asymmetries. Low FMS and YBT scores have been linked with a higher risk of injury among athletic populations. Since FMS and YBT are becoming more widely used screening tools, it is important to examine the various training programs that could improve FMS and YBT scores.
Purpose: This pilot study examined the effects of a 10-week periodized and traditional military training program on FMS, and upper and lower quadrant YBT scores of Reserve Officers Training Corps (ROTC) Cadets.
Methods: Subjects consisted of 36 Army and Air Force ROTC cadets (male=24, female=12), Age 19.7(yrs)±5.96, Height (cm)=175.7±9.28, Weight(kg)=75.70±13.41. The periodized, intervention group (IG n=24) trained for 1 hour/day, 4 days/week and the control group (CG n=12) participated in traditional ROTC training protocol for 1 hour/day, 3 days/week. A 2×2 mixed factorial analysis of variance (ANOVA) was used to compare mean change values of the FMS, upper, and lower quadrant YBT scores for intervention and control groups.
Results: A significant interaction ($p\leq0.05$) was observed for FMS scores. The control group had a much lower initial FMS score and demonstrated more improvement than the intervention group. Both groups demonstrated a significant increase in left side YBT upper (p=0.03) and lower (p=0.02) quadrant scores after 10-weeks of training.
Conclusions: Since FMS and YBT scores are being used more frequently as screening tools for risk of injury, it is important to study methods that will improve FMS and YBT scores in diverse athletic populations. This study found larger improvements in FMS scores in ROTC cadets participating in a traditional military training program compared to cadets participating in a periodized strength training program. Scores in the left side of the YBT upper and lower quadrants were improved in both groups suggesting multiple training programs can improve function in non-dominant sides or asymmetries. Future studies are warranted and should address certain limitations that this study encountered (sample size and length of training period). Further exploration of FMS and YBT scores and mechanisms of improvement in tactical athletic populations would be beneficial.

KEY WORDS: Military training; Periodized training; FMS; YBT.

ABBREVIATIONS: FMS: Functional Movement Screening: YBT: Y-Balance Test; NMTP: Neuromuscular training program; ROTC: Reserve Officers' Training Corps; ANOVA: Analysis of variance.

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INTRODUCTION

Screening tools developed to predict injury in various athletic populations, like the functional movement screen (FMS) and the Y-balance test (YBT), are increasing in popularity.[1,2] The FMS and the YBT identify individuals who have functional limitations, or asymmetries by examining the ability of the subject to perform very specific movements.[1,3,4] The YBT device has a stance platform from which three pieces extend in the anterior, posteriomedial, and posterolateral directions, forming a "Y" shape. In the lower quarter Y-balance test (YBT-LQ) the participant pushes the reach indicator with the foot of his or her reach limb allowing the tester to take measurements of the reach distance.[5] The upper quarter Y-balance test (YBT-UQ) measures the ability of the subject to reach with the free hand while bearing weight on the contralateral upper limb.[5] Tests like these that have the ability to predict injuries, are used as screening tools in various athletic settings.[6,7] Low scores in these tests have been linked to higher risk of injuries in athletic populations.[8,9]

As military personnel regularly engage in physical training to improve performance, it is important to assess the risk of injuries and the methods used to train these athletes. Previous studies have examined the effects of varied neural and individualized training programs associated with FMS scores, but no studies to date have investigated a periodized training program in relationship to FMS and YBT scores. Studies have examined the effects of neural training methods and individualized corrective programs on FMS scores in various athletic and tactical populations.[10,11] Linek et al[10] found increased FMS scores among volleyball players subsequent to an 8-week training program based on the Neuromuscular Activation (NEURAC) method. Similarly, Stanek et al[11] found increased FMS scores in firefighters upon completion of an 8-week individualized corrective exercise program. Being that adaptations to exercise are specific to the training method used,[12] it is important to assess the impact of various training methods used in military populations as they relate to risk of injury.

