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Review Article

The Role of Insulin-Like Growth Factor (IGF-1) Signaling During Physical Exercise: A Systematic Review

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ABSTRACT

Exercise is one of the non-pharmacological therapies that functions to improve public health. This study seeks to determine how increased IGF-1 levels during exercise as a hormone can trigger growth. For this study, a number of journal databases were searched, such as PubMed, Web of Science, Embase, and Science Direct. This study considers several aspects, such as research on exercise and IGF-1 published in reputable journals over the past five years. Our analysis only includes items published in reputable international journals. Using databases total of 159 publications were found. In this comprehensive analysis, about ten carefully selected and peer-reviewed papers were included. The standard operating procedure for this investigation was developed using Preferred Reporting Systematics and Meta-analysis (PRISMA). Based on the results of this systemic investigation, exercise has been shown to increase IGF-1 levels, a hormone that promotes growth. Physical exercise as a therapeutic effort and a means of improving public health.

Introduction

Human beings undergo a biological aging phase that is associated with a decrease in muscular mass, brain size, and a reduction in mental functions including memory, and a decrease in fat-free mass commonly referred to as sarcopenia (1). The aging process is a natural physiological mechanism characterized by a decline in body functions both physically and hormonally. In this phase, most of the body's hormones decline in function including testosterone, growth hormone, and estrogen (2). Aging is strongly associated with the emergence of physiological degenerative effects, including body fat storage, skeletal muscle atrophy, and reduced cardiovascular function (3).

Skeletal muscle atrophy is a result of the decline of muscle function with age, which is closely related to the risk of developing metabolic syndrome in elderly people, is the most important health problem that needs to be anticipated (4). Maintaining healthy skeletal muscle is also important to prevent metabolic syndrome. Muscles have a very important role in glucose uptake (5). Physical exercise is a non-pharmacological therapy that has a beneficial impact on improving people's health status. Physical exercise promotes skeletal muscle mass, enhances insulin sensitivity, and boosts mitochondrial biogenesis (6). Inactivity or sedentary lifestyle worsens the condition of the body by increasing the risk of developing metabolic syndrome (7). Skeletal muscle mass and ability for exercise are influenced by a number of variables, such as hormone levels and metabolic enzyme levels (8).

The function of exercise in improving public health has been well documented. Physical exercise is defined as planned, systematic, and repetitive physical activity that can improve body performance, physical fitness, and motor skills (9). IGF-1 is the most potent mediator that prevents organ failure brought on by illness by promoting cell division and proliferation (10). Furthermore, IGF-1 has a strong correlation with the growth of muscle mass and strength, as well as the control of metabolism and the regeneration (11). Under the direction of growth hormone, the liver produces the majority of the insulin-homologous protein IGF-1 (12). Local production of IGF-1 occurs in many organs, including vascular smooth muscle cells, endothelial cells, and immune cells such as monocytes, macrophages, and lymphocytes (13).

Age-related atrophy can be prevented by exercise by boosting IGF-1 expression, which increases muscle mass and function. This has been demonstrated in previous studies (14). Additional research has demonstrated that by upregulating IGF-1 expression, exercise can decrease oxidative stress, increase neurogenesis, and decrease inflammation (3). However, the mechanism of exercise in increasing IGF-1 expression is still debated and needs to be further explored whether the increase in IGF-1 during exercise can inhibit the mechanism of muscle atrophy or not and how the mechanism of IGF-1 increase during exercise is also still not fully understood. Therefore, this systematic review will discuss the role of physical exercise in increasing the expression of IGF-1.

Subjects and Methods

Study Design

As part of a systematic review process, this study examined and evaluated several journal databases, including Pubmed, Embase, Web of Science, and Science Direct.

Eligibility Criteria

The research on physical activity and the growth factor known as insulin-like (IGF-1) that have been published in the recent five years were the source of the inclusion criteria for this investigation. Among the publications not included in our analysis, papers published in renowned journals met the exclusion criteria for our study analysis.

