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The effect of creatine intake on anthropometric measurements and muscular strength through an 8-week training program for muscle mass among bodybuilding athletes

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ABSTRACT

The purpose of this study is to determine various changes in body measurements and circumferences resulting from the intake of creatine monohydrate supplement in a group consisting of 6 bodybuilding athletes aged between 18 to 35 years. The participants consumed 5 grams of creatine half an hour before the training session while following an 8-week training program, by conducting pre and post-tests, and the results showed increases in weight and circumferences of the chest, anterior and posterior thigh muscles, and calf, in addition to an increase in muscle strength for the chest, shoulder, back, arm, thigh, and calf muscles, as well as a decrease in fat mass.

"**Keywords**: creatine, training program, muscle strength, bodybuilding, anthropometrics measurements

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1. INTRODUCTION

Bodybuilding is considered one of the common and beloved sports activities for many people around the world. It is a sport aimed at developing and strengthening muscles, improving strength, flexibility, and overall physical appearance. It attracts all segments of society of all ages and genders with the goal of improving their physical abilities, enhancing their appearance or general mood, and developing their physical capabilities in preparation for various competitions in different sports.

This sport has witnessed significant transformations and developments over the ages thanks to scientific and technological advancements in the sports field. Research and scientific studies have become an essential part of the bodybuilding world in order to achieve the highest levels of athletic performance and physical form. Trainees and coaches have benefited from new discoveries and techniques to improve and achieve the desired results through research focusing on the effects of exercise and healthy nutrition on muscle development, strength increase, and physical capacity. Advanced research also studies genetic and hormonal factors that contribute to physiological adaptations of the body and muscle responses to various training doses. There is also a focus on nutrition within this field and the emergence of a revolution in the world of dietary supplements dedicated to muscle building and enhancing recovery after training. Additionally, there is a focus on monitoring athletes and their physical and morphological responses using modern tools, computer applications, and digital analysis of various body measurements, nutritional requirements, and performance indicators.

2. THE PROBLEM OF STUDY AND RESEARCH QUESTION

Body measurements are one of the most important aspects of bodybuilding, where a number of physical indicators are analyzed and measured to assess progress, set goals, and compare the results obtained through training. Body measurements in bodybuilding are considered one of the most important tools for monitoring and evaluating athletes. These measurements include several elements such as weight, height, blood circulation, body fat percentage, muscles, and water. Understanding and accurately analyzing these measurements can help trainees achieve their goals effectively and systematically. Taking supplements has become more necessary to provide sufficient energy for exercise performance, as well as recovery and

recuperation on the other hand. One common supplement in bodybuilding is creatine, a natural compound found in the body and muscles, and is considered a popular supplement used by athletes and bodybuilding trainees to increase physical capacity and athletic performance. Creatine enhances the ability to replenish energy in muscles and contributes to increasing strength and the ability to perform intense exercises in order to achieve muscle mass and maximum strength, which is the goal of many bodybuilding enthusiasts according to their goals and levels. This is achieved through programming training sessions, intensity, and volume, as well as following dietary regimes according to the desired goal, whether it is muscle mass, drying, or competition preparation, and taking the appropriate supplements, all within the limits of safe use and under qualified supervision. It is also important to guide athletes and bodybuilding trainees to consume creatine as part of a balanced and integrated diet, including other necessary nutrients to obtain the necessary energy to perform exercises well and ensure excellent athletic performance.

Through understanding the requirements of bodybuilding and the necessity of monitoring athletes in terms of body measurements and the impact of creatine intake to achieve muscle mass and strength, we can pose the following questions to delve into this study:

Are there statistically significant effects between the results of body measurements studied for pre- and post-measurements among bodybuilding athletes in favor of post-measurements after the implementation of the training program?

Are there statistically significant differences between the results of maximum strength for pre- and post-measurements among bodybuilding athletes in favor of post-measurements **after the implementation of the training program?**

3. Research Hypotheses

3.1. General Hypothesis

The proposed training program for muscle mass with creatine supplementation has an impact on various body measurements and maximum strength of bodybuilding athletes.

