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Original Article

The Effect of a Training Program Using the "Kaatsu" Method on the Morphological Shape of Bodybuilders in Relation to the IGF1 Gene

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Abstract

The study aimed to design a training program using the Kaatsu method, which involves restricting blood flow, and to examine its effect on the morphological shape of bodybuilders in relation to the gene expression of fibroblast growth factors (IGF1). The authors employed the experimental method with a single group using pre- and post-measurements. The research population was deliberately selected from bodybuilders participating in the University of Sadat City's championship across all weight categories, aged between 20 and 23 years, and registered with the Egyptian Federation of Bodybuilding. The average grades of the participants of bodybuilders who trained using the training program increased. In the "Kaatsu" method in the post-measurments of the morphological form (length variable), about the average ranks of their grades in the pre-measurement, it was clear that there was a statistically significant difference at the level (0.05) between the average ranks of the grades of the research group in the pre- and post- measurement of the morphological form (the level of muscle hypertrophy of the leg muscles) in favor of the post- measurement The results indicate a clear statistically significant increase in fibroblast growth factors "IGF1" for the research group of bodybuilders who studied using the training program in style Kaatsu.

Keywords: ***Kaatsu style, Morphological form, Bodybuilders, IGF1***.

Introduction

Achieving victory in international, global, and Olympic sports events has become a manifestation of superiority and civilized advancement that developed countries are keen to achieve. It has also become one of the most important priorities that require providing all the necessary budgets, as winning in the sports field reflects their progress in other areas.

Additionally, the development of scientific research is considered one of the most critical aspects that sports institutions prioritize across various fields, including sports training and modern techniques. This is seen as a necessity for progress in the modern era and a major pillar of this development. Therefore, addressing sports problems in a scientific manner, which includes achieving desired goals, has become essential.

As mentioned by Mahmoud Saad and Abdullah Khater (2000), along with Medhat Abdel Razak and Ahmed Abdel Fattah (2004), bodybuilding is not limited to building the body and showcasing it publicly. Its primary aim is to provide practitioners with a healthy body, good health, and self-confidence. Bodybuilding is a sport that pays close attention to the external appearance of the human body, with players assessed based on specific criteria, such as body health, freedom from congenital or acquired deformities, the harmony between body size and weight through muscle mass, and the coordination of different muscles. These factors reflect on the player's performance, skin color, technical ability, and skill to highlight a beautiful, harmonious body with prominent muscles. (Medhat, 2004) (Mahmoud, 2000)

Clark & Sills (1996) emphasized that through the development of sports medicine, scientific studies such as sports morphology have emerged. Morphology focuses on studying the structural changes of the body in response to physical training and how the body adapts and compensates during its various stages of development. Morphology is concerned with both internal anatomy and external anthropology. (Clark, 1996)

Bodybuilding is closely linked to the physiological section of the muscle, which is directly related to muscle strength. It is based on the density and hypertrophy of muscles, along with the definition and anatomy of muscles in a harmonious manner, collectively referred to as the morphological form. This goes beyond simple body shaping and aims at achieving perfection, elevating the player to the highest levels of morphological form through muscle hypertrophy, definition, anatomical structure, and overall body harmony, a concept known as anthropological determinants. (Anitapine, 1992)

Morphology involves the study of the external form and structure of the human body. It is divided into two aspects: internal anatomy and external anthropology. (Takano, 2005)

Clark et al. (2011) highlighted that low-intensity resistance training with blood flow restriction has gained popularity in Japan, known as Kaatsu training, or sometimes referred to as Occlusion training.

The "Kaatsu" method is considered a new training technique that restricts blood flow from the muscles and extremities to the heart, reducing both the inflow and outflow of blood. This training method induces a state of ischemia in the body, where restricting blood flow during standardized training results in a significant increase in muscle strength. The pressure caused by the lack of oxygen and blood flow recruits many muscle fibers to resist this deficiency, ultimately leading to muscle hypertrophy. (Amani, 2018)

Abu Al-Ala Abdel Fattah and Brent Rachael (2016) stated that blood flow restriction is a new technique used in sports training and physical therapy to enhance strength and muscle hypertrophy. This method employs low intensity (20-30% of the maximum intensity for one repetition). It was initially developed by Japanese scientist Yoshiaki Sato in 1983. Following its success in Japan, this innovative approach gained popularity and subsequently spread to other countries, including the United States, Germany, France, and Italy.

