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Effect of Whey protein supplementation on GH-1 and IGF-1 in taekwondo athletes

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ABSTRACT

Introduction: Improving athletic performance has been one of the issues that athletes have long faced. Hundreds of Sport supplements for athletes have been introduced to the market in recent years. The overall aim of the present study was to investigate the interactive effect of whey supplementation and resistance training on growth hormone and IGF-1 levels in taekwondo athletes.

Material & Methods: The method of the present study was a quasi-experimental and clinical trial. 24 taekwondo athletes were selected with an average age of 26.4±5.3 years, weight 73.34±11.6 kg, and BMI 21.81±5.4 kg/m2, and volunteers were randomly assigned into two groups: exercise + whey supplementation (group 1) and exercise (group 2). Before performing the exercise and supplementation program (50g daily in group 1), GH-1 and IGF-1, and physical fitness were measured, and after performing the exercise, testing was performed again for all variables. Data analysis using tests of Kolmogorov-Smirnov and t-test, conducted through SPSS-20 software ($p \leq 0.05$).

Results: the amount of GH and IGF1 increased in two groups compared with before training. Statistical analysis using the results indicated that after eight weeks of a combination exercise program and supplementation, strength, endurance, and agility changed significantly in both groups($p<0.05$), with no significant changes in BMI and velocity($p>0.05$).

Conclusion: The results showed that whey supplementation doesn't increase GH-1, IGF-1, and physical fitness of taekwondo athletes.

Keywords: Whey Supplements, Physical Fitness, Taekwondo, Athlete.GH, IGF-1.

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1. Introduction

Sport organizations such as the American College of Sport Medicine (ACSM) recommend that adult athletes consume higher amounts of protein than the general population to support training adaptations and recovery (ACSM, 2024). Achieving a balance between building lean muscle and consuming high-quality protein through exercise-based nutritional strategies has been widely recognized as an effective approach for promoting optimal body composition and lean muscle mass (1; 2). In all Sport, and particularly taekwondo training, reaching the upper limits of physical fitness demands substantial training volume and intense effort (3). During exercise, the body is subjected to multiple demands that trigger extensive physiological adaptations (4). From this perspective, the nervous and endocrine systems act in coordination to initiate and regulate movement and the numerous physiological processes involved (5). The hormonal system governs various metabolic functions, including enzyme synthesis and activation, alterations in cell-membrane permeability, protein synthesis, and shifts in cellular metabolism (6). Research indicates that the anterior-pituitary-derived hormone Growth Hormone (GH) functions as a potent metabolic regulator promoting muscle growth and hypertrophy by enhancing amino-acid uptake into cells (7; 6). GH is secreted in a pulsatile pattern and is modulated by various stimuli. It is believed to exert its effects directly, or indirectly via production of intermediate proteins such as Insulin-like Growth Factor-1 (IGF-1, or "somatomedin C") in the liver and other tissues; IGF-1 has a structure analogous to pro-insulin and thus is called "insulin-like" (8; 9). Its levels are adjusted by physiological factors such as sleep, hormones, exercise, etc., and pathological factors such as disease, stress, etc. (10; 11). It is now well established that systemic strength training, by combining several factors such as mechanical stress, neurological control, metabolic needs, and endocrine activity, has a strong effect on increasing muscle size (hypertrophy) and muscle strength (12). A strength program based on the principle of progressive overload leads to acute responses such as increased concentrations of anabolic hormones and a temporary decrease in neuromuscular function (13). Therefore, the amount of acute hormonal and neuromuscular response is a criterion in determining the effects of resistance training with different intensities (14). Taekwondo is an Olympic martial art. It is currently held in more than 210 countries worldwide (15,16). Taekwondo can be described as a high-intensity combat sport, known for its precise hand and foot strikes, its intermittent nature, and the high physical demands on the athletes (17,18). The acute hormonal response depends on the type of resistance training program, which in turn is affected by variables such as training load, number of sets, number of repetitions, rest between sets, muscle mass involved, and sessions per week (19; 20). In addition to those factors, protein supplementation may play a role in both acute and chronic hormonal responses related to muscle-building adaptations (21). Whey protein supplementation has gained prominence among athletes, particularly in disciplines like Taekwondo. Whey protein supplementation has gained prominence among athletes, particularly in disciplines like Taekwondo (22). Whey protein has emerged as one of the most popular dietary supplements among athletes, fitness enthusiasts, and health-conscious individuals over the past few decades (23). This rise in popularity is not without eligibility, as whey protein offers a unique blend of nutritional and functional properties that make it particularly well-suited for supporting muscle growth and recovery (24). The importance of protein in the human diet cannot be overstated, particularly for those engaged in regular physical activity or seeking to build and maintain muscle mass (25). Proteins serve as the building blocks for muscle tissue, enzymes, hormones, and various other essential components of the human body (22). Among the different types of protein available, whey protein stands out due to its exceptional amino acid profile and rapid digestibility, making it an ideal choice for post-exercise recovery and muscle protein synthesis (MPS) (24). Growth hormone (GH) and insulin-like growth factor 1 (IGF-1) play pivotal roles in muscle development, repair, and adaptation to training (26).

