THE EFFECT OF OVERLOAD AND TRADITIONAL PITCHER CONDITIONING ON THE VELOCITY OF PITCHED BASEBALLS

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(ABSTRACT)

The purpose of this study was to determine the effects of two methods of conditioning for baseball pitchers: the overload method versus a traditional method. The subjects were 24 college pitchers from two NCAA Division I baseball programs. Data were the pre- and post-conditioning maximum velocities recorded for each pitcher.

Both programs exhibited increases in velocity. The traditional group recorded greater increases in velocity than the overload group. The implications of these results were examined.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION AND CONCEPTUAL DEVELOPMENT

Information for coaches regarding appropriate training techniques has never been in short supply. Baseball is no exception. It seems that every player, scout, or coach has his own proven regimen for success. Pete Rose teaches players to hit "his way;" Mark Langston and Tom House provide in-depth training for pitchers at multiple levels of experience. There are competing strategies for hitting, e.g., Charlie Lau vs. Ted Williams.

While pitching is a fundamental facet of baseball and has received its share of attention, there are many questions as yet unanswered regarding long-term pitcher development. Increasing velocity among college pitchers has been and continues to be a major concern among college coaches.

Coaches and trainers are often outspoken about their approaches. Coaches from all types of programs are publishing training information. Clearly, some of this plethora of training methods is a direct result of an increasing pressure on coaches to win and on players to excel, i.e., get the best scholarships and draft positions. Of course, instructional materials also have the potential to be quite lucrative financially. Aggravating the problem is the faddish nature of training programs, particularly in these recent times of a "more is better" attitude. Everything must be faster, bigger, stronger, more technologically advanced than in the past. "Old fashioned" conditioning programs are often dismissed without consideration of the benefits that they can offer.

There is a lack of scientific research regarding potential training regimens and little guidance for interpreting or using them. Unfortunate for the practicing coach as well as for sports studies as a discipline, little scientific or objective treatment of various techniques has been accomplished. Since many of these "proven" techniques appear to exactly contradict one another in method or philosophy, the coach and player are left, unfortunately, to trial and error selection of conditioning programs. The central thesis of this study is a construction of a traditional training program, in technique as well as philosophy, which will yield success for the player and coach. This study examined two different methods of conditioning for advanced baseball pitchers: the overload versus the traditional method for pitcher development.

Review of the Literature

Background literature on the nature of the primary conditioning schools of thought for baseball pitcher conditioning, as well as the traditionally- and overload-based conditioning programs, will follow. A general review of the importance of both velocity and conditioning in player development will be presented. The available research on overload and traditional conditioning methods are presented.

Pitching Velocity as a Fundamental Baseball Function

Pitching has been argued to comprise anywhere from seventy-five to ninety percent of the game of baseball (Farley, 1986; Schreiber, 1984). This is perhaps overstating the case, for the success of a baseball team is the result of a complex interaction among positions, individuals, coaches and contexts. Still, there can be no doubt that pitching is a critical facet to baseball success. In the long run, it is the team with successful pitching that survives rather than the power hitting teams, for successful pitching shuts down good hitting. A hitter is considered great if he can get a hit as seldom as thirty to forty percent of times at bat.

There is an inherent advantage to pitchers because batting is routinely regarded as the most difficult skill to master in the game because of the necessary visual tracking skills and body coordination (Burroughs, 1984). This fact becomes increasingly relevant as pitcher skills increase. The better the pitcher, the more difficult batting becomes. Therefore, from a coach's strategic position, it becomes paramount to capitalize on this seemingly inherent advantage. Thus, pitcher success is a vital component to team success.

One of the most common indicators of pitcher success is his velocity (read: speed of pitched balls). Since hitters have, on average .4 to .5 seconds to react to pitched balls, changes in ball velocity can have a tremendous impact on hitter success (Burroughs, 1984). No doubt a great measure of many great pitchers' success can be attributed to great arm strength, e.g., Nolan Ryan's 95+ mph pitches. Coaches and players alike want pitchers who throw "heat," high speed pitches which challenge batters with little reaction time.

