

The Effects of Physical Activity on Serum Visfatin Level: A Literature Review

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Abstract

Higher concentration of plasma visfatin in obese and diabetic subjects compared with their healthy counterparts shows visfatin relationship to obesity and overweight. This article reviewed the studies on contradictory and different notions regarding the role of physical activity in visfatin response following aerobic and resistance exercises. Recent reports on the impact of physical activity and exercise on visfatin concentration is contradictory. Some studies have identified that exercise can reduce visfatin concentration depending on the duration of physical activity and calorie expenditure, while others have not reported any changes in visfatin concentration. The present review indicated that a balanced diet, low in fat, and physical exercise (aerobic and aerobic-resistance exercises) can reduce blood visfatin levels depending on the severity and duration, while resistance training alone exerts no significant effects on serum visfatin level.

Keywords: Visfatin, Physical activity, Aerobic exercise, Resistance training, Combined training



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Introduction

Adipose tissue is a part of endocrine system with high metabolic activity. Peptides called adiponectin are molecules produced by these tissues which participate in the regulation of energy intake and energy expenditure, inflammatory process, and insulin sensitivity.¹ Adipose tissue as an active endocrine gland secretes chemicals that regulate metabolism, and physiological processes. Collectively, these chemical messengers such as adiponectin, leptin, resistin, and visfatin are known as adiponectins.² Visfatin was identified as a novel adiponectin in 2005.

The exercise plays an important role in determining the visfatin level by reducing fat reservoirs, changing fat tissue, and improving cell secretory function of fat tissue hypoxia (a condition related to obesity or overweight).³ Visfatin shows gene expression and higher secretion in visceral adipose tissue.⁴ Visfatin involves in the regulation of insulin production stimulated by glucose in beta cells,^{5,6} and

also visfatin acts as a signalling molecule in the blood and cellular organelles (nucleus, cytoplasm, and mitochondria).^{7,8}

Visfatin increases the release of glucose by adipocytes and muscle and prevents the production of glucose in the liver cells, thereby reducing blood sugar and improving insulin resistance.^{9,10} This hormone performs an insulin-like action through binding to insulin receptors. Binding affinity of visfatin to the receptors is similar to insulin, however due to different receptor binding sites and 18 times greater concentration of insulin, these two do not compete for binding to the receptors.¹¹⁻¹³ Mechanisms and factors that affect the production and secretion of visfatin are not yet fully understood.

Some sports have emphasized exercise, as one of the factors that could be involved in the production and secretion of visfatin.^{14,15} Resistance training is a form of exercise involved in the development of sports performance for athletes.^{13,16} Manipulating variables to organize different protocols

of resistance exercise training program aims to develop strength, local muscular endurance, and muscle mass.¹⁷ Each of these resistance protocols have different metabolic and hormonal responses regarding the difference in the intensity of exercise and rest time between sets, one of the factors in determining energy expenditure during resistance exercise.^{18,19}

Kraemer et al examined the levels of certain hormones including growth hormone, and cortisol as well as lactate level in response to resistance exercise with 6 different protocols.²⁰ Studies show that intensity and duration of exercise can affect gene expression and plasma levels of these hormones.^{21,22} Hormonal and metabolic responses to resistance exercise are complex processes and an integrated system for signalling to a large group of target cells.¹⁸ As one of the factors,²³ visfatin and insulin are affected in response to exercise. Considering the role of resistance training in improving insulin sensitivity,²⁴ comparison of visfatin and its possible impact on the response to resistance exercise protocols can show important potential mechanisms on the role of visfatin in insulin resistance.²⁵

In this study, the impact of physical activity on visfatin production was reviewed.

Search strategy

Scientific databases including PubMed, ScienceDirect, and Scientific Information Database (SID) were sought. Keywords of physical activity, sports, aerobic exercise, resistance training, combined training, and visfatin were used.

