1947
University of Tabriz

1987
Faculty of Physical
Education and Sport
Sciences

Booklet of Congress

Exercise Physiology and Nutrition

2^{nd} Biennial International Congress on New Challenges of Sport Sciences and Health on the Silk Road

Iran- Tabriz 2024

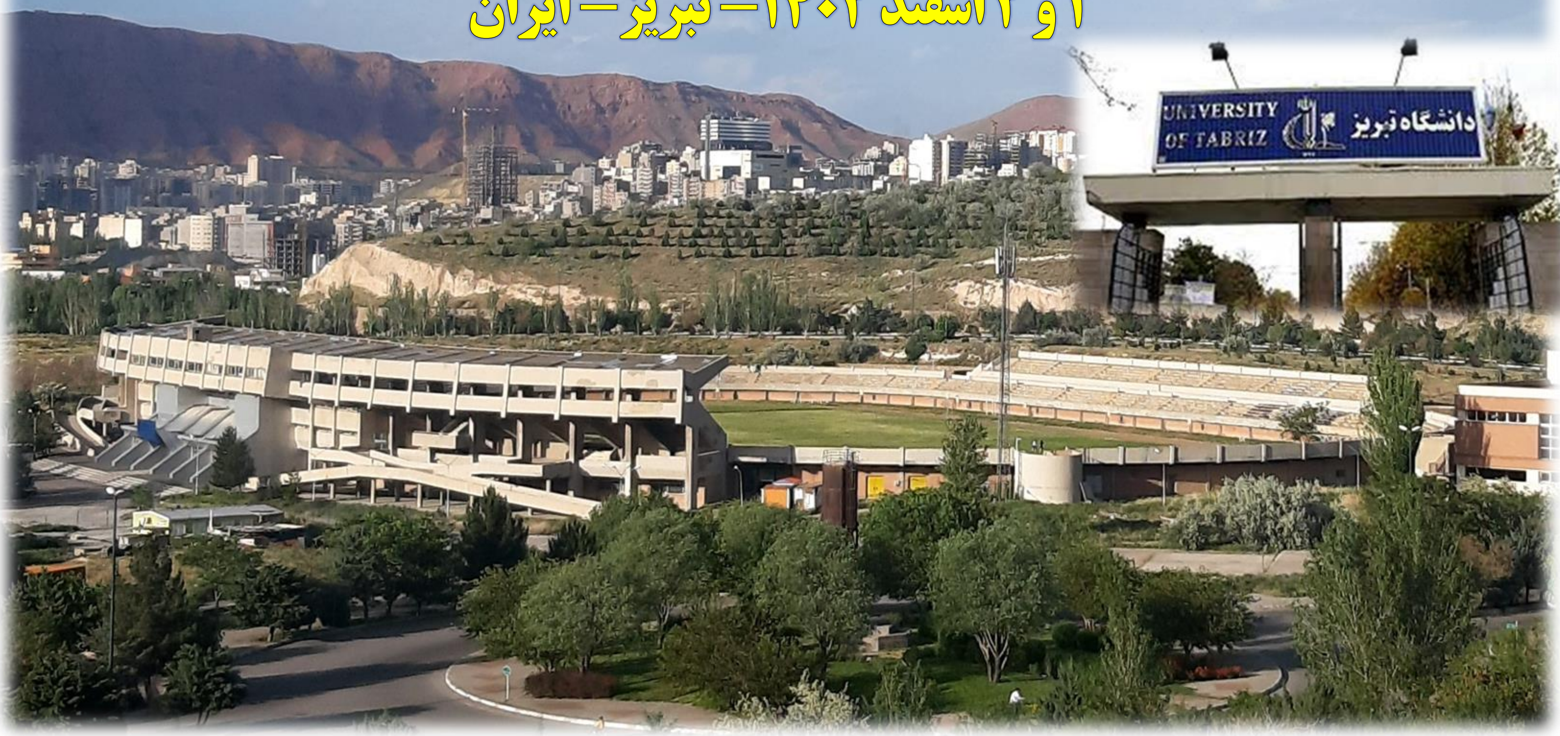
20 and 21 February, 2024

کتابچه مقالات همایش

فیزیولوژی و تغذیه ورزشی

دومین همایش دوسالانه بین‌المللی چالش‌های نوین علوم ورزشی و تندرستی در جاده ابریشم

۱ و ۲ اسفند ۱۴۰۲– تبریز– ایران




دانشگاه تبریز
University of Tabriz


دانشگاه تبریز
UNIVERSITY OF TABRIZ


دانشکده تربیت بدنی و علوم ورزشی
Faculty Of Physical Education And Sport Sciences
96


دانشکده تربیت بدنی و علوم ورزشی
Faculty Of Physical Education And Sport Sciences

Conference sponsors

Table of Contents

Conference Introduction

Dear Participant,

In the past, the Silk Road connected various commercial networks, symbolizing international exchanges in scientific, cultural, and commercial domains. Today, it remains a representation of global interactions and can play a significant role in scientific and sports diplomacy. In this conference, emphasis is placed on the role of our country, Iran, situated along the main route of the Silk Road, serving as a bridge between the East and the West. It can contribute to strengthening international relations, particularly in the field of sports. Nowadays, the role of sports in individual and societal life is prominent, and what our country needs is a scientific and practical approach in various sports sciences. In this regard, presenting the latest scientific achievements and implementing them can lead to sustainable development in this field.

The ***2nd Biennial International Congress on New Challenges of Sport Sciences and Health on the Silk Road*** aims to bring together academics, students, executive managers, athletes, and all enthusiasts for collaborative thinking, exchanging the latest fundamental, developmental, and applied achievements. The focus is on moving towards meeting the health needs of society, with an emphasis on sports sciences and national and international development. The conference is organized by the Faculty of Physical Education and Sports Sciences at the University of Tabriz, Tabriz of Iran, with the participation of prominent domestic and foreign scientists and researchers. The first edition was held virtually on February 27 and 28, 2022, and this year, we are honored to organize the second edition on February 20 and 21, 2024.

This conference provides a valuable opportunity for scientific exchanges and sharing research findings to enhance the scientific and practical level in the field of sports sciences and related disciplines. Side sessions, in the form of specialized scientific workshops, addressed challenges and perspectives in sports sciences, creating a suitable and efficient space for the active participation of sports science specialists to enhance scientific collaboration. It is hoped that the results of this conference will effectively contribute to formulating scientific programs and increasing public participation in sports, ultimately achieving high goals in sports and health for various segments of society.

Scientific Secretary of the Conference,

۲مین همایش
دوسالانه بین المللی
چالش‌های نوین علوم ورزشی و تندرستی
در جاده ابریشم

محورهای همایش:

- فیزیولوژی و تغذیه ورزشی
- مدیریت و جامعه شناسی ورزشی
- رفتار حرکتی و روانشناسی ورزشی
- بیومکانیک، آسیب شناسی ورزشی و حرکات اصلاحی

تمدید شد

تمدید شد

مجری همایش: دانشگاه تبریز **مکان برگزاری:** دانشگاه تبریز، دانشکده تربیت بدنی و علوم ورزشی
برگزاری همایش بصورت مجازی

زمان برگزاری همایش: ۱ و ۲ اسفند ۱۴۰۲
آخرین مهلت ارسال اصل مقالات : ۲۰بهمن
آخرین مهلت ارسال چکیده مقالات : ۲۰بهمن
آخرین مهلت ثبت نام در همایش : ۲۰بهمن

راه های ارتباطی:

آدرس دبیرخانه: تبریز، بلوار ۲۹ بهمن، دانشگاه تبریز، دانشکده تربیت بدنی و علوم ورزشی
تلفن : ۰۴۱۳۳۳۹۳۲۵۱ **فکس:** ۰۴۱-۳۳۳۵۶۰۰۸
سایت همایش: srsc.tabrizu.ac.ir **پست الکترونیک:** srsc@tabrizu.ac.ir
کانال ایتا: https://eitaa.com/srscTabriz
پیج اینستاگرام: Tabrizu.pe.sport

مسئولیت محتوای مقالات چاپ شده بر عهده نویسندگان است.

The 2nd Biennial International Congress of New Challenges of Sport Sciences and Health on the SILK ROAD

Congress topics:

- Exercise physiology and nutrition
- Sports management and sociology
- Motor behavior and sports psychology
- Sports biomechanics, pathology and corrective exercise

Organizer: University of Tabriz Congress will be held **virtually**

Venue: faculty of physical education and sports sciences

Date of the congress: 20 and 21 February 2024

Deadline for sending abstracts of the articles: 9 February 2024

The deadline for registration in the congress: February 9, 2024

EXTENDED

Communication ways:

Secretariat address: Faculty of physical education and sports science, University of Tabriz, 29th Bahman boulevard, Tabriz, Iran

Phone: 984133393251 **Fax:** 984133356008

Instagram: Tabrizu.pe.sport **Email:** srsc@tabrizu.ac.ir

Congress website: srsc.tabrizu.ac.ir

Eitaa Channal: https://eitaa.com/srscTabriz

Organization Committee Members- Exercise Physiology and Nutrition

Chairman of Conference

Dr. Safar Nasrollahzadeh

General Secretary and Scientific Secretary of Conference

Dr. Mahta Eskandarnejad

Scientific Vice of Conference

Dr. Shirin Yazdani

Executive Secretary of Conference

Dr. Mostafa Khani

Secretary of the Scientific Committee of Exercise Physiology and Nutrition

Dr. Saeed Nikoukheslat

Secretary of the International Relations Committee

Prof. Vahid Sari Sarı

Scientific Vice of the Committee of Exercise Physiology and Nutrition

Prof. Ramin Amirsasan

Secretary of the Secretariat Committee

Dr. Elaheh Piralaei

Executive Secretary of the Committee &

Preparing and Editing the Congressional Booklet

Dr. Mehdi Aalizadeh

Exercise Physiology and Nutrition Scientific Committee Members:

Dr. Asghar Khaledan, University of Tehran
Dr. Hojjathollah Nikhbakht, Islamic Azad University of Tehran Branch
Dr. Khosro Ebrahim, Shahid Beheshty University
Dr. Rozita Fathi, University of Mazandaran
Dr. Alireza Safarzadeh, University of Mazandaran
Dr. Bakhtyar Tartibian, Allameh Tabataba'i University
Dr. Rasoul Eslami, Allameh Tabataba'i University
Dr. Niko Khosravi, Al-Zahra University
Dr. Shahnaz Shahrjerdi, Arak University
Dr. Bohlool Ghorbanian, Azarbaijan Shahid Madani University
Dr. Karim Azali, Azarbaijan Shahid Madani University
Dr. Azam Zarneshan, Azarbaijan Shahid Madani University
Dr. Roghaye Fakhrpour, Azarbaijan Shahid Madani University
Dr. Mohamad Shabani, Bojnourd University
Dr. Farzad Nazem, Bu-Ali Sina University
Dr. Reza Attarzadeh, Ferdowsi University Mashhad
Dr. Nahid Bijeh, Ferdowsi University Mashhad
Dr. Mahtab Moazami, Ferdowsi University Mashhad
Dr. Amir Hossein Haghighi, Hakim Sabzevari University
Dr. Roya Askari, Hakim Sabzevari University
Dr. Nabi Shamsaei, Ilam University
Dr. Khadijeh Irandoost, Imam Khomeini International University (IKIU)
Dr. Babak Nakhostin-Roohi, Islamic Azad University of Ardabil (IAUA)

Dr. Sara Barmaki, Islamic Azad University of Ardabil (IAUA)
Dr. Farzad Zehsaz, Islamic Azad Unversity, Tabriz Branch (IAUT)
Dr. Negin Farhangi, Islamic Azad Unversity, Tabriz Branch (IAUT)
Dr. Jabbar Bashiri, Islamic Azad Unversity, Tabriz Branch (IAUT)
Dr. Roghaye Pouzesh, Islamic Azad Unversity, Tabriz Branch (IAUT)
Dr. Dariush Moflehi, Kerman Shahid Bahonar University
Dr. Hamid Rajabi, Kharazmi University
Dr. Ali Asghar Ravasi, University of Tehran
Dr. Saeid Naghibi, Payam Noor University
Dr. Vahid Tadibi, Razi University
Dr. Naser Behpoor, Razi University
Dr. Mohsen Avandi, Semnan UniversityDr. Rana Fayyaz Milani, Shahid Beheshti University
Dr. Sajad Ahmadi zad, Shahid Beheshty University
Dr. Maryam Noorshahi, Shahid Beheshty University
Dr. Abdolhamid Habibi, Shahid Chamran University of Ahvaz
Dr. Majid Kashef, Shahid Rajaee Teacher Training University
Dr. Hadi Samadi, Shahid Rajaee Teacher Training University
Dr. Mehdi Ghafari, Shahr-e Kord University (SKU)
Dr. Mohammad Faramarzi, Shahrekord University
Dr. Ali Yunesian, Shahrood University of Technology
Dr. Farhad Daryanoosh, Shiraz University
Dr. Mohammad Shariatzadeh, Sports Sciences Research Institute of Iran (SSRII)
Dr. Mahdi Bayati, Sports Sciences Research Institute of Iran (SSRII)
Dr. Masoumeh helalizadeh, Sports Sciences Research Institute of Iran (SSRII)
Dr. Hadi Rouhani, Sports Sciences Research Institute of Iran (SSRII)
Dr. Reza Gharakhanlou, Tarbiat Modares University

Dr. Hamid Agha-Alinejad, Tarbiat Modares University
Dr. Mahdi Mogharnasi, University of Birjand
Dr. Farhad Rahmani-Nia, University of Guilan
Dr. Hamid Mohebbi, University of Guilan
Dr. Bahman Mirzaei, University of Guilan
Dr. Arsalan Damirchi, University of Guilan
Dr. Hamid Arazi, University of Guilan
Dr. Fahimeh Esfarjani, University of Isfahan
Dr. Dariush Sheikholeslami-Vatani, University of Kurdistan
Dr. Abbas Ghanbari-Niaki, University of Mazandaran
Dr. Valiollah Dabidi Roshan, University of Mazandaran
Dr. Marefat Siahkouhian, University of Mohaghegh Ardabili
Dr. Lotfali Bolboli, University of Mohaghegh Ardabili
Dr. Farnaz Seifi, University of Mohaghegh Ardabili
Dr. Afshar Jafari, University of Shahid Beheshti
Dr. Vahid Sari Sarraf, University of Tabriz
Dr. Saeid nikookheslat, University of Tabriz
Dr. Elaheh Piralaei, University of Tabriz
Dr. Ramin Amirsasan, University of Tabriz
Dr. Mostafa Khani, University of Tabriz
Dr. Javad Vakili, University of Tabriz
Dr. Mehdi Aalizadeh, University of Tabriz
Dr. Abbas Ali Gaeini, University of Tehran
Dr. Ali Asghar Ravasi, University of Tehran
Dr. Mohammad Reza Kordi, University of Tehran
Dr. Fateme Shabkiz, University of Tehran

Dr.Ali Gorzi, University of Zanjan
Dr. Ahmad Azad, University of Zanjan
Dr. AghaAli Ghasemnian, University of Zanjan
Dr. Jabar Seifpanahi, University of Zanjan
Dr. Asghar Tofighi, Urmia University
Dr. Javad Tolouei Azar, Urmia University
Dr. MohammadReza Zolfaghari, Urmia University
Dr. Akbar Nouri Habashi, Urmia University
Dr. Kazem Khodaei, Urmia University
Dr. Masoud Asgharpour, Amin Police University
Dr. Farhad Gholami, Shahrood University of Technology
Dr. Hassan Pourrazi, Imam Khomeini International University
Dr. Mehdi Faramoushi, Tabriz Islamic Art University
Dr. Hasan Faraji, Islamic Azad University, Marivan Branch
Dr. Fatollah Havil, Technical and Vocational University
Dr. Hamidreza Zolfi, Technical and Vocational University
Dr. Iraj Sadri Islamic, Azad University, Shabestar Branch
Dr. Zhaleh Pashaei, University of Tabriz
Dr. Azizeh Ahmadi, University of Tabriz
Dr. Mahmoud Ahmadzadeh, University of Tabriz
Dr. Mostafa Armanfar, University of Tabriz
Dr. Masoud Abdollahpour, University of Tabriz
Dr. Akram Amaghani, University of Tabriz
Dr. Ameneh Esmaeili, University of Tabriz
Dr. Mansour Aghaei, University of Tabriz
Dr. Zahra Niknam, University of Tabriz

Dr. Ali Zarghami, University of Tabriz
Dr. Maryam Akbari, University of Tabriz
Dr. Vahid Pakzad, University of Tabriz
Dr. Zahra Rostami, University of Tabriz
Dr. Raheleh Dolghari, University of Tabriz
Dr. Farideh Araghi, University of Tabriz
Dr. Roya Zekri, University of Tabriz
Dr. Farid Etemadian, University of Tabriz
Dr. Morteza Nikkhesal, University of Tabriz
Dr. Ebrahim Hosseini, University of Tabriz
Dr. Sohrab Ghalegir, University of Tabriz
Dr. Maryam Dolatabadi, University of Tabriz

Keynote Speakers & Workshop

Exercise Physiology and Nutrition

سخنرانان کلیدی

و

مدرس کارگاه

فیزیولوژی و تغذیه ورزشی

Keynote Speakers & Workshop

Prof. Vahid Sari-Sarraf
(University of Tabriz/Iran)

Title: Athletes' Profile

Prof. Ramin Amirsasan
(University of Tabriz, Iran)

Title: Nutrition in the competition day

Dr. Kishore Mukhopadhyay,
(University of West Bengal, India)

Title: **Physical literacy is imunity booster: a meta synthesis**

Prof. Hamid Rajabi
(Kharazmi University/Iran)

Title: **Optimal exercise training for brain**

Oral Presentations

Exercise Physiology and Nutrition

مقالات سخنرانی

فیزیولوژی و تغذیه ورزشی

دومین همایش دوسالانه بین المللی
چالش‌های نوین علوم ورزشی
و تندرستی در جاده ابریشم
The 2nd Biennial International Congress of
New Challenges of Sports Sciences
and Health on The Silk Road

Evaluate the effect of functional exercises at home and in the gym on new metabolic indicators in obese women aged 20 to 45 years

Zahra Nazari [Shahrekord University, Esfahan, Iran], zahranzri145@gmail.com

[2]*Mostafa Rahimi [Shahrekord University, Shahrekord, Iran]*, mostafa.rahimi20@gmail.com

[3]*Jalil Reisi [Esfahan University, Esfahan, Iran]*, email@gmail.com

ABSTRACT

Obesity and overweight have become a common health problem worldwide, and its prevalence is increasing as a global epidemic (1). According to the report of the World Health Organization, at least 2.8 million adults die every year due to being overweight or obese (2) Overweight and obesity with increased mortality and many complications including diabetes, heart diseases. It is associated with vascular, musculoskeletal, cancers and many other diseases and greatly increases the risk of metabolic syndrome (3).

Excessive accumulation of body fat causes a series of abnormalities and metabolic diseases, including insulin resistance, dyslipidemia, non-alcoholic fatty liver disease, B cell dysfunction, pre-diabetes and type 2 diabetes. Be (4). The most dangerous is the high amount of visceral adipose tissue (VAT). Unlike subcutaneous adipose tissue, VAT is a metabolically active tissue and is associated with dyslipidemia, insulin resistance, and hypertension (5). MetS is associated with visceral obesity (6). People with metabolic syndrome have two to three times the risk of developing cardiovascular disease and five times more risk of developing diabetes (7).

The trend of obesity and metabolic syndrome is increasing dramatically worldwide. MetS is a cluster of metabolic disorders that include abdominal obesity, insulin resistance, dyslipidemia, IR-induced hypertension, and inflammation. Various epidemiological studies have shown a strong relationship between these risk factors and the occurrence of other chronic diseases such as gastrointestinal cancer, cardiovascular diseases, diabetes, or even premature mortality (8). At the molecular level, IR is the main cause of MetS pathogenesis (9). MetS is characterized by certain criteria defined by the International Diabetes Federation. This classification is based on the combination of at least three of the following five factors: visceral obesity, increased serum triglycerides, low HDL cholesterol, arterial blood pressure, and increased serum glucose (10). Therefore, developing strategies to prevent and treat MetS, overweight and obesity is of great importance.

Insulin resistance (IR) includes a decrease in the sensitivity of muscle and adipose tissue to insulin and a decrease in the ability of the liver to suppress glucose production in and outside the liver (11). Insulin resistance is considered a risk factor for type 2 diabetes and cardiovascular disease (12). Insulin resistance and dysfunction of pancreatic beta cells are important factors in the pathophysiology of diabetes and pre-diabetes (13). TyG index is the product of triglyceride and fasting blood glucose and is also used as a surrogate indicator of IR among adults (14). The TyG index is also used in the diagnosis of metabolic syndrome (15). Studies show that triglyceride-glucose index (TyG) and triglyceride-glucose index related to body mass index (TyG-BMI) is a very good indicator for diagnosing insulin resistance, which is considered as a vital pathological mechanism (16). Researchers introduced an alternative index, body fatness index (17). Unlike BMI, BAI provides a corrected percentage of body fat in men and women without statistical correction. BAI calculation does not require body weight measurement. Therefore, body fat index is defined as the non-linear ratio of hip circumference to height. In addition, fat accumulation

product (LAP) and visceral obesity index (VAI) are two new indices that are used to estimate visceral obesity (18). VAI, introduced by a group of researchers, includes anthropometric parameters (BMI and WC) and lipid parameters (TG and HDL-C) (19). LAP and VAI have been proposed as simple and useful indicators of MetS in recent studies (20). The metabolic syndrome Z-score (Z-score) indicates the severity or potential risk for MetS. It has been shown that Z-score is related to other metabolic risk markers such as insulin and adiponectin and predicts the long-term risk of T2D and CVD (21).

Non-pharmacological interventions, including regular exercise, diets and a combination of the two, are known as the first step in controlling metabolic diseases. The beneficial effects of exercise on metabolic diseases, including metabolic syndrome, are known. Exercise can reduce blood pressure, improve lipid profile, improve insulin resistance, and reduce visceral fat accumulation or central obesity in patients with metabolic syndrome (22). Due to the high prevalence of inactivity around the world, lack of time and significant social and economic costs, efficient intervention strategies have been created to deal with the harmful effects of inactivity. Since 2015, it has become customary to use a home exercise program that provides access to exercise for all people (23).

Functional training is a form of physical activity that can be changed according to any fitness level and causes more muscle growth than repetitive aerobic exercises, and as a result, improves cardiovascular endurance, strength and flexibility. Functional training emphasizes multi-joint, functional movements through high intensity interval training (HIIT) and muscle strengthening exercises (24). In functional exercises, the muscles involved in daily activities are trained to make a person strong to perform daily tasks and activities, reduce the risk of injury and functional weakness, and also improve the quality of life (25).

In the field of physical activity and sports, home training and online training have become very popular. One of the main reasons for not exercising is lack of time (26). Exercises at home are accessible to all people (27). Home exercise programs allow for privacy, which is a major concern for most overweight and obese individuals (28). Also, due to the existing conditions during the COVID-19 epidemic, restrictions, quarantines and closure of sports centers (66), many people are confined to their homes to do physical activity (29).Sports training at home has several advantages compared to training in the gym, including that home training is often more affordable than training in the gym (30) and is accessible to all people (27).

The current research is a semi-experimental research with a pre-test and post-test design. Among the population of non-athletes women, who were examined in terms of underlying diseases, some people were selected as samples. The criteria for inclusion in the study include women with an age range of 20-45 years, a body mass index above 25 kg/m2, no history of specific diseases, no adherence to diet, medication or special supplements, and no long-term exercise history of more than 2 months in It was 2 years ago.

The number of 45 subjects was randomly divided into 3 groups of 15 people: control group, training group at the gym and training group at home. 48 hours before the start of the training protocol, blood samples were taken from the elbow vein of all participants in resting conditions with at least 8 hours of fasting by a trained nurse at 8 to 9 am. The exercise groups performed functional exercises (in the gym or at home) for 10 weeks. The control group did not participate in any exercise program during this period. The training sessions were conducted in the gym under the supervision of the expert trainer, and the training sessions at home were provided to the participants by sending the weekly training program on WhatsApp. In this study, functional training protocol was used three days a week on non-consecutive days for 10 weeks. The exercise protocol consisted of 15 minutes of warm-up (stretching movements, walking and jogging) before the main program and 15 minutes of cooling down after the exercise program. 48 hours after the last training session, blood sampling and other tests were done as in the pre-test conditions.

The data obtained from the dependent variables of the research were analyzed with the help of SPSS version 25 statistical software. The normal distribution of the data of each variable was checked using the Shapiro-Wilk statistical test. In most of the variables, the condition of normal distribution and other conditions of parametric statistics were met, so we used the inferential statistics method of analysis of covariance (ANCOVA) to analyze the post-test data. We also used paired t-parametric test to check intra-group differences. A significant level of 0.05 was considered.

The subjects who participated in this study had an average age of 36 ± 5.11, an average weight of 86.9 ± 11, an average height of 165.09 ± 5.87, and an average BMI of 31.8 ± 2.9. The information related to the individual characteristics of the subjects, including age, height, weight and body mass index, separated by groups and at the time of the pre-test, is presented in the form of average and standard deviation in the table below.

Table1: Physical and physiological characteristics of subjects in research groups

body mass index (kg/m2()	weight	height	age	group Variable
2/87±32/2	10/08± 90/91	5/16± 167/93	1/59±34/40	control
3/06±31/24	11/14± 83/78	5/34± 163/53	1/04± 38/55	Exercise at gym
2/87± 31/95	11/35± 86/01	6/34± 163/8	2/48±34/77	Exercise at home

According to the findings of this study, 10 weeks of exercise in the gym caused a significant decrease in body weight, body mass index, hip circumference and BAI index in obese women compared to the control and home exercise groups, but on the levels of glucose, serum insulin, HOMA-index IR and HOMA-β, TyG-BMI, TyG-WC, TYG and LAP index, VAI and Z score and waist size of obese women had no significant effect. However, functional strength and aerobic exercises in sports clubs and under the supervision of a sports coach are another relatively effective training strategy for obese and overweight people, and these people can be encouraged to do these exercises.

References:

1. Djalalinia S, Saeedi Moghaddam S, Sheidaei A, Rezaei N, Naghibi Iravani SS, Modirian M, et al. Patterns of obesity and overweight in the iranian population: findings of steps 2016. Frontiers in endocrinology. 2020;11:42.
2. Emerenziani GP, Migliaccio S, Gallotta MC, Lenzi A, Baldari C, Guidetti L. Physical exercise intensity prescription to improve health and fitness in overweight and obese subjects: a review of the literature. 2013.
3. Kinlen D, Cody D, O'Shea D. Complications of obesity. QJM: An International Journal of Medicine. 2018;111(7):437-43.

4. Klein S, Gastaldelli A, Yki-Järvinen H, Scherer PE. Why does obesity cause diabetes? Cell metabolism. 2022;34(1):11-20.
5. Baggerman MR, Dekker IM, Winkens B, Damink SWO, Weijs PJ, van de Poll MC. Computed tomography reference values for visceral obesity and increased metabolic risk in a Caucasian cohort. Clinical Nutrition ESPEN. 2022;48:408-13.
6. Han TS, Lean ME. Metabolic syndrome. Medicine. 2015;43(2):80-7.
7. Ibrahim MS, Pang D, Randhawa G, Pappas Y. Risk models and scores for metabolic syndrome: systematic review protocol. BMJ open. 2019;9(9).
8. Tibana RA, Navalta J, Bottaro M, Vieira D, Tajra V, Silva AdO, et al. Effects of eight weeks of resistance training on the risk factors of metabolic syndrome in overweight/obese women-“A Pilot Study”. Diabetology & metabolic syndrome. 2013;5:1-8.
9. Lemos GdO, Torrinhas RS, Waitzberg DL. Nutrients, physical activity, and mitochondrial dysfunction in the setting of metabolic syndrome. Nutrients. 2023;15(5):1217.
10. Khalil M, Shanmugam H, Abdallah H, John Britto JS, Galerati I, Gómez-Ambrosi J, et al. The potential of the Mediterranean diet to improve mitochondrial function in experimental models of obesity and metabolic syndrome. Nutrients. 2022;14(15):3112.
11. Matthaei S, Stumvoll M, Kellerer M, Häring H-U. Pathophysiology and pharmacological treatment of insulin resistance. Endocrine reviews. 2000;21(6):585-618.
12. Lillioja S, Mott DM, Spraul M, Ferraro R, Foley JE, Ravussin E, et al. Insulin resistance and insulin secretory dysfunction as precursors of non-insulin-dependent diabetes mellitus: prospective studies of Pima Indians. New England journal of medicine. 1993;329(27):1988-92.
13. Khalili D, Khayamzadeh M, Kohansal K, Ahanchi NS, Hasheminia M, Hadaegh F, et al. Are HOMA-IR and HOMA-B good predictors for diabetes and pre-diabetes subtypes? BMC Endocrine Disorders. 2023;23(1):1-9.
14. Mazidi M, Kengne A-P, Katsiki N, Mikhailidis DP, Banach M. Lipid accumulation product and triglycerides/glucose index are useful predictors of insulin resistance. Journal of Diabetes and its Complications. 2018;32(3):266-70.
15. Mirr M, Skrypnik D, Bogdański P, Owecki M. Newly proposed insulin resistance indexes called TyG-NC and TyG-NHtR show efficacy in diagnosing the metabolic syndrome. Journal of endocrinological investigation. 2021;44(12):2831-43.
16. Zheng S, Shi S, Ren X, Han T, Li Y, Chen Y, et al. Triglyceride glucose-waist circumference, a novel and effective predictor of diabetes in first-degree relatives of type 2 diabetes patients: cross-sectional and prospective cohort study. Journal of translational medicine. 2016;14:1-10.
17. Zwierzchowska A, Grabara M, Palica D, Zając A. BMI and BAI as markers of obesity in a Caucasian population. Obesity facts. 2013;6(6):507-11.
18. Kahn HS. The" lipid accumulation product" performs better than the body mass index for recognizing cardiovascular risk: a population-based comparison. BMC cardiovascular disorders. 2005;5:1-10.
19. Han M, Qin P, Li Q, Qie R, Liu L, Zhao Y, et al. Chinese visceral adiposity index: a reliable indicator of visceral fat function associated with risk of type 2 diabetes. Diabetes/metabolism research and reviews. 2021;37(2):e3370.
20. Shin K-A, Kim Y-J. Usefulness of surrogate markers of body fat distribution for predicting metabolic syndrome in middle-aged and older Korean populations. Diabetes, metabolic syndrome and obesity: targets and therapy. 2019:2251-9.
21. DeBoer MD, Filipp SL, Gurka MJ. Use of a metabolic syndrome severity Z score to track risk during treatment of prediabetes: an analysis of the diabetes prevention program. Diabetes Care. 2018;41(11):2421-30.

22. مفرد ن, سخائی, هادی, روحانی, اکبری, خلفی, et al. تاثیر تمرین ورزشی بر نشانگرهای التهابی در افراد مبتلا به سندرم متابولیک: مرور نظام‌مند و فراتحلیل. مجله ی غدد درون‌ریز و متابولیسم ایران، دو ماهنامه پژوهشی مرکز تحقیقات غدد درون‌ریز و متابولیسم، ۲۰۲۲;۲۴(۱):۵۲-۶۵.

23. کاشانی, معرفتی, عسکری, شاکریان, حلیمه, پور و, et al. تاثیر هشت هفته تمرین پیلاتس در خانه و در معرض و برخی شاخص‌های عملکردی زنان مبتلا به بیماری مولتیپل اسکلروزیس در دوره D مقادیر سرمی ویتامین آفتاب بر همه‌گیری ویروس کرونا. پژوهشنامه فیزیولوژی ورزشی کاربردی. ۲۰۲۲;۱۸(۳۵):۳۱-۴۳.

24. Ben-Zeev T, Hirsh T, Weiss I, Gornstein M, Okun E. The effects of high-intensity functional training (HIFT) on spatial learning, visual pattern separation and attention span in adolescents. Frontiers in Behavioral Neuroscience. 2020;14:577390.

25. Heinrich KM, Becker C, Carlisle T, Gilmore K, Hauser J, Frye J, et al. High- intensity functional training improves functional movement and body composition among cancer survivors: a pilot study. European journal of cancer care. 2015;24(6):812-7.

26. Goodman JM, Liu PP, Green HJ. Left ventricular adaptations following short-term endurance training. Journal of Applied Physiology. 2005;98(2):454-60.

27. Shaw I, Boshoff VE, Coetzee S, Shaw BS. Efficacy of home-based callisthenic resistance training on cardiovascular disease risk in overweight compared to normal weight preadolescents. Asian Journal of Sports Medicine. 2021;12(1).

28. Shaw I, Shaw BS. Hemodynamic changes in normotensive overweight and obese individuals following home-based calisthenics training. African Journal for Physical Health Education, Recreation and Dance. 2014;20(sup-2):82-90.

29. Chaabene H, Prieske O, Herz M, Moran J, Höhne J, Kliegl R, et al. Home-based exercise programmes improve physical fitness of healthy older adults: A PRISMA-compliant systematic review and meta-analysis with relevance for COVID-19. Ageing research reviews. 2021;67:101265.

30. Connolly LJ, Scott S, Morencos CM, Fulford J, Jones AM, Knapp K, et al. Impact of a novel home-based exercise intervention on health indicators in inactive premenopausal women: a 12-week randomised controlled trial. European Journal of Applied Physiology. 2020;120:771-82.

Creatine supplementation and exercise training improve insulin sensitivity and indices of oxidative stress, lipid profiles and homocysteine in streptozotocin -induced diabetic male rats

Hesam Parsa [1],

*Department of Exercise Physiology, Faculty of Sport Sciences, Bu-Ali Sina University,
Hamedan, Iran, h.parsa@basu.ac.ir*

ABSTRACT

Diabetes is known as a metabolic disease characterized by a hyperglycemic state caused by impaired insulin action, insulin secretion, or both (insulin resistance). Complications, damages, costs, and reduced quality of life caused by diabetes have brought about a wide attention to this metabolic disease. According to the spread of this disease in the world, it is estimated that more than 578 million people will be affected by it in 2030 and 700 million in 2045 [1].

Oxidative stress refers to the overproduction of free radicals and the reduction of free radical scavenging enzymes, which are increased in animals and people with diabetes [2]. Increased levels of reactive oxygen species (ROS) in diabetes may be due to decreased production of antioxidants catalase (CAT-enzymatic/non-enzymatic), superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px). A decrease in the levels of these enzymes makes tissues susceptible to oxidative stress, thereby leading to the development of diabetes complications [3].It has been shown that the formation of ROS leads to beta cell dysfunction from the inflammatory cytokine pathway and autoimmune reactions in type 1 diabetes [4].

One of the factors affecting lipid peroxidation is malondialdehyde (MDA). The increase of MDA at the cellular level damages the genomic structure and proteins and can lead to the creation of defective proteins and disease. It is worth mentioning that the amount of MDA increases in the cells and tissues of diabetic laboratory animals [6].

Also, many people with diabetes who have poor blood glucose control have a dyslipidemia such as increased triglycerides (TG), cholesterol, low-density lipoprotein (LDL-C) and decreased high-density lipoprotein cholesterol also experience (HDL-C) [7]. An increase in glucose and insulin levels along with blood lipid disorders in patients with diabetes, along with oxidative stress, provides the basis for the occurrence of various disorders, including insulin resistance [8].

In addition to glucose metabolism disorder, the diabetes can increase in harmful blood lipid and an increase in oxidative stress. So far, no research has been done regarding the simultaneous effect of creatine supplementation and swimming exercise on insulin sensitivity, oxidative stress indices, lipid profile and homocysteine in diabetes, and therefore, in this research, the mentioned cases were investigated in rats diabetized with STZ.

Materials and methods

In this study, 40 Wistar rats weighing between 160 and 170 g were randomly divided into four groups (n = 10 for each group): 1) Healthy control (Con), 2) Diabetes (Dia), 3) Diabetes + training

(Dia+) Tr), 4) Diabetes+training+creatine (Dia+Tr+Cr). At the end of the period of adaptation to the laboratory environment, the rats of the diabetic groups (except the healthy control group) became diabetic following the pattern of previous studies [24]. Thus, a low dose of streptozotocin (dissolved in citrate buffer with pH 4.5) was injected intraperitoneally at a dose of 35 mg/kg. Blood glucose level was measured 48 hours after STZ injection. Rats with blood glucose levels above 200 mg/dL were considered diabetic [24]. This model mimics the advanced stages of type 2 diabetes in humans. Rats that did not reach these glucose values were excluded from the experiment. During the study, blood glucose was checked weekly to ensure that inverse diabetes did not occur. Biochemical measurements At the end of the training period and 48 hours after the last training session, the rats were subjected to an oral glucose tolerance test in fasting condition [26]. To perform this method, 10 ml of 20% glucose solution was prepared. Then, glucose was fed to the rats in the amount of 2 grams per kilogram of rat weight using gavage technique and blood glucose levels were measured at 0, 30, 60 and 120 minutes using a glucometer device (GLUCOCARD01).

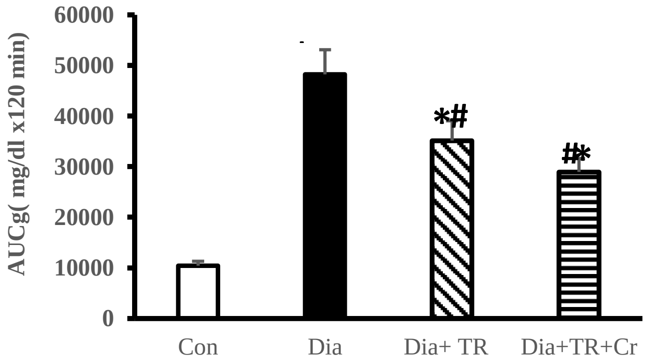
Results

Body weight, blood glucose and insulin

In the comparison of body weight between different groups, the results of Tukey's post hoc test showed that diabetes caused a significant decrease in body weight compared to the healthy control group ($p<0.05$). Also, the weight loss in the Dia+Tr and Dia+Tr+Cr groups was significant compared to the healthy control group $p<0.05$). Compared to the diabetes group, body weight increased significantly in the Dia+Tr and Dia+Tr+Cr groups ($p<0.05$). Induction of diabetes caused a significant increase in AUCg in the Dia, Dia+Tr, and Dia+Tr+Cr groups compared to the healthy control group ($p<0.05$).

Regard the effect of training and supplementation in diabetic groups, it was found that swimming training for 12 weeks caused a decrease of about 22% in the area under the curve compared to the diabetic group ($p<0.05$). Performing swimming training and taking creatine supplement for 12 weeks also led to a 52% decrease in the level under the glucose curve $p<0.05$).

According to the results of the present study, 12 weeks of swimming training with creatine supplementation improves glucose homeostasis and insulin sensitivity by increasing antioxidant factors and reducing lipid peroxidation, homocysteine and lipid variables (harmful blood lipids) in STZ-induced diabetic rats.



Referrences:

1. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the

International Diabetes Federation Diabetes Atlas. Diabetes research and clinical practice. 2019;157:107843.

2. Yang H, Jin X, Lam CWK, Yan S-K. Oxidative stress and diabetes mellitus. Clinical chemistry and laboratory medicine. 2011;49(11):1773-82.

3. Lipinski B. Pathophysiology of oxidative stress in diabetes mellitus. Journal of Diabetes and its Complications. 2001;15(4):203-10.

4. Cernea S, Dobreanu M. Diabetes and beta cell function: from mechanisms to evaluation and clinical implications. Biochemia medica. 2013;23(3):266-80.

5. Ayepola OR, Brooks NL, Oguntibeju OO. Oxidative stress and diabetic complications: the role of antioxidant vitamins and flavonoids. Antioxidant-antidiabetic agents and human health. 2014:923-31.

6. Ansley DM, Wang B. Oxidative stress and myocardial injury in the diabetic heart. The Journal of pathology. 2013;229(2):232-41.

7. Awadalla H, Noor SK, Elmadhoun WM, Bushara SO, Almobarak AO, Sulaiman AA, et al. Comparison of serum lipid profile in type 2 diabetes with and without adequate diabetes control in Sudanese population in north of Sudan. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2018;12(6):961-4.

Effects of HIIT and Curcumin supplementation on miR-208, miR-499 and HSP60 expression level in rat model of isoproterenol induced myocardial infraction

Jabraeel Pouzesh Jadidi[1], Farnaz Seifi-Skishahr*[2], Lotfali Bolboli[3], Karim Azali Alamdari[4], Ameneh Pourrahim Ghoroughchi[5]

1. PHD student of Exercise Physiology, Department of Sport Physiology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran
2. Associate Professor of Exercise Physiology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran (Corresponding Author)
3. Associate Professor of Exercise Physiology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran
4. Associate Professor of Exercise Physiology, Department of Sport Sciences, Azarbaijan Shahid Madani University, Tabriz, Iran
5. Assistant Professor of Exercise Physiology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran

Aim: The aim of this study was to investigate effects of high intensity interval training (HIIT) and curcumin supplementation on cardiomyocyte miR-208, miR-499 and HSP60 expression level in rat model of isoproterenol induced acute myocardial infraction (AMI). Methodology: 40 male rats(200-250 gr, age: 16 weeks old) were randomized into four groups of Training, Curcumin, Concomitant (HIIT+ Curcumin) and Control following intraperitoneal injection of isoproterenol (100 mg/kg) for two consecutive days to induce myocardial infarction. HIIT were done for eight weeks, 5 sessions a week for 60 min. Each session was included to 10 intervals (each interval for 4 min) of running at 85-90% of v VO2 peak with 2 min of active recovery at 50 to 60% of v VO2 peak. Curcumin was administrated through oral gavage 15 mg/kg a day. Expression levels of miR-208, miR-499 and HSP60 genes was evaluated using Real-Time PCR method. Results: All three interventions of training, curcumin and their combination (HIIT+Curcumin) significantly elevated cardiac miR-499, HSP60 expression level as well as Vo2max improvement; meanwhile, miR-208 expression was reduced (p=0.001 under any circumstances). Moreover, the expression levels of miR-208 in the concomitant group were significantly lower than HIIT (p=0.03) or curcumin (p=0.049) either. Conclusion: All three interventions are likely associated with alleviation of MI complications e.g. oxidative stress, ischemia/reperfusion injury and tissue remodeling, through modifications in microRNAs expression level. Moreover, a further reduction in miR-208 expression level in the concomitant group, could imply on a lesser mortality rate or recurrent AMIs as well as a better cardiac structural remodeling following to infraction; emphasizing on better results with curcumin plus HIIT co-prescription. However, more investigations are warranted because of no straight measurement of many factors and also limitations in this study.

---

[1] Email: jpoozesh@gmail.com

[2] Email: f.seify@uma.ac.ir
[3] Email: l_bolboli@uma.ac.ir
[4] Email: k.azali@azaruniv.ac.ir
[5] Email: a.pourrahim@uma.ac.ir

Key words: Curcumin, High Intensity Interval Training, Myocardial Infraction, miRNA

Extended abstract

Background & purpose

Myocardial infarction (MI) is pathologically defined as myocardial cell death due to prolonged ischemia, which is the most severe manifestation of coronary artery disease (CAD) and causes over seven million deaths globally every year (2). The development of CAD can be chronic, by the erosion of endothelium and buildup of plaque and progressive narrowing of the coronary artery. However, a sudden rupture of plaque and formation of thrombus leads to acute MI, which is much more serious. Once the oxygen supply is occluded, the onset of MI is initiated as little as 20 min after and the complete myocardial cell necrosis happens in a few hours. Prolonged ischemia leads to the loss of heart contractility due to the poor proliferation capability of the myocardial cell. Therefore, the timely revascularization of the occluded artery is the key for MI therapy. Antithrombotic agents, percutaneous coronary intervention, and bypass surgery are usually applied to treat the patients (3). However, these treatments only reduce the severity of CAD, rather than restoration of the contractility of the infarcted heart (74). Therefore, novel therapeutic strategies to reduce the myocardial cell death and/or stimulate heart regeneration are highly desirable for the future.

MicroRNAs (miRNAs) are short (19–25 nucleotides) single-stranded noncoding RNA molecules that regulate protein expression. In this regard, inhibition of miR-208a upregulated the expression of Casp1, Casp3, Casp12. On the other hand, increasing miR-499 has been shown to be beneficial for cell survival and decreasing it is associated with cell apoptosis (3).

In addition, it is now well established that physical activity alone(75) or in combination with other interventions has positive effects on reducing cardiomyocyte apoptosis and cardiac structure and function(76). Also, Studies have shown that curcumin has a protective effect on myocardial ischemia-reperfusion injury and can reduce oxidative stress injury and cardiomyocyte apoptosis (36). Therefore, the aim of this study was to investigate effects of high intensity interval training (HIIT) and curcumin supplementation on cardiomyocyte miR-208, miR-499 and HSP60 expression level in rat model of isoproterenol induced acute myocardial infraction (AMI).

Methods

40 male rats(200-250 gr, age: 16 weeks old) were randomized into four groups of Training, Curcumin, Concomitant (HIIT+ Curcumin) and Control following intraperitoneal injection of isoproterenol (100 mg/kg) for two consecutive days to induce myocardial infarction. HIIT were done for eight weeks, 5 sessions a week for 60 min. Each session was included to 10 intervals (each interval for 4 min) of running at 85-90% of v VO2 peak with 2 min of active recovery at 50 to 60% of v VO2 peak (77). Curcumin was administrated through oral gavage 15 mg/kg a day (47).

Results

All three interventions of training, curcumin and their combination (HIIT+Curcumin) significantly elevated cardiac miR-499, HSP60 expression level as well as Vo2max improvement; meanwhile, miR-208 expression was reduced ($p=0.001$ under any circumstances). Moreover, the expression levels of miR-208 in the concomitant group were significantly lower than HHI ($p=0.03$) or curcumin ($p=0.049$) either. Conclusion: All three interventions are likely associated with alleviation of MI complications e.g. oxidative stress, ischemia/reperfusion injury and tissue remodeling, through modifications in microRNAs expression level. Moreover, a further reduction in miR-208 expression level in the concomitant group, could imply on a lesser mortality rate or recurrent AMIs as well as a better cardiac structural remodeling following to infraction; emphasizing on better results with curcumin plus HIIT co-prescription.

Table 1: Results of one-way Anova on relative genes expression after intervention

Tukey post hoc test			ANOVA		variable
Sig	($\bar{x}$ ± SE)	Comparison between groups	Sig	F	
0.001 *	-0.13±0.04	Control-Curcumin	0.001 *	8.06	Relative expression miR-499 to U6
0.006*	-0.14±0.04	Control-Training			
0.001*	-0.18±0.04	Control-Concomitant			
0.99	-0.01±0.04	Curcumin-Training			
0.48	-0.05±0.04	Curcumin-Concomitant			
0.66	-0.04±0.04	Training-Concomitant			
0.004*	0.12±0.03	Control-Curcumin	0.001 *	13.30	Relative expression miR-208 to U6
0.008*	0.12±0.03	Control-Training			
0.001*	0.22±0.03	Control-Concomitant			
0.99	0.008±0.03	Curcumin-Training			
0.049*	0.09±0.03	Curcumin-Concomitant			
0.03*	0.1±0.03	Training-Concomitant			
0.01*	-0.13±0.04	Control-Curcumin	0.001 *	8.06	Relative expression HSP60 to U6
0.006*	-0.14±0.04	Control-Training			
0.001*	-0.18±0.04	Control-Concomitant			
0.99	-0.01±0.04	Curcumin-Training			
0.48	-0.05±0.0	Curcumin-Concomitant			
0.66	-0.04±0.04	Training-Concomitant			
0.87	3.75±4.95	Control-Curcumin	* 0.01	4.12	Body weight (gr)
0.008 *	11.08±4.95	Control-Training			
0.01*	15.78±4.95	Control-Concomitant			
0.46	7.32±4.95	Curcumin-Training			
0.09	12.02±4.95	Curcumin-Concomitant			
0.77	4.7±4.95	Training-Concomitant			

*: Significant Difference($P< 0.05$).

Conclusion

It can be concluded that all three interventions are likely associated with alleviation of MI complications e.g. oxidative stress, ischemia/reperfusion injury and tissue remodeling, through modifications in microRNAs expression level. Moreover, a further reduction in miR-208 expression level in the concomitant group, could imply on a lesser mortality rate or recurrent AMIs as well as a better cardiac structural remodeling following to infraction; emphasizing on better results with curcumin plus HIIT co-prescription.

Similarly, an overproduction in rat myocardium miR-499 gene expression level may increase cell survival via the inhibition of mitochondrial apoptosis. Moreover, an increased HSP60 gene expression level following HIIT and/or curcumin supplementation may also have likely been associated with down regulation of other factors involved in cardiomyocyte apoptosis.

However, more investigations are warranted because of no straight measurement of many factors and limitations in this study.

Article Message

It seems that the hazardous effects of MI could be partially alleviated by HIIT and/or curcumin supplementation via down regulation of the cardiomyocytes apoptosis level with more beneficial effect on cardiac miR-208 gene expression, expected from their concomitance.

Key words: Curcumin, High Intensity Interval Training, Myocardial Infraction, miRNA

References

1. Weintraub, W.S., et al., Value of primordial and primary prevention for cardiovascular disease: a policy statement from the American Heart Association. Circulation, 2011. 124(8): p. 967-990.

2. Sun, T., et al., The role of microRNAs in myocardial infarction: from molecular mechanism to clinical application. International journal of molecular sciences, 2017. 18(4): p. 745.

3. Thygesen, K., et al., Task Force for the Universal Definition of Myocardial Infarction. Third universal definition of myocardial infarction. Nature Reviews Cardiology, 2012. 9(11): p. 620-633.

4. Ghodrati, K., B. Mirzaei, and V. Tadibi, Comparison of The Chronic and Acute Effects of Aerobic Continuous and High Interval Intensity Training (HIIT) on Vascular Inflammation Indices (ICAM-1, E-Selectin) in Sedentary Overweight Men. Journal of Applied Health Studies in Sport Physiology, 2019. 6(1): p. 53-59.

5. Mir Heidari, L., R. Souri, and A.A. Ravasi, Effect continuous training and soya supplement on the expression of the mir-29 gene in the heart of ovariectomized rats. Journal of Applied Health Studies in Sport Physiology, 2018. 5(2): p. 71-77.

6. de Souza Vieira, S., et al., Exercise training potentiates the cardioprotective effects of stem cells post-infarction. Heart, Lung and Circulation, 2019. 28(2): p. 263-271.

7. Waring, C.D., et al., The adult heart responds to increased workload with physiologic hypertrophy, cardiac stem cell activation, and new myocyte formation. European heart journal, 2014. 35(39): p. 2722-2731.

8.Biswas, J., et al., Indian spice curcumin may be an effective strategy to combat the genotoxicity of arsenic in Swiss albino mice. Asian Pac J Cancer Prev, 2010. 11(1): p. 239-47.

Resistance training and hawthorn extract ameliorate cognitive deficits in streptozotocin-induced diabetic rats

***Hamidreza Choobdari[1] , Ebrahim Zarrinkalam[2] , Kamal Ranjbar[3]**

[1]*Department of Exercise Physiology, Faculty of Sport Sciences, Bu Ali Sina University, Hamedan, Iran* hamiidreza1997choobdari@gmail.com

[2] Department of Physical Education and Spot Sciences , Hamedan Branch , Islamic Azad University , Hamedan , Iran Zarrinkalam@gmail.com

[3 2] Department of Physical Education and Spot Sciences , Bandar Abbas Branch , Islamic Azad University , Bandar Abbas , Iran Kamal_ranjbar2010@yahoo.com

Abstract

This study sought to explore the impact of resistance training and natural antioxidants on cognitive function in type 1 diabetic rats, given the documented cognitive impairment in diabetic rodent models. Fifty male Wistar rats were randomly assigned to five groups: Control (Con, n=10), Diabetic (D, n=10), Diabetic + Resistance training (DRT, n=10), Diabetic + Natural antioxidants (DHE, n=10), and Diabetic + Resistance training + Natural antioxidants (DRH, n=10).The resistance training regimen involved climbing a ladder for 5 days per week over 10 consecutive weeks. Natural antioxidants (administered at 100 mg/kg per day) were provided to the relevant groups for the same duration. Cognitive function was assessed using Morris Water Maze (MWM) and shuttle box tests, specifically evaluating spatial and passive avoidance learning and memory.The results revealed a notable 25% reduction ($P < 0.0001$) in the mean total escape latency in the DRH group compared to the D group in MWM. The D and DHE groups exhibited a 34% decrease in the percentage of time spent in the target quadrant compared to the Con group ($p = 0.001$). Additionally, time spent in the dark compartment (TDC) increased by 86% and 95% in the D and DHE groups compared to the Con group ($p < 0.05$), while the DRT and DRH groups showed an 88% decrease compared to the D group in the shuttle box test ($p < 0.05$).Furthermore, the study observed an increase in total antioxidant capacity and a decrease in lipid peroxidation in response to the treatments in diabetic rats. The findings suggest a synergistic amelioration of learning and memory deficits in type 1 diabetic rats through the reduction of oxidative stress by exercise training and natural antioxidants. Consequently, this study proposes a potential role for resistance training and natural antioxidants as adjuvant therapies for preventing and treating diabetic complications.

Introduction

The prevalence of diabetes mellitus, a pervasive chronic metabolic ailment, is projected to surpass 550 million by 2030, particularly escalating in developed nations(1). While diabetes is commonly associated with complications like macrovascular disease, retinopathy, and nephropathy, there is a growing recognition of diabetes-related cognitive disorders.Studies indicate that diabetes expedites mild cognitive impairment in elderly individuals, attributing cerebrovascular changes and neurodegeneration to the genesis and progression of diabetes-mediated cognitive dysfunction(2). Research reveals impairment in hippocampal neurogenesis, neuroplasticity, and dendrite remodeling, coupled with increased apoptosis, neuron degeneration, and oxidative stress in the hippocampus of diabetic rats.Despite numerous investigations into diabetes-mediated cognitive dysfunction, no specific treatments have emerged to prevent or alleviate learning and memory dysfunction. Nonetheless, a wealth of data underscores the therapeutic impact of exercise training on cognitive function (3) . While the molecular mechanisms remain unclear, endurance training has demonstrated efficacy in mitigating learning and memory deficits, yet the impact of resistance training on cognitive impairment in type 1 diabetes remains uncertain.Simultaneously, natural products and herbal extracts, such as Hawthorn, have gained recognition for their preventive and remedial potential in various diseases. Hawthorn, rich in oligomeric proanthocyanidins, flavonoids, and polyphenols, is renowned for its antioxidant and anti-inflammatory properties(4, 5). Traditionally used in cardiovascular diseases, Hawthorn's natural antioxidants combat oxidative stress, a primary factor in diabetes-related cognitive impairment(6, 7).The study aimed to conduct a preliminary investigation into the synergistic effects of resistance training and Hawthorn's natural antioxidants on impaired learning and memory function, as well as oxidative stress indices in type 1 diabetic rats. This exploration stems from the notable dearth of research on the impact of Hawthorn extract on cognitive deficits in diabetic individuals .

