

INVESTIGATION OF INSULIN MECHANISM AND EXERCISE CORRELATION

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1. Introduction

In sports studies, the human organism is faced with loads above the daily working level. There are systems that provide the coordination and order of more than one activity in the human organism. These systems appear as 1. Nervous system 2. Endocrine system (Dündar, 1995; Karbek, 1990; Tortora, 1983; Tuncel, 1994)

While the nervous system in the organism responds quickly to balancing in the cellular dimension, the endocrine system has a slower and longer balancing effect compared to the nervous system. The endocrine system is held primarily responsible for more than one physiological response and adaptation to exercise due to the regulation of functions within the cell (Brooks, Fahey, White, Baldwin, 2000). Different stress situations such as heavy training and exercise work affect the release of hormones, causing the levels of some hormones to increase or decrease in resting states. The effects of sportive studies on the release of hormones in the organism are among the important subjects researched by sport physiologists and sport physicians today (Güneş, 1995; Heipertz, 1985).

Hormones released in the organism are chemical substances that are released into body fluids by endocrine organs and are effective in target organs. The release of hormones from the endocrine glands is regulated by feedback mechanisms. In other words, when the amount of hormones secreted decreases, the release of the hormone increases, and when it increases, there is a decrease in the release (Fox, 1984).

Each hormone differs in terms of its effects and mechanisms of action, and its effects on the target cell occur through different mechanisms.

Mechanisms of action of hormones in the body;

- Activates the enzyme systems in the organism.
- Increases cell membrane permeability inside the cell.
- It allows the muscles in the body to contract or relax.
- They trigger protein synthesis in the body.
- It provides the initiation or regulation of secretory functions in cells (Powers et al. 1992).

Information about hormonal responses during exercises is very limited in the scientific world and depends on the density variability of known hormones in blood and urine in the human body. Various stress situations affect the release of hormones and while increasing the release of some hormones, they decrease the release of some hormones. However, examining the hormonal responses given during exercise by looking at the concentration of hormones in the blood, urine and tissues causes misleading results for the scientific world (Guzel, 2007). This

is due to the fact that the hormone density released in the body is affected by more than one factor.

Factors affecting the hormone density that may occur in the organism;

- Hormone production of the endocrine mechanism.
- Destruction of released hormones by enzymes in kidney, liver and different tissues.
- The amount of hormone that the tissue in the body can absorb from the blood.
- Blood volume difference in the body (Powers et al. 1992).

Nowadays, it is also important how long the hormonal effect lasts in the body, rather than the increased blood density of hormones during exercise.

While some hormones show their effect and break down in a very short time, the other part can continue its effect for hours or days. Although it is known that the increase in hormone density is caused by the production of endocrine system organs, increased hormones may not cause an increase in target tissues at the desired level.

2. Pancreatic Hormones

The pancreas is an exocrine gland that secretes enzymes into the digestive tract, and endocrine secretions are the hormones it secretes. These secreted hormones are synthesized, stored and secreted by pancreatic islets in the endocrine part of the pancreas.

Hormones synthesized from pancreatic islets are glucagon, insulin, somatostatin and pancreatic polypeptides (Braun, Horton, 2001). Of these secreted hormones, the insulin molecule consists of two amino acid chains, while glucagon consists of a single amino acid chain (Freedson, Katch, Sady, Weltman, 1979). The main task of these two hormones in the organism is to keep the blood glucose level under control (Devries, 1986; Güneş, 1995).

3. Glucagon Hormone

This hormone is perceived by the alpha cells in the islets of Langerhans and is a hyperglycemic hormone that increases the blood glucose level by stimulating the breakdown of stored glycogen in the liver into glucose (glycogenolysis), triggering the release of fatty acids and glycerol from adipose tissues and promoting the use of fat for energy (Braun, Horton, 2001; Devries, 1986; Dündar, 1995). On the other hand, glucagon hormone increases the formation of glucose from amino acids in the body (Noyan, 1993). While this hormone in the body increases with aerobic exercise, it decreases with anaerobic exercise (Gökbel and Dölek, 1998). Glucagon hormone has the effect of increasing the glucose level in the body.

During the exercises, the blood glucose level falling with the help of this hormone is balanced by increasing the release of glucose from the liver (Güneş, 1995). It is reported that the glucagon level increases with long-term exercises (Devries, 1986).