Procedure

Articles that had been reviewed and verified were uploaded to Mendeley information database with their full text, abstract, and title. Using the databases from Pubmed, Web of Science, Embase, and Science Direct, 159 publications were located and included in the study's initial phase. In the subsequent phase, 87 publications were assessed for inclusion criterion appropriateness based on the abstract and title. 39 paper items were to be verified for additional processing during the third stage. We then applied a filter depending on whether the topic met the inclusion requirements and was appropriate for general discussion. Ten publications that satisfied the inclusion criteria were carefully chosen after thorough evaluation for this systematic review. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) assessment were utilized in this study.

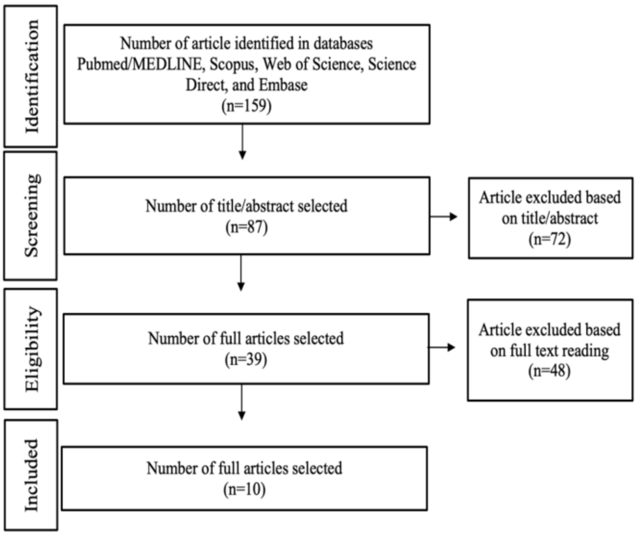

Figure 1. PRISMA flowchart of the article selection process

Results

The effect of the insulin like grawth factors on physical exercise are detailed in Table 1.

Discussion

This systematic review aims to investigate the mechanisms behind physical exercise as a non-pharmacological therapeutic effort in increasing IGF-1 expression. Physical exercise is proven to improve the health status of the community. Studies have demonstrated that engaging in physical activity can elevate IGF-1 expression. In this study, sixty-minute sessions of resistance and aerobic exercise were compared. Five days a week for four weeks. Additionally, compared to aerobic training, resistance training had increased IGF-1 expression, according to the results (3). So, from this study there are differences in IGF-1 expression depending on the kind of activity carried out. The results of another study with the type of resistance exercise intervention with a duration of 60 minutes per session 3x a week for 12 weeks also proved a rise in IGF-1 expression (15).

This also reinforces that resistance training has a beneficial effect on increasing IGF-1. Another factor that affects the high level of IGF-1 is a healthy person without having a disease disorder in the body. In accordance with the results of a study comparing IGF-1 levels in people suffering from dementia and not suffering from dementia, the results showed that people with no dementia had higher IGF-1 levels (16). Research from Pierce et al., 2020 also reinforces that resistance physical exercise provides a significant upregulation of IGF-1 expression (17). We can therefore conclude that exercise positively affects the rise in IGF-1 levels.

Table 1. Results of Physical Exercise Review on Increasing Insulin-Like Growth Factor (IGF-1)