.**Method:**

Fifty male Wistar rats (6–8 week old and 193 ± 19 g) were housed in a room with controlled temperature (22 ± 2 °C), humidity (55 ± 5%), and light (8:00 AM. to 8:00 P.M.). Food and water were available ad libitum. Five rats were housed per cage and all rats were weighed once a week. Animals used in these experiments were treated in accordance with the Guide for the Care and Use of Laboratory Animals (1996, published by National Academy Press, 2101 Constitution Ave. NW, Washington, DC 20055, USA), and the study protocols were approved by the Institutional Animal Care and Use Committee at Hamadan University of Medical Sciences (Ethics committee approval number: ir.umsha.rec.1394.261).

Type 1 diabetes model was induced by repeated intraperitoneal injection of freshly prepared 60 mg/kg streptozotocin (7) .

Exercise training began 1 day after confirmation of diabetes. It was stipulated that the rats undergo 10 weeks (5 days per week) of progressive resistance training. The resistance training consisted of climbing a 1-m-high homemade ladder, inclined at 85°, twelve times. Initially, the rats gained familiarity with the ladder by climbing without weight for 3 days during the adaptation period. The initial weight attached to each animal's tail was 50% of its body weight, and was increased progressively up to 130% after 10 weeks (1st-2nd week: 50–60% of body weight; 3rd-5th week: 70–90% of body weight; 6th-8th week: 100–110% of body weight; 9th-10th week: 110–130% of body weight). Each training session consisted of 3 sets of 4 repetitions, with a 3 min rest between sets and 15 s rest between trials (8).

Extract preparation was done according to the reported method with slight modifications [16,21]. The berries of Hawthorn were collected from the Zagrous Mountains in West of Iran and identified at the Botanic Institute of this University(9, 10) .

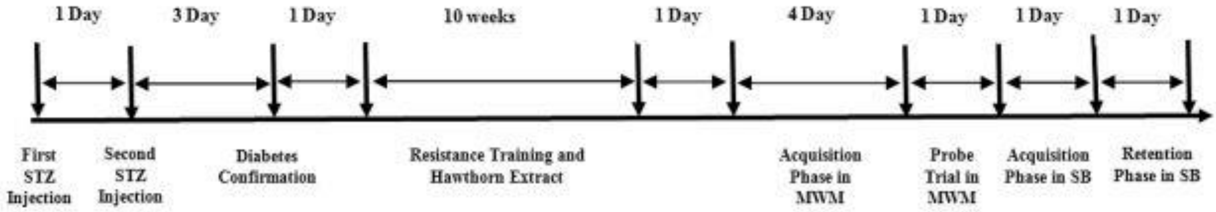
Rats were fasted for 12 h and fasting blood glucose levels were monitored and assessed from the tail vein with a glucometer (OneTouch Ultra, LifeScan, Johnson & Johnson Company, Milpitas, CA, USA) one day before (72 h after second STZ injection) and one day after treatments (10 weeks resistance training and natural antioxidants consumption) in accordance with the manufacturer's instructions. Furthermore, serum malondialdehyde (MDA) concentration assayed as a biomarker of lipid peroxidation. MDA was measured at 532 nm by spectrophotometer and MDA content was expressed as μmol/ml according to the method of Niehaus and Samuelsson [23]. Also, the total antioxidant capacity (TAC) of serum samples were assayed by commercially available kits (Randox labs, Grumlin, UK). For determining the dosage of hawthorn extract is safe, liver enzymes were measured. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are biomarkers for hepatocyte injury (11). ALT and AST were measured using a Roche kit according to the instructions of the company (Penzberg, Germany).

For measurement of spatial (acquisition and retention) and aversive (acquisition and retention) learning and memory after the training programs, we used Morris Water Maze (MWM) and shuttle box test, respectively, in type 1 diabetic rats 1 day after treatments.

2.6.1. Morris Water Maze Learning and spatial memory capability was done using a MWM device (12), including a circular pool (180 cm in diameter, 60 cm in height), black colored, filled to a depth of 25 cm with water at 22 ± 1 °C. Low light was used for illumination and the room was sound insulated.

One day after MWM, a number of animals were subjected to a passive avoidance learning (PAL) test using a shuttle box device to evaluate their performance in avoidance learning and memory. The device and process were basically in line with our previous works (13-15).

In order to analyze data, the SPSS statistical software version 16 was used. To determine whether or not the data were normal Kolmogrov–Smirnoff was used. Escape latencies related to Morris Water Maze test was analyzed through two ways ANOVA and then by LSD test for between-subjects differences and within effects across the blocks. Total mean escape latency and the probe trial data for percent of time spent in four sections and swimming speed were analyzed by ANOVA followed by Bonferroni Post hoc tests. For shuttle box test, overall group differences were analyzed using a one way ANOVA and Tukey test ($p < 0.05$). The data were expressed as mean ± standard error of the mean.



Results:

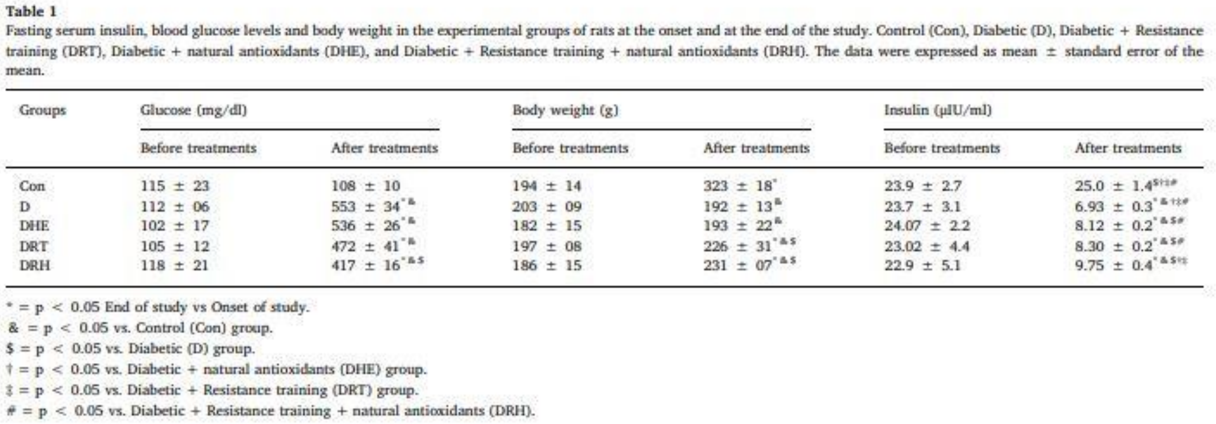


Table 1
Fasting serum insulin, blood glucose levels and body weight in the experimental groups of rats at the onset and at the end of the study. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). The data were expressed as mean ± standard error of the mean.

Groups	Glucose (mg/dl)		Body weight (g)		Insulin (μIU/ml)	
	Before treatments	After treatments	Before treatments	After treatments	Before treatments	After treatments
Con	115 ± 23	108 ± 10	194 ± 14	323 ± 18*	23.9 ± 2.7	25.0 ± 1.4$^{\$\dagger\ddagger\#}$
D	112 ± 06	553 ± 34$^{*\&}$	203 ± 09	192 ± 13$^{\&}$	23.7 ± 3.1	6.93 ± 0.3$^{*\&\dagger\ddagger\#}$
DHE	102 ± 17	536 ± 26$^{*\&}$	182 ± 15	193 ± 22$^{\&}$	24.07 ± 2.2	8.12 ± 0.2$^{*\&\$\#}$
DRT	105 ± 12	472 ± 41$^{*\&}$	197 ± 08	226 ± 31$^{*\&\$}$	23.02 ± 4.4	8.30 ± 0.2$^{*\&\$\#}$
DRH	118 ± 21	417 ± 16$^{*\&\$}$	186 ± 15	231 ± 07$^{*\&\$}$	22.9 ± 5.1	9.75 ± 0.4$^{*\&\$\dagger\ddagger}$

* = $p < 0.05$ End of study vs Onset of study.
& = $p < 0.05$ vs. Control (Con) group.
$ = $p < 0.05$ vs. Diabetic (D) group.
† = $p < 0.05$ vs. Diabetic + natural antioxidants (DHE) group.
‡ = $p < 0.05$ vs. Diabetic + Resistance training (DRT) group.
# = $p < 0.05$ vs. Diabetic + Resistance training + natural antioxidants (DRH).

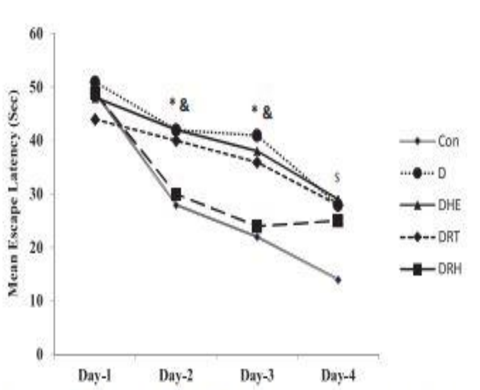


Fig. 2. The effect of resistance training and natural antioxidants on mean escape latency to find a hidden platform in the Morris Water Maze in type 1 diabetic rats. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.
* = P < 0.05, D, DHE, and DRT groups vs. Con group.
$ = P < 0.05, D, DHE, DRT, and DRH groups vs. Con group.
& = P < 0.05 D, DHE, and DRT groups vs. DRH group.

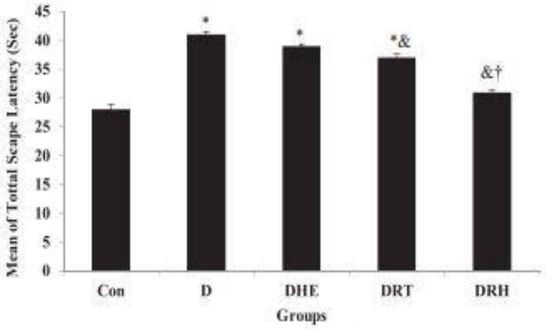


Fig. 3. The effect of resistance training and natural antioxidants on total average duration to find the hidden platform during the four days of training in the Morris Water Maze in type 1 diabetic rats. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.
* = P < 0.05, vs. Con group.
& = P < 0.05, vs. Diabetic (D) group.
† = P < 0.05, vs. DHE and DRT groups.

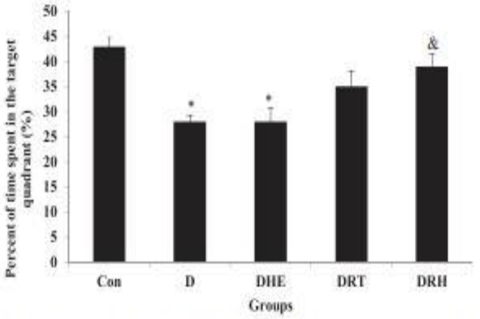


Fig. 4. The effect of resistance training and natural antioxidants on percentage of time spent in the target quadrant in the probe day in the Morris Water Maze in type 1 diabetic rats. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.
* = P < 0.05, vs. Con group.
& = P < 0.05, vs. Diabetic (D) and DHE groups.

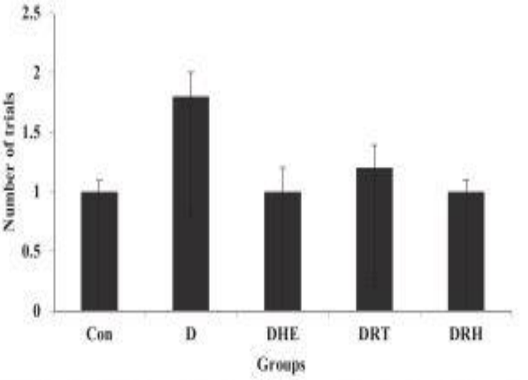


Fig. 5. Number of trials to reach learning in passive avoidance learning test in experimental groups. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.

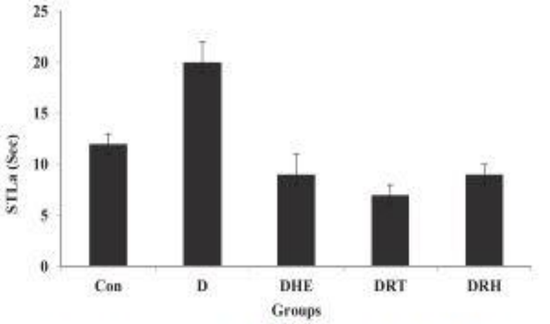


Fig. 6. The entrance latency to the dark section in acquisition phase (step-through latency, STLa) in passive avoidance learning test in experimental groups. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.

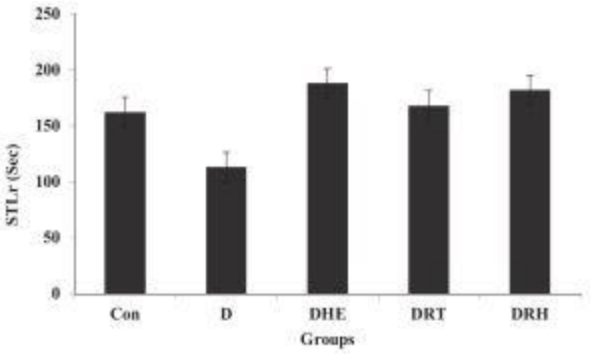


Fig. 7. The entrance latency to the dark section in retention phase (Step-Through Latency, STLr) in passive avoidance learning test in experimental groups. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.

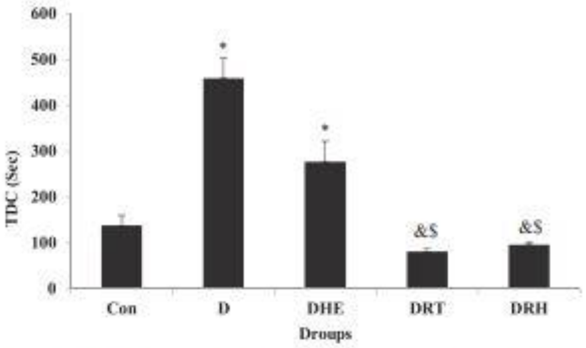


Fig. 8. Time spent in the dark section in the passive avoidance response in retention phase of passive avoidance learning test in experimental groups. Control (Con), Diabetic (D), Diabetic + Resistance training (DRT), Diabetic + natural antioxidants (DHE), and Diabetic + Resistance training + natural antioxidants (DRH). Data are expressed as mean ± SEM.
* = $P < 0.05$ vs. Control group.
& = $P < 0.05$ vs. D group.
$ = $P < 0.05$ vs. DHE group.

Conclusion: ll authors have assumed responsibility for data integrity and accuracy of the data analysis. Study concept and design: A.K., E.Z. Data acquisition: I.S., K.R., N.K., Data analysis and interpretation: E.Z., A. K., I. S. Drafting of the manuscript: A.K. Critical revision of the manuscript for important intellectual content: A.K. and I.S. Statistical analysis: K.R., E. Z., Study supervision: A. K., I. S..

Acknowledgments : Hereby, the authors state their thanks to the staff of Neurophysiology Research Center because of helping to this project. All authors contributed extensively to the work presented in this paper. This research was funded by Hamadan University of Medical Sciences, Hamadan, Iran.

Keywords : Type 1 diabetes , Learning and memory , Resistance training , Natural antioxidants , Stress oxidative

References:

1. Harries A, Satyanarayana S, Kumar A, Nagaraja S, Isaakidis P, Malhotra S, et al. Epidemiology and interaction of diabetes mellitus and tuberculosis and challenges for care: a review. 2013;3(1):3-9.
2. El Batsh MM, Manal M, Shafik NM, Younos IHJEJoP. Favorable effects of vildagliptin on metabolic and cognitive dysfunctions in streptozotocin-induced diabetic rats. 2015;769:297-305.
3. Xu W, Caracciolo B, Wang H-X, Winblad B, Bäckman L, Qiu C, et al. Accelerated progression from mild cognitive impairment to dementia in people with diabetes. 2010;59(11):2928-35.
4. Seto S, Yang G, Kiat H, Bensoussan A, Kwan Y, Chang DJIJoE. Diabetes mellitus, cognitive impairment, and traditional Chinese medicine. 2015;2015.
5. Ho N, Sommers MS, Lucki IJN, Reviews B. Effects of diabetes on hippocampal neurogenesis: links to cognition and depression. 2013;37(8):1346-62.
6. Voss MW, Vivar C, Kramer AF, van Praag HJTics. Bridging animal and human models of exercise-induced brain plasticity. 2013;17(10):525-44.
7. Won SJ, Yoo BH, Kauppinen TM, Choi BY, Kim JH, Jang BG, et al. Recurrent/moderate hypoglycemia induces hippocampal dendritic injury, microglial activation, and cognitive impairment in diabetic rats. 2012;9(1):1-12.
8. Philippe AG, Py G, Favier FB, Sanchez AM, Bonnieu A, Busso T, et al. Modeling the responses to resistance training in an animal experiment study. 2015;2015.

9. Ganji A, Salehi I, Sarihi A, Shahidi S, Komaki AJMbd. Effects of Hypericum Scabrum extract on anxiety and oxidative stress biomarkers in rats fed a long-term high-fat diet. 2017;32:503-11.
10. Elango C, Jayachandaran KS, Devaraj SNJIJoDN. Hawthorn extract reduces infarct volume and improves neurological score by reducing oxidative stress in rat brain following middle cerebral artery occlusion. 2009;27(8):799-803.
11. Ranjbar K, Nazem F, Sabrinezhad R, Nazari AJIhj. Aerobic training and L-arginine supplement attenuates myocardial infarction-induced kidney and liver injury in rats via reduced oxidative stress. 2018;70(4):538-43.
12. Lee Y, Oh SJJogr. Administration of red ginseng ameliorates memory decline in aged mice. 2015;39(3):250-6.
13. Zarrinkalam E, Heidarianpour A, Salehi I, Ranjbar K, Komaki AJLs. Effects of endurance, resistance, and concurrent exercise on learning and memory after morphine withdrawal in rats. 2016;157:19-24.
14. Moradkhani S, Salehi I, Abdolmaleki S, Komaki AJASol. Effect of Calendula officinalis hydroalcoholic extract on passive avoidance learning and memory in streptozotocin-induced diabetic rats. 2015;34(3):156.
15. Shiri M, Komaki A, Oryan S, Taheri M, Komaki H, Etaee FJCjop, et al. Effects of cannabinoid and vanilloid receptor agonists and their interaction on learning and memory in rats. 2017;95(4):382-7.

Response of eight weeks of selected Pilates training on lipid profile and fat percentage of women with non-alcoholic fatty liver disease in Ahvaz city

Sedigheh Kaabomeir*[1], Abdolhamid Habibi[2], Farzad Jassemi Zergani[3], Aliakbar Alizadeh[4], Masoumeh Hosseinzadeh[5]

[1*]Master of Sports Physiology, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran, s.kaabomeir1996@gmail.com

[2]Professor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran, 09161184888, hamidhabibi330@gmail.com

[3]Assistant Professor, Department of Gastroenterology and Hepatology, Jundishapur University of Ahvaz, Ahvaz, Iran, fjassemi49@yahoo.com

[4]Assistant Professor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran, Aliakbar.Alizadeh1984@gamil.com

[5] Instructor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran, m.hosseinzadeh@scu.ac.ir

Keywords: NAFLD, Pilates training, lipid profile, fat percentage

ABSTRACT

Non-Alcoholic Fatty Liver Disease (NAFLD) is the leading liver disease worldwide, with a 20-30% prevalence in the general population (1,2). The main mechanism that leads to non-alcoholic fatty liver is still not fully understood, but factors such as obesity, metabolic syndrome, lack of antioxidants in the body, genetics, unhealthy and sedentary lifestyle, and improper nutrition can be effective in the occurrence of this disease (3).

Lifestyle modification has been the cornerstone of NAFLD management, and exercise has been shown to be effective in its prevention. Pilates exercises, which have been the center of attention in recent years, are a comprehensive method of stretching and strengthening muscles, which are performed with the least possible damage, and by mental focus and emphasis on breathing rhythm, lead to the strengthening of deep muscles (4, 5).

Pilates exercises reduce visceral fat, oxidative stress, blood pressure and subsequently inflammatory cytokines through greater stimulation of the vagus nerve, and also increase insulin sensitivity and improve metabolic processes. In addition, Pilates exercises cause deep and diaphragmatic inhalation and exhalation during exercises and increase the energy level, so that in addition to active muscles,

respiratory muscles also consume energy. Deep and diaphragmatic breathing allows more oxygen delivery to the active muscles, which leads to increased insulin sensitivity as well as less insulin secretion demand. Pilates exercises can also cause further fat oxidation (6).

Methodology:

The present study was semi-experimental and applied. The statistical population of this research consisted of female patients suffering from non-alcoholic fatty liver disease with an age range of 30-55 years in Ahvaz, Iran. For this purpose, 20 voluntary women with non-alcoholic fatty liver disease at Fibroscan Department of Aria Hospital were selected to participate in the study.

First, the patients were briefed on the procedure of conducting the research. The personal information and health questionnaire were distributed among the volunteers. The participants were then randomly divided into Pilates training (n=10) and control (n=10) groups and after the implementation of the protocol, the results of the pre-test and post-test were examined and compared in the two groups .

The inclusion criteria covered patients with non-alcoholic fatty liver disease at an age range of 30-55 years with no cardiovascular, joint and skeletal diseases as well as no regular exercise in the last 6 months. The exclusion criteria included absence from more than two sessions and use of fat-lowering medication. According to the ethical principles of working with human samples, the subjects were told that they have the right to withdraw from the research whenever they wanted. Anthropometric measurements were taken before and after the end of eight weeks of intervention.

To measure the height and weight, a seca scale and stadiometer, made in Germany, were used. Harpenden caliper with 0.2 mm precision, made in England, was also used to measure the subcutaneous body fat. To measure the subcutaneous fat, Jackson et al.’s (1980) seven-point scale (including: breast, abdomen, triceps, supraclavicular, thigh, subscapular, armpit) (7) and to calculate the fat percentage the Siri equation (1950) (8) were used.

*7-point density formula (women) (g/mm):

$$=1.097- 0.00046971(\sum X7) + 0.00000056 ((\sum X7)^2 - 0.00012828 (Age)$$

where:

$\sum X7$= sum of 7 points

Then the fat percentage was obtained from the Siri equation:

$$Fat (\%) = [(4*95/density) -4.5] \times 100.$$

24 hours before the start of the protocol, the subjects attended the laboratory at 9:00 a.m. fasting for 12 hours, and 5 cc of blood was taken from the brachial vein with a syringe by the laboratory

technician to measure TC, TG, HDL, VLDL, and LDL. At the end of eight weeks and 48 hours after the end of the protocol, a blood test (like the pre-test) was taken from the subjects to determine the status again. Blood samples were separated by a centrifugal device. To this end, *Pars Azmoun* kits, made in Iran, and fully automatic machines (Cobas-MiRA-S) and (HITACHI 912) were used.

Training protocol

The training protocol comprised 60 minutes of Pilates training, including 10 minutes of warm-up, 40 minutes of basic movements, and 10 minutes of cooling down. Pilates training started with 8 repetitions in the first week and reached 12 repetitions following the overload principle.

The intensity of training was based on 55-80% of the maximum heart rate, so that it reached 55% of the maximum heart rate in the first four weeks and 80% of the maximum heart rate in the last four weeks (9). The training intensity was controlled with a heart rate monitor. It should be noted that the control group did not participate in the training activities.

Results:

The results of ANCOVA showed that Pilates training reduced TC, TG, LDL, VLDL, and fat percentage and increased HDL compared to the control group (Table 1).

Table 1: Pre-test and post-test lipid profile and fat percentage in the research groups

Variables	Group	Pre-test	Post-test	P Paired samples t-test	ANCOVA
BFP(%)	PG	29.82 ± 2.50	27.96 ± 2.04	0.001	0.001*
	CG	28.95 ± 3.05	29.30 ± 2.92	0.108	
TC(mg/dl)	PG	187.5 ± 14.17	174.4 ± 13.96	0.001	0.001*
	CG	180 ± 16.82	183.1 ± 17.91	0.104	
TG(mg/dl)	PG	223.1 ± 14.82	202.1 ± 15.08	0.001	0.001*
	CG	222.4 ± 12.86	226 ± 15.09	0.124	
HDL(mg/dl)	PG	38.5 ± 4.92	41.2 ± 4.46	0.001	0.001*
	CG	39.9 ± 3.47	38.7 ± 3.77	0.111	
LDL(mg/dl)	PG	129.8 ± 7.71	120.2 ± 9.81	0.001	0.001*
	CG	129.7 ± 6.41	132 ± 6.39	0.277	
VLDL(mg/dl)	PG	30.1 ± 6.57	28.6 ± 6.50	0.005	0.001*
	CG	35.36 ± 5.66	36.3 ± 5.16	0.090	

*$P<0.05$; Values are presented as mean ± SD. PG=Pilates Group; CG=Control Group; BFP (Body fat percentage, TC(Total cholesterol), TG(Triglyceride), HDL(High density lipoprotein),LDL(Low density lipoprotein), VLDL(Very Low density lipoprotein).

Acknowledgment: The authors would like to express appreciation for the support of the sponsors Shahid chamran university of Ahvaz.

References:

1. Loomba R, Friedman S. L., Shulman G. I. Mechanisms and disease consequences of nonalcoholic fatty liver disease. Cell,2021;184(10),2537–2564.
2. Mirhashemi SH, Hakakzadeh A, Yeganeh FE, Oshidari B, Rezaee SP. Effect of 8 Weeks milk thistle powder (silymarin extract) supplementation on fatty liver disease in patients candidates for bariatric surgery. Metabolism Open.2022;14:100190.[peasian]
3. Bahram M.E., Afroundeh R., Ghiyami Taklimi SH., Sadeghi A.,Gholamhosseini M. Effect of High-intensity Interval Training and Loquat Leaf Extract Consumption on Liver Enzymes in Obese Men With Non-alcoholic Fatty Liver Disease. Complementary Medicine Journal, 2021; 11(2), 102–115.
4. Khanna S, Wilkins J, Ning H, Allen NB, Lewis CE, Carr JJ, at al. Lipoprotein Levels in Early Adulthood and NAFLD in Midlife: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. Journal of Nutrition and Metabolism,2022; 2090-0724.
5. Keymasi Z, Sadeghi A, Pourrazi H. Effect of pilates training on hepatic fat content and liver enzymes in men with non-alcoholic fatty liver disease in Qazvin. Journal of Shahrekord University of Medical Sciences.2020;22(1):22-8.
6. Mir P, Mir Z. Effect of 8 weeks Pilates exercise on plasma visfatin and insulin resistance index in obese women. Nurs J Vulnerable. 2016;3:1- 12.[Persian]
7. Jackson A, Pollock M, Ward A. Generalisedvequations for predicting body density in women. In Medicine and Science in Sports and Exercise.1980; (178–182).
8. Siri WE. Body composition from fluid spaces and density: analysis of methods.1956; w-7405.
9. Lael rudi F,Younesian A, Razavianzadeh N, Raesi R. Examining Effects of Pilates Workout and Jujube Supplementation on Liver Fat Content, Enzymes, and Platelet Count. Archives of Advances in Biosciences.2022;13(2):1-13.

The effect of Aerobic Exercise and High-Fat Diet on serum Levels of Visfatin and chemerin in Male Wistar Rats

Adel Tizhoosh[1], Mansour khalilzadeh Kouchameshki[2], Shadi Fakhim[3], Mehri Ghahramani Dereshki*[4]

[1]*MSc of exercise physiology, Department of Exercise Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.* Adel.tizhoosh76@gmail.com

[2]*Assistant Prof, Department of Physical education and sports science, Salmas Branch, Islamic Azad University, Salmas, Iran.* Ma.khalilzadeh@iau.ac.ir

[3]*MSc of exercise physiology, Department of Exercise Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.* fakhimshadi@gmail.com

[4]*(Correspondence) Assistant Prof, Department of Exercise Physiology, Tabriz Branch, Islamic Azad University, Tabriz, Iran,* ghahramani_84@yahoo.com

Abstract

Introduction: The aim of this study is to investigate the effect of aerobic exercise and high-fat diet on visfatin and chemerin levels in male Wistar rats.

Methodology: This research was performed as an experimental study on 40 male rats with 25-days-old and an average weight of 225±25 g. Subjects were randomly divided into four groups: healthy control, high-fat diet, aerobic exercise and combined (aerobic exercise with high-fat diet). Aerobic training protocol was 4 weeks and three times a week, running on a treadmill with a speed of 50 cm/s and moderate intensity. The high-fat diet group was subjected to a high-fat diet for 30 days. 48 hours after the last training session, serum visfatin and chemerin levels were measured in all four groups. One-way ANOVA and Tukey's post hoc test were used to compare the means. The data was analyzed using SPSS version 22 software at a significance level of 0.05.

Results: According to ANOVA test and Tukey's post hoc test, high-fat diet increased visfatin ($p=0.012$) and serum chemerin ($p<0.0001$) levels and exercise decreased visfatin ($p=0.044$) and serum chemerin ($p<0.0001$) levels compared to the control group. but, the combined effect of exercise and diet did not have a significant difference in increasing the amount of Visfatin and serum chemerin. However, the effect of exercise compared to the high-fat and combined exercise and diet decreased the amount of visfatin and serum chemerin.

Conclusion: Aerobic exercise can significantly reduce serum visfatin and chemerin levels. However, if fat control diets are used along with aerobic exercises, the effect of the exercises will be higther.

Keywords: Aerobic exercise, High fat diet, Serum Chemerin, Visfatin, Male rat

Introduction: Obesity poses significant challenges to healthcare globally, because it substantially increases the risk of diseases such as type 2 diabetes mellitus, hypertension, fatty liver disease and stroke, thereby contributing to a decline in both the quality of life and life expectancy (1, 2).

Adipose tissue is considered as an endocrine organ that releases bioactive factors known as adipokines which play an important role in the spread of obesity and its disorders (3). Visfatin is an adipokine secreted from adipose tissue, which is related to body mass index and has an important role in energy and glucose homeostasis (4). Visfatin binds to the insulin receptor and mimics the effects of insulin and increases glucose tolerance and consumption (5, 6). Although it has been reported that visfatin levels decrease in obese people, most of the researches indicate that it increases in obesity and diabetes conditions (7). chemerin is another adipokine that is mainly expressed in adipose tissue, liver and kidney and plays a role in glucose and lipid homeostasis (8).

In various studies that have investigated the effect of aerobic exercise on Visfatin and chemerin, in some studies, the decrease of these adiponectins was significant, such as the decrease of visfatin levels in diabetic women, while the weight and fat mass did not differ significantly (9), and the decrease of visfatin and chemerin in overweight women (10), and in some studies, their increase was significant, such as the increase of chemerin levels in diabetic women, while there was no significant difference in weight and fat mass (9), and some studies also showed no significant change such as 12 weeks of aerobic exercise, which, despite a significant reduction in weight and BMI, had no significant change in visfatin serum levels in obese women (11).

Due to the contradictions in the research literature regarding the effects of exercise on the changes of adiponectins such as visfatin and chemerin, in this research the effect of aerobic exercise and high-fat diet on the levels of visfatin and chemerin in the serum of male Wistar rats has been investigated.

Materials and Methods: This research was performed as an experimental study on 40 male rats with 25-days-old and an average weight of 225±25 g. Subjects were randomly divided into four groups: healthy control, high-fat diet, aerobic exercise and combined (exercise+diet). Aerobic training protocol was 4 weeks and three times a week, running on a treadmill with moderate intensity, at a speed of 50 cm/s for 40 minutes. The high-fat diet group was subjected to a high-fat diet for 30 days. 48 hours after the last training session, serum visfatin and chemerin levels were measured in all groups.

One-way ANOVA and Tukey's post hoc test were used to compare the means. The data was analyzed using SPSS version 22 software at a significance level of 0.05.

Results: Based on the findings of this study, the results of the ANOVA test showed that there is a significant difference in visfatin (p=0.001) and serum chemerin (p<0.0001) between the four groups. Based on Tukey's post hoc test, four weeks of Aerobic exercise significantly decreased visfatin (p=0.044) and serum chemerin (p<0.0001) levels and high-fat diet increased

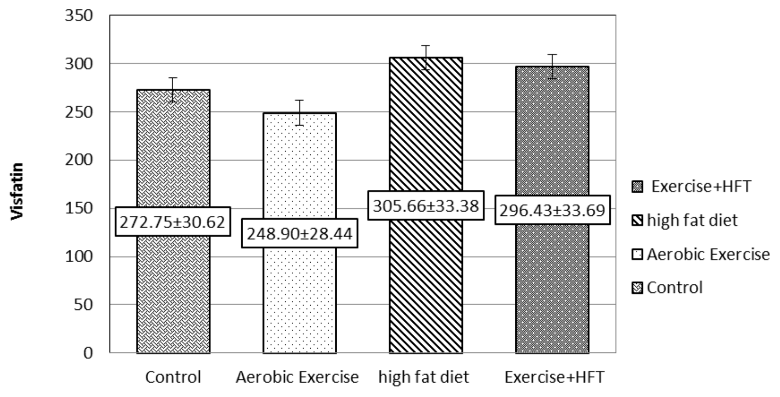


Figure1: Visfatin levels of male rats after intervention.

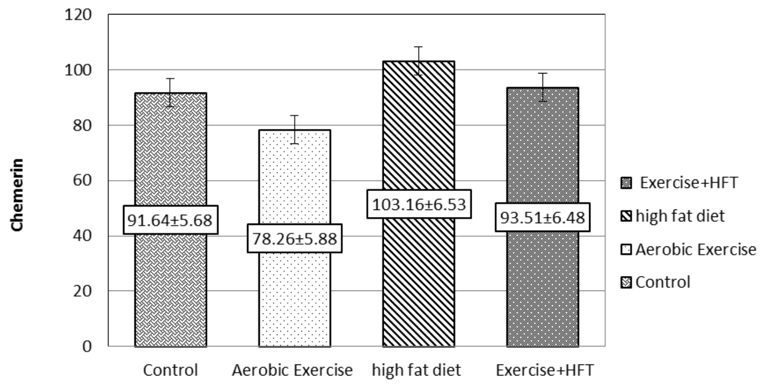


Figure2: Chemerin levels of male rats after intervention.

visfatin (p=0.012) and serum chemerin (p<0.0001) levels compared to the control group. but, the combined effect of exercise and diet did not have a significant difference in increasing the amount of Visfatin and serum chemerin (Figure 1,2).

Discussion: The results of the research indicated that aerobic exercise without the presence of a fatty diet has a significant effect on reducing visfatin and serum chemerin, but a high-fat diet significantly neutralized the effect of aerobic exercise on serum visfatin and chemerin.

Intake of excess calories and inactivity by disrupting the balance of lipogenic and lipolytic pathways leads to the accumulation of lipids. Regular exercise can partially moderate the harmful effects of high-fat diets. Based on traditional notions, people with sufficient physical activity do not have restrictions for high-fat diet, although these cases do not have a scientific basis, but, the results of the present study showed that if the fatty diet is restricted, the effect of exercise on the reduction of serum visfatin and chemerin will be greater. slow Aerobic exercise probably reduces serum visfatin and chemerin by reducing fat mass (12). The reason for the contradiction in some results obtained from different studies can be stated that the response of visfatin and chemerin to sports activity is different in healthy and sick subjects (13). Based on the review of studies and the results of this research, it can be concluded that the effectiveness of aerobic exercise needs more investigations to achieve more accurate results in this field.

Conclusion: The results of this study indicate that Aerobic exercise can significantly reduce serum visfatin and chemerin levels. However, if fat control diets are used along with aerobic exercises, the effect of the exercises will be higther.

Acknowledgment: By this means, I would like to thank the officials, respected professors as well as all those who provided the field for this study.

References:

[1] Shareef N, Abduljalal MH. Obesity, adipose tissue types and adipocytokines. Annals of the College of Medicine, Mosul. 2021;42(2):177-83.

[2] Blüher M. Obesity: global epidemiology and pathogenesis. Nature Reviews Endocrinology. 2019;15(5):288-98.

[3] Ali S, Alam R, Ahsan H, Khan S. Role of adipokines (omentin and visfatin) in coronary artery disease. Nutrition, metabolism and cardiovascular diseases. 2023;33(3):483-93.

[4] Körner A, Garten A, Blüher M, Tauscher R, Kratzsch Jr, Kiess W. Molecular characteristics of serum visfatin and differential detection by immunoassays. The Journal of Clinical Endocrinology & Metabolism. 2007;92(12):4783-91.

[5] Khoshkam F, Taghian F, Jalali Dehkordi K. Effect of eight weeks of supplementation of omega-3 supplementation and TRX training on visfatin and insulin resistance in women with polycystic ovary syndrome. The Iranian Journal of Obstetrics, Gynecology and Infertility. 2018;21(9):58-70.

[6] Sierawska O, Sawczuk M. Interaction between Selected Adipokines and Musculoskeletal and Cardiovascular Systems: A Review of Current Knowledge. International Journal of Molecular Sciences. 2023;24(24):17287.

[7] Sommer G, Garten A, Petzold S, Beck-Sickinger AG, Blüher M, Stumvoll M, et al. Visfatin/PBEF/Nampt: structure, regulation and potential function of a novel adipokine. Clinical Science. 2008;115(1):13-23.

[8] Bozaoglu K, Bolton K, McMillan J, Zimmet P, Jowett J, Collier G, et al. Chemerin is a novel adipokine associated with obesity and metabolic syndrome. Endocrinology. 2007;148(10):4687-94.

[9] Seifi L, Daryanoosh F, Samadi M. The effect of 12 weeks aerobic exercise training on visfatin, chemerin serum changes in 45-60 year old obese women with type2 diabetes. SSU_Journals. 2016;24(1):55-64.

[10] KhajehLandi M, Bolboli L, Bolbol S, Zabihi B. Effect of One Course Pilates Exercise Program on Serum Levels of Resistin, Visfatin, and Chemerin in Overweight Women. Internal Medicine Today. 2020;27(1):98-113.

[11] Taghian F, Zolfaghary M. The effects of acute endurance exercise on visfatin and insulin levels in obese women. 2014.

[12] Schultz S, Beck- Sickinger AG. Chemerin and vaspin: possible targets to treat obesity? ChemMedChem. 2013;8(4):549-59.

[13] Saremi A, Shavandi N, Parastesh M, Daneshmand H. Twelve-week aerobic training decreases chemerin level and improves cardiometabolic risk factors in overweight and obese men. Asian journal of sports medicine. 2010;1(3):151.

The effect of aerobic exercise of parent rats before pregnancy and activity of mother rats during pregnancy on BDNF and NGF Gene expression of hippocampus tissue of their female offsprings

Maryam Cheraghi 1, Akram Karimi Asl 2, Hamidreza Norouzi 3, Ahmad Rahmani 4

- 1.master of sport physiology, sports sciences, faculty of human sciences department, university of zangan, zangan, iran
- 2.assistant professor of sport sciences department, faculty of human sciences department, university of zangan, zangan, iran
- 3. Associate Professor of sport sciences department, faculty of human sciences department, university of zangan, zangan, iran

- **Introduction**: Pregnancy, as a natural period of every woman's life, is accompanied by many anatomical and physiological change (1). Researches show that pre-pregnancy and pregnancy periods are critical periods that affect the Embryonic programing and post-birth development. So that even during these periods, some favorable environmental interventions can change the incidence of various diseases in the following years of life with phenotypic changes in the children and have important consequences for the long-term health of the child (2, 3). Recent evidence shows that maternal exercise, as a positive intervention, can create manipulations on the offspring's genome in the womb environment and ultimately change the offspring's epigenome in rats (4). The most common epigenetic changes caused by exercise are histone modifications, which include methylation and acetylation, DNA methylation, and the expression of different types of microRNA (5). Some studies have shown that these environmental interventions can even affect the father's genome and some phenotypic changes, causing modifications in the genome of the next generations and causing changes in the growth and development of some body systems (6-8). Among these, the nervous system is among the tissues that are strongly influenced by internal and external factors during the embryonic period and even after that (9). New neurons are continuously generated in the dentate gyrus (DG) of the hippocampus of adult mammals, including humans. The hippocampus is one of the important areas of the brain that plays an important role in cognitive functions, spatial learning and memory (10-13). Considering the mentioned information, the present study examines the effect of aerobic exercise of parents before pregnancy and physical activity of mother during pregnancy on the expression of BDNF and NGF genes in the hippocampus tissue of their female children.

Methods:

- In order to carry out the present research, 48 female rats and 48 male rats aged 8 weeks were purchased from Razi Karaj Institute. Then male and female rats were randomly divided into 2 groups (control-exercise). Then, the male and female training groups performed increasing aerobic training (equivalent to 60-70% VO2max) for 6 weeks on an animal treadmill without any shock (Table one). After the training, the female mice of each group (control-exercise) were placed next to the male mice (control-exercise) for mating. After observing the first vaginal plaque, the pregnant mice were separated from the male mice and again divided into two training and non-training groups. The group of trained pregnant rats entered the aerobic exercise protocol (35-45% VO2max) for about 21 days (Table 2). After the end of the pregnancy period and the birth of children, after eight weeks, the children were anesthetized and their hippocampal tissue samples were isolated. The expression level of BDNF and NGF genes in hippocampal tissue was measured using real-time PCR method.
-

sixth week	fifth week	forth week	third week	Second week	first week	
30 minutes	30 minutes	30 minutes	20 minutes	20 minutes	10 minutes	The duration of the exercise
17-18	17-18	14-15	14-15	10	10	Treadmill speed (meters per minute)

- Table number one: Incremental aerobic exercise program

- Table number two: executive protocol during pregnancy

Results:

Third week of pregnancy	Second week of pregnancy	first week of pregnancy	
30 minutes	20 minutes	10 minutes	The duration of the exercise
12 meters per minute	11 meters per minute	10 meters per minute	treadmill speed

The data of this research was analyzed using one-way analysis of variance and Gabriel's post hoc test by SPSS version 26 software at a significance level of P≥0.05. The results of the present study showed that BDNF gene expression in the hippocampus tissue of female children in the group of father's aerobic exercise before pregnancy and mother's physical activity during pregnancy compared to the group of mother's physical activity during pregnancy (P=0.003), father's aerobic exercise group before pregnancy And the physical activity of the mother during pregnancy (P=0.001) and the aerobic exercise group of the father before pregnancy (P=0.015) increased significantly compared to the control group. Also, the expression of NGF gene in the hippocampus tissue of female children in the group of maternal aerobic exercise before pregnancy and maternal physical activity during pregnancy compared to the group of aerobic exercise of father and mother before pregnancy (P=0.004), the group of aerobic exercise of mother before pregnancy (P = 0.001), father's aerobic exercise group before pregnancy and mother's physical activity during pregnancy (P = 0.036), mother's physical activity group during pregnancy (P = 0.002) and father's aerobic exercise group before pregnancy (P = 0.003) P=0) had a significant increase.

Conclusion:

The results of the present study showed that the exercise of parents before pregnancy can activate the mechanisms that control the neural function during development and lead to the improvement of children's memory (14). It seems that parental exercise improves the metabolic status of the fetus and the next generations by creating epigenetic changes. So that the stability of epigenetic changes in children has been seen in human studies and up to 3 generations later in mice (۱۵). Therefore, it can be concluded that the exercise of mothers and fathers will have beneficial effects on the neurogenesis and neural connections of the CNS of their children, which can ultimately lead to the improvement of their memory and learning.

Keywords: BDNF, NGF, aerobic exercise, pregnancy

1. Mottola MF. Physical activity and maternal obesity: cardiovascular adaptations, exercise recommendations, and pregnancy outcomes. Nutrition reviews. 2013;71(suppl_1):S31-S6.
2. Fidalgo M, Falcao-Tebas F, Bento-Santos A, De Oliveira E, Nogueira-Neto JF, De Moura EG, et al. Programmed changes in the adult rat offspring caused by maternal protein restriction

during gestation and lactation are attenuated by maternal moderate–low physical training. British journal of nutrition. 2013;109(3):449-56.

3. Hopkins SA, Cutfield WS. Exercise in pregnancy: weighing up the long-term impact on the next generation. Exercise and sport sciences reviews. 2011;39(3):120-7.

4. Waterland RA, Jirtle RL. Transposable elements: targets for early nutritional effects on epigenetic gene regulation. Molecular and cellular biology. 2003;23(15):5293-300.

5. Ntanasis-Stathopoulos J, Tzanninis J, Philippou A, Koutsilieris M. Epigenetic regulation on gene expression induced by physical exercise. J Musculoskelet Neuronal Interact. 2013;13(2):133-46.

6. Wang JX, Furukawa H. Dissecting diverse functions of NMDA receptors by structural biology. Current opinion in structural biology. 2019;54:34-42.

7. Van Hall G, MacLean D, Saltin B, Wagenmakers A. Mechanisms of activation of muscle branched- chain alpha- keto acid dehydrogenase during exercise in man. The Journal of physiology. 1996;494(3):899-905.

8. Falcao-Tebas F, Bento-Santos A, Fidalgo MA, De Almeida MB, Dos Santos JA, De Souza SL, et al. Maternal low-protein diet-induced delayed reflex ontogeny is attenuated by moderate physical training during gestation in rats. British Journal of Nutrition. 2012;107(3):372-7.

9. Matthews SG. Antenatal glucocorticoids and programming of the developing CNS. Pediatric research. 2000;47(3):291-300.

10. Eriksson PS, Perfilieva E, Björk-Eriksson T, Alborn A-M, Nordborg C, Peterson DA, et al. Neurogenesis in the adult human hippocampus. Nature medicine. 1998;4(11):1313-7.

11. Gould E, Beylin A, Tanapat P, Reeves A, Shors TJ. Learning enhances adult neurogenesis in the hippocampal formation. Nature neuroscience. 1999;2(3):260-5.

12. Kempermann G, Kuhn HG, Gage FH. Experience-induced neurogenesis in the senescent dentate gyrus. Journal of Neuroscience. 1998;18(9):3206-12.

13. Van Praag H, Christie BR, Sejnowski TJ, Gage FH. Running enhances neurogenesis, learning, and long-term potentiation in mice. Proceedings of the National Academy of Sciences. 1999;96(23):13427-31.

14. Gomes da Silva S, De Almeida AA, Fernandes J, Lopim GM, Cabral FR, Scerni DA, et al. Maternal exercise during pregnancy increases BDNF levels and cell numbers in the hippocampal formation but not in the cerebral cortex of adult rat offspring. PLoS One. 2016;11(1):e0147200.

15. Arzo Karimi In the soleus muscle of the first generation offspring of ppar alpha male rats, a study of a period of intense maternal intermittent training on gene expression and its effect, Kharazmi University; 2019.

The effect of aerobic exercise on QUICKI, McAuley's, HOMA-IR as insulin sensitivity indices, lipid profile and body composition in men with metabolic syndrome

Dr. Bahloul Ghorbanian* [1]- Ayda Ghorbanian [2]

[1.] Department of Sports Sciences, Faculty of Educational Sciences and Psychology, Azarbaijan Shahid Madani University, Tabriz, Iran. Corresponding author's email: b.gorbanian@gmail.com
[2.] Bachelor's student, Faculty of Physical Education, Tabriz University, Tabriz, Iran
Email: ghorbanianayda1@gmal.com

Abstract

Introduction: Metabolic syndrome is a condition in which the affected person experiences symptoms such as obesity, high blood fat, hyperglycemia, and hypertension. One of the most important characteristics of metabolic syndrome is abdominal obesity and insulin resistance. Therefore, the prevention of metabolic syndrome and the control of the condition of diabetes have common treatment points [1]. Insulin resistance along with type 2 diabetes has a very high correlation with obesity, so the accumulation of triglycerides in insulin-sensitive tissue is assumed to be one of the causes of insulin signal disorder [2]. It has been shown that the increase in fasting fatty acid concentration as well as the accumulation of triglycerides in the muscle is a predictor of insulin resistance in the human body. In type 2 diabetes, an increase in fasting plasma fatty acids has been observed with insulin resistance [3]. Insulin sensitivity can be assessed indirectly through valid indices calculated using insulin and blood glucose levels [4,5]. These indices include Homeostasis model assessment of insulin resistance (HOMA-IR) [4], Matsuda insulin sensitivity index (MISI) [5], quantitative insulin sensitivity check index (QUICKI) [6] and McAuley index [7]. On the other hand, studies have shown that aerobic exercise and leisure time physical activities can help reduce metabolic syndrome in people and the elderly. Exercise is considered as an important factor for controlling obesity, metabolic syndrome and insulin resistance. Also, physical activity increases the density of glucose receptors (GLUT-4), the activity of mitochondrial enzymes, the activity of glycogen synthase, increases angiogenesis and mitochondrial density. In fact, these effects help to improve insulin sensitivity [8]. Therefore, the aim of this study was to investigate the effect of 12 weeks of aerobic exercise on insulin sensitivity indices and body composition of men with metabolic syndrome.

Methods: In this semi-experimental study, 20 men with metabolic syndrome with an age range of 40 to 60 years were selected and randomly divided into two groups: control (n=10) and aerobic training (n=10). The exercise protocol included aerobic exercise for 12 weeks with a sequence of 3 sessions per week and each session lasted 45 minutes with an intensity of 60-70% of maximum heart rate. The variables were measured before and after the exercise intervention. The criteria for entering the study was defined by the presence of three or more of the following criteria: elevated WC (≥102 cm for men, ≥88 cm for women); elevated fasting triacylglycerol (≥150 mg/dL); reduced HDL (<40 mg/dL for men, <50 mg/dL for women); elevated BP (≥130 mmHg systolic BP [SBP], ≥85 mmHg diastolic BP, or drug treatment for hypertension); and elevated fasting blood glucose (≥100 mg/dL) [9]. To evaluate the subjects' metabolic syndrome, the Z score values were estimated for all subjects according to the following formula [10].

$$Zmets = [(40-HDL)/5.89] + [(Triglyceride-150)/41.11] + [(Fasting\ blood\ sugar-110)/15.82] + [(Waist\ circumference-5.91)/9.46] + [(mean\ arterial\ pressure - 100)/6.65]$$

Also, insulin sensitivity indices were estimated based on the values of fasting glucose, fasting insulin and fasting triglyceride according to the following formulas [11].

$$HOMA\text{-}IR = fasting\ insulin\ (microU/L) \times fasting\ glucose\ (nmol/L)/22.5.$$

$$QUICKI = 1 / [\log (fasting\ insulin\ in\ mU/ml) + \log (fasting\ glucose\ in\ mg/dl)]$$

$$McAuley's\ index = \exp [2.63 - 0.28 \ln (fasting\ insulin\ in\ mU/l) - 0.31 \ln (fasting\ triglycerides\ in\ mmol/l)]$$

The data were analyzed using the correlated t-test and ANCOVA.

Results

The results of the dependent t-test showed that in the training group, in the post-test compared to the pre-test, there was a significant difference in the averages of all variables ($p \leq 0.05$). Also, the results of analysis of ANCOVA test showed that in the post-test the values of insulin sensitivity indices: HOMA-IR ($p=0.001$), McAuley's index ($p=0.001$), QUICKI ($p=0.001$) and Metabolic Z ($p=0.004$), triglyceride ($p=0.001$), body fat percentage ($p=0.012$), body mass index ($p=0.05$) and waist size ($p=0.047$) p) and maximum oxygen consumption ($p=0.041$) was significant.(table1)

Table (1): The mean values of the variables of the two groups before and after the exercise intervention (results of correlated t-test and ANCOVA)

Group / Variable	Control group (n=10)		Exercise group (n=10)		t-test	ANCOVA
	Pre-test	Post-test	Pre-test	Post-test	sig	sig
body weight (kg)	93.90±4.95	93.80 ± 4.70	96.00±5.63	90.00±4.73	*0.001	0.57
fat %	32.54±2.12	32.79±1.76	32.58±1.65	29.86±1.70	*0.001	**0.012
BMI (kg/m^2)	30.79±1.47	30.69±1.27	31.32 ± 1.11	29.38±0.98	*0.001	**0.05
WC (cm)	101.10±2.55	101.20±2.09	101.80±1.98	98.40±2.22	*0.001	**0.047
VO2max (ml.kg.min)	27.47±2.15	28.06±1.37	28.57 ± 2.23	32.79±1.86	*0.011	**0.041
Insulin (mU/L)	10.86±0.56	10.92±0.55	10.75±0.58	9.26 ± 1.14	**0.030	0.54
FG (mg/dl)	122.70±5.85	122.80±4.51	124.20±5.49	120.10±5.58	**0.047	0.87
TG (mg/dl)	251.80±13.63	252.20±11.98	243.30±12.14	234.30±17.32	*0.002	**0.01
TC (mg/dl)	240.90±5.80	240/50±4/40	238.40±11.77	231.50±11.53	*0.001	0.402

HDL (mg/dL)	34.90±4.04	35.80±2.44	35.00 ± 3.82	38.20±2.57	*0.001	0.137
LDL (mg/dL)	150.8±10/23	158.70±7.16	157.70±8.16	147.00±10.45	*0.001	0.103
SBP (mmhg)	135.70±3.77	136.40±3.27	138.80±2.52	133.70±2.05	*0.01	0.97
DBP (mmhg)	85.90±2.68	85.60±1.95	86.70±3.40	84.30±1.82	*0.011	0.47
HOMA-IR	3.29±0.29	3.31±0.23	3.30±0.26	2.74±0.32	*0.001	**0.003
QUICK	0.32±0.004	0.31±0.003	0.32±0.003	0.32±0.005	*0.001	**0.001
McAuley's index	1.28±0.02	1.27±0.02	1.30±0.02	1.37±0.06	*0.002	**0.001
Met Z score	5.53 ± 1.23	5.41±0.56	5.71±1.00	3.91±0.77	*0.001	**0.004

*: intra-group difference, **: inter-group difference; ($p \leq 0.05$)

Conclusion

The result of this study showed that 12 weeks of aerobic exercise had favorable effects on insulin sensitivity indices, lipid profile and body composition of men with metabolic syndrome. Therefore, it seems that aerobic exercise as a non-pharmacological method is one of the best factors for controlling metabolic syndrome, especially controlling glucose metabolism and improving body composition in metabolic syndrome patients.

Acknowledgment: The authors would like to thank the participation of the men in this study.

References:

[1]. Huang PL. A comprehensive definition for metabolic syndrome. Disease models & mechanisms. 2009 Apr 30;2(5-6):231-7.

[2]. Douen AG, Ramlal T, Rastogi S, Bilan PJ, Cartee GD, Vranic M, Holloszy JO, Klip A. Exercise induces recruitment of the “insulin-responsive glucose transporter”. Evidence for distinct intracellular insulin-and exercise-recruitable transporter pools in skeletal muscle. Journal of Biological Chemistry. 1990 Aug 15;265(23):13427-30.

