How Does Hydration Affect the Metabolic Intake of Insulin Type 1 Diabetics?

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1 Introduction

Type 1 Diabetes Mellitus (T1DM) is an auto-immune disorder affecting almost two million people in the United States, with 18,000 more people being diagnosed each year (1). Most often developing during childhood, T1DM is caused by the immune system mistakenly attacking and destroying the natural insulin-producing cells in the pancreas, called beta cells. As a result, individuals living with Type 1 Diabetes have to rely on synthetic insulin, usually injected via syringe or insulin pump, in order for their cells to be able to properly take up glucose in the blood (2). The dosage and timing of insulin injections need to be carefully calculated and are dependent on a multitude of factors, including - but not limited to - diet, exercise, and hydration, which is the primary focus of the current paper.

2 Complications and Research

2.1 Implications of Hydration for Athletes and Diabetics

Hydration is important in the context of athletes, as it reduces the risk of health complications, while also preventing the athlete from experiencing fatigue that can heavily impair performance. Specifically, dehydration can result in kidney stones, urinary tract infections, gastrointestinal disorders, and (in extreme cases) stroke (3). Unfortunately, the added impact of T1DM on athletes poses significant challenges. As a Type 1 Diabetic, dehydration can also result in diabetic ketoacidosis (DKA), an extremely dangerous condition in which an excessive amount of ketones build up in the blood. DKA often leads to organ failure, diabetic comas, and even death. Furthermore, elevated blood glucose levels in Diabetics can also cause dehydration, due to their kidneys having to work harder to remove excess glucose from the bloodstream, which makes the importance of hydration for diabetics of exponential concern (4).

2.2 Glycosuria and Treatment

A study done by Alex Buoite Stella and his team reveals that when a person with T1DM has elevated blood glucose levels and inadequate hydration, they may experience a condition called Glycosuria, characterized by the abnormal presence of glucose in urine (5). Another study, done by Michael C Riddell and his team, suggests a potential solution to this issue. It investigates how athletes with diabetes can prevent high blood glucose levels, which can lead to dehydration and urinary water loss. The study recommends that individuals with diabetes consume water and/or electrolyte beverages at a rate of approximately ~1 serving per hour (6).

2.3 Cardiometabolic and Glucoregulatory Diseases

Hydration can also be important for the prevention of further cardiometabolic and glucoregulatory diseases. An article written by Harriet A. Carroll and her team explains how dehydration has been linked to an increase in arginine vasopressin (AVP), a hormone controlling many aspects of water regulation within the body (7). Carroll explains in her article that an increase in circulating AVP results in a reduction of blood volume, leading to possible cardiovascular problems. While not directly linked to Type 1 Diabetes, Carroll also points out that a repeated increase in this hormone may be linked to glucoregulatory diseases such as Type 2 Diabetes. This means that as dehydration increases, this hormone is also released at a higher rate, leading to the dehydration continuing to be compounded.

2.4 Endocrine Responses

Further evidence may also suggest that hydration can be linked to endocrine responses to exercise. For example, a study done by Daniel A. Judelson and his team explores how hydration affects endocrine markers of anabolism, catabolism, and metabolism in the context of resistance-based exercises, such as weight lifting. In their article, they conclude that hydration levels have a significant effect on endocrine responses to resistance exercise. Specifically, hydration-induced differences in cortisol and catecholamines increased blood glucose. In other words, dehydration resulted in an increase in stress hormones, stimulating elevated blood glucose levels. Most importantly, the authors explain that this elevation of blood glucose is a result of insulin resistance, as opposed to an elevated glucose production. This means that Type 1 Diabetic athletes could also be affected by these stress hormones, which could explain why hydration can combat elevated blood glucose during exercise.

3 Prevention and Treatment Options

A different article written by Elaine Hibbert-Jones and Gill Regan explores various methods of fluid intake for Diabetics, including before, during, and after exercise. Specifically, they explain that drinking 400-600 ml two hours before starting the exercise is best practice. It's noted that,

unless the patient is hypoglycemic, drinks containing carbohydrates should be used with caution pre-exercise, but are a good method of maintaining blood glucose during exercise. During exercise, they advise Diabetics to drink about 200 mL every 15-20 min and to have 30g-60g of carbohydrates every hour. Post-exercise hydration should also include electrolytes in order to restore fluid balance and, most notably, sodium levels lost in sweat. Consuming a sports drink containing 4-8% carbohydrates can be helpful for maintaining blood glucose after exercising as well.

4 Conclusion

Type 1 Diabetes Mellitus poses unique challenges for athletes, particularly regarding hydration. Proper hydration is crucial to prevention of health complications and fatigue for non-diabetic individuals, but plays a particularly critical role in regulating blood glucose levels for individuals with T1DM. Dehydration can lead to diabetic ketoacidosis and other severe conditions, so it is essential for athletes with T1DM to pay close attention to their fluid intake during exercise and training.

Treatment options for T1DM include insulin therapy, diet and lifestyle modifications, and regular monitoring of blood glucose levels. It is important for individuals with T1DM to work closely with their healthcare team to develop a personalized treatment plan that meets their individual needs and goals. With proper management and care, athletes with T1DM can lead healthy and active lifestyles while managing their condition effectively. New studies, proven methods, and technologies such as CGMs and closed-loop insulin pumps have also made this easier than ever before. Despite these new technologies, Type 1 Diabetes treatment remains a constant in the life of a diabetic, so - speaking as a Type 1 Diabetic - any research that makes managing the disease easier improves the quality of life of millions.

5 Implications For Further Research

Further research into understanding the impact of hydration on the metabolic intake of insulin is crucial. The potential benefits of this research are immense, as it could greatly improve diabetes management and the quality of life for individuals worldwide. By delving into this topic, we can gain valuable insights that may lead to more effective treatment strategies and improved overall health outcomes. Therefore, I urge the research community to consider the significance of this research area and explore its potential for making a lasting impact in the lives of countless individuals battling Type 1 Diabetes.

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