3.2. Specific Hypotheses

There are statistically significant differences between the results of body

measurements for pre- and post-measurements among bodybuilding athletes in favor of post-measurements.

There are statistically significant differences between the results of maximum strength for pre- and post-measurements among bodybuilding athletes in favor of post-measurements.

4. Research Objectives

Design and construct training modules for muscle mass and creatine intake to increase muscle mass.

Design and construct training modules to improve maximum strength for bodybuilding athletes.

5. Study Importance:

Adopting methodological and scientific approaches to increase muscle mass and physical strength for bodybuilding athletes and observing the various physical and morphological changes in them.

Identifying the significance of statistical differences between pre- and post-measurements of body measurements and maximum strength in general for bodybuilding athletes.

Enriching the specialized knowledge of both researchers and trainers regarding muscle strength and maximum strength.

6. Study terms

6.1. Bodybuilding

Bodybuilding is a physical activity that includes a set of exercises aimed at developing muscles in order to gain more strength, size and muscular endurance. This activity is the basis of bodybuilding, athletic strength and weightlifting, but it is also the basis of physical preparation for many sports such as gymnastics and can be established as a healthy lifestyle, whether it is practiced for competitive sporting purposes or simply performing an activity whose purpose is to achieve balance in the body and maintain athletic form (Meeus & Mompo, 2021, p. 6).

6.2. Training program

In the view of Lever (1992), the training program is only a set of experiences organized and defined in a systematic scientific manner, according to a thoughtful plan, and defined by specific objectives, which is worked on through a set of practical ways and means according to a specific time frame (Yahya Al-Sayed, 2002, p. 105).

6.3. Creatine

Creatine is one of the most important and widely used supplements among athletes for its importance in improving aerobic capacity (Chwalbiñska-Moneta, 2003) , anaerobic capacity (BAZZUCCHI et al., 2009), increasing strength (Warber et al., 2002), body composition (Kutz & Gunter, 2003). It is a non-essential amino acid, a natural derivative of non-protein amino acids that can be synthesized internally in the human body from glycine, arginine, and methionine in the liver, kidneys, and pancreas to a lesser extent in the body. It can also be obtained from dietary sources such as meat and seafood (Ostojic, 2021). External creatine supplements allow for large amounts of this compound to be provided, and this is absorbed into the bloodstream through the intestinal wall thanks to a specialized transporter, then the blood delivers it to the target organs where creatine can be used or stored. These organs include muscles, the brain, testes, the heart, and more. When creatine is given in this way in sufficient doses, it is stored in the target organs, where it is converted to phosphocreatine and increases the accumulation of both creatine and phosphocreatine inside the cells. This increase (especially the increase in the energy stored by phosphocreatine) enhances the metabolic capacity of tissues, for example, the ability of muscles to contract with greater force and for a longer period (Balestrino & Adriano, 2019).

4.6 Strength Training

When choosing the type of training, one needs to determine the goals. This is the most important and difficult part from the coach's point of view. Strength training goals can vary in types such as maximum strength, explosive strength, strength endurance, and methods that target the growth of the displayed area and neuromuscular coordination.

Based on this, the type of training used is determined in terms of shaping the training load, determining the required tools and devices, and other important factors to consider muscle contraction in its different types, whether static or dynamic, as the physiology of each contraction differs from the other. It may require the use of several types of contractions for muscle groups during

the training unit. Therefore, coaches carefully select the type of contraction to achieve the principle of the physiological specificity of muscle strength training. (Abu Alaa & Nasr Al-Din, 2003, p. 101)

6.5. Muscle Hypertrophy

Increasing the cross-sectional area (size) of muscles can be important for bodybuilders in particular, as well as other athletes, and for seniors to prevent diabetes. It has long been known that muscle strength is related to its cross-sectional area, which reflects on the different muscles and their relative strength. Therefore, to improve strength, one needs to increase muscle size. However, in some sports, large muscles can be a disadvantage. It is important to analyze the characteristics of a specific sport when considering strength training and muscle hypertrophy (Radák, 2018)

6.6. Muscle Strength

From some scientists' perspective muscular strength is the foundation for individuals to reach the highest levels of athletic achievement. It significantly influences the development of physical traits such as speed, endurance, and agility. Some experts in sports testing and assessment mention that individuals with muscle strength can achieve a high level of general physical ability. Muscle strength can be defined as the muscle's ability to overcome or face external resistance. (Mohammed Hassan, 1990, p. 91).