Research on velocity of baseball pitches has focused on a variety of issues. Some of the earliest research was the verification of velocities of various pitches. General velocity research has examined the development of throwing skills in young children (Halverson, Roberton & Langendorfer, 1982; Halverson, Roberton, Safrit & Roberts, 1977; Spieth, 1977). Early research in velocity and baseball in adults (Slater-Hammel & Andres, 1962) simply measured velocity differences between fastballs and curveballs using six college baseball pitchers. Weinstein, Prather and De Man (1987) examined the interesting question of whether or not velocity for college pitchers changes if they are aware that they are being clocked, the so-called case of "scout-itis." They found, in a controlled experiment using 14 college baseball pitchers, that velocity decreased as a function of being observed. Indermill and Husak (1984) explored the relationship between accuracy and speed of the overarm throw, concluding that the seventy-five percent of maximum velocity produced the most accurate pitches for the sample of undergraduates.

Weight Training and Pitcher Conditioning

One of the goals of pitcher conditioning is the increase in the velocity of thrown pitches. But the question remains: How does the pitcher acquire this speed increase? Overall strength conditioning, in addition to throwing preparation, contributes to pitcher success.

In the past, the traditional method for the conditioning of baseball pitchers at all levels was repetitious throwing combined with total body conditioning such as calisthenics and aerobic exercise (namely, running). The rationale behind this method was that the only way to strengthen the pitching arm was through use. The method involved throwing at every practice, either distance throwing or game simulation or bullpen pitching. Pitchers were encouraged to throw regardless of the previous day's activities. Repetition was also thought to enhance the ability of the pitcher, i.e., not only did repetition strengthen the arm but the skill level was increased. In fact, throwing was encouraged to such an extent that it was used as a rehabilitation technique, where pitchers would "work through" minor arm ailments via throwing. Basically, instead of rest, a pitcher experiencing shoulder or elbow pain would throw until the pain went away. Sometimes, this may have worked, but there is no direct evidence that this rehabilitation resulted from extensive throwing.

Total body exercises were encouraged for pitchers, because the strength of the pitcher is as much a function of overall body and leg strength as it is of arm strength. Strong arms notwithstanding, pitchers who are "out of shape" do not last long on the mound. However, up until fairly recently (the past 15 years), weight training was considered not only not useful for pitcher training but detrimental to his performance.

Weight training was thought to restrict the range of motion of pitchers. The goal for pitchers was flexibility rather than bulk, and the common notions about weight training did not allow for this general conditioning. The school of thought about weight training was that even though a player may be stronger with the added bulk and muscle, his performance would suffer and therefore affect the whole team. Currently, with increased attention being given to sports medicine and athletic training, the use of weight training is widely accepted as useful and beneficial . Extensive research in the areas of sport medicine, athletic training, and total body conditioning has developed new methods, new equipment, and a better understanding of how the body works, how to train it, and how to care for it. Today's coaches and trainers understand the benefits of weight training that is properly developed and followed.

The focus is now placed on weight conditioning and toning rather than weight lifting for muscle bulk. Goals now are likely to be strong flexible muscles rather than strong bulky ones. Specific exercises have been developed which isolate and strengthen the muscle groups most likely to affect overall pitcher strength and performance. It is standard procedure today to have an overall conditioning program for baseball players, which includes weight training, stretching, and flexibility and aerobic exercises. Many professional and college programs now have strength and conditioning coaches as part of their staff whose main purpose is to oversee the total body conditioning of their athletes. Unfortunately, many programs cannot afford specialized personnel or may simply choose not to take advantage of strength coaches' knowledge. Thus, there is a need for a training program for pitchers which is primarily self-directed, produces fast results, and is relatively inexpensive.

