Effect of different intensity aerobic exercise on sleep quality in patients with type 2 diabetes

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Abstract: Diabetes is a chronic disease, especially in type 2 diabetes, which is more common in China. According to the report of the 18th International Diabetes Federation (IDF) meeting, there were about 150 million diabetic patients in the world in 2003, of which type 2 diabetes accounted for 90%-95%, and the global incidence rate is on the rise. In this paper, based on the sense of movement and therapy, the sleep quality of patients with type 2 diabetes was analyzed. Based on the pathological study of the disease, some matters needing attention were put forward, with a view to enlightenment.

1. Introduction
This year is the 40th anniversary of reform and opening up. It is of great significance to sort out and study diabetes in China during these 40 years. The development of diabetes and the way people live and manage their own behavior are closely related. In the past 40 years, with the aging of our population and the changes in lifestyle, with the improvement of people's living standards in our country, diabetes has become a major social problem that threatens people's health. Diabetes has changed from a rare disease to an epidemic, and the prevalence of diabetes has risen from 0.67% in 1980 to 10.4% in 2013. According to official data, by 2030, the number of type 2 diabetes patients worldwide will reach 500 million, while in China, the prevalence rate is as high as 11.60%. At present, there are about 30 million people with diabetes in China, most of whom have type 2 diabetes. At present, there are few studies on the quality of life affecting type 2 diabetes in China.

2. Diabetes seriously affects people's quality of life
Diabetes is a group of metabolic syndrome characterized by long-term hyperglycemia, a group of metabolic abnormalities characterized by chronic hyperglycemia caused by the interaction of genetic and environmental factors. Diabetes is divided into type 1 diabetes, type 2 diabetes, and other special types of diabetes. Among them, type 1 diabetes occurs mostly in adolescents, and type 2 diabetes is more common in middle-aged and older people after the age of 30. Diabetes in China is mainly type 2 diabetes, and type 1 diabetes and other types of diabetes are rare. The prevalence of type 2 diabetes in the national survey in 2013 was 10.4%. In particular, the prevalence of diabetes in economically developed areas was significantly higher than that in underdeveloped areas, and the proportion of undiagnosed diabetes was higher. At the same time, it can be found that the prevalence of diabetes in obese and overweight people has increased significantly. According to the 2013 body mass index (BMI), the prevalence of diabetes in BMI<2 was 7.8%, and the prevalence of BMI<30 was 15.4%.

By analyzing the possible influencing factors of diabetes in China, we can find that the main factors affecting diabetic patients in China are as follows. First of all, the development of urbanization has led
to changes in people's lifestyles, physical activity has been significantly reduced, and the accelerated pace of life has also caused people to be in a stressful environment for a long time, which is closely related to the occurrence of diabetes. Secondly, aging has increased the incidence of diabetes in China. As the proportion of elderly people over the age of 60 in China has increased year by year, the prevalence of diabetes in the elderly over 60 years old in the 2013 survey was above 20%. There is a clear upward trend. Again, overweight and obesity have a significant effect on the prevalence of diabetes. According to the Report on Nutrition and Chronic Diseases of Chinese Residents (2015), the overweight rate of adults aged 18 and over in the country was 30.1%, and the obesity rate was 11.9%, an increase of 7.3 and 4.8 percentage points over 2002.

| Year of investigation (diagnostic criteria) | Number of surveys (million) | Age | Prevalence of diabetes (%) | IGT prevalence rate (%) | Screening method |
|--------------------------------------------|----------------------------|-----|---------------------------|------------------------|-----------------|
| 1994(WHO 1985)                             | 21                         | 25-64 | 2.28                       | 2.12                   | Taro meal 2hPG screening high-risk groups |
| 2002(WHO 1999)                             | 10                         | ≥18  | city4.5,rural1.8           | 1.6(IFC2.7)           | FPG screening high-risk groups |
| 2007-2008(WHO 1999)                        | 4.6                        | ≥20  | 9.7                        | 15.5                   | OGTT |
| 2010(WHO 1999)                             | 10                         | ≥18  | 9.7                        | —                      | OGTT |
| 2013(WHO 1999)                             | 17                         | ≥18  | 10.4                       | —                      | OGTT |

Figure 1. Summary of 7 national diabetes epidemiological surveys in China

3. The pathogenesis of type 2 diabetes
Type 2 diabetes is often referred to as non-insulin-dependent diabetes, accounting for approximately 90% of all diabetic patients. Type 2 disease often has a genetic history, mild condition, thirst, dry mouth and other symptoms. Type 2 diabetes occurs mostly in middle-aged or elderly people over the age of 40. It can also be found in other age groups and has proven to be more harmful and influential in type 2 diabetes. However, the current etiology and pathogenesis are currently unclear.

