Optimizing Baseball Velocity: An Empirical Comparison of Two Training Methods

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Abstract

This research project investigates the effectiveness of strength training versus plyometric exercises in improving pitching velocity through a controlled self-study. Over two designated training periods of four weeks, the subject will follow a regimen of two distinct workout protocols—traditional strength training and weighted ball resistance band training– while tracking—while tracking velocity changes using Rapsodo radar measurements. The study aims to determine which method yields greater gains to pitching velocity, providing insights into optimal training strategies for baseball pitchers. By systematically comparing the results against baseline throwing measurements, this project contributes to the ongoing debate on athletic conditioning while offering practical guidance for pitchers seeking increases in their pitch velocities.

Literature Review

The relationship between training methods and pitching velocity has been extensively studied, with researchers examining the effects of strength training, plyometrics, and weighted ball exercises. While these interventions have demonstrated varying degrees of success, the existing literature reveals both consistent findings and unresolved debates regarding optimal training protocols for pitchers. A synthesis of prior research provides a foundation for understanding how different approaches influence velocity while highlighting gaps that warrant further investigation.

MLB pitchers such as Tim Lincecum and Pedro Martinez were some of the hardest-throwing pitchers in their eras, throwing fastballs in the upper 90s, despite their wiry frames. They both achieved their high velocities due to focusing on mechanical efficiency and explosiveness through using plyometric exercises such as using bands, doing jumps, runs, and lightweight exercise. Martinez has spoken out against strength training, saying that it leads to muscle boundness, harming mechanics. However, modern day fireballers such as Aroldis Chapman and Mason Miller rely on extensive strength training regimens to gain velocity. Chapman, who holds the record for the fastest recorded pitch velocity at 105.8 mph, is said to be able to bench over 300 lbs and deadlift over 600 lbs. Miller, who has thrown over 103 mph is said to deadlift 545 lbs. However, no one training method has proven to be a one-size-fit-all approach for young pitchers looking to develop their pitching speed and mechanics.

Traditional resistance training has been shown to produce significant improvements in pitching velocity, particular among untrained athletes. Newton and McEvoy conducted an 8-week study comparing strength training, medicine ball exercises, and a control group, finding that the weight training group achieved a 4.1% increase in throwing velocity, whereas the plyometric group saw only a 1.6% improvement[1]. These results suggest that general strength development may be more impactful than ballistic training for athletes with limited prior conditioning. Similarly, Barrientos observed that compound movements targeting arm deceleration and rotational power contributed to enhanced pitching performance in high school and collegiate athletes[2]. However, plyometric training should not be dismissed entirely, as some studies have reported velocity gains without corresponding increases in strength, suggesting that neuromuscular adaptations may play a key role in certain populations[3].

Weighted ball training has emerged as another popular intervention, with programs such as Driveline[4] selling at-home training programs, though its efficacy and safety remain subjects of debate. Some studies report substantial velocity gains, while others caution against elevated injury risks. For instance, a six-week weighted ball program resulted in measurable velocity improvements but also led to a 24% injury rate among participants[5]. Conversely, research by DeRenne et. al. demonstrated that modestly overloaded balls (20% heavier or lighter than standard baseballs) could enhance velocity without compromising mechanics, provided training emphasized proper throwing technique. Lightweight balls (4-5 oz) have also shown promise, particularly for adolescent pictures, suggesting that underload training may be a viable alternative to traditional weighted ball programs[6]. Nevertheless, progressive resistance protocols using heavier balls (up to 17 oz) have yielded inconsistent results, with some studies reporting no significant advantage over conventional training[6].

Training duration and specificity further complicate the evaluation of these interventions. Longer programs (six weeks or more) with high workloads tend to produce more sustained improvements, as evidenced by multiple studies[7]. For example, a four-week conditioning program yielded measurable velocity gains[8], but extended interventions, such as a 10-week weighted ball regimen, demonstrated more pronounced and lasting effects[6]. Additionally, lower-body conditioning has been linked to pitching performance, with one study finding that sprint training led to greater velocity improvements than lower=body resistance exercises[7].