The Effect of Resistance Training on Serum Visfatin Level

Exercise and muscle mass are the main factors, involved

in determining the resting metabolic rate, which can reduce the risk of cardiovascular diseases and insulin resistance. Desired effects are achieved with physical fitness programs, strength training, physical activity of appropriate intensity, and duration, as well as sufficient periods of rest between the repetitions. However, unlike the physiological and biomechanical responses to resistance exercise, hormonal responses to exercise are variable.²⁶ Several studies have been conducted in this area (Table 1).

Jamshidi et al²⁷ considered visfatin and insulin resistance index upon the application of the protocols of resistance exercise in healthy young men. In this study, concentration of plasma visfatin significantly decreased after 3 types of resistance exercise.²⁷ They noted that the reduced concentration of plasma visfatin after resistance exercise may be due to the absorption of visfatin by subcutaneous adipose tissue.

Soori et al²⁸ showed that a 10-week resistance training had no effect on the serum levels of visfatin in middle-aged obese postmenopausal women. It is possible to adapt the characteristics of participants in the recent study (age at menopause) to make positive changes in insulin resistance and sufficiently improve glucose tolerance. Bassami et al²⁶ studied the effect of resistance exercise on the alternations of serum visfatin levels and insulin resistance in healthy young subjects. They concluded that intensity of resistance exercise is an important factor in determining the visfatin level, and insulin resistance index. One of the reasons for not observing significant differences in factors such as visfatin, and growth hormone may be attributed to the low level of energy expenditure in resistance exercise. Three different intensities used in this study were in the range of low, medium, and high, but due to the volume of activity comparable among these 3 levels, probably

Table 1. Studies Conducted on the Role of Resistance Training on Visfatin Level

Authors	Patients	Intervention	Outcomes	Conclusions	Ref.
Jamshidi et al	10 healthy young men	Three resistance exercise protocols: 1. Muscle strength 2. Hypertrophy 3. Power endurance	Regardless of the type of resistance training, plasma visfatin density was significantly decreased after three types of resistance training.	Hyper activities to prevent insulin resistance could be useful.	27
Soori et al	16 non-active postmenopausal obese women	10 weeks of resistance training	10 weeks of resistance exercise had no significant influence on serum visfatin levels in fat women.	Further studies are needed.	28
Bassami et al	15 healthy young subjects	3 sessions of resistance exercise	Intensity resistance training did not affect the visfatin level, and insulin resistance training	Visfatin is not involved in the process of insulin resistance exercise.	26
Fathi et al	Insulin-resistant rats	8 weeks of resistance training	Visfatin levels were significantly lower after exercise.	The visfatin, involved in improving metabolic conditions induced by exercise, did not affect the insulin tolerance.	29
Sheikholeslami et al	15 healthy young men	6 weeks of resistance exercise, 2 sessions per week	Large or small muscles were considered at the beginning of the exercise. Visfatin influence on hormone release and other factors were not observed.	Small to large or large to small muscles may impact levels of visfatin.	30
Choi et al	48 healthy Korean women	12 weeks of training program involved aerobic training (45 min/session, 300 kcal/d) and muscle strength training (20 min/session, 100 kcal/d), 5 times per week.	A visfatin decrease was observed.	Exercise activity with low weight induced a significant reduction in plasma visfatin level.	14

the difference in their energy consumption was very low. Fathi et al²⁹ examined the role of 8 weeks of weight training in plasma visfatin and its association with insulin resistance in rats. After induction of insulin resistance in control and exercise groups, resistance training group performed resistance exercise for 8 weeks, 3 days per week. Plasma concentrations of visfatin, glucose, insulin, and index of insulin resistance were measured following the training. The findings revealed a significant boost in visfatin level according to the elevation of insulin resistance, insulin, and blood sugar level. Based on the findings, visfatin increased in accordance with insulin resistance and diabetes. Sheikholeslami et al³⁰ studied the acute effects of resistance exercise on the presentation of visfatin hormones, insulin, and insulin resistance index in men. The results showed that serum visfatin concentration increased immediately after the exercise protocols.³⁴ Choi et al implemented a training program with 12-week resistance exercise and a volume of 100 kcal/session as part of programs and reported decreased level of visfatin.¹⁴

