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Effects of combined *channa striatus* with countermovement jumping exercise on jumping performance and isokinetic muscular strength and power among physically inactive males

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Abstract
This study investigates the combined effects of *Channa Striatus* supplementation with countermovement jumping (CMJ) exercise for 12 weeks. It focuses on jumping performance and isokinetic muscular strength and power in young, inactive males. A parallel randomised controlled trial was conducted. Thirty-eight participants aged 21.7 ± 1.44 years old were randomly be recruited and divided into Control (C), *Channa Striatus* supplementation (CS), Jumping (J) and Combined *Channa Striatus* supplementation and Jumping (CSJ). The J and CSJ groups performed CMJ exercises for two sessions daily, three alternate days per week. The CS and CSJ groups consumed one tablet of *Channa Striatus* (500mg) per day. At the pre- and post-test, participants' body composition, jumping performance, isokinetic muscular peak torque (strength), and power on dominant and non-dominant legs were determined. A repeated measure ANOVA was performed for statistical analysis. After 12 weeks, there was a significant increase in fat-free mass (FFM) ($p < 0.05$) in the CSJ group. The CS group exhibited a significantly greater ($p < 0.05$) standing long jump distance, while the CS ($p < 0.01$), J ($p < 0.01$), and CSJ ($p < 0.05$) groups showed a statistically significant increase in vertical jump height. The CMJ force and power showed non-statistically significant increases in all groups. Statistically significant greater values were observed in the J and CSJ groups for dominant and non-dominant leg isokinetic muscular peak torque and power at $60^{o}.s^{-1}$ and $300^{o}.s^{-1}$ angular velocities compared to the C group. Participants who combined CMJ exercise with *Channa Striatus* supplementation improved their body FFM, jumping performance, and isokinetic muscular strength and power.

Keywords: Haruan, biodex dynamometer, jumping force, force platform, healthy male

Introduction
Jumping exercises cause the muscles to use maximum force to increase their strength and speed [1]. The CMJ exercise is recommended for improving bone strength and muscle performance due to the combined movement of the extensor and flexor leg muscles. It leads to high concentric and moderate eccentric activation, thus requiring gradual activation of motor units [1, 2]. This activity results in the enhancement of isokinetic muscle strength and power. According to Robling and Hinant [3], six hours of rest between jumping workout sessions is significant for boosting the effects of osteogenic on bones [3].
An isokinetic dynamometer can be used to assess muscular strength and power by keeping a constant speed of movement. The dynamometer's resistance is equal to the applied muscular force across the whole range of motion (ROM). The isokinetic dynamometer enables muscle forces to be measured in dynamic conditions by applying optimum loads to the muscles [5].
Jumping exercises and isokinetic muscular strength and power have been shown to improve significantly in some studies [4, 6-12]. However, there have been no research conducted on the effects of *Channa Striatus* supplementation combined with CMJ exercise. The majority of Channa Striatus research was done on animals, such as rats [13-15] and rabbits [16]. As for humans, studies were carried out on patients suffering from osteoarthritic knee disease [17] and post-lower segment caesarean section [18-20].
Channa Striata (CS), often known as snakehead fish, is a carnivorous, air-breathing fresh-water fish native to many tropical countries [21]. It is widely consumed in Malaysia and other Southeast Asia and the Malays refer it as "Haruan" [22]. Biochemical components found in *Channa Striatus* include vital amino acids and fatty acids [23-25].

Other non-essential amino acids found in *Channa Striatus* include glutamic acids, arginine, glycine, proline, alanine, and aspartic acid [26]. Three out of the nine essential amino acids are branched-chain amino acids (BCAAs). The other 11 non-essential amino acids are also important for new muscle protein synthesis and inhibit protein breakdown [27, 28]. BCAAs represent 35% to 40% of the essential amino acids in body proteins and 14% to 18% of the total amino acids in muscle proteins [29].

Thus, the main objective of this study was to determine the effects of 12-weeks intervention of *Channa Striatus* supplement combined with CMJ exercise on muscle performance.

Materials and Methods

Study Design

A randomised controlled trial study was carried out among young inactive males at Universiti Sains Malaysia from July 2019 to March 2020 (block randomisation was generated using a computer-based random number www.randomization.com). Pre- and post-test measurement were recorded to determine the effects of *Channa Striatus* supplementation and jumping on body weight, body height, fat-free mass (FFM, body fat percentage, jumping height, muscular strength and power. The participants were randomly divided Control (C), *Channa Striatus* supplementation (CS), Jumping (J), and Combined *Channa Striatus* and Jumping (CSJ).

The CMJ exercise was only assigned to participants in the J and CSJ groups, performed two sessions per day with 6-hour rest between sessions, three times on alternate days per week for 12 weeks. Participants in the CS and CSJ groups took a tablet of *Channa Striatus* every morning for 12 weeks. A checklist and a form were given to participants to keep track of their weekly activities to assess their supplement compliance. Post-test measurements were conducted similar to the pre-test after the 12 weeks of the intervention period.

Sample Size Calculation

G-Power Version 3.1.9.2 was used to calculate the sample size, which was based on data from a prior study by Ooi [30]. The power of the study was set at 80% with a 95% confidence interval with an effect size of 0.91. Forty participants were recruited for this study. After considering a 20% possibility of drop-out, the calculated sample size was eight per group, which is equivalent to 32 participants in four groups.