Physical activity is an important and effective factor and is known as a strong stimulator of the release of growth hormone, prolactin, and cortisol, especially resistance training, which increases growth hormone levels. The magnitude of the response to exercise varies depending on the type, intensity, duration, muscle recruitment, rest time, sex, age, body composition and health, and training status of individuals. GH secretion has shown a similar increase in men and women thirty minutes after resistance training, although resting GH levels are significantly higher in women than in men. GH is a peptide hormone produced by the somatotroph cells of the anterior pituitary and regulated by hypothalamic hormones. The secretion of this hormone has an intermittent pattern, and various stimuli affect the amount and frequency of its secretion. GH affects the metabolism of protein, carbohydrate, and fat. Also, receptors for this hormone are present in all cells and have a direct effect on many tissues, such as skeletal muscle (27). IGF-1 is a good factor for muscle growth among various factors, including growth hormone, insulin, testosterone, and other related hormones. Increased growth hormone and, consequently, insulin-like growth factor-1, cause an increase in the transcriptional rate, and more RNA is produced. Therefore, more mRNA is exported from the nucleus and transported to the cytosol on ribosomes, leading to more protein synthesis. It has also been shown that growth hormone improves body composition by increasing fat metabolism and carbohydrate storage, in which case, by increasing fat metabolism and protein synthesis, body fat mass is reduced and lean body mass is increased (28, 29). Taekwondo is a dynamic and demanding combat sport that

