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Comparing a selected continuous versus interval aerobic exercise program on progranulin and BMI of overweight/fat female students

Hasan Ehteram[1], **Mansour Sayyah**[2], **Hooman Angoorani**[3], **Faeze Tohiditabar**[2], **Majid Etemadhosseini**[2*]

[1] Department of Pathology and Medical Laboratory Sciences, Kashan University of Medical Sciences, Kashan, Iran
[2] Department of Physical Education, Kashan University of Medical Sciences, Kashan, Iran
[3] Department of Sport and Exercise Medicine, School of Medicine, Kashan University of Medical Sciences, Kashan, Iran

[*] **Corresponding author:** Majid Etemadhosseini. Department of Physical Education, Kashan University of Medical Sciences, Kashan, Iran
Email: magidetemad1354@gmail.com

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Abstract

Objectives: This study aimed to investigate the impact of two different aerobic exercise programs on the Body Mass Index (BMI) and progranulin (PGRN) levels of overweight or obese female students.

Methods: In this quasi-experimental study, 36 overweight or obese female students from Kashan University of Medical Sciences and Islamic Azad University volunteered to participate. They were randomly divided into three groups: two groups underwent progressively increasing interval or continuous aerobic exercise programs, while the third group served as a control. The exercise programs lasted for 8 consecutive weeks, with blood samples collected before and after the intervention. Progranulin levels were measured using the ELISA technique with Human PGRN, and BMI was assessed at the beginning and end of the program.

Results: The results of a one-way ANOVA test showed a significant decrease in progranulin levels (P=0.00) and BMI in both exercise groups compared to the control group (P=0.029).

Conclusion: Both interval and continuous aerobic exercise programs were effective in reducing circulating progranulin levels and BMI in overweight or obese female college students. The exercise interventions led to a significant decrease in both variables. Further research is warranted to explore the effects of different aerobic exercise protocols on BMI and progranulin levels in normal adults.

Keywords: BMI, Progranulin, Aerobic Exercise, College Students, Obesity.

Introduction

The high prevalence of overweight and obesity poses significant health risks, with research indicating a strong association between obesity and heart diseases.[1] These risk factors can contribute to the onset and progression of various age-related diseases, including cardiovascular and neurodegenerative conditions, ultimately leading to increased morbidity and mortality in adults.[2-4] In addition to the well-known health risks of overweight and obesity, recent research has highlighted the role of a newly identified protein called Progranulin in inflammatory diseases.[5]

Progranulin is a protein present in various cell types, including nerve, immune, and adipocytes.[5] It plays a crucial role in regulating multiple processes such as inflammation, tumor genesis, wound repair, and development. Progranulin is abundantly expressed in epithelial cells, immune cells, neurons, and various other tissues and cell types. Aerobic exercise has been recognized as one of the key strategies to control or reduce the risk of overweightness or obesity.[6,7]

Aerobic exercise involves prolonged low to moderate-intensity activities and has been shown to have beneficial effects on weight management, ischemic heart diseases, and cognitive functions.[8] Regular aerobic exercise programs are essential for addressing chronic inflammation and obesity-related health issues.[9,10] Inflammatory diseases can disrupt normal body functions and increase the risk of cardiovascular diseases, diabetes, hyperlipidemia, and atherosclerosis. By engaging in aerobic exercises, individuals can mitigate these risks and improve their overall health outcomes.[11-13]

Overweight and obesity are common health risk factors for all age groups, particularly college students. The well-known phenomenon of the "freshman fifteen" is a popular concept that may be considered an important health risk for college students.[14,15] Research results have shown that 8 weeks of core stability exercise had a significant effect on the serum Progranulin levels of multiple sclerosis patients.[16] However, the choice of protocols and their effectiveness on inflammatory markers are not clear. A recent review paper on inflammatory markers concluded that more research is needed on the effects of exercise on inflammatory markers in healthy populations.[17]