Insulin resistance (IR) refers to a decrease in the responsiveness of whole body, organ or tissue to insulin action, and its pathogenesis is very complicated. When insulin resistance occurs in the body, insulin-stimulated glucose utilization is reduced, and at the same time, liver glycogen is not effectively controlled to output glucose, resulting in elevated blood sugar and eventually diabetes. The important mechanism is that PI-3K causes a decrease in glucose function. In addition, glucose operation requires other activations independent of the PI-3K pathway, such as the tyrosine phosphorylation of insulin and the compartmental of the adaptor protein (CAP)/Cb1 complex. This may be the second pathway parallel to the PI-3K pathway. In addition, fat cells secrete resistance-like molecules, which are important factors in linking obesity and type 2 diabetes.

3.1 The pathogenesis of type 2 diabetes
After decades of research, people have a certain degree of understanding of type 2 diabetes. Under normal physiological conditions, the body's sugar is in equilibrium, but in diabetic patients, the body's sugar balance is destroyed. Especially in patients with type 2 diabetes, the production of sugar in the body is increased, the clearance is reduced, and the insulin secretion is slowed after eating. This series of pathophysiological changes leads to the appearance of clinical symptoms of type 2 diabetes. The pathogenesis currently considered is mainly insulin resistance, islet p-cell failure and insulin secretion disorders. The reasons are multi-faceted. In addition to genetic factors, environmental factors also have important relationships. Social and economic development, improved living standards, excessive dietary caloric intake, reduced physical labor, increased psychological stress, and increased obesity are all closely related to diabetes.
3.2 Pathophysiological mechanism of type 2 diabetes

Insulin resistance and islet B cell damage are the two most important factors in the development of type 2 diabetes. It is generally believed that different patients have different importance in the different stages of the disease. Insulin resistance is the initiating factor of most type 2 diabetes. When islet B cells can secrete enough insulin to compensate, blood sugar levels can still be maintained within the normal range, once compensatory insulin secretion cannot be combined with insulin resistance. When you compete, blood sugar inevitably rises.

![Diagram showing the pathophysiological mechanism of type 2 diabetes]

4. Effects of different intensity exercises on sleep quality in type 2 diabetes

In the study of type 2 diabetes, there have been many studies on exercise intervention therapy. In particular, how to analyze the exercise quality of patients by experimental or empirical research is rich. This study is often based on elderly patients. In the following, the study on the sleep quality of elderly patients by exercise is taken as an example. Before conducting an analysis, it is first necessary to clarify what is the exercise intervention therapy and the main treatment mechanism.

The concept of exercise prescription was first proposed by American physiologist Kapovich in the 1950s. Exercise intervention therapy refers to the type of exercise, exercise intensity, and exercise prescribed by the rehabilitation physician or physical therapist for the physical exercise or patient according to the medical examination data according to their health, physical strength, and cardiovascular function.

4.1 Correlation between exercise and insomnia in elderly type 2 diabetic patients

Sleep affects the secretory function of islet p-cells and the sensitivity of insulin. Sleep time and sleep quality have a regulatory effect on glucose tolerance and glucose homeostasis. Sleep disorders can cause disorders in the body's glucose metabolism, thereby accelerating the progression of diabetes. The study found that sleep duration < 6h per day is an independent risk factor for type 2 diabetes. Male sleep time < 8h/night, female sleep time <7h/night will significantly increase the incidence of type 2 diabetes. A lack of sleep for 3 hours per night increased glycated hemoglobin by 1.1%, and for every 0.5 points increase in PSQ1, glycated hemoglobin increased by 1.9%. Type 2 diabetes with sleep disorders is more common in the elderly.
Decreased sleep time can lead to increased levels of inflammatory factors such as IL-1, IL-6, IL-17, and F-a in the body. These inflammatory factors affect insulin secretion signaling and ultimately lead to insulin resistance. Aging reduces the level of melatonin in the elderly at night, and the peak time is late, destroying the circadian rhythm and causing insomnia. Insomnia, the secretion of appetite inhibitors decreased, the secretion of ghrelin increased, the appetite increased, and the food intake increased. However, the amount of spontaneous activity during daytime insomnia patients decreased significantly, which made blood sugar at a higher level.

Studies have shown that fasting blood glucose, postprandial 2h blood glucose, glycosylated hemoglobin, insulin resistance index, and incidence of depression are significantly higher in patients with type 2 diabetes with sleep disorders. In short, sleep disorders increase the difficulty of blood sugar control. Conversely, poor glycemic control can directly affect sleep. Patients with hyperglycemia are mainly characterized by difficulty in falling asleep, shortening sleep time, and early awakening. At the same time, hyperglycemia can also affect central neurotransmitter function, and autonomic dysfunction occurs, which in turn induces various sleep disorders.

