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EXERCISE AND HEALTHY LIFE EXPECTANCY

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Abstract

There is a consensus in the literature on the role of exercise in prolonging healthy life. The strongest effect is held by sports games characterized by intense efforts. As a result, the paper proposes the analysis of anaerobic and aerobic efforts on the release of myokines and stem cell metabolism. Anaerobic exercise should play a significant role in anti-aging programs, as it stimulates muscle secretion of bone morphogenetic protein 7, a myokine that helps prevent cardiovascular diseases, the main cause of mortality. Intense exercise also strongly stimulates the release of irisin, IL-6, IL-15 and progenitor stem cells, which is why they should be given a higher weight in anti-aging training programs and kinetoprophylaxis of the elderly. Anaerobic exercise may prevent myostatin (myokine that accelerates the aging of striated muscle) from growing more than aerobic ones. IGF-1, whose role in increasing life expectancy is controversial, and which is not secreted during aerobic exercise, appears to be only redistributed in plasma as a result of resistance exercise.

Keywords: myokine, irisin, stem cells, anaerobic effort

Introduction

Exercise reduces most of the risk factors for mortality (diabetes, high blood pressure, ischemic heart disease, dyslipidemia, cancer, and stroke), and life expectancy increases by up to 4.2 years, especially for aerobic endurance practitioners (Reimers, Knapp & Reimers, 2012 – [26]). Another study showed that cycling is a sport that prolongs life expectancy, especially through the prophylaxis of cardiovascular disease in both men and women (Dhana et al, 2017 – [8]). Another classification of the increase of the life expectancy according to the practiced sport suggests that the psychological factors have a great importance (in this case the social interaction): health club activities - 1.5 years; calisthenics - 3.1 years; jogging - 3.2 years; swimming - 3.4 years; cycling - 3.7 years; football - 4.7 years; badminton - 6.2 years; tennis - 9.7 years (Schnohr et al, 2018 – [27]). However, the results of the above study show that, in terms of effort intensity, the longest life expectancy is found in the case of sports games that require intense effort. As a result, in this revision paper, I propose to analyze some factors that can prolong the duration of healthy life, namely the release of myokines and the stimulation of stem cells, and what types of exercises have a stronger stimulating effect on those factors.

Effects of exercise intensity on the type of myokines discharged into the circulation

Myokines released during exercise can slow the progression of diseases that occur with advancing age and delay the aging process, influencing communication between tissues (Demontis et al, 2013 – [7]). From a chemical point of view, myokines are proteoglycan peptides, the main ideas of a study aimed at ensuring the maintenance of skeletal muscle health in the elderly being the following (Kwon et al, 2020 – [16]):

- with age, secretion of vascular endothelial growth factor A (VEGF-A), cysteine-rich secreted protein (SPARC), sestrin, stromal cell-derived factor 1 (SDF-1), irisin, interleukin-15 (IL-15), insulin-like growth factor 1 (IGF-1), bone morphogenetic protein 7 (BMP-7), β-aminoisobutyric acid (BAIBA), decorin and apelin decrease, while IL- 6 and myostatin increase
- aerobic exercise stimulates the expression of VEGF-A, SPARC, sestrin, SDF-1, irisin, IL-6, apelin, BAIBA, and IL-15
- anaerobic exercise positively regulates irisin, IL-15, decorin, BMP-7, IGF-1, VEGF-A and IL-6 expression
- myostatin is inhibited by both aerobic and anaerobic exercise
- the conclusion of this study (Kwon et al, 2020– [16]) is that training programs should be designed and developed for the elderly that maintain a balance between aerobic and anaerobic exercise

But which of these myokines have more important roles in anti-aging processes, and especially, what kind of exercises stimulate their secretion? In order to answer these questions, we looked in the literature for the systemic effects of myokines, grouped according to the intensity of the effort at which they are expressed by the striated muscle (after Kwon, 2020– [16]).

a) Myokines expressed in anaerobic effort (but not in aerobic effort) - after Kwon, 2020– [16]:

- BMP-7 has been proposed not only for the treatment of osteoporosis, but also for cardiovascular diseases and the stimulation of cellular plasticity in the case of neurological diseases (Aluganti Narasimhulu & Singla, 2020 – [1]). It is therefore reasonable to assume that high-intensity anaerobic exercise prevents not only the aging of the skeleton but also the brain and cardiovascular system
- decorin is an important myokine not only in the prevention of tendon aging (Dunkman et al, 2013) but its structural changes are related to skin aging (Nomura, 2006 – [24])
- IGF-1 appears to have a shortening effect on life, although not much is known about receptor sensitivity and activation (Vitale et al, 2019 – [32])

b) Myokines expressed during anaerobic effort, but not aerobic effort (after Kwon, 2020– [16]):

- apelin, in addition to increasing the duration of healthy life (Rai et al, 2017 – [25]), may have an effect in preventing visual degeneration (Ishimaru et al, 2020 – [13])
- BAIBA protects neuron-like cells from oxidative stress and thus opposes their apoptosis, being proposed as a pharmacological agent for the treatment of neuronal diseases (Minato et al, 2021 – [23])
- SDF-1 stimulates adipose tissue-derived stem cell survival (Li et al, 2016 – [18])
- also, sestrin has a role in regulating the functions of stem cells and thus prolonging the life span, in relation to the intake of amino acids (Lu et al, 2021 – [20])
- there is a study showing that experimental animals from which the SPARC gene has been removed have an aging phenotype and decreased glucose tolerance (Ghanemi et al, 2022)

Discussions

A summary of the effects of myokines expressed specifically as a function of exercise intensity is provided in Table 1.

