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Effect of Twelve Weeks of Medicine Ball Training on High School Baseball Players

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Abstract. Szymanski, D.J., J.M. Szymanski, T.J. Bradford, R.L. Schade, and D.D. Pascoe. Effect of twelve weeks of medicine ball training on high school baseball players. *J. Strength Cond. Res. 21(3):894–901. 2007.*—This study examined the effect of 12 weeks of medicine ball training on high school baseball players. Forty-nine baseball players (age 15.4 $\pm$ 1.2 years) were randomly assigned using a stratified sampling technique to 1 of 2 groups. Group 1 (n = 24) and group 2 (n = 25) performed the same full-body resistance exercises according to a stepwise periodized model and took 100 bat swings a day, 3 days per week, with their normal game bat for 12 weeks. Group 2 performed additional rotational and full-body medicine ball exercises 3 days per week for 12 weeks. Pre- and post-testing consisted of a 3 repetition maximum (RM) dominant and nondominant torso rotational strength and sequential hip-torso-arm rotational strength (medicine ball hitter's throw). A 3RM parallel squat and bench press were measured at 0 and after 4, 8, and 12 weeks of training. Although both groups made statistically significant increases ($p \leq 0.05$) in dominant (10.5 vs. 17.1%) and nondominant (10.2 vs. 18.3%) torso rotational strength and the medicine ball hitter's throw (3.0 vs. 10.6%), group 2 showed significantly greater increases in all 3 variables than group 1. Furthermore, both groups made significant increases in predicted 1RM parallel squat and bench press after 4, 8, and 12 weeks of training; however, there were no differences between groups. These data indicate that performing a 12-week medicine ball training program in addition to a stepwise periodized resistance training program with bat swings provided greater sport-specific training improvements in torso rotational and sequential hip-torso-arm rotational strength for high school baseball players.

Key Words. ballistic training, plyometric, torso rotational strength

Introduction

Strength and power are integral components of a baseball player's performance. The ability to utilize this strength and power is related to the interaction of the 3 body segments (hips, torso, and upper body) as a kinetic link (24). In order to transfer the forces generated from the lower body to the upper body while hitting and pitching, baseball players need hip and torso rotational strength (13, 15, 30, 39). Powerful motor performance in such movements as hitting and throwing a baseball relies on the rate and sequence of motor unit activation (10). Power, the ability to exert force rapidly (power = force × velocity), generated to hit or throw a baseball is initiated by the hips, is transferred through the torso, and ends with the arms (30). Therefore, baseball-specific resistance training should implement exercises that will improve the strength and power of these performance variables. In order to accomplish these improvements, baseball-specific resistance training should attempt to mimic the powerful, sequential, ballistic, and rotational movements of the game. These same movements are also applicable in other sports that rely on torso rotational strength.

Two training approaches that are often used by baseball and strength coaches to enhance baseball-specific performance are ballistic (explosive training in which the athlete actually throws or jumps with a weight) and plyometric (exercise in which the muscle is loaded in an eccentric contraction, followed immediately by a concentric contraction) (7, 19, 20–23, 26). These types of training methods often involve upper body exercises, such as medicine ball throws, and lower body exercises, such as depth jumps (21). Medicine ball training, which can be described as both ballistic and plyometric, allows baseball players to mimic the powerful, sequential, and rotational actions (e.g., hitting, throwing) that occur during a game. This may allow a hitter to swing a bat with greater velocity. If bat-ball contact occurs with greater bat swing velocity, the ball will travel farther, be hit harder, or both (1, 25). If a pitcher could throw a baseball with greater velocity, a hitter would have less time to identify and react to the pitched ball (14). This will create an advantage for the pitcher and may increase success. Although some baseball players perform ballistic and plyometric medicine ball exercises during their yearly training, no scientific research has investigated whether medicine ball training can enhance the torso rotational strength of baseball players.

Previous research investigating ballistic and plyometric training has examined its effect on lower body (8, 28) and upper body (18, 21) performance. Based on the results of these data, it is difficult to make recommendations as to the efficacy of ballistic and plyometric training on torso rotational strength. Obermeyer (22) and DeMichele et al. (11) conducted research to determine the most effective frequency to improve rotational trunk strength using a rotary torso machine. Based on their research, both recommended that rotary torso training be performed 2 days per week. Baseball and strength coaches could easily implement explosive hip and torso rotational training into an existing resistance training program. Therefore, the purpose of this study was to determine whether performing additional torso rotational strength training would provide further significant improvements in torso rotational strength and power of high school baseball players after completing a 12-week stepwise periodized resistance training program with baseball bat swings.

Methods

Experimental Approach to the Problem

This study was designed to investigate whether significant increases in torso rotational strength and power

TABLE 1. Mean (± *SD*) baseline descriptive data for groups.