requires a balance of physical, technical, and psychological readiness. The nutritional status of Taekwondo athletes is crucial for enhancing performance, especially given the demands of training and competition, which often take place under stressful conditions. So, to achieve competitive success, Taekwondo practitioners must prioritize their nutritional requirements, ensuring adequate energy intake and proper hydration (30). Taekwondo primarily relies on oxidative metabolism, yet decisive lower-limb attacks depend on non-oxidative pathways. Given the importance of muscular strength in many Sport, especially taekwondo, a number of athletes are very keen on strength training. Therefore, achieving muscular strength as quickly as possible has led athletes to use various synthetic supplements such as creatine or whey protein (31, 32). Whey protein has emerged as one of the most popular dietary supplements among athletes, fitness enthusiasts, and health-conscious individuals over the past few decades.1 This rise in popularity is not without merit, as whey protein offers a unique blend of nutritional and functional properties that make it particularly well-suited for supporting muscle growth and recovery.2 As a byproduct of cheese production, whey was once considered a waste product but has since been recognized as a valuable source of high-quality protein with numerous potential health benefits.3 The importance of protein in the human diet cannot be overstated, particularly for those engaged in regular physical activity or seeking to build and maintain muscle mass. Proteins serve as the building blocks for muscle tissue, enzymes, hormones, and various other essential components of the human body.4 Among the different types of protein available, whey protein stands out due to its exceptional amino acid profile and rapid digestibility, making it an ideal choice for post-exercise recovery and muscle protein synthesis (MPS). In addition to providing the necessary amino acids for protein synthesis, whey protein, when combined with exercise, promotes muscle protein synthesis through activation of the AKT/mTOR signaling pathway, which is closely linked to IGF-1 activity. Furthermore, the insulinogenic properties of whey protein may contribute to its anabolic effects by promoting nutrient uptake and inhibiting muscle protein breakdown. The purest form of whey protein is protein isolate, which contains the lowest levels of fat, lactose, and cholesterol and the highest levels of essential amino acids (32,33). Despite growing interest in whey protein supplementation among athletes, several gaps remain in the literature. Most studies have focused on general or resistance-trained populations, with limited research specifically on combat Sport athletes such as Taekwondo practitioners (34). Moreover, the effects of whey protein on GH and IGF-1 are inconsistent, likely due to variations in supplementation timing, dosage, training intensity, and participant characteristics (33). Few studies have examined the long-term hormonal adaptations to whey protein in conjunction with sport-specific training programs, and the mechanisms by which whey protein influences GH and IGF-1 in high-intensity, intermittent combat Sport remain unclear. Additionally, the lack of standardized protocols for assessing hormonal responses further complicates comparisons across studies. These gaps highlight the need for targeted research to clarify the role of whey protein supplementation in optimizing anabolic hormone responses in Taekwondo athletes. Given the use of various supplements among athletes and the existence of profit-seeking individuals who have been observed in some cases to cause great harm to athletes with counterfeit and unsanitary goods, the researcher decided to evaluate the effect of whey supplements consisting of high-quality proteins along with resistance training on the body composition and physical fitness factors of taekwondo athletes. Also, given the high need of high-level taekwondo athletes to have optimal physical fitness, there are various studies that have examined the benefits of whey protein, and given that taekwondo is one of the medal-winning disciplines in major Olympic and Asian competitions, it reveals the need for further research in this field. Given the need for high-level taekwondo athletes to have lean, toned muscles, as well as the effect of physical activity on the secretion of hormones involved in muscle building and protein synthesis, the question that arises is whether there are changes in growth hormones and IGF, body composition, and physical fitness factors in male taekwondo athletes in response to exercise training and supplement consumption. However, limited information is available on the effect of his protein on hormones, especially growth hormone and insulin-like growth factor, in athletes, especially male Taekwondo athletes. Therefore, this study aimed to investigate the interactive effect of whey supplementation and resistance training on growth hormone and IGF-1 levels in male Taekwondo athletes.

2. Methodology

2.1. Materials and methods

In this quasi-experimental study, among 24 professional taekwondo players in the age range of 18 to 29 years from a selected club in Rasht, randomly divided into two equal groups of exercise + whey supplementation and exercise group. The research design was a pre-test-post-test study with a control group. Before and after eight-week exercise BMI, Body Fat (%), training lower and upper limb muscle strength factors, Speed, Upper body muscular endurance, Agility, IGF-1, GH were obtained.

2.2. Participants

24 professional taekwondo players (age 18 to 29 years) from a selected club in Rasht, randomly divided into two groups of exercise + whey supplementation (n=12) and exercise (n=12). The research design is a pre-test-post-test study. the inclusion criteria included having Adherence to diet, not taking any medications or

supplements, not smoking, having no history of illness or infection, not doing regular and heavy exercises in the days before the test, and familiarity with bodybuilding equipment. Also, the excluded criteria include the absence of more than three training sessions, and their non-attendance was determined. The samples first participated in an orientation session before starting the research. In this session, while explaining the exercise program, the time and duration of its completion, some of the athletes' questions were also answered. In addition, a written consent form was obtained from the athletes.

2.3. Measurements

Before and after the exercise program by the research groups, the subjects' body fat percentage was measured by measuring the thickness of the subcutaneous fat layer in the back of the arm, supraclavicular region, and thigh using calipers and calculated using the Jackson and Pollock formula (formula 1) (35). All measurements were taken three times in rotation in each area on the right side, and the average of the three measurements was recorded as the final measurement. Physicality in lower and upper limb muscle strength factors was measured and recorded through chest and leg press tests, speed through the 100 m running test, upper torso muscle endurance through the horizontal bar, and the agility test by the 9×4 running method. To determine the level of IGF1 and GH in all subjects before and after training, blood samples were taken at 8 am in the laboratory after 10 to 12 hours of fasting. 3 to 5 cc of blood was taken from the brachial vein of each subject. To measure growth hormone in terms of micrograms per liter, a radium kit made in Switzerland with an accuracy of 0.2 mg / dL and an internal measurement coefficient of variation (CV) equal to 2.38% and an ELISA method was used. Also, the amount of IGF1 in nanograms per milliliter of each blood sample was measured using the Enzyme immunoassay DRG IGF-1600 kit made in Germany and the ELISA method. The research groups then practiced three sessions a week for eight weeks. The exclusion criteria for the study were the absence of more than 3 consecutive sessions in the exercises.

