

Supplementing before a lift

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Basic Engineering: 2100

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Introduction and Background:

When it comes to fitness, the foods we eat and the supplements we take play a significant role in our performance. A nutritious meal and pre-workout can have a positive impact on our physical and mental performance in the gym. In this report, we will discuss the benefits of a nutritious meal and pre-workout and how they can improve our performance in the gym. Our motivation for researching this topic stems from each group member's dedication to living a healthier lifestyle through the gym.

The benefits of nutritious meals are that a nutritious meal is essential to fuel our bodies and provide us with the energy needed to perform at our best in the gym. A balanced diet should consist of carbohydrates, protein, and healthy fats. Carbohydrates are essential for providing the body with immediate energy and provide the body with glucose, which is converted to energy used to support bodily functions and physical activity. Carbohydrates are the primary fuel source for our bodies during exercise. They provide the energy needed for high-intensity workouts and can improve endurance during longer workouts. Complex carbohydrates are the best type of carbohydrates to consume before a workout, as they release energy slowly and provide sustained energy throughout the workout. Examples of complex carbohydrates include brown rice, sweet potatoes, and whole grains. Protein is needed to repair the body and build muscle. Proteins are made up of chemical 'building blocks' called amino acids. Your body uses amino acids to build and repair muscles and bones and to make hormones and enzymes. It is recommended to consume protein before and after a workout to help with muscle recovery. Good sources of protein include chicken, fish, lean beef, tofu, and legumes. Healthy fats are also important for maintaining good health and providing sustained energy. Fats help your body absorb some nutrients and produce important hormones, too. They help keep you full for longer and can improve overall performance in the gym. Examples of healthy fats include avocados, nuts, seeds, and olive oil. Incorporating the correct amount of these three dietary variables is key to maintaining a healthy lifestyle.

A pre-workout supplement is a combination of ingredients that are designed to improve athletic performance. These supplements often contain ingredients such as caffeine, creatine, and beta-alanine. Pre-workout supplements have become increasingly popular among gym-goers over the years, as they provide a wide range of benefits that can help individuals get in the zone for the gym. From increased energy and focus to improved endurance and strength, pre-workout supplements can help athletes to achieve their fitness goals and perform at their best. The benefits of a pre-workout supplement include increased energy, improved focus, and reduced fatigue. Caffeine is a stimulant that can improve athletic performance. It is commonly found in coffee and tea and is also a common ingredient in pre-workout supplements. Caffeine can improve focus and alertness, and it can also reduce fatigue during high-intensity workouts. Creatine is a compound that is naturally produced by the body and is also found in certain foods, such as meat and fish. It is a popular supplement among athletes and bodybuilders, as it can improve strength and endurance during high-intensity workouts. Creatine works by increasing the body's production of ATP, which is the primary source of energy for muscle contractions. Beta-alanine is an amino acid that is found in meat and poultry. It can improve athletic performance by reducing fatigue and improving endurance. Beta-alanine works by increasing the levels of carnosine in the muscles, which helps to reduce the buildup of lactic acid during exercise.

How a Nutritious Meal and Pre-Workout Supplement Affect Performance in the Gym: Giving our bodies ample fuel begins with a nutritious meal, while pre-workout supplements provide a jolt of energy, most commonly through caffeine. These two factors have a positive impact on our physical and mental performance when lifting heavy weights. In our experiment, we showcased the effects of pre-workout on lifts such as squats (a lift that focuses mainly on legs), deadlifts (a lift that focuses on the back), and bench press (a lift that focuses mainly on the chest).

When we consume a balanced meal that includes complex carbohydrates such as whole grains, bananas, apples, and beans, which provide sustained energy over a longer period of time. Consuming foods high in protein such as beef, turkey, salmon, or chicken will kick-start protein synthesis, which is the process where muscles are built after being destroyed during a workout. Lastly, eating healthy fats, such as avocados, nuts, and flaxseeds, a couple of hours before a workout will provide our bodies with the energy needed to perform at our best. Fats and complex carbohydrates both provide our bodies with energy, but the difference is that fats provide more efficient energy and are best eaten a couple of hours before a workout. Consuming protein after a workout can also improve muscle recovery (protein synthesis) and growth, which can lead to better performance in the long term by increasing our strength and helping us push heavier weight over time. Eating protein before or after a workout both serve the same purpose, but it is recommended to eat it within an hour after a workout for the most optimal gains.

A pre-workout supplement can also improve athletic performance by providing increased energy and reducing fatigue. The most common ingredient in a pre-workout supplement is caffeine, which can improve focus and alertness, which in turn helps improve performance during high-intensity workouts. Creatine is another supplement sometimes found in pre-workout and is also a great supplement to use because it is said to help lifters get that extra rep into a lift, which is crucial in building muscle. Another great supplement is beta-alanine, which can improve endurance in a lift. As a side note, beta-alanine also has other uses, such as antioxidants to clean our system and anti-aging properties that can lead to a happier and healthier life. Considering all of these, supplements are a great addition to any gym-goer's diet; they can lead to better performance during weightlifting and other types of resistance training, and even a healthier lifestyle.