In general, aerobic exercise programs have been successfully used to control or reduce body weight, but different aerobic exercise protocols may be employed for this purpose. The exercise dose can be altered by modifying three components of a program: duration, frequency, and intensity, in addition to the length of the protocol. A review article discussed the dose-association of physical activity and the change in an important nervous system component, brain-derived neurotrophic factor (BDNF), which significantly improves cognitive function. Therefore, different exercise protocols may lead to different results. For the purpose of this research, an 8-week interval versus continuous exercise protocol was used. Aerobic exercise programs have been shown to have a significant effect on the anthropometric and physiological conditions of participants. The type of program that is more frequently used is interval versus continuous workout periods for 8 weeks on other serum components and not Progranulin.[18,19]

Objectives

Therefore, this exercise protocol was employed in this research to compare the effect of interval versus continuous aerobic exercise on Progranulin blood serum levels and body mass index of overweight and obese female college students.

Methods

The participants in this study were female college students who volunteered to participate in the research protocol after learning about the project through advertisements in the girls' dormitories of Kashan universities, including Kashan University of Medical Sciences and Islamic Azad University.

The university's ethical committee approved the research protocol, and participants were informed about the study through ads placed on college campuses and in dormitories.

Inclusion criteria required participants to have a BMI over 25, not be engaged in regular physical activities or sports teams for the past year, and be in good health as determined by a health check conducted by the university at the time of registration. Exclusion criteria included individuals with a Body Mass Index (BMI) less than 25, recent participation in regular physical activities such as sports teams or clubs, or health issues such as high blood pressure or diabetes.

Weight and height measurements were taken using a Seca scale with a height bar at the exercise location, and BMI was calculated by dividing weight in kilograms by the square of height in meters before and after the exercise program. All participants resided on the university campus and consumed food provided by university services. One day before starting the exercise protocols, participants visited a pathology lab where 5 cc of venous blood was drawn by a lab technician. Plasma Progranulin levels were measured using the Sandwich ELISA technique with a Human Progranulin (PGRN) ELISA kit at the beginning and 49 hours after completing the exercise program.[20]

Participants received instructions on how to perform the exercise program before starting the protocol, which included a 5-minute warm-up followed by running exercises. The exercise began at 60 to 75 percent of their maximum heart rate determined by a Polar watch (China-made) for a distance of 1200 meters in the first week. Each week, an additional 400 meters was added to the running program.[21] The interval exercise group ran 1200 meters in three 400-meter intervals interspersed with two-minute walking periods, while the continuous exercise group ran the entire 1200-meter distance without rest intervals but walked for the same duration as the interval group during their breaks. To prevent adaptation to the exercise program, the running distance was increased by 400 meters each week.

The continuous variables were expressed as the mean ± SD, and the categorical variables were presented as a percentage and frequency. The one-way analysis of variance (ANOVA) was used to test the hypothesis. All statistical analyses were performed with SPSS (version 16.0, SPSS Inc, Chicago, IL, USA). A “P-value” less than 0.05 was considered significant.

The study was conducted in accordance with the Declaration of Helsinki. This research protocol was approved by the research secretary of Kashan University of Medical Sciences with KUMS#32138 research grant. All participants signed an informed consent form.

Results

Three participants dropped out of the study; two individuals in the interval exercise group discontinued due to leg discomfort, and one individual in the control group did not continue participation.

The results of the one-way analysis of variance showed that there were no significant differences in age, weight, height, and BMI of the participants in the pretest condition in the experimental groups (P=0.9, P=0.09, P=0.72, P=0.65) [Table 1]. These results indicate that the participants were similar before the exercise protocol.

In Table 2, descriptive statistics for Progranulin and BMI from the pretest to post-test of the participants in the interval, continuous, and control groups are presented.

