The Effects of In-Season Strength Training on Muscular Strength Development

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Abstract

The purpose of this study is to determine if an in-season strength training program will yield statistically significant improvement in muscular strength. This study used a pre-experimental design with a purposive sample. The twelve participants were selected from a junior varsity football team at a Baltimore County public high school. The goal of the study was to determine if an in-season strength training program should be utilized at the high school level. The null hypothesis was there would be no change in muscular strength. The hypothesis was accepted for two exercises, and rejected for two exercises. Further research in this area is recommended.

CHAPTER I

INTRODUCTION

Overview

Participation in interscholastic athletics is a passion for many students in high schools across the United States. Most athletic programs use off-season strength training programs to develop athleticism in each athlete in order to create the most competitive team possible for the season. Most coaches highly value this type of training, as it not only develops strength, which is necessary for most sports, but it also develops power, speed, agility, cardiovascular endurance, and injury prevention (Ruivo, Carita, & Pezarat-Correia, 2016).

Even though strength training is valued, when the season begins, most athletic programs tend to abandon strength training programs in favor of on the field practice and conditioning. Coaches, especially high school coaches, have limited time to interact with their athletes, and most make the decision to sacrifice the development of athleticism for practicing skills and strategy related to their sport.

In this study, the researcher will examine the effects of an in-season strength training program on members of a high school football team. As a high school physical education teacher and football coach, the researcher is especially interested in determining the benefits related to in-season strength training and how it could benefit athletic teams.

The researcher is also interested in determining if the benefits of strength training during the season could outweigh the benefits of on the field practice time. If the benefits are large enough, the researcher will recommend some sort of in-season training for the entire team.

Statement of Problem

The purpose of this study is to determine if an in-season strength training program will yield statistically significant improvement in muscular strength. If athletes who participate in the program gain a significant amount of strength throughout the season, it will provide support for using a strength training program for the whole team during proceeding seasons.

Hypothesis

The null hypothesis is that there will be no significant difference in muscular strength between athlete's pre and post-season measures.

Operational Definitions

The independent variable used in this study is the *Bigger, Faster, Stronger* weight training program. This program was slightly modified by the researcher in order to ensure that each participant would be able to participate at his full ability on days of competition. For example, heavier lifts were done early in the week in order to reduce the risk of muscle soreness on Friday or Saturday, which are typically contest days.

The dependent variable used in this study is the change in each participant's muscular strength. This is measured by an estimated one-rep max test that is assessed across four different exercises: bench press, deadlift, squat, and power clean.

Chapter II

Review of the Literature

This literature review discusses the effects of strength and conditioning programs on an athlete's ability to gain and maintain muscular strength. The first section will examine current usage of strength and conditioning programs and their importance. The second section will examine a cost-benefit analysis of weight training. The third section will examine various types of training, and how they are currently used. And finally conclusions will be drawn about the usage of in-season strength training.

Introduction to Strength Training

Strength and muscular endurance are important co-determinants of athletic performance (Ruivo, Carita, & Pezarat-Correia, 2016). Strength training is an important component of successful athletic teams, as along with other components of physical fitness such as speed, coordination, and flexibility, strength training is necessary to optimize the performance of athletes. Most high level athletic teams engage in strength and conditioning programs designed to increase muscular strength (as well as other components of fitness) to give the athlete a competitive edge (Castillo et al., 2012). This is especially important in sports like football that are heavily strength based. In fact, according to Young and Pryor (2007), "…physical fitness and anthropometric measures are believed to be related to playing performance" (p. 111). However, when the competitive season begins, most teams prefer to sacrifice strength training time in order to spend precious time on the field developing other components that are critical to the sport.

While most teams use pre-season strength and conditioning to build muscular strength, in-season training is more commonly focused on building cardiovascular endurance (Reynolds, Ransdell, Lucas, Petlichkoff, & Gao, 2012). This is achieved on field drills and conditioning sessions usually conducted during or after practices which allows maximum time to practice skills related to the sport while building fitness directly related to the sport. In the sport of football, sprints and agility drills are very common components of practice designed to increase cardiovascular endurance needed during a game. However, these drills are ineffective at building the muscular strength that is needed during a game situation. Since athletes are not training for strength as intensely, muscular strength scores tend to go down as the season progresses (Hrysomallis, & Buttifant, 2012). In order to maintain muscular strength during the season, some teams will use strength training sessions during the season, but a balance must be achieved between building strength, and building on-field skills needed for the sport.

Costs and Benefits of Strength Training

Obvious benefits of strength training exist such as an increase in muscular strength and endurance, along with less obvious benefits such as an increase in agility, cardiovascular endurance, and reduction in chance of injury (Kai, 2010). In fact, pre-season indicators of performance include an athlete's level of muscular strength (Young, & Pryor, 2007); in that the higher an athlete's muscular strength measures, the more likely he is to perform better during the season. Typically, teams will use pre-season strength and conditioning programs to train athletes to be in peak physical condition for their season, however once the season begins, many teams sacrifice training time in exchange for practice time in which they can hone specific skills related to the competition.