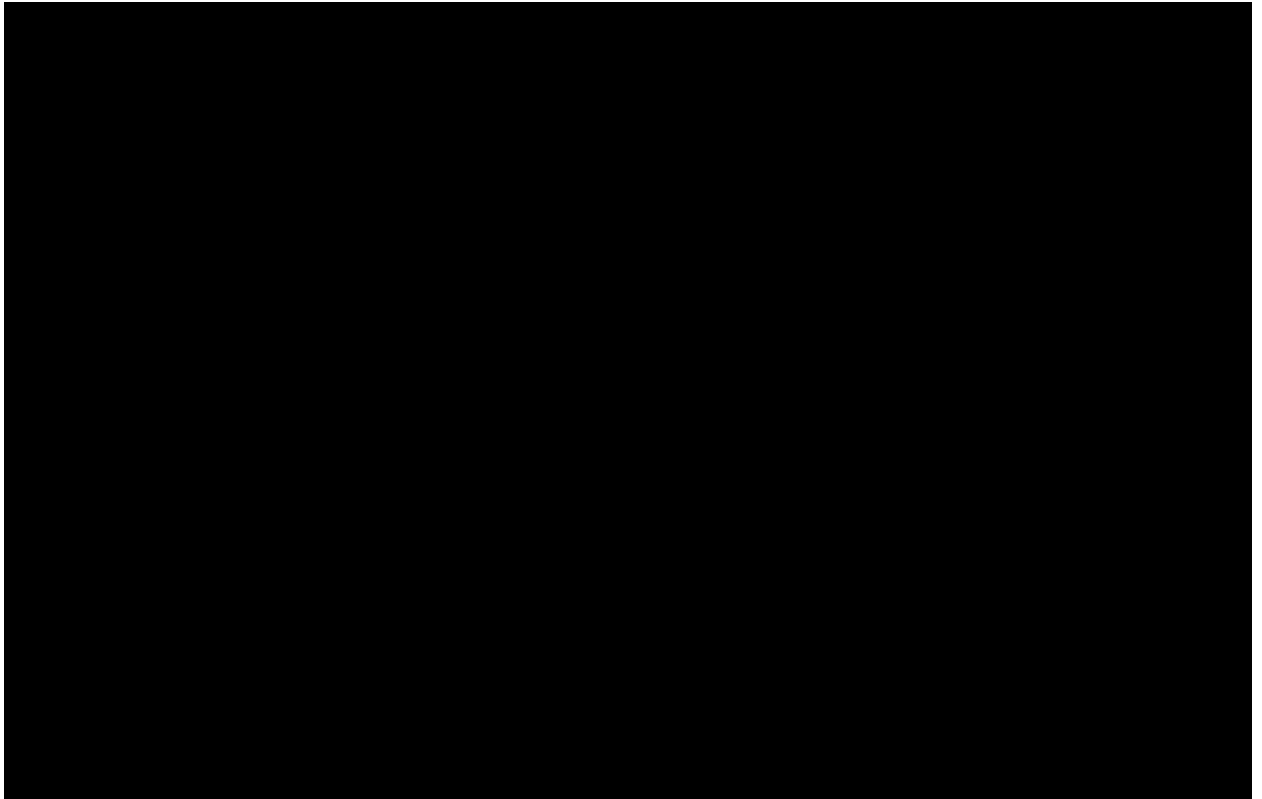
In addition to the physical benefits, a nutritious meal and pre-workout supplement can also improve mental performance. For example, caffeine can improve alertness and focus, which can help athletes stay focused during workouts and perform at their best. A balanced meal that includes healthy fats can also improve brain function and cognitive performance, which can help athletes make better decisions and react more quickly during workouts. It is important to note, however, that the effects of a nutritious meal and pre-workout supplement can vary from person to person. Some individuals may be more sensitive to certain ingredients, such as caffeine, and may experience negative side effects such as jitteriness or anxiety. It is important to consult with a healthcare professional before starting any new supplement regimen to ensure that it is safe and appropriate for your individual needs. an example of a healthy plate is shown below

Some tips for optimizing performance in the gym in addition to consuming a nutritious meal and pre-workout supplement, there are several other tips that athletes can follow to optimize their performance in the gym: Hydrate: Staying hydrated is essential for optimal athletic performance. It is recommended to drink at least 8-10 glasses of water per day, and to drink water before, during, and after workouts to prevent dehydration. Warm-Up: A proper warm-up can help to prepare the body for exercise and reduce the risk of injury. It is recommended to spend at least 10-15 minutes warming up before starting a workout Stretch: Stretching can improve flexibility and range of motion, which can lead to better performance during exercise. It is recommended to stretch before and after workouts to improve overall flexibility. Rest: Rest is essential for muscle recovery and growth. It is recommended to take at least one rest day per week to allow the body to recover and repair.

