Original Article

Effect of protein supplements on cardiovascular health and exercise performance of young adult males

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Abstract

Introduction: The modern fitness culture, propelled by celebrity influence and media exposure, has led to widespread acceptance and consumption of protein supplements, particularly among young adult males aspiring for an ideal physique. Despite the surge in usage, limited research has explored the impact of these supplements on cardiovascular health and exercise performance. This study aims to bridge this gap by clinically examining the cardiovascular system using heart rate variability (HRV) and comparing outcomes between those using protein supplements and a control group. **Methodology:** This study was conducted at the Department of Physiology, AIIMS Raipur. The cross-sectional study involved 60 young adult males aged 18–25 years. Participants were divided into two groups: group I (n = 30), comprising individuals using commercially available protein supplements for a minimum of three months, and group II (n = 30) as age-matched controls. Cardiovascular assessments, including HRV analysis, were performed at rest and after the Harvard step test. Pre-exercise and post-exercise parameters were statistically analyzed, and participants in the test group provided information on supplement labels. **Results:** Participants in both groups exhibited comparable pre-exercise cardiovascular parameters. However, post-exercise results did not reveal significant variations in systolic blood pressure, diastolic blood pressure, mean blood pressure, low frequency/high frequency (LF/HF) ratio, Standard deviation of the successive differences between adjacent NNs (SDNN), and standard deviation of successive differences (SDSD) between the test and control groups. The average exercise duration for the control group was longer than that of the test group. Amino acid profiles and nutritional content varied among 13 different protein supplement brands. **Conclusion:** The study found no statistically significant positive influence of protein supplements on cardiovascular health or exercise performance in young adult males.

Keywords: Cardiovascular health, exercise performance, heart rate variability, protein supplements, young adults

Introduction

The young adults have been idolizing various celebrities with a special focus on their appearance. Every new look of their beloved celebrities is immediately remembered, replicated, and internalized. Free access to media and information has helped fuel this fire. In a bid to sculpt their bodies to look like their favorite idols, the young generation blindly accepts anything and everything that is offered to them. Gymming has become more common than ever and the instructors who may be trained or untrained, prescribe various supplements for quick bodybuilding. The young generation, especially athletes, are comfortable with the latest supplemental trends such as ephedrine, hydroxy-methyl-butyrate, androstenedione, creatine, whey protein extracts, etc., "Protein powders" are available over the counter as well as in grocery stores with other trendy supplements. Protein is a major macronutrient that is required to build muscle mass, tissue repair, and the synthesis of hormones and enzymes.[1]

These promoted health benefits of protein supplementation increased its consumption significantly in adolescents as well as adults. Many "protein supplements" are consumed without medical

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supervision. Whey is the most popular protein supplement, which is derived from a by-product when milk is coagulated in the process of cheese production. It consists of several essential amino acids that are easily digestible and absorbable.[2] Other common protein supplements are soy protein, casein, etc.

The effect of some substances (which are commonly used as supplements) like caffeine, energy drinks, caffeine mixed with aspirin,[3] multi-vitamins, vitamin D, coenzyme Q10,[4] and performance-enhancing drugs[5] on cardiovascular health and sudden death have been studied around the world. However, a literature search reveals that these "protein supplements" have not been studied so far for their effects on cardiovascular health.

According to the Recommended Dietary Allowance (RDA) for healthy individuals, the protein included in our daily diet is 0.8 g/kg/day. To get the desirable benefits, protein intake is increased up to 1.4–1.6 g/kg/day by using protein supplements. It claims to increase muscle mass, improve physical performance, and increase fat loss.[6] To date, numerous studies of reviews, systematic reviews, and meta-analyses have tried to measure and explain these claims, but the results are diverse.[7] Unfortunately, most of the studies revolve around the impacts of protein supplements on muscle synthesis, hypertrophy, and exercise performance. Its effect on cardiovascular health has not been given any consideration, which should be an area of crucial interest for the young individuals in the community.

Protein supplementation was extensively discussed on different platforms with respect to its pros and cons but due to the paucity of literature regarding its beneficial effect on exercise endurance and positive effect on the cardiovascular system was lacking. This study was done to understand the physiological aspects of protein supplementation on exercise and cardiovascular system (CVS) health.

