American Journal of BioMedicine
AJBM 2022;10 (2): 82-91
Research Article doi:10.18081/2333-5106/2022.10/82

Effect of high-intensity aerobic exercise on serum uric acid in hypertension: compare with moderate-intensity aerobic exercise

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Abstract

Hypertension is one of the major risk factors for cardiovascular morbidity and morbidity since high blood pressure can cause damage to microvascular and macrovascular organs. The Sixty non-smoker participants were divided into two main groups. Thirty participants group with high-intensity aerobic exercise and a second thirty group with moderate-intensity aerobic exercise. The electrical treadmill exercise is used three times per week for eight for each 25-30 minutes. Peripheral arterial blood pressure measurements and blood investigation in the form of serum uric acid and renal function tests were tested for each participant. The resulting data showed a significantly decreased effect on both serum uric acid and renal function tests in high-intensity intervals and continuous moderate exercise with more improvement with continuous moderate exercise 16% in serum uric acid and 27.5 % in creatinine. In conclusion, moderate continuous exercise reduces serum uric acid and creatinine better than high-intensity interval exercise. Both have the same effect on blood pressure and urea, but moderate continuous exercise has a crystal-clear effect that cannot be denied.

Keywords: Hypertension; Serum uric acid; Arterial blood pressure; Aerobic exercise

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Received March 22, 2022; revised April 03, 2022; accepted May 22, 2022; published June 01, 2022.

Introduction

Hypertension is one of the major risk factors for cardiovascular morbidity and morbidity since high blood pressure can cause damage to microvascular and macrovascular organs [1]. The prevalence of hypertension varies between countries around the world. According to the World Health Organization (WHO), the African region has the highest prevalence of hypertension (27%), while the Americas region has the lowest prevalence of hypertension (18%) [2]. In 1975 the number of adults with hypertension increased from 594 million to 1.13 billion, in 2015 with a significant increase in low- and middle-income countries and it is predicted to increase to 1.56 billion adults with hypertension by 2025 [3]. This increase was mainly due to an increase in the risk factors for hypertension and lifestyle with reduce exercise [4].

According to its etiology, hypertension is classified into two categories: essential hypertension form 90-95% without clear causes but it encompasses sympathetic nervous system hyperactivity, natriuretic dysfunction, higher intracellular Na+, and $Ca+^{2}$ levels, and high plasma

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renin activity, which can account for 10% of essential hypertension [5]. The secondary hypertension category ranges from 5-10% caused by diseases of the kidneys, arteries, heart, or endocrine system [6].

Hyperuricemia (HUA) is a metabolic disease caused by the disorder of purine metabolism, which results in increased production or decreased excretion of serum uric acid (SUA) and normally in male>7mg/dL, female>6mg/dL of two fasting tests on different days under normal diet [7]. According to statistics, the number of HUA in China has reached 170 million, and the overall prevalence rate is 13.3% [8]. In recent years, the incidence of HUA is on the rise, showing a trend in younger age [9]. HUA patients aggravate with the increase of SUA levels, often leading to the occurrence of gout [10].

Several studies have shown that blood pressure decreases, and some are persistent after aerobic exercise [11]. In hypertensive patients, a study showed that aerobic exercise could significantly reduce blood pressure, both systolic and diastolic blood pressure. In addition, the reduction in blood pressure differed significantly between the studies for all exercise durations (less than 8 weeks, 8-12 weeks, and more than 12 weeks), and aerobic exercise lasting about 8 weeks had a better antihypertensive effect [12].

Regular aerobic exercise decreases arterial blood pressure in both hypertensive and healthy patients, according to multiple studies. In the early treatment of hypertension and other cardiovascular illnesses, several non-pharmacological therapies, including exercise, are advocated, with the pathogenetic significance of endothelial dysfunction noted. A lot of exercise intervention trials have consistently shown that aerobic exercise decreases systolic and diastolic blood pressure in critical hypertension patients.

Patient and Methods

Sixty non-smoker hypertensive patients with age from 40 – 60-year-old, were randomly selected from outpatient clinic in the Minya University Hospital from January 2020 to December 2021. The patients divided in to two group, first group consisted of thirty patients who completed 25-30 minutes of high-intensity interval aerobic activity on an electronic treadmill three times a week for ten weeks. The second group consisted of thirty patients who did a moderate continuous aerobic activity on an electronic treadmill for 25-30 minutes for each session, three times weekly, for ten weeks.

Inclusion Criteria

Sixty men volunteered participated in this study with: age group from 40 to 60 years old, essential hypertension (SBP between 140-159 and DBP between 90-99 mmHg), elevated serum uric acid level (>6mg/ dl), and overweight and class 1 obesity (BMI for each one between 25-35kg /m^2).

Exclusion Criteria

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We excluded patients with one or more of the following: secondary hypertension, BMI (below 25 & above 35 kg/m^2), diabetic disease, cardiac diseases, respiratory diseases, and gouty arthritis.

Evaluation procedures

A doctor and a physical therapist took identical measurements on both categories of patients. The following indicators were recorded at the start and completion of the 10-week practical study period.