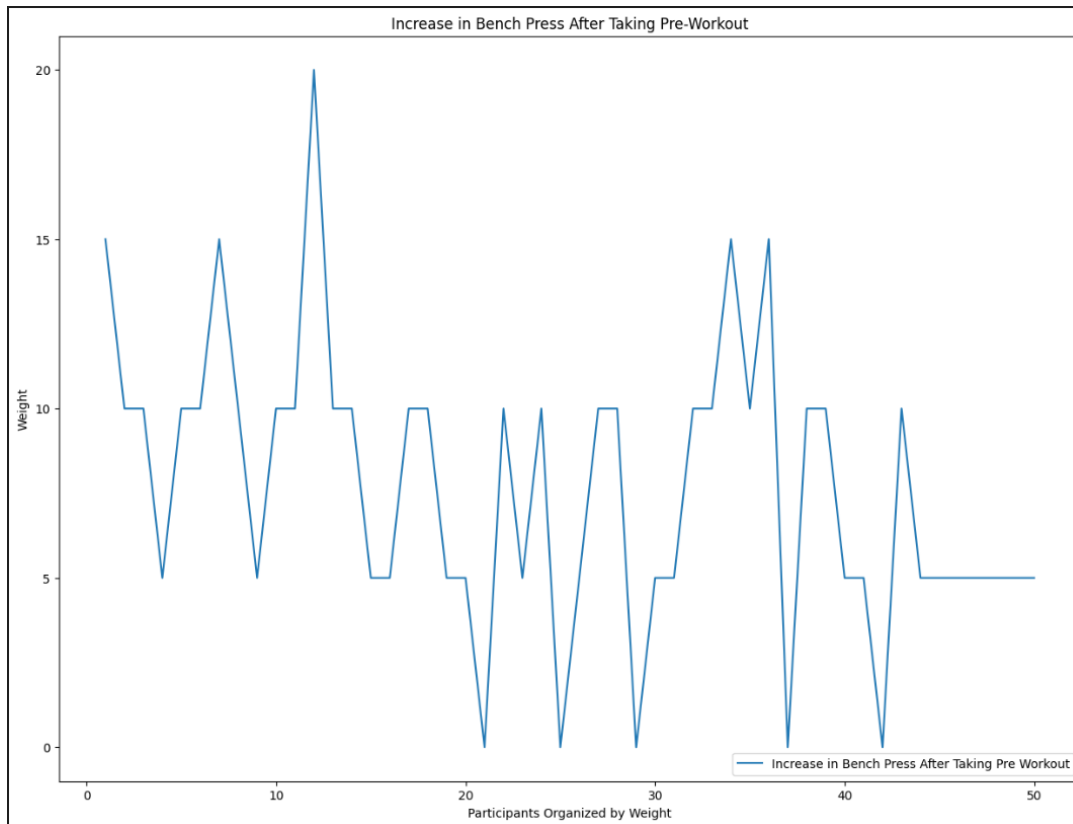
To summarize, a nutritious meal and pre-workout supplement can have a positive impact on our physical and mental performance in the gym. Consuming a balanced meal that includes complex carbohydrates, protein, and healthy fats can provide the body with the energy needed to perform at its best. A pre-workout supplement that includes ingredients such as caffeine, creatine, and beta-alanine can improve energy, focus, and endurance. Pre-workout supplements can be a valuable tool for individuals looking to get in the zone for the gym. By providing increased energy, focus, and strength, pre-workout supplements can help individuals achieve their fitness goals and perform at their best. However, it is

important to use pre-workout supplements responsibly and to follow a healthy diet and exercise routine to maximize their benefits. It is important to note that the effects of a nutritious meal and pre-workout supplement can vary from person to person, and it is important to consult with a healthcare professional before starting any new supplement regimen. Additionally, athletes can optimize their performance in the gym by staying hydrated, warming up properly, stretching, and taking rest days. Overall, a nutritious meal and pre-workout supplement can be valuable tools for athletes looking to improve their performance in the gym. By providing the body with the energy and nutrients it needs to perform at its best, athletes can achieve their fitness goals and see significant improvements in their overall health and wellbeing.