The definite mechanism of the effect of exercise on serum visfatin is not well known. However, it is likely that changes in plasma visfatin level may be influenced by alternations in blood sugar, insulin level, changes in body composition, consumption of high fat diets, and calorie restriction factors. Chen et al showed that among factors such as age, and fasting insulin, waist to hip ratio was positively associated with plasma visfatin level.³¹ The mass of muscles may also affect the visfatin level.³⁰

Seo et al also showed that exercise is effective on body weight, fat, and waist to hip ratio.³² Kamińska et al conducted a study to assess visfatin levels in obese individuals, showing that high levels of visfatin were observed in obese people with anthropometric parameters except for waist to hip ratio.³³ Ghanbari et al showed that a rapid implementation of two anaerobic training sessions significantly augmented visfatin serum levels along with insulin, blood glucose, and adjusted insulin resistance index immediately after the exercise.³⁴ Bo et al reported that modifying life style for 1 year in 335 patients with metabolic disorders significantly decreased plasma levels of visfatin and insulin.³⁵ Considering gender differences for visfatin levels, Fukuhara et al showed a strong correlation with the mass of visceral adipose tissue, while the association was very weak between plasma levels of visfatin and subcutaneous fat.⁴ Other studies have also shown the relationship of body fat content with the plasma levels of visfatin, and visfatin gene expression in adipose tissue.³⁶ Varma et al described a link, considering the plasma levels of visfatin, with BMI and insulin sensitivity.³⁷

Findings on the Effects of Aerobic Exercise on Serum Visfatin Level

Studies on the effect of aerobic exercise on the visfatin level have been described in Table 2. Ahmadzadeh et al³⁸

studied the relationship between the rest levels of visfatin and its changes in response to acute exercise endurance, aerobic fitness and body composition in healthy men. The participants were studied for body composition characteristics including weight and waist to hip ratio. In a one-week period, participants did acute endurance exercise at 60% for 30 minutes on the bike Vo_{2max} . At the end, it was concluded that the level of aerobic fitness was effective in alternation of visfatin basic level, but higher changes were reported in response to acute exercise in the group of aerobic fitness. Fukuhara et al⁴ studied the visfatin association with visceral fat, and evaluated the effect of 4 months of aerobic exercise on the visfatin level. They showed that this relationship was quite strong and significant. In this study, visfatin was correlated with visceral fat but not with subcutaneous fat.⁴ Taghian et al³⁹ evaluated the insulin resistance in obese women, assessing the effect of 4 months of aerobic exercise on serum visfatin concentrations in this population.³⁹ They reported that after 12 weeks, weight and body mass index (BMI) showed a significant fall in experimental group, but fat ratio, visfatin, insulin, glucose, and insulin resistance index did not significantly change.³⁹

Furthermore, longitudinal studies have shown that many factors associated with aerobic exercise are effective in reducing total body obesity including individual characteristics (gender, baseline fat, and genetic signature) and different states of exercise programs (time, intensity, and type of exercise).⁴⁰ According to these factors, perhaps the reason for the lack of significant differences in the study of Taghian et al may be the duration of exercise. Therefore, it may be interpreted that the intensity and duration of exercise was not enough to significantly reduce body fat percentage and visfatin level.

Soltani et al⁴¹ evaluated the effect of 8 weeks of aerobic activity on the visfatin level in female rats. Exercises were done 5 days a week for 2 months with the animals on a treadmill. The authors found no significant difference between plasma levels of visfatin in exercise and control groups.⁴¹ Lee et al evaluated the influence of aerobic exercise over 3 months of training on plasma visfatin levels and showed a significant reduction in the plasma levels of visfatin and insulin resistance.⁴² In a study on 50 professional female basketball and handball players, it was observed that plasma adiponectin levels decreased after 2 hours of aerobic exercise.⁴³ Haus et al also reported that aerobic exercise reduced the level of plasma visfatin followed by improved glucose tolerance.¹⁵ Rezaeian et al examined 10 weeks of endurance swimming training and showed a significant decrease in serum visfatin levels in overweight postmenopausal females.⁴⁴ Larsen et al suggested that after 3 hours of aerobic exercises, maximal oxygen uptake of visfatin in adipose tissue was 68%.⁴⁵ Juryman et al observed that the level of plasma visfatin in elite subjects reduced after 30 minutes of aerobic exercise compared to the control group.⁴⁶ Roupas et al in a study on 17 elite Olympic athletes observed significant changes