They further highlighted that blood flow restriction training requires a specialized device to regulate the restriction process. This device includes bands that are applied to the upper parts of the legs and arms. The pressure exerted on the veins is carefully controlled, typically ranging between 160- and 200-mm Hg. (Abu Al-Ala, 2016)

Takano and colleagues (2005) explained that blood flow restriction exercises work by reducing the oxygen levels in muscle tissue, as blood flow to the cells is impeded, resulting in a state of hypoxia. This condition is accompanied by an increased accumulation of lactic acid in the muscles and the dilation of blood vessels. When the hypoxic state ends—that is, when normal blood flow is restored—the circulation system supplies the muscles with oxygen and eliminates lactic acid through oxidation. (Takano, 2005)

While blood flow is restricted, Kaatsu uses pressure-controlled cuffs or air bandages placed on the upper parts of the muscles in the legs and arms during training. This creates a significant burden on the muscles due to restricted blood flow, leading to a decrease in the amount of oxygenated blood reaching the muscles during training. Consequently, the heart responds by increasing the number of heartbeats, and the muscles resist this deficiency by recruiting ineffective muscle fibers. (Muhammad, 2020)

Abdul Aziz Al-Nimr and Nariman Al-Khatib (2007) stated that the most appropriate methods for developing muscular strength for players in all sports is weight training, as it enhances speed, performance, and focus. (Abdul Aziz, 2007)

Abu Al-Ala Abdel Fattah (1996) emphasized that coaches must continue working on choosing and forming the training load based on scientific foundations, as this is essential for players' progress both technically and physically. Not applying a standardized scientific approach inevitably leads to failure. (Abu Al-Ala, 1996)

Growth hormone levels can increase up to 290 times, surpassing the effects of traditional training. (Mathews, 1987)

Hussein Hashem and Mohamed Salah (2009) noted that the regulation of growth hormone secretion involves a complex system of feedback mechanisms. Many hormone functions are carried out by a group of high school hormones that stimulate growth hormone to release growth factors and provide amino acids for protein formation. This results in conditions that promote tissue repair in general. (Hussein, 2009)

Sundberg (1991), Sato (2005), and Takashi et al. (2005), along with Kalendi and others (2007), reported that training with hypoperfusion (Kaatsu) causes a severe lack of oxygen supply to the blood vessels and thus to the working skeletal muscles during training. This stimulates various hormonal responses, including human growth hormone (GH), catecholamine, creatine phosphate, and an increase in nitric oxide (NO) levels, enhancing the metabolic properties of skeletal muscle. Additionally, it promotes the production of stem cells from the bone marrow into the bloodstream, improving muscle strength and increasing muscle cross-sectional area. (Abdulrahman, 2019)

After reviewing many references and scientific studies on developing muscle strength, the author found that while there are numerous studies on various training methods, those focused on improving the morphological form are relatively rare. For bodybuilders, improving weak points and small muscles is crucial. For instance, leg muscles are among the muscles that develop slowly. Authors noticed this during a master study, where despite applying a training program and performing post measurements, leg muscles did not develop significantly. This prompted further research, revealing that leg muscles have a unique nature compared to other muscles, necessitating a carefully standardized training program, often employing modern scientific methods like the Kaatsu technique for addressing leg muscle weakness and thinness.

Through field experience as an international player, certified international coach, and referee, it was observed that many champions at various levels suffer from thinness and significant weakness in leg muscles (calves) compared to other body parts. This weakness affects coordination and performance in tournaments. Confirming these observations are the results of a survey conducted during the Arab Championship No. 22 (2022), where 60 players were evaluated in the top 6 positions of the tournament. It was found that 25% of players in advanced positions lost grades due to poor leg muscle evaluation in arbitration forms.

Scientific references reveal a lack of modern training methods to improve players' morphological shapes. Recently, the development of modern tools and methods used in training has significantly expanded, offering enormous potential for success. The use of modern training methods, including Kaatsu, plays a crucial role in achieving significant improvements in players' morphological shapes.

Here, the research problem crystallized for the authors, as they reached through various readings and interviews with experts in bodybuilding, sports training science, and physiology that the Kaatsu method positively affects strength and muscle hypertrophy, thereby improving the morphological form, prompting authors to conduct this study.

This study aims to design a training program using the Kaatsu blood flow restriction method and to examine its effect on the morphological shape of bodybuilders, as indicated by the expression of growth factors such as "IGF1".

Study Hypotheses

1. There are significant differences between the pre- and the post measurements of the gene expression IGFI results for the post measurements.
2. There are statistically significant differences between the mean post-test scores for the experimental group using the "Kaatsu" method on the genetic expression of growth factors "IGF1" in favor of the post-test.

Materials and Method

The authors used the experimental method by designing the (pre-post) measurement for one experimental group, due to its suitability to the nature of the research.

Participants

The research population (30 bodybuilders) was selected purposefully, consisting of bodybuilders participating in the Sadat City University Championship across various weight categories. Their ages ranged from 20 to 23 years, and they were registered with the Egyptian Bodybuilding Federation,

The participants was selected purposefully from the population, consisting of 8 bodybuilders. The participants was divided into two groups, The pilot study group included 3 players for conducting pilot study procedures (validity and reliability tests), and the experimental participants included a total of 5 players to implement the proposed training program, as shown in Table (1).