Participants

Thirty-eight physically healthy, young, inactive males aged between 18 and 24 years old recruited in this study were randomly divided into four groups, i.e., Control (C) (n = 9), *Channa Striatus* supplementation (CS) (n = 9), Jumping (J) (n = 10), and Combined *Channa Striatus* and Jumping (CSJ) (n = 10). The participants volunteered themselves for this study. If they experienced any post-jump pains, allergies, or side effects after consuming the *Channa Striatus* supplement they were allowed to withdraw from the study.

The participants were students at University Sains Malaysia (Health Campus). Healthy young males with an inactive lifestyle, normal BMI, normal BMD, no sports events or training (at least 150 minutes of moderate physical intensity throughout the week), and no health concerns such as hypertension, diabetes, or stroke were included in this study. Vaping or smoking, being on medication or taking any dietary supplements prior to the study period, having any health problems such as asthma, diabetes, stroke, or high blood pressure, having a lower limb injury in the previous six months, and participating in jumping exercises prior to the study period are all exclusion criteria.

Channa Striatus Supplementation

The *Channa Striatus* supplement used in this study is called Chantiva 750 was manufactured by a GMP-certified company named Major Interest Sdn. Bhd., Malaysia. The company is registered under the Malaysian Ministry of Health, and the supplement is certified HALAL by the Department of Islamic Development Malaysia. The supplement is manufactured, packaged, and labelled by the supplier. Each tablet weighs 750 mg and consists of 500 mg of *Channa Striatus* (whole fish) and 25 mg of Semen Nigella Sativa. One tablet was consumed every morning for 12 weeks by the participants in the CS and CSJ groups. The supplement and physical activity diaries were provided to participants To monitor their supplementation intake and physical activities during the study, all the participants were provided by supplement and physical activity diaries. Participants were asked not to consume any other dietary supplements that contain vitamins (A, C, D, and E), fatty acids, or amino acids. Participants needed to collect the *Channa Striatus* supplement from the laboratory every two weeks to ensure that the prescribed number of tablets was consumed accordingly.

Countermovement Jumping Exercise

Participants from both the J and CSJ groups were required to participate in the CMJ exercise sessions for 12-weeks, which were developed based on the progressive overload model by Erickson and Vukovich [31], three times each week on alternate days. The participants were required to perform the CMJ exercises on a force platform to obtain their maximum jumping height. Warm-up stretching activities were performed five minutes before the CMJ exercise session. Participants underwent familiarisation sessions under the supervision of researchers during the first week of the jumping exercise session. They had to wear proper sports shoes as they needed to jump on a hard floor. The participants performed two-legged maximum vertical jumps with swinging arms in a countermovement style in several sets and repetitions, as shown in Table 1. Two sets were performed from Week 1 to Week 4 and were increased to three sets from Week 5 to Week 12. The number of jumps was gradually increasing every week. The exercise load was progressively increased to adapt the body to the greater physiological demands, with several repetitions increased every week. Each training session lasted less than two minutes, with the interval between each jump ranging from eight to 12 seconds.

Table 1: Training programme for participants in J and CSJ groups.

Week	Session 1	Rest	Session 2
Week 1	2 set of 5 jumps	6 hours	2 set of 5 jumps
Week 2	2 set of 7 jumps	6 hours	2 set of 7 jumps
Week 3	2 set of 10 jumps	6 hours	2 set of 10 jumps
Week 4	2 set of 15 jumps	6 hours	2 set of 15 jumps
Week 5	3 set of 8 jumps	6 hours	3 set of 8 jumps
Week 6-12	3 set of 10 jumps	6 hours	3 set of 10 jumps

Anthropometry and Physiological Measurements
Each participant's height was measured using a stadiometer (Seca 20, Hamburg, Germany). Body weight, body fat percentage, and lean mass were measured using a body composition analyser (TANITA, TBF-140 Model, Japan). The participant's age, height, and gender were recorded, and they were to stand barefoot on the metal footplate machine. The analyser calculated all the measurements and printed the data automatically.

Standing Long Jump Explosive Power Test
The participants warmed up for five minutes before taking the test. They made their first jump onto the jumping mat, which served as the baseline measurement. The participants were required to stand with their legs apart from behind a line marked on the floor and jump as far as possible, landing on both feet without falling backwards. Participants repeated the jump three times and were given a 2-minute rest period after each jump. The furthest jumping distance was recorded by measuring from the starting line to the back heel of the participant's foot.

Vertical Jump Explosive Power Test
A vertical jump test was used in this study to determine the highest jump a person could accomplish from a standing position. Participants must first stand straight with their sides against the wall. With their feet flat on the floor, they extended the arm closest to the wall as high as they could. The highest position that participants could reach was indicated by the researcher. Then, participants positioned themselves in a standing position, flexed their knees and hips into a half-squat, and immediately extended their knees and hips to perform a vertical jump, marking the highest point on the scale. The vertical jump was repeated three times. The highest jump score value was recorded.