Table 2. Studies Conducted on the Role of Aerobic Training on Visfatin Level

Authors	Patients	Intervention	Outcomes	Conclusions	Ref.
Ahmadzadeh et al	Healthy men	Acute endurance exercise on a bicycle ergometer	Visfatin basic level was affected by aerobic activity, and intense aerobic activity exerted more changes in visfatin level.	Visfatin improved aerobic performance via NAD + biosynthesis and insulin secretion .	38
Fukuhara et al	Chronic disorders such as diabetes	Decreasing a newly identified adiponectin	Visfatin correlated with the amount of visceral obese, but lower correlations were reported in relation to the subcutaneous fat.	Visfatin may regulate glucose homeostasis, promising new treatments for endocrine diseases such as diabetes.	4
Taghian et al	20 obese women	12 weeks of aerobic training	Following 3 month of aerobic training, visfatin levels had no significant changes.	Serum levels of visfatin was not influenced by the body mass index.	39
Lee et al	Fat children (n=10), and children affected by type 2 diabetic mellitus (n=10)	A 12-week training program	Training had a significant effect on lowering plasma levels of visfatin and insulin resistance.	Visfatin may act by increasing glycaemic control, lowering body weight, and reducing cardiovascular risk.	10
Haus et al	16 fat men and women	12 weeks of supervised training program	It was reported that aerobic training lowers the level of plasma visfatin and improves glucose tolerance.	The possible modulatory role of visfatin in regulating the pancreatic insulin and glucose metabolism was confirmed.	15
Frydelund-Larsen et al	Healthy young men	Ergometer cycle training at 60% of V _{O2 max} or rest	Visfatin expression showed a three-fold increase after aerobic training.	The finding that training augments subcutaneous adipose tissue, and visfatin transcript expression indicates a possible metabolic role for visfatin in the recovery stages after training.	45
Jürimäe et al	9 national level male rowers	Prolonged rowing exercise session (approximately 2 h, distance = 20.7) present by a 30 min rest	The level of plasma visfatin in the elite was lower in 30 min after aerobic training, as compared to the control group.	Role of an energy-deficit threshold in regulating visfatin was proved.	46
Fenkci et al	60 fat women with severe nutritional deficiencies	Resistance training and aerobic training	Regular endurance training for 12 weeks increased insulin level.	This study indicated that aerobic and resistance exercises induce/ increase the body fat composition and have a favorable metabolic effect on fat women with severe nutritional deficiencies.	49

Table 3. Studies Conducted on the Role of Resistance -Aerobic Training on Visfatin Level (Resistance-Aerobic) and Visfatin

Authors	Patients	Intervention	Outcome	Conclusions	Ref.
Dastgerdi et al	38 overweight women	Aerobic Exercise: 50 min/d, 80%-85% of heart rate reserve for 4 days a week - resistance training: 60%-70% of one repetition maximum 50 min a day, 4 days a weeks	Plasma visfatin level and insulin resistance significantly decreased in the training group compared with the control group.	Visfatin is reduced by resistance training, probably due to the weight loss and changes in body composition in obese women.	53
Askari et al	30 obese women	Combined training (strength- endurance)	12 weeks of combined exercise in overweigh subjects decreased vaspin, visfatin and growth hormone.	Visfatin is associated with improved lipid metabolism.	54
Domieh et al	28 healthy men	Strength training for 8 weeks with 65% to 80% of one repetition maximum, 3 times a week. The resistance training for 8 weeks at 65% to 80% of maximum heart rate for 20 to 34 min, three times a week	Visfatin level declined in aerobic exercise group.	8 weeks of strength and strength training decreased plasma visfatin concentration by reducing fat mass in middle-aged men.	55
Saghebjojo et al	38 overweight female volunteers	Aerobic exercise (50 min/d, 80%-85% heart rate reserve, 4 days a week), resistance exercise (50 min/d, 60%-70% of one repetition maximum, 4 days a week)	Visfatin level in the training group that did resistance exercise decreased significantly compared with aerobic training group.	Reduction of plasma visfatin is made by resistance training, probably due to weight loss and changes in body composition in overweight women.	56