Table 1. One-way ANOVA table comparing the age, weight, and BMI of participants based on exercise conditions in the pretest

Variables	Source of variation	Sum of Squares	df	Mean Square	F	P value
Age (yr.)	Between Groups	0.870	2	0.435	0.099	0.906
	Within Groups	131.31	30	4.37	-	-
	Total	132.18	32	-	-	-
Height (cm)	Between Groups	71.43	2	35.72	2.511	0.098
	Within Groups	426.80	30	14.22	-	-
	Total	498.24	32	-	-	-
Weight (kg)	Between Groups	10.69	2	5.345	0.325	0.725
	Within Groups	494.03	30	16.46	-	-
	Total	504.72	32	-	-	-
BMI (kg/m^2)	Between Groups	3.219	2	1.610	0.429	0.655
	Within Groups	112.61	30	3.754	-	-
	Total	115.83	32	-	-	-

Table 2. Descriptive statistics for Progranulin and BMI of participants in the interval, continuous, and control groups in pretest and posttest conditions

Experimental State	Variables	Condition Experimental	N	Mean	SD
Pretest	**Progranulin** (ng/m)	Interval	11	347.63	99.89
		Continuous	12	356.00	145.75
		Control	10	237.30	37.02
Post test	**Progranulin** (ng/m)	Interval	11	252.54	25.53
		Continuous	12	290.97	64.592
		Control	10	264.40	44.04
Pretest	**BMI** (kg/m2)	Interval	11	29.58	1.95
		Continuous	12	29.31	1.35
		Control	10	28.80	2.49
Post test	**BMI** (kg/m2)	Interval	11	26.87	2.18
		Continuous	12	26.58	1.69
		Control	10	29.87	2.39

The Kolmogorov-Smirnov test results showed that the dependent variables had a normal distribution, and parametric statistical tests were used. Therefore, parametric statistical tests were employed to analyze the data. The results of the one-way ANOVA in the pretest state indicated that there were no significant differences among the interval, continuous exercise, and control groups regarding the serum level of Progranulin and BMI (P=0.372, 0.78). A similar analysis was performed on BMI and Progranulin levels after the exercise protocol. The results of the one-way ANOVA showed a significant decrease in the mean values of BMI and serum Progranulin level (P=0.002, P=0.029), which are also presented in Table 3.

The LSD post hoc test results indicated no significant difference between the level of Progranulin in interval

versus continuous exercise programs, but there was a significant difference between the exercise groups compared to the control group (P=0.003, P=0.0001). The level of Progranulin decreased in both exercise groups. The post hoc test also revealed no significant differences between the BMI means of the continuous and interval exercise groups (P=0.74). However, there was a significant difference between the BMI mean levels of the interval and continuous exercise groups compared to the control group (P=0.003, P=0.001). Both groups lost weight.

Finally, a paired t-test was employed to compare the level of Progranulin in the experimental groups from pretest to posttest conditions. The analysis indicated a significant decrease in the level of Progranulin in the interval exercise conditions (P=0.009), while this decrease was not statistically significant for the continuous condition (P=0.058). There were also no such differences for the control group from pretest to posttest conditions (P=0.704). These results and the magnitude of mean differences are presented in Tables 4.

Table 3. One-way ANOVA comparing blood serum levels of Progranulin and BMI among the interval, continuous exercise, and control groups in pretest and posttest

Stage	Variables	Sources of Variations	Sum of Squares	df	Mean Square	F	P value
Pre-test	**Progranulin** (ng/m)	Between Groups	216581.26	2	108290.63	2.81	0.78
		Within Groups	1464472.73	28	52302.59		
		Total	1681054.00	30	-		
	BMI (kg/m^2)	Between Groups	.218	2	.109	1.025	.0.372
		Within Groups	267.37	28	9.549		
		Total	267.593	30	-		
Post test	**BMI** (kg/m^2)	Between Groups	69.390	2	34.695	7.973	0.002
		Within Groups	130.55	30	4.352		
		Total	199.94	32	-		
	Progranulin (ng/m)	Between Groups	92095.41	2	46047.708	3.995	0.029
		Within Groups	345826.64	30	11527.555		
		Total	437922.06	32	-		

Table 4. Paired t-test comparing Progranulin levels in the experimental groups from pretest to posttest conditions

Group	Stages	N	Mean	Std. Deviation	t	df	P value (2-tailed)
Interval	Pretest	11	347.63	99.89	-3.248	10	0.009
	Posttest	11	252.54	25.53			
Continuous	Pretest	12	356.00	145.75	-2.120	11	0.058
	Posttest	12	290.91	64.56			
Control	Pretest	10	237.30	37.02	2.125	9	0.063
	Posttest	10	264.40	44.04			

