

Analysis of the Relationship between Physical Activity and Type-II Diabetes Mellitus in China

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Abstract. For the prevention and treatment of type-II diabetes mellitus, physical exercise is crucial. Exercise has several advantages for controlling blood sugar as a lifestyle intervention technique. But in China, there is still a significant lack of thorough and rigorous research on the connection between exercise and type II diabetes mellitus. By stating the link between physical exercise and type II diabetes as a preventative measure or a treatment, this article seeks to close the gap. The findings suggest a negative association between exercise and type-II diabetes mellitus, with losses in insulin sensitivity and glucose tolerance and an improvement in glucose-stimulate uptake and fasting glucose being evident following a period of inactivity. At the conclusion of the article, the fundamental benefits of exercise are no longer ignored. Physical exercise may be one of the main strategies to best control patients' blood glucose levels since it regulates insulin sensitivity, lowers fasting glucose, and increases glucose tolerance.

Keywords: Type-II diabetes Mellitus, Physical Activity, Insulin Sensitivity.

1. Introduction

As the world's second-biggest economy, the quality of life of the Chinese has improved astonishingly, leading to exponential growth in the overall population. According to data from the Chinese National Bureau of Statistics (CNBS), compared with the number of 1.34 billion in 2010, the Chinese population had reached to 1.41 billion, which means the overall population has risen 5.4% in a decade [1]. Mathematically, 5.4% is a paltry number. But when it times to a billion, the result becomes significant. Beneficial to labor forces from the high amount of population, the Chinese economy has developed so rapidly in decades. Under the prosperity, however, some health crises related to overpopulation are threatening this country. The buildings are higher, the high-speed railways are faster, and the entertainments are more splendid. Simultaneously, people are more obese, physically inactive, and more likely to develop diabetes. Although diabetes, especially type-II diabetes, is a common public health problem all around the world, China has the highest prevalence due to its population size. A study in 2017 by Dr. Zhu Dalong indicated that 11.2% of the participants were diagnosed with type II diabetes among the sample of total 76 thousand, which means the actual number would be more much serious than people expected, proving the validity of the previous argument [2]. To prevent this overwhelming tendency, healthy diets and lifestyle modifications, mainly physical activities, are highly promoted in recent years. In terms of diets, researchers in South Korea have put a great amount of effort into discovering the mystery. For example, using brown rice to replace conventional white rice and promoting vegan based diet. which then leads to a systematic and functional understanding of a diabetic diet [3]. Due to the resemblance of race and food culture, Chinese clinicians promoted a similar diet for individuals who suffered from type-2 diabetes. However, on the other hand, the exercise remains blank: even the official guideline of the prevention and treatment of type 2 diabetes mellitus in China 2020 edition has only half a page of 94 pages to examine the relationship between exercise and diabetes. More importantly, it implies even professional clinicians in China have a lacking systematic literature review of diabetes. Current knowledge of exercise on guidelines only includes a reduction in H1A1c 0.66% and improvement in insulin resistance after 8 weeks of trial training [4, 5]. But the details and further understanding of the effects of being physically active on diabetes are still covered by mist. Therefore, this essay is aiming

to examine the adverse relationship between physical activeness and the risks of type-II diabetes. After demonstrating the association between exercise and diabetes, the metabolic mechanism inside the body during the process of being physically active will be discussed. Mostly, scholarly articles are from the PubMed database. Cited resources were selectively addressed for 2 weeks, including scientific reviews from diabetic scholars in North America, using the method of meta-analysis, focusing on examining the increasing risk the increasing sedentary time on diabetes individuals; another scientific review from Australia to conclude the metabolic mechanism of exercise in terms of diabetic individuals. Search terms included: type-II diabetes, glucose tolerance, insulin resistance, exercise, IL-6 metabolism, and insulin sensitivity. No restrictions on the date of publication were set. This not only mentions the explanations of exercise's benefits and its metabolism but also identifies disadvantages in this essay which may enhance the validity of the whole study. Since all of the cited resources are from Western countries, perhaps the cultural difference between Asians and people in Western countries might be incomparable when it comes to the Chinese diabetic population. Nevertheless, hopefully, this essay could provide a deeper and more detailed review of the positive effects of exercise in terms of type-II diabetes.

