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ORIGINAL ARTICLE

The Effects of Two Types of Training on the Physical Ability of University Baseball Players

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ABSTRACT

Background. Training in any sport aims to maximize athletes' physical capacity. **Objectives.** This study aimed to determine the effects of two training programs, functional training, and weight training, on the physical capacity of university baseball players. **Methods.** The participants included 10 university baseball players, divided into the functional training group (FTG, n=5) and the weight training group (WTG, n=5). The training was performed for 1 hour per session, three sessions per week, for 6 weeks. The dependent variables related to the two groups' physical fitness, aerobic and anaerobic capacity, were measured before training and 6 weeks after training. **Results.** The FTG showed significant improvements in right-hand grip strength and plank, and the WTG showed significant improvements in right-hand grip strength, left-hand grip strength, and plank. The FTG showed a significant improvement in side-step, and the WTG showed significant improvements in sit-up and side-step. For anaerobic capacity, the FTG showed significant improvements in pitching and batting speeds, and the WTG showed a significant improvement in batting speed. **Conclusion.** Both training programs led to significant improvements in the physical factors associated with increased athletic performance in baseball players, and the two programs' effects were complementary. Thus, training programs targeting specific areas that require improvement will increase baseball players' performance.

KEYWORDS: ***Baseball Players, Functional Training, Weight Training, Physical Ability.***

INTRODUCTION

Playing baseball requires the synchronous development of technical and physical factors, including muscular strength and endurance, power, and agility, as the sport mainly exhibits the characteristics of anaerobic exercise (1). Recent studies have actively investigated ways to efficiently improve the physical fitness of elite athletes (2, 3). Various studies have focused on specific training rather than uniform training in search of novel training programs (4, 5).

Functional training is a type of integration exercise that allows the use of the entire body where the core is maintained, and muscle and joint stability is developed considering the safety of each joint. Functional training has thus been reported to prepare athletes for specific skills required in a sport (6, 7). For functional training to enhance athletic performance, the principle of Specific Adaptation to Imposed Demands should be applied (8, 9), leading to functional movement patterns. Athletes must achieve an enhanced quality of exercise rather than increased exercise (10).

Weight training is the most common form of effective conditioning to increase athletic

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performance (11). Weight training plays a crucial role in the simultaneous development of muscular strength and cardiopulmonary function while facilitating the improvement of fundamental physical fitness factors and the personalization of training methods, making it a suitable physical fitness training method to enhance athletic performance. Weight training has also effectively stimulated each muscle group to promote muscle development and improve muscular strength (12, 13).

Identifying a novel training method to achieve the best outcome in sports is one of the primary interests of athletes and coaches. The interest is the greatest for elite athletes whose rate of adaptation to a given training and the consequent increase in athletic performance have reached a plateau (14, 15). This study aimed to determine the effects of functional and weight training on the physical capacity of university baseball players.

MATERIALS AND METHODS

Participants. This study included 10 university baseball players with career lengths of 10 or more years at a Seoul, South Korea university. A total of 10 baseball players were selected for this study among the players in various sports trained by the researcher. The athletes were randomly assigned to the functional training group (FTG; n=5) and the weight training group (WTG; n=5). The two groups were homogenous regarding age, height, weight, and athletic career length.

No participant had any physical limitations throughout the study period, as individuals with limitations such as musculoskeletal disorders within the previous 6 months were excluded. Before conducting the study, the purpose and procedures were explained to all participants, from whom consent to participate was obtained. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

Procedures. This empirical study was designed to investigate the effects of the 6-week functional and weight training programs on university baseball players. Each group performed the training once per session and three sessions per week for 6 weeks, and the variables related to physical fitness, aerobic capacity, and anaerobic capacity were measured before and after training using identical methods. Table 1 and Table 2 explain each exercise program. The measured items for the physical fitness assessment, aerobic and anaerobic capacity, were adopted from those used by the Doosan Bears, a professional baseball team in South Korea, with modification and complementation.

Physical fitness Measurement. Grip strength was measured using a dynamometer (Hand Grip, CAMRY, China). The participant held the device in each hand, from which the grip strength was measured twice, and the higher of the two measured values were recorded. The plank was measured using a stopwatch (Stop Watch, Pro-Specs, China) while the participant was prone on the floor. The measurement was taken once until the participant changed posture or a part of his or her body touched the floor at any point other than the supporting points. Trunk forward flexion was measured as the length of the participant's fingertip, whose hand was stretched downwards as they stood on a box. The higher value of the two measurements was recorded.