[3]. Irwin ML, Varma K, Alvarez-Reeves M, Cadmus L, Wiley A, Chung GG, DiPietro L, Mayne ST, Yu H. Randomized controlled trial of aerobic exercise on insulin and insulin-like growth factors in breast cancer survivors: the Yale Exercise and Survivorship study. Cancer Epidemiology Biomarkers & Prevention. 2009 Jan;18(1):306-13.

[4]. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia. 1985.

[5]. Matsuda M, DeFronzo RA. Insulin sensitivity indices obtained from oral glucose tolerance testing: comparison with the euglycemic insulin clamp. Diabetes Care. 1999. Sep;22(9):1462–1470

[6]. Katz A, Nambi SS, Mather K, Baron AD, Follmann DA, Sullivan G, et al. Quantitative insulin sensitivity check index: a simple, accurate method for assessing insulin sensitivity in humans. J Clin Endocrinol Metab. 2000. Jul;85(7):2402–2410.

[7]. McAuley KA, Williams SM, Mann JI, Walker RJ, Lewis-Barned NJ, Temple LA, et al. Diagnosing insulin resistance in the general population. Diabetes Care. 2001. Mar;24(3):460–464.

[8]. Mišigoj-Duraković, M. and Z. Duraković, The early prevention of metabolic syndrome by physical exercise. Collegium anthropological, 2009. 33(3): p. 759-764.

[9]. Tapking C, Popp D, Herndon DN, et al. (2018) Estimated versus achieved maximal oxygen consumption in severely burned children maximal oxygen consumption in burned children. Burns 44, 2026–2033.

[10]. Grundy SM, Cleeman JI, Daniels SR, et al..; American Heart Association; National Heart, Lung, and Blood Institute. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation* 2005; 112:2735–2752

[11]. Taghian F, Nikbakht H, Karbasian A. The effect of an aerobic exercise course on plasma leptin levels in obese women. Sport Sci. 2015; 4(1):1-10.

The Effect Of Aerobic Training Before Pregnancy And Physical Activity During Pregnancy On The Expression Of BDNF And NGF Genes In The Hippocampus Tissue Of Maternal Rats After The Birth Of Offspring

Marzieh Arablou[1], Akram Karimi Asl[2], Hamidreza Norouzi[3], Ahmad Rahmani[3]

[1] - Master's Degree in Sports Physiology, Department of Sports Sciences, Faculty of Humanities, Zanjan University, Zanjan, Iran
[2]- Assistant Professor of Department of Sports Sciences, Faculty of Humanities, Zanjan University, Zanjan, Iran

[3] - Associate professor of Department of Sports Sciences, Faculty of Humanities, Zanjan University, Zanjan, Iran

Introduction

Pregnancy has a significant impact on women's health and hygiene, and even future generations, and is considered one of the important indicators of national health. On the other hand, pregnancy is a very complex physiological process that can affect different systems (1) (2). The review of various research shows that some physiological changes and psychological factors such as reduced movement, stress, and anxiety during pregnancy can lead to a decrease in the memory of mothers after childbirth (3) (4). This is while during pregnancy and even before, many factors such as proper nutrition and physical activity can have a decisive role on the physical and mental health of mothers after childbirth (5). Sports training has been accepted as a behavioral strategy to increase public health, including mental performance (6). The brain is an organ with high adaptability in morphological, metabolic, and functional response to training. Recent studies indicate the beneficial effects of sports activity on brain structure and cognitive function by improving the level of neurotrophins. Neurotrophins prevent memory impairment and improve cognitive function by facilitating neural growth and function and increasing cortical plasticity. (7). Nerve growth factor (NGF) is involved in biological functions such as neuron protection, plasticity, neuron regeneration, and memory improvement, and its secretion is affected by regular aerobic training (8). Also, sports activity can be effective on synaptic plasticity by influencing the expression of the brain-derived nutritional factor (BDNF) gene. BDNF is a neurodevelopmental factor that plays a regulatory role in neuronal differentiation, synaptic plasticity, and cell death processes. The distribution of BDNF has been reported in different brain regions and at a high level in the hippocampus, which is the main pole of memory and learning [13]. Therefore, according to the mentioned materials, the present research was conducted to investigate the effect of aerobic training before pregnancy and physical activity during pregnancy on NGF and BDNF gene expression in the hippocampal tissue of maternal rats after the birth of offspring.

Materials and methods

For this research, 48 female rats and 48 male rats aged 8 weeks were purchased. Then male and female rats were randomly divided into 2 groups (control-training). Then, the male and female training groups performed increasing aerobic training (equivalent to 60-70% VO2 max) for 6 weeks on an animal treadmill without any shock (Table 1). After the training, the female rats of each group (control- training) were placed next to the male rats (control- training) for mating. After observing

---

[3] - Associate professor of Department of Sports Sciences, Faculty of Humanities, Zanjan University, Zanjan, Iran

the first vaginal plaque, pregnant rats were separated from male rats and again divided into two training and non-training groups. The group of trained pregnant rats entered the aerobic training protocol (35-45% VO2 max) for about 21 days (Table 2). After the end of the pregnancy period and the birth of the children, after 21 days, the babies were weaned, and the mother rats were anesthetized to prepare tissue samples, and their hippocampal tissue was isolated. BDNF and NGF gene expression was measured using a real-time PCR method.

Table 1: Incremental aerobic training program

	1st week	2nd week	3rd week	4th week	5th week	6th week
Duration of the training	10 min	20 min	20 min	30 min	30 min	30 min
Treadmill speed (meters per minute)	10	10	14-15	14-15	17-18	17-18

Table 2: Executive protocol during pregnancy

	1st week of pregnancy	2nd week of pregnancy	3rd week of pregnancy
Duration of the training	10 min	20 min	30 min
Treadmill speed	10 m/min	11 m/min	12 m/min

Findings

The data of this research was analyzed using a one-way analysis of variance and Gabriel's post hoc test by SPSS version 26 software at a significance level of $P \geq 0.05$. The results of the present study showed that BDNF gene expression in the group of aerobic training before pregnancy and physical activity during pregnancy increased significantly compared to the groups of aerobic training before pregnancy and without physical activity during pregnancy and the control group ($P = 0.028$, $P = 0.003$). Also, the expression of NGF gene in groups of aerobic training before pregnancy and physical activity during pregnancy and groups of aerobic training before pregnancy and without physical activity during pregnancy had a significant increase compared to the two groups of physical activity during pregnancy and the control group ($P=0.002$, $P=0.001$).

Conclusion

In this research, we concluded that the aerobic training of the mother before pregnancy and the physical activity of the mother during pregnancy led to a significant increase in BDNF in the hippocampal tissue. Research showed that the increase in BDNF production resulting from training increases nerve survival and resistance to brain damage, development of cerebral vessels, stimulation of neurogenesis, and improvement of learning and cognitive function(9).

BDNF is one of the neurotrophins that seems to be one of the most important mediators of the effects of sports activity on the brain, especially cognition (10). Several studies support the idea that BDNF has a dominant role in mediating the effects of training on the brain; However, the mechanisms involved in the increase in BDNF levels induced by muscle activity during training are not clear. It is possible that sports activity increases the levels of other factors that are secreted from the muscles in the bloodstream and they cross the blood-brain barrier, then stimulate the increase in BDNF production in the brain (11).

The results of the present research indicated that aerobic trainings before pregnancy affected NGF so it showed a significant increase in the aerobic training and physical activity groups and the aerobic training group compared to the other two groups. It has been found that NGF plays an important role in the survival and growth of nerve cells and in stopping apoptotic cell death. Also, it is possible that increasing NGF levels in the hippocampus may help improve memory capacity (12). NGF exerts its major effects through the TrkA receptor, and acts as a mediator of inflammatory pain and leads to sensitization of the central and peripheral nervous system (13). It seems that aerobic training can be effective in the production of NGF by increasing the energy available to nerve cells, maturing NGF precursors and increasing the expression of tyrosine kinase A, which is an active receptor for NGF (14).

Keywords: BDNF, NGF, Aerobic Training, Pregnancy

References:

1. Mottola MF. Physical activity and maternal obesity: cardiovascular adaptations, training recommendations, and pregnancy outcomes. Nutrition reviews. 2013;71(suppl_1):S31-S6.
2. Stuebe AM, Oken E, Gillman MW. Associations of diet and physical activity during pregnancy with risk for excessive gestational weight gain. American journal of obstetrics and gynecology. 2009;201(1):58. e1-. e8.
3. Kim K, Chung E, Kim C-J, Lee S. Swimming training during pregnancy alleviates pregnancy-associated long-term memory impairment. Physiology & behavior. 2012;107(1):82-6.
4. Jafari Z, Mehla J, Kolb BE, Mohajerani MH. Prenatal noise stress impairs HPA axis and cognitive performance in mice. Scientific reports. 2017;7(1):10560.
5. Jukic AMZ, Lawlor DA, Juhl M, Owe KM, Lewis B, Liu J, et al. Physical activity during pregnancy and language development in the offspring. Paediatric and perinatal epidemiology. 2013;27(3):283-93.
6. Erickson KI, Gildengers AG, Butters MA. Physical activity and brain plasticity in late adulthood. Dialogues in clinical neuroscience. 2022.
7. Haakstad LA, Bø K. Effect of regular training on prevention of excessive weight gain in pregnancy: a randomised controlled trial. The European Journal of Contraception & Reproductive Health Care. 2011;16(2):116-25.
8. Sadeghi A, SIRATI NM, Hajiamini Z, Ebadi A, Naderi Z, MEHDIZADEH S. The effect of training on level of general health of pregnant women referred to a prenatal-care-clinic of Baghiatallah hospital. 2012.
9. Adlard P, Cotman C. Voluntary training protects against stress-induced decreases in brain-derived neurotrophic factor protein expression. Neuroscience. 2004;124(4):985-92.

10. Loprinzi PD, Frith E. A brief primer on the mediational role of BDNF in the training-memory link. Clinical physiology and functional imaging. 2019;39(1):9-14.

11. Matthews VB, Åström M-B, Chan M, Bruce CR, Krabbe K, Prelovsek O, et al. Brain-derived neurotrophic factor is produced by skeletal muscle cells in response to contraction and enhances fat oxidation via activation of AMP-activated protein kinase. Diabetologia. 2009;52(7):1409-18.

12. Chae C-H, Kim H-T. Forced, moderate-intensity treadmill training suppresses apoptosis by increasing the level of NGF and stimulating phosphatidylinositol 3-kinase signaling in the hippocampus of induced aging rats. Neurochemistry international. 2009;55(4):208-13.

13. Levi-Montalcini R, Dal Toso R, della Valle F, Skaper SD, Leon A. Update of the NGF saga. Journal of the neurological sciences. 1995;130(2):119-27.

14. Chae C-H, Lee H-C, Jung S-L, Kim T-W, Kim J-H, Kim N-J, et al. RETRACTED: Swimming training increases the level of nerve growth factor and stimulates neurogenesis in adult rat hippocampus. Elsevier; 2012.

The Effect of Concurrent Exercises with Electrical Stimulation on the Serum Levels of |Calcium and Vitamin D in Women with Osteopenia

Atena Attaran Miandoab [1] Azam Zarneshan [2] Azizeh Farshbaf Khalili [3]

[1] M.Sc. student of Sport Physiology, Department of Sport Physiology, Azarbaijan Shahid Madani University, Tabriz, Iran, atiattaran@gmail.com
[2] Associate Professor, Department of Sport Physiology, Azarbaijan Shahid Madani University, Tabriz, Iran, zarneshan@azaruniv.ac.ir
[3] Assistant Professor, Department of Nutritional Sciences, Physical Medicine and Rehabilitation Research Center, Tabriz University of Medical Sciences, Tabriz, Iran, azizeh_farshbafkhalili@yahoo.com

Abstract

Introduction: Osteopenia is a bone metabolic disorder that is related to factors such as low physical activity, diet quality, and insufficient intake of calcium and vitamin D. The present study was conducted with the aim of investigating the effect of combined exercise along with functional electrical stimulation on serum levels of calcium and vitamin D in postmenopausal women with osteopenia.

Method: In this experimental study, 45 women with osteopenia (-1 < T-score <-2.5), with an average age of 61.25±4.1 years, were randomly selected and divided into 3 groups: exercise (ME), exercise + electrical stimulation (ME+ ES) and control The ME and ME+ES groups participated in combined aerobic (40-70% HRR) and resistance training for 12 weeks, 3 days a week, 90 minutes per session. The ME+ES group received electrical stimulation with a two-channel STIMULATOR 620 P (NOVIN) device, type Fes, during 12 sessions, for 15 minutes, with a frequency of 45 Hz, a pulse of 300 microseconds, to the paraspinal area. Statistical analysis of the data was performed using ANOVA and Tukey's post hoc test (at the significance level of $P<0.05$).

Results: The results showed that after 12 weeks of the research protocol, the level of Ca did not change significantly in the groups ($P>0.05$). While serum levels of D_3 increased significantly in both intervention groups (EX and EX+ES) compared to the control group ($p=0.002$).

Conclusion: Using combined exercise alone and with electrical stimulation can be useful in improving vitamin D levels and preventing osteoporosis in women with osteopenia. Meanwhile, electrical stimulation did not have a synergistic effect in improving D_3 levels, and future studies using electrical stimulation with greater intensity and duration are needed.

Keywords: Concurrent Exercises, Electrical Stimulation, calcium, Vitamin D_3, Osteopenia

Osteopenia (OS) is a bone metabolic disorder that occurs before osteoporosis (OP) and increases with age and menopause [1]. Osteoporosis can be the result of lack of calcium or other minerals in the bones [2]. Vitamin (D_3) plays an important role in maintaining the skeleton, minerals, strength and mass of skeletal muscles through the regulation of calcium and phosphate homeostasis [3].

The primary treatment approach for osteoporosis management and fracture prevention is medication. Some people do not respond to osteoporosis drugs, suffer fractures or continuous loss of bone mass over time, and on the other hand, adherence to the use of these drugs decreases over time. Therefore, exercise is only considered as an auxiliary strategy to prevent fractures caused by osteoporosis [4]. Also, a rich body of research background on electrical stimulation supports the idea that electrical stimulation technologies can be used clinically as an effective adjunctive therapy for fracture healing, rehabilitation, improvement of quality of life and prevention of osteopenia. [5, 6]. It seems that the investigation and the positive role of electrical stimulation on Ca and D_3 has been given less attention, so the present study was conducted with the aim of investigating of investigating the effect of combined exercise along with functional electrical stimulation on serum levels of calcium and vitamin D3 in postmenopausal women with osteopenia.

In this semi-experimental study, among 500 women with osteopenia, members of the Rehabilitation Center of Imam Reza Hospital, Tabriz, 45 elderly women with osteopenia were selected as a sample and randomly divided into three groups: EX combined exercise, combined exercise + electrical stimulation (EX+ ES) and control. The inclusion criteria were: Hip and lumbar spine BMD -1 < T-score <-2.5, age 55 to 65 years, menopause history of at least two years. Exclusion criteria included: failure to regularly implement the exercise protocol or voluntary withdrawal from the research process, changing diet or medication. Combination exercises including aerobic exercises (aerobics, step and trampoline (40-70% HRR) and resistance exercises with stretch Pilates and body weight) were performed 3 days a week for 60-90 minutes in each session. The ME+ES group received electrical stimulation with a two-channel STIMULATOR 620 P device (NOVIN), in the form of functional electrical stimulation (Fes), 12 sessions, for 15 minutes, with a frequency of 45 Hz, a pulse of 300 microseconds to the paraspinal area. Calcium was measured using a Calorimetry test with fummetric single-point measurement in the range of 1-20 mg/dL, and if it was more than 20 mg/dL, the sample was multiplied by 4 with dilute serum and the test result was multiplied by 5 with the Arsenazo III test kit, of Delta Darman company, and D3 was measured using the 25(OH)D vitamin D Pishghaman kit of Pars company with the ELISA method.

To compare the variables between the three groups, the percentage of changes was compared with the help of one-way analysis of variance and Tukey's post hoc test. P<0.05 was considered significant level

Table 1. Comparison of calcium and vitamin D between groups.

Heading	Group	Pre test	Post test	p-value$^{£}$	p-value*
Ca (mg/dl)	ES+EX(1)	9.28±0.4	9.39±0.22	P [3,1] =0.36	0.39
	EX(2)	9.39±0.27	9.41±0.20	P [3,2] =0.8	
	Control(3)	9.15±0.21	9.11±0.31	P [2,1] =0.71	
D_3	ES+EX(1)	41.8±7.6	49.91±16.6	P [3,1] =0.002$^{£}$	0.002*
	EX(2)	43.8±2.67	48.88±3.63	P [3,2] =0.02$^{£}$	

(ng/ml)	Control(3)	41.92±8.17	39.26±7.46	P [2,1] =0.53

p-value*: Difference between groups based on ANOVA test is significant at $p \geq 0.05$ level**.**
p-value$^{£}$ **:** Difference between groups based on Tukey's post hoc test.

According to the results of Table 1. After 12 weeks of the research protocol, the amount of Ca showed no significant difference between the groups ($P<0.05$). While serum levels of D3 increased significantly in both EX and EX+ES intervention groups compared to the control group ($p=0.002$).

The results of the present study showed that 12 weeks of combined training alone and with electrical stimulation increased serum D3 levels. Exercise has been widely recognized as a critical physical stimulus for the development and maintenance of optimal bone strength throughout life [5]. The effect of aerobic and strength training in significantly increasing vitamin D levels has been reported by previous studies. Vitamin D has a positive effect on bone regeneration [7]. Bell et al. (2020) reported the effect of resistance training on a significant increase in serum D3 levels. The hypothesis of this research was the stimulation of osteoblasts by muscle building exercises to increase bone formation. For this purpose, with the increase of vitamin D, the endocrine system undergoes changes to supply calcium to the skeletal tissue, according to which Matrix Gla protein (MGP) and 1,25 dihydroxy vitamin D serum, which are indicators of bone regeneration, increased [8]. Sports activity increases the level of vitamin D3 by increasing the expression of fibroblast growth factor, which is a growth factor governing vitamin D homeostasis and metabolism [5]. Overall, the current study showed that combined exercise training can be an effective method in improving osteopenia along with drug therapy.

Acknowledgment: The authors would like to express appreciation for the support of the sponsors.

References:

[1] Sözen T, Özışık L, Başaran NÇ. An overview and management of osteoporosis. European journal of rheumatology. 2017;4(1):46.

[2] Holubiac IȘ, Leuciuc FV, Crăciun DM, Dobrescu T. Effect of strength training protocol on bone mineral density for postmenopausal women with osteopenia/osteoporosis assessed by dual-energy x-ray absorptiometry (DEXA). Sensors. 2022;22(5):1904.

[3] Aul AJ, Dudenkov DV, Mara KC, Juhn YJ, Wi C-I, Maxson JA, et al. The relationship of 25-hydroxyvitamin D values and risk of fracture: a population-based retrospective cohort study. Osteoporosis International. 2020; 31:1787-99.

[4] Beck B, Rubin C, Harding A, Paul S, Forwood M. The effect of low-intensity whole-body vibration with or without high-intensity resistance and impact training on risk factors for proximal femur fragility fracture in postmenopausal women with low bone mass: Study protocol for the VIBMOR randomized controlled trial. Trials. 2022;23(1):15.

[5] Chen L-R, Hou P-H, Chen K-H. Nutritional support and physical modalities for people with osteoporosis: current opinion. Nutrients. 2019;11(12):2848.

[6] Ruo Roch M, Martina M, editors. A Low-Cost Compact Output Amplifier for Multichannel Muscle Stimulation. International Conference on Applications in Electronics Pervading Industry, Environment and Society; 2021: Springer.

[7] Çay V, Buyukyazi G, Ulman C, Taneli F, Doğru Y, Tıkız H, et al. Effects of aerobic plus explosive power exercises on bone remodeling and bone mineral density in young men. Turkish Journal of Biochemistry. 2018;43(1):40-8.

[8] Dr. Bell NH, Godsen RN, Henry DP, Shary J, Epstein S. The effects of muscle- building exercise on vitamin D and mineral metabolism. Journal of bone and mineral research. 2020;3(4):369-74.
[9] Santos L, Elliott-Sale KJ, Sale C. Exercise and bone health across the lifespan. Biogerontology. 2017; 18:931-46.

The effect of TRX exercises on Eotaxin and IL-33 indices in inactive obese women

Samaneh Dastah [1]

[1]*Assistant Professor, Department of Sports Sciences, University of Maragheh, Maragheh, Iran,* s.dastah@maragheh.ac.ir

Abstract

Introduction: Obesity and high levels of inflammatory markers are associated with increased risk of chronic diseases such as type 2 diabetes and cardiovascular diseases. The aim of this study was to investigate the effect of TRX exercises on eotaxin and IL-33 indices in inactive obese women.

Method: The current research was applied and semi-experimental. The statistical population of the present study was all obese women with an average age of 52 ± 2.6 years and BMI ≥ 25 in Maragheh city. From this population, 30 people were selected as a statistical sample in a purposeful and accessible manner and were randomly divided into two experimental (15 people) and control (15 people) groups. The exercise group was exposed to an 8-week TRX training program consisting of 10 minutes of warm-up, 40 minutes of TRX training, and 10 minutes of cool-down. Blood samples were collected before and after 8 weeks of training and the amounts of eotaxin and IL-33 were measured by ELISA method. The data were analyzed using the covariance test ($P \leq 0.05$).

Results: The results showed that 8 weeks of TRX training leads to a significant decrease in serum eotaxin levels ($p=0.021$) and a significant increase in IL-33 serum levels ($p=0.011$) in inactive obese women.

Conclusion: It seems that the weight loss due to TRX exercises, which was accompanied by the loss of fat tissue, led to a decrease in eotaxin levels and an increase in IL-33 serum levels.

Keywords: TRX exercise, Eotaxin, IL-33

Introduction

Adipose tissue, as an active tissue and the main product of obesity, in addition to fat storage, secretes peptides called adipokines, pro-inflammatory and anti-inflammatory cytokines, which have endocrine and paracrine effects [1]. One of these adipokines is eotaxin, which is known as a pro-inflammatory adipokine secreted by adipose tissue [2]. Researches have shown that the level of plasma eotaxin is high in obese people [2,3]. On the other hand, inflammation caused by metabolic disorders is associated with a decrease in anti-inflammatory cytokines, including IL-33 [4,5].

In this regard, the evidence shows that the preventive effect of exercise may be related to the anti-inflammatory effect of regular exercise, which reduces visceral fat tissue, or to the induction of an anti-inflammatory environment with each exercise session [6]. Research shows that resistance training increases strength and muscle mass and subsequently increases the potential for consumption of free fatty acids, increases insulin sensitivity and improves quality of life, and is effective in preventing metabolic risk factors. TRX exercises are based on the use of body weight and include various movements related to the whole body and are part of resistance sports [7].

Considering the role of IL-33 and eotaxin in mechanisms related to obesity, the existence of conflicting results regarding the effect of exercise and physical activity on these factors, and also regarding the effect of exercise on improving body composition, the purpose of this research is to investigate the effect of exercise on these factors. TRX was inactive on serum eotaxin and IL-33 levels in obese women.

Method

The current research was applied and semi-experimental. The statistical population of this research was selected through a call and among obese women with an age range of 50-60 years. They were randomly divided into two control groups (25 people) and training group (25 people). The subjects of the training group performed TRX exercises for 8 weeks and three sessions a week. TRX exercises included large muscle groups of upper body, lower body and central. Each training session included 10 minutes of warm-up and 40 minutes of TRX training, respectively, and ended with 10 minutes of cooling down. The control group did not perform any sports activities during 8 weeks. After 12 hours of fasting, 5 cc of blood was taken from the subject in two stages (pre-test and post-test). Serum levels of IL-33 were measured using ELISA laboratory method and the amount of eotaxin was measured by the sandwich ELISA method.

Shapiro-Wilk test was used to check the normality of data distribution. Because the data distribution was normal, ANCOVA analysis of covariance test was used to determine the differences between groups. Also, independent t-test was used to investigate the possibility of differences between the control and training groups (in the pre-test stage). Data analysis was done using SPSS version 23 statistical software at the level of statistical significance ($p<0.05$).

Findings

The Klomogrof-Smirnov test showed that the distribution of all data is normal. The results of covariance analysis and Bonferroni's test showed that 8 weeks of TRX training caused a significant decrease in body weight ($p=0.001$), fat percentage ($p=0.001$) and body mass index ($p=0.001$) =p) became Also, the results of the present study showed that the amount of eotaxin decreased significantly after TRX exercises ($p=0.021$). While, the results showed a significant increase of IL-33 in the training group compared to the control group ($p=0.011$) (Table 1).

Table 1. Descriptive data and covariance analysis results about the research variables

variable	**stage**	**Control group**	**TRX exercise**	**F**	**P-value**	**Eta-square**
Age		53.4±8.09	52.4±4.15			
Height (cm)		160.7±1.78	160.2±1.85			
Weight (kg)	pre	78.9±3.95	82.3±2.95	21.45	0.001*	0.243
	post	78.5±3.77	74.3±3.60			
fat (percentage)	pre	28.1±5.11	29.1±5.05	65.13	0.001*	0.636
	post	30.1±1.18	27.1±7.50			
BMI (kg/m^2)	pre	30.1±8.1	31.1±3.6	16.29	0.001*	0.277
	post	30.1±6.5	29.1±6.5			
Eotaxin (ng/l)	pre	720.2±9.66	730.2±6.15	95.12	0.021*	0.249
	post	724.1±2.8	684.5±2.03			
IL-33 (ng/l)	pre	220.4±10.10	219.5±2.18	99.72	0.011*	0.697
	post	221.4±31.20	240.6±9.75			

Discussion

The results of the present study showed that TRX exercises significantly decrease the amount of eotaxin and significantly increase IL-33 in inactive obese women. Also, a significant decrease in the values of body mass index, weight and fat percentage was observed, therefore, considering that adipose tissue is the main source of eotaxin, the decrease in adipose tissue is accompanied by a decrease in eotaxin levels. In fact, the confirmation of the effectiveness of TRX exercises in reducing body fat mass in the present study and its consistency with previous studies show the effectiveness of this exercise method in weight control and improving body composition.

Increasing energy consumption and creating a negative energy balance is one of the most important reasons for the effectiveness of sports activities in reducing body weight and fat mass. Therefore, perhaps the main reason for improving the body composition of the subjects of the present study can be attributed to increasing the energy cost of the exercises performed. It seems that the exercises that reduce the percentage of body fat are associated with the reduction of eotaxin because adipose tissue is considered the main source of eotaxin secretion; In fact, weight loss, which is accompanied by loss of fat tissue, leads to a decrease in eotaxin levels. Among other results of the present study, there is a significant increase in IL-33 serum levels after 8 weeks of TRX training in inactive obese women. Liu et al. reported that combined aerobic and resistance exercises lead to a significant increase in IL-33 and a significant decrease in glucose, insulin and insulin resistance; therefore, exercise can help improve glycolipid metabolism and reduce mild inflammation in diabetic patients [8], which is consistent with the findings of the present study. Several mechanisms have been described regarding the protective role of IL-33 in conditions of obesity and diabetes. Research shows that the distribution of IL-33 in obese diabetic mice leads to a decrease in fat cells, a decrease in fasting glucose and an improvement in insulin sensitivity [5].

The results of the current research showed that weight loss along with loss of adipose tissue due to 8 weeks of TRX training has reduced the serum levels of eotaxin and increased IL-33; Also, TRX exercises have improved body composition in inactive obese women.

References:

1. Galic S, Oakhill JS, Steinberg GR. Adipose tissue as an endocrine organ. Molecular and cellular endocrinology. 2010;316(2):129-39.
2. Kalhor F, Arshadi S, Zafari A. The effect of resistance training on Atrogin, eotaxin and IL-10 indices in obese women. Razi Journal of Medical Sciences. 2020;27(3):130-7.
3. Fekri Kv, Motamedi P, AMANI SS. The effect of six weeks of interval resistance training on eotaxin and brainderived neurotrophic factor serum levels in overweight young men. 2018.
4. Froozandeh E, Tofighi A, Tolouei Azar J. The Effect of 8 Weeks of Resistance and Aerobic Interval Training on Levels of GLP-1, NRG-1 and IL-33 in Type 2 Diabetic Women. Sport Physiology. 2020;12(46):117-38.
5. Miller AM, Liew FY. The IL-33/ST2 pathway—a new therapeutic target in cardiovascular disease. Pharmacology & therapeutics. 2011;131(2):179-86.
6. Miller AM, Asquith DL, Hueber AJ, Anderson LA, Holmes WM, McKenzie AN, et al. Interleukin-33 induces protective effects in adipose tissue inflammation during obesity in mice. Circulation research. 2010;107(5):650-8.
7. Yazdani F, Ahmadi B. The effect of 8 weeks of resistance training on ovary morphology, glycemic control and body composition on women with polycystic ovary syndrome. medical journal of mashhad university of medical sciences. 2015;58(7):381-9.
8. Liu Y, Liu S-x, Cai Y, Xie K-l, Zhang W-l, Zheng F. Effects of combined aerobic and resistance training on the glycolipid metabolism and inflammation levels in type 2 diabetes mellitus. Journal of physical therapy science. 2015;27(7):2365-71.

The effect of two types of interval training with jujube extract consumption on oxidative stress and BDNF and NGF gene expression in the hippocampal tissue of male rats

Sudabeh Mohammadi Azmoodeh[1], Akram Karimiasl[2], Ahmad Rahmani[3], Hamid Reza Norouzi[4]

1. MA Applied Exercise Physiology, Department of Sport Siences, Faculty of Humanities, University of Zanjan, Zanjan, Iran. sudiazemodeh@gmail.com
2. Assistant Professor, Department of Sport Siences, Faculty of Humanities, University of Zanjan, Zanjan, Iran. karimiasl@znu.ac.ir
3. Associate Professor, Department of Sport Siences, Faculty of Humanities, University of Zanjan, Zanjan, Iran. a_rahmani@znu.ac.ir
. Assistant Professor, Department of Sport Siences, Faculty of Humanities, University of Zanjan, Zanjan, Iran. hnorouzi@znu.ac.ir

Introduction: Researches have shown that sports training can improve brain structure and cognitive learning and memory functions. The effects of exercise have been partly attributed to strengthening performance and increasing levels of neutrophins, especially NGF and BDNF (1). Neurotrophic factors have unique activities on target nerve cells and other types of cells in the nervous system (2). The highest level of gene expression and protein concentration of NGF in the central nervous system has been reported in the hippocampus (3). In researches, it has been pointed out that exercise training is effective in increasing neutrophins, including BDNF and NGF, in promoting neurogenesis and angiogenesis, and as a result, developing dendrites and improving memory (4). Research findings show that the regulation of hippocampal BDNF caused by exercise is mediated by neurotransmitter systems, neuroendocrine systems and insulin-like growth factor IGF-1. Also, exercise plays an important role in BDNF protein content, tyrosine kinase B receptor and cyclic adenosine monophosphate response through the regulation of reactive oxygen species (ROS) and leads to better performance and neurogenesis (5). In addition, NGF plays an important role in maintaining sympathetic and sensory neurons as well as biological activities, including cell growth (6). On the other hand, intense sports activity increases the production of ROS. ROS easily oxidize macromolecules such as lipids, proteins, carbohydrates, and nucleic acids, and on the other hand, it reduces the body's antioxidant level to deal with oxidative stress (7). A type of high-intensity training, such as interval training, helps to restore the brain system and improve neurotrophin gene expression by improving the inflammatory state and oxidative stress in people (8). However, oxidative stress, lipid peroxidation and insufficiency of the antioxidant defense system may also occur with increasing intensity of activity, especially intense training (9). Studies have shown that intense exercise increases the levels of malondialdehyde (MDA) as an indicator of lipid peroxidation (10). The most vulnerable part of the cell is the membrane lipids, which in the face of lipids with free radicals cause their peroxidation, change the fluidity and permeability of the membrane, and as a result, MDA is produced (11). One of the appropriate solutions to protect against the adverse effects of oxidative stress caused by intense activities is to use healthy nutritional measures and use of antioxidant supplements. Due to having compounds such as tannins and flavonoids, jujube has antioxidant and anti-inflammatory properties and protects the body against oxidative stress (12). Studies have shown that jujube contains vitamins E, C, A, carotenoids and special minerals, such as zinc and selenium, which have antioxidant properties and are effective in neutralizing free radicals (13). Therefore, according to the mentioned materials, the present research was conducted with the aim of investigating the effect of two types of intermittent exercise with jujube consumption on oxidative stress and BDNF and NGF gene expression in male rats.

Materials and methods: 72 immature Wistar rats aged 22 days after weighing were randomly divided into 9 groups: control, intense interval training (HIT), intense endurance training (ICT), jujube, ICT + jujube, ICT + Placebo, HIT + placebo, HIT + jujube and placebo. Then, the intense endurance training protocol including running on the treadmill for 4 weeks (5 sessions per week) with progressive duration and intensity and following the principle of exercise overload was implemented. So that the speed in the first week was equal to 10-18 meters per minute and its duration was 10-30 minutes, and in the last week the training speed reached 30 meters per minute and its duration was 55-60. The HIT training protocol was also carried out in the form of training with the pattern of seven-day courses (six days of training and one day of rest to prevent overtraining). Based on the principle of overload, training was applied in such a way that the training speed in the familiarization week was equal to 10-16 meters per minute and its duration was 1 minute, and in the last week the training speed reached 36-40 meters per minute (equivalent to about 85% of Vo2max). The placebo groups were given a gavage of distilled water and the jujube groups were given a gavage of jujube extract at a dose of 600 mg per kilogram of body weight of each mouse, daily after training. The expression of BDNF, NGF genes was measured using real-time PCR method and the amount of MDA and TAC was measured using spectrophotometric method. ANOVA and James Howell's post hoc test were used to analyze the data.

Findings: ANOVA test results showed that there is a significant difference in the level of NGF and TAC gene expression in hippocampal tissue ($P<0.05$). The results of James Howell's post hoc test showed a significant difference in NGF gene expression between the HIT group and the control group ($P = 0.001$), so that HIT training led to an increase in NGF expression in the hippocampus tissue. Also, in the ICT group and the ICT + jujube group, a significant increase in TAC was observed compared to the control group ($P=0.03$, $P=0.002$). The results of the present study did not show significant changes in BDNF gene expression and MDA activity in 9 groups ($P>0.05$).

Conclusion: The results of the present study showed that HIT training led to an increase in the expression of NGF in the hippocampus tissue. Also, the highest level of BDNF gene expression in the present study was related to the HIT exercise group and the placebo group, and this difference was not significant. It seems that the type of exercise program is very important.

Previous studies have reported that exercise stimulates the regeneration of nerve cells and increases NGF gene expression (14). It seems that the lack of change in the 7-day training group compared to the 4-day training group is related to the intensity of the exercises and the duration of the exercise in the 4-day group, and more rest intervals in the 4-day group played a role in increasing NGF gene expression. Therefore, intermittent training probably helps to restore the brain system and improve neurotrophin gene expression by improving the inflammatory state and oxidative stress in people (8). However, in the present study, BDNF gene expression was not significant. It seems that due to the immaturity of the rats in the present study, it can be concluded that there was not enough growth hormone to stimulate and produce IGF-1 to be effective in BDNF gene expression. Also, the results of the present study showed that the amount of TAC in the ICT group and the jujube ICT + group had a significant increase compared to the control group. Meanwhile, there was no significant difference between the groups in MDA. According to the obtained results, it is possible that continuous increasing endurance training will improve the antioxidant function and create oxidative adaptations caused by exercise over time (15).

The findings of this research showed that jujube supplementation alone or together with 7 and 4 days intermittent exercise had no significant effect on BDNF and NGF gene expression (P=1.000). According to the results of the present study, it seems that the beneficial effects of jujube herbal supplement and anti-oxidant treatment appear when the oxidizing and anti-oxidative systems of the body are sufficiently stressed due to various interventions.

1. Bahmani E, Hoseini R, Amiri E. The Compensatory Increased BDNF and NGF in Patients With Multiple Sclerosis Following Home-based Aerobic Training and Vitamin D Supplementation During the COVID-19 Outbreak. 2021.
2. Svensson M, Lexell J, Deierborg TJN, repair n. Effects of physical exercise on neuroinflammation, neuroplasticity, neurodegeneration, and behavior: what we can learn from animal models in clinical settings. 2015;29(6):577-89.
3. Latina V, Caioli S, Zona C, Ciotti MT, Borreca A, Calissano P, et al. NGF-dependent changes in ubiquitin homeostasis trigger early cholinergic degeneration in cellular and animal AD-model. 2018;12:487.
4. Mostafavi HJY. The effect of six months aerobic exercise with moderate intensity on BDNF, IL-6, and short-term memory in 50-65 years old women with syndrome metabolic. 2017;19.(٤)
5. Fallah Mohammadi Z, Sheikh P, Mirzaee S, Ebrahimzadeh MJRoB, Actiuity P. The effect of Voluntary running wheel and allium paradoxum on Plasma Brain Derived Neurotrophic factor in the diabetic rates induced with aloxan. 2012;1(2):69-78.
6. Allen SJ, Watson JJ, Shoemark DK, Barua NU, Patel NKJP, therapeutics. GDNF, NGF and BDNF as therapeutic options for neurodegeneration. 2013;138(2):155-75.
7. Battistelli M, Malatesta M, Meschini SJOM, Longevity C. Oxidative stress to promote cell death or survival. Hindawi; 2016.
8. Vosadi E, Barzegar H, Borjianfard M. Effect of endurance and high-intensity interval training (hiit) on brain-derived neurotrophic factor (BDNF) in the rat hippocampus. 2016.
9. Bagheri Najafbad A, Sharifi G, Mirzaei A. Comparsion of Oxidative Stress Index and Plasma Antioxidant Capacity among Female Handball atheletes and Non Athlete Females %J Armaghane Danesh. 2012;17(4):349-58.
10. Ugras AFJS, Sports. Effect of high intensity interval training on elite athletes’ antioxidant status. 2013;28(5):253-9.
11. Sies HJRb. Oxidative stress: a concept in redox biology and medicine. 2015;4:180-3.
12. Hosseini M, Bambaeichi E, Sarir H, Kargarfard M, Mogharnasi MJIMT. The Effect of Six Weeks of Continuous Training with Ziziphus Jujube Extract Consumption on Lipocalin-2 and Adiponectin Levels in Plasma and Heart Tissue of Rats with Myocardial Infraction (MI). 2018;24(3):193-202.
13. Pahuja M, Mehla J, Reeta K, Joshi S, Gupta YKJE, Behavior. Hydroalcoholic extract of Zizyphus jujuba ameliorates seizures, oxidative stress, and cognitive impairment in experimental models of epilepsy in rats. 2011;21(4):356-63.
14. Chae CH, Kim HT. Forced, moderate-intensity treadmill exercise suppresses apoptosis by increasing the level of NGF and stimulating phosphatidylinositol 3-kinase signaling in the hippocampus of induced aging rats. Neurochem Int. 2009;55(4):208-13.

15. Zalavras A, Fatouros IG, Deli CK, Draganidis D, Theodorou AA, Soulas D, et al .Age-related responses in circulating markers of redox status in healthy adolescents and adults during the course of a training macrocycle. Oxidative Medicine and Cellular Longevity. 2015;2015.

The Effects of Nordic Walking along with Green Tea on Metabolic Status of Pre-Diabetes Women

Khatere Zare[1], **Mostafa Rahimi**[2]

[1] *Department of Sport Science, Shahrekord University, Shahrekord, Iran.* zarekhaterem@gmail.com
[2] *Department of Sport Science, Shahrekord University, Shahrekord, Iran.* M.rahimi@sku.ac.ir

ABSTRACT

Type 2 diabetes (T2D) is a major health concern with a significant impact on human life and well-being. It is currently ranked as the ninth leading cause of death worldwide, with over one million deaths attributed to the disease annually. Reports indicate that diabetes becomes a prevalent and concerning public health issue in individuals aged 50 to 65 years and older, with approximately one in every two elderly individuals being diabetic or pre-diabetic.

Walking is a widely practiced physical activity that is seldom associated with physical injuries due to its low-impact nature. In this regard, Nordic walking (NW), a specific form of walking that involves the use of poles and engages the muscles of the lower limbs, upper limbs, and trunk, has gained attention. Compared to traditional walking, NW is estimated to result in a higher energy expenditure due to its whole-body engagement. A systematic review, meta-analysis, and other studies have demonstrated that NW is more effective and practical for overweight and obese individuals compared to traditional walking.

Green tea (GT) contains a lot of active ingredients including catechins, polyphenols, theanine, caffeine, chlorogenic acid, and gallic acid. Many studies have reported that catechins reduce blood lipids and body weight and improve insulin resistance. Numerous studies have also shown that EGCG in GT have antioxidant, anti-obesity, and anti-inflammatory effects. In contrast, another meta-analysis study found that GT had no effect on blood glucose, HOMA-IR, or insulin resistance in subjects at risk of T2D. Therefore, the aim of this study was investigating the effect of NW, GT supplementation and combination of these interventions on body composition and metabolic status of pre-diabetes women.

In the present study, women exposed to diabetes were recruited to diabetes. After the initial assessment, eligible participants were randomly divided into one of four groups (control group (CO, n= 15), GT supplement group (Sup, n= 15), NW and placebo group (Ex+Pla, n= 15), and NW and GT supplement group (Ex+Sup, n= 15)). The subjects were blinded to the group allocation and during interventions.

Subjects in the exercise groups engaged in three sessions per week on non-consecutive days for 8 weeks, with each session lasting 40-60 minutes in the morning. The main exercise involved walking with special poles, and exercise intensity was monitored using reserve heart rate, with subjects exercising at an intensity of 50 to 75% of their reserve heart rate during the study. In the two groups, Sup. and Ex+Sup., subjects received 3 capsules of 500 mg daily containing GT supplement, which they consumed after meals. The placebo group used roasted wheat flour in identically colored capsules.

Height, weight, body mass index (BMI), and body fat percentage (BF%) were measured at baseline and at the end of the study using standard and similar methods. BF% was measured using a Body Composition Analyzer (Inbody 270). To measure serum indices, 5 cc of blood was drawn from the antecubital vein of each subject before the start of interventions and 48 hours after the last

interventions following a 12-hour fast. Fasting blood glucose (FBG) and serum insulin were measured for each factor using kits (Pars Azmoon, Tehran, Iran) and an Autoanalyzer employing the photometric method.

HOMA-IR and HOMA-β cell indices were calculated using the following formulas:
HOMA-IR = [fasting insulin (U/ml) * fasting glucose (mmol/l)]/ 22/5
HOMA b-cell = [20× fasting insulin (IU/Ml)]/ [fasting glucose (mmol/l)-3/5]

The analysis of covariance (ANCOVA) was used to examine the differences between the groups and the pre-test data were considered as covariate variables. If the results were significant, Bonferroni post hoc test was used to examine the differences. Moreover, independent t-test was used to examine within-group differences. The SPSS.25 was used for data analysis. The level of statistical significance was set at P < 0.05.

The subjects of the study were pre-diabetes women. Individual characteristics of all subjects include age 61.73 ± 4.71 years, height 156.45 ± 6.29 cm, initial weight 72.47 ± 10.47 and BMI 29.6 ± 3.83 kg.m2. Between and within groups comparisons are presented in Table 1.

Table 1. Pre and post treatment characteristics for study participants.

Variable	Time	CO	Sup.	Ex + Pla.	Ex + Sup.	B-G Value
Body Weight (kg)	Pre	69.27 ± 8.05	73.2 ± 8.71	66.66 ± 11.33	78.31 ± 11.19	F= 0.910 P= 0.44 η= 0.069
	Post	69.31 ± 8.8	71.97 ± 8.34	64.99 ± 11.27	74.98 ± 9.92	
	Δ (W-G P-Value)	0.04 (0.986)	-1.23 (0.012)*	-1.67 (0.030)*	-1.42 (0.003)*	
BMI (kg/m2)	Pre	28.94 ± 4.18	29.25 ± 2.8	27.43 ± 3.8	30.34 ± 2.58	**F=17.676** **P= 0.001** **η= 0.583**
	Post	29.08 ± 4.2	28.36 ± 2.6	25.94 ± 3.54	28.76 ± 2.34	
	Δ (W-G P-Value)	0.14 (0.501)	-0.89 (0.001)*a	-1.48 (0.001)*a	-1.58 (0.001)*a	
Body Fat %	Pre	40.65 ± 7.66	39.2 ± 4.72	38.4 ± 4.92	43.95 ± 5.95	**F= 3.795** **P= 0.018** **η= 0.23**
	Post	40.16 ± 8.55	37.28 ± 6.42	35.29 ± 5.13	40.97 ± 5.53	
	Δ (W-G P-Value)	-0.49 (0.223)	-1.92 (0.059)	-3.11 (0.004)*a	-2.98 (0.001)*a	
FBG (mg/dl)	Pre	126.17 ± 18.56	129.1 ± 21.61	126.82 ± 6.88	130.9 ± 17.8	**F= 21.261** **P= 0.001** **η= 0.627**
	Post	130.83 ± 18.74	120.5 ± 19.56	115.27 ± 8.98	112.5 ± 12.68	
	Δ (W-G P-Value)	4.66 (0.001)*	-8.6 (0.001)*a	-11.54 (0.001)*a	-18.4 (0.001)*ab	
Insulin (mg/dl)	Pre	25.88 ± 5.05	26.15 ± 5.65	23.29 ± 4.36	26.6 ± 4.37	**F= 13.312** **P= 0.001** **η= 0.512**
	Post	26.71 ± 4.69	24.54 ± 4.56	20.85 ± 4.27	23.23 ± 3.59	
	Δ (W-G P-Value)	0.83 (0.099)	-1.61 (0.026)*a	-2.44 (0.001)*a	-3.37 (0.001)*a	

HOMA-IR	Pre	8.26 ± 2.84	8.58 ± 3.29	7.31 ± 1.59	8.37 ± 1.82	**F= 26.120 P= 0.001 η= 0.673**
	Post	8.81 ± 2.77	7.49 ± 2.65	5.99 ± 1.59	6.51 ± 1.61	
	Δ (W-G P-Value)	0.55 (0.006)*	-1.09 (0.002)*a	-1.33 (0.001)*a	-1.85 (0.001)*a	
HOMA-β cell	Pre	151.78 ± 18.08	148.47 ± 24.48	132.01 ± 21.58	145.08 ± 19.43	**F= 7.00 P= 0.001 η= 0.356**
	Post	145.7 ± 15.92	162.27 ± 29.16	144.79 ± 23.96	176.25 ± 37.52	
	Δ (W-G P-Value)	-6.08 (0.069)	13.8 (0.033)*	12.78 (0.022)*	31.16 (0.007)*a	

Note. C: control group, Sup.: Green Tea supplementation group, Ex. + Pla.: exercise + placebo group, Ex. + Sup.: exercise + Green Tea supplementation group. BMI: body mass index; FBG: Fasting blood glucose. W-G: Within-group, B-G: Between-group. Δ: posttest score - pretest score. *indicated significant within group pre-post difference. a: indicated significant difference compared to control group. b: indicated significant difference compared to supplement group.

The results showed that there was no statistically significant difference in body weight between groups (P = 0.445). However, the within-group comparison showed that the body weight in the experimental groups decreased significantly. Regarding BMI (P < 0.018) and BF% (P = 0.018), the results showed these variables decreased significantly. Moreover, it was observed that the variables of FBG, insulin and HOMA-IR decreased significantly in the experimental groups and HOMA-β increased significantly (table 1).

We observed that BMI, BF%, FBG, insulin and HOMA-IR decreased in the intervention groups and HOMA-β increased in the NW+GT group. However, it was noted that these two interventions did not have a synergistic effect when combined.

In line with the results of the present study, some previous studies have also concluded that NW training is an effective method to improve body composition. In a comparative study, Pippi et al (2020) found that in obese adults with or without T2D, 3 months of NW exercises are as effective as gym-based exercises in improving body composition and physical fitness. Nevertheless, compared to traditional walking, NW have more physiological and anthropometric effects due to the activation of all the muscles of the body (about 90% of body muscles) and higher energy costs. Another advantage of NW is that using poles reduces the pressure on the knees by almost 30% compared to traditional walking. Therefore, this type of physical activity is more efficient, safe, accessible, and widely used for older, overweight, and obese people who have several diseases along with joint problems.

In line with our results, some studies have concluded that GT/GTE has a beneficial effect on body composition. Previous studies have confirmed the anti-obesity and anti-inflammatory effects of GT and GTE. GT has been shown to cause weight loss through multiple mechanisms, including reducing food intake, reduction in lipid emulsification and absorption, fat oxidation and fat excretion in the stool, suppressing adipogenesis and lipid synthesis, increasing energy expenditure, and thermogenesis.

Regarding the effect of GT on the metabolic status, several review and meta-analysis studies have been conducted and contradictory results have been reported. For instance, in a meta-analysis study (17 RCTs, n= 1133), it was reported that consumption of GT has a positive effect on metabolic status (FBG, HbA1c and insulin). However, our findings and previous research indicate that GT consumption among individuals with prediabetes leads to improvements in FBG, insulin, HOMA-IR, and HOMA-β. This improvement has been attributed to improved glucose uptake into skeletal muscle as well as muscular β-oxidation. Additionally, a meta-analysis study indicated that catechin intake in individuals with T2D may ameliorate hyperglycemia, oxidative stress, dyslipidemia, and obesity.

Acknowledgment: We are grateful to the subjects who participated in this study.

References:

[1] Pippi R, Di Blasio A, Aiello C, Fanelli C, Bullo V, Gobbo S, et al. Effects of a Supervised Nordic Walking Program on Obese Adults with and without Type 2 Diabetes: The CURIA Mo. Centre Experience. 2020;5(3):62.
[2] Cebula A, Tyka AK, Tyka A, Pałka T, Pilch W, Luty L, et al. Physiological response and cardiorespiratory adaptation after a 6-week Nordic Walking training targeted at lipid oxidation in a group of post-menopausal women. 2020;15(4):e0230917.
[3] Sentinelli F, La Cava V, Serpe R, Boi A, Incani M, Manconi E, et al. Positive effects of Nordic Walking on anthropometric and metabolic variables in women with type 2 diabetes mellitus. 2015;30(1):25-32
[4] Golledge J, Maarij K, Moxon JV, Beard JD, Girold S, Wrang H, et al. Systematic review and meta-analysis of clinical trials examining the benefit of exercise programmes using Nordic walking in patients with peripheral artery disease. 2018;56(4):534-43.
[5] Yu J, Song P, Perry R, Penfold C, Cooper ARJD, journal m. The effectiveness of green tea or green tea extract on insulin resistance and glycemic control in type 2 diabetes mellitus: a meta-analysis. 2017;41(4):251.
[6] Rashidy M, Karkehabadi SJPR. Aerobic exercise ameliorates glycemic control by improving the beta cell function and independent of insulin resistance in diabetic rats. 2021;24(1):11-8.

The Role of Kinases (JNK-P38-ERK) in the Regulation of Transcriptional and Copying Factors after Exercise Training with Emphasis on Free Radicals' Role

Abstract

Introduction: This systematic review aimed to investigate the role of kinases (JNK-P38-ERK) in the regulation of transcriptional and copying factors after exercise training with emphasis on free radicals' role.
Method: For this purpose, Sid.ir and Magiran.com databases as well as the system of scientific and research publications approved by the Ministry of Science in the field of sport sciences were searched for domestic articles from 1380 to 1402. The keywords used for searching were "protein kinases (JNK-P38-ERK)" or "exercise training" in combination with "free radicals" or "transcription factors" or "copying factors". For English language articles between 2000 and 2023, PubMed, Megapaper, and Google Scholar databases were used.
Results: The results indicated that reactive oxygen species (ROS) play the role of messengers in cellular signaling cascades by phosphorylating intracellular proteins and activating redox-sensitive transcription factors. In skeletal muscle, MAPKs are the main regulators of gene transcription in response to oxidative stress. Phosphorylation of MAPK increases after all kinds of exercise training, but the degree of adaptation created as a result of exercise training and phosphorylation of MAPK depends on the intensity, duration, volume and type of exercise, as well as the level of physical fitness of the person, the person's exercise training history, gender, and recovery rate, and also it depends on nutrition, the use of antioxidants and supplements. It should be kept in mind that sometimes the level of MAPKs phosphorylation in mice after exercise training is different compared to humans. Also, new techniques are needed to evaluate signaling pathways in human samples.
Conclusion: MAPKs are involved in various processes such as mitochondrial biogenesis, hypertrophy, autophagy, apoptosis and inflammation, which sometimes overlap with other redox signaling pathways and are suggested to be considered in future research.
Keywords: Mitogen-activated protein kinases, cell signaling, free radicals, exercise training.

Mini Oral Presentations

Exercise Physiology and Nutrition

Comparison of some physical fitness factors between bodybuilders and boxers

Hossein Ghasemi Shahna*[1], Hojjatollah Siavoshy[1,2,3]

[1] *Department of Sport Sciences, Faculty of Humanities, University College of Omran_Toseeh, Hamadan, Iran.* Hossein.Ghasemi.student@gmail.com

[2] *Department of Physical Education, Shahid Maghsoudi Campus, Farhangian University, Hamadan, Iran.* Seiavoshy@gmail.com

[3] *Department of Sports Science, Nahavand Higher Education Complex, Bu-Ali Sina University, Hamedan, Iran.* Seiavoshy@alumni.basu.ac.ir

Keywords: Reaction Time, Reaction Speed, Muscular strength, Muscular Endurance, Push Up Test, Hand Grip.

ABSTRACT

Boxing is one of the oldest combat sports in the history of mankind and is historically referred to as a "noble art" (1). The International Boxing Association has stated that the first signs of this sport were found in Egypt around 3000 BC (2). Boxing probably began around 6000 BC in Ethiopia, and in 688 BC at the first Olympic Games, boxing made its historic debut as an Olympic sport (1,3). The Olympic sport of boxing, which is almost 3 thousand years old, is held in 3 or 15 rounds at the tournament level. In boxing, there are two competitors in the body and face in a combination to focus on the defense and the necessary transitions, which makes it very difficult. During an amateur boxing match, a boxer executes a combination of moves in which skills such as strength, speed, muscular endurance, and reaction speed play an important role. To be successful in the sport, a person must possess a wide range of skills, knowledge, and attributes that can be measured, analyzed, and solved using the appropriate tools and techniques during the sport and improve themselves (4). Athletes in this field need strength, endurance, agility, and reaction, and practicing this field increases the ability of these fields in a person.

