

## **EFFECT OF AEROBIC EXERCISE ON STRESS AND THE BRAIN-GUT AXIS**

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### **Abstract**

The aim of this study is to examine the effects of aerobic exercise on stress and brain-gut axis in individuals. Twenty adult individuals who did not exercise regularly before, were 18 years of age and older, had no barriers to aerobic exercise, actively used e-mail addresses and agreed to participate in the study voluntarily participated in the study. The participants were given an aerobic exercise program (exercises such as light-moderate walking, cycling and swimming in the open air), 3 days a week, for a total of 5 hours, without being divided into any groups. Individuals were asked to fill in a 10-item perceived stress scale and a brain-gut axis inquiry form, which included 46 questions, after performing aerobic exercise before and at the end of aerobic exercise. The data obtained were evaluated in the SPSS version 26.0 package program. A significant difference was found between the pre-test and post-test results in terms of the perceived stress and the effects on the brain-gut axis of individuals performing aerobic exercise. While the decrease in the stress subunit of the brain-gut axis questionnaire form was 7.23%, the decrease in the stress perception scale was 22.73%. As a result of the study, it can be suggested that aerobic exercises can reduce the perception of stress in individuals and has the potential to affect the brain-gut axis. The stress subunit of the brain-gut axis also decreased, albeit less in percentage. It can be said that 1 week of aerobic exercise affects the perception of stress more than the brain-gut axis.

**Keywords:** Aerobic exercise, stress, brain-gut axis

## Introduction

The gastrointestinal tract is one of the most important systems of the human body. In this system, 80 to 100 trillion bacteria live and form the human intestinal flora (microbiota) (Mayer, 2017). Each individual has a unique gut microbiota. This microbiota is affected by various factors and differs in each individual. According to the literature, it has been shown that even identical twins have different gut microbiota (Nazlıkul, 2018; Önsü and Tezcan, 2018). Bacteria diversity is highest in the intestines and least in the stomach, respectively. Almost all of the bacteria (95-98%) in the microbiota of healthy individuals are beneficial bacteria and they live in a symbiotic relationship (Erdoğan, 2016). Intestinal flora is associated with many factors. These; genetic factors, stress, antibiotics, mode of delivery (cesarean/vaginal birth), age, exercise and nutrition (Mayer, 2017). Intestinal flora has many positive effects on human health. These; It has an important role in preventing the formation of harmful bacteria in the gastrointestinal tract, ensuring the pre-digestion of B vitamins, and the production and secretion of neurotransmitter substances, which are necessary chemicals for the brain (Junger, 2018). Nutrition plays a key role in regulating the gut microbiota. Namely, Mediterranean-style diet, fibrous and vegetable high-protein foods affect the microbiota positively. However, excessive consumption of carbohydrates and fats, use of processed and packaged foods, stress, sedentary life, smoking and alcohol use affect the intestinal microbiota quite negatively (Coşkun, 2006; Bressa et al., 2017). Exercise and active lifestyle has been thought to have positive effects on the microbiota (Bressa et al., 2017). Looking at the literature, in general, a balanced and regular diet as well as regular aerobic exercise increases the diversity of intestinal flora. For this reason, our primary aim in our study is to examine the effect of aerobic exercise on stress and brain-gut axis in individuals.

## Material and Method

The population of the study consisted of individuals living in Istanbul between April and June 2021. The research sample included individuals who were 18 years of age and over, who did not have any obstacles to aerobic exercise, actively used their e-mail addresses and voluntarily accepted to participate in the study between April and June 2021. Individuals who were 18 years of age or younger, had any condition that prevented them from doing aerobic exercise, did not actively use their e-mail address and did not voluntarily agree to participate in the study were not included in the study. Power analysis was used to determine the sample size.

Cochran's known population size formula was used to calculate the sample size ( $n = (Nt^2pq) / (d^2(N-1) + t^2pq)$ ). According to this formula, at least 12 participants should be included in the minimum sample size to be reached in our study with an error of  $d=0.05$  at 95% ( $\alpha=0.05$ ) confidence interval limits. In order to show the relationships between variables more clearly, the study was completed with 20 individuals.

## Participants

20 adult individuals who did not exercise regularly before participated in the study. The participants were given an aerobic exercise program, 3 days a week for a total of 5 hours, without being divided into any groups. Individuals who are 18 years of age or older, who do not have any obstacles to doing aerobic exercise, who actively use e-mail addresses and who voluntarily agree to participate in the study were included in the study. Individuals who are 18 years of age or younger, who have any obstacles to aerobic exercise, who do not actively use an e-mail address and who do not agree to voluntarily participate in the study are not included.

