EFFECT OF AEROBIC EXERCISE ON MICROCIRCULATION IN SEDENTARY COLLEGE STUDENTS

EFEITO DO EXERCÍCIO AERÓBICO SOBRE A MICROCIRCULAÇÃO EM ESTUDANTES UNIVERSITÁRIOS SEDENTÁRIOS

EFECTO DEL EJERCICIO AERÓBICO SOBRE LA MICROCIRCULACIÓN EN ESTUDIANTES UNIVERSITARIOS SEDENTARIOS

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Zhang Hongmei[1,2]
Physical Education Professional
Yang Jingwei[3]
Physical Education Professional

1. Xinyang College, Xinyang, Henan, China.
2. Graduate School & University of Perpetual Help System DALTA, Las Pinas, Philippines.
3. Xinyang Normal University, Xinyang, Henan, China.

Correspondence:
Yang Jingwei
Xinyang, Henan, China. 464000.
yjw@xynu.edu.cn

ABSTRACT

Introduction: Due to economic development and technological progress, more attention has been given to intellectual education in detriment of physical conditioning, a phenomenon that has corroborated to raise obesity to a contemporary concern in public health. In this sense, studies that can provide reference to guide the scientific sport intervention behavior of college students are the focus of the current research. Objective: Explore the effect of different doses of aerobic exercise on microcirculation function in sedentary college students. Methods: 69 students from Minzu University were recruited and randomly divided into exercise groups A, B and control. The exercise group received 12 weeks of aerobic exercise intervention. Among them, group A practiced 1-2 times per week, group B practiced ≥ 3 times per week. The control group did not practice any sport. Results: After testing, microvascular reactivity showed an interaction to group and time ($p<0.01$). Among them, exercise group B was higher than control group and exercise group A ($p<0.01$), with no significant differences between exercise group A and control group ($p>0.05$). Conclusion: Aerobic exercise affects body microvascular response and endogenous NO level. Aerobic exercise lasting 12 weeks with frequency equal to or greater than three times per week can improve the microvascular response of sedentary college students by promoting endogenous NO production. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Exercise Therapy; Leisure Activities; Microcirculation; Students.

RESUMO

Introdução: Com o desenvolvimento econômico e o progresso tecnológico, mais atenção foi dada à educação intelectual em detrimento do condicionamento físico, fenômeno que corroborou para elevar a obesidade a uma preocupação contemporânea na saúde pública. Nesse sentido, estudos que possam fornecer referência para orientar o comportamento de intervenção esportiva científica de estudantes universitários são o foco da pesquisa atual. Objetivo: Explorar o efeito de diferentes doses de exercício aeróbico sobre a função da microcirculação em estudantes universitários sedentários. Métodos: Foram recrutados 69 estudantes da Universidade de Minzu, divididos aleatoriamente em grupos de exercícios A, B e controle. O grupo de exercícios recebeu 12 semanas de intervenção de exercícios aeróbicos. Entre eles, o grupo A praticou 1-2 vezes por semana, o grupo B praticou ≥ 3 vezes por semana. O grupo controle não praticou nenhum esporte. Resultados: após o teste, a reatividade microvascular mostrou uma interação ao grupo e ao tempo (p<0,01). Entre eles, o grupo de exercícios B foi superior que o grupo controle e o grupo de exercícios A (p<0,01), sem diferenças significativas entre o grupo de exercícios A e o grupo controle (p>0,05). Conclusão: O exercício aeróbico afeta a resposta microvascular corporal e o nível endógeno de NO. O exercício aeróbico com duração de 12 semanas com frequência igual ou superior de três vezes por semana pode melhorar a resposta microvascular de estudantes universitários sedentários, promovendo a produção de endógenos NO. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Terapia por Exercício; Atividades de Lazer; Microcirculação; Estudantes.*