Group	Age (y)	Height (cm)	Weight (kg)	Body fat (%)
1 (n = 24)	15.3 (1.2)	178.4 (7.8)	76.2 (13.4)	14.1 (5.6)
2 (n = 25)	15.4 (1.1)	176.4 (5.0)	72.5 (7.9)	13.5 (5.0)

could be obtained in high school baseball players when adding medicine ball exercises to a typical 12-week off-season baseball training program. An off-season baseball program for position players normally consists of taking batting practice and resistance training. Because both high school and collegiate athletes have limited time (hours per week) for team practices, are these additional medicine ball exercises necessary? To our knowledge, no other study has examined the effect of medicine ball training on high school baseball players or any other participants or used the medicine ball hitter's throw to measure sequential hip-torso-arm rotational strength. The amount of sets and repetitions in this study for medicine ball exercises was determined by information on ballistic strength training methods (7) and personal experience. All of the strength assessments were measured isotonically to compare the strength gains of the 2 groups within and between baseball players.

As the former Exercise Physiologist for a Division I college baseball team, the lead author has used all of these strength measures without injury with reproducible test results for 2 years prior to the study. All participants in this study were shown and verbally told how to execute each exercise correctly during the initial meeting prior to the study. Throughout the familiarization sessions, pre- and post-training testing sessions, and 12-week study period, all participants were constantly instructed and observed by the lead author and his assistants to perform the exercises correctly and safely according to the guidelines described in this paper.

Subjects

Fifty-five male high school baseball players between 14 and 18 years of age volunteered for this study. All volunteers and parents completed a written informed consent in accordance with the university's institutional review board's guidelines before being permitted to participate in this study.

Participants answered a modified physical activity readiness questionnaire, which was immediately evaluated by the lead author to eliminate those who might be at a medical risk of injury. If a contraindication for participating in an exercise program was noted, the athlete was not allowed to participate. Additionally, participants completed a descriptive data questionnaire, which described their past playing and exercise experience. Six participants did not finish the study for reasons unrelated to the project, and therefore only 49 participants completed all training and testing sessions.

Participants were separated by academic grades (freshman, sophomore, junior, and senior) and body mass categories (45.4–58.6, 59.1–72.3, 72.7–85.9, and 86.4+ kg), which were modified from boys wrestling weight classifications used by the Alabama High School Athletic Association (3). To keep the number of participants per group large enough for statistical power and maintain homogeneity as a function of age and body mass, the participants were randomly assigned to 1 of 2 exercise groups using a stratified sampling technique. Participants' descriptive data are listed in Table 1. Group 1 (n = 24) and 2 (n = 25) both performed a stepwise periodized full-body resistance exercise program and took 100 bat swings a day, 3 days per week, with their normal game bat for 12 weeks. Group 2 performed additional rotational and full-body medicine ball exercises 3 days a week for 12 weeks. The participants had to attend 90% (n = 33) of the total 36 exercise sessions to be included in the study. Participants could not miss on subsequent days or they would be dropped from the study.

Procedures

During the first week of the study, before assessment of 3 repetition maximum (RM) parallel squat and bench press, all participants underwent 2 low-resistance (5 × 5RM) strength training sessions in order to become familiar with the exercises and to practice proper lifting and spotting techniques. All participants performed a regimen of full-body, dynamic warm-up exercises before all training and testing sessions. Each participant received a booklet with a weight training log that had photos and written descriptions of each exercise that enhanced correct exercise and spotting techniques.

Pre- and post-testing for height, body mass, body composition, 3RM dominant, and nondominant torso rotational strength, sequential hip-torso-arm rotational strength (medicine ball hitter's throw), and 3RM parallel squat and bench press was conducted and recorded in 1 day. The sequence of tests, protocols, and rest periods for the post-test was consistent with those of the pretest. Table 2 displays the experimental timeline. For control of outside influences, all participants were instructed to consume a normal diet and abstain from additional resistance training and taking ergogenic aids (e.g., creatine, amino acids, metabolite beta-hydroxy beta-methylbutyrate monohydrate) during the 12-week research period. Each participant recorded pre- and post-testing food and drink consumption the day before and the day of strength testing in a diet log to assure his normal diet was maintained.