### 4.2 Main factors affecting sleep in elderly type 2 diabetic patients

The factors affecting sleep in elderly type 2 diabetic patients are complex and diverse, mainly in the following aspects. The first is psychological factors. Psychological problems are an important factor in causing insomnia in elderly diabetic patients. Type 2 diabetes is considered to be a psychosomatic disease that seriously affects people's physical and mental health. Studies have shown that the quality of sleep in elderly diabetic patients is significantly positively correlated with the degree of depression. The second is pathophysiological factors. Aging and persistent hyperglycemia can damage vascular endothelial cells, causing cerebral arteriosclerosis, microcirculatory disorders, insufficient blood supply to the brain tissue, damage to nerve fibers and neurons, and loss of autonomic nervous disorders. The study found that the longer the course of diabetes, the more comorbidities, the higher the incidence of insomnia. The third is environmental factors. The elderly's tolerance to the surrounding sound is weakened, and the environment is a little bit audible, so the surrounding environment is noisy or the sounds of other members of the family can affect the elderly's sleep.

| Prescription element | prescription1 | prescription2 |
|----------------------|---------------|---------------|
| RPE Grading          | 9-10          | 11-12         |
| Heart rate range (times/min) | 85-105 | 100-120 |
| Average heart rate (times/min) | 94.77 ± 6.83 | 114.08 ± 13.69 |
| Exercise time range (h/w) | 10-15 | 5-10 |
| Average exercise time (h/w) | 10.34 ± 1.60 | 7.45 ± 1.75 |
| Speed range (m/min)   | 60-80         | 100-120       |
| Average pace (m/min)  | 68.30 ± 6.50  | 108.45 ± 5.65 |

Table 1 Relevant exercise indicators of two exercise prescriptions

With the deepening of research on diabetes prevention and treatment, exercise therapy is increasingly valued by medical professionals who are engaged in diabetes prevention and treatment. The occurrence of diabetes is related to the lack of exercise in patients. Exercise exercise can treat diabetes. Exercise therapy is a basic measure recognized by the medical community for diabetes treatment. Scientific and rational exercise intervention will have an impact on the body shape, physiology and biochemical indicators of diabetes. Therefore, early diagnosis and early treatment of diabetes should be done as early as possible to prevent complications and reduce mortality and morbidity.

### 5. Treatment of type 2 diabetes patients by exercise

Exercise therapy is one of the main non-pharmacological treatments currently used to treat type 2 diabetes. Through the health test of patients, it was found that the quality of life of the patients after
physical intervention, psychological state, social activities and other aspects of the intervention was significantly higher than before the intervention. This shows that exercise can improve the quality of life of patients with type 2 diabetes.

5.1 Exercise Intervention Therapy
Exercise intervention therapy has been briefly described above. Exercise prescriptions achieve the desired results through purposeful exercise. The development and implementation of exercise therapy should be carried out around the purpose of exercise prescription. It is formulated and implemented according to the specific conditions of each exercise participant, and it has strong scientific nature. Before the exercise prescription is made, the prescribing person must be examined to determine if it is an adaptor to the exercise. At the same time, in the formulation of exercise prescriptions, it is related to the effectiveness and persistence of exercise to provide the most suitable exercise for exercisers. Due to the wide variety of personal circumstances, there may be inappropriate places in the process of exercising prescriptions, and should be checked and corrected in time to ensure the effect of exercise.

Exercise can also enhance the physical fitness of diabetic patients. The exercise of appropriate load can increase the energy consumption of the body, improve the disorder of lipid metabolism, reduce body fat, increase lean body mass, improve immunity and reduce complications. In addition, sports can also cultivate people's sentiments, eliminate tensions, alleviate people's pressures in all aspects, arouse people's yearning for a better life, and stimulate the spirit of progress, thus enhancing the self-confidence of diabetic patients in confrontation with disease.

5.2 Exercise therapy for type 2 diabetes
A tertiary prevention target in the prevention and treatment of type 2 diabetes. The primary prevention goal is to control the risk factors of type 2 diabetes and prevent the occurrence of type 2 diabetes. The goal of secondary prevention is early detection, early diagnosis, and early treatment of patients with type 2 diabetes. The goal of tertiary prevention is to delay the progression of diabetes complications, reduce disability and mortality, and improve the quality of life of patients.

| Index       | Regular exercise group (n=685) | Sometimes sports group (n=587) | Less exercise group (n=468) | Statistics(P) |
|-------------|--------------------------------|--------------------------------|-----------------------------|---------------|
| TG (mmol/L) | 1.64±1.06                      | 2.20±1.48                      | 2.27±1.44                   | 120.32(<0.001) |
| TC (mmol/L) | 5.14±1.35                      | 5.41±1.47                      | 5.95±1.55                   | 85.58(<0.001)  |
| HDL-C (mmol/L) | 1.27±0.51                      | 1.10±0.46                      | 1.01±0.38                   | 92.59(<0.001)  |
Patients with type 2 diabetes should follow the following principles during exercise: First, exercise therapy should be performed under the guidance of a physician. Perform the necessary assessments before exercise, especially medical assessment of cardiopulmonary function and motor function. Second, adult type 2 diabetic patients have a moderate intensity (50% - 70%) maximum heart rate for at least 150 minutes per week, a little bit of exercise during exercise, rapid heartbeat and rapid aerobic exercise without breathing. The third is to have moderate-intensity sports. For example, you can go fast, tai chi, cycling, table tennis, badminton, aerobics, jogging, swimming, etc. Fourth, the sports program should be adapted to the patient's age, condition and physical endurance, and should be regularly evaluated to adjust the exercise plan in a timely manner. The fifth is to develop healthy living habits. Develop an active lifestyle, such as increasing daily physical activity, reducing meditation time, and integrating beneficial sports into everyday life.

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