RESUMEN

Introducción: Con el desarrollo económico y el progreso tecnológico, se prestó más atención a la educación intelectual en detrimento del acondicionamiento físico, fenómeno que corroboró elevar la obesidad a una preocupación contemporánea en la salud pública. En este sentido, los estudios que pueden servir de referencia para orientar el comportamiento científico de intervención deportiva de los estudiantes universitarios son el centro de la investigación actual. Objetivo: Explorar el efecto de diferentes dosis de ejercicio aeróbico sobre la función microcirculatoria en estudiantes universitarios sedentarios. Métodos: Se reclutaron 69 estudiantes de la Universidad de Minzu y se dividieron aleatoriamente en los grupos de ejercicio A, B y control. El grupo de ejercicio recibió 12 semanas de intervención de ejercicio aeróbico. Entre ellos, el grupo A practicaba 1-2 veces por semana, el grupo B practicaba ≥ 3 veces por semana. El grupo de control no practicó ningún deporte. Resultados: Tras las pruebas, la reactividad microvascular mostró una interacción con el grupo y el tiempo (p<0,01). Entre ellos, el grupo de ejercicio B fue superior al grupo de control y al grupo de ejercicio A (p<0,01), sin diferencias significativas entre el grupo de ejercicio A y el grupo de control (p>0,05).

Conclusión: El ejercicio aeróbico afecta a la respuesta microvascular corporal y al nivel de endógeno NO. El ejercicio aeróbico de 12 semanas de duración con una frecuencia igual o superior a tres veces por semana puede mejorar la respuesta microvascular de los estudiantes universitarios sedentarios al promover la producción endógena de NO.
Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.

***Descriptores*:** *Terapia por Ejercicio; Actividades Recreativas; Microcirculación; Estudiantes.*

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INTRODUCTION

As the only place for the exchange of body matter and energy, microcirculation is closely related to human health and exercise ability. Some diseases have obvious abnormal microcirculatory function in the initial stage of pathogenesis, such as in the early stage of atherosclerosis and hypertension, microvascular endothelial dysfunction precedes macrovascular endothelial dysfunction.[1] In the process of rehabilitation of some diseases (such as diabetes, coronary heart disease, etc.), the improvement of microcirculation function has also become an important link to promote disease recovery.[2] In the field of competitive sports, the improvement of microcirculatory function is an important biological basis for improving athletes' sports performance, so improving microcirculatory function is of great significance. Among the methods to improve microcirculatory function, the intervention effect of aerobic exercise on microvascular reactivity is the main research idea.[3] For FATmax strong the biological mechanism by which degree exercise affects microcirculation function in obese people also remains clear and definite.[4] Microvascular reactivity refers to different stimuli (such as blood flow block, local Tissue heating) microvascular blood perfusion ability, this index in the clinic Has been widely used in the evaluation of microcirculation function.[5] Transcutaneous oxygen pressure (TcPO2) is the oxygen content of capillaries that diffuse through the skin, It can be used for the evaluation of skin blood flow perfusion volume and microcirculation function.[6] Muscle oxygen Saturation (SmO2) reflects muscle oxygen supply balance and muscle generation Xie's important indicator has a close relationship to TcPO2.[7] Based on this, In this study, aerobic exercise and aerobic were formulated to FATmax as exercise intensity standard In combination with the resistance exercise protocol, 10 weeks of aerobic exercise and aerobic binding resistance were explored Shadow of exercise on microvascular reactivity, TcPO2 and SmO2 in obese college students Ring, and explore the possible mechanism of exercise to improve the microcirculation function, to improve fertilizer.[8] The microcirculation function of fat college students provides the basis for exercise prescription selection.Among the methods to improve microcirculatory function, the intervention effect of aerobic exercise on microvascular reactivity (MR) is the main research idea. Microvascular reactivity is a common method to evaluate microcirculatory function, which refers to the change of microblood tube blood perfusion under local tissue heating, blood flow blocking, drug injection (acetylphthalecholine, nitropruna) and other stimuli.[9] One meta-analysis (5 RCTs, 2 RCTs) suggested that aerobic exercise improved microvascular reactivity in human skin, but did not have a statistically significant effect because of the small sample size included in the study and the lack of sufficient data to demonstrate the clinically significant effect of exercise on microvascular reactivity.[10]

