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METABOLİK SENDROM

ÖZET. Dünyada sıkça görülen sağlık problemlerinden biri olan metabolik sendrom önemli bir mortalite ve morbidite nedenidir. Metabolik sendrom obezite ve insülin direnci, tip2 diyabetes mellitus, hipertriglisemi, hiperglisemi, hipertansiyon, dislipidemi, non-alkolik yağlı karaciğer hastalığı, HDL düşüklüğü, inflamasyon, adiposit türevli aldosteron salgılayıcı faktörler, stres, uyku apnesi vb. klinik belirtilerinin bir arada gelişmesiyle ortaya çıkmaktadır. Hayvanlarda benzer tanı kriterleri gözlemlenmiş ve metabolik sendrom tanımlanmıştır. Son yıllarda, insan hekimliğinde olduğu gibi veteriner hekimliğinde de metabolik sendroma, nedenlerine ve sonuçlarına ilgi artmıştır. Hastalığın oluşmasında sanayinin ve teknolojinin gelişmesiyle birlikte kentleşme, hareketsiz yaşam, hızlı ve kalorisi yüksek gıda tüketimi, sigara ve alkol kullanımı gibi pek çok çevresel etmenlerin yanında, kalıtımsal nedenler de rol oynamaktadır. Hayvanlarda buna ek olarak cins, kısırlaştırma, sahibiyle olan ilişkisi, rasyon içeriği, günümüz koşullarına asimile olarak avcı, yakalayıcı vb. özelliklerini yitirmesi gibi pek çok durum gösterilmektedir. Metabolik sendrom için Dünya Sağlık Örgütü (WHO), Uluslararası Diyabet Federasyonu (IDF), Ulusal Kolesterol Eğitim Programı (NCEP) ATPIII, Türkiye Endokrinoloji ve Metabolizma Derneği gibi çok sayıda uluslararası geçerliliği olan kurumlar tanımlamalarda bulunmuştur. Bu derlemede amaç insan ve hayvan yaşamı üzerinde kritik etkisi olan metabolik sendromu genel hatlarıyla anlatmak ve önemini vurgulamaktır.

Anahtar Kelimeler: Klinik bulgular, metabolik sendrom, prevalans, tedavi yaklaşımları.

METABOLIC SYNDROME

ABSTRACT. Metabolic syndrome is a common health problem, is an important cause of mortality and morbidity. Metabolic syndrome is a type of disorder that occurs as a result of the coexistence of insulin resistance and obesity-like findings, hipertriglisemi, hypertension, Type 2 diabetes mellitus, dyslipidemia and non-alcoholic fatty liver disease, stress, low HDL, hyperglycemia, inflammation, adipocyte-derived aldosterone-releasing factors, sleep apnea, etc. The same criteria and symptoms are valid for the disease in animals, and similar definitions are made for animals. In recent years, interest in metabolic syndrome, its causes and consequences has increased in veterinary medicine as well as in human medicine. In the formation of the disease, with the development of industry and technology, besides genetic factors urbanization, sedentary life, fast and high-calorie food consumption and many environmental factors such as smoking and alcohol use play role. In addition to this, many situations are shown in animals such as breed, neutralism, relationship with the owner, ration content, loss of hunter, catcher, etc. characteristics by assimilating to today's conditions. Many internationally recognized institutions such as the National Cholesterol Education Program (NCEP) ATPIII, the International Diabetes Federation (IDF), the World Health Organization (WHO), the Turkish Society of Endocrinology and Metabolism have made definitions for metabolic syndrome. In this article, metabolic syndrome, which has a significant impact on human and animal life, is examined in general terms.

Keywords: Clinical findings, metabolic syndrome, prevalence, treatment approaches.

INTRODUCTION

Metabolic syndrome (MetS) emerges as a term that reflects the instability between energy intake and spending, sedentary lifestyle and resulting excessive adiposity, which increase the risk of developing diabetes and cardiovascular diseases (Turkish Society of Endocrinology, 2018). Metabolic syndrome in animals differs from humans in many ways. The most important pathological factor in metabolic syndrome is cardiovascular system disease in humans, laminitis and fatty liver in cattle (Daradics et al., 2021). Many factors are involved in the etiology of MetS. Genetics, smoking and alcohol use, lifestyle, psychological reasons, living environment, eating habits, etc. factors cause the formation and development of MetS. In 1998, Reaven used the phrase "Syndrome X" to describe the symptoms that trigger cardiovascular diseases (CVD), such as insulin resistance, type 2 diabetes mellitus (T2DM), hypertension, low HDL (Akyol, 2006). In the following years, explanations were made indicating the grouping of cardiovascular and metabolic risk factors such as "plurimetabolic syndrome", "visceral fat syndrome", "insulin resistance syndrome", "fatal quadruple". (Cornier et al., 2008). Since the clinical signs of metabolic syndrome in animals are different from those in humans, a clear explanation cannot be made. However, equine "Equine Metabolic Syndrome" (EMS) was first described and put forward by Johnson in 2002 as a coexistence of obesity, insulin resistance and laminitis (Johnson, 2002).