6.7. Body Composition and Anthropometric Measurements

Body composition is an important topic in sports science, not only when considering the selection of athletes for different sports disciplines, but also when evaluating the impact of training and recovery from injuries and aging on athletes (Duda et al., 2019). The American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) pointed out that body composition is now mentioned as part of physical fitness components, with body fat percentage not exceeding 20% of body weight for men and 30% for women. However, it is recommended that body fat percentage should not exceed 15% for men and 20% for women for better fitness. (Abu Alaa & Nasr Al-Din, 2003, p. 24)

7. Previous and Similar Studies

7.1. A study (Antonio & Ciccone, 2013) aimed to determine the difference in the effect of pre-exercise and post-exercise consumption of creatine monohydrate supplements on body measurements, body components, and muscle strength. This study used an experimental method, selecting a sample of 19 individuals randomly divided into two groups: one group consumed 5 grams of the supplement before exercise, and the other group immediately after exercise, with supplement intake on rest days, totaling 5 training sessions per week for four weeks. The study indicated that creatine supplements, combined with resistance exercises, increase lean mass and strength, with post-exercise creatine consumption being better than pre-exercise consumption in terms of body composition and strength according to the researchers' conclusions.

7.2. Study (Hamida & Mustafa, 2018) aimed to investigate the effect of muscle loading with creatine monohydrate on some biological variables (post-exercise heart rate, thigh muscle circumference, calf muscle circumference) in addition to physical variables (maximum speed, muscle power, leg muscle strength, speed endurance) for a sample of 20 individuals selected intentionally and classified into two groups of 10 players each, an experimental sample and a control sample in football sport. The study revealed statistically significant differences in body measurements, muscle strength, and maximum speed between post-test and pre-test for the experimental group in favor of the post-test and the experimental sample.

7.3. Study (Candow et al., 2021) aimed to determine the effects of 12 months of creatine supplements and resistance training on whole-body mineral density, bone geometric properties, muscle accumulation, and strength in older males. The researchers used an experimental approach with a research sample of 18 participants for the two experimental groups taking creatine supplements aged between (49 and 69 years), and the placebo group consisting of 20 individuals aged between (49 and 67 years). The researchers concluded that after 12 months of training, both groups experienced similar changes in bone mineral density and geometry, bone speed of sound, fat-free tissues and fat mass, muscle thickness, and muscle strength.

7.4. Study (Dinan et al., 2022) The aim of this research was to study the effects of creatine monohydrate supplements before and after exercise on resistance training adaptations and body composition. The researchers used a randomized design for an experimental and control group undergoing resistance training for 8 weeks and consuming 5 grams of creatine monohydrate an hour before or after training. The control group took a placebo

solution, and body composition, muscle strength, and endurance were evaluated. The study results showed statistically significant increases in lean mass for the upper body, increased strength in the lower body accompanied by a decrease in body mass and body fat percentage. The researchers concluded that the timing of creatine intake did not affect the results whether athletes took it before or after exercise.

8. Method and Procedures Followed

8.1. Scientific Method Followed

The experimental method is considered the optimal and most suitable method for such studies due to its nature of studying causal relationships between the independent and dependent variables, investigating the cause and how it occurs by intentionally making changes and controlling relevant variables (Haider, 2015, p. 82).

8.2 Sample

Our research relied on a sample of 6 bodybuilding athletes in the city of Bougâa, Setif province, selected deliberately.

8.3 Research Variables

8.3.1 Independent Variable

This is the variable that the researcher wishes to explain, i.e. the assumed cause of the dependent variables (Raja'a Wahid, 2000, p. 105) and is usually known as the experimental variable. In our study, the independent variable is the training program with creatine supplementation.

