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The Importance of the Glycemic Index and Glycemic Load for Body Weight and the Incidence of Chronic Diseases

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https://doi.org/10.37229/fsa.fjas.2026.07.14

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Future Science Association

Available online free at
www.futurejournals.org

Print ISSN: 2767-178X

Online ISSN: 2767-181X

Received: 10 May 2026
Accepted: 2 July 2026
Published: 14 July 2026

Abstract: The purpose of this overview is to examine the scientific data regarding the glycemic index's role in chronic Western diseases and to talk about how beneficial it is for managing and preventing these kinds of issues. Foods are ranked according to their post-meal glycemic reaction by the glycemic index. The etiology of diabetes, coronary heart disease, and cancer has been connected to hyperinsulinemia, insulin resistance, and its determinants (such as high calories consumption, and obesity, and physical inactivity). Because different forms of carbs result in diverse glycemic and insulin responses, carbohydrates have recently drawn a lot of attention as a major causal component among dietary variables. According to certain research, foods with a low glycemic index—which are defined by a slow absorption of carbohydrates—have positive effects on blood lipids, insulin resistance, hyperinsulinemia, glucose regulation, and satiety. Research The etiology of insulin resistance, coronary artery disease and cancer has been connected to hyperinsulinemia, insulin resistance, and its determinants (such as high calorie consumption, obesity, and physical inactivity). But different kinds of carbs have distinct effects on insulin and glycemic levels. According to certain research, foods with a low glycemic index—which are defined by a slow absorption of carbohydrates—have positive effects on blood lipids, insulin resistance, hyperinsulinemia, glucose regulation, and satiety. There will be presentations and discussions on research on the short- and long-term metabolic impacts of diets with varying glycemic indices. In addition to briefly discussing laboratory findings pertaining to putative processes by which glycemic index may affect chronic diseases, the review will mostly concentrate on factors that influence glycemic index. In addition to briefly discussing laboratory findings pertaining to putative processes by which the glycemic index may affect chronic diseases, the review will primarily concentrate on factors that influence glycemic index.

Key words: Dietary carbs, glycemic load, and glycemic index, epidemiology diabetes, obesity.