DEFINITIONS MADE FOR METABOLIC SYNDROME

It is understood from the definition made by the World Health Organization in 1998 that the organism has metabolic syndrome if at least two of the criteria of abdominal obesity, dyslipidemia, hypertension and microalbuminuria are present together with insulin resistance (Saklayen, 2018). National Cholesterol Education Program ATPIII 2001 (NCEP-ATP III) advocated having three or more of the risk factors which are hyperglycemia, abdominal obesity, hypertension, hypertriglyceridemia, low HDL for the diagnosis of MetS. In 2005, the International Diabetes Federation (IDF) evaluated the NCEP-ATPIII criteria and suggested that changes should be made. The IDF has mandated abdominal obesity for diagnosis. In 2009, the Turkish Society of Endocrinology and Metabolism MetS Working Group published the "Metabolic Syndrome Guide" and reported that insulin resistance should be among the diagnostic criteria (Akan, 2012).

Prevalence of Metabolic Syndrome

The prevalence of MetS varies by country and ethnicity. This is due to the fact that the lifestyle, socio-economic status and genetic factors among people are different. Physical activity, age, post-menopausal status, body mass index, carbohydrates, smoking, saturated fats, alcohol use, education, etc. factors increase or decrease the likelihood of MetS. According to the ATP III distinctive features, the prevalence of MetS was found to be 31.3-45.0% in women and 21.7-32.2% in men. According to these data, women are more likely to have metabolic syndrome. In addition, As can be understood from the research, the likelihood of metabolic syndrome increases with increasing age. The occurrence of MetS is highest in the 61-65 age group, but it has been determined that it tends to decrease after the age of 70 (Gündoğan et al., 2013). In their study, Elitok and colleagues found that the frequency of MetS is 7 times higher in obese children compared to the general population. The frequency of metabolic syndrome was found to be 0.85% in all children and 6% in obese children (Elitok et al., 2019).

DIAGNOSTIC CRITERIA OF METABOLIC SYNDROME

Obesity and Insulin Resistance

Body mass index (BMI); It is calculated by dividing the weight by the square of the height. Here, weight is taken in kilograms and height in meters. In humans, a BMI value of 25 and above is considered fat, and 30 and above are considered obese (Guyton et al., 2007). There is still no universally accepted definition of obesity in cats and dogs. There are many different body condition scoring systems to determine the adiposite in cats and dogs. In veterinary medicine, it is necessary to determine a universal system in order to better interpret scientific research, evaluate the body condition more objectively and more accurately, and communicate more clearly with patient owners and veterinarians. For this purpose, the "Body Condition Score" scoring on an integer scale from one to nine (1-9) recommended by the WSAVA Global Nutrition Panel is accepted as a fast, simple and most convenient system. The concept of obesity in animals is defined as 30% more

than the ideal body weight (Ward et al., 2019). Obesity is expressed as less energy consumed than energy intake, resulting in less fat burning and more fat accumulation than normal in the body. Obesity; is a multifaceted disease that depends on factors such as nutritional, endocrine, socioeconomic, neurological, psychological factors, gender, physical activity, metabolic age and speed, etc. The amount of fat in the body is important in the formation of obesity risk, but more important is the amount of abdominal fat (Guyton et al., 2007). As in humans, obesity-related diseases, obesity and metabolic abnormalities are frequently seen in animals (Okada et al., 2017). As a result of scientific researches, it is thought that more than 85% of people and 70-80% of horses and cows will be affected by obesity by 2030 (Daradics et al., 2021). There are studies suggesting that up to 59% of cats and dogs are overweight (Ward et al., 2019). Fat distribution in the bodies of living things is very important for the side effects of obesity. If the localization of the amount of fat is excessive in the pelvic region, the term gynecoid (pear type obesity, female type) is used, and if it is excessive in the abdominal region, the term android (male type, apple type, central type obesity) is used (Blouin et al., 2008). If the fat is localized in the pelvic region, it is considered metabolically extremely inactive, and in the abdominal region it is considered metabolically quite active. Therefore, the risky one of weight gain and related obesity is abdominal obesity (Akan, 2012).