4. Insulin Hormone

The main function of the insulin hormone in the body is to reduce the glucose level in the blood by increasing the glucose entry into the tissues (Dündar, 1995; Karbek, 1990; Tuncel, 1994;

Ganong, 1995). On the other hand, it provides storage by stimulating the conversion of glucose into glycogen (glycogenesis) in the body. The hormone insulin is usually broken down in the liver, to a lesser extent, in the kidney (Guyton and Hall, 1996).

It is necessary to increase the plasma glucose level for its physiological regulation (Murray, Granner, Mayes, Radwell, 1996). Approximately 50% of insulin is supplied from the circulatory system during one pass through the liver (Kurtul, Çıl, Paçacı, 2005). A certain amount of energy is required for insulin secretion in the body.

Since glucose and free fatty acids are necessary for energy in the body, insulin concentrations decrease proportionally depending on the intensity of exercise during exercise, and glucagon concentrations increase (Guyton and Hall, 1996). During exercise, falling insulin and rising glucagon concentrations keep blood glucose constant.

During exercise, low insulin concentrations increase glucose secretion from the liver and fatty acid secretion from adipose tissue (Karbek, 1990; Devries, 1986; Guyton and Hall, 1996). Insulin hormone has an anabolic effect and provides cell growth by converting amino acids into proteins in the body (Devries, 1986; Noyan, 1993).

In addition, there is a decrease in the insulin response to a similar workload with regular long-term exercise programs, that is, the decrease in insulin during exercise. With long-term regular exercise, it increases the sensitivity of insulin receptors and achieves this effect by using lower insulin for the same effect (Guyton and Hall, 1996).

One of the most well-known effects of regular physical activities is the regulation of blood glucose. Because physical activity is a stressor that consumes glucose, which is of great importance for the cells in the body. Regular physical activity of appropriate duration and intensity reduces insulin resistance and contributes to the increase of GLUT4, known as the “muscle glucose carrier protein”, thereby increasing the glucose uptake of the muscles (Kasımay and Metin, 2009). Within 24-72 hours after physical activity, a decrease in blood glucose level and an increase in insulin secretion occur (O'gorman, Karlsson, Mcquaid, 2006; Galbo, Tobin, Van Loon, 2007). There are studies stating that the decrease in blood glucose level is related to the duration of the intensity of the exercise and that the same effects can continue for 5-7 days after the exercises (Horton, 2006; Can and Ersöz, 2003).

It has been reported in a study that there is an increase in the glucagon hormone and a decrease in the insulin hormone during long-lasting and endurance-requiring exercises (Noyan, 1993). However, on the contrary, it has been reported that there is no decrease in insulin hormone in short-term and intense exercises (Tiryaki, 1992). The increase in glucose use during exercise is directly proportional to the intensity and duration of the exercise, and accordingly, the glucose and insulin levels in the blood decrease. The decrease in blood glucose level that occurs during exercise is balanced by the increase in glucose secretion from the liver by the glucagon hormone (Güneş, 1995).

There are studies reporting an increase in glucagon levels and a decrease in insulin levels with long-term exercises (Devries, 1986). In a study, it was reported that moderate and high-intensity aerobic exercises increase insulin sensitivity and facilitate weight loss (Can and Ersöz, 2003). However, it has been reported that the changes in insulin sensitivity caused by a one-time acute exercise disappear within a few days, it has no effect on glucose regulation, and therefore, the

exercises performed to reduce insulin resistance should be regular and long-term (Koz and Ersöz, 2002). There are studies showing that fasting blood glucose can decrease within 24 hours after exercise depending on the intensity of exercise, while combined exercises provide a significant improvement in blood glucose compared to other exercises (Black, Swan and Alvar, 2010).

In a study examining the effects of aerobic exercise on leptin and insulin hormones, it is reported that aerobic exercise reduces the insulin levels of athletes (Karacabey, Yamaner, Saygin, Özmerdivenli, 2014). It has been reported in studies that endurance exercises also reduce the level of insulin hormone (Zeinali, Nodoushan, Firouzian et al. 2012). It has been reported that intense aerobic exercise performed on athletes also lowers the insulin hormone (Moghadas, Nuri, Ahmadi, 2013). It is stated that cycling exercise applied on healthy individuals also reduces insulin levels (Khoo, Wallis, Tsintzas et al. 2010).

In a study examining insulin and blood glucose values after aerobic and anaerobic exercise on nine male football players, it was found that insulin levels decreased again (Aydın, Gökdemir, Cicioğlu, 2000). Insulin levels decreased with aerobic exercise performed in individuals who lead an active life in a sporting sense (Grieco, Swain et al. 2013). After prolonged cycling exercise, there was a decrease in the level of insulin in the blood (Zoladz, Duda et al. 2002). It is a fact that has been demonstrated by studies that physical activity reduces insulin levels and increases insulin sensitivity (Bulut, Bodur, Colak, Turnagöl, 2013).