Author	Sample Characteristics	Study Design	Intervention	Results
(Li et al., 2022) (3)	40 male rats participated in this study and were split up into five groups: eight people each for the groups that received electrical stimulation, whole-body vibration, resistance training, aerobic exercise, and control.	Experimental	Aerobic exercise running on a treadmill 60 minutes per day with an intensity of 76% VO2Max, For four weeks, five days a week. Resistance exercise by climbing stairs performed as many as 9 sets, with 3x per set for approximately For four weeks, spend 60 minutes a day, five days a week.	IGF-1 levels increased in the group that exercised. And the group that engaged in resistance exercise saw the biggest rise in IGF-1 levels.
(Son et al., 2020) (15)	Ten women were assigned to the treatment group and ten women to the control group among the twenty women who participated in the study.	Experimental	Resistance training sessions of sixty minutes each, three times a week for a duration of twelve weeks.	In the group that underwent physical activity intervention, IGF-1 levels rose.
(Stein et al., 2021) (16)	74 people participated in this study consisting of (n=34) with Alzheimer's illness and a group (n=40) free of dementia.	Experimental	Submaximal aerobic exercise on a treadmill	The group free of dementia illness had higher levels of IGF-1.
(Pierce et al., 2020) (17)	20 people participated in this study to administer the pretest and posttest.	Experimental	Acute resistance training test with six sets of ten exercises individual maximum repetitions (6 × 10-RM), separated by a 2-minute recovery period between sets.	Shortly after the physical exercise intervention, IGF-1 levels increased.
(Arazi et al., 2021) (1)	30 elderly men participated in this research and were split up into three groups: physical exercise intervention groups for strength (n = 10), endurance (n = 10), and control (n = 10).	Experimental	Participants in the endurance group jogged for thirty minutes at a maximum heart rate of sixty-seven percent, while those in the strength group engaged in two sets of resistance training (6 exercises with ten repetitions at a maximum of sixty-seven percent of one repetition).	IGF-1 levels significantly increased in the resistance and endurance intervention groups.
(Avazpour, 2020) (18)	27 nurses voluntarily divided into 3 groups namely HIIT type 1 (n=9), HIIT type 2 (n=9), and control group (n=9).	Experimental	HIIT (type 1) consists of 12 seconds of active recovery followed by 8 seconds of spring running. HIIT (type 2), which consists of a sprint-only 40-meter shuttle run. For four weeks, there were three sessions per week of instruction.	IGF-1 levels rose in the two groups that underwent physical activity intervention.
(Kang et al., 2020) (19)	The study involved 20 older women who were divided into two groups: the control group (n = 10) and the physical activity intervention treatment group (n = 10).	Experimental	Aquatic exercise was conducted for 60 minutes throughout a 16-week period, three times a week.	IGF-1 levels in the group that had physical activity intervention rose noticeably.
(Cho & Roh, 2019) (20)	In this study, 37 healthy women were split into two groups: regular taekwondo practitioners (n = 19) and control practitioners (n = 18).	Experimental	Taekwondo training for 60 minutes per session at an intensity of 50%-80% HRmax 5x a week for 16 weeks.	There was an increase in IGF-1 levels in the group with taekwondo training intervention.
(Żebrowska et al., 2020) (21)	28 people consisting of 14 people in the group with type 1 diabetes mellitus and 14 people in the healthy group participated in this study to do the pretest and posttest.	Experimental	On a cycle ergometer, perform a 40-minute continuous exercise at a moderate level (50% lactate threshold) in normoxia (Nor) and hyperemia (FiO2 = 15.1%).	There was an increase in IGF-1 levels in both groups but the highest increase occurred in people without diabetes mellitus.
(Birinci et al., 2022) (22)	In this study, 40 participants were split into 4 groups: 10 table tennis players, 10 long distance runners, 10 chess players, and 10 controls.	Experimental	Each sport's recommended training regimen consists of a 10-minute warm-up and 40 minutes of targeted physical activity.	IGF-1 levels increased significantly in the runners and tennis groups.

Improving the quality of human life is influenced by muscle mass and function. As we get older, organ function and performance decline, so regular exercise can increase muscle hypertrophy and metabolic capacity of the human body (23). Atrophy that occurs with age can be prevented by doing regular physical exercise. So this provides basic assurance that exercise is the best effort in improving the health status of the community. Regular physical exercise is very effective in increasing muscle hypertrophy and reducing muscle atrophy caused by pathological factors (24). It has been studied that variables such as increased IGF-1 levels, protein synthesis, angiogenesis, and proliferation of muscle satellite cells could be targets for exercise-induced muscle hypertrophy (25). It has also been demonstrated that IGF-1 enhances the strength and shape of muscle fibers (26).