Despite these findings, critical questions persist regarding the ideal integration of these training modalities. The current body of research lacks consensus on the safest and most effective methods for different age groups and skill levels, particularly concerning weighted ball implementation. The present study seeks to address these gaps by evaluating two distinct training approaches within one experimentation framework, with both of them designed to optimize velocity development. By synthesizing existing evidence and introducing a novel experimentation framework, this research aims to contribute to a more comprehensive understanding of pitching performance enhancement.

Methods

This study employed an 8-week, two-phase (4-week each) design to compare the effects of weighted ball plyometric training and traditional strength training on pitching velocity. Each phase lasted four weeks, with a three-month rest period separating them to minimize carryover effects. Baseline velocity measurements were recorded prior to each training phase, followed by post-training measurements to assess pitching gains attributable to each training program.

The subject was a 16-year-old right-handed pitcher with two years of competitive experience. His height and weight was recorded as 5’8” and 140 pounds, respectively. He brought four years of prior weight training experience to the study but only minimal exposure to structured weighted ball programs. The subject completed all workouts individually and consistently throughout the study.

During the plyometric training phase, the regimen incorporated plyometric throwing drills and resistance band exercises targeting arm speed and neuromuscular efficiency. Key drills included:

- Marshalls / Pivot Pickoffs (Figure 1)
- Feet-Facing-Forward Throws (Figure 2)
- Rocker Throws (Figure 3)
- Conventional Throws and Pitches
- Resistance Band Exercises (Figure 4)

Figure 1. Marshalls / Pivot Pickoffs

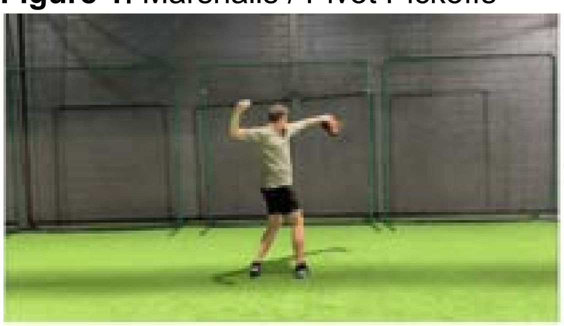

Figure 2. Feet-Facing-Forward Throws **Figure 3**. Rocker Throws

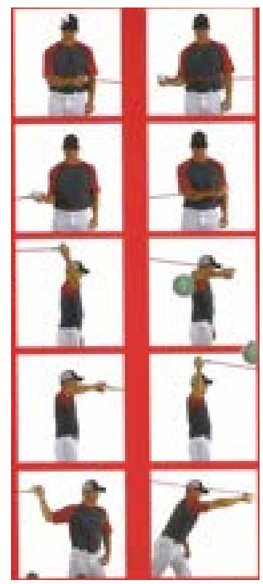

Figure 4. Resistance Band Exercises

Each of the first three drills served as warm-up and were performed for 10 repetitions per set, at 60-70% intensity. Conventional throws were performed at approximately 80% intensity using 200g and 300g weighted balls.

Figure 5. Medicine Ball Throws

These were supplemented by 8 pound medicine ball throws (Figure 5) to reinforce rotational mechanics, and resistance band exercises to strengthen deceleration and stability. The resistance band exercises consisted of internal and external rotation at 3 main positions: With the elbow fixed to the side, hand facing upwards with the elbow bent 90 degrees, and a traditional pitching arm path. The throwing volume consisted of 15 warm-up throws at 60-70% intensity, followed by the 4 weighted ball drills with sets of 8-10 repetitions. Resistance band work involved three sets of 12 repetitions per exercise.

