Rev. Fac. Med. Hum. 2022; 22(1):181-192.
DOI: 10.25176/RFMH.v22i1.4129
REVIEW ARTICLE

ISSN Versión Online: 2308-0531
Facultad de Medicina Humana URP

EXERCISE AS A PROTAGONIST IN MUSCLE PLASTICITY AND IN THE MUSCLE AS AN ENDOCRINE ORGAN: IMPLICATIONS IN CHRONIC DISEASES

EL EJERCICIO COMO PROTAGONISTA EN LA PLASTICIDAD MUSCULAR Y EN EL MÚSCULO COMO UN ÓRGANO ENDOCRINO: IMPLICACIONES EN LAS ENFERMEDADES CRÓNICAS

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REVIEW ARTICLE

ABSTRACT

The active skeletal muscle and the maintenance of muscle mass are essential for good health, wellness and disease prevention and treatment. It has recently been documented that the muscle, as an endocrine organ, is capable of synthesizing myokines. These peptides are secreted in response to muscular contractions induced by exercise, and can develop molecular communication with other tissues, improving cardiovascular, metabolic, and mental health.

The endocrine function of a muscle continues to be in a constant investigation; however, knowledge up to date urges us to continue promoting physical activity. Additionally, the extended knowledge of myokines is useful to prescribe individualized physical exercise programs to each patient.

Keywords: Adaptive plasticity, muscles, cytokines, physical exercise, motor activity, chronic disease (Source: MesH – NLM)

RESUMEN

El músculo esquelético activo y el mantenimiento de la masa muscular son esenciales para la salud, el bienestar, la prevención y el tratamiento de enfermedades. Recientemente se ha documentado que el músculo, como órgano endocrino, es capaz de sintetizar mioquinas. Estos péptidos son secretados en respuesta a las contracciones musculares inducidas por el ejercicio, y son capaces de crear comunicación molecular con otros tejidos, beneficiando así la salud cardiovascular, metabólica y mental.

La función endocrina del músculo continúa en investigación constante, sin embargo, lo conocido hasta ahora nos insta a seguir promoviendo la actividad física. Adicionalmente a esto, extender el conocimiento sobre las mioquinas, es útil para poder prescribir el ejercicio físico de manera individualizada y a la medida de cada paciente.

Palabras Clave: Plasticidad adaptativa, músculos, citocinas, ejercicio físico, actividad motora, enfermedad crónica (Fuente: DecS – BIREME)

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Cite as: Amelia Vargas-Pacheco, Lucy E. Correa-López. Exercise as a protagonist in muscle plasticity and in the muscle as an endocrine organ: implications in chronic diseases. Rev. Fac. Med. Hum. 2022; 22(1):181-192. DOI: 10.25176/RFMH.v22i1.4129

Journal home page: http://revistas.urp.edu.pe/index.php/RFMH

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INTRODUCTION

The muscle is a Dynamic tissue implied in movement, posture, respiration[1], and corporal thermoregulation [2]. It is considered the most abundant organ in the human body[2], since it represents 30 to 50% of total corporal weight [3].

Since 450 B.C., we have evidenced the positive effects of physical activity in health and the prevention of chronic diseases. As was cited by "the father of medicine, Hippocrates of Kos: "Walking is man's best medicine" and "sports is a preserver of health"[4]. in this sense, exercise could also be prescribed as treatment for lifestyle related diseases: cardiovascular diseases, type 2 diabetes, neurodegenerative diseases and cancer [5].

The benefits of exercise for health and wellness of humans have been attributed to innumerable physiological mechanisms, however, the transcendental role that the muscle possesses in these processes has been documented in recent years [6].

In recent years, the skeletal muscle has been identified as a endocrine organ, since it is capable of synthesizing cytokines called myokines, which possess autocrine, paracrine and endocrine function[7,8]. Thanks to the exercise stimulus, these protein molecules are released to the blood stream, allowing the communication of the muscle not just with itself but also with other organs such as the brain, bone, pancreas, intestine, liver, adipose tissue, cardiovascular system, and skin[5], therefore creating a physiological and unique connection between exercise and metabolism regulation[2].

Taking into account the progressive deterioration of muscle physiology with age, the active skeletal muscle and the maintenance of muscle mass are essential for the health care, prevention and treatment of diseases [9]. For this reason, this article seeks to carry out a current literature review about the importance of physical exercise in the preservation of muscle mass during a lifetime, for prevention as well as for treatment of non-transmissible chronic diseases.