2. Analysis of the association between exercises with incident diabetes

2.1. The Inverse relationship between exercise and type-II diabetes

In China, doctors in the endocrine department established a universal concept: three hypes are not alone, including hypertension, hyperlipemia, and hyperglycemia [6]. Interestingly, scholars in Western countries shared the same opinions with the Chinese clinicians that metabolic syndrome has a strong inverse relationship between metabolic syndrome and a sedentary lifestyle, which means individuals who spent abundant time in front of the television will be riskier involved in metabolic issues, especially high blood glucose [7]. The validity of this statement has been proven by researchers in the United States. The purpose of this program was aimed to examine the effectiveness of lifestyle intervention, both increasing physical activities and decreasing sedentary time, on reducing the negative impacts of diabetes [7]. Researchers established a Diabetes Prevention Program (DPP) with a total of 3232 participants, and they gathered data using a specially created questionnaire. The data was mainly focused on time arrangement on being sedentary, such as watching television, sitting at work, and playing video games in front of a digital screen. DPP, a multicenter, randomized controlled clinical study, was monitored for 3.2 years to see if lifestyle changes might postpone or prevent type 2 diabetes in persons at high risk of the condition. The collected data included the results of questionnaires that reported the time spent on sedentary sitting or physical exercising. Except for the questionnaires, demographic information such as sex, age, race, or socioeconomic income, is also collected by researchers. During the process of this study, a treatment group was established, and participants were having metformin treatment solely. By comparing the drug-only patients, this placebo group's goal is to ascertain the efficacy of lifestyle prevention. The findings imply that the lifestyle groups present a higher drop in reported mean television viewing time than those who are involved in the treatment of medicine. However, an interesting fact was also detected: 'The association between the combination of TV watching and sitting at work and the risk of diabetes development was weaker' [7]. The argument is easy to understand since correlation is not causation. Individuals who spent more time watching TV did not equal a high incidence of diabetes. While spending more time being sedentary would lead to a higher chance to be obese, and obesity is undoubtedly one of the most essential risk factors in diabetes. As a result, it is clearly shown that a sedentary lifestyle is indirectly and negatively influencing the blood glucose. Moreover, the chance of acquiring diabetes increased by almost 3.5% for each hour spent in front of a screen in this trial, which is yet another startling discovery made by researchers. This research also suggests that the absence of sedentary activities like watching TV or playing video games may reduce the prevalence of diabetes in people who are in danger of developing the condition [7]. Therefore, the vital value of physical activeness in the prevention of diabetes is perfectly presented. Not alone, another group of

clinicians from Pennington Biomedical Research Center in Los Angeles was also trying to discover the association between physical activities and diabetes [8]. However, instead of recording time expenditures in watching TV or playing football, researchers from LA put the effort into examining the deep physiological mechanism inside diabetic bodies during the process of exercise. With the method of meta-analysis (10 studies), Dr. Hamilton believes that skeletal muscle insulin resistance, which is recognized as one of the most significant elements in the development or progression of type II diabetes, played a major role in the physiological drawbacks of a sedentary lifestyle [8]. Within a study contained with 801 healthy participants, the inverse relationship between sedentary time and insulin sensitivity was measured by a hyperinsulinemia-euglycemic clamp [8]. However, according to Dr. Hamilton, the comparative equilibrium between total inactivity and total daily activity was crucial for insulin sensitivity, and sedentary time also influences the release of insulin from bodies [8].