Introduction

Glycemic Index

Dietary carbohydrates have currently become a subject of interest to a number of researchers, as they vary in their impact on post-prandial glycemic, potentially having both positive and negative health and disease effects, respectively **(Shraboni and Ghosal, 2020)**. Dietary carbohydrates have gained a negative reputation over the past decade, following the widespread recognition of the importance of protein foods in weight loss and recent discoveries about the harmful effects of carbohydrates, such as their role in cardiovascular disease **(Augustin *et al*., 2015)**. The most important indicators of the glycemic impact of blood glucose are postprandial glucose (PPG) blood glucose levels, oral glucose tolerance test (OGTT), and glycemic index (GI). These are recognized by government health institutions, regulatory bodies, and public health authorities in most countries around the world as indicators for controlling and regulating blood sugar, especially in people with diabetes **(Trumbo, 2021)**. The glycemic impact is the sum of the effect of carbohydrates in a meal or food on blood glucose levels within a limited range after eating. In normal individuals, glucose levels peak approximately 30 to 40 minutes after consuming a meal and then return to pre-prandial levels within 2 to 3 hours. This glycemic effect may be due to the functional effect of the quantity or type of carbohydrates consumed (in terms of their bioavailability, whether they are simple sugars or dietary fibers), the presence of other nutrients in the meal or food, the form or composition of the food (solid or liquid, fresh starch versus cooked starch, intact grain versus flour), and the physiological state of the individual (type 1 or 2 diabetes). When carbohydrates are readily digestible, they are called glycemic carbohydrates, which are digestible and absorbable, such as starch and simple sugars. As a result, they have a high glycemic impact. Carbohydrates with a low glycemic impact are called indigestible or no glycemic carbohydrates. Thus, we have two models of glycemic action. Postprandial glucose (PPG) is a measure of plasma glucose concentration after a meal is consumed (**Trumbo, 2021**). Evaluating the quality of carbohydrates in foods and diets from this perspective has become more important than before (**Ludwig *et al*., 2018)**. These facts led to the creation of the concept of the glycemic index, which ranks foods containing carbohydrates based on their effect on blood sugar levels. Then came the interest in systematically studying and defining the vocabulary for measuring and estimating the glycemic index, beginning with Jenkins' publication in 1981 of his research on this topic and the relationship of this index to type II diabetes and blood lipid disorders. He then tabulated and published the glycemic index values for various foods **(Al-Qabati, 2003)**. Thus, the concept of a standard measure or index, the glycemic index (GI), was introduced by Jenkins and colleagues in 1981 to describe the blood glucose response as a result of the rate of carbohydrate absorption after a meal **(Jenkins *et al*., 1981)**. The glycemic index of a food is defined physiologically as the change in blood glucose concentration after eating 25 or 50 grams of digestible carbohydrate, relative to a standard carbohydrate, usually glucose or white bread **(Augustin *et al*., 2015)**. The GI value of a standard food is usually 100, with a glucose response 401% greater than that of white bread, or 71% of the GI of white bread (Beals, 2005). GI values range from 55 or less, and 56 to 69. 70 or higher are considered low, medium, and high, respectively **(Brand-Miller *et al*., 2009)**. The index is a method for classifying carbohydrates and their contents based on their direct effect on blood sugar levels. This classification is useful when comparing foods within homogeneous food groups, such as bread, fruits, and other food groups of grains and seeds **(Riccardi *et al*., 2008)**. In mathematical terms, the index is defined as the area under the glucose response curve (IAUC) after consuming 50 grams of carbohydrate from a test food divided by the area under the curve after consuming 50 grams of carbohydrate from a standard food, which is glucose or white bread **(Wolever *et al*., 1986**). It is a measure of the height of the line and the area under it of the blood glucose response for at least two hours when a specific amount (50 grams) of carbohydrate from a sample food is consumed, compared to the same amount of glucose as a standard food **(FAO/WHO, 1998)**. Over the past decades, the GI has been measured for a large number of the most common carbohydrate-containing foods, and a number of tables have been published containing GI values for a large number of foods worldwide **(Atkinson *et al*., 2008 and Comerford *et al*., 2021)**. Blood glucose levels rise after eating as a direct result of consuming dietary carbohydrates. When consumed in the human body, carbohydrates in various forms, such as simple and complex sugars and starch, are converted into a single sugar, glucose, for metabolism in the body's various cells. This is known as the glycemic response. From this concept, the glycemic index later emerged. Numerous scientific studies have focused on nutritional strategies that regulate the quantity, type, and source of these dietary carbohydrates **(Franz *et al*., 2003)**. In particular, the glycemic index of a food has been identified as an indicator of postprandial blood sugar and insulin responses **(Livesey *et al*., 2008 and Bao *et al*., 2011)**. This explains not only the quality of carbohydrates, but also their quantity, which is important for regulating postprandial blood sugar, especially in the context of mixed meals. Dietary approaches involving the consumption of low-glycemic index foods and low-carbohydrate intake have been shown to reduce postprandial blood sugar and improve glycemic control **(Augustin *et al*., 2015)**.