Table 1. Description of the research community and participants

Participants	number		percentage
Research community	(30) Bodybuilder		100%
The excluded	(22)	Due to the lack of some reasons for selecting the participants on them	73.33%
Pilot Study	(3)	To implement main study and pilot study procedures	10.00%
Main Study	(5)	To implement the suggested training program	16.67%
main participants	(8) Bodybuilders		26.67%

Reasons for Choosing the Participants:

The authors selected the players in the participants based on the following criteria:

1. The player is registered with the Egyptian Bodybuilding Federation and has participated in the Republic Championship, achieving advanced rankings.
2. The player's age is between (20:23) years, and weight is between (70:90) kilograms, with good health.

3. Personal desire of the players to implement, follow instructions, and adhere to the training program until the end of implementation and measurements.
4. The player has achieved one of the top rankings in the university championship qualifying for the Egyptian Universities Bodybuilding Championship (Shaheed Refai 51).
5. Balanced distribution of the participants (pilot and experimental) among bodybuilding players in terms of growth variables (age, height, weight) and training age, as shown in Table (2).

Table 2. Data distribution of the Participants (n = 8)

Variables		Unit	The average	The median	Standard deviation	Skewness
Growth rates	Age	year	22.2	22	0.55	1.09
	height	cm	175	172	5.79	1.55
	the weight	kg	81.4	82	7.72	-0.23
Training age		year	3.6	3	0.99	1.81

It is clear from Table (2) that the values of the skewness coefficients for the participants (pilot - experimental) in the variables of growth rates (age - height - weight) and the training age under study ranged between (-0,23:1,81), where it was limited to (±3), which indicates the moderation of the distribution of the participants in these variables.

Table 3. Descriptive statistics for the participants of bodybuilders (n = 5)

Variables	Minimum value	Maximum value	The average	Standard deviation
Age	21.00	23.00	22.20	0.837
height	169.00	183.00	175.00	5.788
the weight	70.00	92.00	81.40	8.347
Training age	3	5	3.60	0.894

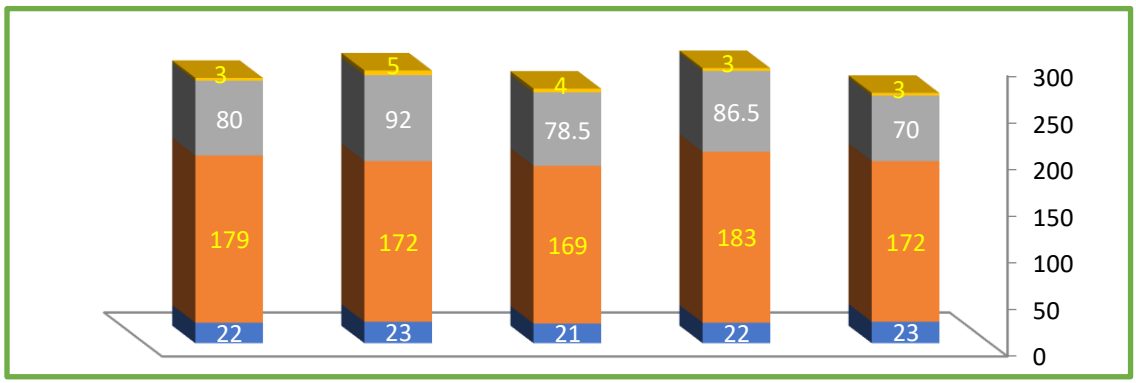

Figure (1) Description of the participants (age, height, weight and training experience)

Data collection

1. The authors prepared and designed a data recording form for basic measurements of bodybuilding players (pilot – experimental) including name and growth rate variables (age, height, weight) and training age under study.
2. The authors reviewed several Arabic and foreign references related to the research topic and utilized the National Information Network (E.N.S.N) affiliated with the Academy of Scientific Research and Technology in Cairo, which allowed for consulting references and research results to select the appropriate method for implementation, practical tests, and morphological measurements under study.
3. The authors conducted a literature review of previous studies to identify exercises that can be relied upon in a calf training program using the Kaatsu method to understand its impact on the morphological shape (muscle hypertrophy of the calf) of bodybuilding players and the suitable components of the program for the group of participants. Based on the guidance of supervisors and necessary adjustments by the supervising committee, the authors arrived at the initial version of the exercises.
4. The authors prepared and designed a survey form for expert opinions on identifying the most suitable exercises for a calf training program using the Kaatsu method in its second version, Annex (4), which was presented to a group of 7 experts in sports training and sports physiology. Annex (5). Based on this, the authors finalized the most appropriate exercises for a calf training program using the Kaatsu method according to expert opinions. Annex (6).
5. The authors presented the final calf training program using the Kaatsu method for bodybuilding players under study in its final form based on the opinions of sports training and physiology experts to a panel of judges and experts in bodybuilding competition, who evaluated its suitability for the study's variables.

Pilot studies

1. First pilot study
2. Second pilot study

The authors conducted the pilot study on Monday, July 1, 2024, on the pilot study group of (3) bodybuilders randomly selected from the research community outside the main group, to ensure the suitability of the devices (CT scanner) under study and their usability. This is crucial to ensure accuracy in the results extracted from the measurements of the main group of participants.