During a season, strength training can be used for many benefits. According to Hrysomallis, & Buttifant (2012), athletes, especially younger athletes, will lose muscular strength as the season progresses. Because these athletes are no longer training for muscular strength during the season, their bodies will adapt to the lower intensity and begin to lose muscular strength until a strength training program is resumed. The in-season strength training program could negate the effects of this strength loss, and athletes may even see an increase in strength as the season progresses. This will not only give these athletes an advantage during the season, but when the season is over, they will be more prepared to resume their normal training routine in preparation for the next season.

Of course there are potential negative components of strength training that come into play. First, there is a risk of injury when participating in the training routine itself. Athletes, especially those who are unfamiliar with training concepts and technique are at risk of injuries ranging from small, inconsequential injuries, such as pulled muscles or bruises, to major injuries such as broken bones and torn ligaments (Fortington et al., 2016). The risk of these injuries can be minimized through proper program planning, proper coaching of technique, and proper monitoring of the training session. All training, especially for younger athletes should focus on safety, fitness and enjoyment (McDaniel, Jackson, & Gaudet, 2009).Second, when looking directly at in-season training, time is valuable, and practice time must be sacrificed if a strength training program is to be implemented. Most coaches either do not have the time to implement an additional training program, or value on-field time over developing strength. There is also a risk that training could impede game performance. When exercising, muscle soreness may occur due to the breakdown of muscle tissue. This soreness could cause athletes to experience a decline in game performance, especially in the days immediately following a training session

(Scudese et al., 2015). To combat this problem, training sessions during the season should avoid heavy training in the days immediately preceding any game or contest; saving the more intense sessions for the days farthest away from the contest, and gradually decreasing the intensity as the contest becomes closer. The day immediately before the contest, any activity should focus on maximum recovery in order for athletes to be in peak physical condition to play in the game.

Types of Strength Training

There are various types of training that are effective for athletes. First, they should be sport specific (Castillo et al., 2012). Young athletes wishing to improve their sports performance should participate in training that builds speed, agility, and most importantly muscular strength, (McDaniel et al. 2009). During pre-season training, strength training should include various exercises at a high volume, high weight, and high frequency. This technique will be effective in building the most strength in a short amount of time (DeWeese, Hornsby, Stone, & Stone, 2015). During the season, strength development should focus on low volume, low weight, and low frequency. This should also be coupled with high rest time between sets (three minutes or longer) in order to maximize muscle recovery (Scudese et al., 2015). Because athletes will be playing games during the season, the low intensity of the in-season training will not impede game performance while still allowing for the growth and maintenance of muscle.

Planning the training program requires an understanding of the principles of overload, variation, and specificity (DeWeese et al., 2015). These principles allow coaches to develop a program that will allow for maximum strength growth across necessary muscle groups for the specific sport in a timely fashion to be most effective. This will ensure that training will have the most potential to carry over to game time performance.

Conclusion

When using an in-season strength training program, careful planning must be insured in order to negate the possibility of negative impacts including injury, loss of game productivity, and loss of other essential practice time, while still ensuring the program achieves the goals of increasing strength, combating possibility of injury, and improving the athleticism of each athlete. The ultimate question is whether or not an in-season strength training program is beneficial to athletes, and to the team as a whole when it comes to game performance and if it helps the team win games.

Chapter III

METHODS

Design

This study used a pre-experimental design with a purposive sample. The independent variable is the type of strength training used by the athletes during the season; specifically, the *Bigger, Faster, Stronger* training program. The dependent variable is the athlete's muscular strength as measured by an estimated one-rep maximum test. This study used a purposive sample because only athletes who were both on the football team and who attended the tenth grade weight training physical education class were used. Both the pre-test and post-test were identical, and administered by the researcher.

Participants

The participants were selected from the junior varsity football team at a large school system public high school. All twelve participants were male, ranging in age from fourteen to sixteen years of age, but were all entering the tenth grade in the fall of 2016. Five participants were Caucasian, six were African American, and one was Nepali. These participants also chose to take an elective weight training physical education course in the 2016-2017 school year.

Instrument

The instrument used for this study was an estimated one repetition maximum test (1RM). This test is designed to estimate the maximum amount of force that an athlete can create in one contraction. The test is administered by letting an athlete choose a weight he believes he can lift at least one time, but not more than ten times. The athlete would then perform the lift with

correct form as many times in a row as he could. After completing the exercise, the athlete could calculate an estimation of his maximal exertion for each lift by entering the weight he used, and how many repetitions he achieved into a 1RM online calculator. Several 1RM calculators are available on the internet, and each athlete was asked to use the same website, "http://www.exrx.net/Calculators/OneRepMax.html" to calculate his 1RM". This online calculator uses the formula developed by Brzycki (1998) to provide an accurate estimation.

Procedures

Pre-test data was acquired over a two-day period in early August 2016. This was the end of the summer weight training and conditioning period that occurred while students were out of school for summer break. It was also positioned right before the start of fall sports practice. Athletes performed the 1RM test for the bench press and squat lifts on the first day, and performed the deadlift and power clean lifts on the following day.