Insulin resistance is considered the most important clinical symptom or diagnostic criterion in MetS pathophysiology. Most of the researchers put insulin resistance at the forefront instead of obesity, which is extremely essential among the MetS diagnostic criteria, and state that insulin resistance directly affects other diagnostic criteria (Akan, 2012). The term ”insulin resistance” is defined as the inability of insulin to show its effects on protein, fat, carbohydrate intake, metabolism or storage, despite its presence in circulation. Almost all obese animals have insulin resistance. However, each animal has a different effect on it. While diabetes develops as a result of insulin resistance in cats, it rarely results in diabetes in dogs and horses. Insulin resistance does not affect fat metabolism in cattle, and glucose concentrations remain in the reference range due to milk production (Tumpa and Baric, 2019). Insulin resistance in horses is one of the most important diagnostic criteria for EMS. Insulin resistance usually results in hyperinsulinemia. Studies show that insulin resistance and resulting hyperinsulinemia induce laminitis (Johnson et al., 2012). In short, it is a biological unresponsiveness to endogenous or exogenous insulin. Insulin resistance in obesity can be determined by impaired or suppressed insulin-stimulated glucose transport, metabolism, and hepatic glucose output in adipocytes, skeletal muscle, and cardiac muscle.

Type 2 Diabetes Mellitus

4 clinical types are found in Diabetes Mellitus (DM). It can be counted as Type I DM, Type II DM, Pregnancy DM (Gestational) and other specific types of diabetes (due to another disease, due to that disease) (Diabetes Diagnosis and Treatment Guide, 2019). The classification of diabetes in humans is very similar to the classification of diabetes in cats and dogs. Although there are differences in etiopathogenic mechanisms, the information obtained from the human mechanism has an important place in the determination of the disease by using it in cats and dogs. In dogs, DM is similar to type 1 diabetes, whereas in most cats, DM is similar to type 2 diabetes (Nelson and Reusch, 2014). Type 2 diabetes mellitus (T2DM) occurs as a metabolic defect caused by insulin resistance or insulin secretion above normal in the determined tissues. Although T2DM is related to many reasons such as obesity, sleep, stress, nutrition and sedentary life in animals and humans, hereditary factors are also an important cause. Although T2DM is associated with many causes such as obesity, sleep disorder, stress, irregular diet and the adoption of a sedentary lifestyle, hereditary factors are also an important cause. In the genes that code T2dm insulin receptor, mitochondrial components, glycogen synthetase, glucokinase, etc. it has been determined that the formation of various mutations and that the genetic transition is polygenic have been determined (Şenol, 2009).

Hypertriglyceridemia

Hypertriglyceridemia refers to an increase in serum triglyceride (TG) concentration, which causes the serum or plasma to appear milky. This condition, which is not common in cats, is quite common in dogs. Hypertriglyceridemia is grouped as primary or secondary, depending on its source. While genetic or familial

disorders of lipid metabolism are shown as primary causes, other factors such as protein-losing nephropathy, hypothyroidism, hyperadrenocorticism, diabetes mellitus, pancreatitis, obesity, cholestasis and hepatic lipidosis are the sources of secondary causes. There are very few reports of primary hypertriglyceridemia in cats, and existing reports are mostly the result of genetic mutations (Miceli et al., 2022). Hypertriglyceridemia is a vital factor in horses, ponies and donkeys. If adequate treatment is not provided, it can lead to hepatic lipidosis and critical conditions such as liver failure. Diagnosis of hypertriglyceridemia is difficult. Because although the onset of the disease is insidious, clinical symptoms are not encountered except for general weakness. Factors such as pregnancy, lactation and colitis in horses increase the risk of occurrence (Waitt and Cebra, 2009). High plasma triglyceride concentrations directly contribute to METS and therefore to an increased risk of CVD, since HDL is accompanied by risk factors that can impair cardiovascular health, such as obesity, T2DM (Yuan et al., 2007).