Second pilot study: The authors conducted the second pilot study to identify the medical analysis laboratory that has the necessary kits and primers to measure biological variables under study, specifically Gene expression of the (IGF-1) gene.

After visiting several laboratories, the authors chose the Biochemistry Laboratory at Cairo University’s Kasr Al-Ainy Faculty of Medicine for testing IGF-1 gene expression.

The authors ensured through the medical laboratory where measurements were conducted that the devices used in IGF-1 gene expression tests were in good condition and calibrated, verifying the suitability of the devices used for sample collection. Additionally, the necessary kits and primers for biological variable measurements were available.

The authors also confirmed through the radiology laboratory where measurements were conducted the safety and calibration of the CT scanner used in tests measuring the physiological section of calf muscles (muscle hypertrophy of the calf). The equipment underwent maintenance, and it was verified as one of the latest CT scanners available at the Military Hospital in Shebin Al-Kom, Monufia Governorate.

The IGF-1 gene expression tests and CT scanner were valid (reliability and validity), as indicated by references, research, and scientific studies.

Homogeneity of the participants: The authors ensured the homogeneity of the participants (pilot– experimental) by calculating skewness coefficients in the morphological shape variables.

Table 4. Description of the total research participants Group (pilot and experimental) (n=8)

Variables	The Average	The Medin	Standard deviation	Skewness
Morphology Shape				
Height	8.359	8.285	0.525	0.895
The width	6.225	6.355	0.314	-0.446
Genes Test				
IGF1	5.838	5,900	0.493	-0.262

Table (4) indicates that the skewness values for the research community's variables range between ±3, suggesting that the research community is normally distributed.

Proposed Training Program

The training program was developed following these steps:

- The authors conducted a reference survey of Arabic and foreign books and studies.
- A survey of related research studies and variables was conducted.
- Personal interviews were held with experts in the field of bodybuilding.
- The proposed training program was then presented to experts for their feedback and necessary adjustments.
- Approval was obtained from the supervisors to implement the proposed training program on the scheduled date.

Main Objective of the Program

This research aims to design a training program using the "Kaatsu" method, which restricts blood flow, to examine its effects on the morphological shape of bodybuilders, specifically the hypertrophy of leg muscles, with a focus on gene expression of fibrous growth factors "IGF1". The authors identified warm-up exercises, core exercises, and cooldown exercises, along with the time distribution and intensity percentage for daily program sessions, based on the proposed training program.

Principles and Criteria of the Program

1. The program is designed based on scientific principles and should align with the objective of improving the morphological shape of bodybuilders in the participants. It should also suit the age group of the selected participants.
2. Principles such as individual differences, progression, balance, adaptation, integration, and specificity were followed in designing and implementing the training content to avoid injuries.
3. The training content should be assessed based on exercises for specific body parts, like (warm-up, core, cooldown). Intensity should be measured through the maximum weight lifted and the maximum pressure of the Kaatsu device applied to leg muscles. Exercises should be stopped when errors are observed, ensuring they are suitable for the participants in the research.
4. Consistency and regularity are maintained in performing the training program to ensure its effectiveness, with safety measures in place with the necessary equipment and devices for bodybuilders during implementation.
5. Adoption of modern training methods in bodybuilding with flexibility in the program to allow for adjustments.
6. The use of Kaatsu training should not exceed 30 minutes when placing the device on the main veins of both legs.

Program Limitations

The authors conducted a reference survey of Arabic and foreign sources, similar studies, and interviews with experts in sports training, physiology, and bodybuilding. The key aspects for preparing the program were determined, including:

1. The proposed training program's duration is 9 weeks, divided into 3 weeks of maximum load (85%-95%) intensity, 3 weeks of sub-maximum load (75%-84%), and 3 weeks of moderate load (65%-74%). This amounts to 27 training sessions distributed at a rate of 3 sessions per week.
2. The program includes a preparatory phase before competitions, with an overall average intensity of (78.5%) below maximum load, using periodization methods (high intensity - low intensity) and repetition methods.
3. Total unit time is 45 minutes. Kaatsu exercises are used for 30 minutes within the daily training unit, resulting in a total training duration of (1215 minutes) or (20.25 hours).

4. The leg focused Kaatsu training is conducted in the first part of the training unit, followed by the completion of the daily training schedule as per the weekly plan.
5. Week 1 involves medium intensity Kaatsu training (65%-74%) with repetitions of (12-15) to enhance muscle hypertrophy and endurance, using Kaatsu techniques with a pressure lock allowing blood flow ranging from (30 to 100) SKU across 8 training sets, with each set increasing by (10) sessions. The first set starts at 30 SKU and reaches 100 SKU by the eighth set, with a 5-second rest between each set for optimal blood flow towards the muscle.
6. Week 2 involves sub-maximum intensity Kaatsu training (75%-84%) with repetitions of (8-12) for muscle hypertrophy, with a pressure lock allowing blood flow ranging from (80 to 150) SKU across 8 sets, increasing by (10) sessions per set. The first set starts at 80 SKU and reaches 150 SKU by the eighth set, with a 10-second rest between each set.
7. Week 3 involves maximum intensity Kaatsu training (85%-95%) with repetitions of (4-8) for strength and hypertrophy, with a pressure lock allowing blood flow ranging from (130 to 200) SKU across 8 sets, increasing by (10) units per set. The first set starts at 130 SKU and reaches 200 SKU by the eighth set, with a 20-second rest between each set.