There is limited research regarding the impact of various training methods in relationship to injury risk assessments, thus the purpose of the current pilot study was to examine the effects of a 10-week periodized resistance training program on FMS, YBT-LQ and YBT-UQ scores of ROTC cadets compared to a traditional military training program. Specifically, the hypothesis is that the periodized resistance program will lead to higher injury risk assessment scores (FMS, YBT-LQ and YBT-UQ) in ROTC cadets.

METHODS

Study Design

FMS, YBT-LQ and YBT-UQ scores of ROTC cadets were measured pre and post a 10-week training program. A control sample of the cadets performed the traditional military training protocol while an intervention sample performed the periodized training program. Results were compared to determine the level of improvement in scores after completion of the training program.

SUBJECTS

Subjects consisted of 36 Army and Air Force ROTC cadets (male=24, female=12: age 19.7±5.96 yrs; height, 175.7±9.28 cm; weight, 75.70±13.41 kg) from the University of West Florida (Pensacola, FL, USA). The research staff briefed potential ROTC cadets on the purpose of the study and potential volunteers wrote their name and contact information on a list. Volunteers were contacted *via* email and a baseline meeting was set where procedures were explained. Volunteers were briefed about the objectives and risks. Institutional approval was granted through the University of West Florida Institutional Review Board (IRB) and volunteers gave written informed consent prior to participation. Subjects were grouped using a convenience sample meaning, those whose schedule did not allow them to participate in the periodized training program were assigned to the control group. The intervention group (IG, n=24) followed a periodized training program for 1 hour/day, 4 days/week and the control group (CG, n=12) participated in a traditional military training protocol for 1 hour/day, 3 days/week. A sample week of the periodized program is shown in Table 1.

Procedures

Prior to starting the program, age and physical characteristics were obtained and all cadets were measured for body mass and height. Height was measured to the nearest centimeter using a stadiometer and weight was measured using a SECA platform scale (Chino, CA, USA). Body mass index (BMI) was calculated by dividing the subject's weight by the height squared (kg/m^2).

The FMS and upper and lower body YBT screenings were completed prior to starting training and after 10 weeks of training. A strength-and-conditioning specialist, certified in FMS and YBT testing, monitored the research staff during all examinations. Before testing sessions, the strength-and-conditioning specialist conducted practice testing sessions among the research staff to ensure homogeneity of inter-rater reliability. Research staff members were assigned to only one test and performed that same test both pre- and post-training. FMS and YBT scoring sheets were given to all participants who then carried them throughout the testing session until they were collected at the end of testing for data entry. Cadets performed the tests in standard military t-shirt, shorts, socks, and sneakers (or without shoes where appropriate). The FMS and YBT assessments were performed in random order once height and weight were recorded.

The seven FMS protocols were administered using the FMS test kit.[6,7] Each test was scored on a 4-point ordinal scale (0 to 3). The seven movements (one score for each) were summed

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Table 1: Sample Week of Periodized Training Program for the Intervention Group.

Sample Week of Training Program				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Dynamic Warm-up: 10 minutes **Strength:** (85% 1RM) Back Squat 4x5-6 Bench 4x5-6 (Perform a warmup set of 10 at 50-60% of 1RM) **Accessory:** Lat-Pulldown: 3x10+1 set to failure Tricep Push down: 3x10 +1 set to failure Inverted Row: 3x10+1 set to failure Push ups: 3 Max rep sets (2-3 min rest between sets) **Cooldown:** Full body stretching	**Dynamic Warm-up:** 10 minutes **Speed/Conditioning:** (3 rounds as quickly as possible with 1 minute rest between each station) 15 Burpee Box Jump Over 50 foot farmers carry (heavy) 30 Strict shoulder press (45/35lbs) 50 foot farmers carry (heavy) 20 Overhead Weighted Walking Lunges (45/35lbs) **Core work:** (3 rounds, keep moving at a consistent pace) 30 second hollow holds 5 wall walks 30 sit ups 30s Side planks **Cooldown:** Full body stretching	**Rest Day**	**Dynamic Warm-up:** 10 minutes **Strength:** (85-87% 1RM) Power Cleans 4x4 Deadlift 4x5-6 Front squat 4x5-6 **Power:** 3 rounds–perform movement as quickly as possible then rest until the next minute. Min 1: Full gym sled push (90/45lbs) Min 2: 15 Kettlebell Swings (heavy) Min 3: 20 Air squats Min 4: 20 Push ups **Cooldown:** Full body stretching	**Dynamic Warm-up:** 10 minutes **Work Capacity:** 16 min–complete as many rounds as possible. 1200 m run 15 Sit ups 15 Weighted Front squats (40-50% 1RM) 20 min–complete as many rounds as possible while increasing reps by 1 each round. 5 box jumps 10 Kettlebell swings 15 wall balls (20/14lbs) **Cooldown:** Full body stretching