Still, it is possible to overtrain in the weight room, creating a situation not unlike the weight lifting philosophy of the past. Instead of haphazard weight conditioning, a specific, controlled regimen of weight exercises must be employed to gain maximum output from pitchers. It is critical for coaches and trainers to have a sound knowledge of weight training principles and to incorporate them wisely into pitcher conditioning programs. Without the proper knowledge, a coach or trainer might lose the opportunity for pitcher enhancement because of the belief that weight training is bad for pitchers (or baseball players in general). Furthermore, weight training may not have the desired effects unless used correctly.

Weight training is indeed beneficial and should be used in conditioning programs. However, there are varying ways of incorporating this weight training into pitcher development. Both overload and the more traditional program presented in this study subscribe to the need for total body conditioning and the judicious use of weight training. However, there are still controversies surrounding whether or not overload techniques are superior to traditional conditioning methods.

Contradictory Approaches to Pitcher Development

One of the conditioning techniques which gained widespread and fast acceptance throughout various levels of baseball was the so-called "overload" method. This method of pitcher training uses the principle of increased resistance through heavier than normal equipment (Litwhiler & Hamm, 1973). For baseball pitchers, this entails using practice balls heavier than the regulation five-ounce weight. This technique has been used successfully in other sports, primarily track and field. In short, the overload method theoretically increases arm speed for throwing balls of normal weight by training with balls that are heavier. One of the benefits of this technique was that it speeds up the conditioning process.

The literature on overload training for baseball pitchers is primarily anecdotal. However, there have been several specific empirical studies examining the effects of this technique on the velocity of pitched balls. Van Huss, Albrecht, Nelson, and Hagerman (1962) conducted a study using 50 members of a university freshman baseball team. Each subject, after an overload warmup, was clocked on ten throws for maximum velocity with an eleven-ounce ball. The velocity of ten more throws with a regulation ball were then recorded. Ten subjects were selected to repeat the testing, using a regulation ball exclusively. The mean velocity of subjects for successive throws shows that velocity after overload warmup was consistently higher than without overload.

Brose and Hanson (1967) conducted a six-week study using 21 freshman baseball players. The subjects were assigned randomly to three groups of equal size. Group 1 used wall pulleys as overload training using ten pounds of tension. Group 2 used a ten-ounce baseball as overload training, while Group 3 served as a control. Each subject threw twenty regulation balls for maximum velocity at a target thirty-five feet away. Prior to the test, each subject was allowed a supervised warmup. Results indicate that velocity gains are not great enough by overload to be considered superior.

Litwhiler and Hamm (1973) conducted a 12-week study on overload using five college pitchers. Weighted and regulation balls were alternated during practices. All throws were made at regulation 60'6", the distance from the front of the pitching rubber to the back point of home plate. All throws with the regulation ball were at maximum velocity, while throws with the weighted balls were alternated between submaximum and maximum velocity. The weight of the overload ball was increased every two weeks, ranging between 7 and 12 ounces. Subjects were tested for velocity every two weeks. The results of this study showed that overload training significantly increased velocity for all five subjects, although the authors provide no statistical results to corroborate their conclusions.

A variation of the overload method is Variable Speed Training, where both heavier and lighter than normal balls are used to increase velocity. DeRenne, Tracy and Dunn-Rankin (1985) conducted a ten-week study comparing overload training to variable speed training using high school varsity baseball pitchers. The overload group began with a warm-up period consisting of easy throwing of a weighted ball, gradually increasing the distance to 150 feet. After the warm-up period, each subject threw to a catcher in the bullpen at one-half to three-quarters speed for ten to fifteen minutes. Once a week during the bullpen segment of the workout, each subject would throw at full speed ten to fifteen minutes with a weighted ball and finally with a regulation ball for ten minutes to conclude the workout. Each subject worked out with a specific weighted ball for two weeks, and at the end of that period, tested velocity with a regulation ball. The variable speed training group used a similar workout but instead of overweighted balls, they used underweighted balls in addition. Both treatments showed significant gains in velocity. The variable speed group did, however, show twice as much average gain (3 mph vs 1.5), though the difference was not statistically significant.