This training program is flexible and can be repeated for three weeks or more, depending on the athlete's needs and level.

Table 5. Percentages and time distribution in the training sessions parts over the proposed training program weeks

Content / Weeks	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Total
Number of training sessions per week	3	3	3	3	3	3	3	3	3	27
Total sessions time per week (min)	135	135	135	135	135	135	135	135	135	1215
Warm-up (min)	16.7 %	16.7 %	16.7 %	16.7 %	16.7 %	16.7 %	16.7 %	16.7 %	16.7 %	270
	30	30	30	30	30	30	30	30	30	
Part Main (min)	75%	75%	75%	75%	75%	75%	75%	75%	75%	810
	90	90	90	90	90	90	90	90	90	
Cooldown (min)	8.33 %	8.33 %	8.33 %	8.33 %	8.33 %	8.33 %	8.33 %	8.33 %	8.33 %	135
	15	15	15	15	15	15	15	15	15	
Total (min)	540				540				135	2700

It is clear from Table (5) that the percentages and time distribution in minutes for the parts of training sessions across weeks of the proposed (Kaatsu) training program to examine

its effect on the morphological shape (muscle hypertrophy of the leg muscles), indicated by gene expression of fibroblast growth factors IGF1 for bodybuilders in the participants, reached (270 minutes) in the warm-up and stretching part, with a percentage of (16.67%) of the total program. Additionally, it reached (810 minutes) in the main part, accounting for (75%) of the total program, and (135 minutes) in the closing part, with a percentage of (8.33%) of the total program.

The main study

a. Pre-measurement:

The authors conducted the pre-measurements for the bodybuilders in the experimental participants, which consisted of (5) players registered with the Egyptian Bodybuilding Federation, aged between (20-23). The winners of the Sadat City University Championship became the core team to represent the university in the Egyptian Universities Bodybuilding Championship (Martyr Rafai 51). These players underwent laboratory experiments and blood sample analyses at the Biochemistry Laboratory, Faculty of Medicine, Kasr Al-Aini, Cairo University. A CT scan of the leg was performed at the Military Hospital in Shebin El-Kom on Monday, 7/1/2024, for the research variables: morphological appearance (muscle hypertrophy of the leg muscles) and gene expression of fibroblast growth factors IGF1.

b. Documenting the condition of the participants players before implementing the training program in style (Kaatsu). Proposed morphological variables (leg muscle hypertrophy) for bodybuilders in the participants, indicated by gene expression of fibroblast growth factors IGF1.

c. Software application

The authors applied the leg muscle training program in a (Kaatsu) style for the experimental participants of bodybuilders. This group of participants consisted of (5) players registered with the Egyptian Bodybuilding Federation, aged between (20-23). The winners of the Sadat City University Championship became the team representing the university in the Egyptian Universities Bodybuilding Championship (Martyr Rafai 51). Training took place inside the gym at Gold's Gym (October and Pyramid branches) and at the gym at the Faculty of Physical Education, Sadat City University, from Tuesday, 7/2/2024, to Thursday, 8/29/2024.

d. Post measurement:

The authors conducted post measurements for the bodybuilders in the experimental participants, which consisted of (5) players registered with the Egyptian Bodybuilding Federation, aged between (20-23). The winners of the Sadat City University Championship became the core of the national team to represent the university in the Egyptian Universities Bodybuilding Championship (Martyr Rafai 51), under the same conditions and controls as the pre-measurements. Laboratory experiments and blood sample analyses were conducted at the Biochemistry Laboratory, Faculty of Medicine, Kasr Al-Aini, Cairo University. A CT scan of

the leg was performed at the Military Hospital in Shebin El-Kom on Monday, 7/1/2024 AD, for the research variables: morphological appearance (muscle hypertrophy of the leg muscles) and gene expression of fibroblast growth factors IGF1.

Documenting the condition of the participants players before implementing the training program in style (Kaatsu), focusing on proposed morphological variables (leg muscle hypertrophy) for bodybuilders, indicated by gene expression of fibroblast growth factors IGF1.

Tools and Devices

1. Instruments and devices for measurements under consideration:
2. CT scan device to measure the physiological section (muscle size of the leg muscles).
3. Medical scale for measuring weight Total body.
4. Measuring Tape for measuring circumference.
5. Polar watch to measure Pulse.
6. Stopwatch.
7. Restameter (REST AMETER) to measure the total body length to the nearest cm.
8. Syringes Medical and test tubes and withdrawal supplies blood samples.
9. Ice Tank or cooler.
10. CDs containing training sessions for the group of participants
11. JVC GZ-MS230 BEU digital camcorder.
12. Gym equipment used in the training hall.