*Body fat percentage for male participants was estimated using the three-site Jackson–Pollock skinfold equation:

$$\text{Body Fat (\%)} = (0.41563 \times \text{sum of three skinfolds}) - (0.00112 \times (\text{sum of three skinfolds})^2) + (0.03661 \times \text{age}) + 0.003653$$

Body density can also be estimated using the sum of three skinfolds (in mm) with the Jackson–Pollock formula for men:

$$\text{Body Density (g/cm}^3) = 1.10938 - (0.0008267 \times \text{sum of three skinfolds}) + (0.0000016 \times (\text{sum of three skinfolds})^2) - (0.0002574 \times \text{age})$$

Once body density is calculated, body fat percentage can be estimated using the Siri equation:

$$\text{Body Fat (\%)} = (495 / \text{Body Density}) - 450$$

2.4. Intervention

Resistance training protocol: Resistance exercise training consisted of 8 weeks and three sessions per week. The duration of each training session was 120 minutes, which included 60 minutes of specialized Taekwondo training and 60 minutes of weight training. The resistance training program included 10 minutes of warm-up (slow running, stretching, and flexibility) and then 50 minutes of performing ten weight movements, in three stations and in a circle, where the subjects experienced a variety of exercises with different exercises each week. The stations included, respectively, chest press with a barbell, overhead press with a barbell, underarm row, forearm press with a barbell, chain press, deadlift, shoulder press with a barbell from the front, back leg with a machine, leg squat, and sit-ups (abdominals), and each session included four sets with 12 maximum repetitions and an intensity of 65 to 80% of the maximum repetition. The rest time between stations was 30 seconds, and the rest time between each set (end of each round of the circuit) was 90 seconds. The cool-down phase was 15 minutes, using stretching and jogging. Finally, specialized exercises were performed for 60 minutes (Table 1) (36). In the present study, the maximum strength of the subjects was obtained using the following equation:

$$1Rm = \text{weight} / 1 - (0.02 \times \text{Repetition})$$

Table 1. *Resistance training protocol*

Type of exercise	Intervention	duration	intensity
Taekwondo	60 minutes of specialized Taekwondo training, including technical training and fighting	60min	As a pre-season training session
Working with weights	Resistance training	60 min	65 to 80% 1RM

1RM: one repetition maximum

Whey supplementation: In the present study, the whey supplement group consumed 50 grams of whey protein daily with 400 cc of water immediately after exercise for two months, and the second group did not receive any supplements. In order to reduce some interfering and confounding factors in the research results and to reduce the effects of food type on the research variables, in the initial session, the subjects were asked to refrain from eating ready-made foods and caffeinated beverages for at least 48 hours before the exercise program and blood

sampling. In addition, a three-day food recall questionnaire and briefing classes were used to control the subjects' nutrition (36).

2.5. Statistical Methods

Descriptive statistics for calculating central indices, the Kolmogorov-Smirnov test to determine the normal distribution of data, and to compare the results before and after supplementation in each group, paired t-test and independent t-test were used between the two groups. For data analysis, SPSS software (version 22) was used and the level of significance were considered at the level of $P \leq 0.05$.

3. Results

The characteristics of the subjects, including age, height, weight, and body mass index, are presented in Table 2.