5. Insulin Resistance

Insulin resistance is called insulin resistance when more insulin is released than normal to create a quantitatively normal response (Berson & And, 1970). Insulin resistance is a condition associated with decreased response to insulin in insulin-sensitive tissues, uncontrolled insulin production in pancreatic beta cells, and decreased glucose uptake in target tissues (Ulukaya et al. 2007). Insulin resistance, which basically occurs in individuals, causes the destruction of beta cells and the presence of more insulin than normal in the blood, as well as laying the groundwork for Type-2 diabetes. Studies have reported that there is an increase in proinflammatory cytokines and a decrease in anti-inflammatory cytokines due to the increase in adipose tissue in obese individuals (Bray, et al., 2017). Insulin resistance, the incidence of which has increased in recent years, poses a risk for many diseases such as obesity (WHO, 2000).

Unhealthy diet emerging today, a sedentary lifestyle, aging, drugs used, pregnancy, genetic factors reveal obesity and insulin resistance. As a result of this situation, conditions such as diabetes, hypertension, dyslipidemia, and vascular occlusion occur. It is possible to get rid of many metabolic diseases by making changes in our lives. With proper nutrition and an active lifestyle, it is possible to get rid of these diseases that will occur by getting rid of excess weight and protecting or increasing muscle mass (Ivy, 1997; Cuff, et al., 2003). Physical activity increases insulin sensitivity in the muscles and provides an increase in glucose entry into the muscle independently of insulin (Dela, et al. 1993). An active life contributes significantly to the prevention or reduction of insulin resistance and positively affects insulin sensitivity (Thorell, et al. 1999; Henriksen, 2002).

Obese individuals have higher circulating free fatty acids than normal individuals. Therefore, the possibility of insulin resistance is higher in obese individuals (Savage et al. 2007). In many studies, it has been revealed that the presence of high amounts of fatty acids in the circulatory system causes insulin resistance (Boden, 1997; Kelley et al. 1993). The accumulation of fatty acids in obese individuals causes insulin resistance (Perseghin et al. 1999; Krssak et al. 1999).

Diabetes occurs when insulin is deficient or insufficient. It occurs in conditions such as carbohydrate, protein and fat metabolism disorders in diabetes. It is one of the most common chronic diseases in society. In addition to genetic factors, environmental factors are also effective in the increase of this disorder (Mcardle et al. 2000). The underlying cause of insulin abnormalities in diabetes is the insufficient effects of insulin on target tissues. Diabetes can cause more than one serious problem, not only on the health of individuals (Erbaş, 2015).

With the increase in population, urbanization and the increase in obesity, the number of diabetic patients is increasing day by day. In addition to many factors that cause diabetes, environmental factors, genetic factors and sedentary life also play an important role in this disease (WHO, 1999). It is the 9th biggest cause of death among the diseases found in the world. If precautions are not taken, it is estimated that more than 5 million people will have this disease by 2025 (Kuzuya et al. 2002).

Types of diabetes; It appears as Type 1 diabetes, Type 2 diabetes and gestational diabetes (Doğan, 2008). Type 1 diabetes is characterized by a decrease in insulin after the destruction of existing cells in the pancreas. On the other hand, type-1 diabetes may arise from the immune system as well as idiopathic (Feyizoğlu, 2015). Type-2 occurs when insulin resistance and insufficiency coexist. This type of diabetes usually does not have an age range, but the diagnosis of this disease is made after the age of 30. Although it is more likely to be seen in overweight or obese individuals, it can also be seen in individuals who do not have weight problems. The common symptoms of people with type 2 diabetes are an increase in appetite, a desire to go to the toilet frequently, and a constant feeling of thirst. People with these symptoms are taken under diabetes follow-up (Vandenoeveria, 2010).