Research object and method

Research Subjects

Recruit current students as test subjects, Subjects met the following characteristics:(1) Divide daily in addition to the necessary physical activity, there is no other systematic and regular physical activity, and the daily physical activity duration is <1h; (2) mental health, sugar-free Urine disease, hypertension, coronary heart disease and other chronic diseases that affect cardiovascular function and surgical history, the heart can bear a certain exercise load. Participants were enrolled69 were divided into exercise A, exercise B and control groups according to the same sex ratio, with 23 students in each group (12 boys and 11 girls).

The study is Purely observational studies which no need to registry ID of ICMJE, and all the participants were reviewed and approved by Ethics Committee of Xinyang Normal University, China (NO. 2022003)

Research method

Exercise form, frequency, exercise time period and exercise cycle: Exercise group A exercises 1~2 times a week, exercise group B exercises more than 3 times a week, each exercise time is 90 minutes, of which the formal exercise time is not less than 60 minutes (Monitor the subject's exercise intensity through a heart rate meter to make the heart rate reach to the bullseye rate requirement). In order to facilitate students' movement, there are two exercise periods (only one time period is selected for exercise) every day from 16:00 to 17:30 or 19:00 to 20:30 for a total of 12 weeks. In addition to the exercise program arranged in this study, participants in the exercise group did not practice other regular sports, and participants in the control group maintained no regular physical activity for the entire trial period. In addition, subjects in exercise group A were required to exercise between 12~24 times during the entire trial period, and subjects in exercise group B exercised no less than 36 times; Otherwise, the sample was considered invalid and was not included in the post-trial data analysis.

Microcirculatory function and blood drawing were tested the day before and one day after training.In this study, the PF6000 dual-channel laser Doppler blood flow and percutaneous oxygen partial pressure measurement (Pari Medicine, Sweden) were used for microvascular reactivity and percutaneous oxygen partial pressure tests at the midpoint of the connection between the elbow fossa of the right forearm and the distal radial projection. Test indicators include basal skin temperature (BKT), average ve-locity of blood cells (AVBC), and concen-trationof moving blood cells CMBC), microcirculatory blood perfusion(MBP), transcutaneous oxygen partial pressure(TcpO2). The test of microvascular reactivity adopts the micro-local heating method, first performing a 5 min basal value test (basal value), and then heating the test probe to 44°C for 10 min (after heating). When the local skin is heated to 44°C, the microvascular state can achieve maximum relaxation, which can objectively reflect the maximum blood perfusion capacity of the microvessel. TcpO2 is heated to 44°C for local skin (set automatically by the module).

Statistical analysis

SPSS25.0 was used to perform statistical analysis of the data. The normal distribution of the data was tested by the S-W detection method, which was expressed as (x±s). Using factorial analysis, one-way variance analysis and paired sample t-test, statistical analysis of the pre- and post-trial indicators of the three groups of subjects was carried out, and the interaction effect and individual effect of group and time bivariate were discussed. Factorial analysis is used for interaction effect analysis to determine the degree of effect of time and group, and one-way ANOVA is used to determine between different groups at the same time paired-sample t-test is used to determine the difference before and after the same group of individual tests. The inspection level α=0.05.

Experimental result and analysis

Changes in skin temperature during testing in 3 groups

There were no significant differences in the basal value, heating value and increase rate of skin temperature between the three groups before and after the test (P value > 0.05). See Table 1.