Aerobic capacity measurement. Sit-up frequency was measured on the Sit Up Machine (Fitex, Korea) once per 2 min, and the maximum repetition frequency was recorded.

The side-step was measured as the number of steps on or outside the left and right lines drawn vertically to the 3-m horizontal distance at either end. The measurements were taken every 2 min.

Anaerobic capacity measurement. The 30-m sprint time was measured using a stopwatch (Stop Watch, Pro-Specs, China), while the participant ran 30 m forward from a stop position as fast as possible. The standing jump height was measured based on the participant's heel while jumping with both feet up and landing with both feet on the ground. The measurement was taken twice, and the higher of the two measured values in cm was recorded. Pitching speed was measured five times using a pitch-speed device (Bushnell Velocity Speed Gun, Bushnell, USA), and the mean value in km/h was recorded. Batting speed was measured five times using a bat-speed device (Baseball Swing Analyzer, Blast, USA), and the mean value in km/h was recorded.

Functional training programs. The functional training program consisted of integrated movements based on unilateral movements in consideration of the characteristics of baseball movements. The exercise intensity was set to level 15 of the Rating of Perceived Exertion (RPE) scale. Table 1 shows a schematic diagram of the functional training program.

Table 1. Functional Training Program

Program	Content	Intensity	Time
Warm up	Dynamic stretching		5min
Activation	Abs & Glute activation		5min
Mon(Upper body)	Dumbbell half chest press, Dumbbell half bent over row, Landmine one arm press, Barbell push press, Pendlay row, Medicine ball slam	RPE 15	45min
Wed(Cardio)	Box sled, Air bike, Rowing, Treadmill run, Battle rope wave, KB swing, Side step, Ski erg, Landmine one arm row	RPE 15	45min
Fri(Lower body)	Bulgarian squat, Single leg deadlift, Lateral squat, Trab bar squat, back squat, Split squat, Sumo deadlift, box jump, Hops, Jumping lunge	RPE 15	45min
Cool down	Static stretching		5min

Weight training program. The weight training program was based on the conventional method involving barbells and dumbbells. The exercise intensity was set to level 15 on the RPE scale. Table 2 shows a schematic diagram of the weight training program.

Table 2. Weight Training Program

Program	Content	Intensity	Time
Warm up	Dynamic stretching		5min
Activation	Abs & Glute activation		5min
Mon(Upper body)	Bench press, Incline bench press, Military press, Barbell row, Lat pull down, Cable triceps push down, Arm curl	RPE 15	45min
Wed(Cardio)	Barbell thruster, Deadlift Dumbbell renegaded row, Barbell clean, Landmine press, Push up, Sit up, Kettle bell swing	RPE 15	45min
Fri(Lower body)	Back squat, Leg press, Leg extension, Leg curl, Lunge, Split squat, Hip thruster, Front squat	RPE 15	45min
Cool down	Static stretching		5min

Statistical analysis. All data were analyzed using SPSS version 21.0. Each group's pre-test and post-test measurements were analyzed using a paired t-test. An exception was the trunk forward flexion measurements for the FTG that were non-normally distributed, which were analyzed using the Wilcoxon signed-rank test. Between-group differences were analyzed using an independent t-test. The level of significance was set to $p<.05$.

RESULTS

Physical fitness. Right-hand grip strength increased by 2.56 and 5.56 in the FTG and WTG after the intervention, respectively, with both groups displaying significant increases. Left-hand grip strength increased by 2.2 in the FTG, although without significance, and 7.62 in the WTG with significance after the intervention. The plank was increased by 47.76 and 47.28 in the FTG and WTG after the intervention, respectively, with statistical significance in both groups. Trunk forward flexion increased by 2.4 and 0.2 in the FTG and WTG, respectively, after the intervention, but no statistical significance was found (Table 3).

Aerobic capacity. Sit-up frequency was shown to have increased by 10.4 in the FTG, although without significance, and by 6 in the WTG after intervention with significance. Side-step frequency was increased by 15.2 and 10 in the FTG and WTG after the intervention, respectively, with statistical significance in both groups (Table 4).

Anaerobic capacity. The 30-m sprint time decreased by 0.05 and 0.04 in the FTG and WTG, respectively, after the intervention, but neither group displayed significant differences. The standing jump height increased by 4 and 0.4 cm in the FTG and WTG, respectively, after the intervention, without significant differences. Pitching speed increased by 2.4 km/h in the FTG with statistical significance and decreased by 2.6 km/h in the WTG without significance after the intervention. Batting speed increased by 3.68 km/h in the FTG with significance and decreased by 6.94 km/h in the WTG with significance after the intervention (Table 5).