Countermovement Jumping Force and Power Test
A force platform measures the force exerted by the participants on its surface. All participants warmed up for at least five minutes before taking the test. The participants were required to stand upright in the centre of the force platform. Their body weight and height were keyed into the system. Participants were then asked to put their hands on their hips, flex their knees and hips into a semi-squat position, and immediately extend the knees and hips to perform a CMJ exercise with both hands swinging up overhead.

Isokinetic Muscular Strength and Power Measurement
An isokinetic dynamometer (Biodex multi-joint system 3 Pro, New York) was used to determine participants' isokinetic knee extension and flexion peak torque and power. Participants performed proper stretching exercises before the tests began. It is to familiarise themselves with the isokinetic test movements. Before the warm-up session, the participants' descriptive data, i.e., age, body height and weight, and sides of the dominant and non-dominant legs, were entered into the computer programme connected to the dynamometer. During knee extension and flexion, they had to perform five repetitions with an angular velocity of $60^{\circ}.s^{-1}$. As for angular velocities of $180^{\circ}.s^{-1}$ and $300^{\circ}.s^{-1}$, the participants had to perform 10 repetitions each. Between each session, the participants had a 20-second break.

Statistical Analysis
The data obtained from this study were analysed using Statistical Package for Social Science (SPSS) Version 27.0. A two-way mixed ANOVA was performed, followed by a post-hoc Bonferroni test. When the data were significantly different between groups or within a group, one-way ANOVA and paired T-Test were used as follow-up tests. Data are presented as mean and standard deviation (mean ± SD) values. Statistical significance was accepted at a *p*-value < 0.05.

Results
Anthropometric of the Participants
Table 2 shows the participants' mean age, body height, body weight, BMI, FFM, and percentage of body fat (%BF) by group. The data were collected during the pre-test. All of the parameters had no significant differences between the groups.

Table 2: Mean age, body height, body weight, body mass index (BMI), fat-free mass (FFM), and percentage of body fat (%BF) of the participants in the C, CS, CSJ, and CSJ groups at pre-test.

Variables	C (n=9)	CS (n=9)	J (n=10)	CSJ (n=10)
Age (years)	21.9 ± 1.3	21.44 ± 1.5	22.0 ± 1.6	21.30 ± 1.2
Body height (cm)	170.1 ± 7.3	168.7 ± 5.4	169.5 ± 10.4	173.3 ± 7.9
Body weight (kg)	63.3 ± 14.7	65.8 ± 16.5	61.5 ± 14.3	62.0 ± 10.5
BMI (kg/m^2)	21.7 ± 3.1	23.0 ± 4.5	21.2 ± 3.4	20.6 ± 2.9
FFM (kg)	51.5 ± 9.8	51.0 ± 4.8	48.7 ± 8.1	53.7 ± 10.7
Body Fat (%)	18.1 ± 5.4	20.4 ± 10.9	19.4 ± 9.2	15.4 ± 5.7

Values are expressed as mean ± standard deviation (SD); BMI, body mass index; FFM, fat-free mass; C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.

This study found no statistically significant difference in all anthropometric parameters except for FFM. There was a significantly higher reading in the CSJ group, with a 2.8% increase in the percentage difference in FFM after the 12 weeks of the intervention period (Table 3).

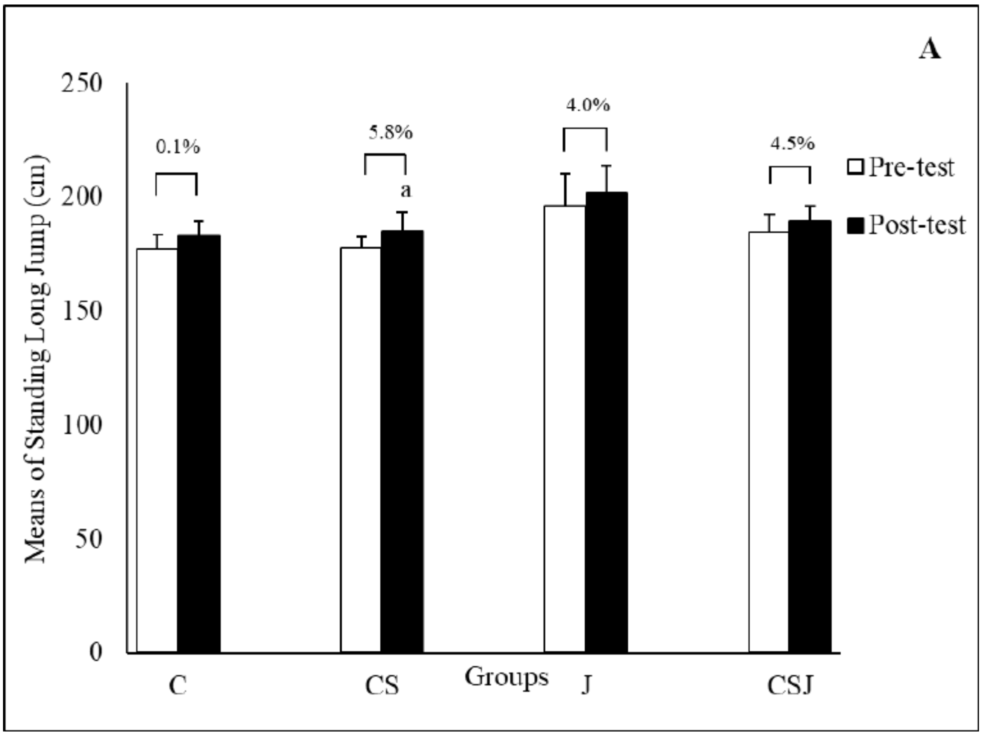
Table 3. Mean fat-free mass at pre- and post-tests.

