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Original Research Article

Retrospective analysis of the effects of high versus extra-high whey protein intake on muscle strength and nutritional status in adults aged 45–65 years

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ABSTRACT

Background: Age-related muscle decline often begins in middle age, affecting strength, functional performance and nutritional status. Protein supplementation supports muscle mass and strength, but comparative data on high versus extra-high protein intake in adults aged 45–65 years are limited. This study evaluated the effects of high (HP) and extra-high whey protein (XHP) supplementation on muscle strength, anthropometry and nutritional outcomes in this transitional age group.
Methods: A retrospective analysis was conducted using medical records of participants who received HP or XHP supplementation for at least 60 days. Inclusion required complete documentation of demographic details, clinical history, anthropometrics, nutritional assessment (mini nutritional assessment short form (MNA-SF)) and handgrip strength. Extracted data included weight, BMI, waist and hip circumference, mid-upper arm and calf circumference and muscle strength at baseline and follow-ups over two months.
Results: HP supplementation led to significant increases in weight and BMI ($p<0.05$), whereas XHP protein intake was associated with reductions in these parameters. between groups in waist and hip circumference, MUAC and calf circumference emerged from 30 days onward ($p<0.05$). Handgrip strength improved in both groups initially, but XHP supplementation produced superior functional gains 45 and 60 days ($p<0.05$).
Conclusions: High-protein supplementation with whey protein provided dose-dependent benefits. Moderate intake supported anabolic recovery, while higher intake improved lean body mass and muscle strength. These findings highlight the therapeutic role of dietary protein in enhancing muscle quality, metabolic health and functional performance, helping prevent and manage sarcopenia and age-related muscle decline.

Keywords: Anthropometry, Adults, Body weight, Extra-high protein, Handgrip strength, High protein, Muscle strength, Nutritional status, Protein, Protein supplementation, Sarcopenia

INTRODUCTION

Protein is a required macronutrient for proper bodily activities. Daily protein intake varies with age, gender and intensity of daily exercise, but it is essential for maintaining muscle growth and strength throughout one's life. Muscle strength are positively correlated, independent of age or gender. In general, higher lean mass is linked to better overall health and the avoidance of age-related functional decline.

However, after the age of 30, muscle mass declines at a rate of 0.3 to 0.8% every year. The loss of lean mass is caused by a decrease in both the number and area of myofibers. Age-related muscle atrophy, decreased mitochondrial activity, heightened oxidative stress, diminished satellite cell function and inflammation.[1]

Adverse factors prevalent in aging adults can be superimposed on the age-related changes to cause pathological under-nutrition, with even greater associated increases in morbidity and mortality. Rates of under-nutrition increase with age and loss of independence. The major markers of existing or pending under-nutrition in aging people are low body weight (particularly body mass index <22 kg/m^2); loss of weight, particularly when involuntary and >5%; substantial loss of muscle mass, which can lead to sarcopenia.[2]

As aging begins, there is gradual loss of muscle mass and function and becomes a significant worry. Sarcopenia has been defined by the European working group on sarcopenia in older people (EWGSOP2) as a progressive muscle disorder characterized by low muscle strength, with low muscle quantity or quality confirming the diagnosis. Improvements in functional strength may therefore reflect neuromuscular adaptation, even in the absence of direct body composition measurements.[3]

Sarcopenia significantly leads to frailty, disability, physical dependency and mortality in aging individuals.[4] Sarcopenia affects between 6% and 19% of adults over the age of 60 worldwide. Sarcopenia increases the risk of falling, fractures, reduced quality of life, cardiovascular illness, lung disease and cognitive impairment.

The leucine threshold hypothesis explains this mechanism, suggesting that a critical concentration of leucine is necessary to maximally activate the mTOR pathway and stimulate muscle protein synthesis. In aging adults, this threshold appears elevated, requiring higher protein doses or leucine-enriched sources to achieve optimal anabolic stimulation.[5] There are currently no licensed medications for treating sarcopenia.[4]

Diet is a modifiable lifestyle factor that can help prevent and treat malnutrition and sarcopenia. However, WHO and National Academies of Sciences current RDA of 0.8 g/kg bodyweight/day for adults may not be sufficient to avoid sarcopenia in elderly people. Recent study suggests that protein intake closer to 1.2-1.5 g/kg bodyweight/day, when accompanied with sufficient activity, is more effective in preventing age-related declines in muscle mass and strength, improving health status and lowering the risk of early mortality.[1,6] Reducing fat mass promotes metabolic health and nutritional therapies involving protein supplementation have been found to improve muscle health.[1]

However, limited data exist in literature comparing the differential impact of high (1.0-1.2 g /kg body weight/day) versus extra-high whey protein (>1.2 g/kg body weight/day) intake supplements on muscle strength and nutritional status specifically in aging adults (45–65 years), a transitional age group where early intervention may prevent future sarcopenia. Therefore, a retrospective comparative analysis of high versus extra-high whey protein intake was conducted to determine which intake level is more effective in improving muscle strength and nutritional status among adults.