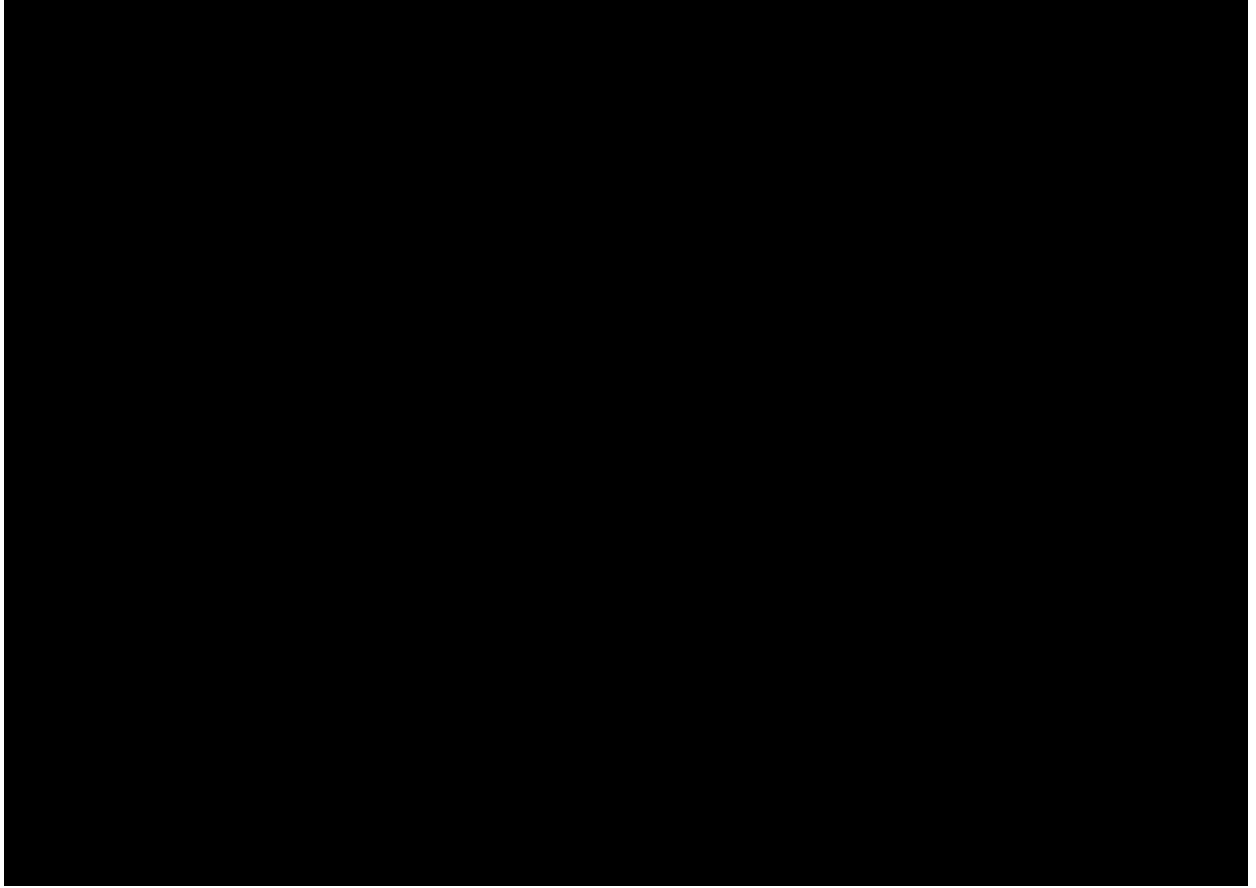
## Discussion and Results



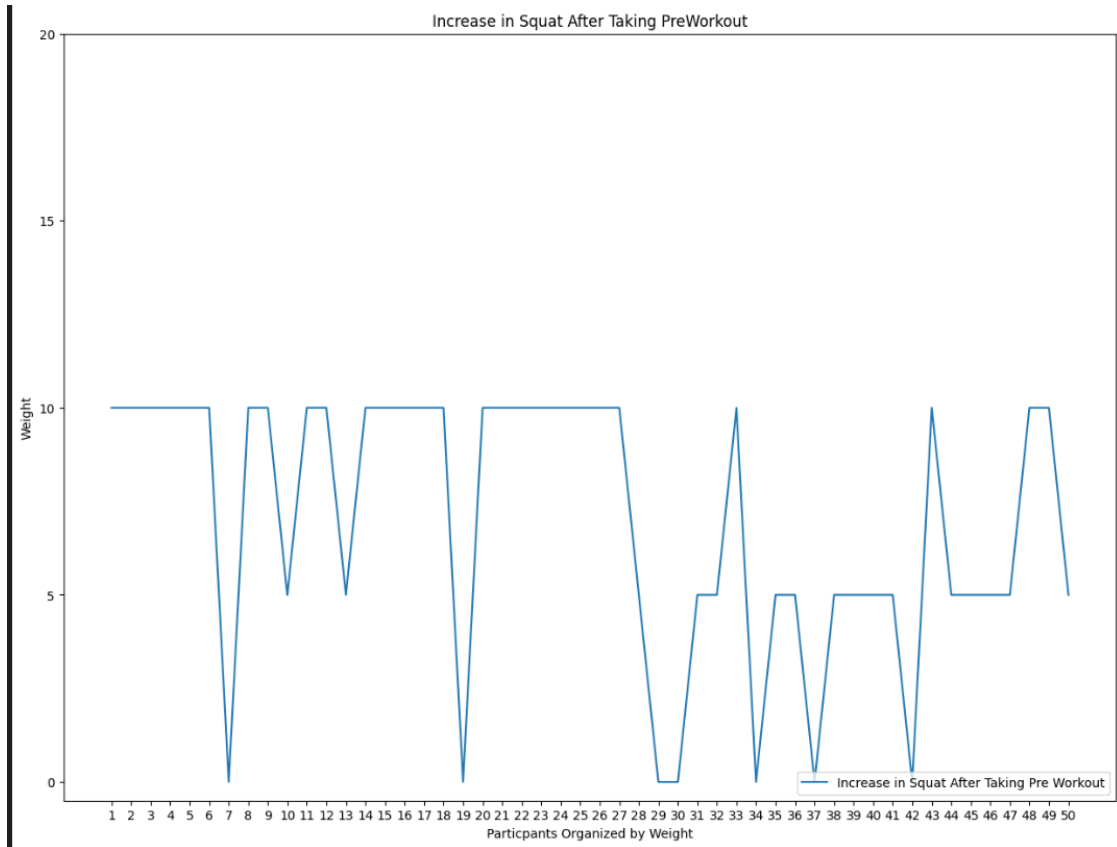
The bench press is an important exercise for powerlifters as it primarily targets the chest, shoulders, and triceps muscles. Along with the squat and deadlift, it is one of the three main powerlifting movements that are often used to test overall strength and power. The results this graph displays, the participants' max bench press, which did not decrease as a result of pre-workout supplementation. In fact, many of the participants experienced an increase in their max bench press after using pre-workout. However, it is important to note that individual responses to pre-workout supplements may vary and some people may experience negative side effects.