Groups	Fat Free Mass (kg) Mean ± SD		
	Pre-test	Post-test	Percent Difference
C (n=9)	51.5 ± 9.8	51.9 ± 9.3	0.8 %
CS (n=9)	51.0 ± 4.8	51.5 ± 4.2	1.0 %
J (n=10)	48.7 ± 8.1	49.3 ± 8.9	1.2 %
CSJ (n=10)	53.7 ± 10.7	55.2 ± 11.0^a	2.8 %

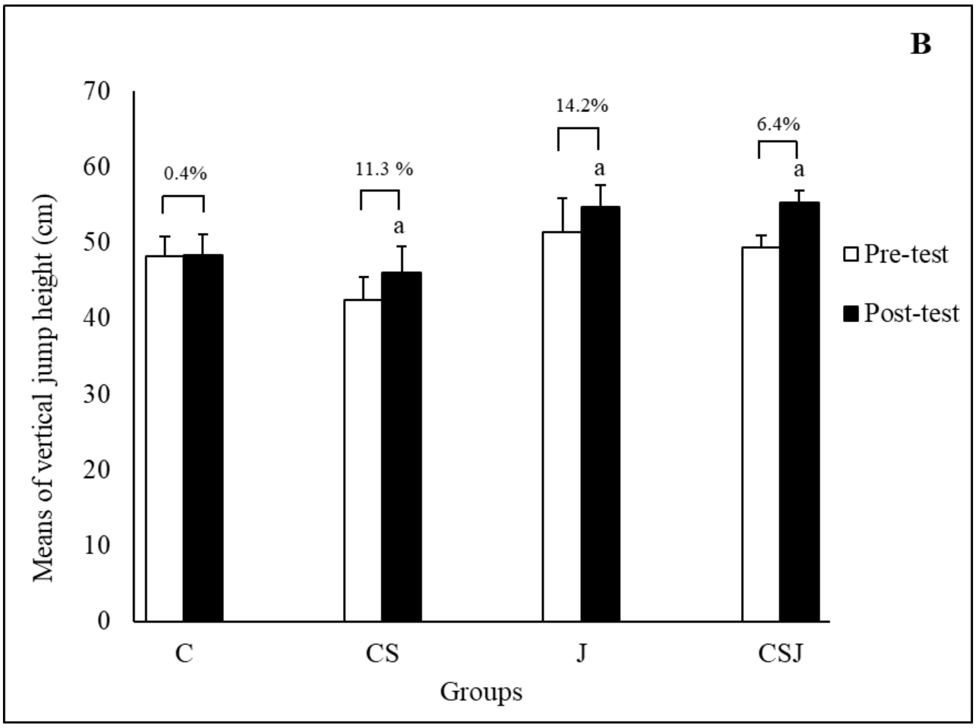
Values are expressed as mean ± standard deviation (SD); C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.

3.2 Standing Long Jump and Vertical Jump Explosive Power Test

This study found that in the CS group (5.8%), the mean standing long jump distance increased statistically significantly ($p < 0.05$) in the post-test (Figure 1A). Meanwhile, CS ($p < 0.01$), J ($p < 0.01$), and CSJ ($p < 0.05$) groups showed statistically significant improvement after 12-week intervention on the mean of vertical jump height (Figure 1B).



*[a], significantly different from pre-test ($p < 0.05$).



[a], significantly different from pre-test ($p < 0.05$).

Fig 1: Standing long jump and vertical jump explosive power test. **A**, mean of standing long jump distance (cm). **B**, mean of vertical jump height (cm).

3.3 Countermovement Jumping Force and Power Test
After the 12-week intervention period, there was no statistically significant difference in the mean force of CMJ within groups (Figure 2A). Similarly, there was no significant difference observed in the mean power of the CMJ exercise (Figure 2B). Although insignificant, J groups showed the highest percentage change at week 12, followed by the CSJ and CS group.