in the levels of serum visfatin and adiponectin.⁴⁷ Different results have been obtained in studies evaluating the effect of exercise on acute changes in serum visfatin level.^{46,48} Unlike aerobic exercises with moderate intensity resistance training, anaerobic stimulus produces different effects on the neural response, metabolism, and neuroendocrine. The difference in resistance training

program may be due to different metabolic processes and hormonal changes particularly related to work performed during resistance training programs. For example, the use of excessive force at relatively low power protocol enables lower activity of anaerobic metabolism and less hormone production.⁴⁹ In contrast, power-endurance protocol with less force applied induces larger system anaerobic

metabolism and hormonal responses.⁵⁰

Findings on the Effect of Compound Exercises (Resistance-Aerobic) on Serum Visfatin Level

Physical activity is the most important factor in human energy consumption, since energy intake can positively or negatively regulate the gene expression of visfatin. The level of visfatin in physical activity may be an important determinant in energy balance.⁵¹ Role of exercise in regulation of the secretion of visfatin has been proposed. Physical activity changes hormonal levels, circulation patterns, and consumption of body fat that can subsequently affect visfatin concentration. Multiple studies have confirmed the effects of exercise on reducing visfatin concentration. Some studies have also indicated opposite results. Research conducted in association with long-term impact of exercise demonstrate a more uniform positive effect of the exercise on visfatin level (Table 3).⁵² Dastgerdi⁵³ took into account the impacts of either aerobic or strength exercise on visfatin levels and plasma lipids in obese women. They randomly divided the participants into 3 groups of aerobic exercise (50 min/d, 80%-85% heart rate reserve, 4 days a week), strength exercise (50 min/d, 60%-70% of one repetition maximum, 4 days a week), and control. The findings indicated that plasma visfatin and insulin resistance decreased significantly in both the strength experimental groups compared to the aerobic and control groups. Thus, the reduction of plasma visfatin, made by resistance training, probably is due to the losing weight and alternation of body composition in the participants. Askari et al⁵⁴ studied the effect of exercise on some adiponectin and indicators' insulin sensitivity in inactive overweight individuals. The experiment was carried out for 12 weeks, 4 days a week, 2 sessions of endurance training with maximum intensity and maximum heart rate of 60%-80%, one-repetition maximum (1RM) intensity of 60-80%, and maximum of 7 stations (3 sets, 8-12 repetitions).⁵⁴ It was found that 12 weeks of combined training for overweight participants decreased vaspin and visfatin adiponectin.⁵⁴ Domieh et al⁵⁵ assessed the effect of 8 weeks of resistance and aerobic exercises on visfatin level in men. The results showed a larger decrease of visfatin level in aerobic group.⁵⁵ Ghanbari et al³⁴ studied the role of resistance training and aerobic exercise in obese women. The visfatin level in the group with resistance training and aerobic exercise group decreased significantly.⁵⁶

Conclusion

Reduction in the concentration of visfatin through the exercise is associated with changes in energy balance, improving insulin sensitivity, as well as alternations in hormonal, carbohydrate, and fat metabolism. Results of the effect of aerobic exercise on visfatin concentration reflect significant changes. Interestingly, in this type of training, lipid parameters (Triglyceride, high-density lipoprotein) are improved and it seems that the effect on body composition reduces the central fat percentage

and body fat index. The effects of training exercise programs on the visfatin level were assessed in visfatin obese individuals versus lean individuals, and men versus women at different ages. The present review indicated that a balanced diet, low in fat along with physical exercises (aerobic exercise and practice combined (aerobic-resistance)) with variable severity and duration can influence blood visfatin levels.

Ethical approval

Not applicable.

Competing interests

Authors declare that they have no conflict of interests.

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