The Role of Glucose in Metabolism and Intelligence

Jill Weddle
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Abstract: In a nation where diabetes is on the rise, glucose regularity is a major concern. This article discusses the importance of maintaining regular blood sugar levels for the purposes of overall health, metabolism, and brain function. The reviewed literature suggests that regular exercise and healthy eating habits, which aid in regulating glucose levels, are especially important for pregnant women and their offspring.
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Introduction: Prevalence of Glucose Irregularity in the U.S.

Glucose is the main sugar found in the body and the body's main source of energy (American Diabetes Association). The ability to maintain normal blood glucose (or blood sugar) levels is extremely important for maintaining one's health, as diabetes is characterized by long-term irregular blood glucose levels. Consistently high glucose levels (hyperglycemia) can cause serious health problems such as heart disease and nerve damage, while low glucose levels (hypoglycemia) commonly cause seizures and loss of consciousness.

Diabetes is becoming an epidemic in the United States. The Center for Disease Control and Prevention (2013) recently reported that over the past twenty years, the number of individuals diagnosed with diabetes in the United States has more than tripled. In 1990, 6.6 million people were diagnosed with diabetes. Ten years later we reached 10 million. By 2010, the number of Americans with diabetes was up to 20 million. These numbers don’t account for those who are undiagnosed or unaware of their illness. Although this is a treatable condition, it remains the seventh leading cause of death in the United States (American Diabetes Association).

For women who are pregnant, diabetes creates health risks for their offspring as well. Gestational diabetes is diagnosed when a woman who has never had diabetes before experiences high blood sugar levels during pregnancy. This condition occurs when the hormones from the placenta create insulin resistance, which makes it difficult for the mother's body to create and use insulin. As a result, the baby's blood glucose
levels rise, creating an environment for fat storage and possibly increasing the risk of obesity later in life.

Not only is glucose irregularity a danger to health, but it also plays a part in intelligence. The brain relies on glucose to function optimally. In order for this to happen, the metabolism also must be in working order. Metabolism, which can also be referred to as glucose tolerance, is the body’s process of converting food into glucose for energy. The faster the metabolism, the faster the brain is able to process and react to the information given. As explained by Gaillot and Baumeister, “people with good glucose tolerance seem more capable than others of transporting glucose to the brain in the face of cognitive demand” (2007, 306). This means that people who have a higher metabolic rate are able to make better decisions than those with glucose irregularities. Maternal diabetes may also affect offspring’s intelligence (Rizzo et al, 1991).

**Variables in Metabolic Rate**

Metabolic rate varies from person to person, depending on age, sex, and body composition (Mayo Clinic). People with larger bodies burn more calories. Muscle also aids in metabolic rate, so since men tend to have more muscle than women, they commonly have a higher metabolism. This is why athletes can eat constantly and still avoid weight gain. While a pound of fat in the body can be maintained by burning two calories a day, each pound of muscle burns six calories a day (Need Citation). As the body ages, though, muscle deteriorates in both men and women. This means that older women who have a high percentage of body fat are most likely to be victims of glucose intolerance.
Diet and physical activity also affect a person’s metabolism. When food enters the body, metabolism is revved and calories are burned through the process of digestion and absorption. Therefore, eating regular meals can increase metabolism. But eating food isn’t the only way to increase metabolic rate. Simply drinking two cups of water has been shown to increase metabolic rate by thirty percent in both men and women for up to an hour (Boschmann et al, 2003).

Exercise has a significant effect on metabolism as well, as the body requires more energy when under stress. With high-intensity aerobic exercise, metabolic rate remains elevated for hours after a workout. Weight training is also essential for maximizing metabolic rate since muscle burns more calories than fat.