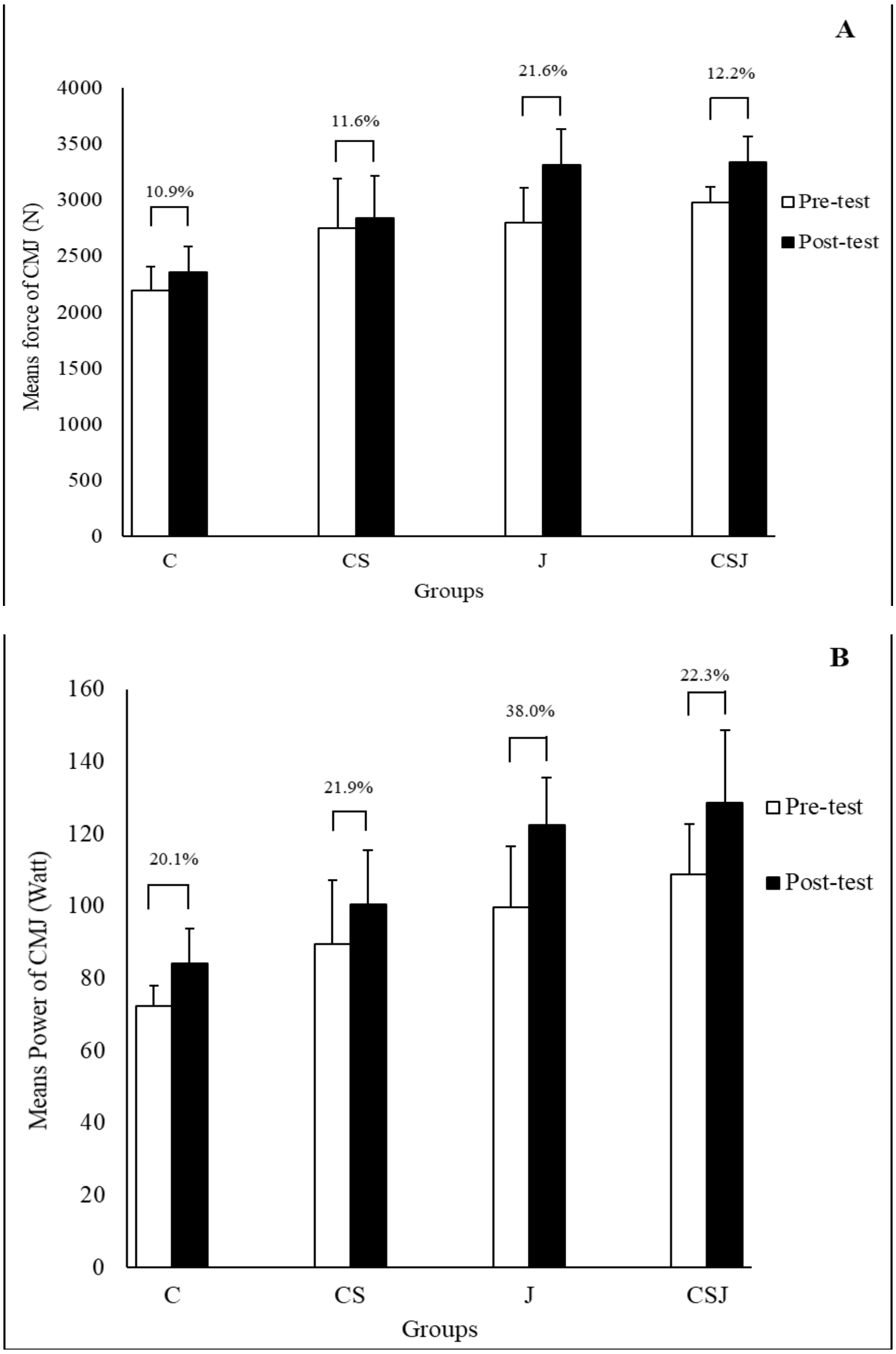


Fig 2: Countermovement jumping force and power test. **A**, mean force of countermovement jumping (N). **B**, mean power of countermovement jumping (Watt).

Isokinetic Muscular Peak Torque (strength) of the Dominant Leg

Table 4 displays the mean peak torque extension and flexion values of the participants' dominant knee at angular velocities of $60^o.s^{-1}$ and $300^o.s^{-1}$ at pre- and post-tests for all groups. After 12 weeks of intervention, there was a substantial increase in the J group's dominant knee extension peak torque at $60^o.s^{-1}$ ($p < 0.01$). When comparing the J and CSJ groups to the C group, the J group ($p < 0.01$) and the CSJ group ($p < 0.01$) had statistically significant higher peak torque. At the post-test, there was no statistically significant difference between groups for dominant knee flexion peak torque at $60^o.s^{-1}$. However, as compared to the C group, there were substantial increases in the CS ($p < 0.05$), J ($p < 0.05$), and CSJ groups ($p < 0.05$).

This study found no statistically significant difference within groups on dominant knee extension and flexion peak torque $300^o.s^{-1}$. At post-test, the CS group ($p < 0.05$), the J group ($p < 0.01$), and the CSJ group ($p < 0.001$) had substantially higher values for dominant knee extension peak torque of 300o.s-1 than the C group.

Table 4. Mean knee extension and flexion peak torque of dominant legs at pre- and post-tests for all groups.