When reviewing this literature, several cautions should be noted. One may not be able to draw any substantial conclusions about the efficacy of overload training on overall pitcher conditioning because of the context of the studies. By far, the context of choice for these studies is limited in the sense that the impact of overload on velocity is measured across a small number of pitches. Overload, in these studies, is used as a warmup method, not as an overall strategy for increasing velocity. For example, velocity increases are often measured after a few pitches. Thus, there is no real assessment of the long-term conditioning potential for overload methods. Though the studies take place over a period of weeks, the warmup philosophy is still employed. Litwhiler and Hamm (1973) argue for more research examining overload techniques over the course of time. Furthermore, the distance thrown in these studies is typically much shorter than the 60'6" distance (e.g. Brose & Hanson, 1967). There is also a wide variation in weights used across studies, from four to twelve ounces, which makes generalization and program development difficult because of an absence of programmatic treatment of the issue.

Hypotheses

One conclusion from the literature reviewed is that overload training does appear to increase velocity within the limited conditions of these studies. In addition, the widespread acceptance of the technique and anecdotal evidence supports its effectiveness claims. Still, training methods seems to be very faddish, probably because of the number of high profile players and coaches pushing individual conditioning programs. Furthermore, there may be unintended negative consequences of training using the overload method. In particular, using equipment that is not regulation game weight for fast conditioning may alter the pitcher's throwing mechanics. However, De Renne (1985) found that Variable Speed Training implements (using varying weights of thrown implements rather than all overload or underload) should be ones that are close to standard game equipment. This enables the throwing motion to remain constant without alteration to compensate for much heavier or lighter weights.

More importantly, Anderson (1979), in a detailed movement sequence analysis of the overarm throw, showed that variable sizes and weights of the throwing implement cause adjustments in the general overarm pattern. In short, every time the weight of the implement changes, the mechanics of the pitcher's arm movement change also. For a coach and player who are attempting to find and maintain a proper and effective throwing sequence, there may be ramifications of the overload method which subtlely undermine the effectiveness of the pitcher. Intensive overload training may also contribute to overuse and premature stress ailments in pitchers.

Overload training may indeed be effective; however, a test of this method as a long-term conditioning technique is in order and is one of the goals of this research. Specifically, overload and more traditional conditioning methods will be examined and compared in this study, where the primary difference between programs is the use or absence of overload techniques.

The null hypotheses tested were the following:

H1: **Over an eight-week conditioning program, there was no difference in pitcher velocity for subjects trained using the overload method.**

H2: Over an eight-week conditioning program, there was no difference in pitcher velocity for subjects trained using the traditional method.

H3: The overload method group will not show greater increases in velocity than the group training without overload training.

Both overload and traditional methods should increase velocity because of increased pitcher strength over time. However, the issue at hand is whether or not overload training causes substantial velocity increases over more traditional conditioning techniques. Given the potential for changes in pitching mechanics and fewer real pitching simulations in the overload method, the question arises whether or not the overload method is beneficial overall for pitchers? This study examined the velocity changes over an eight-week conditioning period using two different training techniques: one using the overload method and the other using the more traditional approach to pitcher development.

CHAPTER 2

METHODOLOGY

This study examined the effect of two conditioning programs on the velocity of pitched baseballs. Subjects were 24 college baseball pitchers, 12 each from two NCAA Division I baseball programs. Subjects were not informed as to the purpose of this study; instead, they viewed the recordkeeping as a part of their regular practice routine. Data were the pre- and post-conditioning maximum velocities recorded for each pitcher. The independent variable in this field experiment was the conditioning program: overload versus traditional conditioning.

Sample and Data Characteristics

The overload conditioning data were collected from 12 members of the Radford University pitching staff in the Fall of 1988. Velocity data for the traditional conditioning group were collected in the Fall of 1989 from 12 members of the Virginia Polytechnic Institute and State University (Virginia Tech) pitching staff. Ideally, all data would have been collected during the same year; however, Radford University employed the specific program only during this one year. Unfortunately, comparable data from Virginia Tech for the same year was unavailable.