**Perinatal Metabolism and Offspring Intelligence**

Genes, diet, and physical activity all play a part in one’s metabolism, but other important factors, such as maternal nutrition and obesity during pregnancy, are commonly looked over (Carter et al, 2012). In a recent study, glucose testing was performed on the offspring of mice who exercised during pregnancy, with a control group of offspring whose mothers were sedentary during pregnancy. The researchers found that perinatal exercise can improve long-term metabolic outcomes in offspring. Specifically, “glucose disposal was significantly enhanced in both male and female offspring born to exercised dams compared to those from sedentary dams” (Carter et al, 2012).

Rizzo et al (1991) found that “poorer metabolic regulation in the mother was attended by her child’s poorer performance on standardized IQ tests” (pp. 915). This
study included 89 women who had diabetes prior to pregnancy, 99 who were diagnosed with gestational diabetes, and 35 who had normal blood glucose levels. Metabolic rate and fasting blood glucose levels were measured during the second and third trimesters of pregnancy, and their offspring underwent intelligence testing at the ages two, three, four and five.

For the 18% of pregnant mothers who are currently affected by gestational diabetes (American Diabetes Association), treatment includes specific dietary instruction and regular physical activity. Exercise not only reduces the risk of developing gestational diabetes, but also helps regulate blood glucose levels for those already diagnosed (Carter et al, 2012).

**Self-Control and Blood Glucose**

According to Gailliot and Baumeister (2007), blood glucose and self-control are closely related. They found that when blood glucose is low, mobilization of energy to the brain is limited. This compromises the brain’s ability to regulate emotions, resist impulsivity, and control attention. Therefore, a constant supply of glucose is needed in order to best perform at everyday tasks. Self-control is necessary in order to abide by social norms and expectations, but it also plays a role in metabolism and intelligence.

As stated earlier, metabolism is highly dependent on body size and activity level. For many people who are looking to lose weight, the goal is to increase metabolism by maintaining a regular exercise regimen and healthy eating habits. Keeping this consistent routine requires much self-control, which is dependent on blood glucose levels. However, Gaillot and Baumeister (2007) note that there is no linear relationship
between glucose and self-control. In other words, eating a candy bar, which is full of sugar, won’t yield more self-control in the long run. Instead, blood glucose levels spike for a very short period of time and then return to normal. These carbohydrates that quickly elevate blood sugar levels are considered fast carbs, and they include breads, cereals, sugars, and fruits. In order to keep a constant supply of glucose handy for use in the brain, the key is to avoid constant spikes and crashes in blood glucose and keep levels normal. This can be achieved by eating slow carbs – those that take a longer amount of time to digest (often because of fiber content) and supply a steady stream of energy. These include whole grains, seeds, nuts, and beans. Processed, sugar-filled foods give the blood glucose a quick spike, but high fiber carbohydrates provide a steady flow of energy to aid in cognitive processes for a longer period of time.

Glucose is consumed by the brain during cerebral activity, and the harder one works at a task, the faster glucose metabolism is depleted (Gailliot and Baumeister, 2007). One study found that people with higher intelligence experience a faster decrease in blood glucose following a learning task (Haier et al, 1992). Thus, people with higher intelligence likely have better glucose metabolism.

**Conclusion**

This discussion has highlighted the importance of glucose regularity for optimal health and brain function. Since the brain relies on glucose in order to complete daily tasks, a constant supply is necessary. This is a concern for many Americans, as diabetes is on the rise. Whether blood glucose levels are too high or too low, the brain and body are affected. Self-control is better regulated for those with regular blood
glucose levels, and their brains are able to respond more quickly to cognitive demands. Perinatal exercise and blood glucose levels even have a direct effect on one’s offspring. Not only do pregnant mothers who exercise lower their risk of gestational diabetes, but their offspring are also less likely to be affected by diabetes later in life.

The implications are obvious. A healthy lifestyle, including limiting carbohydrate consumption to slow carbs and making regular exercise a routine, helps regulate blood glucose levels and lessen the risk of diabetes. In turn, metabolism, intelligence, and overall function reach their peak for individuals and their offspring.
References