Training Protocols

Resistance training for both groups was performed 3 days a week for 12 weeks according to a stepwise periodized method similar to previous research (5, 32, 33, 35). Two warm-up sets of 10 repetitions for the core strength exercises (parallel squat and bench press) were completed to prepare the participants before performing the more demanding 3 working sets. Set workloads were progressively increased every 4 weeks during the study after having 3RM parallel squat and bench press reassessed. Additionally, various assistance exercises (stiff-leg deadlift, dumbbell rows, shoulder press, biceps curls, and triceps extensions) were performed to make the training more comprehensive and realistic to the off-season training programs of high school baseball players. Furthermore, those participants in group 2 performed medicine ball exercises 3 days a week for 12 weeks. Specific medicine ball exercises were chosen to mimic the sequential, ballistic, and rotational movements of hitting and throwing a baseball 2 days a week (e.g., Monday and Friday). The hitter's throw is an exercise in which the athlete stands in his normal batting stance with a medicine ball held at the level of his back shoulder with both hands, then throws the medicine ball forward with maximum rotational effort, simulating his normal baseball bat game swing. The standing figure 8 is an exercise in which 2 athletes stand back-to-back and rotate as quickly as pos-

TABLE 2. Experimental timeline.

Pretraining	Week 1	Week 4	Week 8	Week 12 and post-training
Sunday	MWF	Sunday	Sunday	MWF
First meeting	Begin training protocol	3RM: PS and BP	3RM: PS and BP	
Informed consent				
PAR-Q*				
Descriptive data questionnaire				
Measure foot placement for PS and MBHT				
Measure depth for PS				
Monday and Wednesday				
Familiarization days				
Sunday				Sunday
Height and body mass				Height and body mass
Body composition				Body composition
3RM TRS, MBHT				3RM TRS, MBHT
3RM: PS and BP				3RM: PS and BP

* PAR-Q = physical activity readiness questionnaire; RM = repetition maximum; TRS = torso rotation strength; MBHT = medicine ball hitter's throw; PS = parallel squat; BP = bench press; MWF = Monday, Wednesday, and Friday.

sible while exchanging a medicine ball behind their backs to each other at waist level. The speed rotation is an exercise in which the athlete stands with his back to his partner, receives a passed medicine ball from his partner with both arms fully extended, catches the medicine ball, quickly rotates from the torso, and passes the medicine ball back to his partner with both arms still extended. The standing side throw is an exercise in which the athlete stands in his batting stance, holds a medicine ball with both hands at hip height, quickly rotates, and tosses the medicine ball forward with maximum effort. All of the rotational medicine ball exercises were performed in both directions to maintain and focus on torso muscle balance.

Whole body, explosive medicine ball exercises were performed 1 day a week (e.g., Wednesday) when resisted leg exercises were not performed. The granny throw was performed by holding a medicine ball above the head with both arms extended; in 1 continuous motion, the athlete lowered his extended arms between his legs and buttocks to a parallel squat position and then explosively extended both arms from the shoulders and legs while releasing the medicine ball directly above his head with maximum effort into the air. The standing backwards throw was performed by holding a medicine ball above the head with both arms extended; in 1 continuous motion, the athlete lowered his extended arms between his legs and buttocks to a parallel squat position and then explosively extended both arms from the shoulders and legs while releasing the medicine ball behind his head with maximum effort into the air. The squat and throw was performed by holding a medicine ball with both hands at chin level with elbows pointed in opposite directions; in 1 continuous motion, the athlete lowered his buttocks to a parallel squat position and then explosively extended both elbows and legs while releasing the medicine ball directly above his head with maximum effort into the air. The mass of the medicine ball and number of repetitions progressed every 4 weeks from greater to lighter mass and fewer to greater repetitions to allow each participant to perform each exercise at velocities close to or at "game speed." Training protocols and a schedule of exercises are displayed in Tables 3 and 4, respectively.

Torso Rotational Strength

A Cybex Torso Rotation Machine was used to measure torso rotational strength. Standing torso rotations (warm-up exercise) were performed prior to torso rotational strength testing. Participants sat in the Cybex Torso Rotation Machine, putting both feet on the foot plates while squeezing their knees securely against adductor pads. The seat height was adjusted and recorded so that the participant's knees were at a 90° angle to the foot plates. Participants sat upright, grasped the handles with each hand, and pulled their chests firmly to the chest pads. A warm-up protocol similar to the 3RM parallel squat and bench press test (4) was used before participants attempted the 3RM torso rotational strength test. Participants performed a 3RM torso rotational strength test from their

TABLE 3. Training protocols.*

	Weeks 1–4			Weeks 5–8			Weeks 9–12		
	Sets	Reps	% 1RM	Sets	Reps	% 1RM	Sets	Reps	% 1RM
Groups 1 and 2									
Core	2 WU	10	45, 50	2 WU	10	45, 50	2 WU	10	45, 50
	3	10	65, 70, 75	3	8	70, 75, 80	3	6	75, 80, 85
Assistance	3	10		3	8		3	6	
Bat swings	10	10		10	10		10		10
Group 2									
Medicine Ball @	2	6	5 kg	2	8	4 kg	2	10	3 kg

* Adapted with modifications from Szymanski et al. (35). Reps = repetitions; RM = repetition maximum; WU = warm-up. Groups trained using % of predicted 1RM values based on load assessments by Wathen (38). Rest time between all sets = 90 seconds. @ = See schedule of exercises (Table 4).