Methodology

This study was done at the cardiac-autonomic and vascular function clinic, Department of Physiology, AIIMS, Raipur, after institutional ethical clearance (IEC Proposal no: AIIMSRPR/IEC/2019/277). It was a cross-sectional study including 60 young, healthy adult males between 18 and 25 years of age recruited after giving consent for participation. Group I (n = 30): regularly using commercially available "protein supplements" for at least the last three months. Group II (n = 30): healthy young adult age-matched controls males. Subjects having any known history of cardiovascular disease were excluded from the study.

After a detailed clinical history and general physical examination, the cardiovascular system of all participants was examined (inspection, palpation, percussion, and auscultation) at rest. The participant was instructed to wear loose and comfortable clothing during testing. They should refrain from coffee, nicotine, or alcohol 24 hrs before the testing. They were advised to avoid food for the preceding two hours of the testing.

Study protocol

After the supine rest of 15 minutes, a lead II electrocardiogram (ECG) was recorded on an 8-channel digital physiograph (LabChart®, ADI, Australia). Using the prescribed guidelines of Task Force to quantify sympathetic and parasympathetic cardiac autonomic tone, heart rate variability (HRV) for short-term analysis was calculated offline from a 10-minute recording of the ECG. The ambient room temperature was kept at 27°C. The participant was instructed prior regarding the protocol and was asked to avoid talking, any kind of body movement, to close the eyes, and to avoid coughing during recording. They were instructed not to fall asleep. After taking a resting ECG, the participant was asked to do the exercise (Harvard step test) with the following protocol: The participant was asked to step up and down on a 16-inch platform 30 times per minute for five minutes or until he could no longer do it, whichever was earlier. A metronome was used giving time signals at a fixed rate. Each participant was asked to place one foot on the platform, step up, place the other foot on the platform, straighten legs and backbone, and again step down the same foot that he placed up first. They were instructed to start with the same foot each time and not alternate the foot. Following the exercise, blood pressure was measured, and an ECG was recorded for 10 minutes. ECG recording was stored on the computer for offline analysis. No participant exhibited any sign of distress nor did any participant's ECG show changes of a serious nature during the course of the study.

The following HRV analysis was done from the recorded ECG for each participant:

a. Frequency domain analysis for sympatho-vagal balance (low frequency/high frequency (LF/HF) ratio).
b. Time domain analysis: SDNN – standard deviation of the RR intervals and SDSD – standard deviation of differences between adjacent RR intervals.

Statistical tests like *t*-test and paired *t*-test were performed on pre- and post-exercise parameters, and their differences were compared. Participants of the test group were requested to submit the empty containers of the "protein supplements" or their labels so that the contents of the protein supplements as available on the labels could be listed and correlated with their effects, if any, on cardiovascular health of the participants.

Results

Participants in this study were in the age group of 18–25 years only. The average height of the participants was 175 cm and the average weight was 65 kg. The body mass index (BMI) of all the subjects was calculated. All participants in the test group were found in the normal (n = 18) or overweight (n = 12) category. In the control group, two participants were underweight, while the rest were in the normal (n = 24) or overweight (n = 4) categories. The values of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean blood pressure (MBP) are expressed on average and ECG parameters at rest (pre-exercise) are as

given in Table 1. Both groups were comparable for BP and ECG parameters in the resting state.

On average, participants in the control group were found to perform the exercise prescribed for a longer duration (4.02 minutes) as compared to the participants of the test group (2.93 minutes). The BP and ECG parameters of both groups obtained after exercise were comparable. Table 2 gives a comparison of the values recorded after the exercise.

Average SBP, DBP, MBP LF/HF ratio, SDNN, and SDSD showed no statistically significant variations in either group after exercise.

Table 3 shows the correlation results before and after exercise for each parameter in either group. The control group showed significant change in pairs 1, 3, and 6 only.