Statistical Analysis

The authors used the Statistical Package for the Social Sciences (SPSS), version 27, for statistical processing. Appropriate statistical methods were employed to analyze the data, including:

- Arithmetic Average
- Median
- Standard Deviation
- Coefficient of Skewness
- Wilcoxon Test for rank signals to determine the significance of the difference between the average ranks of the scores of the participants in both the pre- and post-tests.

Results and Discussion

To discus the first hypothesis which suposes the statistically significant difference at (0.05) between the ranks of the scores of the experimental group of bodybuilders in the two tests (pre- and post) of the morphological form (muscle hypertrophy of the leg muscles). To verify this hypothesis, the authors confirmed the normality of data distribution for the research group. The non-normality of the distribution of morphological data (level of muscle hypertrophy of the leg muscles) among the members of the experimental group (participants of

bodybuilders) in the pre- and post-measurements of the morphological form was confirmed by the authors using the tests (Kolmogorov-Smirnov & Shapiro-Wilk), as shown in Table (8).

Table 8. Results of the normal distribution test for morphological shape (level of muscle hypertrophy of the leg muscles) The experimental group participants

Variables	Kolmogorov Smirnov			Shapiro Wilk		
	Test score. Statistics	degree of freedom df	Significance Sig.	Test score. Statistics	degree of freedom df	Significance Sig.
height	0.150	5	0.028	0.940	5	0.033
the width	0.148	5	0.020	0.944	5	0.046

It is clear from the previous Table (8) that the level of significance in the pre- and post-tests for Kolmogorov-Smirnov reached (0.028, 0.020) respectively in the variables of length and width, which are less than the significance level (0.05). Additionally, the significance level in the pre- and post-measurmentss in the Shapiro-Wilk test reached (0.033, 0.046) respectively in the variables of length and width, which are also less than the significance level (0.05). This indicates that the data does not follow a normal distribution, meaning that moderation in its distribution is not achieved.

Table 9. statistical significance for the Wilcoxon Rank Test for the difference between the the pre- and post-tests of the morphological form

Variables	Ranks	N	Average Rank	Total ranks	Z*	Significance
height	Negative	0	0.00	0.00	-2.023	0.043
	Positive	5	3.00	15.00		
	Neutral	0				
	the total	5				
the width	Negative	0	0.00	0.00	-2.023	0.043
	Positive	5	3.00	15.00		
	Neutral	0				
	the total	5				

* z table value at (o.5) =level = ± 1.96

After confirming the non-normality of the distribution of the scores of the participants individuals in the pre- and post-tests of the morphological form (the level of muscle hypertrophy of the leg muscles) indicated by gene expression of fibroblast growth factors IGF1 for bodybuilders, the authors used the "Wilcoxon test" for rank signs to determine the significance

of the difference between the average ranks of the scores of the research group of bodybuilders in both the pre- and post-measurmentss of the morphological form ,see table (9) .

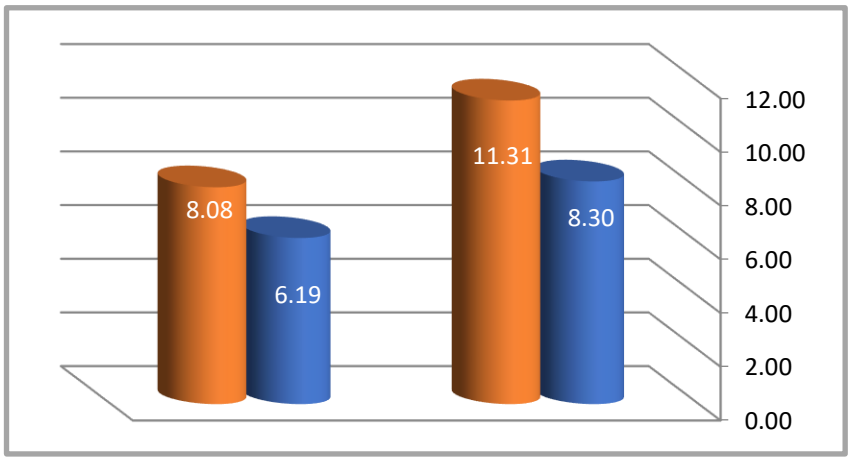

Figure 2. The average scores of the group of participants in the pre-and post measurements

It is clear from Table (8) and Figure (1) that there is a statistically significant difference at the 0.05 level between the ranks of the scores of the experimental group of bodybuilders in the pre- and post-measurements of the morphological form (the level of muscle hypertrophy of the leg muscles) in favor of the post-measurments.

To ensure the impact of the training program "Kaatsu" on improving the morphological form (length and width) of the participants from bodybuilders, this was done by determining the size of the effect of training program on the morphological form (length and width). To understand the strength of the relationship between the independent and dependent variables, the binary correlation coefficient was used for the ranks of the associated pairs (rpb). By calculating the strength of this relationship, it became clear that the value of (rpb) reached (0.905) in both length and width variables, indicating a very strong relationship and a very strong effect size of the independent variable (the training program) on the dependent variable (morphological form) among the research group of bodybuilders.