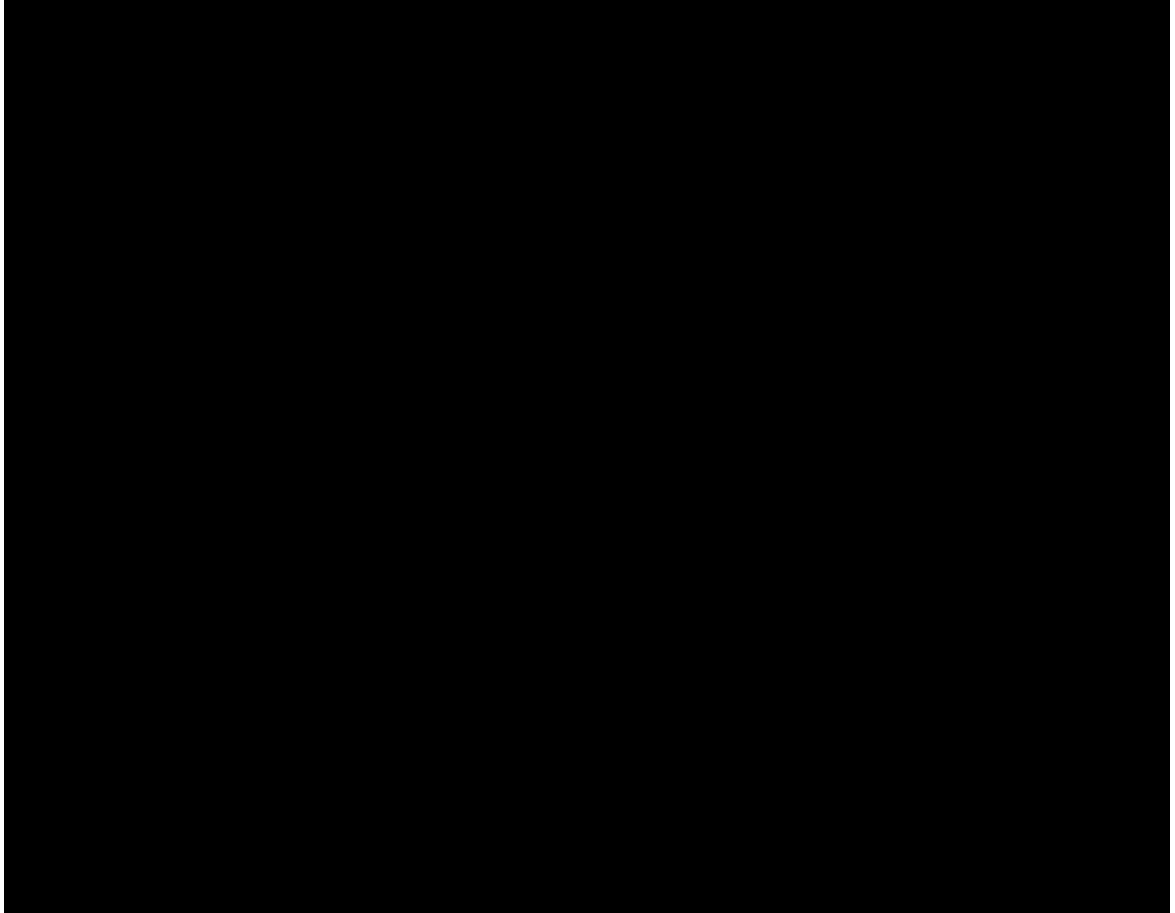
The graph that displays the difference between the max bench press before and after pre-workout can provide insight into the potential benefits of pre-workout supplements for bench press performance. One notable observation from the graph is that the majority of participants who experienced the most significant improvement in bench press performance were in the lower weight class. The overall mean increase in bench press max after using pre-workout was 7.7 lbs, which can be considered a significant improvement in a relatively short period. Furthermore, the maximum increase observed in the study was 20 lbs, suggesting that pre-workout supplements can be a valuable tool for individuals looking to improve their bench press performance.



The barbell squat is another essential exercise in powerlifting that targets several muscle groups, including the quadriceps, hamstrings, glutes, and core. It is a compound exercise that engages multiple joints and requires a significant amount of strength and stability to perform correctly. To determine the effect of pre-workout supplements on squat performance, a similar study was conducted where participants were asked to perform a max squat before and after consuming a pre-workout supplement. As with the bench press statistics, the results of the study revealed that no participants' barbell squat max decreased after using pre-workout. Instead, several participants experienced an increase in their max squat, indicating that pre-workout supplements may be an effective way to enhance squat performance.