Table 1. Effects of prolonging healthy life exerted by myokines released specifically in anaerobic or aerobic exercise, respectively.

Intensity of effort	myokine	antiaging effects/prolongation of healthy life
anaerobic	BMP-7	prevents osteoporosis, cardiovascular and neurological diseases (Aluganti Narasimhulu & Singla, 2020 – [1])
	decorin	can prevent skin aging (Nomura, 2006 – [24])
	IGF-1	possible effect of shortening the lifespan (Vitale et al, 2019 – [32])
aerobic	apelin	may increase healthy life expectancy (Rai et al, 2017 – [25]), prevent visual degeneration (Ishimaru et al, 2020 – [13])
	BAIBA	can prevent neuronal apoptosis (Minato et al, 2021- [23])
	SDF-1	stimulates the survival of adipose tissue-derived stem cells (Li et al, 2016 – [18])
	sestrin	regulation of stem cell functions and thus prolonging the life span, in relation to the intake of amino acids (Lu et al, 2021 – [20])
	SPARC	prolonging life expectancy, increasing glucose tolerance (diabetes prevention) (Ghanemi et al, 2022)

It is difficult to appreciate what kind of effort should predominate in an exercise program to ensure a maximum anti-aging effect. However, BMP-7, a myokine released during anaerobic exercise, can prevent cardiovascular diseases, which is the main cause of mortality (Mc Namara, Alzubaidi & Jackson, 2019 – [22]). Another argument for the high intensity of exercise is that it stimulates the release of irisin more strongly (Daskalopoulou et al, 2014; Löffler al, 2015; Tsuchiya et al, 2014 – [6, 19, 28). Irisin also has a potential senolitic effect (Colaianni et al, 2021 – [5]), the importance of this myokine being highlighted by the senolitic effects of exercise on senescent cells (Chen et al, 2021 – [4]). Although endurance exercise appears to affect cell senescence in a more positive way than resistance training (Brauer et al, 2021 – [2]), the high-intensity endurance effort is also discussed in that review study and can contribute to the relevance of the results. The analysis of the conditions in which the other myokines with anti-aging role common to aerobic and anaerobic exercises are secreted shows that the discharge of IL-6 is stimulated by the intensity of the effort and that of IL-15 requires strength exercises (Vasconcelos & Salla, 2018 – [29]). It turns out that both IL-6 and IL-15 are secreted during anaerobic rather than aerobic exertion. Although the effects of IL-6 on aging processes are controversial, I cite a recent study showing that this inteleukin is an activator of pituitary stem cells (Vennekens et al, 2021 – [30]). Inhibition of myostatin by aerobic exercise is different depending on the intensity of the effort: at an intensity corresponding to the anaerobic threshold the inhibition is stronger after 24 hours compared to the situation in which the intensity corresponded to the maximum rate of lipid oxidation, a trend that remains at 48 and at 72 hours, even if in the first 3 hours after exertion the situation is reversed (He et al, 2019 – [12]). It turns out that anaerobic exercise may have a stronger inhibitory effect on myostatin. The importance of this fact is special, given that anti-myostatin antibodies increase the survival of striated muscle satellite stem cells under conditions of aggression (Cariati et al, 2022 – [3]). Another argument for anaerobic exercise is the increase in the plasma concentration of developmentally early stem cells, fact which is found in long-distance runners (Marycz et al, 2016 – [21]), even if the sestrin discharged during aerobic exercise has the effect of regulating stem cell functions (Lu et al, 2021 – [20]). In order to recommend a higher proportion of anaerobic exercise in anti-aging programs, the controversial role of IGF-1 should be elucidated. However, it appears that resistance exercises do not alter the plasma concentration of IGF-1 as much as its distribution in binding proteins (Kraemer et al, 2017 – [15]). We consider that the data presented and their discussion are important for the kinetoprophylaxis of the elderly. This is because although it is indicated for the elderly to perform physical exercises that require up to the maximum capacity of effort to improve parameters such as the maximum volume of oxygen (Langhammer, Bergland, & Rydwik, 2018 – [17]) the proportion of intense exercises in such a training program is not discussed. The recommendation of an exercise program for the elderly must be individualized and take into account many factors, including comorbidities (Izquierdo et al, 2021 – [14]). Also, the hypothesis of a possible undesirable effect of the intense exercises in the prophylaxis by physical exercises of the severe forms of COVID-19 must be considered (Hagiu, 2021 – [11]).

Conclusions

1. Anaerobic exercise should play a significant role in the elderly's kinetoprophylaxis programs, considering that compared to aerobic exercise, it stimulates the muscular secretion of BMP-7, myokine which contributes to the prevention of cardiovascular diseases, the main cause of mortality.
2. In addition, irisin, a myokine with significant effects on prolonging healthy life, which also has senolitic cellular effects, is secreted in larger quantities during intense exercise. Likewise, IL-6 and IL-15 are expressed as a result of anaerobic exercise rather than aerobic exercise.
3. Anaerobic exercise may have a stronger inhibitory effect on myostatin, a myokine that promotes sarcopenia.
4. Anaerobic exercises also have an advantage over aerobic ones in terms of the anti-aging effect on stem cells, because they stimulate the developmentally early stem cells, unlike aerobic exercises which only improve the stem cells metabolism.
5. It seems that IGF-1, myokine whose anti-aging role is controversial, and which increases only as a result of anaerobic exercise, is only redistributed in plasma as a result of resistance exercises.

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