Table 5. Mean values of changes in Progranulin levels and BMI in the experimental groups from pretest to posttest conditions

Group	Variable	Stages	t-value	Mean difference	P value
Interval	**Progranulin** (ng/m)	Pretest Posttest	-3.248	-95.09	0.009
	BMI (kg/m^2)	Pretest Posttest	13.796	2.70	0.000
Continuous	**Progranulin** (ng/m)	Pretest Posttest	-2.120	-65.08	0.058
	BMI (kg/m^2)	Pretest Posttest	11.580	2.72	0.000
Control	**Progranulin** (ng/m)	Pretest Posttest	2.125	+27.10	0.063
	BMI (kg/m^2)	Pretest posttest	-8.407	-1.06	0.000

Discussion

The aim of this study was to investigate the effect of two types of aerobic exercise on BMI and serum progranulin levels of overweight or obese female college students. The findings revealed that the exercise regimen significantly decreased the serum progranulin levels and BMI of the participants in the exercise groups. Progranulin is a protein secreted by motor neurons that promotes IL-6 expression, which can impair insulin signaling. It is either absorbed through sorting or binds to neural receptors.[22,23] The role of exercise in influencing serum progranulin levels has been minimally explored in previous research. One study by Karimi et al., examined the effects of core stability training on the serum progranulin levels of multiple sclerosis patients and found an increase in progranulin levels among the patients, contrasting with our results which showed a decrease in progranulin levels after aerobic exercise in both exercise groups.[16] This difference may be attributed to the differing health conditions of the participants; healthy overweight college students in our study exhibited reduced serum progranulin levels, while MS patients showed an increase. Our findings align with recent research, such as that by Safarzade et al., who observed a decrease in serum progranulin levels in obese men following circuit resistance training.[24] Similarly, Youn et al., reported a decrease in serum progranulin levels in obese men and women with diabetes after a 4-week physical activity program, suggesting that progranulin levels initially increase post-exercise but decrease after 48 hours of recovery.[25] The discrepancies in findings among studies may be related to the timing of measurements, although this aspect was not discussed in the study involving MS patients. The consistency of our results with other recent studies underscores the beneficial impact of exercise programs on reducing serum progranulin levels irrespective of the exercise type.

Numerous studies have documented the role of exercise in weight loss over extended periods of time. Excess weight and obesity are direct risk factors for conditions like type 2 diabetes, cardiovascular disease, certain cancers, and mortality. Obesity results from storing excess energy in adipose tissue, and increasing aerobic physical activity enhances energy expenditure. Obesity not only poses health risks for young female students but also leads to aesthetic concerns, potentially prompting unhealthy dieting practices for weight loss.[26-28]

Progranulin has been implicated in inflammatory processes, and several investigations have explored its potential role in treating inflammatory arthritis. Additionally, studies have shown that progranulin promotes neurite outgrowth and cell survival in the central nervous system.[29,30]

Conclusions

The results of this study demonstrated a significant decrease in BMI levels within both exercise groups comprising overweight or obese young women. It appears that both types of exercise programs were effective in reducing excess weight, providing individuals with the flexibility to choose either program to improve their health status. Viewing overweight or obesity as an inflammatory condition may trigger the release of more anti-inflammatory factors, such as Progranulin. This mechanism could potentially lead to a decrease in the expected release of these factors, as observed in the reduced Progranulin levels in this study. One strength of this research was the utilization of an exercise protocol previously validated in other studies. However, a limitation was the short time frame for examining the detraining effects of the exercise protocol, warranting further investigation. Future research with larger sample sizes is necessary to elucidate the impact of exercise on this protein and its implications for brain functions.

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Competing interests

The authors declare that they have no competing interests.

Abbreviations

Body Mass Index: BMI;
Brain-derived neurotrophic factor: BDNF;
Progranulin: PGRN.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. This research protocol was approved by the research secretary of Kashan University of Medical Sciences with KUMS#32138 research grant. All participants signed an informed consent form.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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