For the student population, the decline in microvascular reactivity is a physiological decline, and there are no obvious pathological changes in microcirculation, so microcirculation has a certain ability to withstand exercise load. The study found that aerobic exercise intervention with 12 weeks exercise intensity of 30% HRR could not significantly improve the microvascular reactivity of menopausal women, while aerobic exercise with exercise intensity of 45%~60% HRR significantly improved the microblood tube responsiveness of subjects. Therefore, with the extension of the intervention time, the exercise intensity and exercise frequency can be appropriately increased according to the subject's physical fitness, and new stimulation of microcirculation can be generated, and new changes can be induced. The principle of change can be seen in Figure 1.

Comparison of NO, NOS and ET-1 before and after the trial of the three groups

After the testNO has the interaction of group and time (P=0.01); eNOS had group and temporal interactions (P=0.03); And iNOS and ET-1 has no group and temporal interactions (P>0.05). tryPost-test one-way ANOVA showed group pairsNO had a separate effect (P=0.01), in which exercise group B was higher than exercise group A and control group (PThe values are <0.05), group had a separate effect on eNOS (P=0.03),motionGroup B was higher than that of exercise group A and control group (P value < 0.05). The results of the paired sample t-test showed that eNOS and NO had separate effects in the time of exercise B group, which was higher than before the test (P<0.05) after the test, while there was no separate effect in the time in exercise A and control groups (P>0.05). There were no separate effects for iNOS and ET-1 in both group and time (PThe values are >0.05). See Table 2.

Table 1. Comparison of microcirculation reactivity and Tcp O2of different groups of subjects before and after the experiment(x±s).

Group	Before and after the test	Number of people	Statistical values	Piven/°C		MBP		CMBC		AVBC/°C		$Tcp0_2$
				Base Value	Heating value	Base Value	Heating value	Base Value	Heating value	Base Value	Heating value	
Control group	Before the test	23		31.9±1.2	44.1±0.2	7.9±1.8	92.1±24.7	79.6±25.4	237.2±56.4	9.9±1.8	38.8±8.7	62.7±7.6
	After the test	23		31.7±0.6	44.1±0.2	8.5±2.1	93.5±27.1	81.2±30.7	239.5±59.4	9.7±1.3	39.1±9.2	65.7±8.6
			t-value	0.74	0.01	-1.46	-0.97	-0.85	-0.89	0.04	-1.08	-1.76
			P-value	0.48	0.63	0.17	0.40	0.36	0.41	0.67	0.17	0.19
Sports A group	Before the test	23		31.3±0.8	44.2±0.3	8.1±1.4	93.4±30.9	82.8±28.3	240.6±60.2	10.3±2.6	38.8±10.1	63.5±8.1
	After the test	23		31.6±1.1	43.9±0.6	8.7±2.4	93.7±29.2	76.9±21.4	241.6±60.9	9.3±0.8	38.7±9.4	64.9±9.1
			t-value	-0.04	-0.06	-1.40	-0.07	3.47	-1.18	0.86	0.07	-0.96
			P-value	0.52	0.35	0.22	0.63	0.06	0.31	0.09	0.72	0.34
Sports B group	Before the test	23		31.5±1.1	43.8±0.4	8.0±2.0	90.8±20.6	78.9±23.4	239.1±58.8	10.1±2.1	37.9±9.1	60.4±7.2
	After the test	23		31.4±0.9	44.1±0.5	7.5±1.5	98.7±30.2	80.2±19.6	260.3±68.7	9.3±1.1	37.9±8.6	62.6±8.5
			t-value	0.28	-0.22	1.55	-15.27	-2.04	-19.38	0.09	0.03	-0.88
			P-value	0.48	0.47	0.12	0.02	0.09	0.01	0.54	0.77	0.42