Strength and accessory work were complete using supersets for time efficiency.

for a total score that varied from 0 and 21. FMS tests were administered to candidates in a single session in accordance with the standard FMS criteria.[13] The criterion for a successful movement was demonstrated by the administrator prior to each test.

The YBT was administered with a commercially-available device that formed a figure "Y" and had sliders on each arm of the "Y" (Move2Perform, Evansville, IN, USA).[3,4] For the YBT-LQ, the participant pushed the reach indicator with the foot of one limb, while the other foot remained stationary on the device. The tester obtained the reach distance.[5,14] The YBT has demonstrated high intra-tester (0.85-0.89) and inter-tester reliability (0.97-1.00).[15] The movements were demonstrated by the testers and subjects were provided with 1-2 practice trials prior to performing the test. Subjects were given three criterion trials, and the best performance was recorded to the nearest half centimeter. For the YBT-LQ measures, participants stood with one foot flat at the junction (toes at the center line) of the three parts of the "Y". While maintaining balance, and without their reaching foot touching the ground, the participant slid the bar on each of the three parts of the "Y" (anterior, posteromedial and posterolaterial) one part at a time. The right and left feet were tested separately. For the YBT-UQ measures, the participant assumed a push-up position with one arm on the junction (thumb at the center line) of the "Y". With the free arm, participants pushed out the slide as far as possible on the three different bars (one bar at a time) while maintaining the push up position and not touching the ground with their free hand. The right and left arm were tested separately. To normalize for limb-length differences among subjects, YBT upper and lower maximized reach distance (MAXD) was calculated with the following formula: ([excursion distance/limb length]x100).[5] Composite reach distance was calculated taking the average distance in the three reach directions, dividing by limb length and multiplying by 100 (average distance in the three directions/limb length)x100 [16] Upper-limb length was measured as the distance from the C7 spinous process to the most distal tip of the middle finger (in centimeters) with a tape measure with the limb abducted to shoulder height (90º). Lower-limb length was measured from the anterosuperior iliac spine to the medial malleolus.[16]

Participants in the intervention group began the periodized training program subsequent to completing the pre FMS and YBT testing. The control group participated in their regular military training program and schedule. As participation in physical training is a requirement for ROTC cadets, attendance was monitored for both groups by the ROTC and study research staff resulting in regular levels (85% of the sessions) of participation.

ROTC Training Programs

Cadets in the intervention group participated in a four-day-per-week (Mon, Tues, Thur, Fri) training program that incorporated strength, speed/conditioning, strength/power and work capacity (ability to use any physical quality for an extended period of time). Periodized resistance training workouts were developed to enhance muscular strength and power (e.g., squats, cleans, bench press, push press) while also targeting push-ups, sit-ups and running which are required for the military physical fitness tests. There was an emphasis on structural exercises such as squats, deadlifts, power cleans, military press and bent-over

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rows targeting both upper- and lower-body musculature.