All data were collected using the same radar equipment (Ray-Gun[1]) without recalibration during the intervening period. All velocities were recorded in miles per hour by observers other than the experimenter. The data at Radford were collected by the pitching coach, and the data at Virginia Tech were collected by members of the pitching staff. Both data sets were collected in game simulations; however, only the Virginia Tech pitchers faced batters who actually made contact with the ball. The Radford pitchers faced batters who, by design, served as a target reference in the bullpen.

The sample in this study was a representation of college baseball pitchers. In addition, the programs at Virginia Tech and Radford University were similar enough in nature to make them comparable. The schools were both NCAA Division I programs with similar facilities and sizes of coaching staffs. The schools were located close to one another (approximately twenty miles) and recruited in the same region. Both programs had incorporated an eight-week fall program for player development. Furthermore, an examination of the total body conditioning of the two programs (see Appendix A) showed a great similarity in style and design. The key difference, clearly, was the presence/absence of overload training for pitcher conditioning (see Appendix B). Therefore, it

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[1] Copyrighted brand from Decatur Electronics.

was concluded that these programs could be compared.

Overload: Radford University Pitcher Conditioning

This program utilized a six-day program with specific overload conditioning, including not only Variable Speed Training (over- and under-weighted balls) but also resistance training using pulley and partner exercises. The daily program is presented in Appendix B. A total body conditioning program accompanied these workouts (see Appendix A). On Monday, the program started with a bullpen workout utilizing underload and overload principles in throwing. Ten pitches were thrown each with a five-ounce, four-ounce, six-ounce, and five-ounce ball, respectively. Tuesdays consisted of similarly weighted bullpen throwing (same workout) concentrating on mechanics from the stretch and power positions.[2] On Wednesday, the pitchers' workout consisted of 10-12 minutes of a football toss. The football was official size and weight. Long tosses of regulation balls for a minimum distance of 60 yards made up Thursday's regimen. These long tosses lasted approximately 20 minutes. Friday was game day (real and simulated). Each pitcher was encouraged to throw at maximum velocity (regulation weight) for three innings or 50 pitches, whichever came first. Saturday was a long toss day, here only ten minutes. Sunday

[2]The power position is that stage of the pitching delivery when the stride foot is down on the ground and the upper arm has rotated up in a position perpendicularto the shoulder.

was a free day.

Traditional: Virginia Tech Pitcher Conditioning

The Virginia Tech baseball program also used a six-day pitcher conditioning program along with total body conditioning.[3] This regimen began the week with live throwing, either a game or game simulation (live batters). Each pitcher threw approximately 60-80 pitches. Tuesday required easy tossing, which is half-speed tossing a distance of 60 feet for 30 repetitions. On Wednesday, pitchers threw long tosses and did arm speed drills. The long toss consisted of throws of approximately 150 feet at half- to three-quarter-speed. Each pitcher threw 30 distance tosses. Thursday was live throwing, similar to Monday. Friday was easy toss, similar to Tuesday. Saturday was a day off, while Sunday consisted of submaximum bullpen work for control, in preparation for maximum velocity live throwing the following day. Each pitcher threw approximately 20-30 pitches in the bullpen. No overload techniques were used in this program.

Statistical Analysis Plan

Several tests were used to examine the hypotheses. Significance

[3] In actuality, the pitching staff was randomly divided into two smaller groups for instructional ease. Each group used the same conditioning program; the days were staggered. All other details of the program was the same for both groups. For simplicity, only one daily order will be detailed in this section.

was established as $p < .05$. First, the pretest scores from the two groups were examined to see if the two schools were equivalent in pre-conditioning velocity. Given this equivalency, the effectiveness of each program was examined through an analysis of the pre-conditioning and post-conditioning scores within each program. Finally, the posttest scores from both conditioning programs were compared.