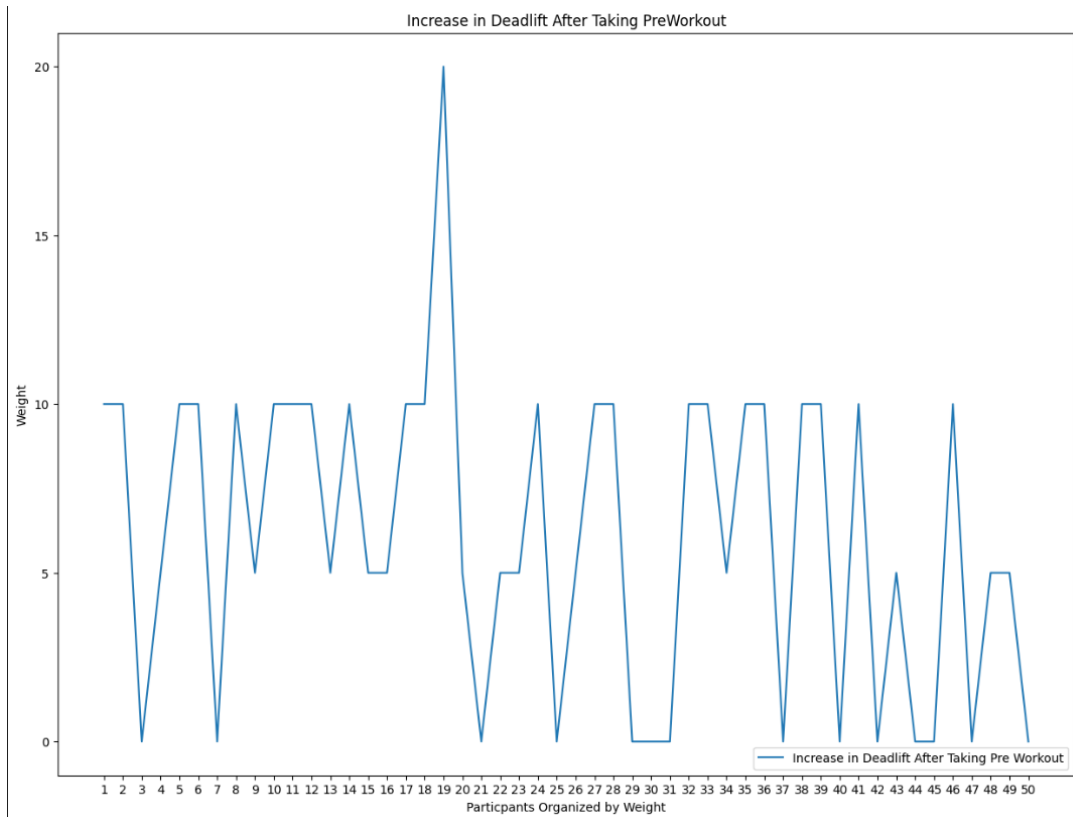


The graph that displays the difference between the max squat before and after pre-workout can provide insight into the potential benefits of pre-workout supplements for squat performance. The study revealed that the mean increase in squat max after using pre-workout was approximately 7lbs, which is a significant improvement in a relatively short period. Additionally, the maximum increase observed in the study was 10lbs, which suggests that pre-workout supplements can be an effective tool for individuals looking to enhance their squat performance. With the mean increase being only 3 lbs different from the max increase, the squat seems to be less affected by pre-workout on the extremes.



The deadlift is the final exercise that was investigated, and it is another fundamental movement in powerlifting that targets multiple muscle groups, including the back, hamstrings, and core. Deadlifts are a compound exercise that requires a significant amount of strength and stability to perform correctly. Similar to the bench press and squat, the study revealed that participants also experienced an improvement in their deadlift performance after using pre-workout supplements.





It is important to note that the mean increase of 6.1 lbs in deadlift max after using pre-workout supplements may not be a substantial improvement for some individuals, particularly those who have been lifting for an extended period. However, it is worth noting that any improvement in performance is positive, and when coupled with consistent training, can lead to significant gains in the long run due to the accumulation of progress. Moreover, the fact that some participants experienced a maximum increase of 20lbs suggests that pre-workout supplements may be more effective for certain individuals than others. This variation in response may be due to several factors, including genetics, training experience, and individual metabolism.

	PARTICIPANTS	Unnamed: 1	AGE	WEIGHT	Unnamed: 4	\
count	50.00000	0.0	50.000000	50.000000	0.0	
mean	25.50000	NaN	29.280000	208.980000	NaN	
std	14.57738	NaN	10.008242	35.511131	NaN	
min	1.00000	NaN	13.000000	135.000000	NaN	
25%	13.25000	NaN	22.250000	187.500000	NaN	
50%	25.50000	NaN	27.500000	208.500000	NaN	
75%	37.75000	NaN	36.750000	234.500000	NaN	
max	50.00000	NaN	51.000000	277.000000	NaN	

	BENCH BEFORE PRE	SQUAT BEFORE PRE	DEADLIFT BEFORE PRE	Unnamed: 8	\
count	50.000000	50.000000	50.000000	0.0	
mean	260.900000	350.500000	427.600000	NaN	
std	86.494603	94.912688	103.259333	NaN	
min	90.000000	180.000000	215.000000	NaN	
25%	205.000000	278.750000	365.000000	NaN	
50%	257.500000	320.000000	405.000000	NaN	
75%	312.500000	405.000000	511.250000	NaN	
max	455.000000	525.000000	600.000000	NaN	

	BENCH AFTER PRE	SQUAT AFTER PRE	DEADLIFT AFTER PRE	Unnamed: 12	\
count	50.000000	50.000000	50.000000	0.0	
mean	268.600000	357.500000	433.700000	NaN	
std	85.266928	94.092063	102.079451	NaN	
min	105.000000	190.000000	225.000000	NaN	
25%	206.250000	288.750000	366.250000	NaN	
50%	267.500000	327.500000	412.500000	NaN	
75%	318.750000	413.750000	512.500000	NaN	
max	460.000000	530.000000	610.000000	NaN	

	DIFFERENCE:	BENCH	SQUAT	DEADLIFT
count	0.0	50.000000	50.000000	50.000000
mean	NaN	7.700000	7.000000	6.100000
std	NaN	4.310642	3.642157	4.660954
min	NaN	0.000000	0.000000	0.000000
25%	NaN	5.000000	5.000000	0.000000
50%	NaN	10.000000	10.000000	5.000000
75%	NaN	10.000000	10.000000	10.000000
max	NaN	20.000000	10.000000	20.000000

The ages of the participants vary widely, with a standard deviation of over 10 years. This suggests that the participants are not a homogeneous group in terms of age.

The weights of the participants also vary considerably, with a standard deviation of over 35 pounds. This indicates that the participants have a diverse range of body sizes and shapes.

The standard deviations for the exercise performance variables (bench, squat, and deadlift) before and after the training program are relatively high, ranging from 86 to 103. This suggests that the participants varied in their initial strength levels and in their response to the pre-workout.

The standard deviations for the difference between before and after performance (bench, squat, and deadlift difference) are relatively low, ranging from 3.6 to 4.7. This indicates that the pre-workout had a relatively consistent effect on the participants' performance in these exercises.

By examining the means of the big lifts before and after taking the pre-workout, we can deduce that the lifters experienced an improvement in their performances. Specifically, when analyzing the bench press, the mean weight lifted before taking the pre-workout was 260 pounds, while after taking the pre-workout, it increased to 268 pounds. This suggests that, on average, the pre-workout had a substantial impact on each individual's performance.