Examining things like strength, speed, and endurance can somewhat challenge different sports to a possible ratio, and this will take to clarify the best training. Studies and research in this field can help the decision of young people and teenagers to choose the desired sport. Many people participate in resistance training, also known as strength training, to improve their appearance, health, and performance. Especially athletes in some sports such as bodybuilders, weightlifters, and American football use resistance sports to move and increase muscle mass (5). Resistance exercise is an anaerobic exercise, so it less consumes oxygen compared to aerobic exercise (5). Other strength sports, such as weightlifting, use high-intensity resistance weight training as a tool to increase strength and power (6,7). For weightlifters, victory or defeat is determined by strength and technique; In other words, the goal of weightlifters is to increase the load that can be lifted through grasping (8).

Strength, since it is vital for many daily activities, is clinically measured as an indicator of overall body strength and health (9). Many professions rely on strength to perform. For example, the admission process for fire departments, police departments, and the army may require them to pass a strength test (10). Food packers, assembly line manufacturing, and many other manual industrial workers may regularly use continuous or intense griping movements (11). Others require lifting and holding heavy loads by hand. Therefore, good musculature is especially important for adolescents

because their workplace activities have more emphasis on physical skills than on cognitive skills (12); The most popular method to assess upper extremity strength is measuring hand grip strength, which also serves as a key performance indicator for athletes (13).

Guidetti et al. (2002) have proven that isometric muscle contraction, especially upper extremity (dominant arm) contraction, is closely related to boxing match rankings (14). The isometric strength of the boxer's hand is a significant physical fitness index and one of the morphological, physiological, and biochemical characteristics of national boxers between senior and junior levels (15). Claw strength is related to both direct impact and lateral impact (3). Sporrong et al. (1996) and Guidetti et al. (2002) suggested that strength gain is one of the most important indicators of medical control in boxing training (14,16). In one research, the isometric performance of the strength of hand grip to the weight categories was investigated and it was found that there is a significant difference between the low, medium, and high weight categories (17).

However, there are few studies to measure physical fitness factors in strength athletes (bodybuilders, boxers) and there are few studies related to strength training among bodybuilders and boxers. During an amateur boxing match, a boxer performs a combination of punches with various skills. Therefore, reduced punching skills may be an influential factor in determining the outcome of a fight as well as injury during a match. By identifying significant differences in physical fitness factors, coaches can implement exercises and training to improve skill levels, and potentially significantly reduce injury risk and optimize athletic performance. Examining the level of physical factors of boxers and bodybuilders can help develop injury-reduction strategies and can help identify and select talent. This research may clarify the physical aspects of boxing and bodybuilding, as well as the possibility of specific positions on physical factors. Understanding these physical differences can improve boxing and bodybuilding techniques, optimize movement patterns, and improve boxing and bodybuilding performance in general. The findings of the study may be used as a comparison to compare the levels of physical fitness factors in athletes of other sports disciplines to distinguish skill patterns and training methods that enhance physical fitness factors. Therefore, this study examines the characteristics of strength-athletes (bodybuilders and boxers) and examines the level of their physical fitness factors to create a training program to increase muscle strength for bodybuilders and boxers; and compares some physical fitness factors between bodybuilders, boxers, and non-athletes.

Methods

In this research, 30 people including 10 boxers and 10 bodybuilders who were selected from gyms in Hamedan city and 10 non-athletes who did not have any experience of bodybuilding or boxing participated (Table 1). After explaining the research to the participants and obtaining informed consent from them, the physical fitness factors including strength (by hand grip test, dynamometer model saehan, made in Korea), muscle endurance (by push-up test), and reaction speed (by Hs43 manual stopwatch) measured.

After data collection, mean and standard deviation were used as descriptive statistics. And one-way analysis of variance (ANOVA), and Tukey's post-hoc tests were used as inferential statistics. All data have been analyzed in SPSS software version 21 and at a significance level of less than 0.05.

Table 1. Research variables and general characteristics of participants.

Variable	Groups	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Age (Year)	non-athlete	20.10	4.122	1.303	17.15	23.05
	bodybuilder	23.20	4.686	1.482	19.85	26.55
	boxer	20.60	3.836	1.213	17.86	23.34
	Total	21.30	4.308	.787	19.69	22.91

Height (Cm)	non-athlete	173.10	7.520	2.378	167.72	178.48
	bodybuilder	173.30	8.327	2.633	167.34	179.26
	boxer	178.10	8.774	2.775	171.82	184.38
	Total	174.83	8.276	1.511	171.74	177.92
Weight (Kg)	non-athlete	70.00	7.944	2.512	64.32	75.68
	bodybuilder	79.50	13.850	4.380	69.59	89.41
	boxer	73.00	10.604	3.353	65.41	80.59
	Total	74.17	11.414	2.084	69.90	78.43
BMI (Kg/m2)	non-athlete	23.3889	2.56225	.81025	21.5560	25.2218
	bodybuilder	26.3703	3.31609	1.04864	23.9981	28.7425
	boxer	22.9712	2.38813	.75519	21.2629	24.6796
	Total	24.2435	3.09675	.56539	23.0871	25.3998
History (Year)	non-athlete	4.40	2.716	.859	2.46	6.34
	bodybuilder	5.60	3.978	1.258	2.75	8.45
	boxer	3.10	2.283	.722	1.47	4.73
	Total	4.37	3.146	.574	3.19	5.54
Reaction Time (S)	non-athlete	22.5000	6.62067	2.09364	17.7639	27.2361
	bodybuilder	24.9000	5.19508	1.64283	21.1837	28.6163
	boxer	16.0000	3.85861	1.22020	13.2397	18.7603
	Total	21.1333	6.42051	1.17222	18.7359	23.5308
Push Up (N)	non-athlete	30.40	15.657	4.951	19.20	41.60
	bodybuilder	46.10	10.005	3.164	38.94	53.26
	boxer	48.60	12.980	4.105	39.31	57.89
	Total	41.70	15.052	2.748	36.08	47.32
Hand Grip (Kg)	non-athlete	36.60	5.680	1.796	32.54	40.66
	bodybuilder	44.60	8.356	2.642	38.62	50.58
	boxer	39.30	4.270	1.350	36.25	42.35
	Total	40.17	6.983	1.275	37.56	42.77

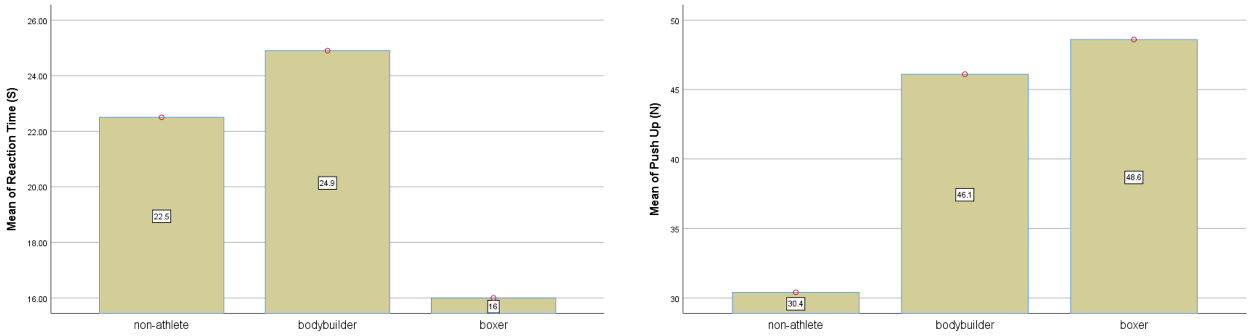
Findings

The results of the one-way analysis of variance (ANOVA) test showed that there is a significant difference in reaction speed, endurance, and muscle strength among the participants. The results of Tukey's post hoc test showed that there is a significant difference in the reaction speed of boxers compared to non-athletes (0.029) and bodybuilders (0.003) and boxers have a better reaction speed than others. Also, non-athletes have a significant and smaller difference in muscle endurance compared to bodybuilders (0.032) and boxers (0.012). The strength of bodybuilders showed a significant difference compared to non-athletes (0.023) and bodybuilders had better hand grip strength (Table 3, Figure 1).

Table 2. Tukey's post hoc test results between research variables.

Dependent Variable	گروه (I)	گروه (J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Reaction Time (S)	non-athlete	bodybuilder	-2.40000	2.39041	.581	-8.3268	3.5268
		boxer	6.50000*	2.39041	.029	.5732	12.4268
	bodybuilder	non-athlete	2.40000	2.39041	.581	-3.5268	8.3268
		boxer	8.90000*	2.39041	.003	2.9732	14.8268
	boxer	non-athlete	-6.50000*	2.39041	.029	-12.4268	-.5732
		bodybuilder	-8.90000*	2.39041	.003	-14.8268	-2.9732
Push Up (N)	non-athlete	bodybuilder	-15.700*	5.852	.032	-30.21	-1.19
		boxer	-18.200*	5.852	.012	-32.71	-3.69
	bodybuilder	non-athlete	15.700*	5.852	.032	1.19	30.21
		boxer	-2.500	5.852	.905	-17.01	12.01
	boxer	non-athlete	18.200*	5.852	.012	3.69	32.71
		bodybuilder	2.500	5.852	.905	-12.01	17.01
Hand Grip (Kg)	non-athlete	bodybuilder	-8.000*	2.832	.023	-15.02	-.98
		boxer	-2.700	2.832	.612	-9.72	4.32
	bodybuilder	non-athlete	8.000*	2.832	.023	.98	15.02
		boxer	5.300	2.832	.166	-1.72	12.32
	boxer	non-athlete	2.700	2.832	.612	-4.32	9.72
		bodybuilder	-5.300	2.832	.166	-12.32	1.72

*. The mean difference is significant at the 0.05 level.



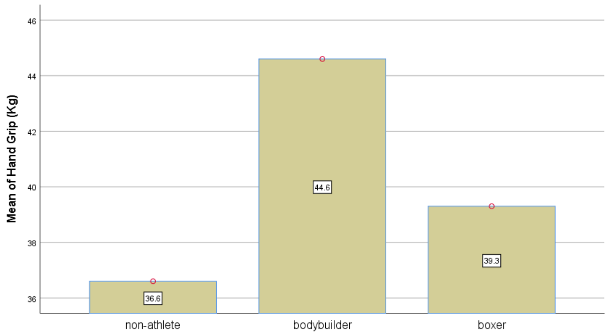


Figure 1. Changes in research variables between non-athletes, bodybuilders and boxers

Discussion

The results of this research showed that boxers have better reaction speed, bodybuilders have better hand grip strength, and both boxers and bodybuilders have better muscle endurance.

One of these causes can be attributed to sports and the difference in the way of their sports training, which are the specialty of the sports field and causes characteristic neuromuscular adaptations, as well as exercises that improve reaction speed, endurance, and strength.

One of the most important differences is the gender of the subjects because women have fewer physical fitness factors than men, which can be an important factor in changing the amount of measured physical factors. Physical fitness factors between males and females were studied, and significant differences between the physical factors of females and males were reported and important, which pays attention to the gender of the subjects (16). Especially, in this research, the subjects were homogenous in terms of gender, and all the participants were selected from males.

Also, another case can be attributed to the age of the subjects and previous sports activities, that the increase of previous sports activities, it is likely that these exercises will increase some physical fitness factors, and this possibility exists in some studies that used participants who had less experience in that sport (boxing or bodybuilding).

Also, another difference between this research and other research can be the age and maturity level of the participants, and clearly, hand grip strength is closely related to the age and maturity level of people (15,16).

Anaerobic strength is one of the components of physical fitness related to sports skills, which plays an important role in the implementation of sports skills. In many sports fields, the important role of anaerobic is acceptable. Boxing matches require rounds of activities including intense and moderate movements (2); according to the physiological needs of sports branches, he said that anaerobic strength and power play an important role in being an elite athlete, and boxing has short stages with more intensity, in which the speed against the opponent's blows and dodging and repelling react blows. The opponent is important in it, and for this reason, boxing probably increases the speed of reaction.

That's why success in boxing and thus excelling in the competition has more to do with reaction speed and anaerobic muscular endurance than aerobic strength. The rapid changes of direction and explosive movements required to strike and counterattack are examples of intense activities common in boxing. Reaction speed, and muscular endurance, which is anaerobic, is strong predictors of successful performance in the sport of boxing. Therefore, boxers should be able to respond to the opponent's blows with a higher reaction speed and react in time. Also, since the sport of boxing consists of short-term activity periods with intense and anaerobic activities, boxers should have good muscular endurance to continue and tolerate such periods of intense and temporary activities for a short period. In bodybuilding, there are no such periods with intense and fast activities and bodybuilding exercises are made up of slow movements.

In the end, according to the findings of this research, it is concluded that boxing may be useful in improving the speed of reaction and muscle endurance, while bodybuilding may improve muscle strength, although to confirm these results, needs more.

References:

1. Chaabène H, Tabben M, Mkaouer B, Franchini E, Negra Y, Hammami M, et al. Amateur boxing: physical and physiological attributes. Sports Med. 2015 2015/03/01;45(3):337-352.
2. Kumar S, Rajput YS. interlimb asymmetry of maximal handgrip strength and wrist circumference in elite international male boxers. Physical Education Theory and Methodology. 2023;23(5):732-738.
3. Siavoshy H. Effects of resistance training on salivary hormone profile and immunoglobulin A in boxers adults with Down syndrome. Exceptional Education. 2016;9(137):60-64 (Persian).

4. Kapo S, El-Ashker S, Kapo A, Colakhodzic E, Kajmovic H. Winning and losing performance in boxing competition: a comparative study. Journal of Physical Education and Sport. 2021;21(3):1302-1308.
5. Cho S-S, Lee H-K, Kim K-W. Physical characteristics and dietary patterns of strength athletes; bodybuilders, weight lifters. Korean Journal of Community Nutrition. 2007;12(6):864-872.
6. De Pauw D, Vrijens J. Physique, muscle strength and cardiovascular fitness of weight-lifters. The Journal of sports medicine and physical fitness. 1972;12(3):193-200.
7. Katch VL, Katch FI, Moffatt R, Gittleson M. Muscular development and lean body weight in body builders and weight lifters. Med Sci Sports Exerc. 1980;12(5):340-344.
8. Kanehisa H, Ikegawa S, Fukunaga T. Body composition and cross- sectional areas of limb lean tissues in Olympic weight lifters. Scand J Med Sci Sports. 1998;8(5):271-278.
9. Nicolay CW, Walker AL. Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. Int J Ind Ergon. 2005 2005/07/01/;35(7):605-618.
10. Ruiz-Ruiz J, Mesa JLM, Gutiérrez A, Castillo MJ. Hand size influences optimal grip span in women but not in men. The Journal of Hand Surgery. 2002 2002/09/01/;27(5):897-901.
11. Dubrowski A, Carnahan H. Grip force when grasping moving cylinders. Int J Ind Ergon. 2004 2004/08/01/;34(2):69-76.
12. Siyavoshi H. Progressive tolerance exercises for young adults suffering from Down syndrome: A clinical experiment. Exceptional Education. 2013;5(118):68-71 (Persian).
13. Fry AC, Ciroslan D, Fry MD, leroux CD, Schilling BK, Chiu LZ. Anthropometric and performance variables discriminating elite American junior men weightlifters. The Journal of Strength & Conditioning Research. 2006;20(4):861-866.
14. Guidetti L, Musulin A, Baldari C. Physiological factors in middleweight boxing performance. Journal of sports medicine and physical fitness. 2002;42(3):309-314.
15. Khanna GL, Manna I. Study of physiological profile of Indian boxers. J Sports Sci Med. 2006;5(CSSI):90.
16. Sporrong H, Palmerud G, Herberts P. Hand grip increases shoulder muscle activity: An EMG analysis with static handcontractions in 9 subjects. Acta Orthop Scand. 1996;67(5):485-490.
17. Ramirez Garcia CM, Harasymowicz J, Arechiga Viramontes J, Alvear Ordenes I, Bonilla Vazquez F. Assessment of hand grip strength in Mexican boxers by training phase. Archives of Budo. 2010;6(1):1-6.
18. Heller J. Physiological profiles of elite badminton players aspects of age and gender. Br J Sports Med. 2010;44(Suppl I):17.
19. Güçlüöver A, Demirkan E, Kutlu M, Ciğerci AE, Esen HT. The comparison of some physical and physiological features of elite youth national and amateur badminton players. 2012.
20. Samavati Sharif MA, Bagheri S, Siavoshy H. Comparison Anthropometrical and Physiological Profile Between National Handball Women's Players and Hamadan's Handball Women's Players. Research on Biosciences and Physical Actiuity. 2015;2(3):47-54 (Persian).

Effect of 8 weeks of circuit training on serum levels of insulin-like growth factor-1 and growth hormone in elderly women

Javad Vakili[1], vahid sari sarraf[1], Fatemeh Baharavar[2*]

1. Associate professor of Exercise Physiology, Dept. of exercise physiology, Faculty of Physical Education and Sports Science, University of Tabriz, Iran.
2. MSc. In physiology, Faculty of Physical Education and Sports Science, University of Tabriz, Iran

Abstract

Background and Purpose: Aging is associated with a decrease in physical aspects. These days, the world is facing an increase in the number of elderly people, so determining the health of this group is very important and necessary. Growth hormone has strong anabolic and lipolytic feathers. Insulin-like growth factor-1 also stimulates these actions more. Insulin-like growth factor-1 has important effects on satellite cells, increases protein synthesis, muscular hypertrophy, and growth hormone directly facilitates the transfer of amino acids into cells by affecting cell membrane permeability and increases the absorption of amino acids. These hormones play an important role in the formation and regeneration of muscles. In older people, the compactness of these hormones decreases. This decrease can reduce muscle mass and increase fat mass and finally sarcopenia in the elderly. Physical and exercise activity can affect the secretion of hormones. Therefore, the aim of this study was to investigate the effect of 8 weeks circuit training on serum levels of insulin-like growth factor-1 and growth hormone in elderly females.

Material and Method: This present study was a quasi-experimental research design with pre-test and post-test. The statistical population was elderly inactive women aged 60 to 70 years in Tabriz that 23 women were randomly assigned (age: 64.84±3.2 years, weight: 72.71±7.45 kg and height: 157.09±3.61cm) and were divided into training (n=12) and control (n=11) groups. The women in the training group performed selected circuit training including aerobic and resistance exercises with an intensity of 40 to 60% of 1RM for an hour and 8 weeks. Exercises were for eight main muscle groups (quadriceps muscles, leg retractable muscles, leg retrograde muscles, serene muscles, fillet and hamstring muscles, calf muscles, pectoral muscles, dorsal muscles) and also one of the exercises was walking, that the intensity was measured according to resting heart rate. Circuit training was performed in 12 stations. Fasting blood sampling were taken 48 hours before and after the training protocol. Insulin-like growth factor-1 and growth hormone were assessed by ELISA method. Shapiro-wilk test was used for normal data distribution, analysis of variance (ANOVA) 2 × 2 and independent t-test were used at a significance level of $\alpha < 0.05$ in data analysis.

Result: Eight weeks of circuit training significantly increased insulin-like growth factor-1 and growth hormone levels ($p \leq 0.001$).

Conclusion: Regular circuit training could increase the growth and synthesis of muscle protein and their body Composition in the elderly due to the increase seen in insulin-like growth factor-1 and growth hormone levels.

Keywords: circuit exercises, insulin-like growth factor-1, growth hormone, elderly

---

[*] Corresponding Author; E-mail: baharavar@gmail.com

Effect of astaxanthin supplementation on immune responses in athletes: a review

MohammadHadi Asghari *[1], Ali Sami GonDoghdi [2], Afshin Rahbargazi [3]

[1] *Master's student in Sports Physiology, Shahid Madani University of Azerbaijan, Tabriz, Iran,* mohammadhadi.azaruniv.ac@gmail.com

[2] *Master's student in Sports Physiology, Shahid Madani University of Azerbaijan, Tabriz, Iran,* alisami199992@gmail.com

[3] *PhD in Sports Physiology, Mohaghegh Ardabili University, Ardabil, Iran,* afshinrahbar89@gmail.com

Abstract

Introduction: Astaxanthin is a red, fat-soluble oxycarotenoid that originates from seafood and has many antioxidant properties that are claimed to improve the immune response and inhibit the growth of cancer cells. Athletes are always exposed to physiological stress caused by exercise, which may cause oxidative stress, inflammation, as well as temporary negative changes in the number and function of immune cells, thus inducing immune system suppression and increasing the risk of infectious diseases. Previous studies have been inconclusive as to whether or not astaxanthin can seriously improve immune responses in athletes. In this review study, the effect of astaxanthin supplementation on immune responses in athletes has been investigated.

Method: Online literature search databases including Google Scholar, SPORTDiscus, PubMed, Web of Science, Science Direct, Scopus were searched to obtain scientific articles from 2000 to January 30, 2024, and articles related to the effect of astaxanthin on immune responses in athletes were used.

Results: Current studies show that astaxanthin, by increasing the production of immunoglobulins and regulating inflammatory factors, has the potential to reduce postexercise inflammation and facilitate immune system function. However, these observations in athletes and human samples did not report consistent and reliable results. Due to the lack of accurate and fully controlled scientific research, more and more comprehensive research is necessary in the future to comment on the effectiveness of astaxanthin supplementation on the immune system of athletes.

Conclusion: It seems that astaxanthin supplementation can modulate the immune response in athletes by preventing the significant reduction of immune cells and prevent the occurrence of related diseases.

Keywords: Astaxanthin, immune system, oxidative stress, athletes, exercise, supplementation.

1. Introduction

Today, sports are considered as one of the integral parts of people's lives around the world, and many people accept sports and physical activity as one of the cheap and fruitful ways to improve health, physical performance, and a healthy pastime, and participate in these activities. Although exercise and physical activities with controlled intensity and volumes have many physical and mental health benefits, including the prevention of diseases such as obesity, diabetes, various cancers, movement problems, and neuromuscular disorders [1, 2],but there are reports that show that these activities may lead to muscle damage, inflammation, increased oxidative stress, upper respiratory tract infections and immune system disorders [3]. It is widely accepted that sustained moderateintensity exercise of short to moderate duration (under 60 minutes) is associated with enhanced immune defenses [4]. However, bouts of intense or highvolume aerobic exercise may cause temporary negative changes in the number and function of immune cells, leading to immunosuppression, increased inflammation, and increased risk of infectious diseases [5, 6]. The immune system is considered one of the most important systems in the body, without its proper functioning, it will be impossible to continue living and it is divided into nonspecific or innate immunity and specific or acquired immunity [7]. As a physiological stressor, intense sports activity may lead to the response of the immune system and, as a result, a significant increase in immune indices [8]. Also, intense exercises can increase inflammation in the body by creating physiological stress beyond the capacity of the body's immune system [9]. In addition, it has been reported that intense exercises have negative effects on the function of immune cells and the secretion of immunoglobulins and cytokines involved in the immune system, which may eventually lead to suppression of the immune system and disease [9, 10]. Reactive oxygen and nitrogen species (RONS) produced during exercise are known to be the main agents of oxidative stress, and if exercise training is increasingly intense, the overproduction of RONS can affect the endogenous antioxidant defense system and cause causing oxidative stress [11]. As a result, lipid molecules, proteins and nucleic acids may be damaged and have potentially harmful effects on the normal physiological function of the body and the immune system [12]. Therefore, the use of nutritionbased strategies, including the recent emphasis on increasing the consumption of plant phytochemicals as countermeasures for exerciseinduced physiological stress, has been considered [12-14]. Astaxanthin (AX) is a plant supplement with abundant antioxidant power and has a unique molecular structure that may facilitate antioxidant, immunomodulatory, and antiinflammatory effects during physiological stress [15]. A number of studies show that astaxanthin plays a regulatory role in transcription factors involved in cellular homeostasis and inflammation [16]. In addition, astaxanthin may exert positive regulatory effects on the immune system by increasing the production of immunoglobulin and increasing the natural responses of lymphocytes to secrete IL6. Collectively, these data suggest that astaxanthin has the potential to reduce postexercise inflammation and immune system dysfunction [16, 17]. Although the studies that investigate the effect of AX on human samples and especially athletes are increasing [18-21], however, contradictory and unreliable results have been reported. Therefore, considering To the few results obtained in the field of the effectiveness of astaxanthin supplementation on the indicators and function of the body's immune system, during and after exercise in human samples and athletes, the focus of the current review study, a critical review of the current literature, is about astaxanthin and its potential use as a It is an effective nutritional supplement in modulating the responses of the immune system in athletes.

2. Research Method

to conduct this review, in order to access scientific articles related to the research topic, from 2000 to the end of 2023, a search was made in Google Scholar, SPORTDiscus, PubMed, Web of Science, Scopus Science Direct databases. Mainly in the title, summary and keywords of the studied articles, the words astaxanthin, immune responses, athletes, sports and supplements were searched in the mentioned databases. First, all relevant titles found in the databases were reviewed. Abstracts of studies related to the present study were selected and then duplicate articles were removed. In the following, a complete review of relevant references in the articles included in the study was done. The first person checked all the incoming articles independently and the next people checked the articles included in the research. The inclusion criteria for the current review were studies that investigated the effect of astaxanthin supplementation on immune system performance in athletes and were published in reliable domestic and foreign publications as well as in English, and were accessible in full text. A total of 1240 articles were found in the initial search, and 137 duplicate articles were removed in the initial review. Then, in the next step, based on the inclusion criteria, the title and abstract of the articles were reviewed and 1081 articles unrelated to the research topic were removed from the target list. Finally, among the remaining 22 articles that met the standards, 19 articles that were available in full text were included in the present review.

3. Result

3-1. Astaxanthin

Astaxanthin ("3,3-dihydroxy-"β,β-carotene--"4,4dione) is a naturally occurring xantophilic carotenoid found in marine species such as microalgae, crustaceans, fish, and some birds [22]. AX is made from carbon precursors. This metabolite is zeaxanthin canthaxanthin, which has hydroxyl and ketone functional groups [23]. AX is fat-soluble and is different from other carotenoids and has a molecular mass of 596.84 g/mol with the formula C40H52O4. Also, this metabolite has double bonds. (double = bond) in its center, which gives it antioxidant properties [22-25].

3-2. Sources of astaxanthin

The human body is unable to synthesize astaxanthin. Therefore, it should be obtained from external sources in the body and consumption of foods such as salmon, crab and shrimp [25]. AX sources mainly include yeasts, krill, salmon, microalgae, shrimp and crab, but the main source of astaxanthin is a type of algae called Haematococcus pluvialis [25, 26]. On the other hand, it is possible to get AX through regular food supplements, with a typical intake of 4 mg per day. Like other carotenoids, astaxanthin, along with fatty acids, is absorbed through passive diffusion in the intestinal epithelium to be transported to body tissues and protect cells such as skin, nucleic acids, phospholipid membranes and proteins involved in the immune system against oxidative stress [27].

3-3. Mechanism of action of astaxanthin

The mechanism by which astaxanthin enhances immunity is complex, but it is speculated that it may be closely related to the antioxidant activities of astaxanthin. Single oxygen has a cytotoxic effect on the immune system, which can lead to the destruction of the cell membrane of macrophages, and as a result, the phagocytic efficiency and the ability to present antigens decrease [28]. Free radicals can also attack T lymphocytes and B lymphocytes. T lymphocytes are mediators of cellular immunity and their activation and proliferation play an essential role in the immune response [29]. After being stimulated by an antigen, T lymphocytes stimulate the immune response and destroy the antigen. Also, B cells, after stimulation, can produce antibodies such as IgG, IgA, IgE and IgM, which bind to antigens and clear them. When these two immune cells are attacked by free radicals, the entire immune system is affected [28, 29]. It has been reported that astaxanthin has a very strong antioxidant activity with antioxidant activity 10 times higher than other carotenoids such as β-carotene and 100 times higher than α-tocopherol (vitamin E) [30, 31]. It seems that AX has a relatively high affinity for singlet oxygen and peroxyl radical intermediates [32]. In addition, astaxanthin is capable of scavenging and deactivating peroxyl radical intermediates, a function that is probably dependent on the formation of resonance-centered radical adducts [32, 33]. Thus, the use of AX has been suggested due to its ability to broadly protect lipid, phospholipid, and amino acid structures against peroxidation during periods of oxidative stress [18, 24, 32, 34]

In addition to the effective role of astaxanthin in dealing with oxidative stress and free radicals, recent studies show that AX has a strong effect in dealing with the reduction of proteins related to immune function [35]. In fact, the main soluble proteins for humoral immunity are immunoglobulins that can combine with specific antigens as a functional component of the host's defense system. In this regard, several studies have shown that astaxanthin can increase immunoglobulin production under different conditions [36, 37]. It has also been reported that astaxanthin increased the production of IgA and IgG by human lymphocytes in response to T-cell dependent stimuli [38]. In animal studies, evidence suggests that astaxanthin supports the increase in IgA and IgM production in plasma and other biomarkers of immune function in dogs and cats fed with astaxanthin [39, 40]. In this regard, it has been reported that AX can enhance cellular and humoral immune functions. In terms of non-specific immunity, experimental results showed that astaxanthin can increase the carbon particle clearance rate of mononuclear macrophages in mice and the phagocytosis of chicken red blood cells by mouse peritoneal macrophages, which can increase the activity of natural killer (NK) cells. Increase in high dose Non-specific immunity was also significantly increased [37]. Davinelli [41], during a study in which mice infected with Heliobacter-pylori were treated with astaxanthin extracted from shrimp, observed that astaxanthin increased the secretion of interferon-gamma (IFN-γ), interleukin-1 (IL-1) and interleukin-6 (IL-6) from spleen leukocytes of infected mice. As a result, they showed that astaxanthin extracted from shrimp has the potential to increase humoral immunity [41]. According to these data, it can be said that astaxanthin, with its strong antioxidant properties, can be effective in modulating immune responses.

3-4. Immune system and exercise

The body's immune system is considered one of the important systems without its proper functioning, it will be impossible to continue living. This system protects people through various cellular and molecular mechanisms and is designed to recognize its own cells and substrates and also has the ability to recognize and destroy foreign organisms. In this way, it maintains the homeostasis of the body. There are two main branches of the immune system, which are divided into non-specific or innate and specific or acquired immune system. Immunoglobulins are part of the important elements of the immune system, which are mainly produced by B lymphocytes in blood serum and tissue fluids [7, 42]. Immunoglobulin (IgG) G, as the main antibody in the secondary immune response, in addition to activating the complement system, facilitates the phagocytosis of bacteria and enables the release of inflammatory factors. Immunoglobulin (IgA) A plays an effective defensive role against local infections in centers such as the respiratory and digestive system, and immunoglobulin (IgM) M is also of particular importance in acquired immunity as the first antibody released in response to infection [43-45]. Also, circulating leukocytes and neutrophils are important factors that play a role in inducing immune responses.

Although the health-oriented benefits and positive psychological aspects of exercise are not hidden from anyone, but besides these benefits, intense and uncontrolled exercises can cause severe physiological stress and dysfunction of the immune system [46]. Intense exercise training may reduce the body's resistance and be considered as a predisposing factor for immune disorders and various infections. Many elite athletes have reported significant bouts of respiratory infections that have impaired their ability to compete and train [47]. The mechanisms underlying exercise-induced immunosuppression, known as the "open window", are multifactorial and include neural and metabolic factors such as catecholamines, cytokines, cortisol, and growth hormones [48]. Immunosuppression usually occurs after intensive training protocols, which leads to increased levels of inflammation, metabolic and oxidative stress [49]. In this regard, it has been reported that the level of serum immunoglobulins decreases one day after intense exercise and B lymphocytes are suppressed [50]. An important immunological marker that is usually investigated in sports science is immunoglobulin A (IgA), which can be measured in blood and saliva. IgA is the first line of defense against viruses and bacteria on the mucosal surface of the respiratory tract. An increase in IgA can be a protective factor for infectious diseases of the respiratory tract, and at the same time, a decrease in IgA can facilitate pathogen adhesion and penetration into the mucosal epithelium [51, 52]. Suppression of the immune system caused by exercise can lead to various complications, including a decrease in the athlete's performance, an increase in the probability of contracting various viral diseases such as an upper respiratory tract infection, and an increase in the psychological and physiological imbalance of the body [53]. Also, intense aerobic exercise increases oxidative stress, activates and secretes high amounts of pro-inflammatory cytokines (TNF-α, IL-6 and cortisol), which will ultimately result in an imbalance between the immune-inflammatory and antioxidant systems [54]. Many studies show that heavy sports, by causing acute physiological stress and increasing the production of free radicals and cortisol secretion, cause a decrease in the production of antibodies and immunoglobulins, especially IgA, and as a result, disrupt the functioning of the immune system [55, 56]. In addition, it has been reported that intense intermittent exercise caused a significant increase in leukocytes and neutrophils. Although the number of neutrophils increased after exercise, their function was decreased. This could be due to the increase in immature neutrophils released from the bone marrow. Also, the decrease in the number and function of lymphocytes during and after intermittent exercise is one of the common concerns in this field [4, 47]. Therefore, in order to maintain the health and performance of athletes, adopting effective nutritional strategies And it is necessary to use the best food supplements to maintain the performance of the athletes' immune system. In this regard, recently the use of astaxanthin herbal supplement as an antioxidant and immune system modulator has attracted the attention of scientific communities.

3-5. Astaxanthin and immune responses in exercise

Intense training sessions and competitive events increase multiple physiological stresses such as muscle damage, oxidative stress, inflammation, and weakening of the immune system [57]. Therefore, investigating strategies that can reduce the negative impact of exercise-induced physiological stress has become increasingly popular. New studies show that using food supplements can support the function of the immune system after exercise and reduce the intensity of inflammation [58]. It has been reported that AX, due to its antioxidant composition, can inhibit oxidative stress and reduce its consequences by inhibiting both pro-oxidant and pro-inflammatory mediators [59, 60].

Some researchers believe that astaxanthin can improve the differentiation and proliferation of B lymphocytes in sports injury model animals and significantly increase the level of serum immunoglobulins IgA, IgM and IgG [61]. Others have shown that astaxanthin increased cytotoxic T lymphocyte activity in mice and inhibited stressinduced suppression of NK cell activity [62]. In other study, astaxanthin heightened NK cell cytotoxic activity [63]. Activated T cells and NK cells produce IFNg, which is involved in immuneregulation, B cell differentiation, and antiviral activity. IFNg production was higher in subjects supplemented with astaxanthin, similar to the response in mice given astaxanthin [61, 64]. Splenocytes of tumorbearing mice fed Astaxanthin decreased bacterial load and gastric inflammation in mice infected with Helicobacter pylori by shifting the Tlymphocyte response from a Th1 response dominated by IFNg to a Th1/Th2 response dominated by IFNg and IL4 [65].

Although the number of studies on the effect of AX on the proteins of the immune system and inflammatory indicators in humans, especially in athletes, is very small, but recently, a number of studies investigating this carotenoid are increasing.

In this regard, Yuan et al [66] reported in a review study that astaxanthin has the potential effects of improving health and the immune system and protecting against inflammation and various diseases such as cancers, chronic inflammatory diseases, metabolic syndrome, diabetes, cardiovascular diseases and Fatigue caused by exercise [66]. Also, Liu et al [67] reported in a short review study that astaxanthin may contribute to intestinal immune homeostasis by directly regulating IgA production and maturation of gut-related immune tissues, thus preventing or preventing dysbiosis. They delay [67]. Park et al [18] conducted a study with the aim of studying the function of dietary astaxanthin in modulating the immune response, oxidative status and inflammation in adult women. 14 participants with a mean age of 21.5 years received 8 mg of astaxanthin daily for 8 weeks in a randomized, double-blind, placebo-controlled study. Immune response was checked in the first, fourth and eighth weeks and the tuberculin test was performed in the 8th week. The results indicated that dietary astaxanthin stimulated mitogen-induced lymphoid proliferation, increased the cytotoxic activity of natural killer cells, and increased the total subpopulations of T and B cells, but did not affect T helper or natural killer T cell populations. They also reported a higher percentage of leukocytes in those who received 2 mg of AX at week 8. There was no difference in TNF and IL-2 concentrations, but plasma IFN-γ and IL-6 were increased at week 8 in subjects receiving 8 mg astaxanthin. This study shows that AX can facilitate the immune and inflammatory responses of the body by increasing the activity of immune cells and increasing the secretion of IL-6 [18]. Recently, a human study investigating the effect of astaxanthin on immunoglobulin sA, oxidative stress, and exercise-induced inflammation in young soccer players showed that astaxanthin supplementation increased sIgA levels, which may protect against exercise-induced mucosal immunodeficiency have protection [15]. Also Nieman et al [21] conducted a study on healthy male and female runners. In this study, a randomized, double-blind, placebo-controlled crossover design with two weekly supplementation periods and a 2-week washout period was used. Study participants were randomly assigned to astaxanthin and placebo trials and consumed daily for 4 weeks before running for 2.25 hours with 70% of VO2max. Blood samples were measured 1 hour before exercise and 1.5 and 24 hours after exercise. Results showed that AX supplementation counteracted exercise-induced decreases in 82 plasma proteins during 24-hour recovery, but had little effect on exercise-induced increases in most inflammation-related factors, including six plasma cytokines and IL-6 [21]. The difference in the results may be related to the training status, physical fitness, demographic and fitness status of the participants, duration of supplement use and other background factors [68]. These results suggest that the demographics of the subjects may be a confounding variable for the performance of astaxanthin. Therefore, future research should consider participant demographics such as training status, training protocols implemented, amount, duration, and manner of supplement consumption, as well as appropriate measurement tools [69-71]. It is worth noting that all Ax used in the human studies presented in this review used natural sources of Ax. However, due to the small number of studies, at present, no conclusions can be drawn about ergogenic effects in humans.

4. Conclusion

In summary, most studies support the positive effect of astaxanthin on immune system function, in both laboratory mouse models and human samples, which is partially attributed to the strong antioxidant capacity of this xanthophyll carotenoid. Despite this evidence, contradictory results are still reported, which may be due to factors such as the difference in the number of confounding factors in animal models and human samples, bioavailability of astaxanthin, absorption and metabolism of AX, diet and habits such as smoking. Therefore, future research is needed with special emphasis on scientific accuracy and contemporary considerations and adopting appropriate cognitive and analytical strategies and methods. By accomplishing this, a stronger conclusion can be made regarding the use of astaxanthin as a dietary supplement for athletes.

Acknowledgment: This research had no financial sponsor.

References:

[1] Adamu, B., M. Sani, and A. Abdu, *Physical exercise and health: a review.* Nigerian Journal of Medicine, 2006. **15**(3): p. 190-196.
[2] Ruegsegger, G.N. and F.W. Booth, *Health benefits of exercise.* Cold Spring Harbor perspectives in medicine, 2018. **8**(7): p. a029694.
[3] Nurmasitoh, T., *Physical activities, exercises, and their effects to the immune system.* JKKI: Jurnal Kedokteran dan Kesehatan Indonesia, 2015: p. 52-58.
[4] Nieman, D.C. and L.M. Wentz, *The compelling link between physical activity and the body's defense system.* Journal of sport and health science, 2019. **8**(3): p. 201-217.
[5] Gonçalves, C.A.M., et al., *Effect of acute and chronic aerobic exercise on immunological markers: a systematic review.* Frontiers in physiology, 2020. **10**: p. 1602.
[6] Souza, D., et al., *Acute and chronic effects of interval training on the immune system: a systematic review with meta-analysis.* Biology, 2021. **10**(9): p. 868.
[7] chroeder Jr, H.W. and L. Cavacini, *Structure and function of immunoglobulins.* Journal of allergy and clinical immunology, 2010. **125**(2): p. S41-S52.
[8] Zwetsloot, K.A., et al., *High-intensity interval training induces a modest systemic inflammatory response in active, young men.* Journal of inflammation research, 2014: p.9-17.
[9] Metsios, G.S., R.H. Moe, and G.D. Kitas, *Exercise and inflammation.* Best practice & research Clinical rheumatology, 2020. **34**(2): p. 101504.
[10] Davison, G., *Innate immune responses to a single session of sprint interval training.* Applied physiology, nutrition, and metabolism, 2011. **36**(6): p. 395-404.
[11] Dalle-Donne, I., et al., *Biomarkers of oxidative damage in human disease.* Clinical chemistry, 2006. **52**(4): p. 601-623.
[12] Pingitore, A., et al., *Exercise and oxidative stress: Potential effects of antioxidant dietary strategies in sports.* Nutrition, 2015. **31**(7-8): p. 916-922.
[13] Peternelj, T.-T. and J.S. Coombes, *Antioxidant supplementation during exercise training: beneficial or detrimental?* Sports medicine, 2011. **41**: p. 1043-1069.
[14] Slattery, K., D. Bentley, and A.J. Coutts, *The role of oxidative, inflammatory and neuroendocrinological systems during exercise stress in athletes: implications of antioxidant supplementation on physiological adaptation during intensified physical training.* Sports Medicine, 2015. **45**: p. 453-471.
[15] Baralic, I., et al., *Effect of astaxanthin supplementation on salivary IgA, oxidative stress, and inflammation in young soccer players.* Evidence-based complementary and alternative medicine, 2015. **2015**.
[16] Galasso, C., et al., *On the neuroprotective role of astaxanthin: new perspectives?* Marine drugs, 2018. **16**(8): p. 247.
[17] Davinelli, S., et al., *Astaxanthin as a modulator of Nrf2, NF-κB, and their crosstalk: molecular mechanisms and possible clinical applications.* Molecules, 2022. **27**(2): p. 502.
[18] Park, J.S., et al., *Astaxanthin decreased oxidative stress and inflammation and enhanced immune response in humans.* Nutrition & metabolism, 2010. **7**: p. 1-10.
[19] Wu, L., et al., *Effect of astaxanthin supplementation on antioxidant capacity, blood lactate and blood uric acid metabolism in human recovery stage after exercise.* Adv Biosci Bioeng, 2019. **7**: p. 60.

[20] Barker, G.A., et al., *Astaxanthin Supplementation Reduces Subjective Markers of Muscle Soreness following Eccentric Exercise in Resistance-Trained Men.* Muscles, 2023. **2**(2): p. 228-237.

[21] Nieman, D.C., et al., *Astaxanthin supplementation counters exercise-induced decreases in immune-related plasma proteins.* Frontiers in Nutrition, 2023. **10**: p. 373.

[22] Nishida, Y., et al., *Astaxanthin: Past, Present, and Future.* Marine Drugs, 2023. **21**(10): p. 514.

[23] Zhu, X., et al., *Sustainable production of astaxanthin in microorganisms: The past, present, and future.* Critical Reviews in Food Science and Nutrition, 2023. **63**(30): p. 10239-10255.

[24] Choi, S. and S. Koo, *Efficient syntheses of the keto-carotenoids canthaxanthin, astaxanthin, and astacene.* The Journal of organic chemistry, 2005. **70**(8): p. 3328-3331.

[25] Stachowiak, B. and P. Szulc, *Astaxanthin for the food industry.* Molecules, 2021. **26**(9): p. 2666.

[26] Cao, Y., et al., *Dietary astaxanthin: an excellent carotenoid with multiple health benefits.* Critical Reviews in Food Science and Nutrition, 2023. **63**(18): p. 3019-3045.

[27] Ng, Q.X., et al., *Effects of astaxanthin supplementation on skin health: A systematic review of clinical studies.* Journal of Dietary Supplements, 2021. **18**(2): p. 169-182.

[28] Munoz, M., et al., *Measurement of reactive oxygen intermediate production in haemocytes of the penaeid shrimp, Penaeus vannamei.* Aquaculture, 2000. **191**(1-3): p. 89-107.

[29] Valko, M., et al., *Free radicals and antioxidants in normal physiological functions and human disease.* The international journal of biochemistry & cell biology, 2007. **39**(1): p. 44-84.

[30] Kidd, P., *Astaxanthin, cell membrane nutrient with diverse clinical benefits and anti-aging potential.* Altern Med Rev, 2011. **16**(4): p. 355-364.

[31] Fassett, R.G. and J.S. Coombes, *Astaxanthin in cardiovascular health and disease.* Molecules, 2012. **17**(2): p. 2030-2048.

[32] Visioli, F. and C. Artaria, *Astaxanthin in cardiovascular health and disease: mechanisms of action, therapeutic merits, and knowledge gaps.* Food & Function, 2017. **8**(1): p. 39-63.

[33] Naguib, Y.M., *Antioxidant activities of astaxanthin and related carotenoids.* Journal of agricultural and food chemistry, 2000. **48**(4): p. 1150-1154.

[34] Choi, H.D., Y.K. Youn, and W.G. Shin, *Positive effects of astaxanthin on lipid profiles and oxidative stress in overweight subjects.* Plant foods for human nutrition, 2011. **66**: p. 363-369.

[35] Pashkow, F.J., D.G. Watumull, and C.L. Campbell, *Astaxanthin: a novel potential treatment for oxidative stress and inflammation in cardiovascular disease.* The American journal of cardiology, 2008. **101**(10): p. S58-S68.

[36] Fakhri, S., et al., *Astaxanthin: A mechanistic review on its biological activities and health benefits.* Pharmacological research, 2018. **136**: p. 1-20.

[37] Fan, Q., et al., *Study on the Enhancement of Immune Function of Astaxanthin from Haematococcus pluvialis.* Foods, 2021. **10**(8): p. 1847.

[38] Lin, K.-H., et al., *Astaxanthin, a carotenoid, stimulates immune responses by enhancing IFN-γ and IL-2 secretion in primary cultured lymphocytes in vitro and ex vivo.* International journal of molecular sciences, 2015. **17**(1): p. 44.

[39] Chew, B.P., et al., *Dietary astaxanthin enhances immune response in dogs.* Veterinary Immunology and Immunopathology, 2011. **140**(3-4): p. 199-206.

[40] Park, J.S., et al., *Astaxanthin stimulates cell-mediated and humoral immune responses in cats.* Veterinary Immunology and Immunopathology, 2011. **144**(3-4): p. 455-461.

[41] Davinelli, S., et al., *Astaxanthin from shrimp cephalothorax stimulates the immune response by enhancing IFN-γ, IL-10, and IL-2 secretion in splenocytes of Helicobacter pylori-infected mice.* Marine Drugs, 2019. **17**(7): p. 382.

[42] Venet, F., et al., *Assessment of plasmatic immunoglobulin G, A and M levels in septic shock patients.* International immunopharmacology, 2011. **11**(12): p. 2086-2090.

[43] Ataeimehr, B., et al., *Study on Effect of Aloe vera (Aloe vera) on Changes of Immunoglobulins IgM, IgA and IgG, Total protein and Differential Counts of white blood cells of Rainbow trout (Oncorynchus mykiss).* Journal of Animal Research (Iranian Journal of Biology), 2014. **27**(1): p. 89-99.

[44] Chaigne, B. and L. Mouthon, *Mechanisms of action of intravenous immunoglobulin.* Transfusion and Apheresis Science, 2017. **56**(1): p. 45-49.

[45] Hand, T.W. and A. Reboldi, *Production and function of immunoglobulin A.* Annual review of immunology, 2021. **39**: p. 695-718.

[46] Wang, J., et al., *Exercise regulates the immune system.* Physical Exercise for Human Health, 2020: p. 395-408.

[47] Brolinson, P.G. and D. Elliott, *Exercise and the immune system.* Clinics in sports medicine, 2007. **26**(3): p. 311-319.

[48] Walsh, N.P., *Recommendations to maintain immune health in athletes.* European journal of sport science, 2018. **18**(6): p. 820-831.

[49] Walsh, N.P., et al., *Position statement part one: immune function and exercise.* 2011.

[50] Hejazi, K. and S.-R.A. Hosseini, *Influence of selected exercise on serum immunoglobulin, testosterone and cortisol in semi-endurance elite runners.* Asian journal of sports medicine, 2012. **3**(3): p. 185.

[51] Bishop, N.C. and M. Gleeson, *Acute and chronic effects of exercise on markers of mucosal immunity.* Frontiers in Bioscience-Landmark, 2009. **14**(12): p. 4444-4456.

[52] Moreira, A., et al., *Monitoring internal training load and mucosal immune responses in futsal athletes.* The Journal of Strength & Conditioning Research, 2013. **27**(5): p. 1253-1259.

[53] Gleeson, M., *Immune function in sport and exercise.* Journal of applied physiology, 2007.

[54] Athanasiou, N., G.C. Bogdanis, and G. Mastorakos, *Endocrine responses of the stress system to different types of exercise.* Reviews in Endocrine and Metabolic Disorders, 2023. **24**(2): p. 251-266.

[55] Forte, P., L. Branquinho, and R. Ferraz, *The relationships between physical activity, exercise, and sport on the immune system.* 2022, MDPI. p. 6777.

[56] Agha-Alinejad, H., et al., *A guide to different intensities of exercise, vaccination, and sports nutrition in the course of preparing elite athletes for the management of upper respiratory infections during the COVID-19 pandemic: a narrative review.* International journal of environmental research and public health, 2022. **19**(3): p. 1888.

[57] Bloomer, R.J., *Effect of exercise on oxidative stress biomarkers.* Advances in clinical chemistry, 2008. **46**: p. 1-50.

[58] Pedersen, B.K., et al., *Nutrition, exercise and the immune system.* Proceedings of the Nutrition Society, 1998. **57**(1): p. 43-47.

[59] Aoi, W., et al., *Astaxanthin limits exercise-induced skeletal and cardiac muscle damage in mice.* Antioxidants and Redox Signaling, 2003. **5**(1): p. 139-144.

[60] Lee, S.-J., et al., *Astaxanthin inhibits nitric oxide production and inflammatory gene expression by suppressing IkappaB kinase-dependent NF-kappaB activation.* Molecules and cells, 2003. **16**(1): p. 97-105.

[61] Jyonouchi, H., L. Zhang, and Y. Tomita, *Studies of immunomodulating actions of carotenoids. II. astaxanthin enhances in vitro antibody production to T‐ dependent antigens without facilitating polyclonal B‐ cell activation.* 1993.

[62] Kurihara, H., et al., *Contribution of the antioxidative property of astaxanthin to its protective effect on the promotion of cancer metastasis in mice treated with restraint stress.* Life sciences, 2002. **70**(21): p. 2509-2520.

[63] Jyonouchi, H., et al., *Antitumor activity of astaxanthin and its mode of action.* Nutrition and cancer, 2000. **36**(1): p. 59-65.

[64] Jyonouchi, H., et al., *Astaxanthin, a carotenoid without vitamin A activity, augments antibody responses in cultures including T-helper cell clones and suboptimal doses of antigen.* The Journal of nutrition, 1995. **125**(10): p. 2483-2492.

[65] Bennedsen, M., et al., *Treatment of H. pylori infected mice with antioxidant astaxanthin reduces gastric inflammation, bacterial load and modulates cytokine release by splenocytes.* Immunology letters, 2000. **70**(3): p. 185-189.

[66] Yuan, J.P., et al., *Potential health‐promoting effects of astaxanthin: a high‐value carotenoid mostly from microalgae.* Molecular nutrition & food research, 2011. **55**(1): p. 150-165.

[67] Lyu, Y., et al., *Carotenoid supplementation and retinoic acid in immunoglobulin A regulation of the gut microbiota dysbiosis.* Experimental Biology and Medicine, 2018. **243**(7): p. 613-620.

[68] Res, P.T., et al., *Astaxanthin supplementation does not augment fat use or improve endurance performance.* Med Sci Sports Exerc, 2013. **45**(6): p. 1158-65.

[69] Goedecke, J.H., et al., *Determinants of the variability in respiratory exchange ratio at rest and during exercise in trained athletes.* American Journal of Physiology-Endocrinology and Metabolism, 2000. **279**(6): p. E1325-E1334.

[70] Achten, J., M. Gleeson, and A.E. Jeukendrup, *Determination of the exercise intensity that elicits maximal fat oxidation.* Medicine and science in sports and exercise, 2002. **34**(1): p. 92-97.

[71] Venables, M.C., J. Achten, and A.E. Jeukendrup, *Determinants of fat oxidation during exercise in healthy men and women: a cross-sectional study.* Journal of applied physiology, 2005. **98**(1): p. 160-167.

Effect of purslane supplementation on oxidative stress in athletes: a review

Ali Sami GonDoghdi *[1], **MohammadHadi Asghari** [2], **Afshin Rahbargazi** [3]

[2] *Master's student in Sports Physiology, Shahid Madani University of Azerbaijan, Tabriz, Iran,* alisami199992@gmail.com

[1] *Master's student in Sports Physiology, Shahid Madani University of Azerbaijan, Tabriz, Iran,* mohammadhadi.azaruniv.ac@gmail.com

[3] *PhD in Sports Physiology, Mohaghegh Ardabili University, Ardabil, Iran,* *afshinrahbar89@gmail.com*

Abstract

Introduction: Purslane (PORTULACA) is a medicinal plant with high environmental compatibility that can grow in hot weather conditions and grows in most parts of the world except Antarctica. This plant is a rich source of omega-3 fatty acids and Alinolenic acid, which may act as antioxidants during oxidative stress. Intense sports activities increase the production of free radicals and induce oxidative stress. These events ultimately lead to the creation of mechanical and metabolic stress on the human body, which can hinder cellular and tissue function. Recent studies show that taking supplements as a strong antioxidant can prevent injuries caused by stress and muscle injuries caused by exercise.

Method: In order to access scientific articles between the years 2000 and the end of 2023, the keywords related to the present research, which included: purslane, oxidative stress, athletes and sports. The following databases were used to find out the articles that related with keywords: Google Scholar, Sport Discus, IranDoc, PubMed, Web of Science, Science Direct and Scopus. And the articles related to the effect of purslane on oxidative stress in athletes were used.

Results: A total of 310 articles were found, which by limiting the search, unrelated studies and removing duplicates, then after cheking titles, abstracts and full texts and detailed evaluation and checking the inclusion and exclusion conditions, 24 articles related to the subject of the current research were entered the research.

Conclusion: Purslane supplement with its antioxidant properties seems to be able to improve the state of oxidative stress in athletes and prevent secondary injuries.

Keywords: Purslane, Oxidativestress, Athelets, exersice, Exercised mice.

