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The Impact of Exercises on Metabolic Diseases

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Abstract:

Exercise has many important positive effects on metabolic diseases. These effects include improving how the body uses insulin. Exercise also helps to regulate how fats are processed in the body. Another benefit of exercise is that it lowers levels of inflammation and reduces oxidative stress. Studies have shown that doing regular exercise can lower the risk of getting type 2 diabetes. It does this by enhancing how mitochondria work in skeletal muscles. It also helps muscles take in more glucose. In addition, exercise helps to lower the amount of fat in the liver. It can also improve the liver's resistance to insulin. This is why exercise plays an important role in preventing and treating non-alcoholic fatty liver disease (NAFLD). Moreover, exercise reduces the risk of obesity and other diseases related to it. It does this by lowering visceral fat and promoting the burning of fatty acids in fat tissue. Exercise is also helpful for protecting how the pancreas works. It can delay the decline of beta cells' function and improve how insulin is secreted. For all these reasons, exercise is a very effective way to prevent and treat metabolic diseases without the need for drugs.

Keywords: Exercise; metabolic disease; treatment.

1. Introduction

With the modern lifestyle changes nowadays, such as being sedentary, staying up late and unhealthy diets, the incidence of metabolic diseases is on the rise every year [1]. Metabolic disease refers to a series of diseases caused by metabolic disorders of the body, mainly including diabetes, obesity, non-alcoholic fatty liver disease (NAFLD) and metabolic syndrome. These diseases are closely related to obesity, insulin resistance, dyslipidemia and hypertension. Metabolic diseases not only have a serious impact on individual health, but also increase the risk of cardiovascular disease, which in turn affects the entire public health system. As shown in Fig.1, there was a steady increase in overall mortality trends from 2000 to 2019, with obesity as the number one absolute burden, followed by HLD, type 2 diabetes, high blood pressure and NAFLD, with obesity also leading the way in deaths. In 2019, experts estimated that there were 43.8 million cases of type 2 diabetes. Additionally, there were around 18.5 million cases of hypertension. For non-alcoholic fatty liver disease (NAFLD), the number of cases was much higher, reaching 1.2 bil-

lion worldwide (Figure 1).