## Scales

**Perceived stress scale (PSS):** The PSS was developed by Cohen, Kamarck and Mermelstein in 1983 to self-assess the level of stress experienced depending on the extent to which the respondent evaluates his/her life as unpredictable, uncontrollable and overloaded. In our country, the Turkish validity study of this scale was conducted by Yerlikaya and İnanç in 2007. In this scale, in which the relationship between sense of humor and stress was examined, individuals were asked to evaluate the degree to which they experienced their feelings and thoughts in the last month. Scoring was asked to be evaluated between 0 and 5, with 0 (not at all) and 5 (very much). The total score of the participants determines their perceived stress level. The higher the score, the higher the perceived stress level.

**Brain-gut axis inquiry form:** Created by Vagustim, a company that produces a wearable medical technology device. The cerebrointestinal axis questionnaire consists of 46 questions. In addition to demographic data of the participants such as age, gender, height and weight, there are questions under the headings of autonomic nervous system, gastrointestinal system, nutrition and stress. The evaluation of the brain-gut axis questionnaire form is performed by Vagustim software.

## Procedure

Before the aerobic exercise, the participants were asked to fill in the perceived stress scale with 10 questions and the brain-gut axis inquiry form, which included 46 questions. Individuals who filled out the scale and form were given an aerobic exercise program, 3 days a week, for a total of 5 hours. The mentioned aerobic exercise program includes outdoor exercises such as light-moderate walking, cycling and swimming. At the end of 1 week, the participants who applied the aerobic exercise program were asked to fill in the perceived stress scale and the brain-gut axis inquiry form again.

## Analysis of Data

Data were analyzed using SPSS version 26.0 (IBM Corp) package program. Data are reported using number, percentage and arithmetic mean.

## Results

**Table 1.** Results of brain intestinal axis evaluation form (N=20)

	Stress (%)	Nutrition (%)	GIS (%)	OSS (%)
Before Aerobic Exercise	33,61	24,57	22,72	19,10
After Aerobic Exercise	31,18	27,21	21,14	20,45

Looking at the data, the problems in the brain-gut axis of the participants before aerobic exercise are mostly related to stress (33.61%). Stress is followed by nutrition (24.57%), gastrointestinal system (GIS) (22.72%) and autonomic nervous system (ANS) (19.10%) components, respectively. The brain-gut axis survey consists of 4 main components and a score close to 25% is expected in each component in healthy individuals. As the score goes above 25%, it shows that the problem in that component of the axis is high. After individuals perform an aerobic exercise program for 3 days a week for a total of 5 hours, problems in the brain-gut axis again are mostly related to stress (31.18%). However, when compared with the

previous data, there was a 7.23% reduction in the stress rate after aerobic exercise. Nutrition (27.21%), gastrointestinal system (GIS) (21.14%) and autonomic nervous system (OSS) (20.45%) components scores were also obtained in this way. In addition to stress, when the data is compared before and after aerobic exercise, there is a 6.97% decrease in the rate of GIS, while the rate of nutrition and ANS problems are increased 10.76% and 7.06%, respectively (Table 1).

**Table 2.** Perceived stress scale scores of individuals before aerobic exercise (N=20)

	Very Often (%)	Frequently (%)	Sometimes (%)	Hardly Ever (%)	Never (%)
How often in the past month, have you been upset by unexpected events?	27,3	31,8	31,8	9,1	0
How often in the past month have you felt that you can't control the important things in your life?	18,2	36,4	40,9	2,3	2,3
How often in the past month have you felt tense and stressed?	45,5	27,3	25	2,3	0
How often in the past month have you been confident in your ability to cope with your personal problems?	2,3	29,5	50	18,2	0
How often in the past month have you felt that things were going the way you wanted?	2,3	34,1	43,2	15,9	4,5
How often in the past month have you felt that you couldn't handle everything you had to do?	9,1	20,5	59,1	6,8	4,5
How often in the past month have you been able to control the disturbing events in your life?	0	15,9	61,4	20,5	2,3
How often in the past month have you felt in control of events in your life?	4,5	31,8	40,9	20,5	2,3
How often in the past month have you been angry because of things that were out of your control?	22,7	34,1	36,4	4,5	2,3
How often in the past month have you felt that the difficulties have become so numerous that you cannot cope?	27,3	22,7	40,9	2,3	6,8