METHODS

This was a retrospective study in which adults (men and women aged 45–65 years), with or without comorbid conditions, who had received high (1.0-1.2 g/kg body weight/day) or extra-high whey protein (>1.2 g/kg body weight/day) Whey protein supplementation for at least 60 consecutive days and whose medical records contained complete data on muscle strength and nutritional status were included in the study.

Study duration and sample size

Retrospective data were collected from December 2024 to May 2025. All participants fulfilling the predefined inclusion and exclusion criteria were included in the analysis.

Study place

Multiple hospitals (ACI Cumballa Hill hospital, Kemps corner, Mumbai, Apollo Spectra Hospitals, Tardeo, Mumbai, Lokamanya Multi-Speciality Hospital, Nashik, Bhatia hospital, Grant Road, Mumbai, Pimpri Chinchawad University, Mavel, Pune, Supreme Clinic, Akurdi, Pune, A. M. Naik Nirali Hospital, Powai, Mumbai, Masina hospital trust, Byculla, Mumbai, Cardinal Gracias Memorial Hospital, Vasai Road, Mumbai).

Exclusion criteria

Individuals aged below 45 years or above 65 years, those who had received whey protein supplementation for less than 60 days or participants with incomplete or missing medical records and individuals with a history of acute illness, advanced organ failure or malignancy were excluded from the study.

Participants who were prescribed and consumed high- and extra-high-protein supplement for at least 2 months were enrolled in this study. Their data were extracted from medical records. The extracted medical data included demographic details, clinical history, anthropometric measurements, nutritional assessment scores, muscle strength measurements and follow-up records.

Outcome measures were evaluated using data available in the medical records. Anthropometric parameters, including height, weight, waist circumference, hip circumference, mid-upper arm circumference and calf circumference, were recorded.

Nutritional status was determined using the (MNA-SF) as documented in the records and muscle strength measurements obtained using a handgrip dynamometer were retrieved. Data recorded at baseline and at follow-up time points over a two-month period were extracted from the medical records and analyzed. Adverse effects, if reported by participants, were analyzed

Statistical analysis was conducted using the SPSS Statistics for Windows, Version 21. Descriptive statistics were used to summarize the data, including actual numbers, percentages, means with standard deviations (SD) and medians with interquartile ranges (IQR), as appropriate. Normality was assessed. Within-group changes over time were analyzed using the Friedman test and between-groups at each time point were assessed using the Mann–Whitney U test.

RESULTS

Baseline characteristics

In this retrospective study, a total of 40 participants were analyzed, of whom 19 belonged to the high protein group and 21 to the extra high protein group. In the high protein group, the mean age was 52.68±6.52 years. The group comprised 11 females (57.9%) and 8 males (42.1%), indicating a female predominance. In the extra high protein group, the mean age was 49.48±4.65 years. The group included 11 males (52.4%) and 10 females (47.6%), showing a nearly equal gender distribution (Table 1).

Within group analysis

In the high-protein group (Table 2), significant improvements were observed in body weight and BMI over the 60-day follow-up period (p<0.05). Mid-upper arm circumference and calf circumference also increased significantly, indicating enhancement in peripheral muscle mass.

Nutritional status, as assessed by MNA-SF, improved markedly by the end of 60 days (p<0.001). Handgrip strength in both right and left hands showed significant gains across follow-up visits (p<0.001). No statistically significant changes were noted in hip circumference, waist circumference or waist-hip ratio.