1.INTRODUCTION

Today's developed society is undergoing major changes, not always of a positive nature, some of which seem to affect health, well-being, and especially longevity. Staying healthy is important and affects a healthy lifestyle [1]. A physically active lifestyle is important for all age groups. There are many reasons to participate in sports and physical activity, such as enjoyment and relaxation, competition, socialization, maintaining and improving fitness and health. Regular physical activity reduces the risk of premature death in general and the risk of coronary heart disease, high blood pressure, colon cancer, obesity and diabetes in particular. However, participating in sports also carries the risk of injury, which in some cases may lead to permanent disability [2]. Intense sports without proper nutritional supplements cause physiological and morphological damage. The highest rate of injury is seen in athletes aged 15 to 25 in team sports such as football, basketball, handball and etc. The incidence of these injuries is 3 to 5 times higher among women than men [3]. There are also reports that these activities may lead to muscle damage, inflammation, increased oxidative stress, upper respiratory tract infections, and immune system disruption [4]. It has been proven that intense exercise increases the production of free radicals and induces oxidative stress [5]. Several studies have reported the induction of oxidative stress in elite team athletes during the sports season, especially during periods with high training and competitive loads [6]. In particular, while regular exercise increases antioxidant regulation and repair of oxidative damage, acute exercise causes a wide range of ROS and RNS in the body. Also, heavy exercise by anaerobic metabolism causes oxidative damage to proteins, DNA and secondary inflammation caused by the phagocytic activity of immune cells by reducing antioxidant defense [7]. Several studies have shown that nutritional interventions and purslane supplementation have a significant effect on oxidative stress, inflammatory indicators, diabetes, cancer and also protect the nervous system. Purslane derives its benefits from polyunsaturated fatty acids and omega-3 fatty acids, beta-carotene, alkaloids, flavonoids, polysaccharides, vitamin C, vitamin E, cardiac glycosides, coumarins, and anthraquinone glycosides [8]. Purslane extract along with its antioxidant compounds such as omega-3 fatty acids, galutanins, α-tocopherols, ascorbic acid, apigenin, quercetin and kaempferol can reduce or improve the oxidative damage caused by hydrogen peroxide in human lymphocytes [9]. Considering that the number of studies investigating the effects of purslane on the oxidative stress of athletes is very limited, the focus of the current review is a critical review of the current literature on purslane and its potential use as an effective nutritional supplement in improving the oxidative stress status of athletes.

2. MATERIALS AND METHODS

To carry out the present review, in order to access scientific articles related to the research topic, from 2000 to the end of 2023, a search was made in Google Scholar, PubMed, SportDiscus, Web of Science, Scopus, IranDoc and Science Direct databases. Mainly in the title, summary and keywords of the studied articles, the words purslane, oxidative stress,exersiced mise, athletes and sports were searched in the mentioned databases. Also, in order to access the Latin articles, the English equivalent of the keywords was searched in all databases. First, all relevant titles found in the databases were reviewed. Abstracts of studies related to the present study were selected and then duplicate articles were removed. In the following, a complete review of relevant references in the articles included in the study was done. The first person checked all the incoming articles independently and the next people checked the articles included in the research. The inclusion criteria for this review were studies that investigated the effects of purslane supplementation on oxidative stress in athletes and were published in reliable domestic and foreign publications, as well as in English or Persian, and were accessible in full text. A total of 310 articles were found in the initial search, and 68 duplicate articles were removed in the initial review. Then, in the next step, based on the inclusion criteria, the title and abstract of the articles were reviewed and 207 articles unrelated to the research topic were removed from the list. Finally, among the remaining 35 articles that met the standards, 24 articles that were available in full text were included in the present review.

3.RESULTS

3.1 OXIDATIVE STRESS

Oxidative stress indicates an imbalance between reactive oxygen species (ROS) and the ability of the antioxidant system to neutralize and inhibit its toxic mediators or repair damage. Any disturbance and disturbance in the natural oxidation-reduction (redox) state, through the production of peroxide and free radicals, leads to the production of toxic effects and damage to all intracellular components and structures, including proteins, lipids and DNA [10]. Free radicals are molecules that contain one or more unpaired electrons that have a high chemical reactivity to accept electrons. The most important free radical in the body is oxygen, which destroys molecules, cells, and DNA by taking a single electron from other molecules when exposed to various radiations, physiological stress, or smoke from smoking. Physiological stress, fat peroxidation and mitochondrial cellular respiration are the main sources of free radicals in the body [11]. Also, oxidative stress caused by cellular respiration can lead to damage to nucleotide bases and breaks in DNA strands. Damage to bases is often caused indirectly by reactive oxygen species such as O2- (superoxide radical), OH (hydroxyl radical) and H2O2 (hydrogen peroxide) [12]. The body's endogenous antioxidant defense system and the use of antioxidant supplements are the most important defense lines of the body against oxidative stres [13].

3.2 ANTIOXIDANTS

Antioxidants are molecules that protect the body against free radicals, so that the possible harmful effects of these free radicals are controlled. Therefore, it can be said that antioxidants stabilize the reaction of free radicals. Some antioxidants may be enzymes such as glutathione reductase, superoxide dismutase, and catalase, which are part of the endogenous antioxidant system [14]. Exogenous antioxidants can also be obtained from supplements and diets, which are absorbed by the body in two forms, soluble in water and soluble in fat. Vitamins A-C-E and beta-carotene are the most common and famous types of antioxidants [15]. Also, purslane plant has been suggested as a strong antioxidant in recent studies [16].

3.3 PURSLANE

Purslane is a plant with high nutritional value that contains biologically active compounds, vitamins, omega-3 unsaturated fatty acids, beta-carotene, beta-tocopherol, glutathione and many amino acids such as L-isoleucine, L-leucine, L-lysine, L-methionine, L-cysteine, L-phenylalanine, L-tyrosine, L-threonine and L-valine [17]. Purslane also contains galutanins, kaempferol, quercetin, apigenin, coumarins, alkaloids and anthraquinone glycosides [18]. Inhibition of free radicals, reduction of lipid peroxidation, and inhibition of nuclear factor-kappa-chain-type enhancer of activated B cells (NF-κB) pathway are possible mechanisms of purslane against oxidative stress [19].

3.4 PURSLANE SOURCES

Purslane is an annual plant with succulent stems, alternating leaves and small yellow flowers. This plant grows a lot in Iran and is used as an oral and traditional medicine, which is from the strain of PORTULACACEAE plants [20].

3.5 PURSLANE EFFECT MECHANISM

Purslane is a rich source of omega-3, B-carotene, flavonoids, glutathione, phenolic components, amino acids, complexes and some other minerals and tocopherol compounds, polysaccharides, biologically active vitamins such as dopamine and norepinephrine [21]. In areas where this "weed" is eaten, the risk of cancer and heart disease is low, possibly due to the naturally occurring omega-3 fatty acids found in purslane .Purslane is also used as an antiseptic, anti-diuretic, and vermifuge in mouth ulcers and urinary discomforts [22]. Recent research shows that it has a wide range of biological effects, including skeletal muscle relaxant, analgesic and anti-inflammatory, antifungal effects [23]. Also, it has shown other beneficial effects such as antidiabetic and wound healing properties [24, 25]. In addition, purslane may have an antioxidant effect caused by vitamin A deficiency [26]. It has been reported that many natural products affect antioxidant systems and are good cell protective agents. SOD, CAT, GPx, GST and GR play an important role in biological systems to act against oxidative stress [27]. The protective role of glutathione, as an antioxidant and detoxification agent, has been shown in various clinical studies [28]. It is a ubiquitous compound that is rapidly synthesized in the liver, kidney, and other tissues, including the gastrointestinal tract. In animal cells, glutathione acts as a substrate for glutathione peroxidase, which reduces lipid peroxides formed from dietary polyunsaturated fatty acids (PUFA), and as a substrate for glutathione-transferase, which conjugates electrophilic compounds. slow A lot of evidence showed that dietary glutathione is directly absorbed by the gastrointestinal tract, and thus dietary glutathione can easily increase the antioxidant status in humans [29]. Antioxidant enzymes such as GST, GPx, GR and SOD participate in maintaining GSH homeostasis in tissues [30]. Also, the increase in the levels of CAT, GST, GR, GPx and SOD were all related to the increase in the level of glutathione and the decrease in MDA and NO in rats, which indicates the antioxidant activity of purslane. It contains high levels of alpha-linoleic acid, beta-carotene, flavonoids, coumarin, monoterpene alkaloid glycosides, antioxidants and omega-3. Plants containing omega-3 and omega-6 fats can suppress lipid peroxidation by breaking the existing oxidizing structure using cytochrome 450 P and neutralizing free radicals, the effects of which are related to these compounds in plants, especially omega-3 and linoleic acid [31].

3.6 PURSLANE AND OXIDATIVE SRESS ON EXERSICE

Intense training sessions and competitive events increase multiple physiological stresses such as muscle damage, oxidative stress, and inflammation [32]. Therefore, the musculoskeletal and cellular damage observed in response to intense exercise or strenuous exercise may not only result from direct destruction by RONS, but the inflammatory cascade may also be involved in this process [14, 33]. Therefore, it has become increasingly popular to investigate strategies that can reduce the negative impact of exercise-induced physiological stress.

A recent study showed that consuming purslane supplement for 10 days reduces oxidative stress levels of hydroxy octadecadienoic acid 9 and 13 [HODE-9, HODE-13], pro-inflammatory cytokines (interleukin 17 [IL-17]) and tumor necrosis. Factor ([TNF α]) and muscle damage (lactate dehydrogenase [LDH]) were reduced compared to pre-supplementation levels in male runners[34]. Charchi Sahlabad et al. (2021) during a study in which 9 female runners first performed a HIIE test on a treadmill and found that a HIIE exercise caused a systemic increase in oxidative stress markers, inflammatory indices and muscle damage in these athletes. They also used purslane supplement which had a positive effect on oxidative stress, inflammation and muscle damage. During this study, the levels of HODE-13 and HODE-9 (fatty acids that indicate oxidative stress) increased with exercise, and with purslane supplementation, a significant decrease in these two fatty acids was observed. Also, interleukin-10 decreased with exercise and a significant increase was observed with purslane supplementation. Also, during this study, interleukin 17 and TNFα increased after exercise and decreased after purslane supplementation and exercise [35]. Also, Arian Fer et al., 2020, during a study, first poisoned 48 rats with hydrogen peroxide (H2O2) and then used 8 weeks of endurance training and purslane supplement. As a result, cytochrome c and mannyl dealdehyde (MDA) decreased in the tissues of mice. Although endurance training reduced these two factors, the effect of purslane supplementation in reducing MDA and cytochrome C was completely related to the supplement dose. So, when a supplement of 50 mg per kilogram of body weight was used, there was no significant effect on the reduction of factors, but at a dose of 200 mg per kilogram of body weight, both MDA and cytochrome C factors were significantly reduced [36]. Also, during a study, Foroghi et al.2022 randomly placed 54 male Wistar rats into 9 groups. All groups received 100 mg per kilogram of body weight of hydrogen peroxide (H2O2) intraperitoneally for 14 days. Mice in the supplement groups received purslane hydroalcoholic extract with doses of 50, 200 and 400 mg per day by gavage method. Aerobic exercise was performed on a treadmill at a speed of 23 meters per minute, 30 minutes a day, 5 days a week and for eight weeks. The results showed that purslane seeds and the combined intervention of purslane seeds with aerobic exercise led to a significant increase in the levels of O-6-methylguanine-DNA-methyltransferase and oxidant-prooxidant balance (PAB), as well as a significant decrease in the amounts of adenosine triphosphate (ATP) and Malon Dialdehyde (MDA) in kidney tissue of rats poisoned with hydrogen peroxide [37]. Also, Chen Khiang et al., 2014, during a study in which 48 rats were divided into 4 groups of 12. Group 1, control and group 2, 100, group 3, 200 and group 4, 400 mg/kg of body weight, detoxified purslane polysaccharides for 28 days. After that, all groups were subjected to a forced swimming stage until the recovery stage, and blood lactic acid (BLA), blood glucose, malondialdehyde (MDA), superoxide dismutase (SOD), superoxide dismutase (SOD) and catalase (CAT) factors was measured. The results showed that the duration of swimming to stagnation of mice in the supplemented groups was longer than the control group. The blood lactic acid of the supplement groups was significantly lower than the control group. The MDA levels of the supplement group were lower than the control group. Also, the blood glucose levels of the supplement groups were higher than the control group. The levels of SOD in the supplemented group were higher than the control group. Also, the levels of CAT and GPx in the supplemented groups were significantly higher than the control group. So it was concluded that purslane polysaccharides increased performance and reduced oxidative stress factors in swimming rats [38].

4. DISCUSSION AND CONCLUSION

Examining the results of the research conducted in the present review shows that animal studies have provided relatively more promising results than human samples. One common reason for this is that it reduces the number of potential confounders in animal research. On the other hand, the weak evidence for the supplemental effects of purslane in human studies may be partly related to its bioavailability or that purslane has been used much less in sports. It is difficult to extrapolate existing original data to clinical trials. Therefore, more human studies are necessary to fully understand the dynamics and kinetics of purslane in order to establish the optimal intake or dosage of the supplement. Another possible reason for the lack of evidence in human studies is related to the redox state dynamics of exercise physiology. Strong evidence emphasizes the importance of exercise-induced oxidative stress as a molecular signaling trigger for promoting long-term exercise adaptations.

Furthermore, reducing this inducer of oxidative stress through antioxidant supplementation seems to reduce the improvement in exercise performance. Therefore, a strong antioxidant approach to exercise should be approached with caution [39].

However, studies conducted on mouse models support the antioxidant activity of purslane in exercised mice. However, the current efficacy surrounding purslane supplementation in athletes is somewhat ambiguous, and this can be said to be evidenced by the limited number of well-controlled scientific studies that have been conducted in this area of research. In this regard, considering the very small number of studies in athletes and conflicting results regarding the effectiveness of purslane on oxidative stress and oxidative indicators of the endogenous antioxidant system in athletes, comprehensive research with special emphasis on scientific accuracy and study considerations It is necessary to use special cognitive and analytical strategies.Therefore, it seems that purslane is an effective antioxidant supplement in inhibiting oxidative stress, and to prescribe it as a dietary supplement for athletes, it is necessary to conduct future research to achieve stronger results.

Acknowledgment: The authors would like to express appreciation for the support of the sponsors [Project Number = XXXXXXX].

References:

[1] Medrano-Ureña, M.d.R., R. Ortega-Ruiz, and J.d.D. Benítez-Sillero, *Physical fitness, exercise self-efficacy, and quality of life in adulthood: a systematic review.* International journal of environmental research and public health, 2020. **17**(17): p. 6343.

[2] Pate, R.R., et al., *Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine.* Jama, 1995. **273**(5): p. 402-407.

[3] Arendt, E. and R. Dick, *Knee injury patterns among men and women in collegiate basketball and soccer: NCAA data and review of literature.* The American journal of sports medicine, 1995. **23**(6): p. 694-701.

[4] Nurmasitoh, T., *Physical activities, exercises, and their effects to the immune system.* JKKI: Jurnal Kedokteran dan Kesehatan Indonesia, 2015: p. 52-58.

[5] Platanou, T. and N. Geladas, *The influence of game duration and playing position on intensity of exercise during match-play in elite water polo players.* Journal of Sports Sciences, 2006. **24**(11): p. 1173-1181.

[6] Schippinger, G., et al., *Lipid peroxidation and antioxidant status in professional American football players during competition.* European Journal of Clinical Investigation, 2002. **32**(9): p. 686-692.

[7] Donev, Y. and M. Aleksandrović, *HISTORY OF RULE CHANGES IN WATER POLO.* Sport Science, 2008. **1**(2).

[8] Parvin, N., et al., *Effects of Portulaca oleracea L (purslane) on psychological symptoms of chronic schizophrenic patients IN SINA hospital.* J Mazand Univ Med Sci, 2013. **22**(97): p. 2-10.

[9] Badgujar, P.C., et al., *Fipronil induced oxidative stress in kidney and brain of mice: protective effect of vitamin E and vitamin C.* Pesticide biochemistry and physiology, 2015. **118**: p. 10-18.

[10] Sies, H., C. Berndt, and D.P. Jones, Oxidative stress. Annual review of biochemistry, 2017. 86: p. 715-748.

[11] Bolarin, D.M., et al., Overview of foods with antioxidant effects–clinical relevance. Eur. Food Res. Technol, 2016. 4: p. 1-9.

[12] Amin, A., et al., Pterostilbene improves CFA-induced arthritis and peripheral neuropathy through modulation of oxidative stress, inflammatory cytokines and neurotransmitters in Wistar rats. Inflammopharmacology, 2022. 30(6): p. 2285-2300.

[13] Peternelj, T.-T. and J.S. Coombes, Antioxidant supplementation during exercise training: beneficial or detrimental? Sports medicine, 2011. 41: p. 1043-1069.

[14] Powers, S.K., W.B. Nelson, and M.B. Hudson, Exercise-induced oxidative stress in humans: cause and consequences. Free Radical Biology and Medicine, 2011. 51(5): p. 942-950.

[15] Bjelakovic, G., D. Nikolova, and C. Gluud, Antioxidant supplements and mortality. Current Opinion in Clinical Nutrition & Metabolic Care, 2014. 17(1): p. 40-44.

[16] Mohammadzadeh, M., et al., Evaluation of antioxidant efficacy of Purslane extract in Patients with Recurrent Aphthous Stomatitis: a randomized, placebo-controlled, triple-blinded, clinical. Brazilian Journal of Oral Sciences, 2016. 15(3): p. 234-237.

[17] Mohamed, A.D., et al., Antioxidant effect of purslane (Portulaca oleracea) and its mechanism of action. Journal of Medicinal Plants Research, 2011. 5(9): p. 1589-1593.

[18] Nemzer, B., F. Al-Taher, and N. Abshiru, Phytochemical composition and nutritional value of different plant parts in two cultivated and wild purslane (Portulaca oleracea L.) genotypes. Food chemistry, 2020. 320: p. 126621.

[19] Karimi, A., Effect of Purslane (Portulaca oleracea) on CRP, TNF-A, Hepatic Enzymes and Serum Nitrate in Rats with Experimental Allergic Encephalomyelitis. 2018.

[20] Naghizadeh, H. and A. Salehikia, Effect of one course exercise with consumption vitamin E on antioxidant status and cardiovascular risk factors. Zahedan Journal of Research in Medical Sciences, 2010. 12(1).

[21] Ghorbanian, B., et al., The effects of Portulaca supplementation on antioxidant biomarkers and oxidative stress in non-active girls. Journal of Medicinal Plants, 2019. 18(72): p. 255-263.

[22] Simopoulos, A.P., Omega-3 fatty acids in health and disease and in growth and development. The American journal of clinical nutrition, 1991. 54(3): p. 438-463.

[23] Chan, K., et al., The analgesic and anti-inflammatory effects of Portulaca oleracea L. subsp. sativa (Haw.) Celak. Journal of ethnopharmacology, 2000. 73(3): p. 445-451.

[24] Gong, F., et al., Hypoglycemic effects of crude polysaccharide from purslane. International journal of molecular sciences, 2009. 10(3): p. 880-888.

[25] Rashed, A., F. Afifi, and A. Disi, Simple evaluation of the wound healing activity of a crude extract of Portulaca oleracea L.(growing in Jordan) in Mus musculus JVI-1. Journal of ethnopharmacology, 2003. 88(2-3): p. 131-136.

[26] Arruda, S.F., E.M. Siqueira, and E.M. Souza, Malanga (Xanthosoma sagittifolium) and purslane (Portulaca oleracea) leaves reduce oxidative stress in vitamin A-deficient rats. Annals of nutrition and metabolism, 2004. 48(4): p. 288-295.

[27] Akyol, Ö., et al., The indices of endogenous oxidative and antioxidative processes in plasma from schizophrenic patients: the possible role of oxidant/antioxidant imbalance. Progress in Neuro-Psychopharmacology and Biological Psychiatry, 2002. 26(5): p. 995-1005.

[28] Simopoulos, A.P., Omega-3 fatty acids and antioxidants in edible wild plants. Biological research, 2004. 37(2): p. 263-277.

[29] Jones, D., et al., Oral administration of glutathione (GSH) increases plasma GSH concentrations in humans. FASEB J, 1989. 3: p. A1250.

[30] Abdel-Moneim, A.E., M.A. Dkhil, and S. Al-Quraishy, The redox status in rats treated with flaxseed oil and lead-induced hepatotoxicity. Biological trace element research, 2011. 143: p. 457-467.
[31] Ebadollahi, S., et al., Evaluation of antioxidant properties of hydroalcoholic extract of purslane (Portulaca oleracea) and Its protective effect on 6-hydroxydopamine induced hepatic damage in parkinsonian male rats. Qom University of Medical Sciences Journal, 2018. 12(1): p. 15-25.
[32] Bloomer, R.J., Effect of exercise on oxidative stress biomarkers. Advances in clinical chemistry, 2008. 46: p. 1-50.
[33] Powers, S.K., et al., Exercise-induced oxidative stress: Friend or foe? Journal of sport and health science, 2020. 9(5): p. 415-425.
[34] Dehghan, F., et al., Purslane (Portulaca oleracea) seed consumption and aerobic training improves biomarkers associated with atherosclerosis in women with type 2 diabetes (T2D). Scientific reports, 2016. 6(1): p. 37819.
[35] Charkhi Sahl Abad, A., et al., Purslane supplementation lowers oxidative stress, inflammatory and muscle damage biomarkers after high-intensity intermittent exercise in female runners. Baltic Journal of Health and Physical Activity, 2021. 13(1): p. 3.
[36] Ariyanfar, H., et al., The Effects of Endurance Training and Purslane (Portulaca oleracea) Seed Consumption on Cytochrome-C and Malondialdehyde in the Heart Tissues of Rats Poisoned with H 2 O 2. Journal of Fasting & Health, 2020. 8(2).
[37] Fuladi, F., et al., Effect of purslane seed supplementation and aerobic exercise on markers of mitochondrial biogenesis and DNA damage of kidney tissue in female rats poisoned with hydrogen peroxide. Research in Sports Sciences and Medicinal Plants, 2022. 3(9): p. 1-10..
[38] Xiang, C., et al., Polysaccharides from Portulaca oleracea L improve exercise endurance and decrease oxidative stress in forced swimming mice. Tropical Journal of Pharmaceutical Research, 2014. 13(2): p. 229-234.
[39] Mason, S.A., et al., Antioxidant supplements and endurance exercise: Current evidence and mechanistic insights. Redox biology, 2020. 35: p. 101471.

Interrelationship between exercise and sleep

Hatami Homeira[1]

1- Department of Animal Biology, Faculty of Natural Sciences, University of Tabriz. Tabriz, Iran. Email: h.hatami@tabrizu.ac.ir

Abstract

Introduction: It has been reported there is an interaction between physical activity and good sleep. Sleep is important to a number of brain functions, including how nerve cells communicate with each other. Sleep improves the neuromuscular connections. Also doing regular exercise can improve sleep pattern by releasing some chemicals from hormone to cytokines. In this extended abstract some of the interaction between exercise and sleep is introduced.

Methods: It is a short review article and the information is summarized from different articles.

Results: According to the literature physical activity is an important component of a healthy lifestyle. Regular exercise increases life span. physical activity reduces the risks of cardiovascular disease, diabetes, and some cancers. Exercise can also reduce the risk for anxiety and depression, and it can help everyone sleep better.

Conclusion: Sleep is a fundamental requirement to maintain a healthy lifestyle, its absence can cause a wide range of disturbances throughout the body. Having regular exercise has improve the positive effects of sleep. Also having enough and good quality sleep can amplify athlete’s performance.

Keywords: Exercise, Sleep, Brain

Extended Abstract

Sleep importance:

Everyone needs sleep, but its biological purpose remains unclear. Sleep affects almost every type of tissue and system in the body – from the brain, heart, and lungs to metabolism, immune function, mood, and disease resistance. Research shows that a chronic lack of sleep, or getting poor quality sleep, increases the risk of disorders including high blood pressure, cardiovascular disease, diabetes, depression, and obesity [1].

Sleep and neurotransmitters:

Clusters of sleep-promoting neurons in many parts of the brain become more active as we get ready for bed. Nerve-signaling chemicals called neurotransmitters can “switch off” or dampen the activity of cells that signal arousal or relaxation. GABA is associated with sleep, muscle relaxation, and sedation. Norepinephrine and orexin (also called hypocretin) keep some parts of the brain active while we are awake. Other neurotransmitters that shape sleep and wakefulness include acetylcholine, histamine, adrenaline, cortisol, and serotonin [1-3].

The role of Genes in sleep process

Genes may play a significant role in how much sleep we need. There are identified several genes involved with sleep and sleep disorders, including genes that control the excitability of neurons, and "clock" genes such as *Per*, *tim*, and *Cry* that influence our circadian rhythms and the timing of sleep. Genome-wide association studies have identified sites on various chromosomes that increase our susceptibility to sleep disorders. Also, different genes have been identified with such sleep disorders as familial advanced sleep-phase disorder, narcolepsy, and restless legs syndrome. Some of the genes expressed in the cerebral cortex and other brain areas change their level of expression between sleep and wake. Several genetic models–including the worm, fruit fly, and zebrafish–are helping researcher to identify molecular mechanisms and genetic variants involved in normal sleep and sleep disorders. Additional research will provide better understand of inherited sleep patterns and risks of circadian and sleep disorder [4].

Health and sleep

Sleep is also essential for the maintenance of the physical health of the body, particularly in the healing and repair of cells, such as those in the cardiovascular system. It also helps to maintain the balance of hormones in the body, such as ghrelin and leptin, which regulate feelings of hunger and fullness and is likely to explain the link between inadequate sleep and increased risk of obesity. Other hormones such as insulin, which is responsible for the regulation of glucose in the blood, also change and can result in an increase in blood sugar level. For this reason, chronic sleep deficiency is also linked to a higher risk of cardiovascular disease, stroke, diabetes and kidney disease. The processes of growth and development are also intricately involved with sleep. Deep sleep triggers the release of growth-promoting hormones, which boost muscle mass and repair cells and tissues in the body. The immune system also relies on sufficient quantity and quality of sleep and deficiency in sleep is linked to difficulty fighting infection and increased risk of sickness [3].

Exercise and sleep

Even small amounts of physical activity can improve your mood and cognitive function, alleviate anxiety, and decrease your risk of diseases and other medical conditions. Studies have also found that physical activity helps people sleep better. Additionally, a good night’s sleep is important for those who exercise regularly. Sleep allows body to recover from the previous day. Getting enough rest after a workout strengthens the muscles and tissues, which can avoid fatigue and exercise-related injuries. Conversely, poor sleep may lead to lower physical activity levels. Yoga and other stretching exercises may be more suitable evening exercises, as they promote feelings of relaxation and can improve sleep quality. Alternatively, you can alleviate physical tension before bed using progressive muscle relaxation, meditation, and other relaxation techniques [2].

Sleep Affect Athletic Performance

Both increased quantity and quality of sleep helps athletes improve performance in many areas related to the demands of the sport. Lack of Sleep Affects an Athlete’s Performance. Poor quality and quantity of sleep lead to several negative effects in person. Mentally, sleep deprivation reduces the ability to react quickly and think clearly. People who are sleep deprived are more likely to make poor decisions and take risks. A lack of sleep also increases irritability and risk for anxiety and depression. Physically, a lack of sleep increases the risk for many medical concerns, including type 2 diabetes, high blood pressure, kidney disease, and stroke. While quality sleep has positive effects specifically on athletic performance, a lack of sleep is detrimental to performance [5].

References:

1- Mark É. Czeisler et al. Sleep and mental health among unpaid caregivers of children, adults, and both: United States, 2022. Sleep Health, 2023. https://doi.org/10.1016/j.sleh.2023.08.013

2- Diane C Lim , Arezu Najafi et al. The need to remote sleep health in public health agendas across the globe. The Lancet Public Health, 2023. Volume 8, Issue 10, , Pages e820-e826

-

3- Zuzana Lattova et al. The stress hormone system in various sleep disorders. Journal of Psychiatric Research Volume 45, Issue 9, September 2011, Pages 1223-1228

4- Nathane Rosa Rodrigues et al. Sleep disturbance induces a modulation of clock gene expression and alters metabolism regulation in drosophila. Physiology & Behavior. Volume 271, 1 November 2023, 114334.

-

5-Ye Zhao, Boya Huang. Exercise to prevent the negative effects of sleep deprivation: A systematic review and meta-analysis Neuroscience & Biobehavioral Reviews. 2023.Volume 155, 105433.

Investigating the changes in some physical fitness factors among beginner and professional badminton players

Zahar Eftekharsanaye*[1]
Hojjatollah Siavoshy[1,2,3]

[1] *Department of Sport Sciences, Faculty of Humanities, University College of Omran_Toseeh, Hamadan, Iran.* z.eftekhar.s@gmail.com

[2] *Department of Physical Education, Shahid Maghsoudi Campus, Farhangian University, Hamadan, Iran.* seiavoshy@gmail.com

[3] *Department of Sports Science, Nahavand Higher Education Complex, Bu-Ali Sina University, Hamedan, Iran.* seiavoshy@alumni.basu.ac.ir

Abstract

Introduction: Having a high level of sports performance is very complex, which requires identifying and selecting athletes and people who have certain physical, skill, and behavioral characteristics. The purpose of this research is to investigate changes in physical factors among beginner and professional badminton players.

Method: For this purpose, in this causal-comparative research, 10 female badminton beginners who have been playing badminton for a few months to a year were selected, and 10 professional badminton players with 4 to 8 years of experience were selected. Then, the physical fitness factors include the hand-grip strength test (using a hand dynamometer made in Korea and SAEHAN model with the dominant hand in Kilogram), the long jump test (the distance between the heel of the rear foot and the starting line in centimeters), and the agility test of running 4 x 9 meters (in seconds), and Sargent's high jump test (the distance between the standing height with open arms and the highest point touched by the jump and in centimeters) was taken from all companies. After collecting the data, mean and standard deviation are used for statistical description, and one-way analysis of variance (ANOVA) and Welch and Brown-Forsyte tests are used for inferential statistics. All statistical analyses have been analyzed in SPSS statistical software number 26 and at a significance level of less than 0.05.

Results: The findings of statistical tests indicate that there is a significant difference between the hand-grip strength, long jump, agility run, and Sargent's jump among professional and beginner badminton players ($P<0.05$).

Conclusion: Therefore, it is concluded that badminton may affect the strength, lower body muscle power, and agility of badminton players.

Keywords: hand grip strength, athletic ability, agility, lower limb, long jump, Sargent's jump, elite and amateur.

The acute effect of Aqueous Extract of Thyme intake on performance (Aerobic-Anaerobic), fatigue rate, and recovery of elite young swimmers

Mostafa Khani [1], Ali Alizadeh [2]

[1] Faculty of Physical Education and Sport Sciences, University of Tabriz, Tabriz, Iran

[2] BSc of Physical Education and Sport Sciences, University of Tabriz, Tabriz, Iran

Introduction

Athletes' use of nutritional supplements has been periodically reported within the literature across the past decades (1-3). Through previous investigations, athletes have said that they believe a higher consumption of nutritional supplements is required to manage high training loads, maximize recovery, improve training intensities and performance, and/or avoid illness and maintain health (4, 5). The questionnaire results showed that 63 out of 72 athletes (87.5%) surveyed were taking at least one nutritional supplement. This was similar between male (32/36; 88.9%) and female (31/36; 86.1%) athletes (6). Further, swimmers and kayakers reported utilizing a considerably higher number of supplements than the remaining sports (6). Also, the percentage of athletes who reported using vitamins and minerals to maintain health, boost immunity, and improve performance was the highest (6).

Athletes widely use antioxidant supplements to avoid elevated oxidative stress, the consequences of which include muscle damage, immune dysfunction, and fatigue (7). The general trend of results shows no effect of antioxidant supplementation on physical performance. However, in a large number of studies, it has been consistently demonstrated that antioxidant supplementation protects against exercise-induced tissue damage (8). The researchers compared the effect of antioxidant supplementation versus placebo in two age groups (younger than 30 years and older than 55) by testing downhill running as a muscle-injurious physical activity. They recognized that vitamin E supplementation eliminated age differences (9). The results about the vitamin C effect are more varied; of the four studies supplementing with vitamin C alone, three studies reported performance impairment, and one reported improvement, although all were nonsignificant(7). However, only in 3 of the 14 studies was muscle soreness found to be significantly reduced in response to vitamin C and/or vitamin E supplementation at all time points when compared to the placebo group. Despite some studies showing the beneficial effects of chronic supplementation with these vitamins on muscle soreness manifesting 24–72 h after eccentric exercise, the evidence is so far insufficient to confirm that the intake of antioxidant vitamins is able to minimize delayed-onset muscle soreness in this context (10-13).

Meanwhile, an herbal plant that contains high flavonoid and antioxidant properties (14) and is widely used in traditional medicine, but its absence in there-searches related to sports supplements is felt, is thyme (14).

Wild thyme can be a source of natural antioxidants, nutritional supplements, or components of functional foods in the food industry (15). In addition, Thyme extract has anti-inflammatory, disinfectant, anti-worm, appetizing, sedative (16), and sexually stimulating effects (17).

A recent pilot human study showed that wild thyme extract would have a beneficial effect on gut health and also resulted in an improved quality of life (18).

Khani realized that thyme supplementation increases endurance exercise tolerance in intact animals and decreases oxidative stress (17). Also, he examined the acute effect of thyme-hydro extract supplementation in the performance of 200 and 400-meter sprints. Findings show significant improvement in 400-meter runner’s performance (3).

To our knowledge, there are no controlled studies investigating the described acute effects of Thyme extract on swimmers. Therefore, the current human study aimed to investigate the impact of thymus extract on swimmers, especially performance, fatigue rate, and recovery.

Methods

Ten young (15-19 years old) male swimmers with a body mass index (BMI) of 18.3-21.7 kg/m^2 participated in this study. All of the swimmers had a minimum training background of 2 Years and had trained for 5 h/week for the last year before the present study. We took two tests: 50-meter and 400-meter freestyle. The subjects completed a 50-meter freestyle swimming sprint one day and swam 400-meter freestyle the other day. Measurements were taken on four occasions during the study period (2 weeks).

In the first two sessions, a wheat flour powder capsule was given to the subjects as a placebo 30 minutes before the activity. All of the records were taken by a stopwatch; additionally, all participants' heartbeats were obtained just after the tests by the polar belt (h-7). In the third and fourth sessions of the test, 200 milliliters of aqueous extract of thyme, which was prepared from Azerbaijanian thyme (15 gr thyme per 250 cc water), was consumed 30 minutes before the test. All the tests were done just like the first session. After these tests, subjects' muscular pain rate, recovery 15 minutes and 24 hours after the last examination, and rate of perceived exertion were measured as follows.

The Intensity of pain was quantified using a Visual Analog Scale (VAS) immediately after the test. On a 10-cm ruler, ‘0’ represented the absence of pain, and ‘10’ was the maximum pain level that active men or women can tolerate (19). Each participant was instructed to record the VAS at baseline (before each 50 and 400m test), 15 minutes after the test, and 24 hours later. The Borg Rating of Perceived Exertion (RPE) scale was used to measure the exertion rate of activity after the test. The scale rates between number 6 and 20; '6' is the absence of exhaustion, and '20' is the maximum level of exertion.

Gathered data were analyzed statically using independent and paired t-tests under the 24th version of SPSS software at the significant level of 0.05.

Results

The results of the paired t-test revealed that time trial records, heart rate, and perceived rate of exertion decreased significantly after the 50-meter freestyle test (t_9=4.89, P=0.001; t_8=3.09, P=0.015; t_9=3.51, P=0.007). Also, surveys showed that using this extract has significantly reduced the amount of perceived pain after 24 hours, which means better recovery in swimmers (t_9=3.31, p=0.016). Furthermore, the consumption of thyme extract caused the record of 400-meter to decrease significantly (10.4 seconds on average) (t_9=2.38, P=0.041). Even though the amount of perceived exertion and muscle soreness after the 400-meter test was reduced 15 minutes and 24 hours after the trial, this reduction was insignificant.

Conclusion

It seems that thyme extract, due to the antioxidant properties of its polyphenols (especially thymol and carvacrol) and its caffeine-like properties, improves the time trial swimming performance of 50-meter and 400-meter and recovery after that and reduces perceived exertion in swimmers. So, coaches and swimmers can use thyme aqueous extract to improve performance and increase recovery. However, more studies are needed to clarify it is underlying mechanisms.

References

1. Huang S-HS, Johnson K, Pipe AL. The use of dietary supplements and medications by Canadian athletes at the Atlanta and Sydney Olympic Games. Clinical Journal of Sport Medicine. 2006;16(1):27-33.
2. Froiland K, Koszewski W, Hingst J, Kopecky L. Nutritional supplement use among college athletes and their sources of information. International journal of sport nutrition and exercise metabolism. 2004;14(1):104-20.
3. Volpe SL. Micronutrient requirements for athletes. Clinics in sports medicine. 2007;26(1):119-30.
4. Juhn MS. Popular sports supplements and ergogenic aids. Sports medicine. 2003;33:921-39.
5. Maughan RJ, King DS, Lea T. Dietary supplements. Journal of sports sciences. 2004;22(1):95-113.
6. Dascombe B, Karunaratna M, Cartoon J, Fergie B, Goodman C. Nutritional supplementation habits and perceptions of elite athletes within a state-based sporting institute. Journal of Science and Medicine in Sport. 2010;13(2):274-80.
7. Braakhuis AJ. Effect of vitamin C supplements on physical performance. Current sports medicine reports. 2012;11(4):180-4.
8. Sen CK. Antioxidants in exercise nutrition. Sports Medicine. 2001;31:891-908.
9. Cannon JG, Orencole SF, Fielding RA, Meydani M, Meydani SN, Fiatarone MA, et al. Acute phase response in exercise: interaction of age and vitamin E on neutrophils and muscle enzyme release. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 1990;259(6):R1214-R9.
10. Torre MF, Martinez-Ferran M, Vallecillo N, Jiménez SL, Romero-Morales C, Pareja-Galeano H. Supplementation with vitamins C and E and exercise-induced delayed-onset muscle soreness: A systematic review. Antioxidants. 2021;10(2):279.
11. Bryer S, Goldfarb AH. Effect of high dose vitamin C supplementation on muscle soreness, damage, function, and oxidative stress to eccentric exercise. International journal of sport nutrition and exercise metabolism. 2006;16(3):270-80.
12. Silva LA, Pinho CA, Silveira PC, Tuon T, De Souza CT, Dal-Pizzol F, Pinho RA. Vitamin E supplementation decreases muscular and oxidative damage but not inflammatory response induced by eccentric contraction. The journal of physiological sciences. 2010;60:51-7.
13. He F, Hockemeyer J, Sedlock D. Does combined antioxidant vitamin supplementation blunt repeated bout effect? International journal of sports medicine. 2015:407-13.
14. Moshafi M, Mansouri S, Sharififar F, Khoshnoodi M. Antibacterial and antioxidanteffects of the essential oil and extract of Zataria multiflora Boiss. Journal of Kerman University of Medical Sciences. 2007;13(1):33-43.

15. Jarić S, Mitrović M, Pavlović P. Review of ethnobotanical, phytochemical, and pharmacological study of Thymus serpyllum L. Evidence-based complementary and alternative medicine. 2015;2015.

16. Naghdibadi H, Makkizadeh Tafti M. Review on Thymus vulgaris L. Journal of Medicinal Plants. 2003;7(1):12.

17. Khani M, Motamedi P, Dehkhoda MR, Dabagh Nikukheslat S, Karimi P. Effect of thyme extract supplementation on lipid peroxidation, antioxidant capacity, PGC-1α content and endurance exercise performance in rats. Journal of the international society of sports nutrition. 2017;14(1):11.

18. Knaub K, Schön C, Suarez CG, Pischel I. Effects of a food supplement with a wild thyme (Thymus serpyllum l.) extract on gut health and the microbiome in humans: a randomized, double-blinded, placebo-controlled clinical trial. Food and Nutrition Sciences. 2022;13(11):931-49.

19. Ueda T, Nabetani T, Teramoto K. Differential perceived exertion measured using a new visual analogue scale during pedaling and running. Journal of physiological anthropology. 2006;25(2):171-7.

The effect of 8 weeks of aerobic training on the resilience of female employees

Solmaz Babaei Bonab

Associate Professor of Sports Physiology, University of Maragheh, Maragheh.iran.
s.babaei@maragheh.ac.ir

Abstract

Introduction: Global organizations and companies are trying to implement health and wellness programs within the organization with the aim of increasing the physical activity of their employees, because today human resources are very important for organizations, especially with increasing age. Chronic diseases appear in them. One of the most important risks for the health of employees is inactivity. And more mental pressures and mental problems are suffered in people's lives in this way. Therefore, one of the important issues that organizations investigate is finding effective factors in employee resilience in order to reduce psychological pressure.

Method: In this semi-experimental research, a pre-test-post-test design with a control group was used. The statistical population of the research is made up of all the female employees of Urmia city, out of which 66 women were selected by purposive sampling and divided into two groups of 33 experimental and control. For the experimental group, three sessions of 60 minutes of aerobic exercises were performed per week for 8 weeks. Cannar resilience questionnaire was used in this research. Data analysis was done by covariance analysis using spss 21 software.

Results: The findings of the present research showed that 8 weeks of aerobic training brings a significant difference between the experimental and control groups in endurance ($p < 0.05$).

Conclusion: : It is recommended that managers of organizations provide suitable opportunities to participate in sports activities in order to reduce mental pressure and increase resilience, so that they can benefit more effectively from their human resources

Keywords: Aerobic exercises, resilience, women

Intrudaction

Global organizations and companies are trying to implement health and wellness programs within the organizations with the aim of increasing the physical activity of their employees. Today, healthy workers or employees are very important for the labor market; The special reason is that with age, various types of chronic diseases appear in them. One of the most important risks for the health of employees is inactivity. So that inactivity at work reduces the health of employees. Some researchers have proposed simple programs to increase physical activity at the workplace and have given recommendations, including going up and down the stairs, sometimes getting up and standing, and walking in time. He mentioned short breaks and... Therefore, exercise and physical activity play a very important role in the health and mental health of people. They suffer more mental problems in this way. Therefore, one of the important and studied topics in global companies and organizations is to find effective factors in increasing the resilience of employees in order to reduce psychological pressures and mental problems of human resources. A general belief in improving resilience is that physical activity has positive effects on reducing depression and mental pressure, but so far little research has been done on the impact of physical activity on resilience. The results of research showed that physical activity has no effect on the resilience of the company's employees. Also, in examining the relationship between physical activity, mental health and resilience of Chinese adolescent students, concluded that physical activity is a suitable method to improve the mental health of adolescents. Research has shown that physical activity can be a mechanism against problems. It works psychologically. The research results indicate that employees who interact constructively with their jobs and employers are more useful and productive than other employees; Because their motivation is beyond individual factors. Organizational research uses a positive occupational psychology concept called work belonging as an indicator related to work well-being. There have been no reasons and evidence for an effective factor to improve work attachment. One of the important issues of global companies and organizations is to find effective factors such as health and wellness in order to increase employees' work motivation. Therefore, according to the contradictory results of past researches and the importance of physical and mental health of people, including the working class, especially female employees in Iran (who suffer from inactivity), the need to prescribe physical and mental health, including resilience, mental well-being and belonging The work of female employees seems important and necessary. The purpose of this research is to investigate the effect of exercises on the resilience of female employees.

Method: The design of this study was semi-experimental, which was conducted with pre-test, post-test and control group stages. The statistical population of the research consisted of all female employees of Urmia city. 66 people were purposefully selected to form experimental and control groups and were considered as a statistical sample. Among them, 30 people were randomly divided into two experimental and control groups. The conditions for entering the study were that the people were not athletes and not exercising, willing to participate in the research and complete the questionnaires. The participants were athletes and Having three sessions of absence in the sessions of moda khaleh or physical training, were considered as exclusion criteria. In order to collect data, first, research questionnaires were given to both experimental and control groups to complete them in order to measure the dependent variables in the pre-test stage. Then the samples of the experimental group participated in a 12-week training program. The statistical population of the research is made up of all the female employees of Urmia city, out of which 66 women were selected by purposive sampling and divided into two groups of 33 experimental and control. For the experimental group, three sessions of 60 minutes of aerobic exercises were performed per week for 8 weeks.

Izen CD-RISC Yessha Connor-Davidson Resilience Scale Questionnaire of Tous (Davidson et al.) for measuring the variability of acidification It was designed (20). The said scale has 25 items that are measured in one scale Eikert's entries from (5 always correct) to (1 completely incorrect) are scored. and Davidson (using CD-RISC questionnaire, Cronbach□s alpha coefficient. Colleagues, Cronbach's alpha coefficient has been increased to 0.95 (20). In the present research, it is 0.91 in Pezish-Amazon and 0.90 in Pazish-Amazon became In order to measure the reliability of the CD-RISC questionnaire in Hazer's research, from Wagnild's Resilience Questionnaire was used, and Zzarib Etabzar's score was 0.84. It was achieved.Cannar resilience questionnaire was used in this research. Data analysis was done by covariance analysis using spss 21 software.

متغیر	منبع متغیر	مجموع مربعات	درجه آزادی	میانگین مربعات	آماره F	مقدار P
ـاب آوری	پیش آزمون	176/67	1	251/22	45/34	0/001

Results: The findings of the present research showed that 8 weeks of aerobic training brings a significant difference between the experimental and control groups in endurance ($p< 0.05$).

Discussion and conclusion: The results of the present research showed that the effect of aerobic is beneficial. Resilience of female employees has been found in many cases of It was aligned. In explaining the results of the present research, we can consider the important role of physical activity Physical and mental health of people, including improvement of depression and mental disorders did So that, in the midst of improving endurance, Physical activity has positive effects on depression, anxiety, and mental disturbances Nia has shown a lot of obedience. There is a significant relationship between general and psychological health. Also, specific. provide mental fluctuations, stress and other psychological vulnerabilities. the general conclusion of the current research, it can be said that due to the fact that Athar working atmosphere in work, employees of power, attraction and more commitment in work from early on they give, tolerating mental and intellectual pressures will improve their resilience. From Therefore, the managers of the organizations, as the managers of human resources, should make the whole field fertile It is a blessing for the resilience and belonging of also for the mental health of the workers can be provided Because of the improvement of health, it is better to think about it is physical, and with the workforce of Symmetzer, it works faster and more efficiently. A job was added. Therefore, the administrators of The physical and mental health of educational staff can be improved with the help of the program to provide suitable opportunities to the employees and make them able to win Doing physical activity during work time is not only due to its physical benefits, but also due to its benefits. to benefit from mental and physical activity at work.

1- Ilmarinen J, Tuomi K, Klockars M. Changes in the work ability of active employees over an 11-year period. Scand J Work Environ Health 1997; 23(Suppl 1): 49-57.
2. Kessler RC, Greenberg PE, Mickelson KD, Meneades LM, Wang PS. The effects of chronic medical conditions on work loss and work cutback. J Occup Environ Med 2001; 43(3): 218-25.

3. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000; 32(9 Suppl): S498-S504.
4. Kilpatrick M, Sanderson K, Blizzard L, Teale B, Venn A. Cross-sectional associations between sitting at work and psychological distress: Reducing sitting time may benefit mental health. Ment Health Phys Act 2013; 6(2): 103-9.
5. Brown HE, Ryde GC, Gilson ND, Burton NW, Brown WJ. Objectively measured sedentary behavior and physical activity in office employees: relationships with presenteeism. J Occup Environ Med 2013; 55(8): 945-53.
6. Emmons KM, Linnan LA, Shadel WG, Marcus B, Abrams DB. The Working Healthy Project: A worksite health-promotion trial targeting physical activity, diet, and smoking. J Occup Environ Med 1999; 41(7): 545-55.
7. Coulson JC, Field MK. Exercising at work and self? reported work performance. Int J Workplace Health Manag 2008; 1(3):176-97.
8. Guilbert JJ. The world health report 2. Educ Health (Abingdon) 2003; 16(2): 230.
9. Coom M. The effect of physical activity on work engagement and resilience among corporate employees [MSc Thesis]. Christchurch, New Zealand: University of Canterbury; 2012.
10. Ho FK, Louie LH, Chow CB, Wong WH, Ip P. Physical activity improves mental health through resilience in Hong Kong Chinese adolescents. BMC Pediatr 2015; 15: 48.
11. Besharat MA, Salehi M, Shahmohammadi K, Nadali H, Zebardast A. Relations of resilience and hardiness with sport achievement and menatal health in a sample of athletes. Contemporary Psychology 2008; 3(2): 38-49

The effect of 8 weeks of aerobic training on the resilience of female employees

Solmaz Babaei Bonab

Associate Professor of Sports Physiology, University of Maragheh, Maragheh.iran.
s.babaei@maragheh.ac.ir

Abstract

Introduction: Global organizations and companies are trying to implement health and wellness programs within the organization with the aim of increasing the physical activity of their employees, because today human resources are very important for organizations, especially with increasing age. Chronic diseases appear in them. One of the most important risks for the health of employees is inactivity. And more mental pressures and mental problems are suffered in people's lives in this way. Therefore, one of the important issues that organizations investigate is finding effective factors in employee resilience in order to reduce psychological pressure.

Method: In this semi-experimental research, a pre-test-post-test design with a control group was used. The statistical population of the research is made up of all the female employees of Urmia city, out of which 66 women were selected by purposive sampling and divided into two groups of 33 experimental and control. For the experimental group, three sessions of 60 minutes of aerobic exercises were performed per week for 8 weeks. Cannar resilience questionnaire was used in this research. Data analysis was done by covariance analysis using spss 21 software.

Results: The findings of the present research showed that 8 weeks of aerobic training brings a significant difference between the experimental and control groups in endurance ($p < 0.05$).

Conclusion: : It is recommended that managers of organizations provide suitable opportunities to participate in sports activities in order to reduce mental pressure and increase resilience, so that they can benefit more effectively from their human resources

Keywords: Aerobic exercises, resilience, women

Intrudaction

Global organizations and companies are trying to implement health and wellness programs within the organizations with the aim of increasing the physical activity of their employees. Today, healthy workers or employees are very important for the labor market; The special reason is that with age, various types of chronic diseases appear in them. One of the most important risks for the health of employees is inactivity. So that inactivity at work reduces the health of employees. Some researchers have proposed simple programs to increase physical activity at the workplace and have given recommendations, including going up and down the stairs, sometimes getting up and standing, and walking in time. He mentioned short breaks and... Therefore, exercise and physical activity play a very important role in the health and mental health of people. They suffer more mental problems in this way. Therefore, one of the important and studied topics in global companies and organizations is to find effective factors in increasing the resilience of employees in order to reduce psychological pressures and mental problems of human resources. A general belief in improving resilience is that physical activity has positive effects on reducing depression and mental pressure, but so far little research has been done on the impact of physical activity on resilience. The results of research showed that physical activity has no effect on the resilience of the company's employees. Also, in examining the relationship between physical activity, mental health and resilience of Chinese adolescent students, concluded that physical activity is a suitable method to improve the mental health of adolescents. Research has shown that physical activity can be a mechanism against problems. It works psychologically. The research results indicate that employees who interact constructively with their jobs and employers are more useful and productive than other employees; Because their motivation is beyond individual factors. Organizational research uses a positive occupational psychology concept called work belonging as an indicator related to work well-being. There have been no reasons and evidence for an effective factor to improve work attachment. One of the important issues of global companies and organizations is to find effective factors such as health and wellness in order to increase employees' work motivation. Therefore, according to the contradictory results of past researches and the importance of physical and mental health of people, including the working class, especially female employees in Iran (who suffer from inactivity), the need to prescribe physical and mental health, including resilience, mental well-being and belonging The work of female employees seems important and necessary. The purpose of this research is to investigate the effect of exercises on the resilience of female employees.

Method: The design of this study was semi-experimental, which was conducted with pre-test, post-test and control group stages. The statistical population of the research consisted of all female employees of Urmia city. 66 people were purposefully selected to form experimental and control groups and were considered as a statistical sample. Among them, 30 people were randomly divided into two experimental and control groups. The conditions for entering the study were that the people were not athletes and not exercising, willing to participate in the research and complete the questionnaires. The participants were athletes and Having three sessions of absence in the sessions of moda khaleh or physical training, were considered as exclusion criteria. In order to collect data, first, research questionnaires were given to both experimental and control groups to complete them in order to measure the dependent variables in the pre-test stage. Then the samples of the experimental group participated in a 12-week training program. The statistical population of the research is made up of all the female employees of Urmia city, out of which 66 women were selected by purposive sampling and divided into two groups of 33 experimental and control. For the experimental group, three sessions of 60 minutes of aerobic exercises were performed per week for 8 weeks.

Izen CD-RISC Yessha Connor-Davidson Resilience Scale Questionnaire of Tous (Davidson et al.) for measuring the variability of acidification It was designed (20). The said scale has 25 items that are measured in one scale Eikert's entries from (5 always correct) to (1 completely incorrect) are scored. and Davidson (using CD-RISC questionnaire, Cronbach□s alpha coefficient. Colleagues, Cronbach's alpha coefficient has been increased to 0.95 (20). In the present research, it is 0.91 in Pezish-Amazon and 0.90 in Pazish-Amazon became In order to measure the reliability of the CD-RISC questionnaire in Hazer's research, from Wagnild's Resilience Questionnaire was used, and Zzarib Etabzar's score was 0.84. It was achieved.Cannar resilience questionnaire was used in this research. Data analysis was done by covariance analysis using spss 21 software.

متغیر	منبع متغیر	مجموع مربعات	درحه آزادی	میانگین مربعات	آماره F	مقدار P
ـاب آوری	پیش آزمون	176/67	1	251/22	45/34	0/001

Results: The findings of the present research showed that 8 weeks of aerobic training brings a significant difference between the experimental and control groups in endurance ($p < 0.05$).

Discussion and conclusion: The results of the present research showed that the effect of aerobic is beneficial. Resilience of female employees has been found in many cases of It was aligned. In explaining the results of the present research, we can consider the important role of physical activity Physical and mental health of people, including improvement of depression and mental disorders did So that, in the midst of improving endurance, Physical activity has positive effects on depression, anxiety, and mental disturbances Nia has shown a lot of obedience. There is a significant relationship between general and psychological health. Also, specific. provide mental fluctuations, stress and other psychological vulnerabilities. the general conclusion of the current research, it can be said that due to the fact that Athar working atmosphere in work, employees of power, attraction and more commitment in work from early on they give, tolerating mental and intellectual pressures will improve their resilience. From Therefore, the managers of the organizations, as the managers of human resources, should make the whole field fertile It is a blessing for the resilience and belonging of also for the mental health of the workers can be provided Because of the improvement of health, it is better to think about it is physical, and with the workforce of Symmetzer, it works faster and more efficiently. A job was added. Therefore, the administrators of The physical and mental health of educational staff can be improved with the help of the program to provide suitable opportunities to the employees and make them able to win Doing physical activity during work time is not only due to its physical benefits, but also due to its benefits. to benefit from mental and physical activity at work.

1- Ilmarinen J, Tuomi K, Klockars M. Changes in the work ability of active employees over an 11-year period. Scand J Work Environ Health 1997; 23(Suppl 1): 49-57.
2. Kessler RC, Greenberg PE, Mickelson KD, Meneades LM, Wang PS. The effects of chronic medical conditions on work loss and work cutback. J Occup Environ Med 2001; 43(3): 218-25.

3. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000; 32(9 Suppl): S498-S504.
4. Kilpatrick M, Sanderson K, Blizzard L, Teale B, Venn A. Cross-sectional associations between sitting at work and psychological distress: Reducing sitting time may benefit mental health. Ment Health Phys Act 2013; 6(2): 103-9.
5. Brown HE, Ryde GC, Gilson ND, Burton NW, Brown WJ. Objectively measured sedentary behavior and physical activity in office employees: relationships with presenteeism. J Occup Environ Med 2013; 55(8): 945-53.
6. Emmons KM, Linnan LA, Shadel WG, Marcus B, Abrams DB. The Working Healthy Project: A worksite health-promotion trial targeting physical activity, diet, and smoking. J Occup Environ Med 1999; 41(7): 545-55.
7. Coulson JC, Field MK. Exercising at work and self? reported work performance. Int J Workplace Health Manag 2008; 1(3):176-97.
8. Guilbert JJ. The world health report 2. Educ Health (Abingdon) 2003; 16(2): 230.
9. Coom M. The effect of physical activity on work engagement and resilience among corporate employees [MSc Thesis]. Christchurch, New Zealand: University of Canterbury; 2012.
10. Ho FK, Louie LH, Chow CB, Wong WH, Ip P. Physical activity improves mental health through resilience in Hong Kong Chinese adolescents. BMC Pediatr 2015; 15: 48.
11. Besharat MA, Salehi M, Shahmohammadi K, Nadali H, Zebardast A. Relations of resilience and hardiness with sport achievement and menatal health in a sample of athletes. Contemporary Psychology 2008; 3(2): 38-49

The effect of 8 weeks of exercise in water along with vitamin D consumption on bone density of elderly men

Solmaz Babaei Bonab

Associate Professor of Sports Physiology, University of Maragheh, Maragheh.iran.
s.babaei@maragheh.ac.ir

Abstract

Introduction: Osteoporosis is a systemic skeletal disease that is characterized by a decrease in bone density and, as a result, an increase in bone fragility and susceptibility to fracture, especially in the spine and the head of the femur, which is a type of spongy bone, and as a result of imbalance It happens between bone absorption and resorption. The results of the studies showed that exercise in water, due to the pressure it does not put on the bones and the effect of weightlessness, stimulates the osteoblasts and imposes the necessary resistance on the body to suit the needs of each person, and insufficient intake Vitamin D can contribute to the prevalence of osteoporosis, so the purpose of this study was to investigate the effect of 8 weeks of exercise in water along with vitamin D consumption on bone density in elderly men.

Methods and Materials: The current semi-experimental research was conducted on 30 men with an age range of 50-65 years, who were randomly divided into two supplement+exercise groups (15 people) and exercise group (15 people). The exercise+supplement group did 3 sessions of water exercise every week for 8 weeks with an intensity of 65-70% of the reserve heart rate and received 600 IU of vitamin D three days a week, and the exercise group only did physical exercises. Mineral density of subjects" femurs was measured before and after 8 weeks by Dexa bone densitometer. Experiment and data analysis was done using independent t-test by SPSS software.

Results: Femur bone density in the water and vitamin D training group showed a significant difference compared to the training group ($p=0.002$).

Conclusion: The findings show that weight bearing exercises and vitamin D consumption in elderly men prevent age-related bone density loss.

Keywords: exercise in water, vitamin D, elderly men, bone density

Intrudaction

The aging of the population worldwide is increasing rapidly, from 461 million people over 65 years of age in 2004 to about 2 billion people by 2050, which is likely to make osteoporosis one of the diseases of the elderly in this population. . Aging is a sensitive period of human life, and paying attention to the special issues and needs of this stage, including the quality of life, is considered a social necessity. Osteoporosis is a skeletal disease characterized by low bone mass and deterioration of microstructures Bone (bone microarchitecture) changes in microstructures such as trabecular bone thickness (bone trabeculare) or in other words spongy tissue blades, trabecular tissue separation (terabecular separation) and cortical bone thickness (bone cortical) cause an increase in osteoprotic people. Microstructures (spatial organization of bone tissue) and bone mass are the two factors that determine the mechanical ability of bone against fracture, which are necessary to investigate in bone loss caused by old age. Bone strength strongly depends on the ability of microstructures to distribute environmental stresses It is dependent on strain and this dependence is independent of BMD changes. The density of microstructures explains more than 40% of the compressive strength of the vertebra and the tensile strength of the tibia. With aging and the destruction of microstructures, osteoporosis, although not uniformly, but in each It happens in two ways. First, it is affected by the destruction of the trabecular micro-architecture (trabecular micro-architecture of long bones and the body of the vertebrae). Osteoporotic fracture of the vertebra and femoral neck, in addition to disability, high treatment costs will accompany In Iran, 50% of men and 50% of women over fifty years of age suffer from osteoporosis. Therefore, one should look for ways to maintain or improve bone density in this disease. While there are many drug options for the prevention and treatment of this disease, their long-term use is limited due to side effects, so researchers are looking for non-drug solutions. The evidence shows that physical activity is an accessible model without side effects, which, in addition to preventing and treating this disease, increases posture by strengthening muscles. Changes in the body's physiology, such as stress factors, deteriorating mitochondria, malformation of the body's posture, decrease in the release of hormones and total energy consumption.It may cause the deterioration of the body during this period, and finally, these processes cause gradual damage to nerve cells, decrease in

bone density, decrease in muscle mass and strength. As sarcopenia contributes to adverse outcomes, exercise programs are optimal in preventing loss of muscle mass, strength, and performance. Several studies have suggested regular physical activity as an effective tool to prevent the effects of aging and improve bone health. Considering the prevalence of inactivity in elderly people and the decrease in their physical activity level with age, it is important to choose exercise methods or patterns for the health of the elderly society. One of these training methods is circular exercise in water. According to research reports, exercise in water promises to improve physical and muscular performance in the elderly. exercise in water activity alone. Researchers have observed that combined exercises have a significant effect on BMD in different body areas of the elderly, and this increase is greater with hormone therapy and the consumption of calcium and 25-hydroxyvitamin D. Knowing the positive effect of combined sports activities on the health of the elderly, it is very important to understand the effect of combined sports activities on the strength and performance indicators of the elderly. Combined exercise with different mechanisms increases strength by increasing the cross-sectional area of the muscle, contraction speed and strength in each two types of muscle fibers become fast and slow, among which the most important are adaptations created through the neuromuscular system.

Method: The current semi-experimental research was conducted on 30 men with an age range of 50-65 years, who were randomly divided into two supplement+exercise groups (15 people) and exercise group (15 people). The exercise+supplement group did 3 sessions of water exercise every week for 8 weeks with an intensity of 65-70% of the reserve heart rate and received 600 IU of vitamin D three days a week, and the exercise group only did physical exercises. Mineral density of subjects" femurs was measured before and after 8 weeks by Dexa bone densitometer. This research was a semi-experimental research with a pre-test and post-test design with a control group. The statistical population of the present study consisted of elderly men aged 65 to 75 years who referred to the retirement center of Shahreza city. Among elderly men with osteoporosis referred to Urmia Clinic, 60 male patients with osteoporosis were purposefully selected from among the eligible volunteers in this research. The criteria for entering the research include: 1) suffering from osteoporosis, at least 3-5 years have passed since its diagnosis, and the diagnosis of the disease has been confirmed by a specialist doctor based on physical examination and DEXA test. 2) male gender with an age range of 65-75 years; 3) lack of cardiovascular, respiratory, skin and neuromuscular diseases, 4) ability to regularly participate in training sessions and 5) lack of regular participation in rehabilitation and sports programs other than the program prescribed in the present study. The exclusion criteria included the following: 1) absence of more than 5 sessions during the training period, 2) disease recurrence during the study, 3) suffering from specific diseases such as skin diseases, covid-19 or problems related to Participating in the study is harmful for them, 4) not participating in the examination sessions. Experiment and data analysis was done using independent t-test by SPSS softwar.

Results: Statistically significant difference in weight and age there were no subjects. Femur bone density in the water and vitamin D training group showed a significant difference compared to the training group (p=0.002).

Discussion and conclusion: The findings show that weight bearing exercises and vitamin D consumption in elderly men prevent age-related bone density loss. The mechanical bar applied to the bone creates a gradient within the ulnar-canalicular fluid network of the bone, which causes an increase in intracellular events such as an increase in intracellular calcium, matrix production, and osteogenesis. In terms of anatomy and positioning, long weight-bearing bones (such as tibia and femur) are different from lumbar vertebrae, so that during running, more mechanical load is imposed on these two bones, which stimulates Bone osteogenic response is necessary. According to the research hypothesis that has been discussed in this study, the change in the studied variable of serum hydroxyvitamin D3 level in elderly men with osteoporosis syndrome after 8 weeks in the exercise groups and the control group was not significant, although the improvement Significance was observed in BMD levels of resistance and combined training groups. In this study, the serum levels of hydroxyvitamin D3 changed in all training groups and the control group.

1.Vásquez-Araneda E, Solís-Vivanco RI, Mahecha-Matsudo S, Zapata-Lamana R, Cigarroa I. Characteristics of physical exercise programs for older adults in Latin America: a systematic review of randomized controlled trials. International Journal of Environmental Research and Public Health. 2021;18(6):2812.

2.Khursheed R, Singh SK, Wadhwa S, Kapoor B, Gulati M, Kumar R, et al. Treatment strategies against diabetes: Success so far and challenges ahead. European journal of pharmacology. 2019;862:172625.

3.Raj NB, Lee WZ, Eswaramoorthi V, Razali H, Othman NYH, Rao U. Exercise programmes for reducing [Downloaded from jsmt.khu.ac.ir on 2023-11-15] https://jsmt.khu.ac.ir/ 164 the risk of falls in elderly: a review. Research Journal of Pharmacy and Technology. 2020;13(6):2977-84.

4. Sallis JF, Cain KL, Conway TL, Gavand KA, Millstein RA, Geremia CM, et al. Peer reviewed: Is your neighborhood designed to support physical activity? A brief streetscape audit tool. Preventing chronic disease. 2015;12.

5.Marin-Puyalto J, Gomez-Cabello A, Gonzalez-Agüero A, Gomez-Bruton A, Matute-Llorente A, Casajus JA, et al. Is vibration training good for your bones? An overview of systematic reviews. BioMed Research International. 2018;2018.

6.Bemben D, Stark C, Taiar R, Bernardo-Filho M. Relevance of whole-body vibration exercises on muscle strength/power and bone of elderly individuals. Dose-Response. 2018;16(4):1559325818813066.

7.Hassanzadeh HA, Gozashti M, Dehkhoda MO, Kazemi A. The effect of calcium and vitamin d consumption and combined training on parathyroid hormone and alkaline phosphatase of postmenopausal women. Medical journal of Mashhad University of medical sciences. 2012;55(2):96-101.

8.Karamesha P, Morteza Dehghan, Razieh P, Morteza Hashemzadeh CH, Masoud A, Siddiqa K. Relationship between ApaI and TaqI polymorphisms of the vitamin D receptor gene with osteoporosis in women aged 45 years and older in Chaharmahal and Bakhtiari province. Shahrekord Medical University. 2014; 17th year(2):17-

9.Wang Y, Kong L, Chen J, Li X, Yang D, Ding H. Treatment of Osteoporosis in Rats with Parathyroid Hormone Combined with Calcitonin. Revista Científica de la Facultad de Ciencias Veterinarias. 2020;30(5):2448-58.

10.Lombardi G, Ziemann E, Banfi G, Corbetta S. Physical activity-dependent regulation of parathyroid hormone and calcium-phosphorous metabolism. International journal of molecular sciences. 2020;21(15):5388.

11.Cao S, Wang Z, Li C, Wang Q. The effect of whole-body vibration exercise on postmenopausal women with osteoporosis: A protocol for systematic review and meta-analysis. Medicine. 2021;100(18).

12.Abbasi E, Kahrizi S, Razi M, Faghihzadeh S. The effect of whole-body vibration training on the lower extremity muscles' electromyographic activities in patients with knee osteoarthritis. Medical journal of the Islamic Republic of Iran. 2017;31:107.

The effect of 8 weeks of exercise in water along with vitamin D consumption on bone density of elderly men

Solmaz Babaei Bonab

Associate Professor of Sports Physiology, University of Maragheh, Maragheh.iran.
s.babaei@maragheh.ac.ir

Abstract

Introduction: Osteoporosis is a systemic skeletal disease that is characterized by a decrease in bone density and, as a result, an increase in bone fragility and susceptibility to fracture, especially in the spine and the head of the femur, which is a type of spongy bone, and as a result of imbalance It happens between bone absorption and resorption. The results of the studies showed that exercise in water, due to the pressure it does not put on the bones and the effect of weightlessness, stimulates the osteoblasts and imposes the necessary resistance on the body to suit the needs of each person, and insufficient intake Vitamin D can contribute to the prevalence of osteoporosis, so the purpose of this study was to investigate the effect of 8 weeks of exercise in water along with vitamin D consumption on bone density in elderly men.

Methods and Materials: The current semi-experimental research was conducted on 30 men with an age range of 50-65 years, who were randomly divided into two supplement+exercise groups (15 people) and exercise group (15 people). The exercise+supplement group did 3 sessions of water exercise every week for 8 weeks with an intensity of 65-70% of the reserve heart rate and received 600 IU of vitamin D three days a week, and the exercise group only did physical exercises. Mineral density of subjects'' femurs was measured before and after 8 weeks by Dexa bone densitometer. Experiment and data analysis was done using independent t-test by SPSS software.

Results: Femur bone density in the water and vitamin D training group showed a significant difference compared to the training group (p=0.002).

Conclusion: The findings show that weight bearing exercises and vitamin D consumption in elderly men prevent age-related bone density loss.

Keywords: exercise in water, vitamin D, elderly men, bone density

Intrudaction

The aging of the population worldwide is increasing rapidly, from 461 million people over 65 years of age in 2004 to about 2 billion people by 2050, which is likely to make osteoporosis one of the diseases of the elderly in this population. . Aging is a sensitive period of human life, and paying attention to the special issues and needs of this stage, including the quality of life, is considered a social necessity. Osteoporosis is a skeletal disease characterized by low bone mass and deterioration of microstructures Bone (bone microarchitecture) changes in microstructures such as trabecular bone thickness (bone trabeculare) or in other words spongy tissue blades, trabecular tissue separation (terabecular separation) and cortical bone thickness (bone cortical) cause an increase in osteoprotic people. Microstructures (spatial organization of bone tissue) and bone mass are the two factors that determine the mechanical ability of bone against fracture, which are necessary to investigate in bone loss caused by old age. Bone strength strongly depends on the ability of microstructures to distribute environmental stresses It is dependent on strain and this dependence is independent of BMD changes. The density of microstructures explains more than 40% of the compressive strength of the vertebra and the tensile strength of the tibia. With aging and the destruction of microstructures, osteoporosis, although not uniformly, but in each It happens in two ways. First, it is affected by the destruction of the trabecular micro-architecture (trabecular micro-architecture of long bones and the body of the vertebrae). Osteoporotic fracture of the vertebra and femoral neck, in addition to disability, high treatment costs will accompany In Iran, 50% of men and 50% of women over fifty years of age suffer from osteoporosis. Therefore, one should look for ways to maintain or improve bone density in this disease. While there are many drug options for the prevention and treatment of this disease, their long-term use is limited due to side effects, so researchers are looking for non-drug solutions. The evidence shows that physical activity is an accessible model without side effects, which, in addition to preventing and treating this disease, increases posture by strengthening muscles. Changes in the body's physiology, such as stress factors, deteriorating mitochondria, malformation of the body's posture, decrease in the release of hormones and total energy consumption.It may cause the deterioration of the body during this period, and finally, these processes cause gradual damage to nerve cells, decrease in bone density, decrease in muscle mass and strength. As sarcopenia contributes to adverse outcomes, exercise programs are optimal in preventing loss of muscle mass, strength, and performance. Several studies have suggested regular physical activity as an effective tool to prevent the effects of aging and improve bone health. Considering the prevalence of inactivity in elderly people and the decrease in their physical activity level with age, it is important to choose exercise methods or patterns for the health of the elderly society. One of these training methods is circular exercise in water. According to research reports, exercise in water promises to improve physical and muscular performance in the elderly. exercise in water activity alone. Researchers have observed that combined exercises have a significant effect on BMD in different body areas of the elderly, and this increase is greater with hormone therapy and the consumption of calcium and 25-hydroxyvitamin D. Knowing the positive effect of combined sports activities on the health of the elderly, it is very important to understand the effect of combined sports activities on the strength and performance indicators of the elderly. Combined exercise with different mechanisms increases strength by increasing the cross-sectional area of the muscle, contraction speed and strength in each two types of muscle fibers become fast and slow, among which the most important are adaptations created through the neuromuscular system.

Method: The current semi-experimental research was conducted on 30 men with an age range of 50-65 years, who were randomly divided into two supplement+exercise groups (15 people) and exercise group (15 people). The exercise+supplement group did 3 sessions of water exercise every week for 8 weeks with an intensity of 65-70% of the reserve heart rate and received 600 IU of vitamin D three days a week, and the exercise group only did physical exercises. Mineral density of subjects" femurs was measured before and after 8 weeks by Dexa bone densitometer. This research was a semi-experimental research with a pre-test and post-test design with a control group. The statistical population of the present study consisted of elderly men aged 65 to 75 years who referred to the retirement center of Shahreza city. Among elderly men with osteoporosis referred to Urmia Clinic, 60 male patients with osteoporosis were purposefully selected from among the eligible volunteers in this research. The criteria for entering the research include: 1) suffering from osteoporosis, at least 3-5 years have passed since its diagnosis, and the diagnosis of the disease has been confirmed by a specialist doctor based on physical examination and DEXA test. 2) male gender with an age range of 65-75 years; 3) lack of cardiovascular, respiratory, skin and neuromuscular diseases, 4) ability to regularly participate in training sessions and 5) lack of regular participation in rehabilitation and sports programs other than the program prescribed in the present study. The exclusion criteria included the following: 1) absence of more than 5 sessions during the training period, 2) disease recurrence during the study, 3) suffering from specific diseases such as skin diseases, covid-19 or problems related to Participating in the study is harmful for them, 4) not participating in the examination sessions. Experiment and data analysis was done using independent t-test by SPSS softwar.

Results: Statistically significant difference in weight and age there were no subjects. Femur bone density in the water and vitamin D training group showed a significant difference compared to the training group (p=0.002).

Discussion and conclusion: The findings show that weight bearing exercises and vitamin D consumption in elderly men prevent age-related bone density loss. The mechanical bar applied to the bone creates a gradient within the ulnar-canalicular fluid network of the bone, which causes an increase in intracellular events such as an increase in intracellular calcium, matrix production, and osteogenesis. In terms of anatomy and positioning, long weight-bearing bones (such as tibia and femur) are different from lumbar vertebrae, so that during running, more mechanical load is imposed on these two bones, which stimulates Bone osteogenic response is necessary. According to the research hypothesis that has been discussed in this study, the change in the studied variable of serum hydroxyvitamin D3 level in elderly men with osteoporosis syndrome after 8 weeks in the exercise groups and the control group was not significant, although the improvement Significance was observed in BMD levels of resistance and combined training groups. In this study, the serum levels of hydroxyvitamin D3 changed in all training groups and the control group.

1.Vásquez-Araneda E, Solís-Vivanco RI, Mahecha-Matsudo S, Zapata-Lamana R, Cigarroa I. Characteristics of physical exercise programs for older adults in Latin America: a systematic review of randomized controlled trials. International Journal of Environmental Research and Public Health. 2021;18(6):2812.

2.Khursheed R, Singh SK, Wadhwa S, Kapoor B, Gulati M, Kumar R, et al. Treatment strategies against diabetes: Success so far and challenges ahead. European journal of pharmacology. 2019;862:172625.

3.Raj NB, Lee WZ, Eswaramoorthi V, Razali H, Othman NYH, Rao U. Exercise programmes for reducing [Downloaded from jsmt.khu.ac.ir on 2023-11-15] https://jsmt.khu.ac.ir/ 164 the risk of falls in elderly: a review. Research Journal of Pharmacy and Technology. 2020;13(6):2977-84.

4. Sallis JF, Cain KL, Conway TL, Gavand KA, Millstein RA, Geremia CM, et al. Peer reviewed: Is your neighborhood designed to support physical activity? A brief streetscape audit tool. Preventing chronic disease. 2015;12.

5.Marin-Puyalto J, Gomez-Cabello A, Gonzalez-Agüero A, Gomez-Bruton A, Matute-Llorente A, Casajus JA, et al. Is vibration training good for your bones? An overview of systematic reviews. BioMed Research International. 2018;2018.

6.Bemben D, Stark C, Taiar R, Bernardo-Filho M. Relevance of whole-body vibration exercises on muscle strength/power and bone of elderly individuals. Dose-Response. 2018;16(4):1559325818813066.

7.Hassanzadeh HA, Gozashti M, Dehkhoda MO, Kazemi A. The effect of calcium and vitamin d consumption and combined training on parathyroid hormone and alkaline phosphatase of postmenopausal women. Medical journal of Mashhad University of medical sciences. 2012;55(2):96-101.

8.Karamesha P, Morteza Dehghan, Razieh P, Morteza Hashemzadeh CH, Masoud A, Siddiqa K. Relationship between ApaI and TaqI polymorphisms of the vitamin D receptor gene with osteoporosis in women aged 45 years and older in Chaharmahal and Bakhtiari province. Shahrekord Medical University. 2014; 17th year(2):17-

9.Wang Y, Kong L, Chen J, Li X, Yang D, Ding H. Treatment of Osteoporosis in Rats with Parathyroid Hormone Combined with Calcitonin. Revista Científica de la Facultad de Ciencias Veterinarias. 2020;30(5):2448-58.

10.Lombardi G, Ziemann E, Banfi G, Corbetta S. Physical activity-dependent regulation of parathyroid hormone and calcium-phosphorous metabolism. International journal of molecular sciences. 2020;21(15):5388.

11.Cao S, Wang Z, Li C, Wang Q. The effect of whole-body vibration exercise on postmenopausal women with osteoporosis: A protocol for systematic review and meta-analysis. Medicine. 2021;100(18).

12.Abbasi E, Kahrizi S, Razi M, Faghihzadeh S. The effect of whole-body vibration training on the lower extremity muscles' electromyographic activities in patients with knee osteoarthritis. Medical journal of the Islamic Republic of Iran. 2017;31:107.

The effect of 12 weeks of endurance exercise with curcumin consumption on α-TNF level in inactive obese women

Solmaz Babaei Bonab

Associate Professor of Sports Physiology, University of Maragheh, Maragheh.iran.
s.babaei@maragheh.ac.ir

Abstract

Introduction: obesity and overweight as a chronic and inflammatory metabolic disease has become one of the main health challenges all over the world and tumor necrosis factor alpha (TNF-α) as one of the pro- It is an inflammation that can play a role in the inflammation process and its increased level is associated with the inflammatory state in overweight people. In recent years, attention has been paid to the use of physical exercises and curcumin due to its strong antioxidant and anti-inflammatory properties. Therefore, the aim of this research was to investigate the effect of 12 weeks of endurence exercises along with curcumin consumption on α-TNF levels in inactive obese women.
Method: The current semi-experimental research was conducted on 20 overweight women who were randomly divided into two supplement + exercise groups (10 people) and exercise group (10 people). The exercise+supplement group performed 3 sessions of interval training every week for 12 weeks with an intensity of 65-75% of the reserve heart rate and daily 20 mg per kilogram of body weight of curcumin supplement (Sina capsules) curcumin) and the exercise group only performed physical exercises. Blood sampling was done 24 hours before and after the start of training. The statistical method of one-way analysis of variance and paired t-test was used for data analysis.

Results: Significant changes in the level of TNF-α were observed in the two exercise + supplement groups and the exercise group, respectively, p=0.002 and p=0.007 compared to the pre-test. Also, when examining the inter-group changes, the changes in TNF-α (p=0.003) of the exercise+supplement group were statistically significant compared to the exercise group.
Conclusion: performing 12 weeks of intermittent exercises with moderate intensity along with curcumin caused a significant decrease in TNF-α.
interval training, curcumin, TNF-α, inactive obese wome

Intruduction

As a chronic metabolic disease, obesity and overweight have become one of the main public health challenges around the world, and despite global warnings and increased awareness of its complications and harms, we are witnessing a significant increase in the prevalence of obesity and overweight in the world. The increase in the prevalence of obesity leads to a progressive increase in cardiovascular diseases society has become. Today, cardiovascular disease is known as one of the main causes of death in the world, and various factors and mechanisms are involved in the occurrence of this disease. One of the most important risk factors for these diseases is an increase in low-density lipoprotein (LDL), very low-density lipoprotein (VLDL), total cholesterol (TC), triglyceride (TG) and a decrease in high-density lipoprotein (HDL). Studies show they show that some people with normal levels of low-density lipoprotein and high-density lipoprotein have also suffered from cardiovascular diseases. Therefore, it is very important to pay attention to indicators that predict the risk of cardiovascular diseases with greater accuracy and sensitivity. Evidence has shown that there is a relationship between oxidative stress and fatigue or muscle damage, which can affect sports performance. Therefore, it is very important to prevent these damages by increasing the content of the diet with antioxidants. Curcumin is the main and active compound of turmeric and has a wide range of biological and pharmacological activities. The most important biological effects of this substance are its anti-inflammatory and anti-tumor properties. In addition, curcumin, as an antioxidant, is one of the strongest scavengers of free radicals, which is able to prevent the production of all kinds of oxygen free radicals in the biological and physical environment. As research shows that obese and overweight people are more susceptible to diseases such as cardiovascular diseases, diabetes, etc., and also considering the importance of disease prevention and its close relationship with nutrition and physical activity. , in this area, to diverse, wider researches and More comprehensive is needed. The purpose of this research is to investigate the effect of 12 weeks of endurance exercises along with curcumin consumption on α-TNF levels in inactive obese women.

Metod

The current semi-experimental research was conducted on 20 overweight women who were randomly divided into two supplement + exercise groups (10 people) and exercise group (10 people). The exercise+supplement group performed 3 sessions of interval training every week for 12 weeks with an intensity of 65-75% of the reserve heart rate and daily 20 mg per kilogram of body weight of curcumin supplement (Sina capsules) curcumin) and the exercise group only performed physical exercises. Blood sampling was done 24 hours before and after the start of training. Other criteria for entering the research were being healthy, not taking medicine, not using tobacco, and not participating in regular exercise programs for at least one year before participating in the research. The criteria for exiting the study included: refusing to participate in the exercise protocol, not taking the supplement or taking it more than once a day during the 12 weeks of supplementation, doing sports during the training period, suffering from a cold or other inflammatory diseases. First, the study subjects were given the necessary information and awareness about the objectives of the study, how to conduct the research and its steps. Then from all subjects a written consent letter was received, and by submitting a questionnaire, 24 notes were recorded After meals, nutritional conditions were made the same in 4 groups. The current semi-experimental research was conducted on 20 overweight women who were randomly divided into two supplement + exercise groups (10 people) and exercise group (10 people). The exercise+supplement group performed 3 sessions of interval training every week for 12 weeks with an intensity of 65-75% of the reserve heart rate and daily 20 mg per kilogram of body weight of curcumin supplement (Sina capsules) curcumin) and the exercise group only performed physical exercises. Blood sampling was done 24 hours before and after the start of training. The statistical method of one-way analysis of variance and paired t-test was used for data analysis.

Results: Significant changes in the level of TNF-α were observed in the two exercise + supplement groups and the exercise group, respectively, p=0.002 and p=0.007 compared to the pre-test. Also, when examining the inter-group changes, the changes in TNF-α (p=0.003) of the exercise+supplement group were statistically significant compared to the exercise group.

Conclusion: performing 12 weeks of intermittent exercises with moderate intensity along with curcumin caused a significant decrease in TNF-α. In addition to the effect of physical activity in the prevention and treatment of diseases, including cardiovascular diseases, the use of food supplements is also of special importance. One of these food supplements, curcumin is an effective substance in turmeric and has significant antioxidant properties. Curcumin prevents the formation of free oxygen radicals and its antioxidant effects may be effective in reducing the progress and complications of inflammation and hyperlipidemia. Evidence shows that curcumin has an inhibitory effect on the proliferation of inflammatory cells, attacks on these cells, and angiogenesis by different mechanisms. Also, various studies have shown that curcumin increases the activity of fatty acid synthase (FAS). inhibits and strengthens the oxidation of β-fatty acids; As a result, it can lead to an effective reduction of fat reserves. Using this mechanism, curcumin can improve lipid metabolism Adjust. the facts have shown that curcumin reduces inflammatory responses by reducing the activity of cyclooxygenase 2, lipoxygenase, and nitric oxide synthase, and by reducing the production of inflammatory cytokines, including tumor necrosis factor alpha(TNF-α). It reduces Interleukin 2 and 6 inhibits the expression of nuclear factor KB (KB-NF), cyclooxygenase enzyme and nitric oxide synthase enzyme, thus inhibiting the process of inflammation and tumorigenesis.

Reference

1. Bhupathiraju SN, Hu FB. Epidemiology of obesity and diabetes and their cardiovascular complications. Circ Res 2016; 118(11): 1723-35. 2.
2. Bastien M, Poirier P, Lemieux I, Després JP. Overview of epidemiology and contribution of obesity to cardiovascular disease. Progress Cardiovascular Dis 2014; 56(4): 369-81.
3. Atashak S. The effect of eight weeks of pilates training on C-reactive protein, insulin resistance, and body composition in middle-aged obese women. J Rafsanjan Univ Med Sci 2018; 17(5): 421-34. [in Persian]
4. Khairandish R, Ranjbar R, Habibi A, Effects of pilates training on body composition, lipid profile and some physical fitness parameters in sedentary obese women. J Jundishapur Sci Med 2018; 17(1): 49-61. [in Persian]
5. Bijeh N, Hejazi K. The effect of aerobic exercise on levels of HS-CRP, insulin resistance index and lipid profile in untrained middle-aged women. RJMS 2018; 24(10): 1-1. [in Persian]
6. Dabidi-Ravshan V, Gaeini A, Ravassi A, Javadi I. Effect of continues training on CRP in vistar 14848 rats. Olympic 2006; 2: 7-21. [in Persian]
7. Kasapis C, Thompson PD. The effects of physical activity on serum C-reactive protein and inflammatory markers: a systematic review. JACC CardioOncol 2005; 45(10): 1563-9.
8. Mann S, Beedie C, Jimenez A. Differential effects of aerobic exercise, resistance training and combined exercise modalities on cholesterol and the lipid profile: review, synthesis and recommendations. Sports Med 2014; 44(2): 211-1.

9. Babraj JA, Vollaard NB, Keast C, Guppy FM, Cottrell G, Timmons JA. Extremely short duration high intensity interval training substantially improves insulin action in young healthy males. BMC Endocr Disord 2009; 9(1): 3.
10. Trapp EG, Chisholm DJ, Freund J, Boutcher SH. The effects of high-intensity intermittent exercise training on fat loss and fasting insulin levels of young women. Int J Obes (Lond) 2008; 32(4): 684-91.
11. Shadkam T, Nazarali P, Bijeh N. The Effect of Aerobic Exercises Combined with Curcuma Longa Supplementation on Cardiovascular Inflammatory Indexes and Body Composition in Sedentary Women. J Sport Biosciences 2016; 8(2): 193-206. [in Persian]
12. Shehzad A, Rehman G, Lee YS. Curcumin in inflammatory diseases. Biofactors 2013; 39(1): 69- 77. [30] Donmez L, Gokkoca Z, Dedeoglu N. Disability and its effects on quality of life among older people living in Antalya city center, Turkey. Arch Gerontol Geriatr 2005; 40(2): 213-23.
13. Shing CM, Adams MJ, Fassett RG, Coombes JS. Nutritional compounds influence tissue factor expression and inflammation of chronic kidney disease patients in vitro. Nutrition 2011; 27(9): 967-72.
14. Sohaei S, Amani R, Tarrahi MJ, GhasemiTehrani H. The effects of curcumin supplementation on glycemic status, lipid profile and hs-CRP levels in overweight/obese women with polycystic ovary syndrome: a randomized, doubleblind, placebo-controlled clinical trial. Complement Ther Med 2019 Sep 26: 102201.

The effect of a course of yoga exercises on glycemic and anthropometric indices of women with type two diabetes

Sanaz Salahpour, Mostafa Khani

Faculty of Physical Education and Sport Sciences, University of Tabriz, Tabriz, Iran

Abstract

Introduction: Diabetes is one of the five causes of death in the world, and its prevalence is increasing. Prevention and control of diabetes are considered as one of the main priorities. Physical activity and performing sports exercises play an important role in the prevention and control of diabetes. The purpose of this research is to investigate the effect of a course of yoga exercises on glycemic and anthropometric indicators of women with type two diabetes.

Method: Its statistical population will include inactive women with type two diabetes with an age range of 40 ± 5 years in Tabriz city in 1402, among whom 20 people were selected as subjects using the available sampling method and randomly divided into two experimental and control groups of 10 people. The experimental group did yoga exercises for eight weeks and three sessions for 60 minutes each week, and the control group did not have any regular physical activity. In this study, the variable of fasting blood sugar, glycosylated hemoglobin and body composition before and after eight weeks of training in both The group was measured. The difference of means was analyzed using T-test.

Results:A significant difference was observed in the levels of blood sugar, glycosylated hemoglobin, and body composition in the experimental group compared to the control group ($p < 0.05$). while no significant difference was observed in body weight ($p > 0.05$).

Conclusion: Yoga exercises have a significant effect on blood sugar control in people with type two diabetes.

Keywords: body composition, blood sugar, Cutaneous, FatType 2 diabetes, Yoga

Introduction

Decreased physical activity, improper nutrition and stress are among the most important reasons for increasing the prevalence of diabetes, which is considered one of the most important problems in the world. More than 350 million people in the world are suffering from this disease [1]. According to the International Diabetes Federation (IDF), the global prevalence of diabetes between the ages of 20 and 79 in 2021 was 10.5% (536.6 million people), which will increase to 12.2% (2.783 million) in 2045. People) will increase. The prevalence of diabetes in men and women is similar, and in 2021, diabetes in urban areas (12.1%) is more than in rural areas (8.3%), and in high-income countries (11.1%) more than in low-income countries (5 5.0%) was reported. The greatest relative increase in the prevalence of diabetes between 2021 and 2045 is expected to occur in middle-income countries (21.1%) compared to high-income (12.2%) and low-income (11.9%) countries. Decreased physical activity and immobility is one of the most important risk factors compared to other known risk factors. It seems that physical activity and exercise play an important role in controlling the risk factors of type 2 diabetes; So that the prevalence and incidence of risk factors are lower in rural people compared to urban people and active and inactive people[2]. The main goals of diabetes management and control are diet, exercise, complete care, medication and education according to research, yoga causes changes in the profile fat and blood sugar and also reduces insulin resistance [3] and concluded that yoga has a positive effect on various cardiovascular risk factors including weight, body composition, lipid profile, blood glucose level, stress, inflammation and oxidative stress [4] and also in another research they concluded that yoga has a positive effect on fat profiles, anthropometric characteristics, blood pressure, oxidative stress, and coagulation profiles [5].The purpose of this research is to determine the effect of a course of yoga exercises on glycemic and anthropometric indicators of women with type 2 diabetes in Tabriz city.

Method: The method of the current research is semi-experimental with a pre-test and post-test design, and the statistical population of the current research was women with type two diabetes in Tabriz city between the ages of 40 and 45. Among the volunteers, 20 women with type two diabetes (non-menopausal, no history of illness and no history of sports training in the past year) were selected. After selecting people as a statistical sample, they were randomly divided into two experimental and control groups of 10 people. The experimental group did yoga exercises for eight weeks and three sessions for 60 minutes each week, and the control group did not have any regular physical activity. All subjects were examined in two stages, including pre-test and after eight weeks of training, and blood was taken from them. And glycemic indices (fasting blood sugar, two-hour blood sugar, and hemoglobin A1C) and body composition of women with type two diabetes was investigated, and a body composition device made in Japan was used to measure body composition.

Results

The results of changes in fasting blood sugar, glycosylated hemoglobin, body composition, weights in two experimental and control groups in pre-test and post-test are shown in Table 1.

Table 1: Research variables in the pre- and post-test in the experimental and control groups

Variable	**group**	**Before Mean±standard deviation**	**After Mean±standard deviation**	**p-value**
B.M.I (Percent)	Yoga	29.31±3.75	28.61±3.64	0.000*
	Control	28.86±3.60	28.73±3.24	0.299
Weight(kg)	Yoga	74.61±12.26	74.02±0.44	0.572
	Control	66.9±8.33	66.86±6.87	0.955
HBA1C(milliliter)	Yoga	6.68±0.44	6.32±0.36	0.016*
	Control	6.90±0.15	7.40±0.22	0.001
FBS(milligrams per decimeter)	Yoga	130.90±19.84	120.4±19.70	0.084*
	Control	141.0±26.08	151.33±31.70	0.1

Table 1 shows that there was a significant difference in the levels of blood sugar, glycosylated hemoglobin and body composition in the experimental group compared to the control group, while there was no significant difference in body weight between the two groups.

Discuss

The results of this research showed that there is a significant difference in the levels of blood sugar, glycosylated hemoglobin and body composition in the experimental group compared to the control group, while there was no significant difference in body weight between the two groups. The present results were consistent with the results of Rahimi et al, They believe that a course of yoga exercises improves diabetes and blood sugar changes in inactive type 2 diabetic patients[6].

1. Amanat, S., et al., *Exercise and type 2 diabetes*. Physical Exercise for Human Health, 2020: p. 91-105.
2. Amani-Shalamzari, S., et al., *Generic vs. small-sided game training in futsal: Effects on aerobic capacity, anaerobic power and agility*. Physiology & behavior, 2019. **204**: p. 347-354.
3. Association, A.D., *Standards of care in diabetes—2023 abridged for primary care providers*. Clinical Diabetes, 2023. **41**(1): p. 4-31.
4. Charoenpiriya, A., L. Chailurkit, and B. Ongphiphadhanakul, *Comparisons of biochemical parameters and diabetic ketoacidosis severity in adult patients with type 1 and type 2 diabetes*. BMC Endocrine Disorders, 2022. **22**(1): p. 1-8.
5. Chen, N., *Epidemiological and Clinical Characteristics of 99 Cases of 2019-Novel Coronavirus (2019-nCoV) Pneumonia in Wuhan, China*.

6.رحیمی, et al., تأثیر یک دوره تمرینات یوگا بر چربی خون در بیماران زن مبتلا به دیابت نوع *II*. مجله علوم پزشکی صدرا, ۲۰۱٤. ۲(۳): p. 223-234..

The effect of a period of aerobic exercise along with melatonin injection on body weight and blood glucose level of male Wistar rats with experimental diabetes

Azam Farzampour[1]- Abdulhamid Habibi[2]- Mohammad Rami[3]

1. Master's degree, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

- (azam.farzam@yahoo.com)

2. Professor, Sports Physiology Department, Faculty of Sports Sciences, Ahvaz Shahid Chamran University, Ahvaz, Iran.

- (hamidhabibi330@gmail.com)

3. Assistant Professor, Department of Sports Physiology, Faculty of Sports Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

- (m.rami3035@gmail.com)

Abstract

Introduction: Diabetes and its complications are among the most important issues related to the health of all people in society; Of course, sports exercises and melatonin consumption have played a positive role in controlling it due to its antioxidant properties. The purpose of this study is to investigate the effect of a period of aerobic training and melatonin injection on body weight and blood glucose levels of rats with experimental diabetes.

Method: : In this applied research, 20 male Wistar rats weighing 204 ± 3.11 and 8 weeks old were randomly divided into 4 groups: diabetic-melatonin (DM), diabetic-melatonin-exercise (DME), healthy group-melatonin (HM) and healthy-melatonin-exercise (HME) were divided and exposed to aerobic exercise and melatonin injection for 6 weeks; At the same time, their glucose and body weight were also measured weekly.

Results: At the end of the study, the body weight of the rats in the diabetic-melatonin and diabetic-melatonin-exercise groups increased compared to the control group ($P<0.05$), while the blood glucose levels decreased significantly ($P< 0/001$).

Conclusion: This study showed that aerobic exercise and melatonin injection, while reducing the blood glucose level of diabetic rats, also prevents them from losing body weight; Therefore, melatonin and exercise can be considered as a treatment method to control the complications of diabetes.

Keywords: melatonin, antioxidant, experimental diabetes.

1- Introduction

Diabetes mellitus (DM) as one of the most important health-related issues in the 21st century is increasing in most countries [1] . Meanwhile, diabetes as a global health problem affects the economy of all countries, especially developing countries; Because about 70% of diabetes cases occur in middle and low-income countries. Diabetes occurs due to a combination of genetic and environmental factors such as excess calorie intake, reduced physical activity, smoking and excessive alcohol consumption[2] . The complications of this disease include nephropathy, neuropathy, retinopathy, muscle atrophy, and cardiovascular diseases[3].. Among these complications, cardiovascular diseases are known as the most common cause of death worldwide [4] and one of the most important causes of death among diabetic patients [5]. Diabetes mellitus (DM) is increasing as one of the most important health-related issues in the 21st century in most countries [1]. Meanwhile, type 2 diabetes is the most common type of diabetes, which, as a global health problem, affects the economy of all countries, especially developing countries; Because about 70% of type 2 diabetes cases occur in middle and low-income countries. Diabetes occurs due to a combination of genetic and environmental factors such as excess calorie intake, reduced physical activity, smoking, and high alcohol consumption [2]. Now, according to various researches for many years in the field of finding a way to reduce the complications of diabetes, many studies have confirmed the positive effects of exercise for diabetic patients because exercise has anti-inflammatory, anti-oxidative and anti-atrophic effects. [3] and on the other hand, it acts as a cheap and effective intervention in the prevention and treatment of cardiovascular diseases [6] so that It significantly reduces oxidative stress and myocardial fibrosis [7]. On the other hand, another group of studies indicate that melatonin reduces oxidative stress and protects tissue damage by inhibiting the formation of ROS [8]; Because melatonin and its metabolites have powerful antioxidant properties [5] and according to some researches, melatonin can prevent diabetes by increasing insulin; In addition, it has a protective role in various cardiovascular diseases [9]. Therefore, according to the mentioned contents, the use of exercise and melatonin as a therapeutic approach in reducing the complications caused by diabetes can be considered.

2- method and material

In this research, 20 male Wistar rats, which were 8 weeks old and weighed 204 ± 3.11 gr, were prepared. Mice were kept in standard polycarbonate cages with a temperature of 22±2 degrees Celsius and in a cycle of 12-12 hours of darkness and light in groups of 4. During the research period, the weight of the mice was recorded weekly, and water and food suitable for mice (pallet, Pars Feed Co., Tehran) were provided to the mice except during the experiments. After a week of adaptation to the laboratory environment, familiarization with the turntable and manipulation, the rats were randomly divided into 4 groups of 5, including the diabetic melatonin group (DM), the diabetic melatonin exercise group (DME), and the healthy melatonin group (HM). the healthy melatonin-exercise (HME) group were divided. The present research was conducted based on the ethical principles of working with animals reviewed and approved by the ethics committee of Chamran Ahvaz University. During the familiarization phase, in order to adapt to the laboratory conditions, the animals walked on the treadmill 5 days a week for 10-15 meters per minute. And after the adaptation of diabetes, mice were induced.

1-2- The steps of doing the work

After the adaptation process, the rats were deprived of food for 12 hours, then diabetes was induced by intraperitoneal injection of 55 mg per kilogram of body weight streptozotocin (STZ) solution (Sigma, St. Louis MO, USA). In the form of a solution in citrate buffer m 0.5 with pH 5.4: it was induced in diabetic-melatotin, diabetic-melatotin-exercise groups [10]. Non-diabetic mice were also injected intraperitoneally with a volume equivalent of 0.5m buffer citrate with a pH of 5.4 using an insulin syringe. After 48 hours from the time of injection, by creating an injury on the tail vein with a lancet, a drop of blood was placed on a glucometer strip and the strip was measured by a glucometer device (Gluco trend 2, Roche, Germany). Those whose blood sugar was higher than 250 mg/dl were considered diabetic. Also, in order to ensure that the blood sugar does not drop at the beginning of each week and until the end of the study, the blood sugar of the mice was measured, and the mice with blood sugar lower than the diabetic threshold were excluded from the study. 2 weeks after the induction of diabetes, endurance training protocol and melatonin injection were performed for 6 weeks.

2-2-Melatonin injection

After 2 weeks of diabetes induction, at the same time as the beginning of the endurance training protocol, the diabetic-melatonin, diabetic-melatonin and exercise, healthy-melatonin group to the healthy melatonin-exercise group, melatonin substance (10 mg per kg of body weight) were given by intraperitoneal injection and in the form of solution in saline containing ethanol and daily for 6 weeks [11].

2-3-Endurance training protocol

In this research, aerobic exercise protocol from moderate to intense with progressive intensity and duration and following the principle of gradual overload taken from Han Chi's research [12] was implemented for 6 weeks. In this way, the aerobic exercise sessions were performed by the groups who should be exposed to aerobic exercise in the form of 5 sessions per week for a period of 6 weeks. During this period, all training sessions were held after the sleep cycle and between 16-18 hours in the evening. During the exercises, the speed and duration of the exercise were gradually increased, so that in the first week, the speed and duration of the exercise were 10 meters per minute and for a period of 10 minutes, in the second week, 10 meters per minute and for a period of 20 minutes, in the third week. 15 meters per minute for 20 minutes, in the fourth week it was 14-15 meters per minute for 30 minutes, and in the fifth and sixth weeks it was 17-18 meters per minute for 30 minutes. During the training, in order to make the obtained adaptations uniform, all training variables were kept constant in the sixth week. The duration and intensity of training in different weeks of the research are given in table one.

2-4-sample extraction

After completing the 6-week training period, 48 hours after the last training session, the rats were anesthetized by intraperitoneal injection of a combination of ketamine (90mg/kg) and xylazine (10mg/kg). To check the biochemical variables, the heart was removed from the body under sterile conditions and under the supervision of a doctor of human anatomy and frozen in nitrogen at -80°C and the samples were kept in a freezer at -80°C.

2-5-Data analysis method

In this study, in the descriptive statistics section, charts, dispersion and central indices including standard deviation and mean were calculated, and in the inferential statistics section, the normality of the data distribution was evaluated through the Shapiro-Wilk test. And the result of the test was that the data distribution was normal. Then Levene's test was used to determine the homogeneity of variances. Also, for the significance of the difference between the groups, the one-way analysis of variance test was used, and in case of significance, Tukey's post hoc test was used to determine the difference between the averages of the two groups. In this research, $P \le 0.05$ was considered as a significant level for testing the hypotheses.

2-6-Inferential statistics

Before evaluating the hypotheses of the research, the presuppositions of the parametric test were examined. The Shapiro-Wilk test was used to check the first assumption that the data was normal, and with the non-significance of the statistic of this test ($P>0.05$), the normality of the data distribution was confirmed. The second assumption based on the equality of error variances in the dependent variable was also confirmed by the non-significance of the Lone test statistic ($P>0.05$); Finally, due to the relativity of the data scale and the acceptance of the third assumption, it was possible to use parametric tests in this research.

3- Results

3-1-The effect of exercise and melatonin injection on the body weight of rats

At the beginning of the study, there was no significant difference in the body weight of the mice in all groups. The body weight of rats in DM and DME groups was significantly higher than that of healthy rats ($p<0.05$). The changes in the weight of mice in the HM and HME groups were also not significant. (Graph 1)

3-2-The effect of exercise and melatonin injection on the blood glucose level of rats

The blood glucose level increased significantly 48 hours after the induction of diabetes by streptozotocin injection in the rats of the diabetic groups ($p<0.05$) and until the end of the research, there was a significant difference in the blood glucose level among the diabetic rats in comparison with healthy mice ($p<0.001$). At the end of the research, blood glucose levels in the DM and DME groups significantly decreased compared to the control group ($p<0.001$) (Chart two).

Table 1: Numerical representation of training program in different weeks

week	Duration (minutes)	Speed (m/min)
1	10	10
2	20	10
3	20	14-15
4	30	14-15

5	30	17-18
6	30	17-18

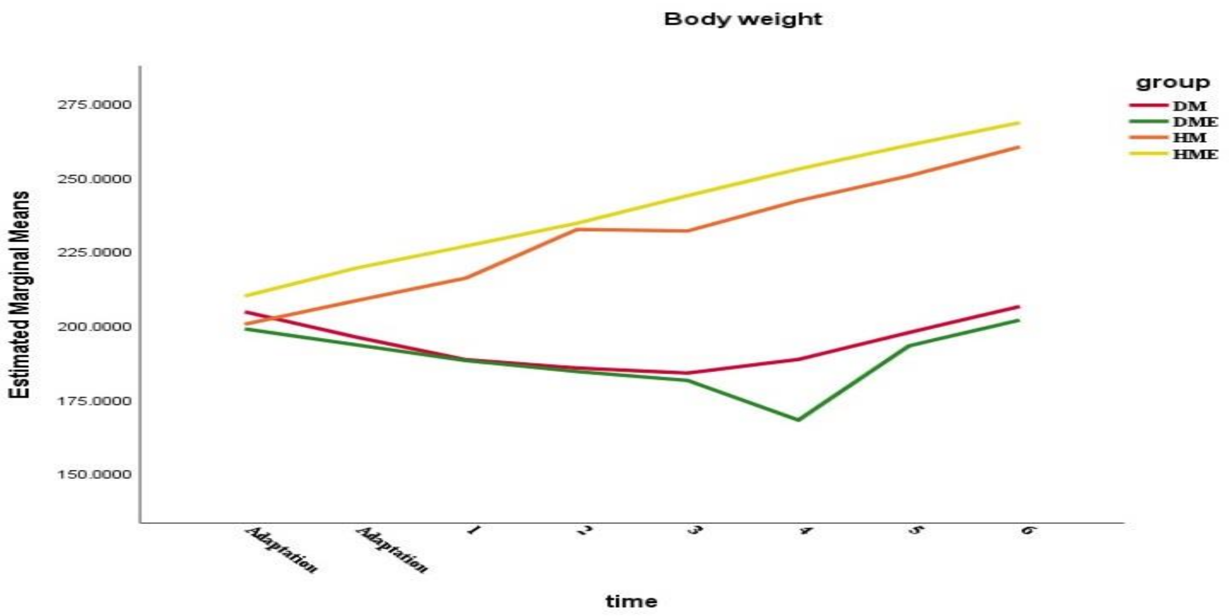


Chart 1: Body weight changes of different groups in different weeks of research

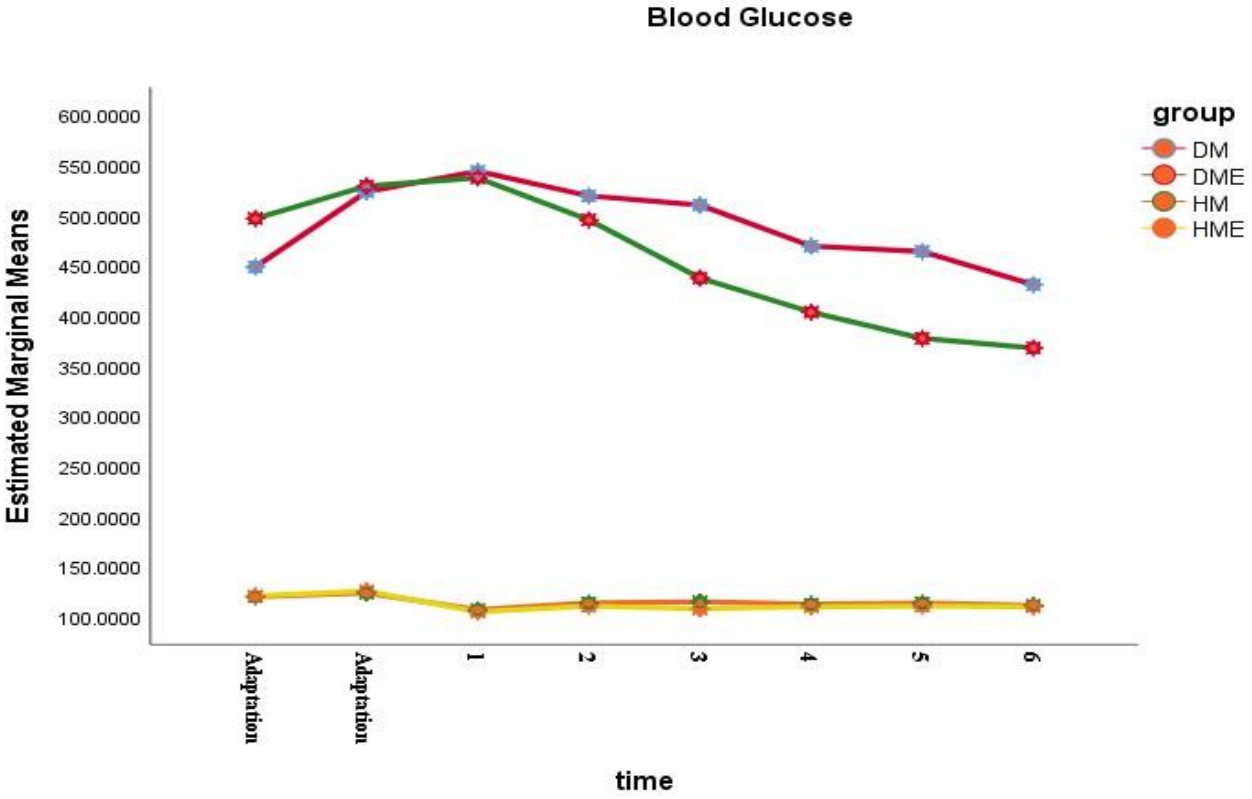


Chart 2: Blood glucose changes in different groups in different weeks of research

4-Discussion

Hyperglycemia is one of the most important characteristics of diabetes [3]. . In this study, we showed that six weeks of aerobic exercise and melatonin injection prevented body weight loss in diabetic rats (DME and DM) and reduced blood glucose in rats treated with melatonin and the combination of melatonin and exercise. Intracellular hyperglycemia initially causes excessive production of reactive oxygen species (ROS) in mitochondria and then increases ROS production through three other pathways (AGE formation, activation of piole and PKC pathways) [13], [14]. Imbalance between ROS production and their neutralization by antioxidant defense systems usually leads to oxidative stress [15]. The role of oxidative stress in diabetes is like two sides of a coin because it not only causes the onset of diabetes but also aggravates the complications and diseases caused by it [16]. In fact, excess ROS by forming OX-LDL, enhancing insulin resistance, activating ubiquitin-related pathways and decreasing the activation of adiponectin, AMP-activated protein kinase (AMPK) and endothelial nitric oxide synthase (eNOS) indirectly cause Acceleration of inflammation in atherosclerosis [13]. In diabetic conditions, oxidative stress stimulates muscle protein degradation by upregulating the ubiquitin proteasome pathway; On the other hand, heat shock proteins, caspases, atrogin-1, FOXO and PGC-1α also play a decisive role in relation to oxidative stress and muscle atrophy [3], [17]; In the current study, diabetes caused weight loss in diabetic rats compared to healthy rats, while melatonin and exercise prevented weight loss in DM and DME groups [18]. This happened because, on the one hand, exercise has anti-inflammatory, anti-oxidative and anti-atrophic effects and regulates factors such as insulin-like growth factor and heat shock protein [3], [19]and some studies show a significant decrease in the expression of MURF-1 in diabetic rats after exercise, which can be a result of reducing oxidative stress [3]. And on the other hand, melatonin, as a powerful antioxidant and scavenger of free radicals [20], [21], can almost completely inhibit the production of ROS [20], [22] and indirectly prevent weight loss due to diabetes. Exercise and melatonin in combination cause the regulation of PGC1α and GLUT4, which leads to the regulation of blood glucose in diabetes conditions, and the up-regulation of blood glucose itself leads to the improvement of inflammatory cytokines, adiponectins and oxidative stress [8]. In addition, separately, melatonin improves glucose absorption by regulating energy metabolism and the insulin signaling pathway, thereby reducing insulin resistance [23], [24]. Exercise can also help in two ways: 1) by increasing insulin sensitivity (increasing insulin action) and 2) increasing beta cell function by reducing the harmful effect of autoimmunity; The combination of these two effects may cause a significant increase in glucose tolerance [25]. The results of this research also show that melatonin, either alone or in combination with exercise, is able to control and regulate blood glucose in diabetic rats. In the current research, the amount of ROS was not measured, which may affect the research results as one of the limitations of the research. The second limitation in this research is the comparison of the use of different doses of melatonin in the subject groups, which can be considered in future research. It is appropriate for future research to consider the mentioned limitations in order to obtain more accurate results. In summary, the results of the present study show that melatonin, both independently and in combination with exercise, improves weight loss due to diabetes and regulates blood glucose.