Hypotheses 1 and 2 state that both groups would exhibit no significant increase in velocity, i.e., the post-conditioning velocities for pitchers in each program would not be higher than their respective pre-conditioning velocities. Hypothesis 3 states that the two groups' velocity gains would not be substantially different, i.e., that the overload group would not exhibit greater post-conditioning velocities than the traditional group.

Pitching velocities were examined using t-tests. However, the small sample sizes (12 in each group) precluded the use of the parametric paired-t or Student's t for comparisons (Huck, Cormier & Bounds, 1974). Normality assumptions are also difficult to assess with extremely small samples. Nonparametric tests are distribution-free and are not affected by violations of normality or homogeneity of variance assumptions, though they are less powerful than parametric counterparts (Huck, Cormier & Bounds, 1974).

To examine the equivalency of pre-conditioning scores, the Mann-Whitney U Test was used. Wilcoxon Matched-Pairs Signed-Ranks Test was used to assess within-group velocity changes. Finally, post-conditioning velocities for the overload group were compared to the post-conditioning velocities for the traditional group using the Mann-Whitney U Test.

This study had a small sample. However, it is difficult to acquire a reasonable sample size because of the inherent number of subjects contained on college pitching staffs. College baseball programs typically carry only 10 to 15 pitchers on their rosters. The pooling of data from different programs was rejected as an alternative because of the lack of control over the administration of the conditioning programs. Furthermore, few coaches are willing to sacrifice their pitching staffs for eight weeks for an experimental program, whether effective or not.

CHAPTER 3

RESULTS AND DISCUSSION

The pre- and post-conditioning velocities recorded for all 24 subjects are found in Table 1. One important fact to note is that post-conditioning scores are higher or equal in all instances, regardless of the type of conditioning program used. There were no decreases in velocity. This is clearly evident in an examination of group means as well (see Table 2). Table 3 shows the results of the nonparametric tests used in the study.

Tests of the Hypotheses

In order to assess changes in velocity, it was first important to determine that pre-conditioning velocity levels in the two programs were equivalent. The Mann-Whitney U Test shows that the pre-conditioning velocities are equivalent ($U = 98.5$, $p = .126$).

Internal consistency, i.e., reliability, of the traditional group velocity scores was estimated using intraclass correlation. Data were not available for repeated trials using the overload method. The 45 velocity trials for the traditional group were blocked into nine sets of five trials each. A one-way ANOVA as applied to the trial blocks to estimate the intraclass

TABLE 1

RAW DATA FROM TWO CONDITIONING PROGRAMS

	Subject Number	Pre-Conditioning Velocities (MPH)	Post-Conditioning Velocities (MPH)
	1	81	85
	2	85	87
	3	85	85
	4	85	85
	5	81	84
Traditional	6	82	83
	7	81	82
	8	79	83
	9	77	78
	10	80	82
	11	86	88
	12	74	76
	1	78	80
	2	83	83
	3	78	81
	4	81	81
	5	76	77
Overload	6	75	77
	7	81	83
	8	75	78
	9	83	85
	10	82	82
	11	80	80
	12	74	75

TABLE 2

DESCRIPTIVE STATISTICS

PRE-CONDITIONING VELOCITY SCORES

	Traditional	Overload
Number of observations	12	12
Mean	81.333	78.833
Standard Deviation	3.601	3.271
Standard Error	1.040	0.944

POST-CONDITIONING VELOCITY SCORES

	Traditional	Overload
Number of observations	12	12
Mean	83.167	80.167
Standard Deviation	3.433	2.949
Standard Error	0.991	0.851

TABLE 3

SUMMARY OF STATISTICAL TESTS

Condition/ Hypothesis	Statistical Test	Test Statistic	Std. Dev. of Test Statistic	z	p	Accept/ Reject H_0
Equivalency of pre-test velocities	Mann-Whitney	U = 98.5	17.321	1.530	.126	Accept
Overload does not increase velocities	Wilcoxon Signed Ranks	T = 36	7.141	2.521	.012	Reject
Traditional does not increase velocities	Wilcoxon Signed Ranks	T = 55	9.811	2.803	.005	Reject
Equivalency of post-test velocities	Mann-Whitney	U = 111	17.321	2.252	.024	Reject

correlation coefficient. The estimate for reliability for the velocity scores was $R = .99$, which indicated that the scores were extremely stable across the recorded observations.