Hyperglycemia

A normal plasma glucose concentration depends on endogenous glucose uptake, glucose utilization, and glucose transmission in the body (Giugliano et al., 2008). According to NCEP ATP III, fasting blood glucose level should be 100 mg/dl and above in order to be considered as a diagnostic criterion for hyperglycemia. DM appears as a diagnostic criterion used in the diagnosis of the widespread and leading metabolic syndrome observed in cats and dogs after humans. It is rarely observed in horses, cattle, buffalo, pigs and other small animals. As in many cases, humans and animals are very similar in the mechanism of DM, based on this situation, laboratory animals are preferred for DM mechanism research (Niaz et al., 2018). In animals and humans, risk factors such as pregnancy, obesity, genetics, T2DM, hyperlipidemia, hypertension, polycystic ovaries, etc. are involved in the formation of hyperglycemia.

Hypertension

Blood pressure (BP) should be measured using the appropriate type of measuring instrument and to ensure accurate measurement under the conditions in which the patient is being tried. Standards are well established for accurate measurement of BP measuring devices in humans, but the same cannot be said for cats and dogs. Factors such as measurement method, breed, temperament, anesthesia-wake status, veterinary experience, patient position affect blood pressure results in animals. Therefore, it is not possible to determine specific values and ranges in animals (Acierno et al., 2020). The risk of cardiovascular morbidity and mortality increases as systolic and diastolic blood pressure increases (Aronov, 2012). It is the most common preventable risk factor among the causes of cardiovascular diseases (Ayinapudi et al., 2018). There are medical treatment protocols for hypertension in both animals and humans, but it is necessary to eliminate the underlying secondary causes, make dietary changes, increase movement, and reduce stress (Acierno et al., 2020).

Dyslipidemia

In METS, the table consisting of high triglyceride (TG), low HDL and high LDL, is called dyslipedemia. Limited studies are available for dogs with naturally occurring obesity. Most information has been obtained from empirical studies. Published studies suggest that changes in the lipid profile may occur with increases in cholesterol, triglycerides, and phospholipids in obese dogs, but studies have shown that parameters often do not exceed the upper limit of the reference range (German, 2006). Classical hyperlipidemia in horses is characterized by plasma TG concentration reaching 500 mg/dL and higher. Many predisposing factors such as some pony and mule breeds, obesity, advanced age, gender, lactation period, secondary diseases, pregnancy, metabolic syndrome, pituitary pars intermedia dysfunction have been encountered (Ribeiro et al., 2023). Dyslipidemia may have the potential to increase the risk of CVD, as metabolic syndrome is accompanied by waist circumference adiposity and hypertension risk factors (Onat et al., 2001).

Non-Alcoholic Fatty Liver Disease

It is a liver problem that resembles fatty liver caused by alcohol in terms of histological and pathological findings, but is defined as a liver problem that develops without the use of alcohol. Liver disease is an important health problem not only in the field of human health, but also in the field of veterinary medicine. Obesity and fatty liver disease are frequently observed in cats and dogs (Yang et al., 2018). Fatty acids in the liver participate

in the synthesis of triacylglycerol, lipoprotein and phospholipid and are used for energy generation by the heart and skeletal muscle. In case of fatty acids continue to enter the body, the liver will not be able to use it and accumulation will occur. As well as this accumulation is due to lipoprotein etc it may also be due to a defect in its synthesis or from fat degeneration (Nizamlıoğlu, 1998). Hepatic lipidosis with histological morphologies similar to Human Nonalcoholic Fatty Liver Disease (NAFLD), mostly occurs in old animals not eating for a long time, intense lactation, advanced pregnancy status, high-energy feeding, inadequate care, lack of hygiene, stress, etc. (Yang et al., 2018). Non-Alcoholic Fatty Fatty Diseases (NAFLD) constitute the hepatic manifestations of MetS. It is thought that approximately 60% of ectopic hepatic triglycerides in obese NAFLD patients are caused by free fatty acids released from adipose tissue (Chait et al., 2020).

Low HDL

HDL is a type of lipoprotein synthesized in the small intestine and liver that contains a high concentration of protein, a much lower proportion of cholesterol and phospholipids. HDL shows antioxidant, antiaggregant, anti-inflammatory, fibrinolytic and anticoagulant effects. It performs these effects with the help of various components, enzymes and specific phospholipids (Ata et al., 2007).

Inflammation

MetS and in cases of visceral obesity which is in the front row of MetS' the clinical symptoms, low or high inflammation is mentioned. The cause of inflammation in METS is adipokines, chemokines, cytokines synthesized and secreted from adipose tissue and other factors (Akan, 2012).

CRP (C-reactive protein): Although it is an indicator of inflammation, it is an important factor, especially in the assessment of cardiovascular risk (Akan, 2012). Because CRP is one of the acute phase reactants synthesized from the liver in response to inflammation, and high CRP indicates inflammation in the heart vessels. This elevation means an increased risk of heart attack. In the studies conducted, it has been determined that CRP is high in individuals who have at least three of the MetS diagnostic criteria.