Variables	Groups			
	C	CS	J	CSJ
Peak Torque Extension 60°.s^{-1}				
Pre-test	126.5 ± 44.3	163.0 ± 32.0	177.0 ± 33.0	194.3 ± 33.4
Post-test	143.5 ± 29.2	181.7 ± 32.5	197.9 ± 31.6^{ab}	205.1 ± 28.1^{b}
Peak Torque Flexion 60°.s^{-1}				
Pre-test	65.2 ± 25.6	76.6 ± 19.2	81.6 ± 19.0	89.7 ± 23.5
Post-test	67.1 ± 13.3	89.4 ± 10.2^{b}	88.8 ± 16.0^{b}	89.9 ± 20.5^{b}
Peak Torque Extension 300°.s^{-1}				
Pre-test	86.5 ± 22.8	96.8 ± 25.8	102.2 ± 27.1	100.4 ± 21.9
Post-test	69.1 ± 13.3	103.0 ± 26.9^{b}	111.5 ± 22.0^{b}	117.4 ± 23.2^{b}
Peak Torque Flexion 300°.s^{-1}				
Pre-test	56.1 ± 19.8	86.0 ± 21.5	72.6 ± 25.0	81.4 ± 15.8
Post-test	64.4 ± 29.1	84.3 ± 24.3	89.5 ± 18.8	87.9 ± 13.1

Values are expressed as mean ± standard deviations (SD); C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.
[a], significantly different from pre-test ($p < 0.05$).
[b], significantly different from control group ($p < 0.05$).

Isokinetic Muscular Peak Torque (strength) of the Non-dominant Leg

Table 5 shows the mean knee extension and flexion peak torque of the participants' non-dominant leg at angular velocities of 60°.s^{-1} and 300°.s^{-1} of the non-dominant leg of the participants in all groups at pre- and post-tests. On non-dominant knee extension peak torque at 60o.s-1, the CSJ group had substantially higher values ($p < 0.01$) than the C group after 12 weeks of intervention. Meanwhile, the J group had a statistically significant increase in non-dominant knee flexion peak torque at 60o.s-1 when compared to the time in pre versus post-tests ($p < 0.05$). Furthermore, there was no statistically significant difference observed in both non-dominant knee extension and knee flexion at 300°.s^{-1} in all groups at post-test. However, there were significantly higher values in the CSJ group ($p < 0.05$) compared to the C group in non-dominant knee extension peak torque at 300°.s^{-1}.

Table 5: Mean knee extension and flexion peak torque of non-dominant legs at pre- and post-tests for all groups.

Variables	Groups			
	C	CS	J	CSJ
Peak Torque Extension 60°.s^{-1}				
Pre-test	137.6 ± 31.5	173.4 ± 28.4	161.6 ± 37.1	198.8 ± 37.2
Post-test	146.4 ± 41.5	176.5 ± 32.9	186.0 ± 30.0	205.7 ± 32.7^{b}
Peak Torque Flexion 60°.s^{-1}				
Pre-test	63.6 ± 20.4	76.2 ± 17.5	77.6 ± 22.1	86.8 ± 26.5
Post-test	66.7 ± 20.3	80.3 ± 14.2	91.4 ± 21.9^{a}	89.7 ± 20.1
Peak Torque Extension 300°.s^{-1}				
Pre-test	76.0 ± 22.9	97.3 ± 19.1	100.1 ± 37.6	107.1 ± 28.1
Post-test	81.2 ± 27.3	102.9 ± 21.8	109.8 ± 26.9	123.3 ± 32.7^{b}
Peak Torque Flexion 300°.s^{-1}				
Pre-test	63.7 ± 23.2	89.2 ± 29.2	73.0 ± 22.5	84.8 ± 16.6
Post-test	67.5 ± 32.6	88.7 ± 22.3	97.2 ± 21.1	92.7 ± 20.5

Values are expressed as mean ± standard deviations (SD); C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.
[a], significantly different from pre-test ($p < 0.05$).
[b], significantly different from control group ($p < 0.05$).

Isokinetic Muscular Average Power of Dominant Leg

Table 6 shows the pre – and post-test mean knee extension and flexion average power values at angular velocities of 60º.s^{-1} and 300º.s^{-1} of the participants' dominant leg in all groups. Analysis within the groups revealed significantly higher values between pre-and post-test in dominant knee extension average power at 60º.s^{-1} in the CSJ group ($p < 0.05$). In addition, the CS group ($p < 0.05$), the J group ($p < 0.05$), and the CSJ group ($p < 0.001$) showed significant increases compared to the C group in dominant knee extension and knee flexion average power at 60º.s^{-1} and 300º.s^{-1}, respectively.

Regarding dominant knee extension, average power at 300º.s^{-1}, there was a significant increase after 12 weeks of intervention in the CSJ group ($p < 0.05$). Meanwhile, there were significantly higher values in the CS group ($p < 0.01$), the J group ($p < 0.01$), and the CSJ group ($p < 0.01$) compared to the C group. Additionally, the within-group analysis demonstrated a significant increase in the J group ($p < 0.01$) at post-test on knee flexion average power at 300º.s^{-1}. When it came to the differences between groups, the J group ($p < 0.01$) and the CSJ group ($p < 0.05$) had considerably higher values than the C group.

Table 6: Mean knee extension and flexion average of dominant legs at pre- and post-tests for all groups.