Over the course of the ten week season, each athlete participated in daily practices or games at least five days per week. In addition, the athletes also participated in their weight training class that was taught by one of two physical education teachers. The "Bigger, Faster, Stronger" training model was used, which focuses on athletic performance and increasing strength across the four major lifts that this study focuses on. This model was slightly modified by the instructors in order to more effectively benefit the athletes in the class. For example, the heaviest lifts were performed farthest away from game days, and progressively became lighter through the week. Days following contests consisted of recovery via slow, controlled, mobility movements designed to restore muscles.

In the week following the end of the season, post-test data was collected in exactly the same manner as pre-test data. Bench press and squat were performed one day, and deadlift and power clean the following.

CHAPTER IV

RESULTS

Analysis of the Data

This study examines the effects of an in-season strength training program on muscular strength development of high school athletes. For this study, a null hypothesis was proposed stating the intervention would have no effect on muscular strength development. Twelve high school sophomores were chosen to participate in this study. Pre-test strength measures were collected prior to the beginning of the season using an estimated one-repetition maximum calculator across four different exercises. Final testing was administered following the season using the same method as the pre-test measures. Pre- and post-test means and standard deviations are displayed in Table 1.

Table 1
Pre and Post-Test Measures of Strength for the Group

Measure	Pre-test M (SD)	Post-test M (SD)
Bench Press	146.50 (35.923)	149.42 (36.243)
Squat	198.42 (51.527)	200.25 (54.458)
Deadlift	216.67 (44.219)	234.50 (52.238)
Power Clean	98.17 (22.997)	109.08 (20.943)

A series of dependent t-tests were run to examine any effects of the in-season training program on the four identified exercise lifts. Results showed no significant difference in bench press [$t(11) = -1.390$, $p > .05$] or squat [$t(11) = -.674$, $p > .05$]. The null hypothesis was accepted for these two exercises. Results also showed a significant difference in deadlift [$t(11) = -4.748$, $p < .01$] and power clean [$t(11) = -1.608$, $p < .05$]. The null hypothesis was rejected for these two exercises. Athletes demonstrated a significant increase in deadlift and power clean strength. These results and their implications will be discussed in the following chapter.

CHAPTER V

DISCUSSION

The purpose of this study was to determine if an in-season strength training program will yield statistically significant improvement in muscular strength. A null hypothesis was proposed stating there would be no difference in muscular strength. Because this study measured four different exercises, the results were mixed. There was no significant difference in bench press and squat strength; the null hypothesis was accepted for both of these exercises. Results for the deadlift and power clean did show a significant difference; the null hypothesis was rejected for these two exercises.

Implications of Results

The implication of results demonstrates that there are benefits to athletes participating in strength-training exercises during the competitive season for deadlift and power clean, but no benefits for squat or bench press. These findings suggest the use of in-season weight training is particularly useful for football, as an increase in strength in the deadlift and power clean exercises are beneficial to the performance of the sport.

Threats to Validity

There are several threats to validity that could compromise the results of this study. Most obviously, there is a threat with the method of sampling, as well as the sample size. This study used a convenience sample with a very small sample size.

Also, when measuring human performance, there are several personal factors that each performer must handle. During the pre- or post-test, there is no guarantee that each athlete is at

their peak physical condition, as it could change on a daily basis. Similarly, athletes (especially high school students) may also have emotional issues to cope with at the time of testing. These issues may have prevented the performers from reaching their true potential.

Another threat is based on the experience of the subjects. Since most of these athletes are novices to weight training, their ability to perform these exercises are tied strongly to their form. Many athletes experience a large increase in strength once they have had ample opportunity to practice performing the exercise correctly. This is especially true for the squat and power clean lifts, which are very technical exercises that may require years of training before they can be perfected.

Finally, while every measure was taken to ensure identical testing situations, of course there are situations in which that is impossible. For example, the pre-test was administered at the end of the summer, when the only thing that most athletes were doing was weight training for four days each week. The post-test was administered following the season after school, so athletes have been required to be in a mentally and physically demanding routine for several weeks, which could take a toll on each performer's abilities.

Connections to Previous Studies/Existing Literature

While there is not much research is available for strictly in-season muscular strength training, it is important to note that strength is important for athletic performance (Ruivo, Carita & Pezarat-Correia, 2016). Typically, muscular strength scores decrease during the season, so it is important that athletes, especially those who participate in strength based sports, take measures to maintain their strength during the season (Hrysomallis & Buttifant, 2012).

Implications for Future Research

Future studies could use a similar pre and post-test format, however it is recommended that an increase in sample size is advised. Also, using more experienced lifters would ensure that results would be based on an increase in muscle strength and not more experience lifting. Using athletes from all levels, including varsity, college, and professional athletes would also be beneficial.

Comparisons of results from different levels could also be compared to on-field performance to draw conclusions about exactly how an increase in muscular strength could affect the success of the team.

Conclusion

While the null hypothesis was accepted for two of the four exercises measured, the fact that a statistically significant increase in the other two exercises suggests that there is some benefit to participation in an in-season weight training program. More research is recommended in order to determine the best types of training and the effects related to performance.

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