TABLE 4. Schedule of exercises.

Exercise	Monday	Wednesday	Friday
Groups 1 and 2			
Parallel squats*	X		X
Stiff-leg deadlift†	X		X
Barbell bench press*	X	X	X
DB row+	X	X	X
Barbell shoulder press†	X	X	X
Lying triceps extension†	X	X	X
Barbell biceps curl†	X	X	X
Bat swings	X	X	X
Group 2‡			
Hitter's throw	X		X
Standing figure 8	X		X
Speed rotations	X		X
Standing side throw	X		
Granny throw		X	
Standing backwards throw		X	
Squat and throw		X	

* Core exercise.
† Assistance exercise.
‡ Medicine ball exercise.

dominant side first. This was the direction they swung their bats. After completing the 3RM torso rotational strength test for the dominant side, the participant's nondominant side was measured. This allowed the lead author to evaluate unilateral rotation strength. Participants performed a torso rotation that was similar to the range of motion of a baseball swing ($-30°$ to $+75° = 105°$) and similar to the range of motion used in other research (6, 11). One of the limitations of the Cybex Torso Rotary Machine was that the participant's body (chest, hips, and thighs) could not be completely restrained from movement. Therefore, participants could have some forward, backward, or lateral movement of the shoulders, hips, or legs. Each participant's movements were monitored and corrected according to the directions of the Cybex Torso Rotary Machine. If the participant failed to complete the full range of motion (105°) or did not perform the test properly, he was given 2 minutes of rest and then asked to perform another test with the load decreased by 2.3 kg.

Sequential Hip-Torso-Arm Rotational Strength: Medicine Ball Hitter's Throw

A 1-kg, 2-handed medicine ball hitter's throw test for maximum distance was used to assess sequential hip-torso-arm rotational strength. A suspended 0.75-m square (target), through which the participant was required to throw the medicine ball, was positioned 3.0 m in front of the participant at a height of 0.75 m. Research suggests that whole body medicine ball throw (31) and seated medicine ball throw (16) tests are valid and reliable for assessing explosive power for an analogous total-body movement pattern, general athletic ability, and upper body dynamic performance. During pilot work, reproducibility of the medicine ball hitter's throw test for collegiate baseball players was high, with a statistically significant correlation between repeat tests performed on 2 consecutive days ($r = 0.96, p < 0.001$). A 1-kg medicine ball was used because it is approximately the same mass as the normal game bat (0.85 kg) of each participant. Before the 2 familiarization practice sessions began, during the first week of the study, the lead author demonstrated the medicine ball hitter's throw test. Then the participants were allowed to perform as many practice throws as they desired until they were able to make 3 consecutive throws with correct mechanics within 0.50 m of their longest practice throw.

On the testing day, the participants were instructed to stand in their normal game batting stance, holding the medicine ball at their back shoulder height with 2 hands behind a white taped line. They were then asked to throw the medicine ball (similar to the movement of their normal batting swing) for maximum distance. The medicine ball throwing technique for each participant was monitored, and corrections were made to reinforce traits identified for swinging a baseball bat by Breen (9) and Race (25). In an attempt to maximize reliability for each testing session, foot placement was recorded to assure that each movement was duplicated. Distance was measured from the front of the white line to the closest edge of the medicine ball imprint. The participant was given 2 practice trials to coordinate his aim through the square, followed by 3 maximal efforts (2). The best distance (in meters) was recorded.

Muscular Strength: Parallel Squat and Bench Press

According to Baechle et al. (4), many of the participants in this study were classified as a beginner or intermediate lifter (<1 year of resistance training experience). Due to this training status, an estimation of 1RM (the most amount of weight lifted 1 time) was determined by performing 3RM tests (the most amount of weight lifted 3 times) on the parallel squat and bench press using Olympic standard free weights because it was safer (36). Furthermore, 3RM tests were used because the participants may not have been accustomed to handling heavy loads and may have had a fear of failing or getting injured (17).