Hypothesis 1, that overload conditioning would have no effect on velocity, was rejected. Wilcoxon Matched-Pairs Signed-Ranks Test showed that post-conditioning velocities were higher than pre-conditioning velocities for the Radford University pitchers ($T = 36$, $p < .012$). Hypothesis 2, that traditional conditioning would have no effect on velocities, was likewise rejected for the Virginia Tech pitchers ($T = 55$, $p < .005$).

Hypothesis 3 was not supported. The results were favorable for the traditional conditioning program and were consistent with the arguments stated in this study for traditional training methods. The means of the post-conditioning velocities were found to be significantly different using the Mann-Whitney U Test ($U = 111$, $p < .024$). An examination of the means shows that the traditional conditioning method increased velocities significantly more than the overload method.

Discussion

The results of this investigation are supportive of previous research as well as surprising in their own right. Consistent with the previous research on overload (e.g., DeRenne et al., 1985), this study found that overload training increased velocity. Further, this study was an experimental test of velocity changes, as compared to previous research which relied solely on anecdotal evidence (Litwhiler & Hamm, 1973; Van Huss et al., 1962.

The investigation also found that a more traditional program also significantly increased velocity. To date, this study may be the most explicit comparison of velocity improvement between overload and a traditional workout which relied on repetitious throwing at regulation weight. It is unknown, however, what exactly constituted the control group in a limited number of studies. Van Huss and his associates (1962) used 10 subjects who threw only regulation balls; however, these 10 subjects had previously trained using an overload method which may have undermined their status as a control. Brose and Hanson (1967) used an unknown control group workout.

The most intriguing result found in the present study was that overload and traditional conditioning programs are not equally successful at increasing velocity. While subjects in both conditions did show consistent increases, the traditional approach proved to be more effective than the overload method. The statistical and practical significance of this finding has strong implications. Even a small change in velocity can work in a pitcher's favor. More dramatic are the increases in velocity after a focussed pitcher development program. Both groups exhibited at least a 1 m.p.h. increase in velocity after only eight weeks development. Clearly, the amount of change that can occur for a pitcher is not infinitely increasing, for a pitcher is likely to regress during the off-season. For the coach and pitcher, however, it is important to find ways to help the pitcher reach peak performance levels as soon as possible. A carefully constructed conditioning program will facilitate this progress.

As expected, both methods increased velocity over time. However, the coach and pitcher must also note that the traditional approach, in short, worked better. Greater gains in velocity were exhibited by pitchers who did not use overload training. Pitchers will be able to increase velocity without the potential side-effects of overload training. Altered body and arm mechanics are less likely to occur in a traditional conditioning programs. Because only regulation balls are used, there is no need for the pitcher to compensate for varying weights. The use of consistent body and arm mechanics increases the likelihood of better control on the part of the pitcher. He may be able to throw more strikes if he has had an opportunity to pitch using a consistent technique. In order to perfect any complicated motor skill, the athlete must perform that skill as routinely as possible.

For the successful pitcher, his mechanics must be second-nature. His concentration needs to be on the batter and the game situation rather than on his own pitching mechanics. If he has practiced those mechanics often and realistically enough, he learns that motor skill. If he has used overload or variable speed training, much of his practice of the skill has been with equipment that is different from what he would be using in a live game where the skill counts the most. The basis of motor skill learning is repetition. Overload training has the potential to compromise this learning process.