The effectiveness of pre-workout supplements is influenced by several factors, including an individual's weight, age, gender, physical fitness level, and overall health. Each of these factors can affect how the body processes and absorbs the active ingredients in pre-workout supplements, which can impact their effectiveness. One of the most significant factors that can affect the effectiveness of pre-workout supplements is an individual's weight. The heavier a person is, the less of an effect pre-workout supplement will have on them. This is because pre-workout supplements often contain stimulants such as caffeine, which can increase heart rate and blood pressure. However, in heavier individuals, these stimulants may have a weaker effect due to their larger body mass. This means that they may require a higher dosage of the supplement to achieve the desired effect, which can be dangerous and increase the risk of side effects. Another thing to note is that if a person takes caffeine regularly, they may build a tolerance and will require a higher intake in order to feel the full effect of pre workout.

Heavier individuals often have a higher body fat percentage, which can affect how their body processes and absorbs nutrients. This can lead to a slower metabolism and a reduced ability to absorb and utilize the active ingredients in pre-workout supplements. This can make it more difficult for heavier individuals to experience the full benefits of pre-workout supplements, such as increased energy and improved focus.

Another factor that can impact the effectiveness of pre-workout supplements is an individual's physical fitness level. Pre-workout supplements are designed to enhance performance, but if an individual is already in good physical condition, they may not see a significant improvement in their performance. In fact, in some cases, the use of pre-workout supplements may have no effect at all. However, for individuals who are less physically fit, pre-workout supplements can be very effective. This is because they can provide an energy boost and improve endurance, making it easier to complete a workout. Additionally, pre-workout supplements can increase focus and mental clarity, which can be especially helpful for individuals who struggle to stay motivated during exercise.

Age is another factor that can affect the effectiveness of pre-workout supplements. As we age, our metabolism slows down, and our body becomes less efficient at absorbing and utilizing nutrients. This can make it more difficult for older individuals to experience the full benefits of pre-workout supplements.

Gender can also impact the effectiveness of pre-workout supplements. Women may require a lower dosage of pre-workout supplements than men due to their smaller body size and lower body weight. Additionally, women may have a higher sensitivity to stimulants such as caffeine, which can lead to a greater risk of side effects such as jitters, nervousness, and sleep disturbances.

Finally, an individual's overall health can impact the effectiveness of pre-workout supplements. Individuals with underlying health conditions, such as heart disease or high blood pressure, may be more sensitive to the stimulant effects of pre-workout supplements, which can increase the risk of side effects such as heart palpitations and dizziness.

Additionally, some pre-workout supplements may contain ingredients that can interact with certain medications or exacerbate existing health conditions. For example, creatine can increase the risk of kidney damage in individuals with pre-existing kidney disease. Therefore, it is essential for individuals

to consult with a healthcare provider before taking pre-workout supplements, especially if they have underlying health conditions.

Pre-workout supplements have become increasingly popular among fitness enthusiasts and athletes as a way to enhance performance and increase energy levels during exercise. These supplements are designed to provide a boost in energy, focus, and endurance, allowing individuals to push themselves harder and achieve better results in their workouts. However, it is important to note that the effectiveness of pre-workout supplements can vary greatly depending on several factors. One of the most significant factors is an individual's weight. Heavier individuals may require a higher dosage of pre-workout supplements to achieve the desired effect, as they have more body mass to support and energize during their workouts. Another critical factor is an individual's physical fitness level. Individuals who are already physically fit may not see a significant improvement in their performance, as their bodies are already accustomed to intense exercise. In contrast, individuals who are just starting their fitness journey may experience a more significant improvement in their performance with the use of pre-workout supplements. Age and gender are also factors that can influence the effectiveness of pre-workout supplements. Generally, younger individuals may respond better to pre-workout supplements than older individuals, as their bodies are better equipped to handle the stimulants found in these supplements. Additionally, some pre-workout supplements may be more effective for men than women, as men typically have higher muscle mass and a faster metabolism. Overall health is another important consideration when using pre-workout supplements. Individuals with underlying health conditions, such as high blood pressure or heart disease, should consult with a healthcare provider before taking these supplements, as they may pose a risk to their health. In conclusion, pre-workout supplements can be an effective way to enhance performance and increase energy during exercise. However, the effectiveness of these supplements can be influenced by several factors, including an individual's weight, physical fitness level, age, gender, and overall health. It is essential for individuals to consult with a healthcare provider before taking pre-workout supplements, especially if they have underlying health conditions. By understanding the factors that influence the effectiveness of pre-workout supplements, individuals can make informed decisions about their use and ensure that they are getting the most out of their exercise routine.

#### Methodology:

Recruitment of participants is a crucial aspect of any research study, as the quality of data collected depends on the suitability of the participants for the research question. In this study, we aimed to recruit physically active individuals who had experience with weightlifting, as these individuals were more likely to have a significant response to pre-workout supplements.

To recruit participants, we utilized a combination of social media advertisements and surveying random individuals in local gyms who were willing to participate in the study. The use of social media advertisements allowed us to reach a wide audience of physically active individuals who were interested in weightlifting. On the other hand, surveying individuals in local gyms allowed us to target individuals who had already demonstrated a commitment to physical fitness and were more likely to have experience with weightlifting.

We recruited a total of 50 participants for the study, all of whom provided written informed consent before participating. This informed consent process was an essential step in ensuring that participants understood the study's purpose, procedures, and potential risks and benefits. It also helped to ensure that participants were willing to participate voluntarily and had the right to withdraw from the study at any time.

The recruitment process was carefully designed to ensure that the study's participants were representative of the population of physically active individuals with experience in weightlifting. By recruiting participants through a combination of social media advertisements and local gym surveying, we were able to reach a diverse group of individuals with a range of weightlifting experience.