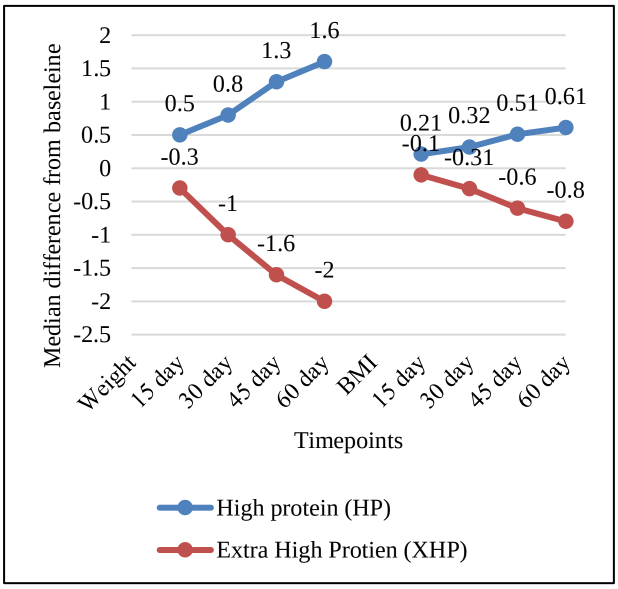

Figure 1: Comparison of weight and BMI changes between the two groups.

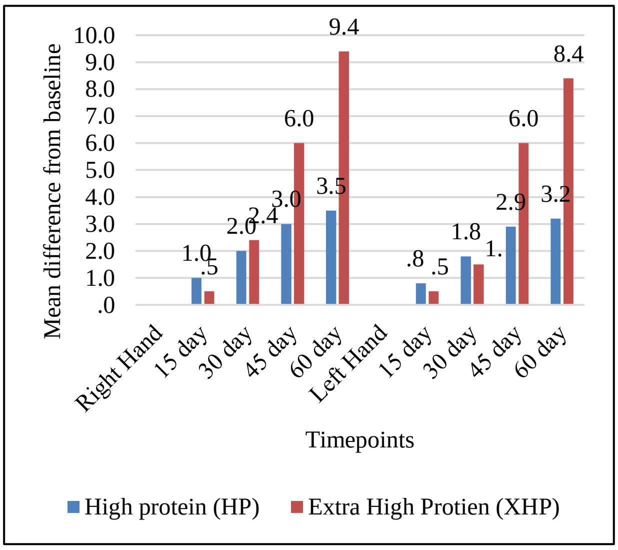

Figure 2: Comparison of hand grip muscle strength changes between the two groups.

In the extra-high protein group (Table 3), a significant reduction in body weight and BMI was observed over the 60-day follow-up period (p<0.001 for both). Waist circumference also demonstrated a statistically significant change (p<0.001), while hip circumference showed significant variation across time points (p<0.001).

Waist–hip ratio showed borderline significance (p=0.050). Mid-upper arm circumference and calf circumference did not exhibit statistically significant changes. Nutritional status (MNA-SF) improved significantly by the end of follow-up of 60 days (p=0.012). Handgrip strength in both right and left hands increased markedly over time (p<0.001), indicating improved muscle strength

Between group analysis

Both groups were comparable at baseline. During follow-up, significant intergroups were observed. The high protein group demonstrated a significant increase in weight and BMI across all time points (p<0.05). In contrast, the extra high protein group showed a reduction in these parameters. Waist and hip circumference, MUAC and calf circumference showed significant between groups from 30 days onward (p<0.05) (Table 4). Hand grip strength (right and left) was comparable at 15 and 30 days but showed significantly greater improvement in the extra high protein group at 45 and 60 days (p <0.05). Waist–hip ratio did not differ significantly between groups at any time point (Table 5). Overall, the high protein group showed greater improvement in anthropometric measures, whereas the extra high protein group demonstrated superior gains in muscle strength at later follow-up.

Table 1: Baseline demographics.

Parameters		Value
Total participants		40
Participants in high protein group (HP)		19
Gender	Male	11
	Female	8
Mean age (in years)		52.68
Mean weight (in kg)		57.95
Mean BMI (kg/m²)		22.22
Participants in extra high protein group (XHP)		21
Gender	Male	11
	Female	10
Mean age (in years)		49.48±4.65 years
Mean weight (kg)		73.95
Mean BMI (kg/m²)		27.93

Table 2: Within-group changes in anthropometric, nutritional and muscle strength parameters in the high protein group (baseline to 60 days).