A regimen of full-body, dynamic warm-up exercises was performed before all testing and training sessions. There were 3 minutes of rest between near-maximal lifts (12). The 1RM was estimated using the load assessment table adapted from Wathen (38). The 3RM for parallel squat and bench press was assessed to estimate 1RM at 0 and after 4, 8 (to ensure that appropriate % was used during training), and 12 weeks of training using the methods described by Earle and Baechle (12). The 3RM was determined to be the maximal weight lifted after 2 consecutive unsuccessful trials (27). The progression of incremental load increases used for both tests had already been established for 1RM testing (4). Weight belts were worn during near-maximal lifts. Proper spotting techniques were demonstrated and used for all exercises (12). In an attempt to maximize reliability from pre- to post-test, both the foot placement and squat depth were recorded and replicated using a Z-Squat. An adjustable bungee cord was stretched between 2 metal poles with holes marked every inch at a level that assured that the 90° of knee flexion was repeated. The 90° squat depth was determined when the upper thigh was parallel to the floor (knee is in 90° of flexion). When the buttocks of the participant touched the cord, the participant performed the concentric phase of the parallel squat. The lead author used a weight training percentage table to determine the appropriate resistance (%) of the predicted 1RM for parallel squat and bench press for each participant during training sessions (38).

Statistical Analyses

SPSS (version 11.5; SPSS Inc., Chicago, IL) was used for the statistical analyses. Independent sample t-tests were conducted prior to the 12-week study to determine if any

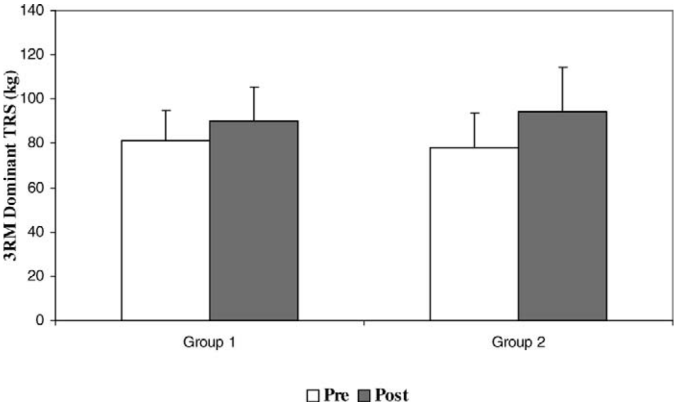

FIGURE 1. For 3 repetition maximum (3RM) dominant torso rotational strength (TRS), there was a significant difference (*) within groups ($p \leq 0.05$) and (+) between groups ($p \leq 0.05$). Group 2 made significantly greater improvements than group 1.

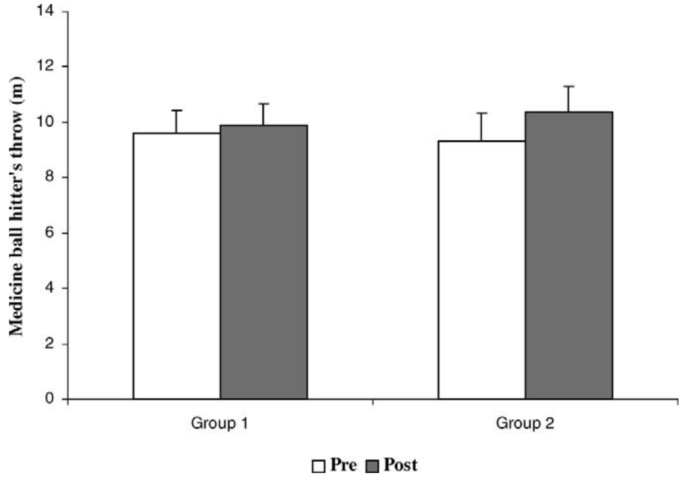

FIGURE 3. For medicine ball hitter's throw, there was a significant difference (*) within groups ($p \leq 0.05$) and (+) between groups ($p \leq 0.05$). Group 2 made significantly greater improvements than group 1.

differences existed between the groups. To determine if any statistically significant differences existed between or within groups, 2 (group) × 2 (trials) repeated measures analyses of variance (ANOVAs) were conducted on torso rotational strength and sequential hip-torso-arm rotational strength: medicine ball hitter's throw. For parallel squat and bench press 2 (group) × 4 (trials) repeated measure ANOVAs were conducted. Effect size and observed power were also examined with the repeated measures ANOVAs on all variables. For all analyses, significance was set at an alpha level of $p \leq 0.05$. All data are presented as a group mean (± *SD*).

RESULTS

Torso Rotational Strength

Independent sample *t*-tests demonstrated no statistically significant differences between the 2 groups for 3RM dominant and nondominant torso rotational strength prior to training. Pre- and post-treatment means for 3RM dominant and nondominant torso rotational strength for group 1 and group 2 are presented in Figures 1 and 2. Although both groups made significant increases in 3RM dominant and nondominant torso rotational strength, a significant ($p \leq 0.01$) interaction effect between groups for dominant and nondominant torso rotational strength was observed. Group 2 had significantly greater increases in 3RM dominant and nondominant torso rotational strength than group 1 after 12 weeks of training.