The order of exercises progressed from power to multi joint to single joint. Volume was dictated by the resistance load, number of sets and number of reps for each workout. Speed-and-conditioning-development days were programmed to target neuromuscular function and operational readiness with multiple types of training methods, including plyometrics and high intensity interval training, and implements like medicine balls, weight sleds, kettlebells and sand bags. Work-capacity days focused on improving cadet's ability to resist the onset of fatigue and improve recovery rates from high-intensity exercise. All training sessions were preceded by a 10-minute dynamic warm-up (high knees, monster walks, lateral shuffles, carioca, walking lunges, inch worms, bear crawls, etc) and followed by a cool-down of full-body static stretching. All training sessions were 60 minutes in duration and were supervised by a strength-and-conditioning professional.

Cadets in the control group participated in the regular ROTC physical training that consisted of 60-minute sessions performed three days per week. This training was focused on developing the physical abilities (push-ups, sit-ups, running) necessary to pass the required physical fitness tests. These sessions involved a warm-up followed by a combination of moderately- and vigorously-intense aerobic activity with progressive increases in the time spent in continuous exercise. Cadets then participated in a muscular-fitness-development segment using movements that worked the whole body including calisthenics, plyometrics and field exercises. All sessions were completed with a cool-down that involved static stretching for flexibility.

Statistical Analysis

Descriptive statistics were calculated for physical characteristics, total FMS scores, and total YBT scores. A 2x2 mixed-factorial ANOVA was used to compare mean-change values of total FMS and YBT scores for intervention and control groups. Effect size was interpreted using Cohen[17] (1988, pp. 284-7): 0.01=small effect, 0.06=moderate effect, 0.14=large effect. Statistical Package for the Social Sciences (SPSS, Version 18, Chicago, IL, USA) was used for statistical analysis with an alpha level set at $p<0.05$.

RESULTS

Mean-change values of total FMS and YBT scores for experimental and control groups are shown in Table 2. A significant interaction F (1,34)=8.82, $p<0.05$ was observed for pre- and post-FMS scores and group assignment. The mean difference in FMS scores was 1.33 with a 95% confidence interval ranging from 0.76 to 1.90. The partial eta square statistic (.21) indicated a large effect size. A significant main effect was observed for pre- and post-FMS scores, F (1,34)=22.58, p=0.000. The mean difference in FMS scores was 0.42 with a 95% confidence interval ranging from -1.31 to 1.21. The partial eta square statistic (0.40) indicated a large effect size. While both groups increased in FMS scores after 10 weeks of training, the control group presented with a much lower initial score and demonstrated a larger improvement than the intervention group.

The interaction between group assignment and lower left quadrant YBT test was not statistically significant, F (1,34)=0.02, p=0.89. The mean difference in lower left quadrant YBT scores was 2.28 with a 95% confidence interval ranging from -2.83 to 7.34. The partial eta square statistic (0.00) indicated a small effect size. There was a significant main effect F (1,34)=5.55, p=0.02 between lower left YBT quadrant and pre and post-testing. The mean difference in from pre- to post-scores was 2.18 with a 95% confidence interval ranging from 0.30 to 4.06. The partial eta square statistic (0.14) indicated a large effect size.

The interaction between group assignment and upper left quadrant YBT test was not statistically significant, F

Table 2: 2x2 Repeated Measures ANOVA Mean Change Values of Total FMS and YBT Scores for Experimental and Control Groups.

Test	Group	Mean±SD		ANOVA		
		Pre-measures	Post-measures	Group *p*-value	Pre-post *p*-value	Group X pre-post *p*-value
FMS total score	Control intervention	14.75±1.76 15.54±1.96	16.92±1.38 16.04±1.88	0.94	<0.00*	<0.05*
YBT lower body right side	Control intervention	99.86±9.37 98.97±7.36	99.22±6.89 100.42± 6.95	0.95	0.69	0.29
YBT lower body left side	Control intervention	96.78±8.39 98.92±7.74	98.83±7.21 101.24±7.16	0.37	0.02*	0.89
YBT upper body right side	Control intervention	93.72± 9.48 92.95± 7.90	96.10±9.65 94.84±6.83	0.67	0.11	0.85
YBT upper body left side	Control intervention	93.08±9.26 91.50±8.16	94.83±9.02 95.43±7.30	0.85	0.03*	0.39

*Significance was set at the 0.05 alpha level.