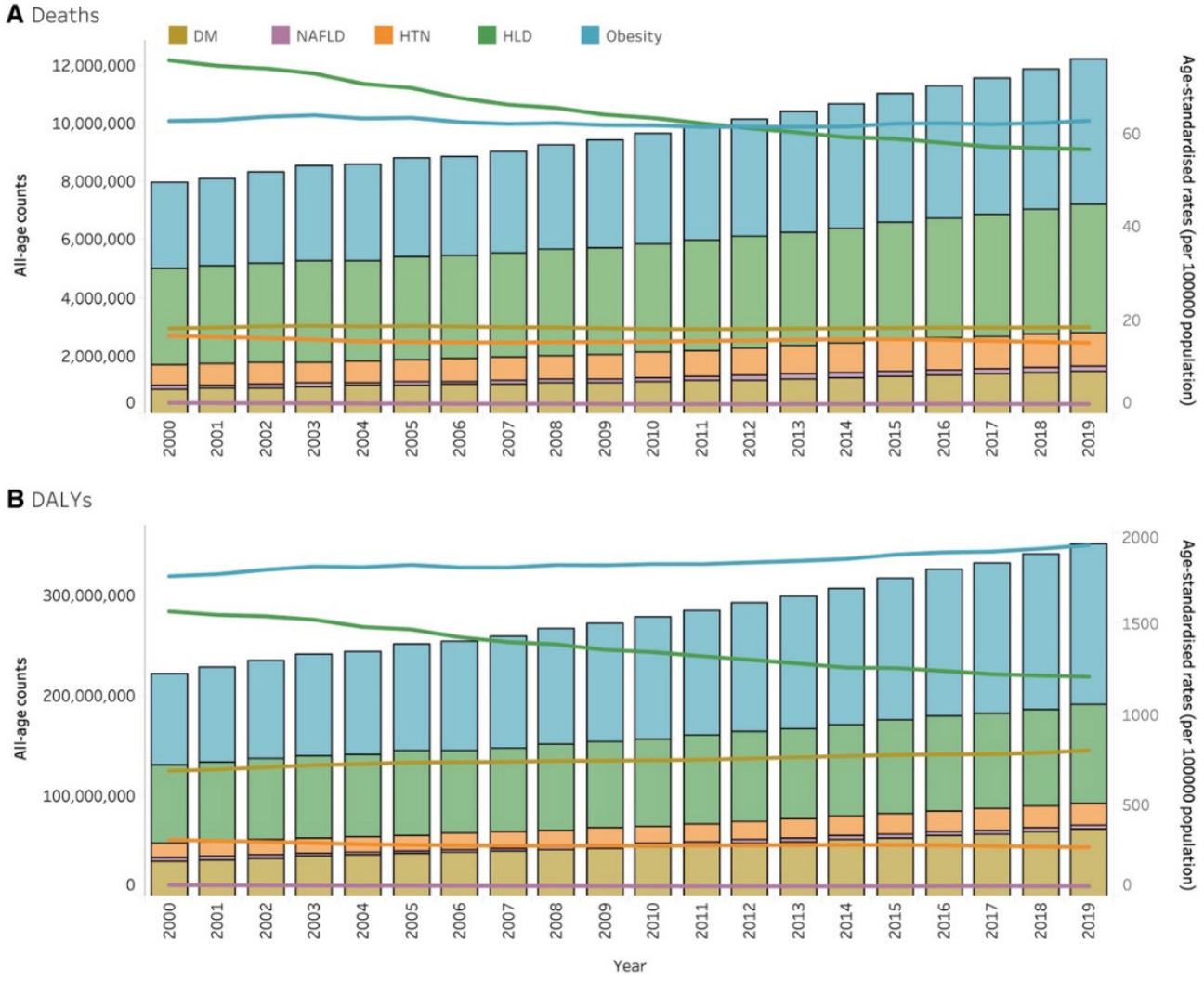

Fig 1. The overall mortality trends from 2000 to 2019 [1]

Therefore, the prevention and treatment of metabolic diseases has become a major challenge for global public health. Medications such as insulin, metformin, and statins are often used to control the symptoms of metabolic diseases. However, although pharmacological treatments can relieve symptoms, they are often accompanied by side effects and do not fundamentally reverse the state of metabolic disorders. Surgical interventions, such as gastric bypass surgery, can significantly improve obesity and diabetes symptoms in some cases, but their high cost and potential surgical risks make it unsuitable for all patients. In contrast, lifestyle changes, especially exercise, are still the corner stone of treatment and are considered as a more sustainable solution, both to improve the symptoms of metabolic diseases and to reduce the risk of their occurrence. This review systematically introduces the role of exercise in the prevention of metabolic disease and discusses the effect of exercises on human metabolism system.

2. Exercise and Prevention of Metabolic Disease

Type 2 diabetes is one of the most common metabolic diseases. Its main feature is insulin resistance. This condition happens because the body does not produce enough insulin. As a result, blood sugar levels stay high for a long time. Research shows that regular aerobic exercise and resistance exercise are effective ways to lower the risk of type 2 diabetes. Resistance exercise, in particular, can help the body use insulin better and reduce blood sugar levels. This is because exercise can make the body more sensitive to insulin. It also helps muscles take in and use more glucose. Both aerobic exercise and strength train-

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ing have been proven to help prevent type 2 diabetes [2]. Exercise lowers blood sugar levels by increasing the need for glucose in the muscles. It also helps muscles absorb more glucose. In addition, exercise can reduce insulin resistance by regulating the activity of insulin receptors. It also improves insulin signaling. A lifestyle intervention trial has shown that doing at least 150 to 175 minutes of physical activity every week, combined with a diet aimed at losing 5% to 7% of body weight, can reduce the risk of developing type 2 diabetes by 40% to 70% in people with impaired glucose tolerance [3].

Non-alcoholic fatty liver disease (NAFLD) is another common metabolic disorder. This disease is closely linked to obesity, high levels of fat in the blood (hyperlipidemia), and insulin resistance. NAFLD requires immediate treatment, or it may get worse. If untreated, it may turn into more serious conditions like non-alcoholic steatohepatitis (NASH), liver fibrosis, or even liver cancer. Exercise also plays a key role in preventing and treating non-alcoholic fatty liver disease. Research has shown that both aerobic and resistance exercise can decrease the buildup of fat in the liver. Exercise improves insulin sensitivity in the liver and reduces fat accumulation by promoting the burning of fatty acids [4]. In addition, exercise helps control the liver's inflammatory response. It lowers the release of substances that cause inflammation, which reduces the risk of liver damage.