Following a three-month rest period and second baseline testing, the subject entered the next training phase. This phase also lasted four weeks with four sessions per week and prioritized compound lifts and rotational power. Exercises included:

- Barbell Squats
- Deadlifts
- Rotational Cable or Medicine Ball Twists
- Trap Bar Jumps
- Overhead Press
- Bent-Over Rows
- Bench Press
- Leg Extensions and Curls
- Lateral raises
- Leg Press
- Tricep Extensions

The prioritized compound lifts were programmed at 60-80% of 1RM for four sets of 10 repetitions. This phase aimed to enhance force transfer from the lower body while maintaining the velocity gains achieved during the weighted ball segment.

Velocity data was collected using a Rapsodo device following a standardized warm-up protocol. Each session began with dynamic stretching and resistance band activation before progressing to weighted ball warm-up throws and 30 baseball throws at increasing intensity. The testing protocol required 10 max-effort fastballs with 30 seconds of rest between throws, with Rapsodo capturing velocity and spin rate metrics. Each test was done in similar conditions on flat ground. Pitching mechanics were held as consistent as possible in order to isolate the effects of the training regimens.

For analysis, an independent two-sample t-test compared pre- and post-phase velocities. Python's SciPy library and Google Sheets handled statistical computations and data visualization. This methodological approach ensured rigorous evaluation of how each training modality contributed to velocity development.

Results

The following section will analyze the data and determine the effect that each training regimen had on pitch velocities. The significance of the impact of each training regimen will be determined through a paired t-test, which compares the mean of two related samples. The first training regimen, plyometric training, yielded two samples of ten pitching velocities each: one baseline sample before the training intervention and one end sample after the training intervention.

Plyometric Training

	1	2	3	4	5	6	7	8	9	10	**Avg**
Baseline	63.6	66.1	60	63.4	65.3	63.2	62.3	61.5	62.7	65.9	**63.4**
End	66.1	66.3	67.2	66.9	68.0	68.4	64.5	65.9	65.7	64.6	**66.4**

Strength Training

	1	2	3	4	5	6	7	8	9	10	**Avg**
Baseline	63.6	65.4	64.5	63.2	64.9	62.2	64.3	62.1	62.8	62.2	**63.5**
End	66.4	66.9	67.8	68.0	65.7	66.8	67.1	68.2	67.7	67.4	**67.2**

The subject saw a 3.0 mph increase in mean throwing velocity over the 4 week span with plyometric training. A t-test showed this change was highly significant, with a p-value of 0.00083528. The subject then saw a 3.7 mph increase in mean throwing velocity over the 4 week span with strength training, with a 0.7 mph greater increase in velocity. This increase in velocity had a p-value of 0.0000002052, also that this change was highly significant. These p-values represent the probability of observing a difference of this magnitude or greater if, in reality, the training had no effect and any changes in pitching velocity were due to random variation. In other words, there is less than a 0.1% chance that these results occurred purely by chance under the null hypothesis. Because this probability is far below the commonly accepted significance threshold of 0.05, there is strong evidence to reject the null hypothesis and conclude that both trainings resulted in a meaningful increase in pitching velocity.