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(1,34)=0.75, *p*=0.39. The mean difference in upper left quadrant YBT scores was 4.96 with a 95% confidence interval ranging from -4.84 to 5.83. The partial eta square statistic (0.02) indicated a small effect size. There was a significant main effect, $F(1,34)=5.12$, $p=0.03$. The mean difference in from pre- to post-scores was 2.84 with a 95% confidence interval ranging from 0.29 to 5.39. The partial eta square statistic (0.14) indicated a large effect size between upper left YBT quadrant and pre- and post-testing. Both intervention and control groups experienced significant increases post training in upper and lower left quadrants YBT scores.

DISCUSSION

The purpose of this research was to examine the effects of two 10-week physical training programs in relationship to FMS, YBT-LQ and YBT-UQ scores of ROTC cadets. The findings do not support the hypothesis that a periodized resistance training program would result in different injury-risk-assessment scores when compared to a traditional military training program. Specifically, significant improvements were seen in both the periodized and the traditional training groups for total FMS scores and upper and lower left YBT quadrants scores.

Since both programs were designed to address all major muscle groups and movement patterns required for military populations, it is relevant to note the main differences between the two training protocols. The traditional military training program focused on running, general body-weight exercises, and repetitive practice of the push-ups and sit-ups required for physical testing. The periodized training program involved a greater variety of equipment and exercise modalities and used a very specific resistance-training progression protocol. The traditional military training protocol was only performed three days per week in comparison to the four-day-a-week periodized training model. Based on the current results, we can suggest that regular participation in a three day-a-week training program was sufficient to increase FMS and YBT left side scores.

This is not the first research to investigate the relationship between different exercise programs and injury-risk assessments. The FMS and YBT tests have been widely used as a screening tool to predict risk of injury in athletic and military populations.[8,13,18] As a result, several studies have tested training programs geared toward the improvement of balance and locomotion to improve FMS scores.[10,11,19] Researchers have also focused on developing programs based on each participant's individual weaknesses on the FMS total score. Stanek et al[12] demonstrated significant improvement in total FMS scores after an individual eight-week intervention that focused on stability and mobility. While prescribing individual exercise programs is certainly ideal, the drawback of adding additional individual exercises into any group-training regimen has a negative impact on time management and efficacy. Based on the results of the current research, alternative-group training methods have the capacity to enhance FMS and YBT scores. Therefore, it is important to continue to investigate the relationship between various training methods and FMS and YBT tests scores.

In the present study, both the intervention and control group presented improvements in FMS and left-side upper and lower YBT scores. To our knowledge this is the only study to examine the effects of a periodized training program on FMS and upper-and lower-quadrants YBT scores of ROTC cadets. Because of scarce research including intervention and control groups on training programs to improve FMS and YBT scores, it is difficult to compare our results with previous literature with the current study.

While in the present study the intervention group showed lesser improvement in FMS scores than the control group, it is worth noting that our results are consistent with other studies where an exercise intervention was used to improve FMS scores.[8,11,19] As mentioned above, Stanek and colleagues[11] observed improved FMS scores in firefighters after an 8-week individualized workout program. The researchers used the FMS Pro-360 software program that prescribed exercises that enhance mobility followed by static and dynamic control and strength exercises.[11] Several of the exercises used by the FMS Pro-360 software are similar to the exercises prescribed in this study (shoulder mobility, planks, single leg squats) for the intervention group.