Parameters		Baseline	15 days	30 days	45 days	60 days	F /Z value	P value
Weight (kg)	mean	57.95	58.39	58.89	59.57	60.08	21.69	<0.001
	median	57.60	56.00	56.20	58.00	60.00		
BMI (kg/m²)	mean	22.22	22.93	23.10	23.36	23.51	17.42	0.002
	median	23.19	23.66	24.00	23.80	23.70		
Hip circumference (cm)	mean	92.19	86.75	92.02	91.83	91.62	4.89	0.298
	median	90.00	87.00	91.90	91.00	90.00		
Waist circumference (cm)	mean	83.62	83.23	83.07	82.95	82.79	8.41	0.077
	median	80.00	81.50	82.05	81.70	82.00		
WHR (waist–hip ratio)	mean	0.92	0.92	0.89	0.93	0.93	2.32	0.676
	median	0.92	0.93	0.95	0.95	0.95		
MUAC (mid upper arm circumference) (cm)	mean	28.56	28.63	28.96	29.07	29.29	24.64	<0.001
	median	28.00	28.00	29.00	29.40	29.80		
Calf circumference (cm)	mean	31.26	31.50	31.65	32.11	32.40	34.93	<0.001
	median	30.00	30.20	30.40	31.00	32.00		
Mini nutritional assessment (MNA-SF)	mean	9.79				13.32	-3.73	<0.001
	median	9.00				14.00		
Hand grip right	mean	37.64	38.94	40.12	40.97	42.07	51.33	<0.001
	median	23.60	23.80	25.0	24.40	26.20		
Hand grip left	mean	35.62	36.64	37.98	39.09	40.63	51.18	<0.001
	median	24.50	24.40	25.10	25.20	25.50		

Table 3: Within-group changes in anthropometric, nutritional and muscle strength parameters in the extra high protein group (baseline to 60 days).

Parameters		Baseline	15 days	30 days	45 days	60 days	F	P value
Weight (kg)	mean	73.95	73.57	72.91	72.26	71.66	53.046	<0.001
	median	74.00	74.00	73.50	72.50	72.00		
BMI (kg/m²)	mean	27.93	27.79	27.51	27.25	27.01	51.252	<0.001
	median	27.84	27.53	27.53	26.90	26.89		
Hip circumference (cm)	mean	85.57	84.83	84.28	79.21	83.54	26.901	<0.001
	median	102.00	101.00	100.00	95.00	98.00		
Waist circumference (cm)	mean	77.90	82.24	81.62	80.86	80.09	60.283	<0.001
	median	86.00	88.00	87.00	86.20	85.80		
WHR (waist–hip ratio)	mean	0.97	0.98	0.98	0.97	0.97	9.506	0.050
	median	1.0	1.0	1.0	1.0	1.0		
MUAC (mid upper arm circumference) (cm)	mean	31.67	31.38	31.34	31.29	31.19	5.000	0.287
	median	30.00	30.00	30.00	30.00	30.00		
Calf circumference (cm)	Mean	34.29	34.21	34.20	34.18	34.25	1.037	0.904
	Median	34.00	34.00	34.00	34.00	34.00		
Mini nutritional assessment (MNA-SF)	mean	12.90				13.62	-2.51b	0.012
	median	14.00				14.00		
Hand grip right	mean	25.13	26.73	28.64	32.30	34.79		<0.001
	median	22.00	23.00	25.00	28.0	31.0		
Hand grip left	mean	23.62	24.53	25.38	29.48	31.99		<0.001
	median	20.20	22.00	23.00	27.00	29.00		

Table 4: Intergroup comparison of difference in mean/median change in parameters between high protein and extra high protein groups at each time points from baseline.

Parameters (Difference in the mean change from baseline)			Mean±SD	Median	z value	P value
Weight (kg)	at 15 days	HP	0.44±1.51	0.50	-2.754	0.006
		XHP	-0.39±0.42	-0.30		
	at 30 days	HP	0.94±3.06	0.80	-3.037	0.002
		XHP	-1.04±1.12	-1.00		
	at 45 days	HP	1.62±4.31	1.30	-3.471	0.001
		XHP	-1.69±1.52	-1.60		
	at 60 days	HP	2.13±5.72	1.60	-3.569	0.000
		XHP	-2.29±1.72	-2.00		
BMI (kg/m²)	at 15 days	HP	0.18±0.59	0.21	-2.751	0.006
		XHP	-0.14±0.15	-0.10		
	at 30 days	HP	0.35±1.19	0.32	-3.130	0.002
		XHP	-0.42±0.44	-0.31		
	at 45 days	HP	0.61±1.65	0.51	-3.522	0.000
		XHP	-0.68±0.63	-0.60		
	at 60 days	HP	0.76±2.19	0.61	-3.562	0.000
		XHP	-0.91±0.70	-0.80		
Waist circumference (cm)	at 15 days	HP	-0.39±1.37	0.00	-1.202	0.229
		XHP	-0.43±0.93	0.00		
	at 30 days	HP	-0.56±2.51	0.00	-2.461	0.014
		XHP	-1.05±1.12	-1.00		
	at 45 days	HP	-0.67±3.33	1.00	-3.005	0.003
		XHP	-1.80±1.36	-1.00		
	at 60 days	HP	-0.83±4.31	1.00	-3.613	0.000

Continued.