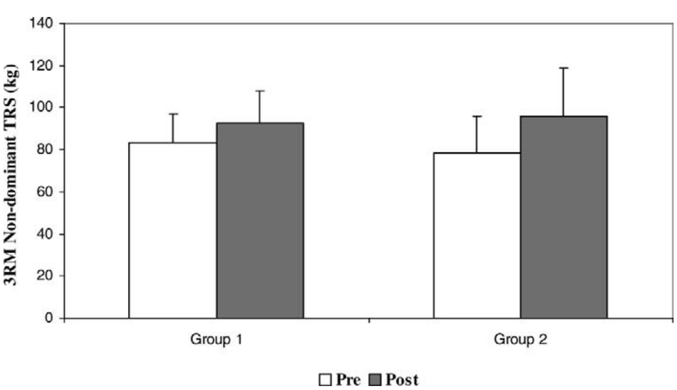

FIGURE 2. For 3 repetition maximum (3RM) nondominant torso rotational strength (TRS), there was a significant difference (*) within groups ($p \leq 0.05$) and (+) between groups ($p \leq 0.05$). Group 2 made significantly greater improvements than group 1.

Sequential Hip-Torso-Arm Rotational Strength: Medicine Ball Hitter's Throw

An independent sample *t*-test identified no statistically significant differences between the 2 groups for medicine ball hitter's throw prior to training. Pre- and post-treatment means for medicine ball hitter's throw for groups 1 and 2 are presented in Figure 3. Although both groups made significant increases in medicine ball hitter's throw, a significant ($p \leq 0.001$) interaction effect between groups for medicine ball hitter's throw was observed. Group 2 had significantly greater increases in the medicine ball hitter's throw than group 1 after 12 weeks of training.

Muscular Strength: Parallel Squat and Bench Press

Independent sample *t*-tests revealed no statistically significant differences between the 2 groups for predicted 1RM parallel squat and bench press prior to training. Pretreatment means, listed under 0 weeks, for predicted 1RM parallel squat and bench press for groups 1 and 2 are presented in Table 5.

Mean and percent change after 4, 8, and 12 weeks of training for predicted 1RM parallel squat and bench press for groups 1 and 2 are presented in Table 5. Both groups made significant increases ($p \leq 0.05$) in predicted 1RM parallel squat and bench press after 4, 8, and 12 weeks of training; however, there were no significant differences between groups on any of these testing days.

DISCUSSION

In the current study, group 2 (medicine ball group) made statistically greater increases in 3RM dominant and nondominant torso rotational strength (17.1 and 18.3%) than group 1. These results were hypothesized because group 2 performed the same stepwise periodized resistance program and number of total bat swings as group 1 and additionally performed a periodized rotational medicine ball program 2 days per week for 12 weeks. Even though group 1 did not perform any medicine ball exercises, they significantly increased 3RM dominant and nondominant torso rotational strength 10.5 and 10.2%, respectively.

TABLE 5. Mean (± *SD*) predicted 1RM PS and BP at 0 and after 4, 8, and 12 weeks of training and percent (%) change.*

Variable	0 wk	4 wk	8 wk	12 wk
PS, kg				
Group 1	108.8 (27.2)	129.8 (28.4)	142.4 (28.8)	154.8 (33.4)
Group 2	106.3 (23.4)	122.7 (23.9)	134.0 (26.2)	145.0 (27.7)
% change				
Group 1		16.2%†	23.6%‡	29.7%§
Group 2		13.4%†	20.6%‡	26.7%§
BP, kg				
Group 1	74.9 (18.5)	80.5 (17.5)	86.6 (18.0)	90.5 (17.9)
Group 2	71.7 (15.9)	79.0 (15.6)	82.5 (15.8)	86.1 (15.2)
% change				
Group 1		6.9%†	13.5%‡	17.2%§
Group 2		9.2%†	13.1%‡	16.7%§

* RM = repetition maximum; PS = parallel squat; BP = bench press.
† Significant difference within groups after 4 weeks of training at $p \leq 0.05$.
‡ Significant difference within groups after 8 weeks of training at $p \leq 0.05$.
§ Significant difference within groups after 12 weeks of training at $p \leq 0.05$.

Torso rotational strength gains can be attributed to swinging a normal game baseball bat (resistance implement) 100 times per day, 3 days per week, for 12 weeks.