DISCUSSION

Physical fitness allows athletes to achieve a higher level of performance and endure repeated training (16). McDaniel reported that improved grip strength could increase the technical expertise of holding the ball and the force exerted upon throwing the ball (17). In this study, the right-hand grip strength in the FTG increased significantly after the intervention, although the left-hand grip strength showed no significant difference. While a direct comparison is difficult due to the lack of studies monitoring the changes in grip strength associated with functional training, Liu et al. reported an improvement in muscular strength after functional training (18), and Proto reported a significant correlation between muscular strength and grip strength (19). Based on the findings of these studies, functional training led to improved grip strength, which may be attributed to the effects of unilateral resistance exercise. After the weight training intervention in this study, both right- and left-hand grip strength showed significant improvement. It was in line with Dahan's study, which reported a significant improvement in grip strength after a 14-week weight training program (20). The significant increase in both the right- and left-hand grip strengths is presumed to be because participants in the WTG performed bilateral movements throughout the training period, whereas those in the FTG mainly performed unilateral movements.

Table 3. Comparison of Physical Fitness within Group and between Groups

	FTG	WTG	t	p[a]
Right hand grip strength(kg)				
Pre	55.14 ± 3.40	53.84 ± 6.69		
Post	57.70 ±3.65	56.04 ± 8.91		
Post-pre	2.56 ± 1.84	5.56 ± 3.86	1.567	0.156
T	-3.108	-1.355		
p[b]	.036*	.247		
Left hand grip strength(kg)				
Pre	53.84 ± 6.69	59.52 ± 4.70		
Post	56.04 ± 8.91	67.14 ± 7.53		
Post-pre	2.20 ± 3.63	7.62 ± 3.00	2.257	0.033*
T	-1.355	-5.673		
P	.0247	.005**		
Plank(sec)				
Pre	191.40 ± 35.90	123.00 ± 54.83		
Post	239.16 ± 42.27	170.28 ± 51.93		
Post-pre	47.76 ± 37.82	47.28 ±23.68	-0.024	0.981
t	-2.824	-4.462		
p	.048*	.011*		
Trunk-hip forward flexion(cm)				
Pre	3.60 ± 17.91	11.60 ± 2.19		
Post	6.00 ± 17.82	11.80 ± 2.28		
Post-pre	2.4. ± 3.13	0.2. ± 2.28	-1.064	0.287
t	-1.473 +	-2.276		
p	.141	.783		

FTG: Functional Training Group. WTG: Weight Training Group. [a] Independent t-test. [b] Paired t-test. + Wilcoxon signed rank test. Values: Mean ± Standard deviation. *, $p<0.05$; **, $p<0.01$

Table 4. Comparison of Aerobic Capacity within Group and between Groups

	FTG	WTG	t	p[a]
Sit up(times)				
Pre	64.40 ± 8.38	66.60 ± 10.24		
Post	74.80 ± 12.87	72.60 ± 10.74		
Post-pre	10.40 ± 9.32	6.00 ± 2.35	-1.024	0.336
t	-2.496	-5.721		
p[b]	.067	.005**		
Side-step (times)				
Pre	86.40 ± 10.78	80.40 ± 3.65		
Post	101.60 ± 7.64	90.40 ± 6.91		
Post-pre	15.20 ± 9.44	10.00 ± 3.39	-1.159	0.280
t	-3.599	-6.594		
p	.023*	.003*		

FTG: Functional Training Group. WTG: Weight Training Group. [a] Independent t-test. [b] Paired t-test. Values: Mean ± Standard deviation. *, $p<0.05$; **, $p<0.01$

Table 5. Comparison of Anaerobic capacity within group and between Groups

	FTG	WTG	t	p[a]
30m sprint(sec)				
Pre	3.99 ± .19	4.06 ± .10		
Post	3.94 ± .14	4.10 ± .08		
Post-pre	0.05 ± 0.05	-0.05 ± 0.05	3.191	0.013*
t	2.250	-2.283		
p[b]	.088	.085		
Standing long jump(cm)				
Pre	262.00 ± 16.32	253.40 ± 11.45		
Post	266.20 ± 16.36	253 ± 12.20		
Post-pre	4.20 ± 5.07	-0.40 ± 10.69	-0.869	0.410
t	-1.853	0.084		
p	.138	.937		
Pitching speed(km/h)				
Pre	136.00 ± 5.96	140.20 ± 8.34		
Post	138.40 ± 50.3	137.60 ± 7.02		
Post-pre	2.40 ± 1.52	2.60 ± 3.21	-3.150	0.014*
t	-3.539	1.812		
p	0.24*	.144		
Batting speed(km/h)				
Pre	102.66 ± 4.88	113.20 ± 9.77		
Post	106.34 ± 3.47	106.26 ± 9.55		
Post-pre	3.68 ± 1.94	-6.94 ± 2.78	-6.997	0.001***
t	-4.237	5.575		
p	.013*	.005**		