Parameters (Difference in the mean change from baseline)			Mean±SD	Median	z value	P value
		XHP	-2.58±1.73	-2.00		
Hip circumference (cm)	at 15 days	HP	-5.44±2.38	0.00	0.000	1.000
		XHP	-0.74±1.87	0.00		
	at 30 days	HP	-0.17±1.93	0.30	-2.476	0.013
		XHP	-1.29±2.43	0.00		
	at 45 days	HP	-0.36±2.47	0.50	-2.611	0.009
		XHP	-6.36±2.54	-1.00		
	at 60 days	HP	-0.57±3.45	0.90	-2.309	0.021
		XHP	-2.03±3.62	-1.00		
WHR (waist–hip ratio)	at 15 days	HP	0.00±0.01	0.00	-0.904	0.366
		XHP	0.01±0.03	0.00		
	at 30 days	HP	-0.03±0.15	0.00	-0.811	0.417
		XHP	0.00±0.02	0.00		
	at 45 days	HP	0.01±0.03	0.00	-0.710	0.478
		XHP	0.00±0.02	0.00		
	at 60 days	HP	0.01±0.03	0.00	-1.524	0.128
		XHP	-0.01±0.03	0.00		
MUAC (mid upper arm circumference) (cm)	at 15 days	HP	0.07±0.33	0.50	-1.750	0.080
		XHP	-0.29±0.64	0.00		
	at 30 days	HP	0.40±0.96	1.00	-2.973	0.003
		XHP	-0.32±1.21	0.00		
	at 45 days	HP	0.51±1.31	1.00	-2.853	0.004
		XHP	-0.38±1.21	0.00		
	at 60 days	HP	0.73±1.70	3.00	-3.239	0.001
		XHP	-0.48±1.24	0.00		
Calf circumference (cm)	at 15 days	HP	0.24±0.50	0.00	-2.311	0.021
		XHP	-0.07±0.46	0.00		
	at 30 days	HP	0.39±0.49	0.50	-3.816	<0.001
		XHP	-0.09±0.47	0.00		
	at 45 days	HP	0.85±1.17	0.90	-3.725	<0.001
		XHP	-0.11±0.55	0.00		
	at 60 days	HP	1.14±1.50	1.00	-3.732	<0.001
		XHP	-0.04±0.77	0.00		
		XHP	9.66±1.98	8.40		

Table 5: Intergroup comparison of difference in mean/median change in MNA-SF and hand grip strength between high protein and extra high protein groups at each time points from baseline.

Parameters (Difference in the mean change from baseline)			Mean ±SD	Median	z value	P value
Mini nutritional assessment (MNA-SF)	at 60 days	HP	3.53±2.37	3.00	-4.231	<0.001
		XHP	0.71±1.27	0.00		
Hand grip right	at 15 days	HP	1.02±1.97	1.00	-0.572	0.568
		XHP	0.91±1.13	.50		
	at 30 days	HP	2.36±304	2.00	-0.896	0.370
		XHP	1.76±1.65	2.40		
	at 45 days	HP	3.47±3.63	3.00	-3.797	<0.001
		XHP	5.86±1.90	6.00		
	at 60 days	HP	5.01±5.99	3.50	-4.106	<0.001
		XHP	8.37±2.34	9.40		
Hand grip left	at 15 days	HP	1.30±1.83	0.80	-0.286	0.775
		XHP	1.60±2.59	0.50		
	at 30 days	HP	2.48±2.71	1.80	-0.624	0.533
		XHP	3.51±3.58	1.50		
	at 45 days	HP	3.34±2.96	2.90	-2.983	0.003
		XHP	7.17±2.80	6.00		
	at 60 days	HP	4.43±3.66	3.20	-2.940	0.003
		XHP	9.66±1.98	8.40		

DISCUSSION

This retrospective study indicates that Whey protein supplementation with either high or extra high proteins led to notable enhancements in muscle strength, nutritional indicators and body composition over a 60-day period. Although both protein groups experienced positive effects, the nature of these changes varied depending on the amount of protein consumed.

