

# The Impact of Academic Stress on Athletic Performance

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**Abstract:** Student-athletes at the United States Military Academy (USMA) must complete a rigorous academic program in addition to competing in Division I sports. The academic semester at USMA has “Thayer weeks,” stressful weeks tied to a number of deliverables for different classes. This study analyzes the change in athletic performance for football players from a baseline week to a “Thayer” week. The athletic performance is quantified by a system that measures the speed of a barbell while conducting the back squat and overhead press, in-line with a velocity-based training approach. The analysis found a significant change in the measurements between the baseline week and the “Thayer week.” Further, the analysis also found that these differences were greater amongst the underclassmen than the upperclassmen. The results also indicated that there was a larger difference in the bench speeds where the squat speeds did not show as significant a change from the rest week to the more difficult week. Further experiments are recommended to further explore these trends.

*Keywords:* Athletic Performance, Human Testing, Academic Loading

## 1. Introduction

The impact of academic stress on athletic performance directly relates to college athletics across the country. The United States Military Academy is definitely unique in its weeks of high academic loads planned to teach cadets how to properly manage their time, but all colleges and universities have weeks where there are mid-term and final exams which take the students outside of their normal routines because of a higher focus on academics. This study is designed to capture athletic performance through the use of technology measuring the speed of a barbell while conducting the back squat and overhead press. Each of these exercises includes large muscle groups in the body which require high amounts of energy to conduct. The purpose of this study is to determine whether the high energy demand and large amount of muscle recruitment will cause the major muscle groups involved in the exercise to react differently during a week of little academic demand compared to a week with very rigorous academic demand.

## 2. Background

### 2.1 Army West Point Football Program

When students at the United States Military Academy (USMA) at West Point complete their undergraduate studies, not only do they get a Bachelor of Science in their academic major, they also earn a commission as an officer in the United States Army. As such, the four-year program not only includes the academic requirements associated with any other accredited university, but extensive military training. Despite these time demands, many students decide to compete in Division 1 sports while at USMA.

Division 1 athletes at USMA are required to meet the same academic standards as their classmates. Additionally, while Division 1 athletes at other universities can withdraw from their universities without negative repercussions, athletes at USMA are required to repay the cost of their tuition if they withdraw or fail out of the academy.

Additionally, many Division 1 universities have a large assortment of majors, with some majors being substantially easier. Table 1 shows the top five majors across all Division 1 Football programs (Willis, 2019). The top 3 majors—arts and science, communication, and general studies—are typically not accredited programs, resulting in flexible schedules and looser

academic standards. However, USMA offers significantly fewer majors, with all majors accredited by Middle States or ABET, requiring the curriculum passes a set level of rigor. Note that the top major for football players is engineering management, which is an ABET accredited degree.

Table 1. Most popular majors by Division 1 college football players nationally and at USMA

	NCAA Division 1 Football	Army West Point Football
1.	Arts and Sciences	Engineering Management
2.	Communication	Psychology
3.	Exploratory and General Studies	Law and Legal Studies
4.	Business	Management
5.	Sociology	Sociology

## 2.2 “Thayer” weeks

The Office of the Dean collects a list of major graded events across the academy each semester. They compile these events in order to deconflict major graded events and to avoid “Thayer” weeks, those weeks that carry a significant academic burden. These events can be compiled to identify trends and periods of time when students had numerous deliverables. Figure 1 plots the number of students with major graded events against the week for the spring semester of Academic Year 2020.

The results show that during the first two weeks of the semester, very few students have any deliverables. More deliverables are due during weeks 3 and 4. During Week 5, the number of deliverables substantially increases, culminating in the first “Thayer” week, where most students have at least one major deliverable. The number of deliverables decreases and stays constant until another “Thayer week” at Week 9, immediately prior to Spring Break. Following Spring Break, their number of deliverables gradually builds, culminating in a large number of deliverables during Weeks 15, 17, and 18.

Academic stress is typically accompanied by numerous effects that hinder athletic performance (Lee, Kang, & Kim, 2017). In particular, sleep deprivation is common during “Thayer weeks” where students will periodically get less than four hours of sleep. A number of studies have identified that decreased sleep has an immediate effect on athletic performance (Belenky, et al., 2003; Fullager, et al., 2015; Watson, 2017). Additionally, the pure anxiety from academic testing can also result in a degradation in athletic performance (Zeidner & Matthews, 2005).