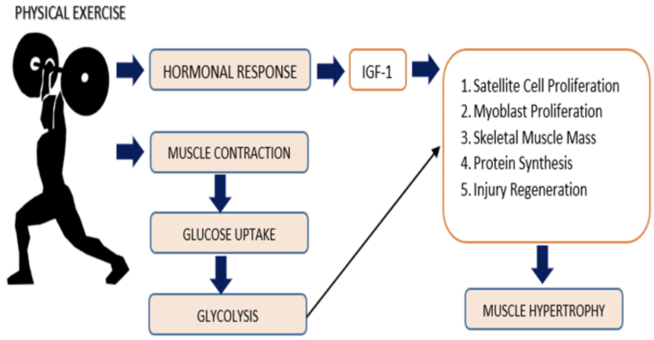

Figure 2. The Mechanisms Physical Exercise Increase Insulin-Like Growth Factor (IGF-1)

Skeletal muscle growth has been shown to be mediated by IGF-1/IGF-1R via a number of mechanisms, including the PI3K/Akt signaling pathway (11). In this animal studies, we discovered that physical exercise greatly increased skeletal muscle composition and performance, which is highly correlated with the IGF-1/IGF-1R-PI3K/Akt signaling pathway's activation (3). Still unknown, though, is whether other elements also contribute to muscle growth or if physical exercise's ability to promote muscle hypertrophy is primarily due to IGF-1 signaling activation (3). In mice with myocardial infarction, previous studies have shown that resistance and aerobic exercise can increase the expression of IGF-1 protein and promote skeletal muscle growth (14). Insulin-like growth factor-1 (IGF-1) controls the proliferation, differentiation, and survival of cells, which is essential in correcting disease-induced organ failure (10). IGF-1 has also been linked to the growth of muscle mass and strength, as well as the control of metabolism and the regeneration of skeletal muscle (11).

The mechanism of IGF-1 increase during physical exercise is still not entirely clear and is debated among researchers. The complex molecular mechanisms that occur in cells make us always want to understand more deeply how the stages that occur in cells during physical exercise. During physical exercise, the need for ATP will increase along with the activity undertaken. The primary regulator of skeletal muscle metabolism is adenosine monophosphate-activated protein kinase (AMPK), an intracellular sensor that controls ATP consumption (11). The primary source of circulating IGF-1 is the liver, and deletion of the IGF-1 gene unique to the liver causes a 70–80% reduction in serum IGF-1 levels (11). Nonetheless, IGF-1 levels in serum rose dramatically following aerobic exercise, according to a study done on aged males (1).

Other research' findings demonstrate that high intensity interval training (HIIT) is proven to increase IGF-1 levels (18). Another study, an aquatic exercise intervention of 60 minutes demonstrated that the IGF-1 levels significantly increased after each session, three times a week, for sixteen weeks (19). The findings of other research support this idea, showing that taekwondo athletes who receive taekwondo training interventions have elevated IGF-1 levels. Five sessions of sixty minutes a week for sixteen weeks (20). So, it has been proven that IGF-1 levels increase during physical exercise. However, this systematic review has the limitation that it only examines the increase in IGF-1 during physical exercise. There are still many other parameters that should be further explored that are related to increasing muscle mass and growth. This is very important because it can provide knowledge to researchers and readers in the wider audience related to how the role of physical exercise provides efforts related to public health benefits and increased muscle mass through IGF-1 secretion.

Conclusion

Research results prove that physical exercise can increase IGF-1 levels. These IGF-1 levels circulate and become a trigger signal for muscle hypertrophy. Regular physical exercise is a non-pharmacological therapy in improving the health status of the community.

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Conflict of Interest

The authors declare no conflict of interest.

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