8.3.2 Dependent Variable

This variable is the result of the impact of the independent factor on the phenomenon (Rebhi Mustafa, 2001, p. 57) In our study, the dependent variable is the body measurements and maximum muscular strength.

8.4 Research Tools

8.4.1 Measurements

Measurement of height and weight

Measurement of neck circumference

Measurement of shoulder length

Measurement of chest circumference

Measurement of waist circumference

Measurement of arm circumference

Measurement of forearm circumference

Measurement of thigh circumference

Measurement of calf circumference

Measurement of body fat percentage

Measurement of various lengths and circumferences

8.4.2 Physical Tests

1RM test for chest muscles

1RM test for thigh muscles

1RM test for shoulder muscles

1RM test for back muscles

1RM test for leg muscles

Lower body explosive strength test

Upper body explosive strength test

9. Limitations

9.1 Spatial Scope

The field study was conducted at the "Sassi Gym" in the city of Bougaa, Setif province, for both pre and post-tests.

9.2 Temporal Scope

This research was conducted between January and March 2024.

Preliminary tests were conducted on January 6, 2024, on the research sample individuals before implementing the training program.

Follow-up tests were conducted on March 9, 2024, on the research sample individuals after implementing the training program and taking creatine supplement.

9.3 Training Program

The training program was implemented over a period of 8 weeks, with four sessions per week targeting different muscle groups as follows:

Day 1: Chest muscles (bench press + Dumbbell Fly + Chest Fly + Incline Bench Press) with Triceps muscles (Lying Dumbbell Tricep Extension + Tricep Pushdown + Cable Overhead Tricep Extension)

Day 2: Back muscles (T Bar Row + Bent Over Row + Lat Pulldown) and Biceps muscles (Hammer Curl + preacher curl + Dumbbell Curl)

Day 3: Shoulder muscles (Dumbbell Lateral Raise + Machine Shoulder Press + Upright Row + Face Pull) and Abdominal muscles (Crunches + Dumbbell Side Bend + Reverse Crunches + High Pulley Crunch)

Day 4: Front thigh muscles (Squat + Sled Leg Press + Horizontal Leg Press + Leg Extension) and back thigh muscles (Lying Leg Curl) with leg muscles (Barbell Calf Raise)

Week 1: Work intensity 65% 1RM, three sets for each exercise with 8 to 12 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 2: Work intensity 70% 1RM, three sets for each exercise with 8 to 12 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 3: Work intensity 75% 1RM, three sets for each exercise with 8 to 12 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 4: Work intensity 80% 1RM, three sets for each exercise with 8 to 12 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 5: Work intensity 80% 1RM, three sets for each exercise with 8 to 12 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 6: Work intensity 82% 1RM, three sets for each exercise with 8 to 10 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 7: Work intensity 84% 1RM, three sets for each exercise with 6 to 8 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

Week 8: Work intensity 86% 1RM, three sets for each exercise with 5 to 8 repetitions and a rest period of 1 min 30 sec to 2 min between sets, and 30 sec to 1 min between each exercise.

9.4. Statistical methods used

- Data analysis was performed using the statistical processing program SPSS Calculation of means and standard deviations

- Paired sample t-test for pre- and post-measurements to determine differences

10. Results and discussion

10.1 Analysis, and discussion of hypothesis results

The first hypothesis stated that there are statistically significant differences between the results of physical measurements for the pre- and post-measurements among bodybuilding players in favor of the post-measurement.

We relied on the use of paired sample t tests to verify the validity of the hypothesis, and the results are presented in the following table:

The table (1)