References:

[1] M. Sedaghat, S. Choobineh, and A. A. Ravasi, “Taurine with combined aerobic and exercise training alleviates myocardium apoptosis in STZ-induced diabetes rats via Akt signaling pathway,” *Life Sci.*, vol. 258, p. 118225, 2020, doi: 10.1016/j.lfs.2020.118225.

[2] Y. Bi *et al.*, “Advanced research on risk factors of type 2 diabetes,” *Diabetes. Metab. Res. Rev.*, vol. 28, no. SUPPL.2, pp. 32–39, 2012, doi: 10.1002/dmrr.2352.

[3] G. Q. Chen, C. Y. Mou, Y. Q. Yang, S. Wang, and Z. W. Zhao, “Exercise training has beneficial anti-atrophy effects by inhibiting oxidative stress-induced MuRF1 upregulation in rats with diabetes,” *Life Sci.*, vol. 89, no. 1–2, pp. 44–49, 2011, doi: 10.1016/j.lfs.2011.04.018.

[4] X. Zhao, Y. Wang, and X. Sun, “The functions of microRNA-208 in the heart,” *Diabetes Res. Clin. Pract.*, vol. 160, p. 108004, 2020, doi: 10.1016/j.diabres.2020.108004.

[5] F. Nduhirabandi, E. F. Du Toit, D. Blackhurst, D. Marais, and A. Lochner, “Chronic melatonin consumption prevents obesity-related metabolic abnormalities and protects the heart against myocardial ischemia and reperfusion injury in a prediabetic model of diet-induced obesity,” *J. Pineal Res.*, vol. 50, no. 2, pp. 171–182, 2011, doi: 10.1111/j.1600-079X.2010.00826.x.

[6] X. Wei, X. Liu, and A. Rosenzweig, “What do we know about the cardiac benefits of exercise?,” *Trends Cardiovasc. Med.*, vol. 25, no. 6, pp. 529–536, 2015, doi: 10.1016/j.tcm.2014.12.014.

[7] M. Acikel Elmas *et al.*, “Protective effects of exercise on heart and aorta in high-fat diet-induced obese rats,” *Tissue Cell*, vol. 57, no. February, pp. 57–65, 2019, doi: 10.1016/j.tice.2019.01.005.

[8] M. M. Rahman, H. S. Kwon, M. J. Kim, H. K. Go, M. H. Oak, and D. H. Kim, “Melatonin supplementation plus exercise behavior ameliorate insulin resistance, hypertension and fatigue in a rat model of type 2 diabetes mellitus,” *Biomed. Pharmacother.*, vol. 92, pp. 606–614, 2017, doi: 10.1016/j.biopha.2017.05.035.

[9] X. Wang *et al.*, “Melatonin alleviates cigarette smoke-induced endothelial cell pyroptosis through inhibiting ROS/NLRP3 axis,” *Biochem. Biophys. Res. Commun.*, vol. 519, no. 2, pp. 402–408, 2019, doi: 10.1016/j.bbrc.2019.09.005.

[10] J. E. Yan, W. Yuan, X. Lou, and T. Zhu, “Streptozotocin-induced diabetic hyperalgesia in rats is associated with upregulation of toll-like receptor 4 expression,” *Neurosci. Lett.*, vol. 526, no. 1, pp. 54–58, 2012, doi: 10.1016/j.neulet.2012.08.012.

[11] Zangiabadi, “Effects of Melatonin in Prevention of Neuropathy in STZ-Induced Diabetic Rats,” *Am. J. Pharmacol. Toxicol.*, vol. 6, no. 2, pp. 59–67, 2011, doi: 10.3844/ajptsp.2011.59.67.

[12] C. H. Chae, S. L. Jung, S. H. An, C. K. Jung, S. N. Nam, and H. T. Kim, “Treadmill exercise suppresses muscle cell apoptosis by increasing nerve growth factor levels and stimulating p-phosphatidylinositol 3-kinase activation in the soleus of diabetic rats,” *J. Physiol. Biochem.*, vol. 67, no. 2, pp. 235–241, 2011, doi: 10.1007/s13105-010-0068-9.

[13] T. Yuan *et al.*, “New insights into oxidative stress and inflammation during diabetes mellitus-accelerated atherosclerosis,” *Redox Biol.*, vol. 20, no. September 2018, pp. 247–260, 2019, doi: 10.1016/j.redox.2018.09.025.

[14] M. Keshvari, M. Rahmati, R. Mirnasouri, and F. Chehelcheraghi, “Effects of endurance

exercise and Urtica dioica on the functional, histological and molecular aspects of the hippocampus in STZ-Induced diabetic rats," *J. Ethnopharmacol.*, vol. 256, no. January, p. 112801, 2020, doi: 10.1016/j.jep.2020.112801.

[15] C. Marques *et al.*, "The dipeptidyl peptidase 4 inhibitor sitagliptin improves oxidative stress and ameliorates glomerular lesions in a rat model of type 1 diabetes," *Life Sci.*, vol. 234, no. February, p. 116738, 2019, doi: 10.1016/j.lfs.2019.116738.

[16] O. M. Ighodaro, "Molecular pathways associated with oxidative stress in diabetes mellitus," *Biomed. Pharmacother.*, vol. 108, no. September, pp. 656–662, 2018, doi: 10.1016/j.biopha.2018.09.058.

[17] M. Keshvari, M. Rahmati, R. Mirnasouri, and F. Chehelcheraghi, "Effects of endurance exercise and Urtica dioica on the functional, histological and molecular aspects of the hippocampus in STZ-Induced diabetic rats," *J. Ethnopharmacol.*, vol. 256, no. March, p. 112801, 2020, doi: 10.1016/j.jep.2020.112801.

[18] M. Rahmati, M. Keshvari, R. Mirnasouri, and F. Chehelcheraghi, "Exercise and Urtica dioica extract ameliorate hippocampal insulin signaling, oxidative stress, neuroinflammation, and cognitive function in STZ-induced diabetic rats," *Biomed. Pharmacother.*, vol. 139, p. 111577, 2021, doi: 10.1016/j.biopha.2021.111577.

[19] N. Colomo *et al.*, "Relationship between glucose control, glycemic variability, and oxidative stress in children with type 1 diabetes," *Endocrinol. Diabetes y Nutr. (English ed.)*, vol. 66, no. 9, pp. 540–549, 2019, doi: 10.1016/j.endien.2019.10.003.

[20] Y. Liu *et al.*, "Melatonin improves cardiac function in a mouse model of heart failure with preserved ejection fraction," *Redox Biol.*, vol. 18, no. July, pp. 211–221, 2018, doi: 10.1016/j.redox.2018.07.007.

[21] Y. Wu, F. Si, L. Luo, and Q. Yi, "Serum levels of melatonin may contribute to the pathogenesis of heart failure in children with median age of 1 year," *J. Pediatr. (Rio. J).*, vol. 94, no. 4, pp. 446–452, 2018, doi: 10.1016/j.jped.2017.06.023.

[22] M. Schaefer, M. M. Gebhard, and W. Gross, "The effect of melatonin on hearts in ischemia/reperfusion experiments without and with HTK cardioplegia," *Bioelectrochemistry*, vol. 129, pp. 170–178, 2019, doi: 10.1016/j.bioelechem.2019.05.017.

[23] R. Patel, N. Parmar, S. P. Palit, N. Rathwa, R. A.V., and R. Begum, "Diabetes mellitus and melatonin: Where are we?," *Biochimie*, Jan. 2022, doi: 10.1016/j.biochi.2022.01.001.

[24] R. Guo, H. Zheng, Q. Li, X. Qiu, J. Zhang, and Z. Cheng, "Melatonin alleviates insulin resistance through the PI3K/AKT signaling pathway in ovary granulosa cells of polycystic ovary syndrome," *Reprod. Biol.*, vol. 22, no. 1, p. 100594, 2022, doi: https://doi.org/10.1016/j.repbio.2021.100594.

[25] R. Codella, I. Terruzzi, and L. Luzi, "Why should people with type 1 diabetes exercise regularly?," *Acta Diabetol.*, vol. 54, no. 7, pp. 615–630, 2017, doi: 10.1007/s00592-017-0978-x.

The effect of aerobic training on the expression of the mir-1 gene in cardiomyocytes of male rats

Samaneh Dastah [1]

[1] *Assistant Professor, Department of Sports Sciences, University of Maragheh, Maragheh, Iran ,* s.dastah@maragheh.ac.ir

Abstract

Introduction: microRNAare a new class of biological indicators that are involved in the structural and functional changes of the heart at the cellular level and signaling pathway. The aim of the present study was to compare a period of intense intermittent exercise with continuous endurance on the expression of mir-1 gene in cardiomyocytes of male rats.

Method: For this purpose, 14 male rats were randomly divided into two control and experimental groups after familiarization with the training protocol. The experimental group performed a program (12 weeks) of aerobic exercises on a treadmill. In the following 48 hours after the end of the last training session, they were anesthetized and dissected, then their hearts and left ventricles were removed and the expression level of -1 miR in their hearts was measured using real-time PCR method.

Results: The result of the study showed that the mir-1 expression of the training group was significantly lower than the control group.

Conclusion: In fact can said that Aerobic exercises increase heart efficiency by reducing Mir-1 expression.

Keywords: Aerobic exercise, Mir-1, Cardiomyopathy

Introduction

Heart diseases are one of the important problems that are increasing in different societies, and nowadays a wide range of researches have investigated the effects of physical activity on these types of diseases. Diabetic cardiomyopathy is defined as a defect in the function of the left ventricle in patients with diabetes without any symptoms of high blood pressure, heart congestion or any other heart disease [1].

For several decades, many experiments have been performed at the molecular level to clarify the molecular mechanisms involved in cardiomyocyte apoptosis; In recent years, researchers managed to discover and identify potential microRNAs that not only determine the emergence of cardiomyopathy, but can be a new marker for early detection and possibly prevention of diabetic cardiomyopathy in the future [2].

In recent years, non-coding RNAs called microRNAs (miRs) have been discovered and found to regulate gene expression at the post-transcriptional level. Among these microRNAs, we can mention miR-1, which is involved in a number of muscle processes and plays a role in the proliferation and differentiation of cells during the embryonic period of the heart [3]. Researches have shown that aerobic physical activities affect the expression of miRs in skeletal muscles [4]. Considering the effect of endurance activities on heart tissue and the role of miR-1 on its reconstruction, the aim of this research is to investigate the effect of 14 weeks of endurance training (treadmill running) on the expression of miR-1 in the heart muscle.

Method

For this purpose, 20 male Wistar field rats aged 5 weeks (115±24 grams) were purchased from Pasteur Institute. The rats were randomly divided into two groups (10 heads as the control group and the other 10 heads as the training group). The training protocol included 12 weeks of treadmill running. Finally, 48 hours after the end of the last training session, the rats were anesthetized with a combination of ketamine (50 mg per kilogram) and xylazine (5 mg per kilogram). Then the rats' hearts were removed under sterile conditions and their left ventricles were isolated. Mir-1 gene expression was done by real time PCR method. Shapiro-Wilk test was used to check the normality of data distribution. Because the data distribution was normal, ANCOVA analysis of covariance test was used to determine the differences between groups. Also, independent t-test was used to investigate the possibility of differences between the control and training groups. Data analysis was done using SPSS version 23 statistical software at the level of statistical significance ($p<0.05$).

Result

The results showed that the mean expression of cardiac miR-1 in the experimental group compared to the control group is reduced after 12 weeks of aerobic exercise (figure 1).

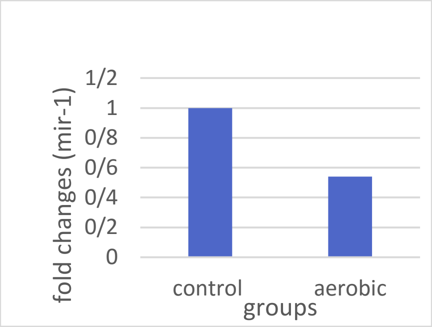


Figure 1. Effects of aerobic exercise on gene expression mir-1 in control and aerobic exercise groups

Discussion

The results of the present study showed that long-term aerobic exercise for 12 weeks (5 days a week) with moderate intensity reduces the expression of miR-1 in heart muscle tissue. In this context, Han (2011) 3 showed that miR-1 expression decreases in hypertrophy, but when heart failure progresses, it returns to the first state or more than that [5]. Therefore, it can be said that miR-1 expression is related to heart hypertrophy. , but whether there is a difference in the expression of miR-1 in the types of hypertrophy or not? It is not clear, because the hypertrophy that occurs as a result of physical activities is different from the one that occurs as a result of heart failure or blood pressure [6]. The function of the heart is determined, the physiological type of hypertrophy improves the function of the heart and the pathological type causes a decrease in the heart's efficiency. One of the target genes of miR-1 is the histone deacetylase-4 (HDAC4) gene [3], which causes chromatin compaction, so the access of RNA polymerase to DNA is severely limited to initiate transcription [7], downstream of HDAC4 is myocyte enhancer factor 2 (MEF2) [8]. In fact, HDAC4 is the inducer of slow-type filaments and MEF2 is repressor [8]. Therefore, if endurance activities lead to a decrease in miR-1 expression, HDAC4 expression increases and MEF2 is suppressed, the final result is a decrease in the expression of beta-2MHCβ heavy chain or slow-type filaments, which in fact it leads to an increase in the efficiency of the heart.

In summary, the results of this research showed that aerobic activities have a significant effect on the expression of miR-1 which can affect the function of the heart.

References:

[1]. .Murarka S, Movahed MR. Diabetic cardiomyopathy. Journal of cardiac failure. 2010;16(12):971-9.

[2]. Tang X, Tang G, Özcan S. Role of microRNAs in diabetes. Biochimica et Biophysica Acta (BBA). Gene Regulatory Mechanisms. 2008;1779(11):697-701.

[3]. van Rooij, E., N. Liu, and E.N. Olson. (2008). MicroRNAs flex their muscles. Trends in Genetics. 24(4): p. 159-166.

[4]. Soci, U.P., et al. (2011).MicroRNAs 29 are involved in the improvement of ventricular compliance promoted by aerobic exercise training in rats. Physiol Genomics. 43(11): p. 665-73.

[5]. Han, M., J. Toli, and M. Abdellatif. (2011). MicroRNAs in the cardiovascular system. Curr Opin Cardiol. 26(3): p. 181-9.

[6]. Hill, J.A. and E.N. Olson. (2008). Cardiac plasticity. N Engl J Med. 358(13): p. 1370-80.

[7]. Kehat, I., et al. (2011). Modulation of chromatin position and gene expression by HDAC4 interaction with nucleoporins. J Cell Biol. 193(1): p. 21-9.

[8]. Miska, E.A., et al. (1999). HDAC4 deacetylase associates with and represses the MEF2 transcription factor. EMBO J. 18(18): p. 5099-107.

The effect of six weeks of Crossfit training on some indexes of physical fitness and blood lactate response in female professional taekwondo athletes

Roonak Hossainzadeh*[1], Bahloul Ghorbanian[2], Behrooz Ghorbanzadeh [3]

[1] *Msc student, Department of Sport Sciences, Faculty of Psychology and Education, Azarbaijan Shahid Madani University, Tabriz, Iran, E-mail: hosseinzadehroonak@gmail.com*

[2,3]*Department of Sport Sciences, Faculty of Psychology and Education, Azarbaijan Shahid Madani University, Tabriz, Iran, E-mail: b.gorbanian@gmail.com*

[3]*Department of Sport Sciences, Faculty of Psychology and Education, Azarbaijan Shahid Madani University, Tabriz, Iran, E-mail: behroozghorbanzadeh@gmail.com*

Abstract

Introduction: Success in any sport requires physical and physiological abilities specific to that sport. One of the main methods in determining the effectiveness of training programs on sports performances is to know the state of physical fitness of athletes (1). Taekwondo is one of the sports that is followed professionally in 140 countries of the world and 170 countries are officially members of the World Taekwondo Federation (2). The sport of Taekwondo is an unarmed fighting technique for self-defense that involves the skillful use of techniques such as jumping kicks, dodging, and hand and footwork. In Taekwondo, the ability to generate maximum force in the shortest time is considered as a basic principle to obtain a high level of sports performance. In this regard, athletes have always tried to show their best performance. It seems that having aerobic power, anaerobic power, speed and agility are effective factors on the performance of martial athletes, especially taekwondo (3).

CrossFit is a training model which involves high intensity and repetitive functional movements (Butcher et al., 2015). CrossFit training, which has gained great popularity today, was introduced to the world by Glassman from California in 1995 and this training model keeps spreading rapidly (Goins, 2014; Dilber and Doğru,2018). CrossFit training is a form of high intensity interval training, is a strength and conditioning workout that is made up of functional movement performed at a high intensity level. These movements are actions that you perform in your day-to-day life, like squatting, pulling, pushing and etc. CrossFit is sports discipline with unique training principles (using barbell conditioning; preparation for any combination of strength and endurance in one workout; a combination of Olympic weightlifting with other exercises; energy cost of locomotion in bodyweight and free weight exercises (4). Some of CrossFit unit trainings are based on the principle of repeating as many rounds as possible in one round (Smith et al., 2013). CrossFit trainings aim to develop strength and endurance. These trainings are thought to improve the aerobic capacity and anaerobic capacity of the individual thanks to the trainings performed with high intensity movement combinations. Together with the fact that CrossFit trainings affect the positive development in aerobic capacity, muscle endurance and body composition, it also requires high technical capacity in the implementation of the movements (Moran et al., 2017).

The purpose of this study was to investigate the effect of crossfit exercises on physical fitness factors (aerobic power, anaerobic power, speed and agility) and blood lactate response in female professional taekwondo athletes.

Methods

This study is semi-experimental and its statistical population consists of female taekwondo athletes in Kermanshah city. According to the criteria for entering the study, 20 athletes as available subjects with an age range of 16-35 years and with at least 8 years of experience in sports competitions selected and were randomly divided into two groups of Crossfit (n=10) and control (n=10). The training protocol included 6 weeks of CrossFit training (three sessions per week, and each session was 60 minutes), which was done in compliance with the principle of overload. In the pre and post-test, to measure the studied variables, the 45-meter sprint test was used to evaluate speed, the T-Test was used to evaluate agility, the RAST test was used to evaluate anaerobic power, and the shuttle run test (SRT) was used to evaluate aerobic power. Also, to evaluate changes in blood lactate before and after the intervention of the six-week exercise program, after performing an acute maximum exercise including the Buruce test on the treadmill before exercise and 48 hours after the last exercise session were evaluated through blood sampling. The data were analyzed using the correlation t test and ANOVA using SPSS version 24 software at a significance level of $p \geq 0.05$.

Results:

The results of the correlated t-test were showed that the average values of speed (p=0.001), agility (p=0.002), aerobic power (p=0.045), anaerobic (p=0.001), and blood lactate level (p=0.001) in the exercise group improved significantly in the post-test compared to the pre-test. And the results analysis of difference between groups (ANOVA) were showed that the average values of speed (p=0.006), aerobic power (p=0.025), anaerobic (p=0.015) and blood lactate level (p=0.01) had a significant difference, but the difference between the average of the two groups in the agility variable (p=0.49) was not significant.

Table 1: Demographic characteristics of the subjects

group / Variable	Crossfit (n=10)		Control (n=10)	
	Mean	Standard deviation	Mean	Standard deviation
age (years)	25.87	5.91	24.4	4.47
weight (kg)	60.9	3.5	60.20	2.93
height (cm)	166	1.04	166	1.03
body mass index (kg/m2)	21.83	0.39	21.98	1.04
Sports history (years)	9.7	1.76	9.5	1.43

Table 2: The results of the paired t-test and ANOVA of the studied variables in the subjects

group / Variable	Crossfit (n=10)			Control (n=10)			ANOVA
	Pre-test	Post-test	T-test (sig)	Pre-test	Post-test	T-test (sig)	(sig)
Speed (m/s)	8.07 ± 0.22	7.73 ± 0.32	*0.001	8.12 ± 0.17	8.19 ± 0.13	0.123	**0.006
Agility (s)	14.98 ± 1.36	13.60 ± 1.57	*0.045	14.77 ± 1.05	15.76 ± 1.55	0.809	0.49
VO2max (ml/kg/min)	49.89 ± 3.39	50.96 ± 3.42	*0.001	47.16 ± 1.96	47.24 ± 2.27	0.739	**0.025
anaerobic power (kg.m/s	88.51 ± 2.08	92.60 ± 2.06	*0.001	88.28 ± 2.73	88.79 ± 3.08	0.084	**0.015
blood lactate (mg/dL)	51.78 ± 3.23	46.24 ± 3.27	**0.001	52.10 ± 4.14	51.62 ± 4.00	0.304	**0.01

*: within-group difference, **: between-group difference

Conclusion:

According to the findings of this study, which showed that 6 weeks of Crossfit exercises significantly improved the all variables in Crossfit training group, and the analysis of the difference between groups also showed that except for the agility variable, the average difference of the other variables was significant. It is concluded that according to the results of the study, Crossfit exercises can be suggested as a type of complementary exercise to improve the level of aerobic and anaerobic fitness and motor performance of taekwondo athletes.

References

[1]. Conte D, Favero TG, Lupo C, Francioni FM, Capranica L, and Tessitore A. Time- motion analysis of Italian elite women's basketball games: individual and team analyses. J Strength Cond Res, 2015; 29: 144-150.

[2]. Shah S. Plyometric exercises. International journal of health sciences and research. 2012;2(1):115-26.

[3]. Booth MA, Orr R. Effects of plyometric training on sports performance. Strength & Conditioning Journal. 2016;38(1):7-30.

[4]. Butcher, S. J., Neyedly, T. J., Horvey, K. J., and Benko, C. R. (2015). Do physiological measures predict selected CrossFit benchmark perforamance? Journal of Sports Medicine, 6: 241-245.

[5]. Dilber, A., and Doğru, Y. (2018). The effect of high intensity functional exercise on anthropometric and physiological characteristics in sedantery. International Journal of Sports Exercise and Training Science, 4(2): 64-69.

[6]. Goins, J. M. (2014). Physiological and Performance Effects of CrossFit. Master Thesis. The University of Alabama. 26-28.

[7]. Gäbler M, Prieske O, Hortobágyi T, Granacher U. The effects of concurrent strength and endurance training on physical fitness and athletic performance in youth: a systematic review and meta-analysis. Frontiers in physiolog, 2018 Aug 7:9:1057

[8]. Smith, M., Sommer, M., Starkoff, A. J., and Devor, S. T. (2013). CrossFit-based high intensity power training improves maximal aerobic fitness and body composititon. Journal of Strength and Conditioning Research, 27(11): 3159-3172.

[9]. Moran, S., Booker, H., Staines, J., and Williams, S. (2017). Rates and risk factors of injury in CrossFit: a prospective cohort study. Journal of Sports Medicine and Physical Fitness, 57(9): 1147-1153.

The effect of swimming exercises on the core strength of women

Mahta Eskandarnejad*[1] ,Vaghar Asadi Zonuz[2]

[1] *Department of Motor Behavior, Faculty of Physical Education and Sports Sciences, Tabriz University, Tabriz, Iran. (Corresponding),* eskandarnejad@tabrizu.ac.ir

[2] *Masters student in Motor behavior department, physical education and sport science faculty, University of Tabriz, Tabriz, Iran,* vaghar.a.zonuz@gmail.com

Abstract

Introduction: Humans can stand straight, bend and walk with the help of their core. Therefore, strengthening the core is very important. Therefore, the purpose of this research is to investigate the effect of swimming exercises on the strength of the core.

Method: The research method is semi-experimental. The statistical population of the present study included all beginner swimmers of one of the swimming schools in the province. 30 people were selected by the available sampling method and randomly selected in two experimental (15 people) and control (15 people) groups. The Plank test was used to check the strength of the core. Swimming exercises were provided by the researcher for one hour during eight weeks for the experimental group and the control group didn’t receive training. Analysis of covariance test was used to analyze the data.

Results: The result of the study showed that there is a significant difference between the strength of the core of the two groups ($p \leq 0.001$) and according to the average core muscle strength of the swimming group, it has increased. M1=54/73, M2=26/93). The power of the test to detect this difference was 100%, so it can be said that swimming exercises affect the core .

Conclusion: One of the sports that increases endurance and strength of the core is swimming. The core in swimming causes the effective transfer of power from this area to the lower and upper limbs and progress in the water, as a result, it improves it. It is recommended that coaches of various sports teams and general sports use this type of training method to increase the strength of the central muscles of the body.

Keywords: Swimming, The core, core stability, plank

This Regular physical activity is one of the indicators of society's health, and it leads to the modification of the risk factors of cardiovascular diseases and causes mental health and self-esteem (Tamimi, Noroozi, 2016). It can be said that one of the most accessible and least expensive methods of preventing death and disability caused by diseases is physical activity and sports (Saremi, Moradzadeh et al., 2022), including sports that have received increasing attention in recent years. found, that sport is swimming (Troup, 1999). Swimming is an excellent aerobic exercise that is also useful for strengthening the body. This is because even parts of the body that are not actively moving support the body against water resistance. Pool exercises are also unique because they provide solid resistance without impact. Lifting free weights can cause you to lose your balance, but this provides an excellent opportunity to build strength with less risk (Ruiz-Navarro, 2023). Swimming is a low-impact sport that involves a wide range of muscle groups, and when stroke techniques are performed correctly, the muscles are stretched and their flexibility increases. This is why most competitive swimmers have wider shoulders and a very well-shaped body (Barbosa, 2023). There are different strokes that you can use to diversify your swimming practice, including breaststroke, backstroke, sidestroke, butterfly and freestyle. Each focuses on different muscle groups (Lee, 2015). Swimming allows you to deeply work your abs and core thanks to kicking and arm movements (Diversi, 2016).

In recent years, core stability exercises have become very popular in the field of rehabilitation and sports performance, therefore, core stability exercises are not only a necessary parameter to prevent sports injuries but also improve performance in sports and daily activities, core stability muscles are strengthened, They provide a solid foundation for the production of the body's required torque (Sedaghati, Saki et al., 2018) and all dynamic movements are effective and have special functions such as trunk control during an activity. Therefore, the optimal stability of this area as a communication bridge helps to effectively transfer the force produced in the lower limb to the upper limb through the trunk and better performance of sports skills. The results of the research of Golmoradi Marani et al. (2021) show that the core stability exercises applied in this research are a suitable, scientific solution to improve the general performance of a person, and by increasing this factor, they prevent personal injury.Due to the importance of the use and activity of the muscles of the core, as well as the central part of the body, which is the endpoint, the point of connection and receiving power, all the movement chains are used during all dynamic activities. In the background of the research, the effect of core stability training on dry land has been investigated on swimmers or normal and injured people, but the effect of swimming training on the core has not been done. Since the core play a great role in the performance of swimmers, the necessity of this research was felt and the answer to the question of whether swimming exercises are effective in strengthening the core or not? is showing.

method: This research is semi-experimental and 30 people were selected by the available sampling method and were randomly selected into two experimental (15 people) and control (15 people) groups. The Plank test was used to check the strength of the core. Swimming exercises were given to the experimental group for one hour during eight weeks. One-variable analysis of covariance (ANCOVA) was used to compare groups in SPSS software version 26 for analysis.

The premise of using the covariance test is to establish the assumption of normality and homogeneity of the variances of the research variables, which according to the Shapiro-Wilk test, p=0.83 and Levene's test, p=0.406, these assumptions are established.

Table 1: The result of Levene's test to check the assumption of equality of variances

P	Df2	Df1	F	The dependent variable
0/406	28	*1*	0/711	Pre-test

Table 2: Summary of the results of covariance analysis related to the effect of swimming exercises on the central muscles of the body

The dependent variable	Indicator	sum of squares	DF	F	Eta2	observed power
Post-test	contrast	2510/06	1	33/04	0/56	1.0
	Error	1974/84	26			

Based on the findings of Table2, by controlling the pre-test , the results between the two groups show that there is a significant difference between the core strength of swimmers and inactive people (P≤0.001) and according to the average core muscle strength of the swimming group, it has increased. M1=54/73, M2=26/93)(Table3). The squared value of Eta is 0/56, which shows that 56% of the changes are due to cognitive training. The power of the test to detect this difference was 100%, so it can be said that swimming exercises affect the core muscles.

Table3: Mean and standard deviation of the studied variables in swimming and inactive groups

Post-test		Pre-test		N	group
SD	M	SD	M		
18/60	54/73	18/57	40/80	15	swimming

14/99	26/93	16/55	30/06	15	Inactive

Conclusion: The present study aimed was to investigate the effect of swimming exercises on the core of women aged 30 and over. Univariate analysis's results showed that taking into account the pre-test scores as a covariate (auxiliary) variable, swimming exercises affect the improvement of the core. The results of the present study are in line with the research findings of Yu Kwok, So et al (2021) and Keiner, Yaghobi et al. (2015), Flis, Dzik et al. (2019). Research showed that swimming strengthens the body muscles more. Although each stroke uses different muscle groups to execute different techniques, all swimming strokes develop core muscles. deltoid and shoulder muscles to help the arms enter the water properly and extend longer. Forearm muscles that work more for propulsion when pulling water. Upper back muscles that stabilize the shoulders during swimming strokes. gluteal muscles and hamstrings to keep the body in a balanced position and assist in movement (Karpiński, 2020). This shows that swimming is the best exercise for building muscle. This sport requires you to constantly keep yourself in the water, which engages all the muscles of the body simultaneously. Therefore, swimming develops significant muscle mass while greatly improving your strength and endurance (Rodríguez González, Melguizo-Ibáñez et al., 2022). The breaststroke and backstroke, with their alternating (and therefore faster) rhythm, will eliminate your "love handls" while working the diagonals. The butterfly movement is undoubtedly the best way to strengthen the abdominal muscles. Wave kicks and leg kicks are the best options for

strengthening the abdominal muscles (Boer, 2020). Therefore, researchers believe that athletes must have sufficient strength in the muscles of the trunk and thighs to create the necessary stability in different movement planes. While the existence of limitations in the strength and stability of the core region leads to the implementation of incorrect sports techniques and makes the athlete prone to injury (Sedaghati, Saki et al., 2017), the results of Mahdavi et al.'s research (2010) It shows that core stability exercises can improve posture control and as a result, the amount of falling on the ground in the elderly, which indicates the necessity of performing core stability exercises in non-athletes and elderly people. Swimming provides the opportunity to develop both physical and mental qualities and provides a foundation for a variety of sports activities by developing skill, coordination, endurance, speed, speed, agility, flexibility and mobility. Therefore, it is suggested to use swimming training to strengthen the core of different disciplines and teams, and coaches and doctors recommend swimming to strengthen body muscles.

Acknowledgment: At the end of the swimming pool management University of Tabriz and SHAN swimming Academy we are grateful to all the athletes, students, coaches and colleagues who helped in distributing and completing the questionnaires.

References:

Tamimi H, Noroozi A. Determinants of Physical Activity in High School Girl Students: Study Based on Health Promotion Model (HPM) . j.health 2016; 6 (5) :527-537

Saremi A, Moradzadeh R, Bahrami A. Physical Activity and Body Composition in Infertile and Fertile Women. J Arak Uni Med Sci 2022; 24 (6) :888-901URL: http://jams.arakmu.ac.ir/article-1-7050-fa.html

Troup, J. P. (1999). The physiology and biomechanics of competitive swimming. Clinics in sports medicine, 18(2), 267-285

Lee, B. A., & Oh, D. J. (2015). Effect of regular swimming exercise on the physical composition, strength, and blood lipid of middle-aged women. Journal of exercise rehabilitation, 11(5), 266.

Diversi, T., Franks-Kardum, V., & Climstein, M. (2016). The effect of cold water endurance swimming on core temperature in aspiring English Channel swimmers. Extreme physiology & medicine, 5(1), 1-12.

Ruiz-Navarro, J. J., López-Belmonte, Ó., Gay, A., Cuenca-Fernández, F., & Arellano, R. (2023). A new model of performance classification to standardize the research results in swimming. European Journal of Sport Science, 23(4), 478-488.

Barbosa, T. M., Barbosa, A. C., Simbana Escobar, D., Mullen, G. J., Cossor, J. M., Hodierne, R., ... & Mason, B. R. (2023). The role of the biomechanics analyst in swimming training and competition analysis. Sports Biomechanics, 22(12), 1734-1751.

Karpiński, J., Rejdych, W., Brzozowska, D., Gołaś, A., Sadowski, W., Swinarew, A. S., ... & Stanula, A. (2020). The effects of a 6-week core exercises on swimming performance of national level swimmers. PloS one, 15(8), e0227394.

Sedaghati P, Saki F, Sarlak P. (2018) The Impact of Specific Core Stability Training on the Sports Performance of Teenage Competitive Swimmers. JRUMS; 17 (4) :305-318URL: http://journal.rums.ac.ir/article-1-3987-fa.html

Sedaghati Parisa, Saki Farzaneh and Serlak Parisa. (2017). The role of core stability training in dynamic balance and sport performance of girl child-age range competitive swimmers., Journal of Sport in Biomotor Sciences.9(17), 10-19.

Mahdavi S, Golpaigani M, Shavandi N, Farzaneh Hessari A, Sheikh Hoseini R. The Effect of Core Stabilization Training (Six Weeks) on Falling Rate in Elderly Female. Salmand: Iranian Journal of Ageing 2010; 5 (3)

Yu Kwok, W., So, B. C. L., Tse, D. H. T., & Ng, S. S. M. (2021). A Systematic Review and Meta-Analysis: Biomechanical Evaluation of the Effectiveness of Strength and Conditioning Training Programs on Front Crawl Swimming Performance. Journal of sports science & medicine, 20(4), 564–585. https://doi.org/10.52082/jssm.2021.564

Keiner, M., Yaghobi, D., Sander, A., Wirth, K., & Hartmann, H. (2015). The influence of maximal strength performance of upper and lower extremities and trunk muscles on different sprint swim performances in adolescent swimmers. Science & Sports, 30(6), e147-e154.

Flis, D. J., Dzik, K., Kaczor, J. J., Cieminski, K., Halon-Golabek, M., Antosiewicz, J., ... & Ziolkowski, W. (2019). Swim training modulates mouse skeletal muscle energy metabolism and ameliorates reduction in grip strength in a mouse model of amyotrophic lateral sclerosis. International Journal of Molecular Sciences, 20(2), 233.

Rodríguez González, M. L., Melguizo-Ibáñez, E., Martín Moya, R., & González Valero, G. (2022). Study of strength training on swimming performance. A systematic review.

Boer, P. H. (2020). The effect of 8 weeks of freestyle swim training on the functional fitness of adults with Down syndrome. Journal of Intellectual Disability Research, 64(10), 770-781.

Temur, H. B. (2018). Investigation of the Relationship between Basic Swimming Instruction and Some Physical and Motor Characteristics. Journal of Education and Training Studies, 6(11), 67-74.

Golmoradi Marani M, Khalegi M, Ahmadi A, Alavi S F.(2021) Effect of 12 Weeks of Core Stability Exercises on Functional Movement and Balance of Women Working in Hospitals. J Sport Biomech; 7 (2) :122-135

The effect of turmeric curcumin and aerobic exercise on Alzheimer's disease

Hojjatollah Siavoshy[1,2,4], Zahra Izadi[2], Sedigheh Sadat Hojjati[3]

*1. Assistant Professor, Department of Sport Sciences, Faculty of Humanities, University College of Omran_Toseeh, Hamadan, Iran. *Corresponding Author: seiavoshy@gmail.com*

2. Assistant professor, Department of Horticultural Sciences and Engineering, Nahavand Higher Education Complex, Bu-Ali Sina University, Hamedan, Iran. z.izadi@basu.ac.ir

3. Assistant Professor, Department of exercise physiology, Payam Noor University, Tehran, Iran. s.sadat.hojjati@pnu.ac.ir

4. Assistant Professor, Department of Physical Education, Shahid Maghsoudi Campus, Farhangian University, Hamadan, Iran. seiavoshy@alumni.basu.ac.ir

Abstract

Introduction: Alzheimer's disease is the most common cause of dementia in the world, but strategies to slow or prevent its clinical progression have remained largely elusive until recently; therefore, this research was conducted with the aim of investigating the effect of exercise and turmeric on Alzheimer's disease.

Method: For this purpose, in this study, 42 Alzheimer's patients were selected and divided into three groups: exercise, turmeric, and control; Subjects in the exercise group did aerobic exercise for 12 weeks, 3 sessions per week, and the turmeric group received 800 mg of turmeric powder in capsule form daily for 12 weeks (approximately 100 mg of curcumin daily). Participants completed the Pittsburgh Sleep Quality Index (PQSI), Neuropsychiatric Inventory-Questionnaire (NPI-Q), Quality of Life-Alzheimer’s Disease (QOL-AD) at the beginning and after the end of the intervention. Then the data were analyzed by Friedman and ANCOVA test in SPSS version 21 ($P<0.05$).

Results: The findings showed that the scores of the PQSI improved significantly only in the group that exercised, but the values of the NPI-Q and the QOL-AD in both the exercise and turmeric groups showed a significant improvement compared to the control group.

Conclusion: gave Advances in understanding the etiology of the disease require a multiple-site-targeted therapy, and the combination of curcuminoids from turmeric with exercise, each of which has different merits, makes this combination even more promising in combating the challenging disease.

Keywords: Alzheimer, turmeric, curcumin, exercise, aerobic Training, physical activity

Introduction

Alzheimer's disease is the most common cause of dementia worldwide, but strategies to slow or prevent its clinical progression have remained largely elusive until recently (1). Neuropathologically, Alzheimer's is characterized by the presence of senile plaques, neurofibrillary tangles, and persistent neuronal loss, although the neurotoxic mechanisms are not fully elucidated. Both oxidative stress and inflammation play a key role in this disease; Thus acetylcholinesterase inhibitors and non-competitive receptor antagonists (memantine hydrochloride) are commonly used to treat Alzheimer's, which are effective in the main symptoms and treatment of Alzheimer's (2). Also, for the treatment of Alzheimer's, research on herbal remedies has recently been conducted and has been shown to relieve the condition by improving symptoms (3). Plants with bioactive compounds with antioxidant effects, such as coriander and turmeric, are considered for clinical applications due to minimal side effects (4). The three main chemical components responsible for the biological activities of turmeric are curcumin, demethoxycurcumin, and bisdemethoxycurcumin (5); studies show that the use of curcumin in Alzheimer's treatment reduces the destruction of cholinergic neurons because it is widely available and has fewer side effects than other drugs, such as allopathic drugs (3). Recent reports have suggested the therapeutic potential of curcumin in Alzheimer's pathophysiology due to its antioxidant, anti-inflammatory, and anti-amyloid effects, turmeric contains about 5% curcumin, which gives the spice its yellow color and is widely used as a yellow food coloring, and many pharmacological studies It has been done to describe multiple biological effects of curcumin; Also, curcumin has shown neuroprotective effects in animal models of Alzheimer's disease (2).

On the other hand, exercise and a subset of physical activities are recognized as an important approach to maintaining or improving the health of our bodies, including the brain, and increasing evidence supports the positive effects of exercise on emotional and cognitive functioning during brain aging, while physical inactivity It is considered a risk factor for the occurrence and progression of various mental disorders and neurological diseases. The neuroprotective effects and overall benefits of physical exercise may be due to the improvement of neurogenesis and neuroplasticity, the improvement of angiogenesis and autophagy, the increase of neurotrophin secretion, and the reduction of neuroinflammation (6). In addition, it has been confirmed that the right amount of exercise can effectively delay and improve neurodegenerative diseases, especially Alzheimer's (7). In addition, exercise exerts neuroprotective effects, thereby increasing the release of neurotrophic factors, promoting neurogenesis, modulating inflammatory responses, and reducing Aβ burden in AD subjects. Therefore, insight into the effects of exercise on AD will help understand how it may interact with the damaged brain, given its effects on memory and cognitive functions, neurotrophic factors, Aβ deposition and plaque formation, and neuroinflammation (8). Observational evidence in humans suggests that higher levels of cardiorespiratory fitness and physical activity are associated with greater brain volume, less brain atrophy, slower progression of dementia, and reduced risk of dementia; Thus, randomized controlled trials of aerobic exercise in people with mild cognitive impairment and mental complaints of memory have shown that exercise improves cognitive performance and a separate program of exercise and home-based counseling compared to usual care in people with Alzheimer's disease, physical performance and improved depression, and another study of people with Alzheimer's showed some improvement in cognitive test scores when analyzes were restricted to athletes; In addition, aerobic exercise is a low-cost, low-risk, and widely available intervention that may have disease-modifying effects, and demonstrating that aerobic exercise modifies the Alzheimer's process would have enormous public health implications (9). Therefore, according to the above, in this review, we consider the effect of turmeric and sports activity on Alzheimer's disease.

Methods

In this semi-experimental study, 42 people with Alzheimer's disease were selected and after explaining the research and obtaining informed consent, they were randomly divided into three groups: exercise, turmeric, and control. The subjects of the exercise group did aerobic exercises for 12 weeks and 3 sessions per week and each session lasted for 45 minutes with an intensity of 50 to 70% of the maximum reserve heart rate. Subjects in the turmeric group received 800 mg of turmeric powder in capsule form daily (at approximately 9 p.m.) for 12 weeks, which contained approximately 100 mg of curcumin per day. The control group also did their usual daily activities, which included anything except regular exercise or foods rich in turmeric or curcumin.

Table 1. General characteristics of subjects

Group	Variable	No.	Mean	Std. Dev
Exercise	Age (y)	14	79.14	5.709
	Course	14	6.14	2.878
Turmeric	Age (y)	14	81.29	4.140
	Course	14	5.64	2.763
Control	Age (y)	14	79.64	3.875
	Course	14	5.93	2.868

Then, at the beginning and after the end of 12 weeks of sports training, research variables were taken from the subjects, which include:

Pittsburgh Sleep Quality Index (PQSI): This scale includes seven components and 18 inputs, components 1 to 7 including overall sleep quality, sleep latency (i.e., how long it takes to fall asleep), sleep duration, habitual sleep efficiency (i.e., the percentage of time in bed that one is asleep), sleep disturbances, use of sleeping medication, and daytime dysfunction, with a total score of 0 to 21, that a lower score indicates better sleep status (10).

Neuropsychiatric Inventory-Questionnaire (NPI-Q): This instrument assesses 12 neuropsychiatric behavioral disorders that are common in dementia; This questionnaire first confirms the existence of each symptom (yes = 1, no = 0) and subsequently determines the frequency and severity of symptoms in patients who show symptoms; The score for each symptom is the result of frequency and severity, and the total NPI-Q score for all symptoms is 0 to 144 points, with higher scores indicating greater severity of psychosocial behavioral disorder (11,12).

Quality of Life-Alzheimer’s Disease (QOL-AD): This scale evaluates the quality of life of Alzheimer's patients in the form of patient self-assessment or caregiver assessment, which includes 13 questions; each entry has four options that correspond to 1 to 4 points, the total score is between 13 and 52 points, with a higher score indicating a better quality of life (13).

Table 2. mean and standard deviation of research variables

Group	Exercise		Turmeric		Control	
Variable	Mean	Std.D	Mean	Std.D	Std.D	Mean
PQSI (Pre-test)	12.29	2.52	10.57	5.61	9.71	3.60
PQSI (Post-test)	9.86	2.25	8.79	3.77	8.93	3.36
NPI-Q (Pre-test)	6.36	1.78	5.71	3.20	5.00	2.22
NPI-Q (Post-test)	5.86	1.92	5.21	2.94	5.57	2.74
QOL-AD (Pre-test)	29.79	1.76	30.57	3.99	31.43	2.68
QOL-AD (Post-test)	29.86	2.18	30.71	4.84	30.14	1.79

In the end, mean and standard deviation were used for descriptive statistics; Friedman's test and one-way analysis of covariance (ANCOA) with pre-test values as covariates were used for inferential statistics and research hypotheses, and Bonferroni's post hoc test was used for pairwise comparisons. All analyses were performed by SPSS version 26 software and at a significance level of less than 0.05; Graphpad software (version 8) was also used to draw the graphs.

Findings

The findings of this research showed that the PQSI scores improved significantly only in the group that exercised, but the NPI-Q and QOL-AD values in both the exercise and turmeric groups showed significant improvement compared to the control group (Table 3,4; Chart 1).

Table 3. Friedman and ANCOVA test results

V	Source	Type III Sum of Squares	df	Mean Square	F	P	η

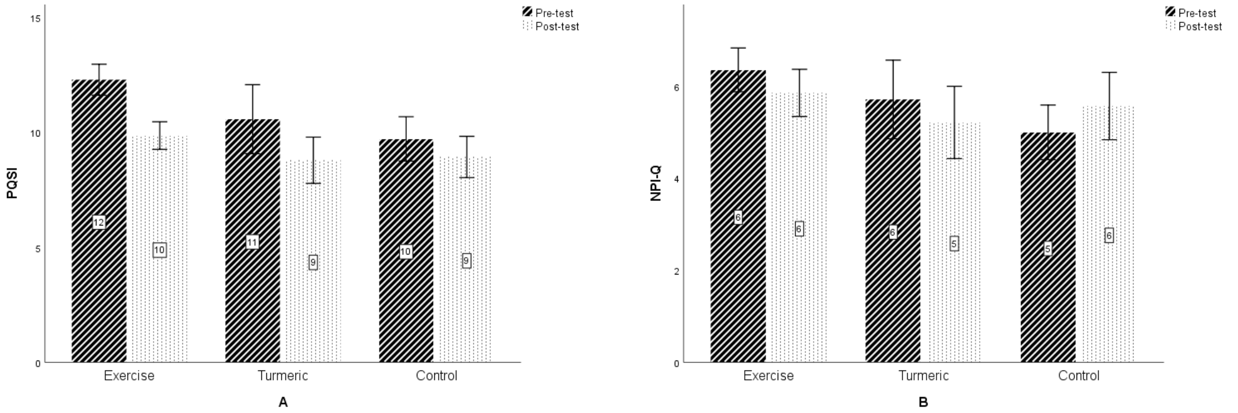
PQSI	Corrected Model	371.154[a]	3	123.718	133.099	.000	.913
	Intercept	6.661	1	6.661	7.166	.011	.159
	Pre-test	361.678	1	361.678	389.102	.000	.911
	Group	7.040	2	3.520	3.787	.032	.166
	Error	35.322	38	.930			
	Total	3954.000	42				
	Corrected Total	406.476	41				
NPI-Q	Corrected Model	220.439[a]	3	73.480	69.866	.000	.847
	Intercept	.073	1	.073	.070	.793	.002
	Pre-test	217.535	1	217.535	206.836	.000	.845
	Group	9.444	2	4.722	4.490	.018	.191
	Error	39.965	38	1.052			
	Total	1553.000	42				
	Corrected Total	260.405	41				
QOL-AD	Corrected Model	344.123[a]	3	114.708	62.722	.000	.832
	Intercept	.022	1	.022	.012	.913	.000
	Pre-test	338.790	1	338.790	185.249	.000	.830
	Group	17.338	2	8.669	4.740	.015	.200
	Error	69.496	38	1.829			
	Total	38816.000	42				
	Corrected Total	413.619	41				

a: Based on R Squared and Adjusted R Squared, η: Partial Eta Squared (Effect Size), PQSI: Pittsburgh Sleep Quality Index, NPI-Q: Neuropsychiatric Inventory-Questionnaire, QOL-AD: Quality of Life-Alzheimer’s Disease.

Table 4. results of pairwise comparisons by Bonferroni post hoc test

Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
PQSI	Exercise	Turmeric	-.197	.370	1.000	-1.123	.730
		Control	-.973*	.377	.041	-1.917	-.029
	Turmeric	Exercise	.197	.370	1.000	-.730	1.123
		Control	-.777	.366	.121	-1.693	.139
	Control	Exercise	.973*	.377	.041	.029	1.917
		Turmeric	.777	.366	.121	-.139	1.693
NPI-Q	Exercise	Turmeric	.028	.390	1.000	-.948	1.005
		Control	-1.012*	.398	.046	-2.008	-.015
	Turmeric	Exercise	-.028	.390	1.000	-1.005	.948
		Control	-1.040*	.391	.034	-2.018	-.062
	Control	Exercise	1.012*	.398	.046	.015	2.008
		Turmeric	1.040*	.391	.034	.062	2.018
QOL-AD	Exercise	Turmeric	-.074	.514	1.000	-1.363	1.214
		Control	1.351*	.525	.042	.036	2.666
	Turmeric	Exercise	.074	.514	1.000	-1.214	1.363
		Control	1.426*	.515	.026	.136	2.715
	Control	Exercise	-1.351*	.525	.042	-2.666	-.036
		Turmeric	-1.426*	.515	.026	-2.715	-.136

Based on estimated marginal means, *: The mean difference is significant at the 0.05 level, b. Adjustment for multiple comparisons: Bonferroni, PQSI: Pittsburgh Sleep Quality Index, NPI-Q: Neuropsychiatric Inventory-Questionnaire, QOL-AD: Quality of Life-Alzheimer's Disease.



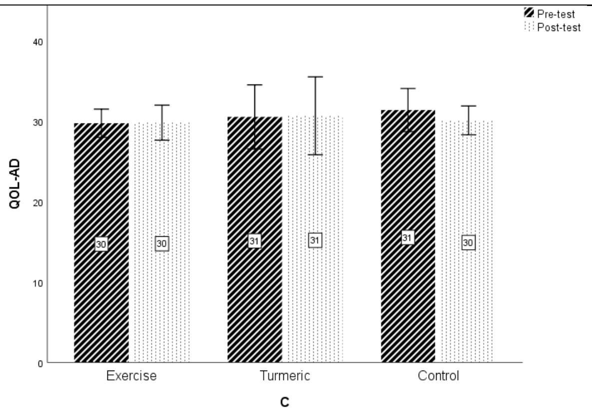


Figure 1. The amount of changes in the values of research variables in all three groups; A: Pittsburgh Sleep Quality Index (PQSI), B: Neuropsychiatric Inventory-Questionnaire (NPI-Q), C: Quality of Life-Alzheimer's Disease (QOL-AD).

Discussion

The beneficial effects of physical activity go beyond skeletal muscles and include adaptations in other organs. Exercise causes changes in the brain at anatomical, cellular, and molecular levels by inducing a chain of cellular and molecular processes that induce various physiological phenomena, including angiogenesis, neurogenesis, synaptogenesis, and stimulate neurotrophic factors that enhance learning, memory, and the brain; Transgenic animals that mimic the main neuropathological features of Alzheimer's have made it possible to study the main protective mechanisms of exercise on brain aging, including increased cerebral blood flow (CBF) in several cortical and subcortical regions, along with reduced Aβ formation and tau protein phosphorylation (14); Also, exercise increases cholinergic input in the cortex and hippocampus. In the cerebral cortex, a significant increase in ACh content was observed in rats following a 5-minute walk, indicating that ACh is released in response to exercise stimulation, even if the exercise volume is not high; Also, chronic exercise programs, i.e. months of treadmill running or voluntary ergometric activity, lead to age-related reduction of cholinergic fibers, reduction of forebrain cholinergic nerve abnormalities, and prevention of loss of cholinergic inputs to the hippocampus, which, along with these changes, Improvement in cognitive and motor behaviors also occurs; Also, voluntary running can reverse age-related cholinergic neurodegeneration in the hippocampus of nestin-GFP promoter transgenic mice; and in addition to this, cause the re-emergence of the cholinergic/nestin neuronal phenotype (i.e. CHAT/nestin neurons) in the medial septum/diagonal band (MS-DB) after exercise training; Also, long-term voluntary running increases the density of dendritic spines in the hippocampus, granule neurons of the dentate gyrus, CA1 pyramidal neurons, and layer III pyramidal neurons of the entorhinal cortex; Also, the neuroprotective effects of physical activity on the brain in Alzheimer's disease suggest that physical activity reduces Alzheimer's neuropathology and has positive effects on hippocampus-mediated cognitive function, especially when started early in the disease process.

On the other hand, diet plays a key role in delaying the progression of Alzheimer's, so the inflammatory component of Alzheimer's is treated with dietary fatty acid supplementation, vitamins, flavonoids, polyphenols, probiotics, and advanced glycation end products, and ketogenic diets also seem to have great potential in prevention and treatment; but in humans, few clinical trials have been conducted using ketogenic diets; instead, ketogenic agents have been used, such that in animal models of Alzheimer's, increasing ketone levels in the body through intermittent fasting or supplementation with esters Ketone has shown promising results (15).