METHODOLOGY

A review of scientific articles in Spanish and English related to the research topic was carried out, which were collected from PubMed, Elselvier and SciELO. On the other hand, we took into account certain criteria for the adequate article selections: that the article title be chosen with the research topic and that it has a maximum of 6 years old, meaning dated from 2015 onward. We excluded the letter to the editors related with the topic.

RESULTS

Out of the 37 articles found, 35 were chosen. One was excluded because it was published before 2015 and the other because it was a letter to the editor. Tables 1 and 2 detail the most relevant results and conclusions of the chosen articles according to the objective of the present study.

Table 1: Selected articles pertaining to muscle and its plasticity

AUTHORS	TITLE	YEAR	RESULTS/CONCLUSIONS	TYPE OF ARTICLE
Josep M. Argilés PhD, Nefertiti Campos PhD, José M. Lopez-Pedrosa PhD, Ricardo Rueda MD, PhD, Leocadio Rodriguez-Mañas PhD	Skeletal Muscle Regulates Metabolism via Interorgan Crosstalk: Roles in Health and Disease	2016	The muscle is notably plastic. Physical activity, especially resistance exercise stimulate the protein synthesis and it is the essence for treatment of muscular atrophy.	Review article
M. S. Brook, D. J. Wilkinson, B. E. Phillips, J. Perez-Schindler, A. Philp, K. Smith1 and P. J. Atherton	Skeletal muscle homeostasis and plasticity in youth and ageing: impact of nutrition and exercise	2015	Exercise continues to be the most efficient therapeutic strategy for treatment of sarcopenia. Furthermore, it increases muscle strength and basal metabolic rate, optimizes blood pressure, lipid profile and insulin sensitivity.	Review article
Rosanna Piccirillo	Exercise-Induced Myokines With Therapeutic Potential for Muscle Wasting	2019	Physical activity is one of the pathways in which the muscle protects itself from diseases secondary to muscle wasting.	Review article
Christoph Hoffmann, Cora Weigert	Skeletal Muscle as an Endocrine Organ: The Role of Myokines in Exercise Adaptations	2017	Myokines are crucial for muscle adaptation for the increase in physical condition.	Review article
Pablo Jorge, Marcos-Pardo, Noelia González-Gálvez, Abraham López-Vivancos, Alejandro Espeso-García, et all.	Sarcopenia, Diet, Physical Activity and Obesity in European Middle-Aged and Older Adults: The LifeAge Study	2020	Low muscle mass and low muscle strength are criteria for determining sarcopenia European guides. Muscle strength is a predictor of mortality and disability in older adults.	Research article cross-sectional study
Jonathan C. Mcleod, Tanner Stokes, Stuart M. Phillips	Resistance Exercise Training as a Primary Countermeasure to Age-Related Chronic Disease	2019	Additional to cardiorespiratory condition, muscle mass and strength are also associated with the risk of developing cardiovascular disease and greater mortality rate. The evidence presented emphasizes that resistance training is equivalent and even superior to aerobic exercise as the first line of prevention of chronic diseases.	Review article
Sandra Maria Barbalho, Uri Adrian Prync Flato, Ricardo José Tofano, Ricardo de Alvares Goulart , Elen Landgraf Guiguer, Cláudia Rucco P. et al.	Physical Exercise and Myokines: Relationships with Sarcopenia and Cardiovascular Complications	2020	Physical inactivity and muscle mass reduction lead to an increase in visceral fat – culminating in an imbalance between anti-inflammatory and proinflammatory state- increasing the vicious cycle between sarcopenia, accumulation of adipose tissue and cardiovascular complications.	Review article
José Andrés Rubio del Peral, M. Sonia Gracia Josa.	Ejercicios de resistencia en el tratamiento y prevención de la sarcopenia en ancianos. Revisión sistemática	2017	Performing resistance exercise is one of the most adequate patterns to prevent and treat sarcopenia, since this type of exercise alone or combined with aerobic training, reach benefits on mass, muscle strength and basic daily activity functions.	Review article Systemic review
Youngju Choi, Jinkyung Cho, Mi-Hyun No, Jun-Won Heo, Eun-Jeong	Re-Setting the Circadian Clock Using Exercise against Sarcopenia	2020	Exercise could reduce and even reverse loss of mass and muscle strength.	Review article