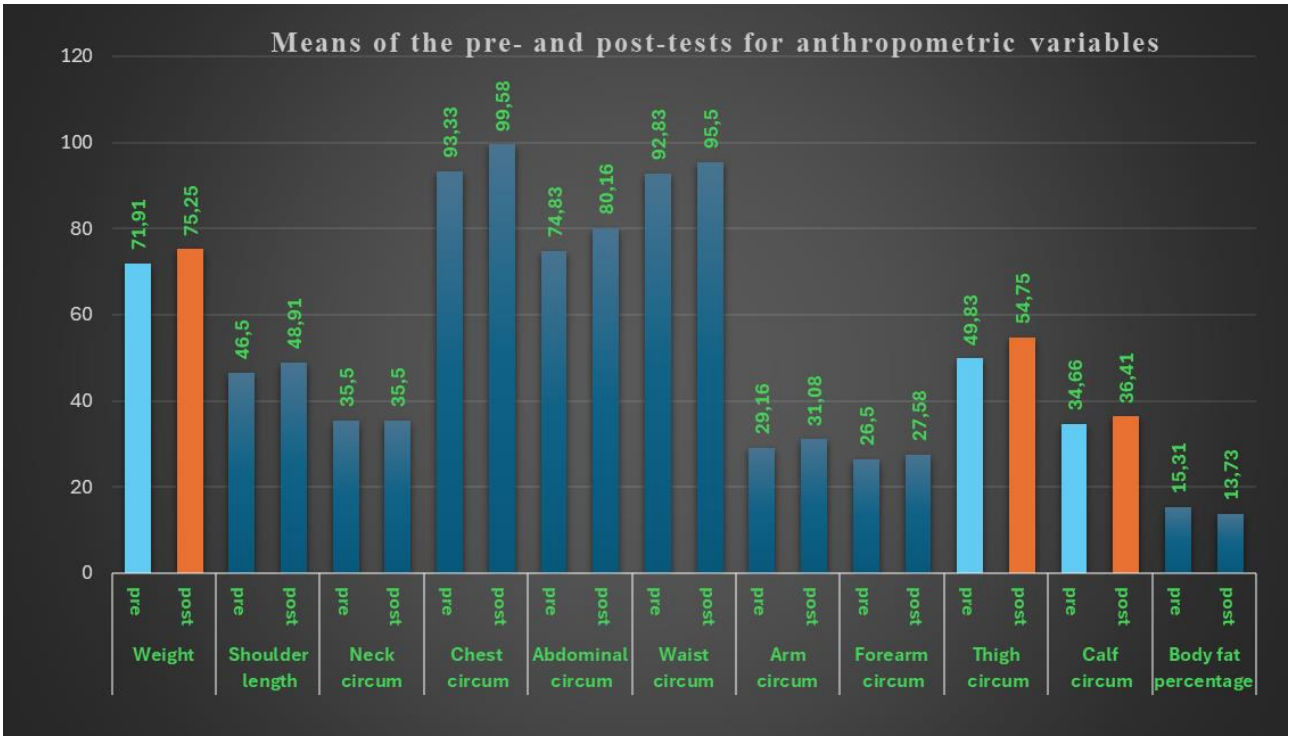
Variables	Measurement	Mean	Standard Deviation	(T) value	Degree of Freedom	(Sig)	Statistical Decision
Weight	**Pre**	71,91	12,45	3.071	**5**	0.028	**Significant**
	Post	75,25	13,7				
Shoulder length	**Pre**	46.50	2.50	1.735	**5**	0.143	**Not significant**
	Post	48.91	2.93				
Neck Circumference	**Pre**	35.5	1.37	1.705	**5**	0.149	**Not significant**
	Post	36.91	2.13				
Chest circumference	**Pre**	93.33	4.718	2.101	**5**	0.09	**Not significant**
	Post	99.58	7.767				
Abdominal circumference	**Pre**	74.83	4.53	1.022	**5**	0.354	**Not significant**
	Post	80.16	12.62				
Waist circumference	**Pre**	92.83	7.60	1.294	**5**	0.252	**Not significant**
	Post	95.50	7.28				
Arm Circumference	**Pre**	29.16	1.32	1.165	**5**	0.297	**Not significant**
	Post	31.08	4.10				
Forearm circumference	**Pre**	26.50	0.83	1.904	**5**	0.115	**Not significant**
	Post	27.58	1.98				
Thigh circumference	**Pre**	49.83	3.25	4.073	**5**	0.010	**Significant**
	Post	54.75	3.72				
Calf Circumference	**Pre**	34.66	1.96	2.573	**5**	0.050	**Significant**
	Post	36.41	1.96				
Body Fat percentage	**Pre**	15.31	3.29	- 0.844	**5**	0.437	**Not significant**
	Post	13.73	5.94				