Limitations and Implications for Future Research

This study attempted to show the merits of traditional conditioning programs for the development of college pitchers. Statistical comparisons demonstrated that, while both overload and traditional programs increased the velocity of pitched regulation baseballs, the traditional method was more effective. To investigate the complete effect of overload training, this study would have examined the minute changes in mechanics due to varying weights. Unfortunately, this was far beyond the scope of this study but should prove a useful avenue for future research by those interested in biomechanics and sports medicine.

One of the primary limitations of this study was its scope. Ideally, these hypotheses would have been tested over a longer training period and incorporated larger samples. The ceiling effect for velocity, i.e., the maximum velocity for a given pitcher, deserves more extensive research. One question that arose from these results is how these velocity gains act over time. Do pitchers regress in the off-season? And what would be the long-term effects of continued conditioning over several years on velocity gains?

Methodologically, this study would be stronger if the data were not solely the maximum velocities from a single post-conditioning trial period but rather were taken from a number of trial periods. Furthermore, greater control over both field conditions would enhance the ability to draw conclusions. This study demonstrated that the programs were roughly equivalent, but the fact remains that these two programs were conducted at different locations by different coaches. A more stringent test for future research should make an effort to control conditions more strictly. For example, measured velocities should be obtained in two conditions that are fully equal except for the presence/absence of overload techniques. These facts should be interpreted cautiously, but there seems to be a clear benefit from traditional pitcher conditioning programs.

Conclusion

This study was designed to investigate the effect of traditional and overload training on the velocity of pitched baseballs. The results appear to support the continued use of traditional pitcher development programs. The traditional conditioning program presented here has the potential to save valuable practice time. Muscle memory, which is enhanced in the traditional approach, will eventually yield a more effective pitcher. Muscle memory relies on repetition as its basis. So does the traditional conditioning program presented in this study. Accuracy might also be enhanced due to muscle memory effects. Future research should explore this link between conditioning programs and accuracy levels.

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APPENDIX A

GENERAL CONDITIONING PROGRAMS FOR VIRGINIA TECH AND RADFORD UNIVERSITY[1]

Type of Conditioning	Virginia Tech (No Overload)	Radford University (Overload)
Aerobic	Jump Rope Run (distance)	Run (drill)
Stretching	All muscle groups (before practice)	All muscle groups (before and after practice
Weights	2 days/week light weights/ repetitions	2 days/week light weights/ repetitions
Other	Plyometrics: Box-Hops Skates Gaint Walks Hill Sprints	Resistance Pulley- Stretch * Tension Throwing * Swim (1 mile) Air-dyne

[1] Overload techniques marked with "*"

APPENDIX B

DAILY PITCHING WORKOUTS OF TRADITIONAL (VIRGINIA TECH) AND OVERLOAD (RADFORD UNIVERSITY) PROGRAMS[1]

Day	Virginia Tech	Radford University
Monday	Live Throwing	Weighted Throwing * (over- and under-)
Tuesday	Easy Toss	Weighted Throwing * (stretch and power)
Wednesday	Long Toss Arm Speed Drill	Football Toss *
Thursday	Live Throwing	Long Toss
Friday	Easy Toss	Live Throwing
Saturday	OFF	Long Toss
Sunday	Submaximum Live Throwing	OFF

[1] Overload techniques marked with "*"

VITA

MICHAEL EUGENE NICHOLSON

Michael E. Nicholson was born on July 3, 1962 in North Carolina where he spent his youth, attended school and college, and met his wife, Carolyn. His interests include sports of all types (as spectator and participant), reading, and travel.

Mike earned a B.S. in Parks and Recreation Administration from Wingate College in Wingate, North Carolina. At Wingate, he was a pitcher for the Bulldog baseball team. Following graduation, he pursued a graduate degree in Health and Physical Education at Virginia Tech. He has had graduate teaching experience as well as extensive coaching experience.

He is currently the assistant baseball coach at Virginia Polytechnic Institute and State University. His previous professional experience has included coaching positions with American Legion and collegiate summer league teams. He has also be an instructor at various baseball skill camps since graduating from college. His professional plans are to continue his studies of baseball, either at the collegiate or professional level.