In addition, diabetic researchers from the University of Ottawa in Canada provided a systematic review of how physical activeness could interfere with insulin activity significantly [9]. Moreover, they also presented the findings on the relationship between exercise with fasting glucose, and glucose tolerance test. For the insulin sensitivity portion, Dr. Saunders summarized three crossover studies with 161 attendees, which contained 41 individuals in the randomized group and 120 individuals in two nonrandomized groups, trying to examine how the cute bouts of uninterrupted sedentary behavior could affect the measurement of insulin sensitivity in healthy adults [9]. The measurement includes HOMA (homeostasis model of assessment), which means the feedback of glucose on β -cells to promote insulin secretion is a link with blood glucose and insulin concentrations [9]. insulin-stimulated glucose uptake; AUC (area under the curve), deriving from the Oral Glucose Tolerance Test (OGTT), which is frequently used in clinics to identify Impaired Glucose Tolerance (IGT); and insulin sensitivity index during the process of oral glucose tolerance test, and hyperinsulinemic euglycemic clamp [9]. In the crossover studies, insulin sensitivity was measured in different time settings, as well as on different days [9]. The non-randomized treatments assessed insulin sensitivity before to and following 3, 5, 6, and 7 days of inactivity [9]. The author derives the conclusion that acute durations of uninterrupted sedentary behavior are likely to result in a moderate-to-large reduction in insulin sensitivity due to the intermediate quality of the available evidence [9]. A 39% reduction in insulin-stimulated glucose uptake ($n=12$) [14]; a 30% increase in the AUC from the randomized trials [9]. While the proportion of insulin sensitivity loss in the 10 non-randomized groups ranged from 12.5% to 100% after prolonged inactivity; a 50% decreasing HOMA insulin sensitivity but a 12.5% decreasing insulin sensitivity index was also explained in these 10 trials [9]. By contrast, the AUC was boosted 16.6% in men ($n=10$) and 74.9% in women ($n=7$) during the oral glucose test [9]. Despite some of the studies looking at insulin sensitivity have shown a deficiency in control groups, the effect sizes of the sedentary behavior treatments were nevertheless typically moderate to high.

Except for examining the association between insulin sensitivity with sedentary behavior, researchers, the same research group then unravels the relationship between fasting glucose and physical inactivity [9]. Data from two parallel group studies ($n = 22$), one randomized controlled trial ($n = 20$), and fourteen nonrandomized intervention studies ($n = 149$) were acquired using the meta-analysis methodology [9]. These 17 studies, according to Dr. Saunders, "may lead to a small-to-moderate rise in fasting glucose levels during an acute bout of sustained sedentary activity" [9]. Following 7 days of nonstop bed rest, the randomized controlled trials found that plasma glucose increased by 34% [9]. This randomized controlled trial's effect size was larger than 1, indicating a significant impact [9]. However, neither of the randomized crossover trials has demonstrated a quantifiable change in response to the continuous sedentary behavior [9]. Furthermore, the results in non-randomized groups also indicated a low quality of evidence [9]. Only 2 groups succeed in proving the hypothesis about the changing blood glucose while others have effect sizes that are too low to be convincing [9].

2.2. Metabolism inside diabetic individuals during exercise

Analysis of the negative association between physical inactivity and incidence diabetes has abundantly demonstrated the advantages and validity of exercise. However, the metabolism inside human body has remained unknown. Fortunately, experts in Australia were an effort to explain this question by discussing the link between inflammation and metabolism, which is highly associated with type-II diabetes and strongly stimulated by regular physical activities [10]. They suggest that during muscular movements, cytokines, and peptides, which exert autocrine, paracrine, and endocrine effects, should be recognized as myokines [10]. During decades of research and among hundreds or even thousands of types of peptides, Interleukin-6 (IL-6) was classified as one of the most multifunctional myokines, while its functions would be increasingly salutary combined with regular exercise:

IL-6 stimulates fat oxidation [10].

IL-6 mediates lipolysis [10].

IL-6 mediates communication between intestinal L cells and pancreatic islets, which has systemic effects on the immune system, liver, and adipose tissue [10].

Exercise causes an anti-inflammatory response by significantly raising the circulation amount of IL-6, the first cytokine to be detected after muscle contractions. The length and level of exercise, however, affect the reaction [10].

IL-6 restrains the production of $\text{TNF-}\alpha$, which is a molecule that plays a major role in insulin resistance. Meanwhile, in terms of exercise, its suppressive effect on $\text{TNF-}\alpha$ is astounding by booming insulin sensitivity at the progress of physical activities [11].

IL-6 engenders the stimulation of IL-1ra, which then limits the normal function of IL-1 β that would cause devastating damage to the insulin system in terms of β -cell dysfunction [11]

IL-6 stimulates α -cell proliferation as a result of physical activity. Another study found that higher IL-6 levels in response to exercise cause the release of glucagon-like peptide-1 from intestinal L cells and pancreatic beta cells, which enhances glycemia and insulin secretion. This implies that IL-6 interacts in an endocrine loop that promotes insulin secretion but might be beneficial in T2DM. [12].