ADIPOCYTE-DERIVED ALDOSTERONE-RELEASING FACTORS

Obesity, especially visceral obesity, plays an important role in the pathophysiology of the metabolic syndrome. Adipose tissue is considered an endocrine organ and secretes adipokines such as tumor necrosis factor (TNF-α), non-esterified fatty acids and interleukin-6 (IL-6). Adipokine imbalance in the metabolic syndrome is the result of both adipose cell expansion and macrophage-associated infiltration. Cytokines such as TNF-α and IL-6, which are produced in excess by the infiltration of macrophages into the adipose tissue, impair the effect of insulin, signal with different structures and cause insulin resistance. Due to the increasing importance of adipokines in health and disease, there is an increasing need to know their biological structures in veterinary medicine. As obesity rates increase in animals, it is expected that the effect of changing adipokine balance on animal health will increase (Radin et al., 2009). Components of the reninagiotensin-aldosterone (RA-aldosterone) system are also in adipose tissue, and their presence not only induces insulin resistance and hypertension, but also triggers aldosterone secretion. Known for a long time to be a hormone that balances electrolytes, fluid volume and homeostasis in the organism, aldosterone has recently been determined to be an important finding of target organ damage. Aldosterone directly affects the brain, heart and kidneys, and an excess of aldosterone leads to proteinuria and chronic kidney disease (Fujita, 2010). Although several studies have documented RA-aldosterone activation in diet-induced obesity in dogs, the effect of RA-aldosterone changes on obesity-related disorders in dogs, cats, and horses has not been fully defined (Radin et al., 2009).

Stres

The number of pets is increasing day by day. However, problems regarding the welfare of pets are increasing. Stress factors such as shipping problems, exposure to new environments, and inappropriate maintenance procedures occur. Stress can cause behavioral problems, illness, and death in animals. On the other hand, stress can lead to undesirable consequences such as deterioration of animal welfare, harming the pet-owner relationship, and abandonment of pets (Fan et al., 2023).

The main factors of stress are locus ceruleus-norepinephrine/autonomic structures (LC/NE), corticotropin-releasing hormone (CRH), and their peripheral effectors, hypothalamic-pituitary-adrenal (HPA) axis and components of the autonomic system (Vgontzas et al., 2000).

These effectors include logic-cognitive, fear-reward, immune, metabolic etc. systems. Glucocorticoids (GC), which are among the steroid hormones that act as the end product of the HPA axis, are found in almost every organ and tissue of the human organism (Nader et al., 2010).

Glucocorticoids stimulate hepatic gluconeogenesis and promote visceral adiposity and metabolic syndrome, inhibits and potentiates insulin status respectively on adipose tissue and skeletal muscle (Ata et al., 2007). Glucocorticoids play is a decisive factor in determining the distribution of body fat. The autocrine production of cortisol from inactive cortisone by 11ßHSD1, which is expressed from adipose tissue, may be a very important factor in the pathogenesis of central obesity (visceral obesity). However, it has been reported that not every fat patient has a high circulating cortisol concentration (Stewart et al., 1999).

Sleep Apnea

It is a symptom that occurs with the closure of the upper airways, especially the hypopharynx, during breathing during sleep. Due to sleep apnea some symptoms such as sleep disorder, right heart failure and hypertension due to recurrent hypoxic events, etc. can occur. The pathophysiology of sleep apnea is unclear, and most of the available treatments for this disease are mechanical. As a result of the studies, it has been observed that TNF-α and IL-6, among the cytokines that cause fatigue or sleepiness, are increased in sleep apnea and obesity, and that these findings are a determining factor in the pathogenesis are found. TNF- α is also strongly associated with lipolysis, and this cytokine causes significant insulin resistance (Vgontzas et al., 2000). Current evidence has shown that the causal relationship between sleep apnea and metabolic syndrome may be due to biochemical markers such as oxidative stress, increased sympathetic activity, insulin resistance, dyslipidemia, and endothelial dysfunction (Barros and Garcia-Rio, 2019).