In conclusion, the recruitment process for this study was a critical step in ensuring that the data collected was representative of the population of interest. The use of social media advertisements and local gym surveying allowed us to recruit a diverse group of physically active individuals with experience in weightlifting. The informed consent process also ensured that participants were fully aware of the study's purpose, procedures, and potential risks and benefits, which is essential for ethical research.

### Design:

In this study, we utilized a within-subjects design, which involved testing each participant twice; once with pre-workout and once without pre-workout. The purpose of this design was to compare the effects of pre-workout supplements on lifting performance for each individual, rather than comparing individuals to each other. To ensure the accuracy and reliability of the data collected, the order of testing was randomized to minimize order effects. This means that the order in which participants were tested with and without pre-workout was determined randomly, to reduce the likelihood that the results were influenced by the order of testing.

The study aimed to assess whether pre-workout supplements had an effect on maximal lifting capacity in three different lifts: bench press, squat, and deadlift. These lifts were chosen as they are commonly used in weightlifting and powerlifting and require significant upper and lower body strength.

### Procedure:

Each participant was tested on six separate days over a two-week period, with three days dedicated to testing the three lifting motions on each of the two testing conditions (with and without pre-workout). On each testing day, participants were required to fast from caffeine at least 12 hours prior to testing. Participants were also asked to avoid any strenuous exercise for 24 hours prior to testing.

On each testing day, participants were asked to perform the designated lift for their maximum weight. Participants were allowed a maximum of three attempts to determine their maximum lift weight for each lift motion. Each participant was given 10 minutes to warm up with a resistance band, and was allowed to gradually increase the weight to not provoke injuries. To minimize the effects of fatigue, participants were given at least 5 minutes of rest between each attempt.

Pre-workout supplements are commercially available products that contain beta-alanine and caffeine, so participants were asked to use Gorilla Mode pre-workout if available, but were allowed to use other pre-workouts with similar dosages (around 225 mg of caffeine per serving). Participants were instructed to consume the supplement 20 minutes before the testing session. Participants were also required to abstain from any other supplements or stimulants on the day of testing.

### Data Collection:

In this study, the effects of pre-workout on lifting performance were explored. To collect data on lifting performance, each participant was asked to perform lifting motions both with and without

pre-workout. To ensure the accuracy of the data, each of the surveyors involved in the study was responsible for collecting data on the maximum weight lifted for each participant for each lift motion.

This data collection process was carefully designed to ensure that the data collected was accurate and reliable. Each surveyor was trained to accurately record the weight lifted by each participant, and they were instructed to record this data for each lift motion both with and without pre-workout.

After collecting the data, the next step was to analyze it to determine if there was a significant difference in maximum lift weight with and without pre-workout. To achieve this, the data was carefully recorded and organized in a way that allowed for easy analysis.

#### Data Analysis:

In this study, we aimed to explore the effects of pre-workout on lifting performance. To achieve this, we collected data from participants who engaged in lifting motions before and after taking pre-workout. After collecting the data, we utilized a program that we wrote in Python to analyze the data.

The program was designed to process the data in a way that allowed us to obtain valuable insights and conclusions about the effects of pre-workout on lifting performance. To achieve this, we used descriptive analysis, a statistical method that allows for the summary and presentation of data in a way that is easy to understand and interpret.

Using this method, we constructed multiple interactive graphs that displayed the difference in the lift before and after using pre-workout. These graphs allowed us to visualize the changes in lifting performance that occurred after participants consumed pre-workout. By presenting the data in this way, we were able to identify any significant changes in lifting performance and determine whether pre-workout had any impact on lifting performance.

Furthermore, our analysis also involved examining how much pre-workout truly affected the individual during a lift, based on their weight. This allowed us to explore whether pre-workout had a greater or lesser impact on lifting performance, depending on the weight of the individual.

Overall, the use of descriptive analysis allowed us to gain a comprehensive understanding of the effects of pre-workout on lifting performance. By utilizing a program that we wrote in Python, we were able to process and analyze the data in a way that allowed us to draw meaningful conclusions and insights from the study. This analysis can be used to inform future research on the effects of pre-workout on lifting performance, and can also be applied in a practical context to improve lifting performance.

#### Ethical Considerations:

In any study involving human subjects, it is crucial to ensure that participants are fully informed about their participation and that their rights are protected throughout the study. Therefore, in this study, participants were required to provide written informed consent before participating in any aspect of the study. This informed consent process was designed to ensure that participants fully understood the nature of the study, including any potential risks and benefits, and were free to make an informed decision about their participation.

Furthermore, to ensure that participants felt comfortable and confident in their participation, they were assured that they could withdraw from the study at any time without any negative consequences or

repercussions. This allowed participants to exercise their right to autonomy and to withdraw from the study if they felt uncomfortable or if they encountered any issues. Additionally, to maintain the confidentiality and anonymity of the participants, all data collected during the study was kept confidential and anonymous. This helped to protect the privacy of the participants and ensured that their personal information was not shared or disclosed to any unauthorized parties.

Moreover, to ensure the safety of the participants during the lifting motions, each of the surveyors who were involved in the study had plenty of experience with each of the lifts and were present at all times during the testing. This was done to provide an extra layer of safety and to ensure that the participants were able to perform the lifting motions safely and effectively. Overall, these measures were implemented to protect the rights and safety of the participants and to ensure that the study was conducted in an ethical and responsible manner. By following these guidelines, the study was able to collect valuable data while also prioritizing the well-being and privacy of the participants.

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