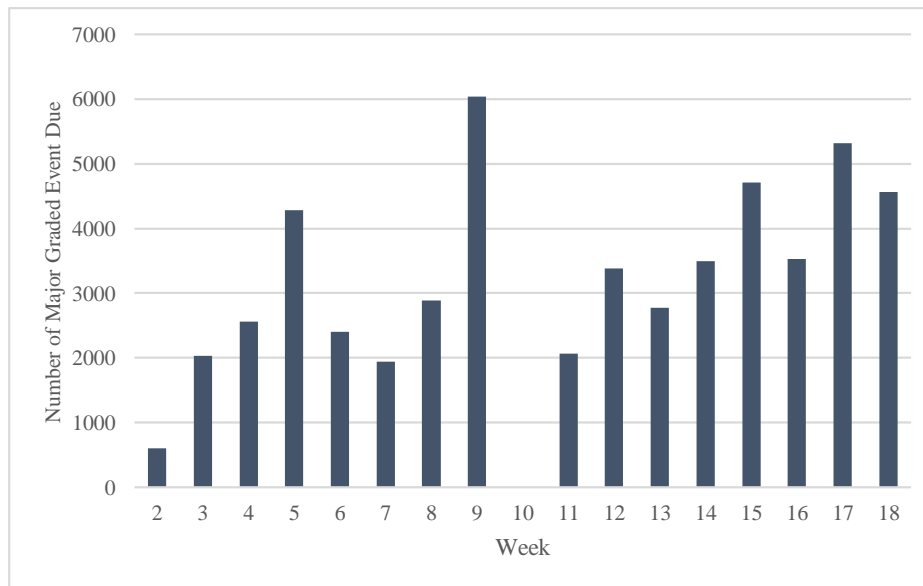


Figure 1. Number of major graded events due at the academy by week during spring semester of Academic Year 2020

### 2.3 Velocity Based Training

When developing a weight lifting program, there is always more than one way to gain strength and achieve the goals of the program. With the many different theories that many in the strength and conditioning world consider the “perfect theory,” one must be able to sort through and find the movements and programming aspects that fit their goals most efficiently and effectively. There are various types of barbell training such as volume-based training or bodybuilding, intensity-based training such as powerlifting and strongman training, cross training, or velocity-based training. In this study, the focus is on velocity-based training. By conducting this type of training during a week with a minimal academic load followed by a week with a heavy academic load, the study will aid in determining whether the academic load correlates to the speed of the barbell movement for the back squat and bench press movements.

In his article “Velocity Based Training,” Bryan Mann speaks on velocity-based barbell training and the many different uses it has for the goals of that athlete’s program. Velocity-based training (VBT) is categorized based on the barbell speeds and the aspect of strength which those speeds are helping the athlete achieve. There are five different categories which are in ascending order from the fastest barbell speed to the slowest barbell speed when training being Absolute Strength, Accelerative Strength, Strength-Speed, Speed-Strength, and Starting Strength.

Absolute Strength is exactly what it describes, the highest amount of weight the athlete can successfully complete the full range of motion for that movement. The definition the article by Bryan Mann uses is, “the ability to exert force maximally and moving towards increasing the 1 repetition maximum” (Mann, Ivey, & Sayers, 2015). Although a 1 repetition maximum (1RM) may be achieved by an athlete one day, that athlete will not be able to hit that weight as a 1RM every time he or she trains that movement. The reason velocity based training helps with this is because it is not necessarily testing the weight the athlete is using, but uses the bar speed to determine when that athlete has reached their 1RM for that movement which for a back squat is .3 m/s and the bench press is .15 m/s (Mann, Ivey, & Sayers, 2015). Although these 1RM speeds have been determined, the range for working absolute strength is any barbell speed below .5 m/s.

Accelerative strength is the next speed zone which VBT takes into account. Accelerative strength is defined as “driving against a heavy load as fast as possible” (Mann, Ivey, & Sayers, 2015). This is the type of training the Strength and Conditioning coaches for the Army West Point Football team focus on along with Absolute strength. The barbell speeds for this zone are between .5 m/s and .75 m/s. The reason the strength and conditioning staff for football focus heavily on accelerative strength is because of its benefit of not only building toward a better absolute strength due to the heavy weights but allows the athlete to be explosive and move the heavy weight at a higher speed than absolute strength allows. By slightly lowering the weight and moving the barbell faster, the athlete is developing an explosive strength on top of the absolute strength the athlete had gained from prior powerlifting type training. When speaking to Head Strength Coach Connor Hughes, he agreed with the statement that Velocity Based Training is not the end all be all to gaining strength because there is no substitute for moving heavy weight to gain strength, but it is certainly a training that almost enhances the athletes ability to move those heavy weights.