In a related study, Blanton (6) found that using a torso rotary machine 1 and 2 times per week for 12 weeks increased torso rotational strength 17.9 and 21.8%, respectively. DeMichele et al. (11) had participants perform 1 set of 8 to 12 repetitions from right to left and vice versa to volitional fatigue using a torso rotary machine. Results indicated that training 1, 2, and 3 days per week for 12 weeks increased torso rotational strength 4.9, 16.3, and 11.9%, respectively. Because there was not a significant difference in torso rotational strength between the groups that trained 2 or 3 days per week, they recommended that the torso be trained twice per week.

Results from our study indicate that a high school baseball player can statistically increase torso rotational strength by performing a stepwise resistance training program and swinging a normal game baseball bat 100 times per day, 3 days per week, for 12 weeks. However, if one wants significantly greater gains in torso rotational strength, it is recommended that players perform our rotational medicine ball program. The percent improvement in dominant and nondominant torso rotational strength was similar between group 2 (17.1 and 18.3%) in our study and in the 2 related studies (21.8 and 16.3%) mentioned above. Another reason one should consider using our rotational medicine ball training program is that all medicine ball exercises were performed ballistically and sequentially in a manner that tried to closely mimic explosive, rotational baseball-specific movements. Even though the torso rotary machine does isolate and strengthen the muscles of the torso in the transverse plane, it does not train those muscles to move at the speeds and in the multiple planes they would while a player is performing dynamically on the field.

Group 2, as expected, made significantly greater increases (10.6%) in the medicine ball hitter's throw than group 1 because they completed the same stepwise periodized resistance program, took the same number of total bat swings, and performed the additional rotational medicine ball program that included the medicine ball hitter's throw as part of their training program. Like hitting or pitching, the sequential action of the medicine ball hitter's throw is dependent on a player's timing. If executed correctly, optimal transfer of energy from the large base segments (legs, hips, and torso) to the smaller distal segments (shoulders and arms) and finally to the object (bat or ball) that is projected away from the body will occur (24). Regardless of a player's hitting or pitching mechanics, timing is essential for the most efficient acceleration of each successive body segment in the kinetic link (39). If a player has good timing and increased strength (legs, torso, and upper body), he will be able to produce successively higher rotational velocities, which, in turn, will increase power (39). For a hitter, increased rotational power will produce greater bat swing velocity. For a pitcher, increased rotational power will produce greater throwing velocity. Both of these improved velocities are desired by baseball players and coaches at any playing level because it potentially equates to better performance, more wins, and ultimately more money.

Lyttle et al. (16) compared the effectiveness of maximal power training (MPT) with combined weight and plyometric training (CT) on various performance tests. The MPT group performed weighted squat jumps and bench press throws. The CT group performed traditional weight exercises (squats and bench press) and plyometric exercises (depth jumps and seated medicine ball throws) similar to our study. The results indicated that both groups produced significant improvements in all performance variables measured over the control group after 8 weeks of training. In particular, results indicated that both the MPT and the CT groups increased seated medicine ball throw 11.2 and 10.3%, respectively. Although the medicine ball tests (seated medicine ball throw and medicine ball hitter's throw) and the length of the 2 studies (8 and 12 weeks) were not the same, it is interesting to note that the percent improvement for the 2 different medicine ball tests for the CT group and group 2 in our study were similar.

Vossen et al. (37) used the seated medicine ball throw as a performance test to compare dynamic push-up (DPU) training and plyometric push-up (PPU) training on upper body power and strength. They reported that both groups made significant improvements on the seated medicine ball throw and that the PPU group had significantly greater improvements than the DPU group. These data indicate that plyometric training may be advantageous for improving upper body power and strength. The medicine ball exercises performed in our study were executed both ballistically and plyometrically. Because group 2 had significantly greater improvements in the medicine ball hitter's throw than group 1 in our study, performing additional medicine ball exercises should theoretically be advantageous for improving power for the baseball-specific, rotational movements of hitting and throwing.

Even though group 1 did not perform any medicine ball exercises, they significantly increased medicine ball hitter's throw 3.0%. Because they took 100 swings per day, 3 days per week, for 12 weeks with an implement that was similar in mass (0.85 kg) to the 1 kg medicine ball used to perform the pre- and post-test, it would not be unreasonable for sequential hip-torso-arm rotational strength to increase, because swinging a baseball bat is a form of resistance implement training.

In a related study, Sergo and Boatwright (29) stated that swinging any bat 100 times a day, 3 days per week, for 6 weeks increased bat swing velocity. Velocity is a change in position with respect to time. Power is the product of force multiplied by the velocity of movement (7). Thus, if swinging a baseball bat for 6 weeks increased bat swing velocity, then power would have also increased as long as force was maintained. Therefore, assuming bat swing velocity and power increased from 12 weeks of baseball bat swings in our study, this would, theoretically, result in a significant increase in the distance players could throw the 1-kg medicine ball.