Toh *et al*. (2020) suggested that low-glycemic index breakfasts appeared to be more beneficial in controlling postprandial blood glucose and insulin levels than high-glycemic index breakfasts, as well as reducing the acute glycemic response following hypoglycemia compared to a high-glycemic index breakfast. Proper management of postprandial blood sugar and insulin contributes to reducing clinically relevant glycemic instability. Low-glycemic index foods are widely recommended for diabetics, as they can reduce the risk of hypoglycemia **(Hu *et al*., 2014)**. In their study on the glycemic response in the blood, **Livesey *et al*. (2008)** indicated that this could be attributed not only to the low carbohydrate content of the diet, but also to the slower absorption of these substances in low-GI foods, along with increased insulin sensitivity. Several studies have been reviewed regarding the relationship between the glycemic index and the development and treatment of type 2 diabetes. **Wong and Jenkins (2007)** reported in a recent meta-analysis comparing low-GI and high-GI foods in the treatment of diabetes that glycated proteins and hemoglobin-binding (HbA1c) were lower compared to high-GI foods. This, in turn, led to a lower risk of developing diabetes and a reduced incidence, progression, and death from the disease. There were also parallel positive indicators of a reduced risk of myocardial infarction and atherosclerosis **(Stratton *et al*., 2000)**. However, the Diabetes United Kingdom's Guide to Diabetes (DUKGD) emphasizes that not all low-glycemic index foods are good choices. For example, chocolate has a low glycemic index, but it contains a high fat content. Therefore, when aiming to eat low-glycemic foods, one should not simply choose this goal without considering the appropriate combination of foods, such as saturated fats, cholesterol, unhealthy fats, table salt, excess protein, and other nutrients within a balanced diet. Therefore, combining different foods with different glycemic indexes will alter the overall glycemic index of a meal, maximizing the benefits of shifting the glycemic index toward the desired goal when choosing the right food or meal **(Trumbo, 2021)**.

Glycemic load (GL)

is the second concept, method, or indicator, synonymous with the glycemic index (GI), to express the effect of dietary carbohydrates on the post-meal glycemic response (PGR). GL can be calculated from the GI of a meal and digestible carbohydrates, which include starch, sugars, oligosaccharides, and malt dextrin **(Barclay *et al*., 2005)**. The University of Wisconsin School of Medicine and Public Health **(Arscott, 2018)** published a summary of the GI and GL, stating that the GI of a given food is a useful value for understanding the relative ranking of different foods, but it does not accurately reflect the effect of a serving or meal of a food on blood sugar. Hence, the concept of glycemic load (GL). GL is calculated by multiplying the glycemic index (GI) of a food by the amount of carbohydrate in a serving of the same food. GL includes both the quality and quantity of carbohydrates into a single value. GL can be considered the precise amount of carbohydrate in a food relative to its glycemic effect. Glycemic load (GL) is a more accurate way to predict and express the effects of different nutrients and their amounts. For example, watercress has a high GI (GI 72–80), but a low GL (GL 4–5) because the amount of sugar in a 120-g serving of watercress is low, mostly from water and dietary fiber. A GL below 10 is considered low, 11–19 is considered moderate, and above 20 is considered high **(Fan *et al*., 2012 and Bhupathiraju *et al*., 2014)**. **Brand-Miller *et al*. (2009)** noted that using the GI and GL to rank carbohydrate-containing foods according to their effect on blood sugar is important for people with and at risk of diabetes. In a study conducted by **Shao *et al*. (2017)** from Huazhong University of Science and Technology in Wuhan, China, on the glycemic index and glycemic load of pomelo, they investigated the effects of consuming pomelo in patients with type 2 diabetes. The study found that consuming pomelo had a significant effect on blood sugar levels in diabetic patients. The glycemic index value was as low as 4.23 in diabetic patients who consumed 100 grams of pomelo, indicating that pomelo is a fruit with a high glycemic index but a low glycemic load. They reported that consuming pomelo in hospitalized patients with type 2 diabetes did not cause significant glucose fluctuations. The researchers concluded that pomelo, with its high glycemic index, could be a low-glycemic index fruit if consumed in limited daily amounts and could therefore be accessible to diabetics. Their findings suggest that there are more dietary options for type 2 diabetics if consumed in limited amounts. **However, Franz *et al*. (2003) and Vega-Lopez *et al*. (2018)** reported that the glycemic index provides a good summary of post-meal glycemia, predicting rapid response, peak glucose variability, and other response curve characteristics. Two systematic reviews of the glycemic index and glucose index in people with diabetes and those at risk for diabetes reported no significant effect on glycated hemoglobin (A1C) levels, and mixed results regarding fasting glucose levels.