Variables	Groups			
	C	CS	J	CSJ
Average Power Extension 60º.s^{-1}				
Pre-test	66.9 ± 24.9	93.2 ± 22.9	102.7 ± 21.4	111.0 ± 22.6
Post-test	78.6 ± 21.2	109.1 ± 24.5^{b}	110.2 ± 16.5^{b}	125.4 ± 18.1^{ab}
Average Power Flexion 60º.s^{-1}				
Pre-test	39.3 ± 20.0	50.4 ± 16.6	54.9 ± 18.9	62.9 ± 21.3
Post-test	40.6 ± 14.6	62.8 ± 11.4^{b}	60.9 ± 16.6^{b}	64.9 ± 17.6^{b}
Average Power Extension 300º.s^{-1}				
Pre-test	138.2 ± 50.5	193.2 ± 61.2	206.0 ± 51.7	190.7 ± 41.2
Post-test	143.5 ± 57.5	216.4 ± 47.4^{b}	230.1 ± 29.4^{b}	233.3 ± 38.8^{ab}
Average power Flexion 300º.s^{-1}				
Pre-test	72.7 ± 41.4	115.0 ± 40.9	107.1 ± 39.5	114.6 ± 39.8
Post-test	78.7 ± 49.2	120.6 ± 21.7	140.0 ± 38.5^{ab}	125.6 ± 24.1^{b}

Values are expressed as mean ± standard deviations (SD); C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.

[a], significantly different from pre-test ($p < 0.05$).

[b], significantly different from control group ($p < 0.05$).

Isokinetic Muscular Average Power of Non-dominant Leg

Table 7 shows the mean knee extension and knee flexion average power values of the participants' non-dominant leg at angular velocities of 60o.s-1 and 300o.s-1 in all groups during pre- and post-tests. There was no statistically significant difference between pre- and post-test within the groups at the end of the study, but the CSJ group ($p < 0.01$) had significantly higher values on non-dominant knee extension average power at 60º.s^{-1} than the C group. After a 12-week intervention, there were no significant differences in knee flexion average power at 300o.s-1 among or between groups.. However, the J group showed the highest increment at the post-test.

Regarding knee extension, the average power was 300º.s^{-1}. There was no statistically significant difference between the groups at post-test. In addition, the CS group ($p < 0.05$), the J group ($p < 0.5$), and the CSJ group ($p < 0.01$) all had considerably higher values than the C group. Next, the J group showed a significant increase ($p < 0.01$) at pot-test on knee flexion average power at 300º.s^{-1}. Lastly, the CS ($p < 0.05$), J ($p < 0.001$), and CSJ ($p < 0.05$) groups all had considerably higher values than the C group.

Table 7: Mean knee extension and flexion average power of non-dominant legs at pre- and post-tests for all groups.

Variables	Groups			
	C	CS	J	CSJ
Average Power Extension 60°.s^{-1}				
Pre-test	79.5 ± 19.4	103.3 ± 15.0	95.3 ± 27.0	119.3 ± 23.7
Post-test	86.0 ± 26.2	111.1 ± 23.7	110.1 ± 18.0	124.8 ± 26.4^{b}
Average Power Flexion 60°.s^{-1}				
Pre-test	40.9 ± 16.9	51.6 ± 15.7	54.4 ± 20.9	65.1 ± 24.1
Post-test	46.2 ± 19.0	57.6 ± 12.4	63.9 ± 18.4	62.1 ± 16.0
Average Power Extension 300°.s^{-1}				
Pre-test	145.2 ± 52.5	194.6 ± 56.2	191.6 ± 57.0	210.7 ± 46.6
Post-test	152.5 ± 60.6	217.0 ± 43.0^{b}	223.5 ± 41.3^{b}	227.0 ± 35.4^{b}
Average power Flexion 300°.s^{-1}				
Pre-test	70.6 ± 44.6	111.9 ± 43.8	105.1 ± 30.5	102.9 ± 43.3
Post-test	68.7 ± 38.4	117.4 ± 21.4^{b}	139.9 ± 39.0^{ab}	119.4 ± 28.9^{b}

Values are expressed as mean ± standard deviations (SD); C, control group; CS, *Channa Striatus* supplement group; J, jumping exercise group; CSJ, combined *Channa Striatus* supplement with jumping exercise group.
^{a}, significantly different from pre-test ($p < 0.05$).
^{b}, significantly different from control group ($p < 0.05$).

Discussion

In this study, the age, body height, body weight, BMI, FFM, and % BF values at pre-test had no significant difference in all groups. These results reveal homogeneous data among the participants in the groups. According to Irving and Davis [32], exercise training produces a beneficial adaptation to body composition and reduces cardiometabolic risk. After 12 weeks of intervention, the combination of CMJ exercise and *Channa Striatus* supplementation resulted in considerably greater FFM at post-test than at pre-test. These findings are consistent with Weeks and Beck [33]. They stated that students who made various jumping activities for 10 minutes for eight months had considerably greater FFM at post-test than the control group. Meanwhile, Carvalho and Mourão [7] found that among handball players, a seven-week strength training programme mixed with particular plyometric activities has increased the FFM significantly, followed by a decrease in body fat content and fat mass.

As Channa Striatus includes amino acids and fatty acids, it's thought that supplementing with it alone will help gain muscle mass. Churchward-Venne and Murphy [34] mentioned that these nutrients are regulators for muscle protein turnover. The rate of muscle protein synthesis (MPS) increases following ingestion of amino acids, reduces muscle protein breakdown during resistance exercise, and then enhances net muscle protein accretion [35]. This study focuses on combining the CMJ exercise with the *Channa Striatus* supplement that contains amino acids, fatty acids, albumin, and proteins. According to Kwan and Baie [36], the proteins found in *Channa Striatus* are classified as structural proteins (e.g., actin, myosin and tropomyosin), enzymes (e.g., trypsin), calcium-related proteins (e.g., calmodulin and parvalbumin), and collagen. The combined jumping exercise and *Channa Striatus* supplementation resulted in a considerable increase in FFM.