The mean of the pre-measurement in the cross-section of the leg muscles was (6.18) with an average negative rank of (0.00), while the mean of the post measurement in the cross-section of the leg muscles was (8.08) with an average positive rank of (3.00).

The arithmetic mean of the pre-measurement in the longitudinal section of the leg muscles was (8.30) with an average negative rank of (0.00), while the arithmetic mean of the

post measurement in the longitudinal section of the leg muscles was (11.31) with an average positive rank of (3.00).

Using the Wilcoxon test to calculate the value "Z," it was (-2.023), which is lower than the table peak with a significance of (0.043), less than the significance level (0.05). This indicates the presence of a statistically significant difference in the morphological form (muscle hypertrophy of the leg muscles) between the pre- and post-measurements in favor of the post measurement, resulting in a positive effect for training in style (Kaatsu) on the morphological variables (leg muscle hypertrophy) for bodybuilders.

These results indicate a difference between the pre- and post-measurements in both the longitudinal and cross-sectional sections, favoring the post-measurement. The difference in the longitudinal section was an increase of 3.1% on average for the entire participants in favor of the post measurement, while the cross-sectional difference was 1.89% on average for the entire participants, also in favor of the post measurement. This suggests that training in style (Kaatsu) contributes to increased strength and muscle mass.

The authors attribute the increase in muscle size of the leg muscles to following correct instructions and designing a carefully planned and standardized training program using resistance training, whether with devices or free weights, while maintaining gradual increases in intensity and program sizes. This includes weights and the degree of mercury pressure on the veins, which restrict blood flow during training, along with proportional rest periods, leading to the development of muscle hypertrophy and the improvement of the morphological shape of bodybuilders.

These results are consistent with previous studies, such as Muhammad Qutb Abdul Salam Qutb (2021), Amani Fathy Mohammed (2018), and Abdul Rahman Basyouni Ghanem (2019), which found that training programs in gyms using free weights and resistance devices, such as in style (Kaatsu), have a significant positive effect on changing the shape of the body in terms of developing strength and muscle mass for bodybuilders.

This supports the acceptance of the first hypothesis, which indicates a difference between the pre- and post-measurmentss of the morphological form (the level of muscle hypertrophy of the leg muscles) among individuals in the research group.

It is clear from Table (10) that the level of significance in the pre- and post-test measurmentss using Kolmogorov Smirnov were (0.040, 0.011) respectively in the IGF1 variant, which is less than the significance level (0.05). Additionally, the significance level in the pre- and post-test measurmentss of Shapiro Wilk was (0.033, 0.046) respectively in the IGF1 variable, also less than the significance level (0.05). This means that the data does not follow a normal distribution, meaning its distribution is not normal.

Table 10. Normal distribution test results for fibroblast growth factors"IGF1" The experimental group members

Variables	Kolmogorov Smirnov			Shapiro Wilk		
	Test score Statistics	degree of freedom df	Significance Sig.	Test score Statistics	degree of freedom df	Significance Sig.
GF1	0.777	5	0.040	0.216	5	0.009

It is clear from Table (10) that the level of significance in the pre- and post-test measurmentss using Kolmogorov Smirnov were (0.040, 0.011) respectively in the IGF1 variant, which is less than the significance level (0.05). Additionally, the significance level in the pre- and post-test measurmentss of Shapiro Wilk was (0.033, 0.046) respectively in the IGF1 variable, also less than the significance level (0.05). This means that the data does not follow a normal distribution, meaning its distribution is not normal.

After confirming the non-normality of the distribution of the scores of the participants of bodybuilders in the pre- and post-tests of fibroblast growth factors "IGF1", the authors used the "Wilcoxon test" for rank signs to determine the significance of the difference between the average ranks of the scores of the research group of bodybuilders in both the pre- and post-tests of fibroblast growth factors "IGF1". Table (9) illustrates this.

Table 11. Wilcoxon Rank Test for the difference between the average ranks of the scores of the participants in the pre- and post-tests of fibroblast growth factors

Variables	Ranks	N	Average Rank	Total ranks	Z	Significance	Significance level
IGF1	Negative	0	0.00	0.00	-2.032	0.042	Function at (0.05)
	Positive	5	3.00	15.00			
	Neutral	0					
	the total	5					

The average ranks of the research group of bodybuilders who trained using the training program in style "Kaatsu" increased in the post-tests of fibroblast growth factors "IGF1" compared to their average ranks in the pre-tests, showing a statistically significant difference at the (0.05) level, favoring the post-tests.

The results indicate a clear and statistically significant increase in fibroblast growth factors "IGF1" among the research group of bodybuilders who trained using the program in style "Kaatsu."