Most of the participants in the test group were found to have been using the supplement for the last six months to one year. None of the supplements were prescribed by medical professionals. The source of information about the supplements for all the subjects was either gym trainers or the internet. None of the subjects had a specific time of the day for the use of the supplements. As gathered from the labels of the protein supplement containers, many of the supplements mentioned to have contained all 20 amino acids, but some had only a few amino acids. All the supplements were noted to contain the amino acids leucine, isoleucine, and valine. Few supplements mentioned branched chain amino acids (BCAA) in the contents other than valine, isoleucine, and leucine but the exact chemical nature was not mentioned. Thirteen brands of protein supplements were found to be used by the participants in the test group. The information collated from the labels collected from the participants in the test group is compiled in Tables 4 and 5. The brand names of the supplements have been masked to avoid bias, as advised by the IEC. Instead, numbers have been assigned to each of the brands from 1 to 13.

The amino acid profile of the collected supplements is mentioned in Table 4.

The quantity of nutritional factors (per 30 grams of the supplements) was tabulated from the labels of packets and is shown in Table 5.

Table 1: Pre-exercise BP and ECG parameters

Group	Average SBP	Average DBP	Average MBP	Average LF/HF	Average SDNN	Average SDSD
Control	114.85	74.5	87.94	1.69	50.94	41.45
Test	118.22	76.44	90.36	1.31	56.38	48.69
P	NS	NS	NS	NS	NS	NS

Table 2: Post-exercise BP and ECG parameters

Group	Average SBP	Average DBP	Average MBP	Average LF/HF	Average SDNN	Average SDSD (ms)
Control	158.5	90.78	93.35	4.56	35.43	14.56
Test	170.22	90.88	97.32	3.22	46.03	25.74
P	NS	NS	NS	NS	NS	NS

Table 3: Paired sample correlations

Group	Parametres	*n*	Correlation	Sig.
Case				
Pair 1	SBP_B* and SBP_A	30	0.329	0.183
Pair 2	DBP_B and DBP_A	30	0.230	0.358
Pair 3	MBP_B and MBP_A	30	0.206	0.412
Pair 4	LF_HF_B and LF_HF_A	30	0.059	0.818
Pair 5	SDNN_B and SDNN_A	30	0.197	0.433
Pair 6	SDSD_B and SDSD_A	30	0.134	0.595
Control				
Pair 1	SBP_B and SBP_A	30	0.663	0.000
Pair 2	DBP_B and DBP_A	30	0.218	0.266
Pair 3	MBP_B and MBP_A	30	0.384	0.044
Pair 4	LF_HF_B and LF_HF_A	30	0.288	0.137
Pair 5	SDNN_B and SDNN_A	30	0.243	0.212
Pair 6	SDSD_B and SDSD_A	30	0.441	0.019

Discussion

The aim of this study was to examine and draw some conclusions about whether the use of protein supplements has any outcome on the cardiovascular health of young adult males. All the participants of the study (both test and control groups) belonged to the male sex. This may be due to the belief that the male gender is more muscular with a sculpted body as compared to the female gender. The researcher did not come across any single female individual who admitted to using protein supplements and hence only male participants were included in the study.

However, studies have found that oral supplements of amino acids like lysine, tyrosine, arginine, ornithine, and others in any formulation whichever singly or in combination, do not have any positive effects on the cardiovascular health or exercise performance of the test group.[8] Recent studies have shown that increased intake of most dietary amino acid supplements is not completely safe and may cause many side effects.[9]

A study by Joy JM, *et al.*[10] has shown that the use of whey isolates every day increases lean body mass, muscle mass, strength, and power while decreasing the fat mass. The present study also shows that all the participants of the test group are either in the normal or overweight category. As the number of participants was small, this study design was not able to draw definite conclusions about the correlation between the use of protein supplements and obesity in the test participants.

Some studies also demonstrated that some food protein sources and whey protein are effective at improving physical performance and cardiometabolic health in obesity[11] but in this study, it was found that most of the participants using protein supplements were not able to perform the Harvard step exercise for an average duration of more than three minutes, which was less than the control group.