FTG: Functional Training Group. WTG: Weight Training Group. [a] Independent t-test. [b] Paired t-test. Values: Mean ± Standard deviation. *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$

Strengthening the core abdominal muscles and the trunk, the muscles responsible for maintaining spinal stabilization, could improve trunk muscular strength and agility. In contrast, balance and overall muscular strength could be enhanced via the routes of force across the upper and lower bodies based on the lumbar areas and the center of the trunk (21). The plank is the most common exercise for core stabilization that increases core muscle activity (22, 23). The FTG and WTG showed significant increases in the plank measurements following the intervention. It is presumed that the efforts to maintain a diversity of postural patterns against weight during each training program caused the changes in performance by increasing trunk stability.

Neither group showed significant differences in forwarding trunk flexion. The 5-min dynamic stretching prior to training in this study is thought not to have been sufficient to cause a significant improvement, while the exercise programs also lacked an adequate influence on improving agility. Further studies should develop and verify the effects of complementary programs regarding agility.

Baseball requires a sufficient aerobic capacity to enable the athletes to endure games played over an extended period of 3 hours per game while each team alternates in offense and defense nine times.

Sit-ups were performed for 2 min to measure the upper body's aerobic capacity, and only the WTG showed a significant improvement. The contrast between the WTG and FTG is thought to be due to the FTG performing exercises requiring multiple joints that do not affect the development of specific muscle groups. The side-step was performed for 2 min to measure the aerobic capacity of the lower body. Both groups showed significant improvements following the intervention, in line with Park's study on functional training and Ford's study on weight training (24, 25). Based on previous studies, functional and weight training significantly influence the lower body's aerobic capacity.

Baseball requires anaerobic performance in most elements of the sport, from running between bases to pitching and batting. Anaerobic capacity has thus been used as an indicator of the ability to utilize the ATP-PC system during energy metabolism and has shown a strong correlation with athletic performance in those who perform sprinting, throwing, and jumping (26). According to Hagerman et al., anaerobic capacity is the most powerful predictor of performance in baseball players (27).

The 30-m sprint time showed no significant improvement in either group. This study's lack of significant variation is thought to be due to the relatively short training period and the absence of transfer to actual movements. In contrast, in Hong et al.'s study, the 10-week training was followed by position-specific technical and physical training and practice games to transfer the enhanced physical capacity (28).

Standing jump height showed no significant improvement in either group. It contrasted with Faigenbaum's study, where resistance exercise was performed with or without plyometric training. The factors directly affecting this result, such as the exercise type, program, and intensity, should be thoroughly investigated in further studies (29).

Pitching speed showed a significant difference only in the FTG. Pitching performance is reportedly determined not by the contribution of specific segments of the upper or lower body but by the collaborating muscular contraction activities via the movements of the ankle, elbow, shoulder, and trunk joints based on each joint of the body. The pitch speed based on the link system has been shown to increase not simply by the strengthened muscles in a specific area but by the overall muscular balance (30, 31). It is thus presumed that the pitching speed increased after the FT, which promoted the use of various joints to perform integrated movements.

Batting speed significantly increased in the FTG but significantly decreased in the WTG. Batting in baseball has been reported in biomechanics, radiologic and electromyography studies to be a series of muscular activities in a kinetic chain connecting the hip, trunk, and arms (32-36). It may explain the contrast between the FTG, where functional training necessitates the coordination of the entire body through multiple joints, and the WTG, where weight training mainly involves single-joint movements.

CONCLUSION

This study aimed to determine the effects of functional and weight training on the physical capacity of university baseball players. The results of the 6-week training program were compared in terms of the athlete's performance before and after training. The measured variables showed that both training programs led to significant improvements in the physical factors associated with the increase in athletic performance of baseball players, while the effects of the two programs were complementary. Thus, training programs suitable for specific areas requiring improvement will positively affect baseball players' performance.

APPLICABLE REMARKS

- This study supports that functional training and weight training improve physical fitness, aerobic capacity, and anaerobic capacity in university baseball players.

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