In conclusion, IL-6 has beneficial consequences on glucose and lipid metabolism, and the mechanism through which exercise might be therapeutic in managing the blood glucose [10] is described. Coincidentally, this Australian research team also included a claim regarding the preventive benefits of exercise on chronic illnesses including type 2 diabetes and cardiovascular disorders [10], which then insightfully implied the interplay between hypertension, hyperlipemia, and hyperglycemia should not be neglected. This statement is manifesting a consilience with the Chinese universal concept: Three hypes are not alone. Therefore, they declare that the first-line treatment for T2DM is physical activities based on its physiological benefits [10].

3. Disadvantages of the studies

First of all, even though the benefits of exercise in terms of diabetes could be defined, the drawbacks have still existed. For example, in a study from Canada, researchers mentioned that the supervision of physical activities is insufficient, at least the controlled variable about the appearance of surveillance during the process of the exercise was seldom discussed. Secondly, the prolonged training advice was also blank in all of the cited resources. As a result, the long-term benefits of exercise were not examined among the cited resources. Thirdly, despite both clinicians from the east and west having a common or similar understanding of diabetes, such as the concept of three hypes, there is no experimental research in China that aims to discover the benefits of exercise on the Chinese. Admittedly, these foreign studies contain indispensable value and knowledge that may be helpful for Chinese endocrine clinicians. However, the difference in genes, cultures, diets, food sources, socioeconomic status, and even policies indicated that these conclusions about T2DM from western countries are unsensible to have a copy-paste action in terms of encouraging the popularity of being physically active in China. For example, a group of Chinese health educators established a

randomized study in 2012 involving 4500 participants aged over 60 [13]. The valid participation score for the questionnaire was 96.14%, and this revealed that the average health literacy level of nursing home residents was considerably stunted. In addition, the health literacy score also represented an inverse relationship in terms of unhealthy behaviors like smoking, alcohol abuse, sedentary lifestyle, and less health examination [13]. A higher healthier score will lead to a less likely chance of risky behaviors. Behind the data, socioeconomic development would be the greatest contributor to this situation. Thanks to the Revolution and Open policy, the living quality of Chinese citizens has improved exponentially in the past decades. Chinese people were changing from poor and starving to wealthy and gluttony, while health education was not consistent with improving living quality simultaneously. Explaining easily: people eat more than before but become less physically active when they got older with deficient health education. Thus, the high prevalence of chronic diseases, especially type-II diabetes, is plausible in China. Because of the cultural and social differences as well as the larger population, China is in a significantly more complex position than Western nations when it comes to the high incidence of type II diabetes. The Chinese government and physicians still have a long road ahead to go before they can develop a viable intervention to lessen China's high type-II diabetes prevalence.

4. Conclusion

In conclusion, an inverse relationship has been clearly examined after reviewing data from various diabetic scholars. Generally, those with type-II diabetes who are already diagnosed and those who are at risk for developing it will notice their blood glucose levels drop as they engage in more physically active. Mathematically, the risk increased by 3.5% for every hour spent in front of the television. The unfavorable link between exercise and type-II diabetes mellitus is further supported by decreases in insulin sensitivity, insulin-stimulated glucose uptake, and increased plasma glucose in response to exercise. Additionally, an inactive lifestyle will affect other aspects of glucose metabolism through the molecule IL-6, including insulin sensitivity, glucose tolerance, fasting glucose, and lipid metabolism. These mentioned statements foreshadow a lucid explanation that exercise, as a lifestyle intervention, should be promoted to individuals who have already been diagnosed with type-II diabetes mellitus or who are highly risky of hyperglycemia. This essay will fill the blank in the realm of physical treatment in terms of type-II diabetes mellitus in China by providing detailed information about the effects of being physically active. Although, as most people consider, exercise provided tremendous advantages rather than being sedentary, these experiments could be improved by considering the effect of diet. Since all the collected data, during the process of the long-term experiment, have not discussed the influences of food intake among participants, the result might not be complete accuracy. Clinicians should consider diet as another factor for diabetic treatment in the future. Besides, all of the collected data were from western countries which means participants, at least most of them, were of different races other than Chinese. The selection biases also indicate the difference in races, cultures, seriocomical levels, and so on, which implies that the conclusion might not be perfectly consistent with the Chinese situation. However, hopefully, this thesis could help Chinese diabetic scholars in current diabetic treatment and set up the direction for future research.

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