The medicine ball hitter's throw test was designed to assess explosive, sequential strength of the hips, torso, and arms using the specific movement pattern of swinging a baseball bat with a 1-kg medicine ball. It was hoped that this could provide baseball and strength coaches with a reliable field test for assessing explosive, sequential strength and indicate that the medicine ball hitter's throw could be used as an exercise to train the torso and help improve sequential hip-torso-arm rotational strength. Based on our results, we believe that this was accomplished.

The percent change in predicted 1RM parallel squat and bench press in the current study is comparable to the results of other research projects using similar training programs (5, 35, 41). In our study, predicted 1RM significantly improved after 12 weeks of training 29.7 and 26.7% for parallel squat and 17.2 and 16.7% for bench press for group 1 and group 2, respectively. Baker et al. (5) reported that a 12-week linear periodized program, which is currently described as stepwise program (33), improved parallel squat and bench press strength 27.7 and 11.6%, respectively, for college-aged male participants who had at least 6 months of weight training experience. Szymanski et al. (35) reported that predicted 1RM strength improved 33.7 and 30.7% for parallel squat and 17.4 and 15.9% for bench press for 2 groups of high school baseball players after completing a 12-week stepwise periodized training program. These improvements are very similar to the results in our present study because the training program, maturation status, and type of athlete were virtually identical. Willoughby (41) demonstrated that 16 weeks of a linear periodized program increased 1RM parallel squat and bench press strength 34.0 and 23.0% for previously weight-trained participants. The low total training volume performed by participants in the study by Willoughby (41) should have contributed, in part, to the significant gains in parallel squat and bench press because they did not complete any assistance exercises. Also, the greater strength gains could be expected because the participants trained for 4 additional weeks.

In contrast to research cited above, Willoughby (40), in a similar training program, indicated that trained college-age participants increased 1RM parallel squat and bench press 48.0 and 28.0% after performing a linear periodized program. Training status of participants was identical to Willoughby (41). These results suggest that significant strength improvements in parallel squat and bench press can be accomplished by training 2 days per week. College-age participants who performed a 12-week stepwise program in Stone et al. (33), similar to previous research training programs (5, 35, 40, 41), reported significant strength gains in parallel squats but not to the extent as the research listed above. Results indicated that the stepwise program increased 1RM parallel squat 13.0% after 12 weeks of training. As expected, the participants in our study accomplished greater parallel squat gains (>27%) than the participants in Stone et al. (33) due to a lower maturation status, a lack of previous weight training experience, and lower initial parallel squat strength.

A baseball player's ability to utilize his body as a kinetic link when performing the rotational movements that occur during a game depends on the interaction of the 3 body (hips, torso, and upper body) segments (24). Improvements in torso rotational and sequential hip-torso-arm rotational strength in our study may be, in part, related to the improvements in parallel squat (leg) strength. Not only will an increase in leg strength contribute to increased vertical force production but also to rotational force production (torque) about an axis or joint. During the preswing and swing phase of hitting, the quadriceps, buttocks, and hamstrings have a high level of activity, which contributes to the legs' stabilizing role needed to initiate power as the torso rotates during a baseball swing (30). Therefore, the forces generated from the hips will be transferred through the torso to the upper body when performing explosive, sequential movements, such as the medicine ball hitter's throw, swinging a baseball bat, and throwing a baseball (30).

Practical Applications

Virtually all baseball movements (hitting, throwing, and crossing over from an athletic stance) are performed with explosive hip and torso rotation (34). In order to enhance baseball performance (hitting and throwing), baseball players need to improve the way they use their body as a kinetic link. Explosive, rotational power can be developed by performing movement-specific resistance training (31). For baseball players, this can be accomplished by swinging a baseball bat and performing medicine ball exercises (15, 34). This study suggests that a 12-week stepwise periodized strength training program with baseball bat swings can significantly improve torso rotational strength, sequential hip-torso-arm rotational strength, and predicted 1RM parallel squat and bench press strength for high school baseball players. Significantly greater improvements in torso rotational strength and sequential hip-torso-arm rotational strength can be developed by performing additional movement-specific medicine ball exercises at the end of each training session. Medicine ball training has several advantages: it is inexpensive; allows a wide variety of exercises to be performed sport specifically; allows athletes to strengthen the muscles of the torso in all 3 planes (frontal, sagittal, and transverse) of human movement; and develops sequential, explosive, rotational strength that mimic specific movement patterns. Additionally, medicine ball performance tests can provide strength and baseball coaches with a means of evaluating the effectiveness of their strength training program. Finally, the medicine ball hitter's throw test used in this study appears to be a reliable and valid method of assessing sequential hip-torso-arm rotational strength, which directly applies to the sport-specific movements of hitting and throwing a baseball.

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