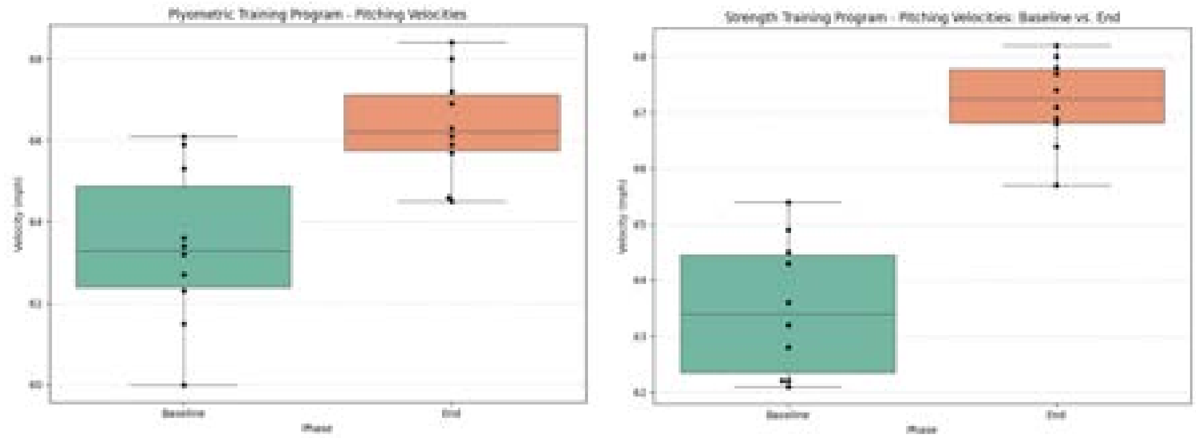

Figure 6. Box plots depicting the distribution of pitching velocities before and after each training regimen

The box plot above and to the left is a visual representation of the pitching data points before and after the 4 week plyometric training program. The mean pitching velocity after the plyometric training program was greater than the highest pitch velocity in the baseline, indicating a significant increase in overall pitch speeds over that time period.

The box plot above and to the right is a visual representation of the pitching data points before and after the 4 week strength training program. The slowest pitch after the 4 week strength training program had a greater velocity than the fastest pitch in the baseline, indicating a significant increase in overall velocity.

Discussion

This study set out to evaluate the effectiveness of two distinct training methodologies—plyometric training and strength training—on pitching velocity in controlled, 4-week training periods on the same subject. The results demonstrate that both training regimens produced statistically significant improvements in pitching velocity with p-values of less than 0.001, with the plyometric phase resulting in a 3.0 mph average gain, and the strength training phase yielding a slightly higher average gain of 3.7 mph. While the data may show significantly positive quantitative results, the subject experienced moderate arm discomfort while throwing after the strength training period due to a perceived decrease in flexibility. One potential explanation is the subject's limited prior exposure to weighted ball and resistance band training. Novel stimuli often produce rapid neuromuscular adaptations, such as improved muscle flexion and arm speed. These results support literature suggesting that plyometric and ballistic training can lead to improvements independent of raw strength games, especially in younger pitchers.

Although this study was limited due to its single-subject design and relatively short training windows, it provides an additional perspective through performing both main training methodologies on the same subject, allowing for another level of similarity in conditions. Additionally, it provides a perspective on the viability of both training regimens on younger athletes, indicating that both are able to cause a significant increase in velocity at a young age.

There is also the possibility of confounding variables influencing results. For instance, the subject had significant prior strength training experience but limited exposure to plyometric protocols, which may have affected responsiveness to each intervention. Recovery, sleep, and throwing volume outside of testing sessions were not controlled and may have influenced outcomes.

Despite limitations, the results offer practical insights for pitchers and coaches. Strength training may offer a slightly greater return on velocity development, particularly for athletes with an existing foundation in resistance training. However, plyometric and weighted ball training still proved effective, suggesting these approaches can stimulate physical adaptations and are especially useful for improving pitching speed. It should be noted that caution is warranted with weighted ball programs, particularly in younger or less-experienced populations. The 24% injury rate reported in various studies[5] highlights the need for carefully managed progressions to avoid overuse injuries.

This study underscores the need for further research with larger cohorts of subjects and longer intervention periods. Future work should examine the effects of concurrent (hybrid) training models—combining strength and plyometric elements within the same cycle—to determine whether such integration yields benefits. It is also advisable to incorporate injury tracking to assess the long-term safety of various training interventions, particularly those involving weighted equipment. Additional studies comparing trained versus untrained athletes, or examining how adaptations differ across age groups, would also help refine insights.

Both training approaches evaluated in this study, plyometric weighted ball training and traditional strength training, produced statistically significant improvements in pitching velocity over four weeks. In fact, the significance of the statistical tests were among the strongest compared to several existing studies. Strength training yielded a slightly greater improvement, suggesting that continued focus on force production and transfer may be more beneficial for performance. Ultimately, the findings support a tailored approach, with the choice of training modality influenced by the athlete’s training history, goals, and risk tolerance.

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