Table 2. *Demographic characteristics of the subjects (n = 12)*

Variable	Complement + Training group	Training group
Age(years)	26.4±5.3	25.3±4.5
Weigh (kg)	73.35±11.6	71.7±7
Height(cm)	173.9±7.7	176.6±6.2
BMI*(Kg / m²)	21.89±4.7	22.30±5.3

*BMI: Body mass index

Table 3. *Results of the correlated t-test between the pre-test and post-test of group 1 and group 2 (n=12)*

Variable	Group	Mean ± SE (Pre-test)	Mean ± SE (Post-test)	t	Sig.
IGF-1(ng/ml)	Exercise + whey supplementation	401.89±10.92	437.21±14.84	8.109	0.001*
	Exercise	406.34±9.01	429.11±11.73	7.761	0.002*
GH(mg/dl)	Exercise + whey supplementation	0.98±0.11	3.34±0.56	8.453	0.001*
	Exercise	1.01±0.42	2.77±0.74	6.564	0.001*
BMI* (Kg / m²)	Exercise + whey supplementation	19.56±7.37	20.34±5.56	0.952	0.453
	Exercise	20.96±5.81	20.77±8.74	1.129	0.230
Body Fat(%)	Exercise + whey supplementation	13.12±4.92	11.02±3.84	7.102	0.001*
	Exercise	13.01±3.01	11.11±4.73	8.410	0.001*
Lower limb strength (Leg press)(kg)	Exercise + whey supplementation	99.88±4.92	118.21±3.84	7.236	0.001*
	Exercise	95.34±3.01	116.11±4.73	6.356	0.001*
Upper limb strength (chest press) (kg)	Exercise + whey supplementation	44.56±7.37	63.34±5.56	9.104	0.001*
	exercise	42.96±5.81	59.77±8.74	10.328	0.002*
Speed(s)	Exercise + whey supplementation	13.11±1.37	12.01±1.56	1.651	0.457
	Exercise	13.24±1.81	12.21±1.74	1.128	0.234
Upper body muscular endurance (repetitions)	Exercise + whey supplementation	13.1±9.5	19.2±10.9	7.370	0.003*
	Exercise	14.7±4.9	18.7±9.6	6.298	0.002*
Agility(s)	Exercise + whey supplementation	9.91±.13	9.01±.27	6.389	0.003*
	Exercise	9.76±.34	8.96±.31	8.432	0.001*

BMI: Body mass index; *Statistically Significant p< 5%

Table 3 shows the changes in research variables in both groups. Findings showed that IGF1 and GH levels in both groups increased significantly from pre-workout levels. The two groups had no significant effect. However, no significant difference was observed between the two groups in the post-test in any of the dependent variables.

Table 4. *Results of an independent t-test between two groups (n=12)*

Variable	Mean difference	t	Sig.
IGF1	8.102	2.654	0.564
GH	1.24	2.238	0.115
BMI*	1.231	1.943	0.432
Body Fat	1.432	0.112	0.490
Upper limb strength	5.123	1.004	0.216
Lower limb strength	2.123	1.114	0.321
Speed	-0.42	1.126	0.430
Upper body muscular endurance	4.101	1.761	0.276
Agility	-0.543	0.671	0.176

*Significant at the 5% level *BMI: Body mass index

Also, the results of the independent t-test (Table 4) showed that there was a significant difference between the post-test results of the research variables in both groups in IGF1, GH, muscle strength, and endurance. That is, resistance training in both groups caused a significant improvement in the studied variables, and supplementation did not affect them. Considering that there is no significant difference between the post-test results of the research variables, it can be concluded at least that his supplementation did not have a significant effect on body composition and physical fitness factors of professional male taekwondo, or that it was significant. Within the group in the supplement and exercise group, supplementation may have exerted a significant effect, but it has been overlapped by the significant effect of exercise.

4. Discussion

The present study investigated the effects of resistance training combined with taekwondo-specific exercises, with or without whey protein supplementation, on several physiological and performance parameters in athletes. Across all measured outcomes—including growth hormone (GH), insulin-like growth factor-1 (IGF-1), muscular strength, speed, agility, muscular endurance, and body fat percentage—resistance training elicited significant improvements in both the control and whey-supplemented groups. However, no significant differences were observed between the groups, indicating that whey protein supplementation did not provide additional benefits over training alone.