Source: The Researcher

Analysis of the results of Table (1)

It is clear from the data in Table No (1) that the averages of the variables (weight, thigh circumference, leg circumference) in the pre- and post-tests were as follows, in the order (71.99, 75.25), (49.83, 54.75), (34.66, 36.66) and a standard deviation of (12.45, 13.50), (3.25, 3.72), (1.96, 1.96). The result of the T-test was (3.071) with a probability value of (0.005) for weight and (4.073) with a probability value of (0.01) which is a value smaller than the significance level (0.05) and a result of (4.073) with a probability value of (0.010) for thigh circumference and a result of (2.573) With a probability value of (0.05) for leg circumference, we determine that there are statistically significant differences at the significance level (0.05) between the means of the pre- and post-tests for weight, thigh circumference, and leg circumference for the pre- and post-tests in favor of the post-test for each. Of weight, thigh circumference, and leg circumference, as shown in the following figure

Figure (1): Means of the pre- and post-tests for anthropometric variables



Source: The Researcher

10.2 Analysis and discussion of the results of the second hypothesis

There are statistically significant differences between the results of maximum strength for the pre- and post-measurement among bodybuilding players in favor of the post-measurement

The table (2)

Variables	Measurement	Mean	Standard Deviation	(T) value	Degree of Freedom	(Sig)	Statistical Decision
Chest muscles	**Pre**	62.00	21.419	4.889	5	0.005	**Significant**
	Post	66.66	23.593				
Triceps muscle	**Pre**	51.50	17.626	5.217	5	0.003	**Significant**
	Post	55.00	17.888				
Back muscle	**Pre**	54.33	17.682	5.270	5	0.003	**Significant**
	Post	57.50	18.641				
Biceps muscle	**Pre**	29.66	4.760	9.00	5	0.000	**Significant**
	Post	34.16	3.763				
Shoulder muscle	**Pre**	43.16	10.628	5.855	5	0.002	**Significant**
	Post	47.16	11.321				
Anterior thigh muscle	**Pre**	61.33	10.628	6.425	5	0.001	**Significant**
	Post	67.00	12.165				
Posterior thigh muscle	**Pre**	48.83	10.943	7.746	5	0.001	**Significant**
	Post	52.83	11.839				

Source: The Researcher

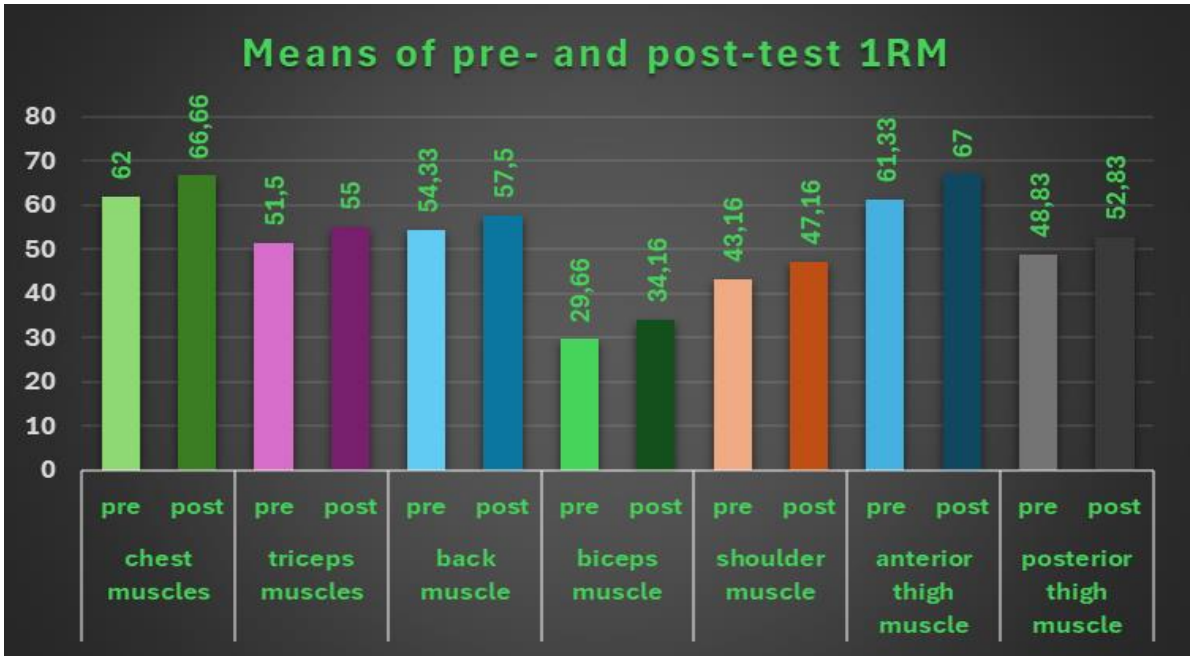
Analysis of the results of Table (2)