Factors Affecting the Glycemic Index (GI)

In addition to the various forms of carbohydrates, such as sugar, starch, and fiber, the ratios of the nutritional components of these foods—such as foods containing various quantities and mixtures of proteins, fats, vitamins, minerals, phytochemicals, prebiotics, and anti-nutritional factors—all have an impact on food quality and human health. Currently, there is no standard or single method for assessing the quality of carbohydrates in foods to achieve most of the goals of improving food quality for health benefits. There is also an urgent need to develop a unit of measurement or index to accurately define and classify carbohydrate foods in terms of quality and high quality **(Comerford *et al*., 2021)**. The glycemic index of carbohydrate-rich foods varies depending on several factors, including the type and variety of the food, the origin of the food relative to the place of cultivation, the stage of food formation, the degree of maturation and/or ripeness, other nutrients present in the food, accompanying and ingested with the food, food processing processes, food preparation methods, food handling processes such as soaking and germination, and the conditions under which the glycemic index is measured **(Pi-Sunyer, 2002 and Beals, 2005; Lal *et al*., 2021)**. These factors associated with low glycemic index values are classified as internal (intrinsic) factors, such as amylose, resistant starch (RS), lipids, protein, dietary fiber, and phytic acid. External factors (extrinsic) that affect the glycemic index and digestibility of starch include various processing processes, cooking, starch retro gradation, soaking, and germination **(Lal *et al*., 2021)**. The glycemic index of carbohydrate-rich foods also varies greatly depending on several factors, including the type of food, its origin, processing, and preparation, other nutrients consumed with the food, and even the time of day at which the measurement is performed **(Pi-Sunyer, 2002)**. Certain indices, such as dietary fiber content, added sugar, starch-to-sugar ratio, and liquid-to-solid ratio, determine the glycemic index, a measure of glycemic activity per gram of carbohydrate **(Atkinson *et al*., 2008). Gabriele *et al*. (2008)** stated that dietary carbohydrates can increase blood sugar levels, especially postprandial. Therefore, for people with diabetes, both type 1 and those with more severe forms of type 2, a high-carbohydrate diet can impair glycemic control, leading to micro vascular and macro vascular complications, along with elevated plasma glucose, insulin, and triacylglycerol levels. **Liljeberg *et al*. (1992)** indicated that not all carbohydrate-rich foods lead to hyperglycemia upon ingestion. They also demonstrated differences in postprandial blood glucose responses to various carbohydrate-containing foods in both healthy individuals and diabetics, even when consumed in portions containing identical amounts of carbohydrate. **Eleazu (2016)** pointed out that differences in individual carbohydrate components may be responsible for the reported differences in postprandial glycemic responses following consumption of various carbohydrate-containing foods by healthy individuals and those with diabetes.

Urooj and Puttraj (1999) and Bahado-Singh *et al*. (2011) explained that differences in glycemic responses to carbohydrate foods, which also tend to affect the GL of foods, are due to different carbohydrate components present in foods and their properties, such as starch composition and properties (digestibility, indigestibility, amylose-to-amylopectin ratio, gelatinization, and retrogradation of starch), dietary fiber and sugar content, and other factors such as insulin response, protein content, food processing processes, variety, food particle size, fat, acidity, storage, and harvest time.

Sugars

Raben *et al*. (1997) reported that overweight individuals who consumed moderately large amounts of sucrose (28% of energy), mostly in the form of beverages, experienced increased energy expenditure, body weight, fat mass, and blood pressure after 10 weeks. These effects were not observed in a similar group of individuals who consumed artificial sweeteners. Regarding diet, **Sheard *et al*.**

(2004) and Slavin (2013) suggest that carbohydrates are the first macronutrient to be broken down into glucose, the primary driver of insulin secretion. Therefore, one might assume that simply reducing carbohydrate intake would lead to improved diabetes management. However, each individual may respond differently to a variety of diets. Most diets containing monosaccharide's and disaccharides and lacking dietary fiber sources have led to worsening of diabetes, as demonstrated by fasting blood glucose, HbA1c, fructosamine, or oral glucose tolerance test (GTT), regardless of the carbohydrate content of the diet. When consumed with similar amounts of carbohydrate, low-glycemic index and high-fiber diets lead to lower postprandial blood glucose compared to high-glycemic index diets. Therefore, **Stanhope *et al*. (2016)** reported that a diet high in sucrose can accelerate the development of metabolic syndrome and cause fatty liver disease. Furthermore, it may lead to pancreatitis with increased macrophage infiltration, which may reduce insulin secretion and consequently worsen blood glucose levels. Similarly, diets containing only fructose and glucose were shown to worsen diabetes in 67% of studies, while the other 33% showed no difference. **Klurfeld (2016)** demonstrated that high fructose consumption leads to increased pyruvate production and increased lipid synthesis in the body. High-carbohydrate diets, where dietary carbohydrate content was 70% or more of total daily energy intake, significantly worsened T2DM in animal models. Macronutrient composition modulates fatty acid deposition and inflammation in various tissues such as the liver, brain, and adipose tissue **(Wolk *et al*., 2001; Antunes *et al*., 2020)**.