- Physiological Measurement The stethoscope and sphygmomanometer were used to measure the patients' resting heart rate (HR), SBP, and DBP from the right arm.
- Anthropometric Measurements Physical attributes of participants, such as weight [kg] and height [m], as assessed by a weight and height scale, and body mass index [BMI] (kg/ m^2) The assessment was conducted using the accepted anthropometric technique outlined in the formula below: BMI is calculated as follows: weight (kg) / height (m) (m^2) [13].
- Laboratory Investigation performed the chemical analysis.

A laboratory inquiry was performed on both groups of patients before the start of the experiment and after it was completed (10 weeks). A fasting venous blood sample was collected using a 5-ml antiseptic syringe (after a 12-hour overnight fast). Before and after the experiment, each patient's serum uric acid (SUA) and kidney function (serum urea and creatinine) were examined (10 weeks).

Measurement of Blood Pressure Arterial blood pressure of each subject was measured in the brachial artery of the right arm before the study began. Fix the cuff of the mercury sphygmomanometer on the patient and wait five minutes for proper measurement, then measure three times with the stethoscope, and the average was recorded.

Measurement and Calculating Maximum Heart Rate First, by placing a stethoscope over the apex of the heart at the left 5th intercostal space midclavicular line, each patient's resting heart rate is determined; then, using the Karvonen method, the maximum heart rate altogether with the target heart rate for each participant were calculated as follows: Max. heart rate = 210- age. Rated Perceived Exertion (RPE): will be used to measure the level of exertional effort for both groups.

Statistical methods

Data are presented as mean ± standard error (SE). Statistical analysis was performed using StatView software (Abacus Concepts, Calabasas, CA, USA). Analysis of variance (ANOVA) with Fisher post-hoc test was used to analyze differences between experimental groups, and differences were confirmed using the Mann-Whitney *U*-test. Statistical significance was defined as $P \leq 0.05$.

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Results

The data on systolic and diastolic blood pressure, serum uric acid, serum creatinine, and blood urea collected from both groups were statistically evaluated in comparison to each other. Patients' Major of Features of both groups:

Table (1) show the statistical analysis of age, height, weight, and body mass index of the first group and second group: mean value, standard deviation, and the level of significance between the two groups. It is indicated that there was no clear disparity between the two groups, p->0.05.

There was a significant increase in the percent of improvement of serum uric acid of high intensity interval aerobic activity compared with that of moderate continuous aerobic activity (p > 0.002). There was no significant difference in the percent of improvement of RPE between two group (p= 0.11) as in table 2.

Table 1.

Statistical analysis of age, height, weight, and body mass index of the participants.

Feature	Number	Minimum	Maximum	Mean Std.	Deviation	Group
Age	30	40	60	47.10	1.841	First
BW/Kg	30	70.40	96.25	89.0100	3.27353	
Height/M	30	1.56	1.69	1.6093	0.04350	
BMI/ Kg/m^2	30	28.43	34.79	32.6747	2.05465	
Age	30	40	60	47.10	1.841	Second
BW/Kg	30	78.60	90.85	85.0200	3.27353	
Height/M	30	1.56	1.69	1.6093	0.04350	
BMI/ Kg/m^2	30	28.43	34.79	32.6747	2.05465	

Table 2.

Comparison of the percent of improvement of serum uric acid and RPE between high intensity interval aerobic activity and moderate continuous aerobic activity.

	First group Mean ± SD	**Second group Mean ± SD**	**MD**	**t- value**	**p value**
Serum uric acid	30.33 ± 5.35	20.32 ± 2.21	6.31	3.38	0.002
RPE	55.2 ± 12.11	41.13 ± 2.14	4.14	1.13	0.11

Discussion

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Hypertension is a never-ending medical condition that frequently results in cardiovascular and renal issues [14]. As a result, hypertension management necessitates medical consideration and self-administration education, assisting in the reduction of severe complications [15]. Studies have shown that the improvement of SUA level helps reduce the risk of chronic disease, such as hypertension [16], obesity, diabetes, insulin resistance [17, 18].

The main aim of this study to compare the efficacy of intermittent (high intensity) aerobic exercise vs continuous moderate aerobic activity in people with hypertension. Thirty sedentary, uncomplicated hypertensive male patients with mildly controlled hypertension were included in this research study (three of whom did not finish the training regimen). The variables (serum uric acid, creatinine, urea, systolic blood pressure, and diastolic blood pressure) were measured and assessed before and after the study program (10 weeks).

Several small clinical trials have evaluated the effect of short-term physical exercise on SUA in HUA patients. Other study reported that the SUA of a 45-day aerobic exercise program (1600-meter jogging) decreased by 10.5% ($P < 0.05$) [19].

This is consistent with the findings of other resulted data [20], they reported that patients with mild to moderate high blood pressure in men with 60-79% maximum heart rate reserve for 8 weeks of aerobic exercise, SUA reduced by 41.8% ($P < 0.05$) [21, 22]. However, another study showed that 12 weeks of strength training increased the SUA of patients with type 2 diabetes ($P < 0.001$) [23]. Other showed that the SUA level of professional athletes was significantly increased after short-term high-intensity training ($P < 0.05$) [24]. The mechanism may be reduced uric acid excretion after high-intensity exercise, which in turn leads to an increase in SUA. Therefore, low and medium exercise may be a suitable choice to improve HUA [25].