It is clear from the data in Table No. (2) that the averages of the 1RM tests for each of the muscles (chest, triceps, back, biceps, shoulder, anterior thigh muscle, and posterior thigh muscle) in the pre- and post-tests were as follows: Next in order: (62.00, 66.66), (51.55, 55.00), (54.33, 57.50), (29.66,

34.16), (43.16, 47.16)), (61.33, 67.00), (48.83, 52.83) and with a standard deviation in order of (21.419, (23.593), (17.626, 17.888), (17.682, 18.641), (4.760, 3,763), (10.628, 11.321), (10.628, 12.165), (10.943, 11.839). The T-test result was (4.889) with a probability value of (0.005) for the chest muscles and a value of (5.217) with a probability value of (0.003) for the triceps muscle. A value of (5.270) with a probability value of (0.003) for the back muscle, a value of (9.00) with a probability value of (0.000) for the biceps muscle, a value of (5.855) with a probability value of (0.002) for the shoulder muscles, and a value of (6.425) with a probability value of (0.001) For the anterior thigh muscles, the value is (7.746) with a probability value of (0.001) for the posterior thigh muscles.

Accordingly, we determine that there are statistically significant differences at the significance level (0.05) between the averages of the pre- and post-tests of the 1RM maximum strength tests for each of the chest muscles, triceps muscles, back muscles, biceps muscles, shoulder muscles, front thigh muscles, and back thigh muscles after taking a creatine supplement and applying it. An 8-week training program for muscle mass. as shown in the following figure.

Figure (2): Pre- and post-test averages of 1RM maximum strength for each muscle group



Source: The Researcher

11. Conclusion

in conclusion of this research, many important results and recommendations can be drawn regarding the association of muscle hypertrophy training program and creatine monohydrate supplementation on body composition, various measurements, and maximal strength in bodybuilders when applied for eight weeks. The results showed a significant improvement in anthropometric and body measurements for the research sample, manifested in an increase in muscle mass in the chest, thigh, and leg muscles statistically parallel with a slight increase in waist, abdomen, and arm measurements but not statistically significant, as well as a slight decrease in body fat percentage among athletes. It was also noted that there was an increase in maximal muscle strength in the chest, back, biceps, triceps, shoulder, leg muscles, as well as both anterior and posterior thigh muscles statistically, indicating the effectiveness of creatine supplement in enhancing muscle hypertrophy when combined with an appropriate training program.
It is worth mentioning the importance of full adherence to the intensity limits applied in muscle hypertrophy-targeted exercises, with a gradual increase in workout intensity each week and close adherence to the training program to ensure desired results and improvements in muscle mass and hypertrophy, along with following a suitable nutritional program to ensure integration between it, training, and supplement intake for optimal results.
Based on these results, we recommend conducting further studies in this research field to identify various variables that may have a direct impact on the development and muscle hypertrophy that athletes strive for to reach the highest levels.

Finally, it can be said that taking creatine when combined with a suitable training program can elevate bodybuilders' physical capabilities, body measurements, and muscle strength. However, it is necessary to be cautious in taking the appropriate dose, seek medical consultation, and work under the supervision of specialized trainers before taking such supplements to avoid any side effects.

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