Antunes (2020) found that feeding mice a diet containing 73.8% carbohydrates for two months resulted in increased lipid deposition and increased inflammation due to increased pro-inflammatory prostaglandins (PGs) and decreased anti-inflammatory substances. This is consistent with the findings of **Slavin (2013)**, where both inflammation and fat accumulation exacerbate metabolic syndrome, which is closely linked to T2DM. In a systematic review by **Fulkerson (2018)**, he investigated the effect of the amount and type of carbohydrates used in the diets of animal models of T2DM. His research findings showed that sucrose leads to a deterioration in blood sugar levels regardless of its nutritional content. On the other hand, he reported that resistant starch and dietary fiber improve T2DM parameters even when combined with high-carbohydrate diets, such as fast food and high-sugar foods, which contribute to poor eating habits. Furthermore, the large portion sizes typically served in restaurants also raise concerns about the amount of additional calories consumed. The use of different carbohydrate sources also altered the blood glucose response and glycemic index of the original carbohydrate-containing foods, such as boiled and processed wheat products **(Thannoun and Al-Kubati, 2010). Ma *et al*. (2017)** reported that the dietary shift from a traditional vegetable-based diet to a processed and unhealthy diet was associated with the rapid growth of non-communicable diseases such as diabetes. The consumption of naturally occurring fructose from fruit sources led to improved blood glucose control compared to sucrose and starch. The presence of free fructose had no adverse effect on lipid levels such as triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL), even though the intake was not significant. Sugar-sweetened beverages (from sweeteners, such as sucrose and high-fructose corn syrup) should be avoided by people with diabetes or those at risk for diabetes to avoid the risk of weight gain and cardiovascular disease **(Usman *et al*., 2020)**.

Starch

From a structural perspective, starch is one of the main forms of plant dietary carbohydrates. It consists of many glucose units linked together in a linear (amylose) and branched (amylopectin) manner, with α1–4 or α1–6 linkages. These are polysaccharides. Its most important plant sources are grains such as wheat, rice, and potatoes, and grain products (such as bread). It is a staple in the global diet. Starch is found in plants as granules, which serve as a means of storing insoluble carbohydrates. Their shapes, sizes, and starch deposition methods vary depending on the source and species **(Cornejo-Ramírez *et al*., 2018)**. In general, digestible starches are broken down (hydrolyzed) by the enzymes α-amylases, glucoamylase, and Ras isomaltose in the small intestine to produce free glucose, which is then absorbed. Starch hydrolysis begins with the action of the enzyme amylase. Alpha-amylase continues in the small intestine in conjunction with other enzymes. However, resistant starch, which typically comprises more than 3% of cooked rice, undergoes digestion and becomes unavailable for use by cells. Resistant starch is classified into five types based on its resistance to enzyme digestion. Rice contains type RS5, where amylose forms a complex with lipids, making it more thermostable. The more resistant starch it contains, the slower the digestion of rice and the lower the glycemic index (GI), which indicates the food's ability to raise blood sugar levels. Rice is known to have a relatively high GI compared to other starchy foods **(Kumar, 2018)**. Resistant starch (RS) is the fraction of starch and starch products that resist digestion as they pass through the gastrointestinal tract **(Sofi *et al*., 2017). Goldring (2004)** stated that these starches can be fermented in the large intestine. Some forms of resistant starch are found naturally in many foods, but among the best forms of this starch are those derived from high-amylose maize (HAM). He emphasized that resistant starch (RS) can provide added value, such as health benefits and fiber content, to many processed foods without compromising taste and product quality. RS is defined as the total amount of starch and starch degradation products that resist digestion in the small intestine of healthy individuals. Average global consumption is estimated at 3–10 g/day. **Qi and Tester (2019)** also emphasized that resistant starch (RS) is the fraction of starch that bypasses digestion by digestive enzymes in the upper gastrointestinal tract and reaches the large intestine, where it can be partially or completely fermented by colonic bacteria. The main health outcomes of RS consumption can be described primarily in terms of modifying glycemic response, body weight control, and gut health. This was confirmed by **Nugent (2005)**, who stated that the presence of resistant starch (RS) has a positive effect on colon health and improves glucose and lipid metabolism. To understand the nature of resistant starch, it is necessary to find a way to describe and classify it. This component is classified into three components: rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS). Based on this classification, we have rapidly available glucose (RAG), which includes rapidly digestible starch, free glucose, and glucose units derived from sucrose. According to these concepts, foodstuffs can be classified based on their available carbohydrate content. A significant and direct relationship has been found between the glycemic index and both rapidly digestible starch (RDS) and rapidly available glucose (RAG) **(Kumar, 2018 and Sofi *et al*., 2017)**. The high proportion of resistant starch and total dietary fiber, both present as components of undigested carbohydrates in legumes, makes these foods of interest as low-glycemic index foods **(Fujiwara *et al*., 2017)**.