Resistance training significantly increased serum levels of GH and IGF-1 in both groups. These findings are consistent with studies by Murray et al. (2025) and Gulick et al. (2020), which reported exercise-induced elevations in these hormones without significant enhancement from whey supplementation. However, more recent work by Murray et al. (2025) found that even with additional protein supplementation, the IGF-1 response was not significantly different, representing a partial non-concordance with our findings. This discrepancy may be attributed to differences in training duration, protein dosage, or participant training status among studies. This discrepancy may be due to longer supplementation periods in other studies, higher doses of whey protein, differences in participant training status, as untrained individuals may respond differently to protein intake, and variations in measurement methods, including gene expression versus serum hormone levels (40). Resistance training significantly increased serum GH and IGF-1 levels in both groups (42). This increase is physiologically explained by mechanical stress-induced stimulation of the pituitary gland, which enhances GH secretion. GH, in turn, stimulates hepatic IGF-1 production, promoting anabolic processes in skeletal muscle (42). Whey protein supplementation did not produce additional elevations, likely because participants already consumed adequate protein, and the training stimulus alone was sufficient to maximally activate GH/IGF-1 pathways. Some studies reported greater IGF-1 increases with prolonged whey supplementation (38). This discrepancy may be due to enhanced amino acid availability, particularly leucine, which activates mTORC1 signaling and promotes muscle protein synthesis (43).

Both upper- and lower-body strength, as well as muscular endurance, improved significantly in both groups. These results are in agreement with Griffen et al. (2022) and Murray et al. (2025). Some studies (McAdam et al., 2022) reported greater improvements with whey supplementation, constituting non-concordance. Possible reasons include longer-term interventions allowing protein to impact muscle hypertrophy, differences in training volume or intensity, and participant populations with lower baseline protein intake, making supplementation more effective. These effects can be physiologically attributed to mechanical tension, muscle fiber recruitment, and satellite cell activation, which enhance muscle hypertrophy and endurance capacity (46).

Significant improvements in speed and agility were observed in both groups, consistent with Griffen et al. (2022). Studies reporting additional benefits from whey (Cava et al., 2024) show partial non-concordance, likely due to Differences in exercise modality (endurance vs resistance) ،Longer duration or higher frequency of supplementation, and Age or training level of participants affecting neuromuscular adaptation. These improvements are attributed to neuromuscular adaptations, including enhanced motor unit recruitment, increased firing frequency, and improved intermuscular coordination. Such adaptations are crucial for optimizing strength and performance outcomes (47). Resistance training significantly reduced body fat percentage in both groups,

while whey supplementation provided no additional effect. This aligns with Griffen et al. (2022) and Murray et al. (2025). Fat loss is physiologically mediated by increased resting metabolic rate, enhanced mitochondrial density, and improved lipolysis via catecholamine responses (Christoffersen et al., 2022). Contrasting studies (McAdam et al., 2022) showing additional fat reduction with whey protein may be due to longer-term supplementation, energy restriction, or lower baseline protein intake, which enhances fat-free mass retention. Overall, resistance training is the primary driver of hormonal, performance, and body composition improvements in athletes. Whey protein supplementation may provide additional benefits in specific contexts such as long-term interventions, energy deficits, or untrained populations, due to enhanced amino acid availability, mTOR signaling, and satellite cell activation (49). Non-concordant findings in the literature highlight the influence of supplementation duration, dosage, training status, and participant characteristics (45). This study has several limitations that should be considered when interpreting the results. First, the sample size was relatively small, which may limit the generalizability of the findings to larger athletic populations. Second, whey protein supplementation was provided only over a short- to medium-term period; longer interventions may yield different outcomes. Third, all participants were trained athletes, and untrained or novice individuals may respond differently to both resistance training and supplementation. Fourth, dietary intake outside the provided supplementation was not strictly controlled, which could influence the observed effects. Fifth, the study included athletes within a specific age and gender range, limiting the applicability of results to other populations. Finally, physiological markers were measured at limited time points, and more frequent or longitudinal assessments could provide deeper insight into the dynamics of adaptation.

5. Conclusion

Resistance training combined with taekwondo-specific exercises significantly improves GH, IGF-1, muscular strength, speed, agility, and muscular endurance and reduces body fat in trained athletes. Whey protein supplementation did not provide additional benefits, suggesting that the training stimulus is the primary driver of these adaptations.

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