TREATMENT APPROACHES IN METABOLIC SYNDROME

Although there are genetic factors involved in the formation of MetS, the underlying lifestyle decreasing physical activity due to the advancement of technology, the hustle and bustle of life in crowded cities, etc. lead people to consume easy-to prepare calorie foods . The first thing to do in the treatment of MetS is to eliminate these causes. There are up-to-date and reliable pharmacological agents for the control of each of the clinical manifestations of metabolic syndrome separately. Many drugs are currently used for blood pressure to be brought to the desired level in the the Seventh Report of the National United Committee, to reduce HbA1c in patients with diabetes to the level specified in the American Diabetes Association (ADA) guidelines and o adapt the criteria affecting lipid and lipid profile to NCEP ATP III. But it is not enough to use only these drugs. What is more necessary and difficult than the use of medication is to convince the patient to exercise regularly and follow the appropriate diet (Işıldak et al., 2004).

The basic rule of weight management in cats and dogs is to follow a diet. Exercise and behavior management are important but considered as auxiliary elements. The diet protocol should be arranged according to the patient. If weight loss is done only with energy restriction, it will cause simultaneous protein loss. For this reason, while the diet protocol is supported with protein, it should be prepared with a reduced fat ratio and suitable for the purpose. Increasing physical activity provides support to diet therapy. It supports fat loss and helps to protect lean tissue. Exercises such as walking with lead, hydrotherapy and swimming, walking on a treadmill are considered appropriate for dogs. In cats, weight loss can be achieved by increasing play activities with cat toys (German, 2006). In the diet protocol of ponies or horses with EMS, it is necessary to reduce the non-structural carbohydrate (NSC) content in order to reduce the amount of energy and reduce the glycemic and insulinemic index. In obese horses, the total amount of energy should be reduced and weight loss should be supported by increasing the level of physical activity. Approximately 200 minutes of moderate-intensity exercise per week is desirable. This exercise will provide improvements in insulin sensitivity, structural damage in the lipid profile of the foot, and foot pain (Frank et al., 2010).

CONCLUSION

Metabolic syndrome has become a problem of great importance globally (Saklayen, 2018). In a study conducted by the Metabolic Syndrome Research (METSAR) throughout Turkey in 2007, it was observed that more than a third of the population over the age of 20 participating in the study met the diagnostic criteria that constitute METS defined in ATP III. The participants of the study were randomly selected from seven geographical regions of Turkey. The incidence of MetS has been found to be lower in men than in women (Kozan et al., 2007).

Although the prevalence of EMS diagnostic criteria for animals, especially equines, has been evaluated by some studies, there are few and unclear epidemiological data on this subject (Durham et al., 2019).

MetS, which is defined as a clinical picture with high morbidity and mortality, with different and multiple diagnostic criteria developing due to hereditary and environmental factors, and accepted as one of the ten most risky diseases according to recent studies, appears as a fatal endocrinopathy case that manifests itself with insulin resistance that has been known since 1998 and glucose intolerance or diabetes mellitus, abdominal obesity, dyslipidemia, hypertension and related cardiovascular diseases (Akan, 2012). Internationally accepted definitions that best explain metabolic syndrome have been made by the World Health Organization (WHO), the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), and the International Diabetes Federation (IDF) (Saklayen, 2018).

When treating metabolic syndrome, it is aimed to reduce or eliminate the clinical symptoms that cause the development of cardiovascular diseases. For this purpose, it is necessary to create an awareness of healthy living that includes such criteria as to make exercise a way of life, an adequate and balanced eating habit, regular sleep etc. and to conduct necessary studies and enlightment for its placement in the entire society seem to be the most appropriate solution.

In animals, pathophysiological pathways and diagnostic criteria are observed similar to the occurrence of MS in humans. Insulin resistance, type 2 diabetes mellitus, obesity in cats; Symptoms such as obesity, hyperglycemia and hyperlipidemia are quite common in dogs (Okada et al., 2017). In horses, on the other hand, equine metabolic syndrome, characterized by insulin resistance and laminitis resulting from increased adipose tissue in the dorsal region, occurs (Walsh et al., 2009). As in humans, obesity can cause problems such as reproductive disorders, diabetes mellitus, abnormalities in circulating lipid profile, heart-respiratory diseases, orthopedic diseases, neoplasia, dermatological diseases and urinary tract disorders (Okada et al., 2017).

The goal in the treatment of metabolic syndrome is to reduce or eliminate the clinical manifestations that cause the development of cardiovascular diseases for animals and especially humans, laminitis for horses, and fatty liver disease for cows. For this, increasing physical activity, arranging a diet protocol suitable for the person and the animal, raising the awareness of healthy life in humans and animal owners, including criteria such as sleep patterns and removing stress factors, and doing the necessary information and studies for this seems to be the most appropriate solution.

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