A study that examined a multi-domain intervention consisting of diet, exercise, cognitive training, and vascular risk monitoring to prevent cognitive impairment and disability led to improvement or maintenance of cognitive function in at-risk older adults from the general population. The population of this trial showed that with a 2-year intervention, it is possible to reduce the risk of cognitive decline among the elderly rather than only with patients in a clinical setting (16). Recently, it has been shown that a diet rich in antioxidants and curcumin may have additive protective effects in delaying the progression of Alzheimer's disease, as well as greater physical activity and lower vascular risk, independently of the negative association of Aβ burden with cognitive decline and neurodegeneration in asymptomatic individuals. reduces (14); Also, a potential consequence of amyloid-induced oxidative stress in brain endothelial cells, as shown in Alzheimer's model mice, is the dissociation of endothelial nitric oxide synthase NOS (eNOS); Peroxynitrite, generated from the spontaneous reaction of superoxide with NO, can oxidize tetrahydrobiopterin, an essential cofactor for all nitric oxide synthase (NOS) isoforms, so that NOS is dissociated and produces superoxide instead of nitric oxide; Also, oxidative stress can increase the release of NOS by inhibiting dimethylarginine dimethylaminohydrolase (DDAH), an enzyme that catabolizes asymmetric dimethylarginine (ADMA), and ADMA, which results from the catabolism of proteins in which arginine is post-translationally When methylated, it creates, sequesters NOS by competing with the substrate arginine for binding to NOS (17). It is reasonable to expect that neuronal NOS is somewhat dissociated in neurons under oxidative stress, as occurs in Alzheimer's disease; It has also been suggested that microglial activation is similarly mediated by TLR2/LTR4 activation, in this case by the High mobility group box 1 (HMGB1) injury-associated molecular pattern protein released by dead or injured neurons; that a wide range of antioxidant nutrients such as turmeric may have a practical potential to oppose the proinflammatory activation of M1 microglia and at the same time promote M2 differentiation (17). Therefore, these nutrients are expected to help prevent or control AD by inhibiting microglial production of IL-1ß while promoting a neuroprotective M2 microglial phenotype.

The cause of Alzheimer's disease is multifactorial, which increases the oxidative state and deposition of amyloid plaques and tau protein fibrillary tangles in the central cortex and limbic system of the brain. Regular physical activity increases the endurance of cells and tissues against oxidative stress, vascularity, energy metabolism, and neurotrophin synthesis, all of which are important in neurogenesis, memory improvement, and brain plasticity. Although extensive studies are needed to understand the mechanism, it is clear that physical exercise is beneficial in preventing Alzheimer's and other age-related neurological disorders (18). Prevention by promoting lifestyle changes in the pre-symptomatic and pre-dementia disease stages may have the potential to delay one-third of dementia (19). Engaging in physical exercise programs appears to be effective, but not sufficient. An integrated approach to address multiple risk factors for Alzheimer's may be more successful in producing benefits than single-component interventions. Multimodal interventions often include changes in diet, physical activity, and cognitive training (14). In this review, it is emphasized that each component of the curcuminoid mixture plays a specific role in making the curcuminoid mixture useful in Alzheimer's disease, and therefore, the curcuminoid mixture of turmeric shows better medicinal value than curcumin alone. Advances in the understanding of disease etiology require a multi-targeted therapy, and the curcuminoid mixture of all components, each with different merits, makes this combination even more promising in combating this challenging disease.

References

1. Self WK, Holtzman DM. Emerging diagnostics and therapeutics for Alzheimer disease. Nat Med. 2023:1-13.
2. Hishikawa N, Takahashi Y, Amakusa Y, Tanno Y, Tuji Y, Niwa H, et al. Effects of turmeric on Alzheimer's disease with behavioral and psychological symptoms of dementia. Ayu. 2012 Oct;33(4):499-504. PubMed PMID: 23723666. Pubmed Central PMCID: PMC3665200. Epub 2013/06/01. (eng)
3. Mate P, Kale A, Asane Y, Somase D, JS A, Sutar RC, et al. Therapeutic Effects of Curcumin Extracts on Tau Protein in Alzheimer’s Disease: An Overview. Journal of Survey in Fisheries Sciences. 2023;10(4S):954-63.
4. Kaokaen P, Sorraksa N, Phonchai R, Chaicharoenaudomrung N, Kunhorm P, Noisa P. Enhancing Neurological Competence of Nanoencapsulated Cordyceps/Turmeric Extracts in Human Neuroblastoma SH-SY5Y Cells. Cellular and molecular bioengineering. 2023;16(1):81-93.
5. Shahrajabian MH, Sun W. The Golden Spice for Life: Turmeric with the Pharmacological Benefits of Curcuminoids Components, including Curcumin, Bisdemethoxycurcumin, and Demethoxycurcumin. Current Organic Synthesis. 2023.
6. Li S. Benefits of physical exercise on Alzheimer’s disease: an epigenetic view. 2023.
7. Cui K, Li C, Fang G. Aerobic Exercise Delays Alzheimer’s Disease by Regulating Mitochondrial Proteostasis in the Cerebral Cortex and Hippocampus. Life. 2023;13(5):1204.
8. Azevedo CV, Hashiguchi D, Campos HC, Figueiredo EV, Otaviano SFS, Penitente AR, et al. The effects of resistance exercise on cognitive function, amyloidogenesis, and neuroinflammation in Alzheimer’s disease. Front Neurosci. 2023;17:1131214.
9. Morris JK, Vidoni ED, Johnson DK, Van Sciver A, Mahnken JD, Honea RA, et al. Aerobic exercise for Alzheimer's disease: A randomized controlled pilot trial. PLoS One. 2017;12(2):e0170547.
10. Buysse DJ, Reynolds III CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193-213.
11. Kaufer DI, Cummings JL, Ketchel P, Smith V, MacMillan A, Shelley T ,et al. Validation of the NPI-Q, a brief clinical form of the Neuropsychiatric Inventory. The Journal of neuropsychiatry and clinical neurosciences. 2000;12(2):233-9.
12. Cummings JL, Mega M, Gray K, Rosenberg-Thompson S, Carusi DA, Gornbein J. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. Neurology. 1994;44(12):2308.-
13. Logsdon RG, Gibbons LE, McCurry SM, Teri L. Quality of life in Alzheimer's disease: patient and caregiver reports. Journal of Mental health and Aging. 1999;5:21-32.
14. De la Rosa A, Olaso-Gonzalez G, Arc-Chagnaud C, Millan F, Salvador-Pascual A, García-Lucerga C, et al. Physical exercise in the prevention and treatment of Alzheimer's disease. Journal of Sport and Health Science. 2020 2020/09/0.۴۰۴-۳۹۴:(۵)۹;/۱
15. Pawlosky RJ, Kemper MF, Kashiwaya Y, King MT, Mattson MP, Veech RL. Effects of a dietary ketone ester on hippocampal glycolytic and tricarboxylic acid cycle intermediates and amino acids in a 3xTg AD mouse model of Alzheimer's disease .Journal of neurochemistry. 2017;141(2):195-207.
16. Ngandu T, Lehtisalo J, Solomon A, Levälahti E, Ahtiluoto S, Antikainen R, et al. A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring

versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. The Lancet. 2015;385(9984):2255-63.

17. McCarty MF, DiNicolantonio JJ, Lerner A. A fundamental role for oxidants and intracellular calcium signals in Alzheimer’s pathogenesis—and how a comprehensive antioxidant strategy may aid prevention of this disorder. International Journal of Molecular Sciences. 2021;22(4):2140.
18. Radak Z, Hart N, Sarga L, Koltai E, Atalay M, Ohno H, et al. Exercise Plays a Preventive Role Against Alzheimer's Disease. Journal of Alzheimer's Disease. 2010;20:777-83.
19. Viña J, Sanz- Ros J. Alzheimer's disease: only prevention makes sense. European journal of clinical investigation. 2018;48(10):e13005.

The impact of acute consumption of red grape juice and intense aerobic activity on the total antioxidant capacity of elite athletes on two consecutive days

Hamidreza Salmanloo[1], Hamid Mohebbi[2], Ali Sayyah[3], Abuzar Jorbonian[4]

[1] *Master of Sports Physiology, Guilan University, Zanjan, Iran,* hamidreza.salmanloo@gmail.com

[2] *Professor, Faculty of Physical Education and Sports Sciences, Guilan University, Guilan ,Iran,* mohebbi_h@yahoo.com

[3] *Assistant Professor, Faculty of Humanities, Sports Science Department, Zanjan, Iran,* alisayyah@znu.ac.ir

[4] *Assistant Professor, Faculty of Physical Education and Sports Sciences, Guilan University, Guilan ,Iran,* jorbonian.a@guilan.ac.ir

Abstract

Introduction: When the production of free radicals exceeds the capacity of the body's antioxidant defense system, it can lead to an imbalance in antioxidant defense, which may ultimately lead to oxidative stress. Oxidative stress increases the body's need for antioxidants, and if there is a deficiency, the benefits of physical activity may decrease due to the occurrence of damage from free radicals. For this reason, the use of antioxidant supplements in sports is necessary to protect the body tissues against ROS. Due to the antioxidant and anti-inflammatory effects of polyphenols, grape juice is an important source for increasing total antioxidant capacity and aiding the performance of athletes.

Method: The subjects of this research were 13 elite young volleyball players from Zanjan province who had continuous training three sessions a week and were randomly divided into two groups, one grape juice consumption group (7 people) and a placebo group (6 people). They were divided. Athletes received the supplement (10mg/kg of bw) on two consecutive days. Blood sampling was done on the first day, once before consuming grape juice, once two hours after consumption, and once after intense aerobic activity, and on the second day, two hours after consuming grape juice and immediately after intense aerobic activity. Athletes engaged in vigorous aerobic activity on both days after taking the supplement.

Results and Conclusion: According to the results of the research, it was observed that grape juice had a significant effect on plasma TAC, and on the first day of the test, in the grape juice group, the amount of plasma TAC increased significantly after the test. But on the second day and also in the comparison of the first and second day, no significant difference was observed.

Keywords: grape juice, aerobic activity, antioxidant capacity, elite, athletes.

By doing intense exercise, oxygen consumption in muscles increases up to 100 times, and 2 to 5% of this oxygen consumption is converted into reactive oxygen species (ROS) in mitochondria [1]. Whenever the production of free radicals exceeds the capacity of the body's antioxidant defense system, it leads to an imbalance in the oxidant defense, which may eventually cause oxidative stress [2-4]. Oxidative stress increases the body's need for antioxidants, and if faced with their deficiency, the benefits of exercise decrease due to the occurrence of damage caused by free radicals [5]. For this reason, it is necessary to use antioxidant supplements in sports to protect body tissues against ROS [6].

We are looking to see that in sports activities that are of high intensity and are performed on consecutive days, red grape juice, which contains natural antioxidants, can reduce free radicals by increasing the total antioxidant capacity. Will it lead to a reduction in oxidative stress and improve performance with better recovery for the next day or not?

The intended research is a semi-experimental-applied type that investigates the effect of grape juice supplement on muscular endurance, aerobic and anaerobic power. Data collection was done by field test method. The effect size was calculated as d=0.30 by the Cohen test, which revealed 12 participants as the minimum sample size considering an α error of 0.05 and a β error of 0.80.

The statistical population of the present study consists of 13 young men who have exercised, who were between the ages of 17 and 20 years. All subjects were volleyball players of the selected team of Zanjan province. The reason for choosing professional volleyball players in this research was that in this research we were examining athletes who have at least 3 sessions a week and 3 years of regular training and whose training is in a way that causes oxidative stress. Participants of the present study were randomly divided into 2 groups of grape juice supplement (7 people) and placebo (6 people) by lottery.Among the conditions for the entry and selection of the subjects in the present study were the absence of cardiovascular and respiratory diseases, the absence of physical injury and the absence of sensitivity to grape juice. After being informed and reading the research introduction form, the subjects were asked to complete the sports medicine records questionnaire and finally, the subjects were selected to participate and cooperate in the research by filling out the informed consent form. The exclusion criteria in this study were supplement consumption during the study, exercise outside the study, acute illnesses such as colds, etc. during the study and not attending one of the study days.

Two days before the test, full explanations about the study were given to the participants and all of them signed the consent form with full satisfaction. In the next step, the participants were randomly divided into two groups and they were taught the details related to the test and the necessary measurements. After that, the subjects' weight was measured in order to prepare the grape juice supplement and placebo. Next, the athletes were asked to refrain from exercising until the day of the test and not to consume any food supplements or foods that are rich in antioxidants during the research. The test was conducted on two consecutive days.

On the first day of the test, the subjects appeared in gym No. 1 of Zanjan University. Grape juice supplement and placebo that were prepared in advance and were given to the subjects to consume according to the grouping that was done on the day of the explanatory session. After 2 hours of supplementation, participants were asked to step on a treadmill and perform the Bruce test for vigorous aerobic activity.The second day of the test was done 24 hours after the first day, and the subjects consumed the grape juice supplement and placebo according to the same grouping, and the same tests were taken on the first day.

In order to measure plasma TAC, blood was drawn 5 times in two days. On the first day, before taking the supplement, 2 hours after taking the supplement and immediately after intense aerobic exercise, and on the second day, 2 hours after taking the supplement and immediately after intense aerobic exercise, blood was drawn.

According to the results obtained in the present study which are shown in Table 1, the amount of TAC in the supplement group increased significantly on the first day after intense aerobic activity compared to after consuming a drink (P=0.013). And the average TAC reached from 1.69 to 1.86. However, no significant difference was seen at different measurement times and on the second day.

Table 1. TAC variable results.

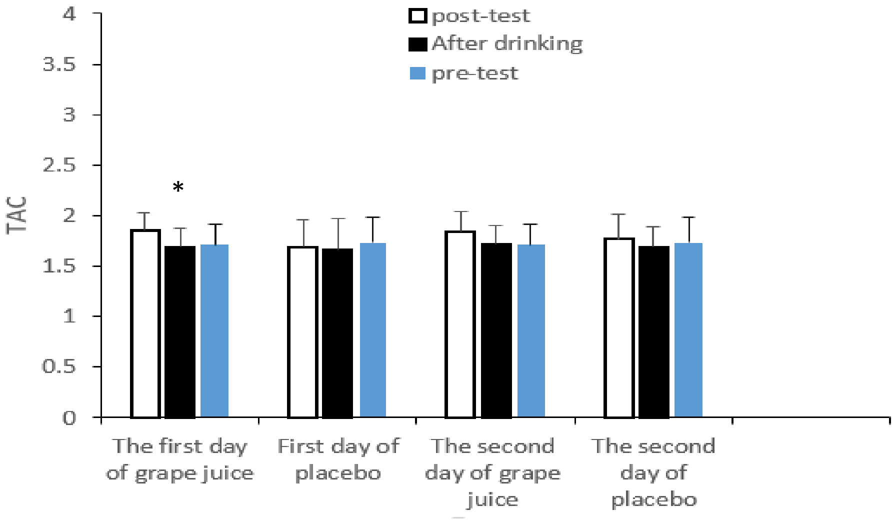
Variable	Group	Repeated measurement	Degrees of freedom	F	P
TAC	grape juice	Times	2	6/302	0/013
		Days	1	0/006	0/943
		Time and Days	2	0/291	0/753
	placebo	Times	2	0/892	0/44
		Days	1	0/361	0/574
		Time and Days	2	0/273	0/767

The current results with the results of Lafay et al who investigated the effect of consuming grape extract at the rate of 400 mg per day for 30 days and observed the improvement of oxidant compounds, the inconsistency of the results of this research can be due to the time of drug administration [7].

However, in another study by Toscano et al. (2019), they investigated the effect of acute consumption of grape juice and showed that TAC was higher in the supplement group, and these results were consistent with the results of the first day of the present study and inconsistent with the second day [8].

Consumption of red grape juice, which contains polyphenols, can increase TAC, but it cannot be effective in TAC recovery.

Figure 1. Mean and standard deviation of plasma TAC
* Indicates significance with pre-test



References:

1. Fukai T, Folz RJ, Landmesser U, Harrison DG. Extracellular superoxide dismutase and cardiovascular disease. Cardiovascular research. 2002;55(2):239-49.
2. Vincent HK, Bourguignon CM, Vincent KR, Weltman AL, Bryant M, Taylor AG. Antioxidant supplementation lowers exercise- induced oxidative stress in young overweight adults. Obesity. 2006;14(12):2224-35.
3. Child RB, Wilkinson DM, Fallowfield JL, Donnelly AE. Elevated serum antioxidant capacity and plasma malondialdehyde concentration in response to a simulated half marathon run. Med Sci Sports Exerc. 1998;30:1603–1607.
4. Lushchak VI. Free radicals, reactive oxygen species, oxidative stress and its classification. Chemico-biological interactions. 2014;224:164-75.
5. Banerjee AK, Mandal A, Chanda D, Chakraborti S. Oxidant, antioxidant and physical exercise. Mol Cell Biochem ۲۰۰۳ .Nov;253(1-2):307-12. doi: 10.1023/a:1026032404105. PMID: 14619981.
6. Skarpańska-Stejnborn, A., Basta, P., Pilaczyńska Szcześniak, Ł., & Horoszkiewicz-Hassan, M .(۲۰۱۰) .
7. Lafay S et al (2009) Grape extract improves antioxidant status and physical performance in elite male athletes. J Sports Sci Med 8:468–480
8. Toscano LT, Tavares RL, Toscano LT, Silva CSOd, Almeida AEMd, Biasoto ACT, et al. Potential ergogenic activity of grape juice in runners. Applied Physiology, Nutrition, and Metabolism. 2015;40(9):899-906.

The role of exercise in preventing Alzheimer's disease by increasing neuroplasticity

Sama BanaAzarpanah [1] ,Homeira Hatami[2*]

[1]*Author affiliations [Department of Plant and Cellular-Molecular Biology, University of Tabriz, Tabriz, Iran]*, azarsam936@gmail.com
[2]*Author affiliations [*Department of Animal Science, Faculty of Natural Sciences, University of Tabriz, Tabriz, Iran*]*, h.hatami@tabrizu.ac.ir

Abstract

Introduction: Alzheimer's disease stands out as the predominant cause of dementia in the elderly population. The pervasiveness and impact of Alzheimer's disease within our communities propel us towards research endeavors aimed at preventing this condition [1].
The gradual decline in functional plasticity within the brain due to the inability of individual neurons to compensate for age-related damage results in progressive impairment of learning and memory. While this decline occurs gradually during typical aging, it is markedly accelerated in neurodegenerative conditions such as Alzheimer's disease (AD), causing patients to experience significant cognitive incapacitation within a decade of symptom onset [2].
The brain's capacity for neuroplasticity is subject to influence by lifestyle elements, including physical exercise [3].

Method: This brief review article compiles information gathered from various studies.

Results: Regular exercise promotes neural growth, synaptic plasticity, and neurotransmitter activity in the brain. Additionally, exercise is associated with a reduced risk of Alzheimer's disease, possibly through mechanisms such as improved cerebral blood flow and reduced inflammation. These findings emphasize the importance of exercise in maintaining brain health and reducing the risk of cognitive decline and neurodegenerative diseases.

Conclusion: In summary, exercise plays a crucial role in promoting neuroplasticity and reducing the risk of Alzheimer's disease. The findings emphasize the importance of incorporating regular physical activity into daily routines to maintain brain health and reduce the risk of cognitive decline and neurodegenerative diseases. Moving forward, further research should focus on elucidating the specific mechanisms underlying the exercise-brain relationship and identifying optimal exercise strategies for maximizing cognitive benefits and neuroprotection. In general, the evidence underscores the significance of exercise as a beneficial and readily available method for promoting healthy aging and maintaining cognitive function.

Keywords: Alzheimer’s disease, exercise, neuroplasticity, plasticity.

Alzheimer's disease

Alzheimer's disease is distinguished by a gradual deterioration in cognitive function, loss of memory, and reduced ability to perform daily activities, presenting substantial difficulties for affected individuals, their families, and healthcare systems [4]. Although there is presently no known cure for Alzheimer's disease, recent research indicates that lifestyle elements such as dietary habits, social interaction, and physical activity may impact the risk and advancement of the disease. Of these lifestyle interventions, physical exercise appears to be a particularly promising approach for enhancing brain health and reducing the risk of Alzheimer's disease. This review seeks to offer a comprehensive examination of the role of exercise in preventing Alzheimer's, emphasizing its impact on neuroplasticity and cognitive function.

The most significant risk factors for Alzheimer's disease include older age (typically over 65 years, although this is not a rigid criterion) and possessing at least one APOE ε4 allele [5]. The distinctive neuropathological and neurochemical characteristics of Alzheimer's disease encompass the loss of synapses and targeted neuronal degeneration, a reduction in particular neurotransmitters, and the existence of anomalous protein deposits in neurons and the extracellular environment [6]. In most cases, Alzheimer's disease is caused by the failure to clear beta-amyloid peptides from the interstitial space of the brain, with rare cases resulting from mutations in beta-amyloid processing genes [6]. Alzheimer's disease primarily impacts the cortical regions, resulting in shrinkage in multimodal association cortices and limbic lobe structures. This is characterized by enlarged spaces between the folds of the brain, changes in the ventricles, and atrophy in the medial temporal lobe [7]. A significant neuropathological observation in the brains of individuals afflicted with Alzheimer's disease (AD) is the reduction of synaptic connections in the neocortex and hippocampus [8]. In individuals affected by Alzheimer's disease, an irregularity is observed in the equilibrium of neurotransmitters, encompassing glutamate, acetylcholine, dopamine, and serotonin. This imbalance manifests through perturbations in the concentrations and receptor levels of these neurotransmitters, specifically within brain regions implicated in emotional activities and cognitive functions [9].

Neuroplasticity:

Neuroplasticity is the intrinsic capability of the brain to undergo both structural and functional adaptations in direct response to experiences, and this intricate process is closely linked with the domains of learning, memory consolidation, and the augmentation of cognitive function [3]. Neuronal plasticity encompasses not only morphological alterations in brain regions and changes in neuronal networks, including modifications in neuronal connectivity and the generation of new neurons (neurogenesis), but also involves neurobiochemical changes [10]. The equilibrium between the dynamic stabilization and destabilization of synapses might underlie the breakdown of plasticity in the context of aging and diseases [11].

Neuroplasticity and Alzheimer's Disease:

The gradual reduction in the brain's functional adaptability, arising from neurons' incapacity to offset age-related damage, leads to a gradual decline in learning and memory capabilities. Although this decline is a gradual process in normal aging, it is significantly hastened in neurodegenerative disorders like Alzheimer's disease (AD), resulting in substantial cognitive impairment within a decade of initial symptoms [2].

Exercise and Neuroplasticity:

Recent research suggests that the impact of physical activity on cognitive function extends beyond previous understanding. It has been consistently demonstrated that exercise yields beneficial effects on learning and memory in both human and animal subjects. In the elderly population, physical activity enhances cognitive performance, mitigates age-related cognitive decline, and is linked to alterations in hippocampal volume [12]. Physical activity has been shown to be successful in reversing the decrease in hippocampal volume that occurs in older adults, leading to enhanced memory function [13]. The enhancements in memory observed in rodents as a result of physical exercise are linked to heightened cell proliferation, neurogenesis, dendritic complexity, and spine density. These changes are underpinned by molecular regulatory processes related to neurotransmission, metabolism, and synaptic plasticity. Physical exercise triggers the activation of transcriptional processes within the nucleus, leading to the modulation of gene expression associated with synaptic plasticity, learning, and memory through epigenetic mechanisms [14], [15], [16].

The effect of exercise on plasticity and Alzheimer's prevention:

Physical activity stimulates the brain's ability to change and adapt, leading to an increase in the production of new neurons and the growth of blood vessels [17], [18], [19]. Exercise influences multiple mechanisms implicated in Alzheimer's prevention, including neurotrophic factors, neurotransmitter systems, inflammatory pathways, and energy metabolism. Physical activity stimulates the release of neurotrophic factors, such as brain-derived neurotrophic factor (BDNF), which promote neuronal growth and synaptic plasticity [20]. Exercise also modulates neurotransmitter systems involved in learning and memory, such as dopamine, serotonin, and acetylcholine [21], [22], [23]. Through the reduction of inflammation and enhancement of energy metabolism, physical activity fosters a favorable setting for neuroplasticity and cognitive well-being [20].

The overall volume of the brain and the hippocampus exhibit variations between individuals without cognitive impairment and those diagnosed with dementia. As individuals age, there is a decline in brain and gray matter volume, with greater levels of cardiorespiratory fitness being linked to a lesser reduction in gray matter and the prefrontal cortex among the elderly population [20]. Research indicates that a 12-week regimen of treadmill exercise, involving 1-hour sessions conducted 5 days per week at an exercise intensity ranging from 50% to 65% of maximum oxygen consumption, results in enhanced synaptic plasticity, improved spatial memory, increased synaptic density, enhanced synaptic structure, elevated levels of synaptophysin expression (a presynaptic marker), elongation of axons, increased dendritic complexity, and a higher number of dendritic spines in mice with Alzheimer's disease [20]. Therefore, exercising enhances synaptic plasticity represents as a potential mechanism to prevent the reduction of spatial learning and memory in Individuals with AD [24].

References:

[1] H. Liu, G. Zhao, H. Zhang, and L. Shi, "Long-term treadmill exercise inhibits the progression of Alzheimer's disease-like neuropathology in the hippocampus of APP/PS1 transgenic mice," *Behavioural Brain Research*, vol. 256, pp. 261–272, Nov. 2013, doi: 10.1016/j.bbr.2013.08.008.

[2] E. J. Koller and P. Chakrabarty, "Tau-Mediated Dysregulation of Neuroplasticity and Glial Plasticity," *Front Mol Neurosci*, vol. 13, Aug. 2020, doi: 10.3389/fnmol.2020.00151.

[3] J. W. Pickersgill, C. V. Turco, K. Ramdeo, R. S. Rehsi, S. D. Foglia, and A. J. Nelson, "The Combined Influences of Exercise, Diet and Sleep on Neuroplasticity," *Frontiers in Psychology*, vol. 13. Frontiers Media S.A., Apr. 26, 2022. doi: 10.3389/fpsyg.2022.831819.

[4] L. Guo, X. Yang, Y. Zhang, X. Xu, and Y. Li, "Effect of exercise on cognitive function and synaptic plasticity in Alzheimer's disease models: A systematic review and meta-analysis," *Front Aging Neurosci*, vol. 14, Jan. 2023, doi: 10.3389/fnagi.2022.1077732.

[5] S. J. van der Lee *et al.*, "The effect of APOE and other common genetic variants on the onset of Alzheimer's disease and dementia: a community-based cohort study," *Lancet Neurol*, vol. 17, no. 5, pp. 434–444, May 2018, doi: 10.1016/S1474-4422(18)30053-X.

[6] C. L. Masters, R. Bateman, K. Blennow, C. C. Rowe, R. A. Sperling, and J. L. Cummings, "Alzheimer's disease," *Nat Rev Dis Primers*, vol. 1, no. 1, p. 15056, Oct. 2015, doi: 10.1038/nrdp.2015.56.

[7] M. A. DeTure and D. W. Dickson, "The neuropathological diagnosis of Alzheimer's disease," *Mol Neurodegener*, vol. 14, no. 1, p. 32, Dec. 2019, doi: 10.1186/s13024-019-0333-5.

[8] S. W. Scheff, D. A. Price, F. A. Schmitt, and E. J. Mufson, "Hippocampal synaptic loss in early Alzheimer's disease and mild cognitive impairment," *Neurobiol Aging*, vol. 27, no. 10, pp. 1372–1384, Oct. 2006, doi: 10.1016/j.neurobiolaging.2005.09.012.

[9] K. H. Chen, E. A. Reese, H.-W. Kim, S. I. Rapoport, and J. S. Rao, "Disturbed Neurotransmitter Transporter Expression in Alzheimer's Disease Brain," *Journal of Alzheimer's Disease*, vol. 26, no. 4, pp. 755–766, Oct. 2011, doi: 10.3233/JAD-2011-110002.

[10] E. Fuchs and G. Flügge, "Adult neuroplasticity: More than 40 years of research," *Neural Plasticity*, vol. 2014. Hindawi Publishing Corporation, 2014. doi: 10.1155/2014/541870.

[11] B. Teter and J. W. Ashford, "Neuroplasticity in Alzheimer's disease," *Journal of Neuroscience Research*, vol. 70, no. 3. pp. 402–437, Nov. 02, 2002. doi: 10.1002/jnr.10441.

[12] J. Fernandes, R. M. Arida, and F. Gomez-Pinilla, "Physical exercise as an epigenetic modulator of brain plasticity and cognition," *Neurosci Biobehav Rev*, vol. 80, pp. 443–456, Sep. 2017, doi: 10.1016/j.neubiorev.2017.06.012.

[13] K. I. Erickson *et al.*, "Exercise training increases size of hippocampus and improves memory," *Proceedings of the National Academy of Sciences*, vol. 108, no. 7, pp. 3017–3022, Feb. 2011, doi: 10.1073/pnas.1015950108.

[14] H. van Praag, G. Kempermann, and F. H. Gage, "Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus," *Nat Neurosci*, vol. 2, no. 3, pp. 266–270, Mar. 1999, doi: 10.1038/6368.

[15] I. Lista and G. Sorrentino, “Biological Mechanisms of Physical Activity in Preventing Cognitive Decline,” *Cell Mol Neurobiol*, vol. 30, no. 4, pp. 493–503, May 2010, doi: 10.1007/s10571-009-9488-x.

[16] H. van Praag, “Neurogenesis and Exercise: Past and Future Directions,” *Neuromolecular Med*, vol. 10, no. 2, pp. 128–140, Jun. 2008, doi: 10.1007/s12017-008-8028-z.

[17] Y.-H. Ding, J. Li, Y. Zhou, J. Rafols, J. Clark, and Y. Ding, “Cerebral Angiogenesis and Expression of Angiogenic Factors in Aging Rats after Exercise,” *Curr Neurovasc Res*, vol. 3, no. 1, pp. 15–23, Feb. 2006, doi: 10.2174/156720206775541787.

[18] H. van Praag, T. Shubert, C. Zhao, and F. H. Gage, “Exercise Enhances Learning and Hippocampal Neurogenesis in Aged Mice,” *The Journal of Neuroscience*, vol. 25, no. 38, pp. 8680–8685, Sep. 2005, doi: 10.1523/JNEUROSCI.1731-05.2005.

[19] J. E. Black, K. R. Isaacs, B. J. Anderson, A. A. Alcantara, and W. T. Greenough, “Learning causes synaptogenesis, whereas motor activity causes angiogenesis, in cerebellar cortex of adult rats.,” *Proceedings of the National Academy of Sciences*, vol. 87, no. 14, pp. 5568–5572, Jul. 1990, doi: 10.1073/pnas.87.14.5568.

[20] H. A. Pahlavani, “Exercise therapy to prevent and treat Alzheimer’s disease,” *Front Aging Neurosci*, vol. 15, Aug. 2023, doi: 10.3389/fnagi.2023.1243869.

[21] “Serotonin and exercise-induced brain plasticity,” *Neurotransmitter*, May 2015, doi: 10.14800/nt.793.

[22] T. M. Jay, “Dopamine: A potential substrate for synaptic plasticity and memory mechanisms,” *Progress in Neurobiology*, vol. 69, no. 6. Elsevier Ltd, pp. 375–390, 2003. doi: 10.1016/S0301-0082(03)00085-6.

[23] M.-F. Kuo, J. Grosch, F. Fregni, W. Paulus, and M. A. Nitsche, “Focusing Effect of Acetylcholine on Neuroplasticity in the Human Motor Cortex,” *The Journal of Neuroscience*, vol. 27, no. 52, pp. 14442–14447, Dec. 2007, doi: 10.1523/JNEUROSCI.4104-07.2007.

[24] L. Mu *et al.*, “Treadmill Exercise Prevents Decline in Spatial Learning and Memory in 3×Tg-AD Mice through Enhancement of Structural Synaptic Plasticity of the Hippocampus and Prefrontal Cortex,” *Cells*, vol. 11, no. 2, p. 244, Jan. 2022, doi: 10.3390/cells11020244.

Developing a strategic plan to attract and maintain sports tourists in the commercial-industrial free zone of Mako using the combined SWOT-QSPM model

Mousavi nezhad M·

Department of Sports science, Khoy Branch, Islamic Azad University, Khoy, Iran.

Email: mhmousavi@yahoo.com

Introduction

Many studies have been done in the field of sports promotion and development around the world. Sports can be developed and promoted through various activities, including sports tourism, etc. (1). The arrival of tourists is also influenced by big sports events and the holding of sports events provide beneficial opportunities for tourism. A study has shown that the flow of tourism to the host countries between 1995 and 2006 witnessed a positive influx of tourists from more than 200 countries (2). One of the key elements in the development of sports tourism in a region is the attraction and sustainability of tourists(3).

Many factors, including transportation infrastructure, information technology, as well as the ability of regions in the health sector, cultural and historical attractions, and some other variables can be effective in attracting tourists. On the other hand, the length of stay in tourism research is also a significant issue because it is one of the most important variables in the decision-making processes of visitors (4). The studies conducted in connection with tourist attraction and permanence have identified a series of factors related to these two categories(5). Considering the importance of the category of tourism in free zones, as well as the existing research gap in the field of developing a strategic plan in the field of tourist attraction and retention in free zones, the researcher seeks to identify weaknesses and strengths, opportunities and threats, calculate the matrices of internal and external factors, and The ranking of the strategies for attracting and retaining sports tourists is to answer the question, what are the strategic plans for attracting and retaining sports tourists in Mako Industrial Free Zone?

Materials and methods

The current research is a combination of descriptive-survey and exploratory research. The statistical population of the research included experts from the cultural heritage and tourism organization and the sports and youth department of Mako city, faculty members and tourism experts from the Mako free zone organization. 30 people were selected as the research sample.

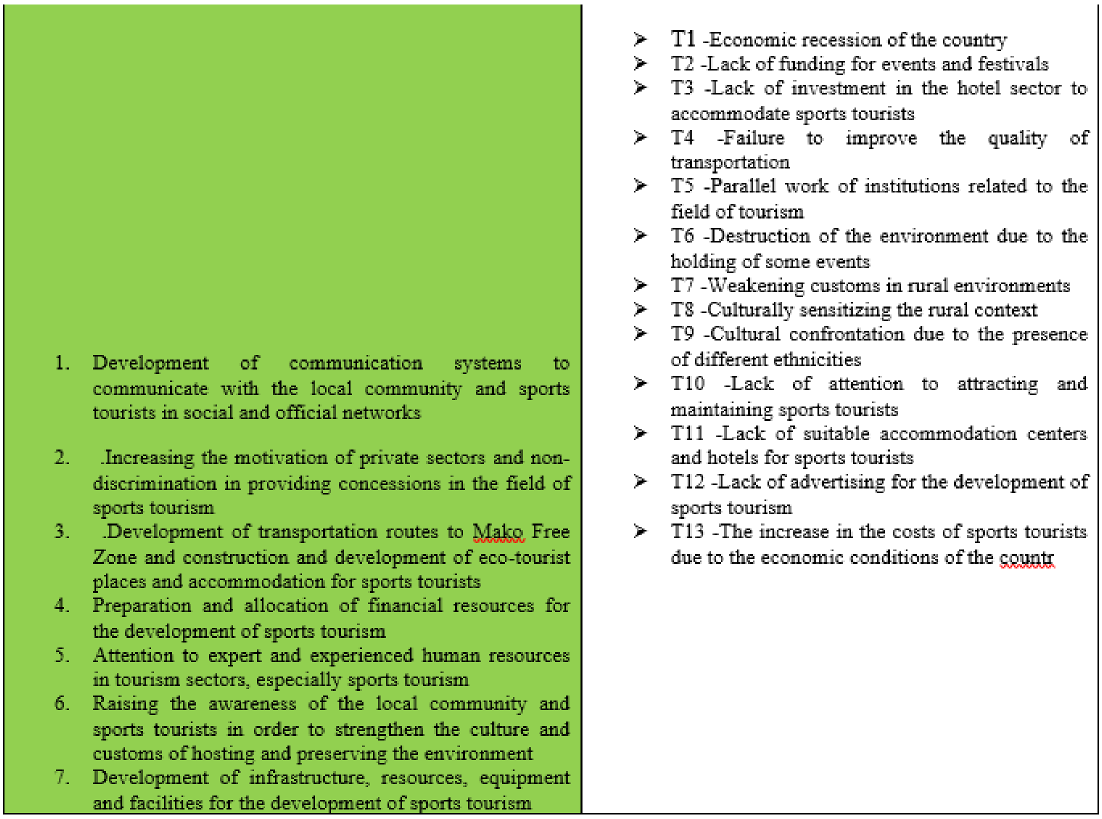
In order to collect information in the qualitative part of the research, the required information was collected through semi-structured interviews with experts in the field of tourism and sports management. In the quantitative phase, using a questionnaire extracted from the qualitative section, which was approved by 12 sports management experts, the sample of the quantitative section of the research was provided. In-depth and semi-structured interview to determine the mission statement and vision, as well as the most important strengths, weaknesses, opportunities and threats and the valuation and weight of the extracted codes were ranked by the research focal group in 4 sections and answered by the statistical sample.

Statistical Analysis: In the qualitative part of data analysis, maxqda software was used. The reliability of the research instrument was reported using Cronbach's alpha reliability coefficient, Spearman's reliability coefficient, combined reliability coefficient (CR) and shared reliability coefficient (AVE). The matrix tables of internal and external factors were presented, and by calculating EFE and IFE.

Results

Table 1. SWOT matrix (defensive strategies "WT")

Weaknesses of attracting and maintaining sports tourists in Mako Free Commercial-Industrial Zone	**Internal factors** **External factors**
➢ W1 -Non-use of information and communication technology ➢ W2 -Lack of adequate government facilities ➢ W3 -Failure to hold international and national conferences in Mako for introduction ➢ W4 -Failure to provide a codified and strategic plan for the development of sports tourism ➢ W5 -Economic stagnation of the country, especially in the sports sector ➢ W6 -Lack of full introduction of the region's capacities among the members of the society ➢ W7 -Failure to attract sports tourists in social media ➢ W8 -Not using experienced and expert people in the field of sports tourism ➢ W9 -Lack of content production and colorful presence of the region in virtual space ➢ W10 -Not meeting the demands of sports tourists and encouraging them to maintain ➢ W11 -The absence of a codified database in the field of sports tourism ➢ W12 -Lack of attention from officials and boards and lack of sufficient knowledge in the field of tourism ➢ W13 -Lack of motivation of private sectors due to discrimination regarding sports tourism activity	
WT strategies ↓	Threats of attracting and maintaining sports tourists in Mako Free Commercial-Industrial Zone ↓



1. Development of communication systems to communicate with the local community and sports tourists in social and official networks 2. .Increasing the motivation of private sectors and non-discrimination in providing concessions in the field of sports tourism 3. .Development of transportation routes to Mako Free Zone and construction and development of eco-tourist places and accommodation for sports tourists 4. Preparation and allocation of financial resources for the development of sports tourism 5. Attention to expert and experienced human resources in tourism sectors, especially sports tourism 6. Raising the awareness of the local community and sports tourists in order to strengthen the culture and customs of hosting and preserving the environment 7. Development of infrastructure, resources, equipment and facilities for the development of sports tourism	➢ T1 -Economic recession of the country ➢ T2 -Lack of funding for events and festivals ➢ T3 -Lack of investment in the hotel sector to accommodate sports tourists ➢ T4 -Failure to improve the quality of transportation ➢ T5 -Parallel work of institutions related to the field of tourism ➢ T6 -Destruction of the environment due to the holding of some events ➢ T7 -Weakening customs in rural environments ➢ T8 -Culturally sensitizing the rural context ➢ T9 -Cultural confrontation due to the presence of different ethnicities ➢ T10 -Lack of attention to attracting and maintaining sports tourists ➢ T11 -Lack of suitable accommodation centers and hotels for sports tourists ➢ T12 -Lack of advertising for the development of sports tourism ➢ T13 -The increase in the costs of sports tourists due to the economic conditions of the countr

Discussion

Weaknesses in attracting and maintaining sports tourists in Mako Free Commercial-Industrial Zone include the lack of sufficient government facilities, the lack of providing a codified and strategic plan for the development of sports tourism, the lack of attention of officials and delegations and the lack of sufficient knowledge in the field of tourism and etc . These results with the research of Valizadeh and Ameri (2020); Mayer (2004), Parent and Seguin (2007) agreed(6, 7, 8).

In the second part of the internal factors, the strengths of attracting and keeping sports tourists in the commercial-industrial free zone were pointed out, which include the existing natural climbing facilities, the existence of historical monuments in the Mako Free Zone, the existence of the capacity to hold martial sports events, the potential to attract sports tourists due to different capacities, These results were consistent with the research of Mahmoudi et al. (2023), Valizadeh and Ameri (2020), Ziakas and Bokas (2012)(3, 6, 9).

In the commercial-industrial free zone of Mako, special attention has been paid to attract and retain sports tourists. Hospitable and friendly people provide a better way to attract and retain tourists in Mako. This good behavior can create a positive experience for sports tourists and encourage them to return to this area again (10).

In the section of external factors affecting the attraction and retention of tourists, the opportunities available in this route were mentioned. Natural facilities and attractions in Mako Free Zone, which include beautiful mountains, rivers and lakes. The presence of unique plains that provide a suitable environment for various sports such as football and golf. The existence of a stone cap as the second largest cap in the world, which attracts the attention of many sports tourists. The existence of historical capacities in the Mako Free Zone that introduce the history and culture of the region to sports tourists.

The development of a strategic plan for attracting and maintaining sports tourists which was examined by the evaluation matrix of external factors, showed that the threats have overcome the opportunities in front of it. According to the obtained results, the strategic position of attracting and maintaining sports tourists was obtained as a defensive strategy. Therefore, the organization must be able to fix its weak points and vulnerable cases inside the organization and use the advantages of the external environment such as new technology, improvement of facilities and repair of existing technology, or specialized force with high skills to solve its problems(11, 12, 13).

References

1. Arulmozhi, S. J, & Vinayagamoorthi, G. (2019). MARKETING SPORT TOURISM IN INDIA. Advance and Innovative Research, 6(2), 23.
2. Alegre, J, & Pou, L. (2006). The length of stay in the demand for tourism. Tourism Management, 27, 1343-1355.
3. Mahmodi, S., Yektayar, M., & Moharramzadeh, M. (2023). Developing adventure tourism strategy using the SOAR model. Strategic Studies on Youth and Sports, 21(58), 185-200.
4. Decrop, A, & Snelders, D. (2004). Planning the summer vacation. An adaptable process. Annals of Tourism Research, 31(4), 1008–1030.
5. DİLEK, S. E. (2019). E-Sport events within tourism paradigm: A conceptual discussion. International Journal of Contemporary Tourism Research, 3(1), 12-22.
6. Valizadeh, V., & Amery, M. H. S. (2020). Identification and analysis of factors affecting the development of sports tourism in maku free trade and industrial zone with an effectual approach. Journal of Advanced Pharmacy Education & Research, 10, 105.
7. Meyer, D. (2004). Tourism routes and getaways: key issues for the development of tourism routes and gateways and their potential for pro-poor tourism.

The effect of endurance training on cardiac muscle angiogenesis and downstream factors of PI3KR2 pathway in diabetic rats

Mousavi nezhad M[1]

Department of Sports science, Khoy Branch, Islamic Azad University, Khoy, Iran.

Email: mhmousavi@yahoo.com

Introduction

There are increasing evidences which show diabetes causes reduce in the angiogenesis, diameter of capillaries, relative reduce of capillaries to fibers and formation of peripheral vessels of the heart in the human and animal models (1, 2). Diabetes also influence the proangiogenic and anti- angiogenic factors and this effect changes balance between stimulant and inhibitory factors of angiogenesis and consequently increases cardiovascular disease through changing angiogenesis(3,4). On the other hand different studies have shown that exercise improves endothelial function and neutralizes micro-vascular density (5).

Vascular Endothelial Growth Factor (VEGF) starts up signaling cascade of angiogenesis from the two paths, one of which is PI$_3$K /Akt/eNos. The activated Akt inhibits apoptosis through Phosphorylation of BAD proteins and caspase 9. Moreover Akt activates its eNOS causing cellular migration (6). The main source of nitric oxide production in the vascular endothelial cells is eNOS which is activated during exercise and shear stress(7).

Since fat and glucose increases in the diabetic patients’ blood stream it seems that the created inflammation decreases blood stream level due to excessive accumulation of glucose in the body tissues and creating blood clots and thrombosis in the vessels, in this case angiogenic factors won’t have opportunity and conditions for incidence and hence Angiogenesis is decreased.(8). However, The purpose of this study is to determine the effect of aerobic exercise on the Changes in stimulating factors of angiogenesis and capillary density in the cardiac tissue of diabetic rats.

MATERIALS AND METHODS

Research method of the present study is experimental-laboratory which was conducted in experimental way with post tests and control group. Twenty rats of Vistar (with average weight of 191.9±10.85) were randomly divided into diabetic control (n=10) and diabetic exercise (n=10) groups and the groups were synchronized based on their weights. Diabetes was created in the study by combination of feeding fatty foods and Streptozotocin injection(35mg in ratio of each kg of the body weight). The blood sample was taken 48 hours after the drug injection form the animals’ eye and serum isolation and then using enzymatic glucose oxidase method. Glucose concentration above 300mg/dl was considered as diabetes (9).

Aerobic exercise was conducted for 8 weeks and 6 sessions in a week on an engine treadmill (10, 11).

Sample were taken after 48 hours of the last exercise session and night fasting. The rats were anaesthetized by Intraperitoneal injection combined with Ketamine (75mg/kg) and Zylosin (100mg/kg). the blood sample was directly taken from the animals' heart.

ELISA test was conducted for evaluation of level of underlying proteins using specific commercial kits (Akt ELISA Kit, Catalog no.: ABIN2114824, antibodies CO. eNOS ELISA Kit, Catalog no.: ABIN367489, antibodies CO.).

Statistical Analysis was performed using SPSS software version 23.0. Independent t-test was used to compare the means difference($p<0.05$).

RESULTS

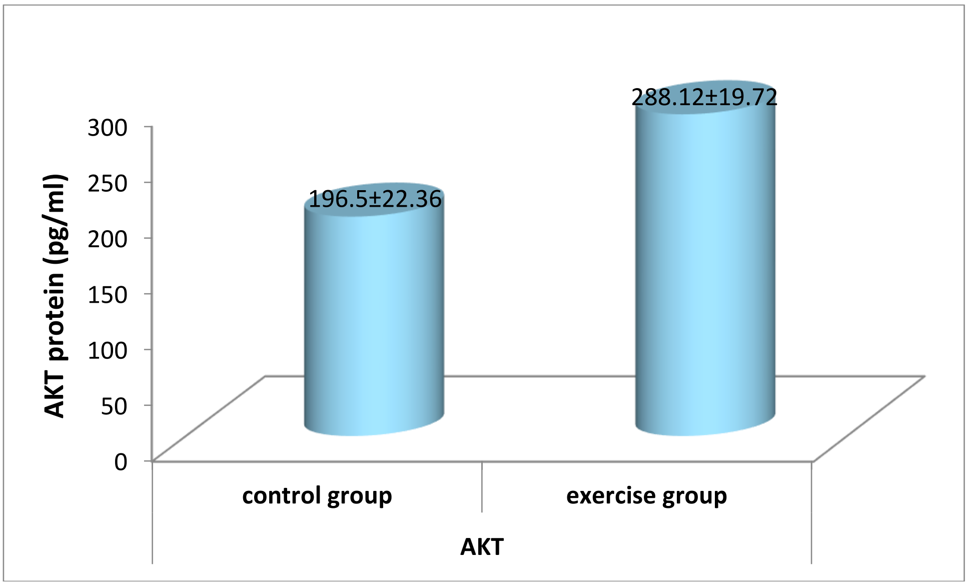


Fig 1. Average Akt protein levels of cardiac tissue in diabetic control and diabetic exercise groups.

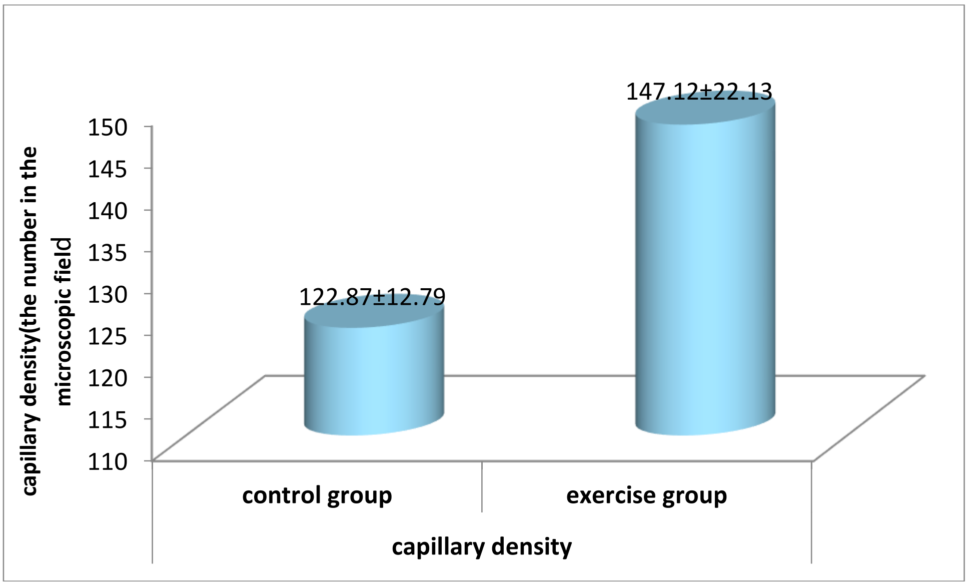


Fig 2. Average capillary density of cardiac tissue in diabetic control and diabetic exercise groups.

DISCUSSION

Results of the present study indicated that cardiac tissue AKT protein amount showed significant increase in the diabetic exercise group. Hyperglycemia causes messaging defects in the downstream $VEGFR_2$ in endothelial cells. Moreover Chemotaxis response and monocytes migration which are conducted in the response to VEGF suffer defect, too. (12, 13).

Results of the study indicated that level of differences of AKT was not significant in the three groups however Phosphorylation AKT ratio to AKT, Phosphorylation eNOS ratio to Heart eNOS was high in the exercise group, significantly(14). Results of the present study are in balance with Natan et.al (2012) where aerobic exercise increases mir126 and downstream factors of the path such as eNOS, Akt, PI_3KR_2(15).

findings of the present study indicated significant increase in eNOS protein expression amount after 8 weeks of endurance training in the diabetic exercise group. Findings of the present study are in balance with the studies carried out by Natan et.al (2012). In contrast with the present study, Shekarchizadeh et.al(2012) carried out a study indicated that plasma level of VEGFR1, VEGF,NO is not significant difference in the exercise group compared to the control group(7, 15).

Other findings of the present study indicated that capillary density level of cardiac tissue indicated significant increase in the diabetic exercise group. The effect of endurance exercise on the capillary density has been investigated in different studies and its changes have been reported with different results (decrease or increase of capillary density) in the diabetic animals and humans (16, 17).

REFERENCES

1. Yazdani F, Shahidi F, Karimi P. The effect of 8 weeks of high-intensity interval training and moderate-intensity continuous training on cardiac angiogenesis factor in diabetic male rats. J. Physiol. Biochem. 2020; 76, 291–299.

2. Dastaha S, Tofighi A, Tolouei Azar J, Alivand M. Aerobic exercise leads to upregulation of Mir-126 and angiogenic signaling in the heart tissue of diabetic rats. Gene Reports. 2020; 21(2):100914.
3. Khazaei M, Fallahzadeh A, Sharifi M, Afsharmoghaddam N, HaghjooJavanmardSh, Salehi E. Effects of diabetes on myocardial capillary density and serum biomarkers of angiogenesis in male rats. CLINICS. 2011; 66(8):1419-1424.
4. Kivela R, Silvennoinen M, Lehti M, Jalava S, Vihko V, Kainulainen H. Exercise-induced expression of angiogenic growth factors in skeletal muscle and in capillaries of healthy and diabetic mice. Cardiovasc Diabetol. 2008; 7: 13.
5. Fernandes T, Fla´vio C. Magalha˜es, Fernanda R. Roque, M. Ian Phillips, Edilamar M. Oliveira. Exercise Training Prevents the Microvascular Rarefaction in Hypertension Balancing Angiogenic and Apoptotic Factors Role of MicroRNAs-16, -21, and -126. Hypertension. 2012; 59[part 2]:513-520.
6. Gharbi S, Tavassoli M and Faghihi M. Association of Phosphatidylinositol 3-Kinases Mutations and Mtastasis in Isfahanian Breast Cancer Patients. Journal of Isfahan University (Basic Sciences). 2008; 2(31): 2-14.
7. Shekarchizadeh P, Khazaei M, Gharakhanlou R, Karimian J, Safarzadeh AR. The effects of resistance training on plasma angiogenic factors in normal rats. J Isfahan Med Sch. 2012; 30: 65-73.
8. Mahrou□ M, Gaeini A, Javidi M, Chobbineh S. Changes in stimulating factors of angiogenesis, indused by progressive Resistance traininge in diabetic rats. Iranian journal of Diabetes and Metabolism. 2014; 14(1).
9. Nikoii R, Rajabi H, Gharakhanlou R, Atabi F, Omidfar K. The effect of endurance training on mitochondrial and sarcollema lactat transporters in skeletal and cardiac muscles in diabetic rats. Iran J Diabetes Lipid Disord. 2012; 11: 223-236.
10. Brett A Osborn JTD RA, Laddaga F, J RaD. Exercise training increases sarcolemmal GLUT-4 protein and mRNA content in diabetic heart. Journal of Applied Physiology. 1997; 82:828-34.
11. leosco D, Rengo G, laccarino G. exercise promotes angiogenesis and improves b-adrenergic receptor signalling in the post-ischaemic failing rat heart. cardiovascular research. 2008; 78(2):385-94.
12. Sasso FC, Torella D, Carbonara O, Ellison GM, Torella M, Scardone M, et al. Increased vascular endothelial growth factor expression but impaired vascular endothelial growth factor receptor signaling in the myocardium of type 2 diabetic patients with chronic coronary heart disease. Journal of the American College of Cardiology. 2005; 46(5):827-34.
13. Chou E, Suzuma I, Way KJ, Opland D, Clermont AC, Naruse K, et al. Decreased cardiac expression of vascular endothelial growth factor and its receptors in insulin-resistant and diabetic states a possible explanation for impaired collateral formation in cardiac tissue. Circulation. 2002; 105(3):373-9.
14. Iemitsu M, Maeda S, Jesmin S, Otsuki T and Miyauch T. Exercise training improves aging-induced downregulation of VEGF angiogenic signaling cascade in hearts. Am J Physiol Heart Circ Physiol. 2006; 291: H1290–H1298.
15. DA Silva Junior ND, Fernandes T, Soci UP, Monteiro AWA, Phillips MI, Oliveira EM. Swimming training in rats increases cardiac MicroRNA-126 expression and angiogenesis. Medicine and science in sports and exercise. 2012; 44(8):1453-1462.
16. Jensen L, Bangsbo J, Hellsten Y. Effect of high intensity training on capillarization and presence of angiogenic factors in human skeletal muscle. J physiol. 2004; 557: 571-582.
17. Salehi E, Amjadi F, Khazaei M. Angiogenesis in health and disease: role of vascular endothelial growth factor (VEGF). J Isfahan Med Sch. 2011; 29: 312-326.