**Table 3.** Perceived stress scale scores of individuals after aerobic exercise (N=20)

	Very Often (%)	Frequently (%)	Sometimes (%)	Hardly Ever (%)	Never (%)
How often in the past month, have you been upset by unexpected events?	13,6	15,9	31,8	31,9	6,8
How often in the past month have you felt that you can't control the important things in your life?	6,8	20,5	38,6	27,3	6,8
How often in the past month have you felt tense and stressed?	11,4	15,9	34,1	38,6	0
How often in the past month have you been confident in your ability to cope with your personal problems?	2,3	40,9	45,5	9,1	2,3
How often in the past month have you felt that things were going the way you wanted?	0	40,9	47,7	9,1	2,3

How often in the past month have you felt that you couldn't handle everything you had to do?	0	18,2	45,5	29,5	6,8
How often in the past month have you been able to control the disturbing events in your life?	2,3	47,7	43,2	4,5	2,3
How often in the past month have you felt in control of events in your life?	4,5	40,9	43,2	9,1	2,3
How often in the past month have you been angry because of things that were out of your control?	13,6	11,4	40,9	22,7	11,4
How often in the past month have you felt that the difficulties have become so numerous that you cannot cope?	4,5	15,9	50	27,3	2,3

The scores of the Perceived Stress Scale before and after exercise protocol are written in Table 2 and 3.

**Table 4.** Perceived stress scale total score before and after aerobic exercise (N=20)

	Before Aerobic Exercise	After Aerobic Exercise
<b>Perceived Stress Scale (PSS) Score</b>	22	17

The total scores of the perceived stress scale range from a minimum of 0 to a maximum of 40 points. When the scores are added together, the higher the score, the higher the perceived stress level of the individual. Considering the data, there is a decrease of 22.73% in the total score of the perceived stress scale applied to individuals before and after aerobic exercise (Table 4).

## Discussion and Conclusion

In this study, it was tried to evaluate the effect of a total of 5 hours (3 days a week) of aerobic exercise program (exercises such as outdoor, light-moderate walking, cycling, swimming) on individuals' perceived stress and brain-gut axis. When the pre-test and post-test results were examined, it was thought that exercise might have positive effects on stress and can affect the brain-gut axis by decreasing stress. According to a study by Cerdá et al. in 2016, moderate physical exercise was found to be effective in increasing microbiota diversity. In a study conducted by Barton et al. in 2018 comparing professional rugby players and sedentary individuals, it was suggested that exercise increases the production of short-chain fatty acids formed by the microbiota and therefore positively affects gut health. According to studies conducted on mice, it has been found that when the microbiome taken from the stressed mouse is given to the healthy mouse, the stress level of the healthy mouse also increases significantly (Bercik et al., 2011; Heijtz et al., 2011; Sudo et al., 2004).

According to a recent study in the literature, it was found that there is a significant decrease in the stress level when the gut microbiota is improved. In this study, in which the effect of aerobic exercise on stress and brain-gut axis in individuals was examined, it was thought that aerobic exercises affected the brain-gut axis, and reduction was seen in stress and anxiety levels (Katasonov, 2021). Looking at the study of Babaoğlu and Özdenk in 2017, it is found that there is a significant relationship with irritable bowel syndrome in individuals with high stress levels. Özer et al. (2019) found that stress causes some metabolic disruptions by affecting the gut microbiota. The effect of stress on the brain-gut axis varies depending on external factors such as antibiotics and nutrients. Considering our study, it was seen that 1 week of aerobic exercise could cause a decrease of 22.73% in the total score of the perceived

stress scale. The decrease in the stress subunit of the brain-gut axis questionnaire form (7.23%) was lower than the decrease in the stress perception scale. This may be due to the difference in the assessment of stress in the questionnaires. In addition, it can be thought that the decrease in stress is not fully reflected in the brain-gut axis within 1 week.

Since there are not many studies investigating the effects of exercise on stress, anxiety and quality of life in the literature, more scientific studies are needed on these issues.

### **Credit Author Statement**

Study concept/design: HD, MB, AVO; Data collection/data processing: HD; Data analysis and interpretation: HD; Manuscript drafting: HD; Critical review of content: HD, MB, AVO; Final approval and responsibility: HD, AVO; Technical and material support: None; Supervision: AVO.

### **Conflict of Interest**

There is no conflict of interest between the authors.

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