Long-term use of amino acids as found in the literature can contribute to the development of insulin resistance and thus finally can progress to type 2 diabetes mellitus,[12] which can further increase the risk for cardiovascular disease. There is a paucity of research literature addressing the effect of protein supplements on cardiovascular health hence studies concentrating on long-term supplementation and its effect on cardiovascular health are needed.[13]

HRV calculates beat-to-beat changes in the heart rate, which is under the influence of sympathetic and parasympathetic nervous control. This analysis serves as a dynamic window into autonomic function and balance of cardiac autonomic tone. HRV is offline analyzed for time domain and frequency domain parameters from recorded ECG. HRV is an extensively used noninvasive tool to quantify the cardiac autonomic tone. It has been associated with high predictive value in many diseases. LF/HF ratio, SDNN, and SDSD showed differences in pre- and post-exercise values in both the test and control groups. However, these parameters were not found to be statistically significant in our study. The average values for SBP, DBP, and MBP, were also not significant in both groups. This finding suggests that "protein supplement" usage does not have any positive influence on sympatho-vagal balance in the test group and hence their exercise performance compared to the control group. We suggest more studies in this direction are required to be done with larger sample sizes for a longer duration to establish the relation between protein supplement usage and its effect on the HRV parameters. Also, the study should be conducted for the long-term effects of protein supplement use in the cardiovascular system. Further studies are required to be done using larger samples for establishing or rejecting such an association.

Table 4: Amino acid profile of collected protein supplements

Amino acids	1	2	3	4	5	6	7	8	9	10	11	12	13
Leucine	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Isoleucine	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Valine	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lysine	✓		✓			✓	✓	✓		✓			✓
Methionine	✓		✓			✓	✓		✓	✓			✓
Phenylalanine	✓		✓			✓	✓		✓	✓			✓
Threonine	✓		✓			✓	✓			✓	✓		✓
Tryptophan	✓		✓			✓	✓	✓		✓	✓	✓	✓
Histidine	✓		✓			✓	✓				✓		✓
Arginine	✓	✓	✓			✓	✓	✓	✓		✓		✓
Cysteine	✓		✓			✓	✓		✓		✓		✓
Glycine	✓		✓			✓	✓				✓	✓	✓
Proline	✓		✓			✓	✓						✓
Tyrosine	✓	✓	✓			✓	✓		✓				✓
Glutamic acid	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓
Alanine		✓	✓			✓	✓				✓		✓
Serine			✓			✓	✓					✓	✓
Asparagine							✓		✓	✓			✓
Aspartic acid			✓			✓	✓			✓	✓	✓	✓
Glutamine				✓	✓	✓	✓	✓		✓		✓	
BCAA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Conclusions

The use of protein supplements leads to a significant gain in body weight, but there is a significant reduction in the average duration of exercise done by the participants. Significant variations are not found in pre- and post-exercise cardiovascular parameters in both groups.

Strength of study

This study highlighted the underreported issue of cardiovascular health among protein consumers of the community. This study will help the primary caregiver and community to wisely use protein supplements for the young population.

Limitation of study

The total number of participants in the study groups was small to draw any definite statistically significant conclusions. Further

Table 5: Contents of collected protein supplements

Supplement no.	Calories (kcal)	Protein (g)	Total FAT (g)	Carbohydrate (g)	Cholesterol (g)	Sodium (g)	Calcium (g)	Potassium (g)	Creatin (g)
1	125.45	25	1.15	3.71	0.02143	NM	NM	NM	NM
2	120	25	2	3	0.04	0.115	0.13	NM	NM
3	119	24	1.5	2.5	NM	NM	NM	NM	NM
4*	125.2	8	5	13.56	NM	NM	NM	NM	NM
5	160	30	2.5	4	0.08	0.15	0.135	NM	3
6	140	25	2	4	0.07	0.135	0.06	0.32	NM
7	120	24	1.5	2.5	0.02	0	NM	NM	NM
8	114	22	1	4	NM	0.1	NM	NM	NM
9	116	27	1	0	NM	NM	NM	NM	NM
10	136	10	2	20	NM	NM	0.036	NM	0.833
11	114	23.9	1.4	2.1	0.062	NM	NM	NM	NM
12	136.3	26.5	1.4	5.3	NM	0.07	0.105	0.122	NM
13	142	24	1.27	6	0.057	NM	0.11	NM	NM
Averages	128.30	22.65	1.82	5.44	0.05	0.10	0.10	0.22	1.92

*Calculated values; NM=Not mentioned

study using a larger sample size may be required to establish correlations between commercially available protein supplement use and cardiovascular health.

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Conflicts of interest

There are no conflicts of interest.

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