This supports the second hypothesis of the research, which asserts that there is a difference between the pre- and post-tests of fibroblast growth factors "IGF1" for the research group of bodybuilders, with those who studied under the training program in style "Kaatsu" showing a benefit in the post-tests.

To ensure the impact of the training program in style "Kaatsu" on improving fibroblast growth factors "IGF1," the authors assessed the magnitude of the effect of this program on fibroblast growth factors. To determine the strength of the relationship between the independent and dependent variables, the binary correlation coefficient was used for rank pairs (rprb). Calculating this relationship revealed a very strong relationship, with a value of (rprb) reaching (0.909) for both variables "IGF1," indicating a very strong effect size of the independent variable (the training program) on the dependent variable (fibroblast growth factors).

The arithmetic mean of the pre-test for fibroblast growth factor "IGF1" was (5.80) with an average negative rank of (0.00), while the arithmetic mean of the post measurement for fibroblast growth factor "IGF1" was (7.36) with an average positive rank of (3.00).

The value of "Z" was (-2.023), which is lower than its table peak with a significant significance of (0.043), less than the significance level (0.05). This indicates the presence of a statistically significant difference in fibroblast growth factors "IGF1" between the pre- and post-measurements, favoring the post measurement and the resulting positive effect of training in style "Kaatsu."

It is evident from the presentation of the special results for fibroblast growth factors that there is a difference between the pre- and post-measurements, favoring the post-measurement in each of "IGF1". The difference in "IGF1" increased by 1.56% on average for the entire participants, favoring the post-measurement.

The authors attribute the reason behind the increase in muscle size of the leg muscles to following the correct instructions and designing a carefully planned and standardized training program using resistance training, whether with devices or free weights, in training the leg muscles in style "Kaatsu." This involves maintaining a gradual increase in intensity and sizes of the program, including weights and the degree of mercury pressure on the veins, to restrict blood flow by the device during training, with proportionality in rest periods. This approach has led to the development of the level of muscle hypertrophy of the leg muscles and, consequently, the improvement of fibroblast growth factors "IGF1" for the participants of bodybuilders.

And it is agreed with Sundberg (1991), Sato (2005), Takashi et al. (2005), and Kalenji and others (2007) that training with hypoperfusion (Kaatsu training) causes a severe lack of oxygen supply to the blood vessels and thus to the working skeletal muscles during training. This stimulates various hormonal responses, including human growth hormone (GH),

Catecholamine, and Creatine phosphate (P), and improves the metabolic properties of skeletal muscles. Additionally, it enhances the production of stem cells from the bone marrow into the bloodstream, improves muscle strength, and increases muscle cross-section through resistance training in style (Kaatsu).

These results are consistent with the findings of Amani Fathy Mohammed (2018), Abdul Rahman Ghanem (2019), Takano et al. (2005), and Mathews, D et al. (2010) for training programs used in gyms using free weights and equipment in style (Kaatsu). These programs have a very positive impact on fibroblast growth factors "IGF1" for bodybuilders.
This means accepting the second hypothesis of the research, which indicates that there is a difference between the pre- and post-tests of fibroblast growth factors "IGF1" for the research group of bodybuilders who studied in the training program in style Kaatsu, benefiting from the post-tests.

Conclusion

The average grades of the bodybuilders who trained using the training program increased. In the "Kaatsu" method in the post-measurement of the morphological form (length variable), about the average ranks of their grades in the pre-measurement, it was clear that there was a statistically significant difference at the level (0.05) between the average ranks of the grades of the research group in the pre- and post-measurement of the morphological form (the level of muscle hypertrophy of the leg muscles) in favor of the post-measurement.

The average grades of the research group of bodybuilders who trained using the training program increased. In the "Kaatsu" method in the post-measurement of the morphological form (width variable), about the average ranks of their grades in the pre-measurement, it was clear that there was a statistically significant difference at the level (0.05) between the average ranks of the grades of the research group in the pre- and post-measurement of the morphological form (the level of muscle hypertrophy of the leg muscles) in favor of the post-measurement.

The results indicate a clear and statistically significant growth in the morphological form (length and width variables) for leg muscles. The research group of bodybuilders who studied using the training program in style "Kaatsu" experienced this improvement.

The average grades of the research group of bodybuilders who trained using the training program increased. In style "Kaatsu" in the post-test of fibroblast growth factors "IGF1" about the average ranks of their grades in the pre-test. It was evident that there was a statistically significant difference at the level (0.05) between the average ranks of the grades of the research group in the pre- and post-test of fibroblast growth factors "IGF1" in favor of the post-test.

The results indicate a clear and statistically significant increase in fibroblast growth factors "IGF1" for the research group of bodybuilders who studied using the training program in style Kaatsu.

Recommendations

Based on the results of this research, authors were able to identify the following recommendations for improving work in the field of bodybuilding, it is recommended to apply the same methodology on different age groups of bodybuilders using the Kaatsu training style. Conducting the training program for bodybuilders after the player has been involved in training for at least three years. The duration of training using the blood flow restriction method should not exceed 30 minutes if the device is placed on the main veins of the legs

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