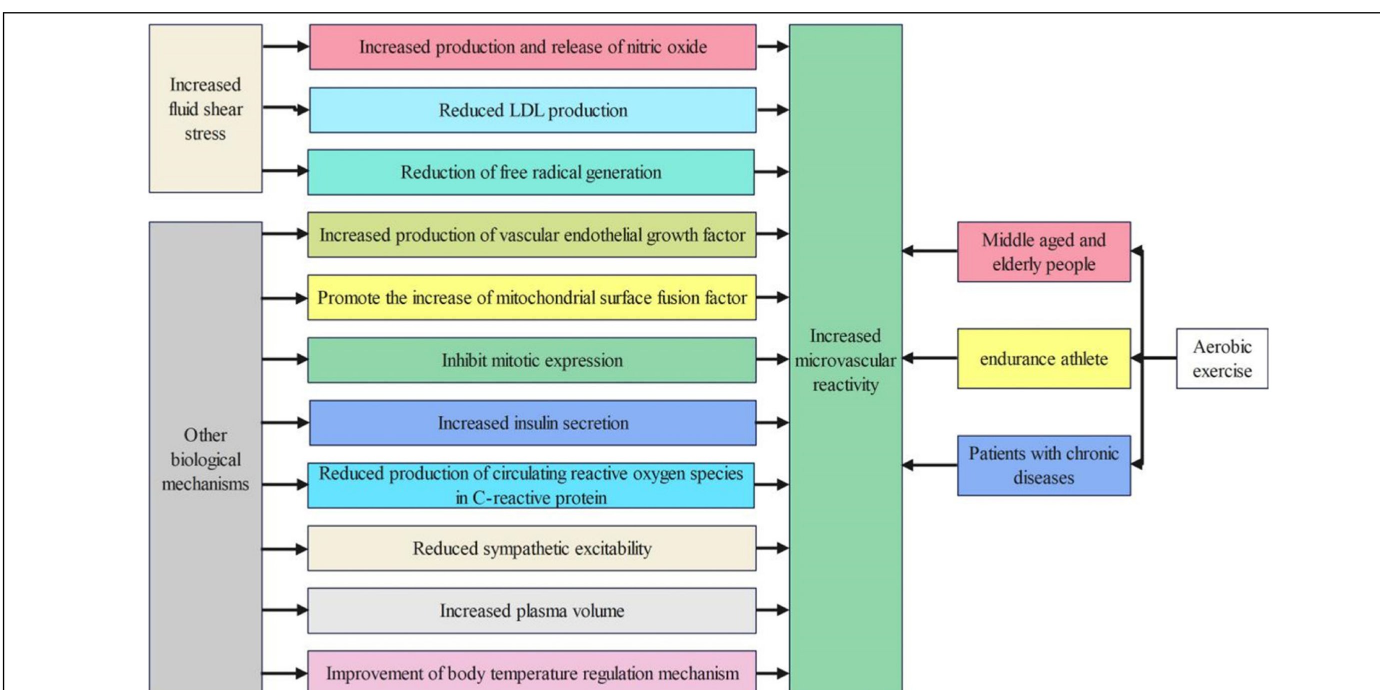

Figure 1. Changes in abnormal indicators in elderly patients with chronic diseases.

Table 2. Changes of NO, NOS and ET-1 in three groups before and after the experiment (x±s).

Group	Before and after the test	Number of people	Statistical values	NO / (umol · L^{-1})	TNOS / (U · mL^{-1})	eNOS / (U · mL^{-1})	iNOS / (U · mL^{-1})	ET-1 / (pg · mL^{-1})
Control group	Before the test	23		51.0±4.0	38.6±1.9	12.7±3.8	19.3±2.9	13.5±2.3
	After the test	23		50.9±3.8	37.8±2.0	13.9±4.5	19.8±3.2	13.9±2.6
			t-value	0.01	0.02	0.70	0.09	0.00
			P-value	0.76	0.63	0.34	0.53	0.82
Sports A group	Before the test	23		52.4±4.6	38.1±1.8	13.4±2.8	19.5±2.8	13.1±2.5
	After the test	23		53.7±5.7	39.2±1.8	14.1±4.3	21.1±3.5	14.2±2.1
			t-value	0.09	1.17	1.05	1.37	1.23
			P-value	0.17	0.10	0.09	0.08	0.07
Sports B group	Before the test	23		51.9±5.1	37.4±2.0	13.1±5.7	20.4±3.1	13.4±2.5
	After the test	23		55.6±5.2	41.0±2.1	15.5±3.6	20.1±3.3	14.8±2.3
			t-value	9.73	12.02	8.91	0.04	0.87
			P-value	0.02	0.01	0.02	0.63	0.28