By measuring and recording the speed of the barbell during the back squat and bench press exercises, the study will be able to determine whether there is a difference in barbell speed using the same number of repetitions for each individual completing the exercise. By keeping the number of repetitions and doing so with the same weight on the bar from the first week to the second week, the study should reveal whether or not there is a correlation to the academic load those individuals are facing that week and the speed of the barbell during the workout.

### 3. Methodology and Data Collection

The null hypothesis for this analysis is that weeks associated with higher academic load (i.e., “Thayer weeks”) correlate with a decrease in athletic performance. If the hypothesis holds, the strength training team should account for these academically demanding weeks when developing training plans. As such, data was collected from members of the football team during a base week and a week with a higher academic loading.

Before gathering and recording data from the athletes, the players were divided into two groups based on the types of workouts they would be doing and were later broken down by class. The first group was made up of freshmen on the team and the second group was a mixture of sophomores, juniors, and seniors on the team. In order to collect the necessary data and measure athletic performance, a factor that could be considered extremely subjective, the collection method used was a Tendo unit. By using the Tendo units to read the speed of the bar, the data was consistent among each of the racks being tested. In order to keep the data consistent and reduce the amount of opportunity for error, the Tendo units were positioned in the same place on the same side of each barbell and the weights were all loaded in the same order for each repetition. Another factor taken into consideration was the number of repetitions for each player. These numbers were dependent on which group the player fell under. The freshmen group had one set of repetitions for each exercise, while the upper three classes had a different set of repetitions from that of the freshmen. The next possible opportunity for inconsistent data was which reading would the

data record. In order to mitigate any inconsistency, the first repetition of every set was the one used in the data. Using the first repetition minimized the chance for fatigue during the exercise to play a role in hindering the data due to the variations of repetitions between the two groups. Another factor was the rest time between sets for each player. This was also regulated so that each player had about the same amount of rest time between sets within 30 seconds of one another. Once the first repetition was completed, the spotter would yell out the number reading on the Tendo unit and the recorder would write down that number on the data table. Once all the data was collected, it was put into a table broken down by exercise, set number, and class. None of the player's names were used when inputting the data, they were each assigned an ID number based on their class.

The average values for each of the test subjects is shown in Table 2. Note that for several of the test subjects, injuries or other commitments prevented them from lifting during Week 2 or completing the bench or squat.

Table 2. Velocity measurements for the bench press and squat exercises for a baseline week and a “Thayer” week

	Week 1	Bench Week 2	% change	Week 1	Squat Week 2	% change
<b>Freshman</b>						
1	0.47			0.63	0.57	-10%
2	0.45	0.39	-13%	0.62	0.62	0%
3	0.39	0.39	-1%	0.60	0.59	-1%
4	0.53	0.43	-19%	0.67	0.73	8%
5	0.47	0.44	-6%	0.66	0.67	1%
6	0.44	0.43	-4%	0.65	0.72	11%
7	0.40	0.47	19%	0.68	0.75	11%
8	0.47	0.42	-9%	0.58	0.55	-5%
9	0.81	0.56	-32%	0.89	0.90	1%
10	0.42	0.46	9%	0.74	0.75	0%
11	0.49	0.43	-12%	0.61	0.66	7%
12	0.54	0.46	-14%	0.67	0.63	-7%
13	0.60	0.50	-17%	0.58	0.51	-11%
14	0.62	0.34	-45%	0.51	0.47	-8%
15	0.56	0.40	-28%	0.53	0.50	-6%
16	0.66	0.57	-13%	0.71	0.80	12%
<b>Sophomore</b>						
1	0.90	0.83	-8%	0.70	0.60	-13%
2	0.95	0.93	-2%	0.61	0.66	9%
3				0.72	0.72	-1%
4				0.68	0.66	-3%
<b>Junior</b>						
1	0.90	0.86	-4%			
2	0.82	0.79	-4%	0.64	0.58	-10%
<b>Senior</b>						
1	1.10	1.12	2%	0.67	0.74	12%
2	1.02	1.05	3%	0.67	0.69	2%
3	0.84	0.87	4%	0.83	0.80	-3%
4	0.80	0.78	-3%	0.77	0.73	-5%
5	0.93	0.98	5%			

## 4. Data Analysis and Findings

### 4.1. Statistical Analysis

The values presented in Table 2 indicate that there was a decrease in performance between Week 1 and Week 2, especially for underclassmen on the bench press. The changes are summarized in Figure 2, which indicates the percentage of

athletes that saw a decrease or increase in performance for the bench press and the squat. Note that more athletes saw a decrease on the bench press than the squat, with almost half of the athletes seeing an increase in performance for the squat.