This study showed improvements in the jump height values in the CS, J, and CSJ groups after 12-week intervention. Although the post-test values of CMJ force and jumping power were higher in these three intervention groups, the difference between pre- and post-tests was not statistically significant. Both jumping force (21.6%) and jumping power (21.6%) showed the greatest percentage decrease in the J group at post-test when compared to the other groups (38.0%). These results are consistent with studies conducted by Chtara and Chaouachi [37] on male physical education students. After 12 weeks of intervention in a circuit training group that included strength, endurance, and explosive power training, the authors observed a substantial increase in peak jumping height.

According to Bobbert and Casius [38], the lower limb extensors create more force and work during the first phase of the upward motion in CMJ, resulting in a higher jump height. The muscles are in an active condition to initiate the push-off during the preparatory downward action, which provides more force in jumping [39]. The positive findings in this study for jumping performance in the J and CSJ groups suggest that major muscles can be developed at beginning of the jump. As a result, the extensor muscles of the lower limb may create more force, resulting in a higher jump after the study period of 12 weeks. In relation to the positive findings of the CS group on jumping performance, it is speculated that the rhythmicity of dynamic loading in this high-impact jumping exercise may improve the blood flow to activate muscles by supplying them with nutrients [40, 41] contained in *Channa Striatus*. Thus, it allowed the participants to perform jumping exercises more efficiently.

As for isokinetic muscular power and strength, this study found statistically significant higher values in the CS, J, and CSJ groups in both dominant and non-dominant legs of knee extension and flexion at angular velocities of $60^o.s^{-1}$ and $300^o.s^{-1}$ compared to the C group. Meanwhile, the J and the CSJ groups showed statistically significant greater values in the dominant leg of isokinetic muscle strength and power extension at $60^o.s^{-1}$ and $300^o.s^{-1}$ at post-test. These findings imply that combining jumping exercise with *Channa Striatus* supplementation may have more positive effects on muscle performance than *Channa Striatus* supplementation alone. These positive findings are consistent with study done by Uzelac-Sciran and Sarabon [12]. After eight weeks of jump training, they found that male participants' knee extensor muscle strength (peak torque) had improved significantly.

Previous research on athletes have also found that exercise had a positive influence on muscle performance. During the eight weeks of plyometric training, elite female volleyball players improved significantly in knee extension [42]. Carvalho and Mouro [7] in male handball players and Franco Márquez and Rodrguez Rosell [43] in young soccer players found similar increases in lower extremity muscle strength. In Nordic athletes, Paasuke and Ereline [9] found a substantial relationship between standing long jump and CMJ and peak torque of isokinetic knee extension at an angular velocity of $60^o.s^{-1}$.

Uzelac-Sciran and Sarabon [12] mentioned that changes in muscle size improved the muscle strength in young, inactive males. The strength improvements from the CMJ exercise could be explained by the fact that it necessitates proper technical abilities and acceptable levels of muscle strength by increasing inter-and intramuscular capacity to contract and generate force [44]. CMJ is a combination of complicated extensor and flexor leg muscle actions that result in high concentric and moderate eccentric activation, requiring gradual motor unit activation [1, 2]. In other words, during jumping exercises, the muscles exert their maximum force for a short period, resulting in an increasing combination of strength and speed, ultimately leading to power production. The positive effects of isokinetic muscle strength and power reported in the J and CSJ groups could be attributed to the aforementioned mechanism.

The results on isokinetic muscle performance in this study are consistent with previous findings. Trzaskoma and Tihanyi [11] and Tsiokanos and Kellis [4] both found positive relationships between isokinetic muscle torque and maximum power output developed during CMJ. These are in line with the statement by Paasuke and Ereline [9], stated that at an angular velocity of $60^o.s^{-1}$, CMJ height was found to be substantially linked to isokinetic knee extension strength. Furthermore, Śliwowski and Grygorowicz [2] discovered a strong relationship between peak torque of the quadriceps (extensors) of both dominant and non-dominant legs and jumping performance.

Conclusions

In this study, the sedentary control group without the *Channa Striatus* supplement had no significant difference in all parameters measured. The combination of performing the CMJ exercise with consuming *Channa Striatus* supplementation or by doing only jumping exercises has shown statistically significant effects on jumping height and most parameters of isokinetic muscular strength and power. But there were no significant effects on jumping distance, CMJ force, or power. Meanwhile, consuming the *Channa Striatus* supplementation alone showed significant differences in jumping distance, jump height, and parameters in isokinetic muscular strength and power. But non-dominant peak torque on knee extension and flexion at angular velocities of $60^o.s^{-1}$ and $300^o.s^{-1}$ was not significantly affected. In conclusion, muscular strength and power have increased in physically young, inactive males when consuming only *Channa Striatus* supplementation, doing only jumping exercise, or having a combination of *Channa Striatus* supplementation and CMJ exercise for 12 weeks.

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