3. Effect of Exercise on Metabolic Disease

3.1 Skeletal Muscle Adaptations

Skeletal muscle is an important metabolic organ in the body and plays a crucial role in glucose and fat metabolism. Exercise can improve the metabolic function of skeletal muscle through multiple mechanisms [5]. On the one hand, exercise can increase the number and function of mitochondria in muscle cells, which are structures responsible for energy production in cells, and their function directly affects cellular energy metabolism and insulin sensitivity. For example, aerobic exercise (e.g. running, swimming, etc.) can increase the number and function of mitochondria, thus improving the oxidative metabolism of muscles and reducing the accumulation of fat in the body; on the other hand, exercise also promotes glucose to enter the muscle cells, thus improving the blood glucose level. Both aerobic exercise and resistance training can increase GLUT4 translocation through different mechanisms. In particular, aerobic exercise can improve muscle sensitivity to insulin, resulting in enhanced glycogen synthesis [6].

3.2 Liver Adaptations

The liver is the body's main organ for metabolism. It plays a key role in controlling the metabolism of sugars, fats, and proteins. Metabolic diseases often come with problems related to how the liver functions. These issues can include insulin resistance in the liver and fat buildup within it. Exercise is an effective way to reduce fat buildup in the liver. Aerobic exercise helps burn fat all over the body. It also lowers the release of fatty acids from fat tissue. This, in turn, reduces the amount of free fatty acids that reach the liver, which helps lower fat storage in the liver.

Additionally, exercise improves the sensitivity of liver cells to insulin. It also decreases the liver's production of sugar by activating the AMPK pathway. Exercise can help reduce fasting blood sugar levels. It can also stop the liver from producing too much fat, which prevents fatty liver formation. In this way, exercise helps stop non-alcoholic fatty liver disease (NAFLD) from getting worse [7].

3.3 Adipose Tissue Adaptations

Adipose tissue is not just a place where the body stores energy. It also acts as an endocrine organ. This means it releases different hormones that influence metabolism. Some of these hormones include leptin and adiponectin. In people with metabolic diseases, the function of adipose tissue often becomes abnormal. This can lead to fat cells becoming larger. It can also cause them to produce substances that lead to inflammation.

Exercise can help prevent and treat metabolic diseases by reducing the size of adipose tissue and improving how it functions [8]. Aerobic exercise can greatly reduce the size of adipose tissue, especially the fat around the organs, known as visceral fat. Adipose tissue releases fatty acids through a process called lipolysis. During exercise, the breakdown of these fatty acids speeds up, which reduces the amount of fat stored in the body. This is important for improving insulin sensitivity and lowering the risk of metabolic diseases. In obesity and other metabolic diseases, there is a long-term, low-level inflammation in adipose tissue. This inflammation is a key factor in causing problems. Exercise can help reduce the severity of metabolic disorders by decreasing the number of macrophages (a type of immune cell) in adipose tissue. It also lowers the production of inflammatory substances, such as TNF-α and IL-6.

3.4 Pancreas Adaptations

The pancreas is an important organ when it comes to metabolic diseases. It plays a vital role in how the body processes sugar. The effects of exercise on pancreatic func-

tion mainly show in the improvement of insulin secretion and β cell function [9]. Exercise can improve the way the pancreas works in several ways. One key way is by helping the pancreas respond better when it needs to release insulin. Aerobic exercise can make islet beta cells more sensitive to changes in blood sugar levels. It also helps the pancreas release insulin at the right time and improves glucose metabolism.

A gradual decline in the function of islet beta cells is one of the main reasons why the disease gets worse. Exercise can help slow down or stop the decline in the function of islet cells. It does this by improving how sensitive the body is to insulin and increasing insulin secretion. In addition, exercise lowers the stress on islet beta cells, allowing them to work more efficiently.

4. Conclusions

In conclusion, exercise is a simple and effective method for preventing and treating metabolic diseases without the use of drugs. It has clear and noticeable benefits. Exercise works by improving the metabolic adaptation of skeletal muscles, the liver, fat tissue, and the pancreas. This improvement can lead to better overall metabolic health. Additionally, exercise lowers the risk of developing metabolic diseases. It also helps improve the health of patients and encourages better daily eating habits. For these reasons, exercise should be viewed as an important part of managing and treating metabolic diseases. It should be used together with other treatment methods to achieve the best results.

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