Similar studies have examined the effects of alternative interventions on FMS scores.[19,22,23] Cowen used yoga as an intervention in firefighters and found increases in FMS scores after six-weeks of participation. Kiesel[19] studied the effects of an off-season resistance training program on professional football players and observed increases in FMS scores subsequent to participation. The limitation of the study by Kiesel et al[19] was the lack of a control group making it difficult to establish a cause/effect relationship. More specific to the current population, Goss et al[22] observed improvements on FMS scores in special-operation soldiers after a 6-week functional training program. Our findings were consistent with these three studies. Both groups in the present study experienced improvements in FMS scores after participation in a training program. We can stipulate that a consistent exercise routine that incorporates multiple modes of exercise will influence proprioception activation and fundamental movement/balance that will result in a positive influence on FMS assessments. In the present study, exercises like planks, push-ups and different forms of sit-ups and crunches that would stimulate core activation were used by both groups. These general, non-specific exercises might influence fundamental movement patterns and asymmetries that the FMS measures. It is worth noting that these are fundamental components of human movement and are not necessarily sport specific. Further research is warranted to test the degree of influence of each exercise stimulus in relationship to FMS scores in multiple athletic populations.

Both groups in the present study had significant improvements in the left side of the YBT, upper and lower quad-

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rants. To our knowledge, this is the first study that examined the impact of a periodized training program and a traditional ROTC training program on upper- and lower-quadrant YBT scores in ROTC cadets. The results of our study are similar to research by Filipa and colleagues[24] where an improvement in the star excursion balance test was observed in female soccer players following eight-weeks of a neuromuscular training program (NMTP). The NMTP focused on lower-extremity strength and core stability. The researchers found that star excursion balance test (SEBT) improved with neuromuscular and proprioception training. Similarly, subjects in both groups of the present study performed exercises like planks, plyometrics, single-leg squats, and RDLs that could have improved neuromuscular activation leading to better YBT-LQ scores.

Interestingly, the gains in YBT-LQ balance scores observed in the present study occurred in the non-dominant side or, in this case, the left side. The majority of the ROTC cadets in the present study were right-side dominant. The gains in a non-dominant side observed in the current study concur with findings from by Hudson et al,[25] who determined normative YBT-LQ scores by assessing 90 healthy (19.6±1.2 y/o), collegiate female volleyball players. Baseline values for this population were 94.1±6.6% on the dominant limb and 93.9±6.2% on the non-dominant limb. We can hypothesize that the higher improvements in lower-and-upper quadrant YBT scores that were observed in the non-dominant side after consistent training was due to the lower scores observed in both groups before their training programs. Again, it is problematic to compare our results with other studies since limited research has been conducted regarding the YBT-UQ test and its relationship to muscular strength. Borms et al[26] investigated the relationship between shoulder and elbow flexion and extension on YBT-UQ performance in 29 male and female overhead athletes. It was observed that performance on the YBT-UQ was not related to upper-limb strength. Therefore, the gains observed in both groups in the left YBT-UQ could be attributed to consistent whole-body mobility and stretching that was performed at the end of each training session for both the intervention and control groups. Further research needs to be conducted to better understand the relationship between strength and mobility and the YBT-UQ test.

The present study encountered several limitations that need to be addressed. This study did not have a control group that did not engage in a training program to account for the influence of test/re-test. The majority of ROTC cadets engage in physical training in order to pass their physical fitness tests, and because of the small sample size in the current study it was not an option to ask the cadets to abstain from physical activity. A larger sample size could have been more representative of the general ROTC population. There were only 12 females that participated in this study *versus* 24 males and all female participants were in the intervention group. Future studies should have equal number of females in a control group to make more valid comparisons among genders. Due to scheduling constraints, a convenience sample was used to split the study participants into the intervention and control group. Another possible limitation was that the researchers in this study were not able to supervise the traditional military training performed by the control group. It is possible that cadets in the control group performed additional training on their own time, which could have influenced the results of the post-tests. Future studies that address these limitations are warranted.

CONCLUSION

In conclusion, the present study showed that both a periodized and traditional training program resulted in similar changes in FMS scores and left-side YBT scores for the upper and lower quadrants. The results of this study suggest that a three-day-a week, traditional military training program is sufficient to improve upper and lower YBT and FMS scores in ROTC cadets. Future research is necessary to better determine the relationship between various training methods and their ability to improve FMS and YBT scores among military and athletic populations.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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