In the high protein group, significant increases in body weight, BMI, mid-upper arm circumference (MUAC) and calf circumference suggest enhanced peripheral muscle accretion and anabolic activity. The concurrent improvement in MNA-SF scores and handgrip strength further supports improved nutritional status and muscle function. These findings are consistent with previous evidence showing that adequate protein intake stimulates MPS and promotes gains in lean body mass, particularly in middle-aged and aging adults. A systematic review and meta-analysis by Zhang et al reported that protein supplementation significantly improves muscle mass and handgrip strength in physically inactive aging adults.[7]

In contrast, the extra high protein group exhibited a significant reduction in body weight and BMI, alongside improvements in handgrip strength and MNA-SF scores. The absence of significant increases in MUAC and calf circumference suggests that strength gains may have been driven by improved neuromuscular efficiency and preferential fat loss rather than overt muscle hypertrophy. The observed later superiority in handgrip strength (at 45 and 60 days) supports a potential dose-dependent enhancement in neuromuscular adaptation. Similar findings have been described in meta-analyses demonstrating that higher protein intake can improve muscle strength independent of substantial changes in muscle mass.

Between-group comparisons showed that the high protein group achieved greater improvements in anthropometric parameters, whereas the extra high protein group demonstrated superior late-phase gains in muscle strength. These findings align with current literature suggesting that moderate protein doses may favor anabolic weight gain, while higher protein intake may enhance muscle quality and metabolic efficiency through improved fat-to-lean mass distribution. Direct comparison of the findings with existing literature is challenging as to the best of our knowledge, this is the first study to specifically compare the effects of high versus extra-high whey protein intake on muscle strength and nutritional outcomes in adults aged 45–65 years.

The results of the present study are in agreement with the findings reported by Ishaq et al who observed that increased protein intake contributed to better preservation of muscle mass and improvement in physical performance among elderly women with sarcopenia.[8] In their study, participants receiving a moderately high-protein diet demonstrated enhanced muscle composition and strength compared with those consuming the standard recommended protein intake.[8] Likewise, the study found that higher whey protein consumption was associated with improved muscle-related outcomes, with individuals receiving extra-high protein supplementation showing greater improvements in lean body mass and muscle strength. These findings collectively emphasize the importance of adequate protein intake in maintaining muscle health and reducing age-related decline in physical function.

The findings are also supported by the study conducted by Mojtahedi et al which evaluated the effects of higher protein intake during energy restriction in older women.[9] The authors reported that a protein-rich dietary intervention helped preserve lean body mass and maintain physical function despite weight loss.[9] Similarly, the present study demonstrated that increased whey protein intake was associated with favorable changes in muscle-related outcomes, which was similar to previous studies.[8-12] Participants receiving extra-high protein supplementation showed greater gains in lean body mass and muscle strength. Although the study by Mojtahedi et al focused on older women undergoing caloric restriction, while the study assessed adults receiving varying levels of whey protein supplementation, both studies underscore the beneficial role of higher protein intake in supporting muscle preservation and functional performance.[9]

Overall, high-protein supplementation with whey protein demonstrated dual benefits anabolic recovery in moderate doses (high protein) and lean mass optimization in extra high protein doses. The results reinforce the role of dietary protein in enhancing muscle quality, metabolic health and functional performance, supporting its therapeutic potential in managing sarcopenia and age-related muscle decline.

This study has some limitations. It was retrospective and included a small number of participants, which may affect the reliability of the results. The groups were not age and BMI matched. The follow-up period was short, so long-term effects were not studied. Only handgrip strength was measured for muscle function. Despite these limits, the study provides useful information on how different protein doses affect muscle strength and nutrition. Further, randomized controls trials are needed to validate these beneficial findings.

CONCLUSION

High-protein supplementation with whey proteins demonstrated dual benefits: high doses promoted anabolic recovery, while extra high doses (>1.2 g/kg body weight/day) enhanced muscle functional capacity. While body composition was not directly assessed in this study, the observed improvements in handgrip strength suggest enhanced functional muscle adaptation following protein supplementation. These findings reinforce the role of dietary protein supplementation in improving muscle quality, metabolic health and functional performance, supporting its therapeutic potential in preventing and managing sarcopenia and age-related muscle decline.

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