CONCLUSIONS

In this paper, it was found that the number of aerobic exercises per week was between 1~2 times, and the microvascular function of the subjects did not significantly improve. The number of exercise times ≥ 3 times, the microvascular function response was significantly improved, indicating that aerobic exercise > 3 times a week could significantly improve the microcirculatory function of sedentary college students. Compared with the middle-aged and elderly groups where TcpO2 has decreased significantly, the change in Tc-pO2 in young college students is small, so aerobic exercise can not further improve microcirculatory function, but further research is still needed to confirm it.

Aerobic exercise can improve the microvascular reactivity of patients with metabolic diseases, cardiovascular diseases, cancer and other diseases, and promote the recovery of diseases, but there are few related clinical studies. In the future, research in this area should be strengthened to improve the scientific and application of research results.

All authors declare no potential conflict of interest related to this article

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REFERENCES

1. Fernandes T, Casaes L, Soci U, Silveira A, Gomes J, Barretti D, et al. Exercise training restores the cardiac microrna-16 levels preventing microvascular rarefaction in obese Zucker rats. Obes Facts. 2018;11(1):15-24.
2. Padro T, Manfrini O, Bugiardini R, Canty J, Cenko E, De Luca G, et al. ESC Working Group on Coronary Pathophysiology and Microcirculation position paper on 'coronary microvascular dysfunction in cardiovascular disease'. Cardiovasc Res. 2020;116(4):741-55.
3. Morrissey C, Montero D, Raverdy C, Masson D, Amiot MJ, Vinet A. Effects of exercise intensity on microvascular function in obese adolescents. Int J Sports Med. 2018;39(4):450-5.
4. Hurley DM, Williams ER, Cross JM, Riedinger BR, Meyer RA, Abela GS, et al. Aerobic exercise improves microvascular function in older adults. Med Sci Sports Exerc. 2019;51(4):773-81.
5. Masi S, Rizzoni D, Taddei S, Widmer RJ, Montezano AC, Lüscher TF, et al. Assessment and pathophysiology of microvascular disease: recent progress and clinical implications. Eur Heart J. 2021;42(26):2590-604.
6. Okada H, Tanaka M, Yasuda T, Okada Y, Norikae H, Fujita T, et al. Decreased microcirculatory function measured by perfusion index is a novel indicator of diabetic kidney disease in patients with type 2 diabetes. J Diabetes Investig. 2020;11(3):681-7.
7. Holmes CJ, Hastings MK. The application of exercise training for diabetic peripheral neuropathy. J Clin Med. 2021;10(21):5042.
8. Caldwell JT, Jones KMD, Park H, Pinto JR, Ghosh P, Reid-Foley EC, et al. Aerobic exercise training reduces cardiac function and coronary flow-induced vasodilation in mice lacking adiponectin. Am J Physiol Heart Circ Physiol. 2021;321(1):H1-14.
9. Stupin M, Stupin A, Rasic L, Cosic A, Kolar L, Seric V, et al. Acute exhaustive rowing exercise reduces skin microvascular dilator function in young adult rowing athletes. Eur J Appl Physiol. 2018;118(2):461-74.
10. Chen J, Or CK, Chen T. Effectiveness of using virtual reality–supported exercise therapy for upper extremity motor rehabilitation in patients with stroke: Systematic review and meta-analysis of randomized controlled trials. J Med Internet Res. 2022;24(6):e24111.