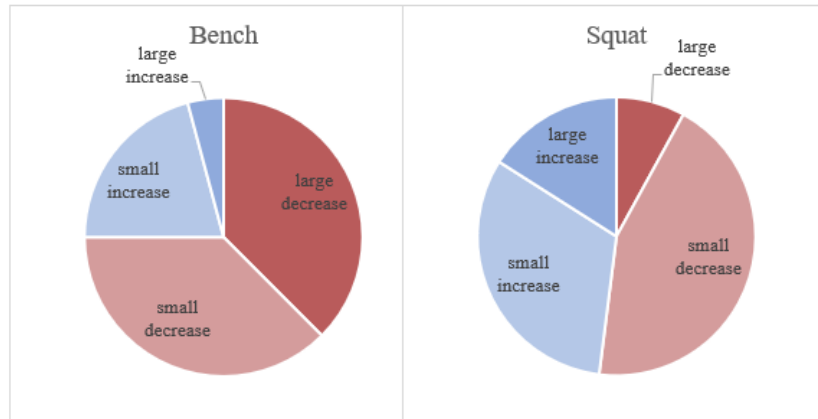


Figure 2. Distribution of athletes with increases and decreases in athletic performance between the baseline week and the “Thayer” week

Though Figure 2 indicates that a large percentage of athletes saw a decrease in performance, especially for the squat, a proper statistical analysis is required to determine the significance of these changes. A paired t-test is a statistical test that can be used to compare two data sets, where each observation is paired to a second observation. In this case, the analysis looked at the velocity measurements from a given athlete for each of the two weeks. The test generates a confidence interval; if that confidence interval does not overlap with 0, the results show statistical significance. The 95% confidence interval for this data set is -0.0005 and -0.0493, indicating that there is a statistically significant change in performance between the two weeks.

A linear model was constructed to further analyze this change in performance, in particular, looking at the decrease in performance associated with each exercise and by the year. A linear model was generated using R where the dependent variable was the degradation in performance and the two independent variables were the year (freshman, sophomore, junior, or senior) and the exercise (bench press or squat). Table 3 displays the results of the linear model. The p-value associated with the exercise is less than 0.05, indicating that the athletes’ change in performance correlates with the exercise. In particular, the degradation in performance for the bench press was more substantial than for the squat. Note that several of the athletes had a reduction in performance for the bench press but an increased performance for the squat. Additionally, the model indicated that there was a correlation, albeit a weak one, between the year and the degradation in performance, with underclassmen having a larger degradation than the upperclassmen.

Table 3. Coefficient table for the linear regression relating the change in velocity measurements to the exercise and the year of the athlete

Coefficients:				
	Estimate	Std. Error	t value	Pr (> t )
(Intercept)	-0.19685	0.05621	-3.502	0.00105 **
Exercise	0.09694	0.03511	2.761	0.00831 **
Year	0.05184	0.02672	1.940	0.05862 .
Exercise:Year	-0.02469	0.01641	-1.505	0.13940

## 4.2. Limitations and Future Work

Though the analysis found a statistically significant decrease in performance between the two weeks, the t-test only indicates correlation and not causation (Montgomery, 2012). As such, the decrease in performance could be linked to other externalities not included in the study. For example, the two weeks were in-season, so some of the athletes may have sustained minor injuries between the two weeks.

Additionally, the analysis only used 27 test subjects, with the freshman class being disproportionately represented. The trends relating year to the degradation in performance should be further studied with a larger data set containing a larger representation from upperclassmen. Similarly, the change in performance should be looked at for more than two exercises. The trends indicate that the degradation in velocity measurements was dependent on the exercise. Other exercises could have a more substantial change, and hence resulting in an increased chance of injury. A further study would also include athletes from programs outside of the football program.

If these tests follow the initial results from this study, the football athletic trainers need to account for the academic calendar and “Thayer weeks” when designing their strength conditioning programs. In particular, they should consider decreasing the workout intensity in certain exercises to account for a degraded athletic state, hence reducing the likelihood of injury.

## 5. Recommendations and Conclusions

Student-athletes at USMA are enrolled in rigorous academic programs that have periods of significant academic loading. These “Thayer weeks” are expected to result in a decrease in athletic performance. This study explored this hypothesis by collecting and analyzing velocity measurements from 27 football players at USMA in the bench press and squat exercises for a baseline week and a “Thayer” week.

The analysis found a significant change in athletic performance between the baseline week and the “Thayer week.” The analysis also found that these differences were greater amongst the underclassmen than the upperclassmen, and that the amount of degradation was dependent on the exercise. These trends can be further studied to identify strategies and modifications to training plans to account for periods of time with significant academic burden.

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