Physical activity causes different metabolic and hormonal changes in the body of the person. For this reason, before applying physical activity programs for diabetic patients, necessary examinations should be made and exercise programs should be applied after that by minimizing possible problems (Loveman et al. 2008; Nagi & Gallen, 2010). Moderate-intensity aerobic exercises are recommended for patients with diabetes, not less than 150 minutes per week. For patients without complications, higher intensity exercise programs can be recommended. Thanks to regular exercises, it is possible to prevent or delay the symptoms and complications of the disease in diabetes patients (Pilkis & Claus, 1991). Individual exercise programs should be recommended or implemented in diabetes patients, not general ones (Loveman, 2008; Nagi & Gallen 2010). With the help of the exercises to be performed, it is possible to provide glycemic control as well as fat loss in the abdominal region (Loveman, 2008). There are different purposes and benefits of performing exercises in diabetic patients. The aims of the exercise; It is to reduce the insulin demand in the body, to increase the glucose uptake to the muscle tissues and to reduce the plasma blood glucose concentration by carrying the necessary glucose to the muscle fibers.

Its benefits are to reduce the high blood pressure that may occur, to provide hormonal balance in the body, to increase performance by increasing muscle strength, to increase joint mobility and to improve quality of life by increasing personal self-confidence (Artal, 1990).

Exercises are used as a treatment method in patients with Type-2 diabetes because they reduce the level of glucose in the blood. The first effect of physical activities on the body is on abnormal insulin secretion and peripheral insulin resistance. These patients have a lower functional capacity than their normal peers, but an increase in oxygenation in peripheral tissues is observed during exercise (Polat, 2016). After low and moderate-intensity physical activity, a decrease in blood glucose level occurs in patients with Type-2 diabetes and obesity. It is observed that this effect continues after physical activity (Kjaer et al. 1990).

In regular exercises in patients with type-2 diabetes; It has been determined that there are positive physiological effects on resting or submaximal heart rate and on blood pressure during exercise (Koivisto, DeFronzo, 1984). There are also studies on insulin-dependent glucose uptake, improvement in skeletal muscle and adipose tissue within 72 hours of physical activity in these patients, but this positive effect is restored within a certain period of time. For this reason, it is stated that the exercise programs applied for the treatment of patients with Type-2 diabetes require continuity (Blair, et al. 1989).

Many studies conducted today focus on the effects of physical activity on insulin sensitivity and glycemic control (Koivisto et al. 1986; Blair, Cheng & Holder, 2001). Recently, more than one drug has been produced against diseases such as diabetes, circulatory system disorders and obesity, but physical activity, nutrition and regular living habits continue to be the most effective method used in the treatment of these diseases (Chakravarthy et al. 2002).

Regular exercise to improve endurance not only increases physical performance, but also helps reduce the risk of chronic diseases in individuals. Studies have shown that the increase in muscle oxidative and glucose transport potential, which occurs with exercise, reduces the risks that may occur in patients with insulin resistance and Type-2 diabetes (BMJ, 2020).

Women who do not have diabetes and who do vigorous exercise at least once a week have been followed for 8 years and it has been determined that the risk of developing diabetes is 33% less (Manson et al. 1991).

Again, in a subject group followed for 8 years, it was determined that the most active group had 26% less diabetes than the sedentary group (Hu et al. 1999). Studies have shown that regular physical activity reduces the rate of developing diabetes by 30% (Jensen and Leighton, 2000). In a study conducted on people diagnosed with type-2 diabetes, a significant decrease was found in insulin resistance after 6-8 weeks in the exercise group, which was provided with at least 1000 steps per day (Yamanouchi et al. 1995).

The results of various studies in which aerobic studies were applied were evaluated and it was determined that there was a significant decrease in HbA1c values in the groups that exercised (Boulé et al. 2001). In addition to the decrease in the HbA1c values of the exercise group, there is also a decrease in LDL cholesterol levels (Kelley and Kelley, 2007). There are studies investigating the effect of the intensity of exercise in addition to the form of exercise in patients with diabetes. It has been reported that there is a greater difference in insulin resistance in HbA1c values in individuals who spend the same total calories but perform higher-intensity

exercise (Coker et al. 2006; O'donovan et al. 2005). Until recently, the effects of resistance exercises on chronic diseases were not included in the studies. However, recent studies have revealed that resistance exercises also affect insulin tissues and can be used to prevent the risk of diabetes formation and to treat the disease (O'hagan et al. 2013). It was found that there was a decrease in HbA1c values in individuals who underwent 12 weeks of moderate-intensity resistance exercise (Eriksson et al. 1997). It was revealed that resistance exercises performed in the randomized control group caused an increase in muscle mass, a decrease in body fat and HbA1c values (Baldi and Snowling, 2003; Castaneda et al. 2002).

In the exercise programs in which aerobic and resistance exercises are applied in combination, a significant change was found in HbA1c values compared to aerobic exercise, resistance exercise and individuals who do not exercise (Sigal, 2007).

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