The results of variables corresponding to that moderate continuous training was more significant reduction in serum uric acid, serum creatinine, while arterial blood pressure and urea had significant results in both study groups [26]. The results of this study consistent with previous research, like Lamina and Okoye's (2012) investigation of the effects of continuous exercise training on serum uric acid and psychological status in essential hypertension patients. There were two groups of participants: experimental and control, the experimental hypertensive group conducted an 8-week continuous exercise training program ranging from 45 to 60 minutes throughout this time, while the control hypertensive group did not. SBP, DBP, and VO2 max, as well as serum uric acid and psychological status, were all measured [27, 28]. According to the findings, moderate-intensity (continuous) workout routines can help persons with hypertension control their blood pressure, serum uric acid (SUA), and psychological stress [29]. The effects of interval aerobic exercise in patients with essential hypertension were explored by other [30], which supports the current study. A 12-week interval aerobic exercise intervention experiment looked at the effect of brisk walking on resting blood pressure in people with essential hypertension [31]. Men with stage 1 or 2 essential hypertension who were not taking any antihypertensive drugs took part in the trial [32]. Three to five times per week, the aerobic exercise training program included 30 minutes of brisk walking at 50% VO2max on an

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ergometer cycle. They reported a 3.7 mm Hg reduction in blood pressure that was statistically significant [33]. According to the study, interval aerobic exercise decreased high blood pressure in men with stage one or two essential hypertension. This agrees with other, who found that people with asymptomatic hyperuricemia who exercised moderately lived four to six years longer and avoided the factors that lead to death associated with high uric acid levels when compared to inactive individuals with normal uric acid levels in an observational study of 467 Taiwanese adults [6].

375 men with diastolic blood pressure (DBP) of 90 to 109 mm Hg and mild to moderate systolic blood pressure (SBP) of 140 to 179 mm Hg. The essential hypertension interval, continuous, and control groups were all age-matched. The interval and continuous groups exercised for 45-60 minutes at intensities ranging from 60 to 79 percent of maximal heart rate for an 8-week period, whereas the control group did nothing. SUA, SBP, DBP, maximum oxygen uptake (VO2max), and SBP were all taken into consideration [9].

The study's findings demonstrated a significant reduction in SBP, DBP, and SUA. Both moderate-intensity interval and continuous training regimens were found to be efficient in lowering SBP and DBP, however, interval training outperformed continuous training by a significant margin [6]. This could be because the intensity and duration of interval training in this study were different from those in the current study. Light, moderate, and vigorous-intensity aerobic exercise effectively manages blood pressure.

However, moderate-intensity aerobic exercise was more effective for managing blood pressure than both high-intensity and light aerobic exercise [3]. In addition, studies have shown that 30 minutes of intense exercise more than 3 times a week can help treat systemic hypertension19. One of the mechanisms in the reduction in systolic blood pressure during exercise is associated with an increase in functional sympatholysis [8]. Sympathetic vasoconstriction during exercise is attenuated in contracting muscles by vascular endothelial-derived factors such as nitric oxide (NO). However, vascular endothelial function declines with age leading to decreased functional sympatholysis in older individuals with a sedentary lifestyle [11].

Furthermore, according to the ACSM (American College of Sports Medicine) guidelines, aerobic exercise depends on the duration, intensity, and frequency of the work interval and the length of the recovery interval. The recommended duration is at least 30 minutes of moderate-intensity physical activity 5 days a week and 20 minutes of vigorous activity 3 days a week.

Conclusion

Based on the findings of this study, both high-intensity interval exercise and moderate-intensity continuous exercise reduced serum uric acid, creatinine, urea, and arterial blood pressure, with moderate-intensity continuous exercise having a larger effect on serum uric acid and serum creatinine. While both types of exercise had similar effects on blood pressure and blood urea, their effects on body composition were different.

Competing interests

The authors declare no conflict of interest.

Ethics Statement

This study has been approved by the Ethical Review Committee of the Shanghai University of Sport (approval number: 312672411BN112). The publication of any potentially identifiable images or data contained in the article requires personal written informed consent. The research team will provide consultations for all subjects and their families to answer any research questions. Before signing the informed consent form, after the patients and their families fully understand the research process, our team members will organize the patients to sign the informed consent form or withdraw from the research. All subjects or their guardians will sign informed consent. Authors tend to submit research results to peer-reviewed journals or academic conferences for publication.

Authors' contributions

All authors shared in the conception and design and interpretation of data, drafting of the manuscript and critical revision of the case study for intellectual content and final approval of the version to be published. All authors read and approved the final manuscript.

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Research Article doi:10.18081/2333-5106/2022.10/25

American Journal of BioMedicine
Journal Abbreviation: AJBM
ISSN: 2333-5106 (Online)
DOI: 10.18081/issn.2333-5106
Publisher: BM-Publisher
Email: editor@ajbm.net