The glycemic index and digestibility of food starch are influenced by internal and external factors that influence the strategy for managing blood sugar levels to ensure human health. A high proportion of amylose versus a low amylopectin, and an increase in resistant starch, fats, and proteins in foods have been found to reduce starch degradation. Gelatinization, degradation, or retro gradation of starch, various cooking methods, and starch modification by physical and chemical means, naturally lower the glycemic index and increase resistant starch **(Lal *et al*., 2021)**. The results obtained by **Sahu *et al*. (2020)** confirm that high levels of phytic acid, an ant nutrient, have an adverse effect on starch digestibility, slowing starch digestion in the human gastrointestinal tract. This, in turn, leads to a reduced blood glucose response. However, the starch and protein digestibility of rice, some legumes, and their blends increased as a result of fermentation. This change is attributed to the low phytic acid content of these foods, which inhibits amylose breakdown and proteolysis **(Sharma and Khetarpaul, 1995)**. Resistant starch has significant health benefits and important functional properties **(Fuentes-Zaragoza *et al*., 2010)**. The addition of resistant starch to bread, cakes, and pies has been studied (**Baixauli *et al*., 2008; Sanz *et al*., 2009)**, resulting in positive effects on the texture and sensory characteristics of bread. In a study on the effect of cooking on resistant starch content in rice, **Kumar *et al*. (2018)** investigated the composition of rice in terms of moisture content, resistant starch, total carbohydrate, dietary fiber, protein content, ash content, and glycemic index (GI) of three popular rice varieties in both raw and parboiled states and using three cooking methods: rice cooker method, boiling and straining method, and conventional cooking. They observed significant differences in RS content among the three rice varieties. Parboiling and the cooking method had no effect on the protein and fiber contents of the rice varieties. However, parboiling significantly increased the ash content in both varieties. The researcher concluded that cooking methods had no effect on the rice composition or GI. Both resistant starch and total dietary fiber are affected by processing processes such as soaking, hydrothermal treatment, roasting, and frying **(Dhingra *et al*., 2012)**. The results showed that foods prepared based on amylopectin had a high glycemic index (96) compared to the low glycemic index (44) of foods prepared primarily from a boiled wheat product, such as granary, in experimental animals, namely rats **(Thannoun and Al-Kubati, 2010)**. **Roman *et al*. (2019)** stated that the development of RS-enriched bread with acceptable quality characteristics may have a positive impact on modifying glycemic response, controlling body weight, and improving gut health in bread consumers. The growing evidence of the positive health outcomes of RS use has led to the emergence of new RS-based ingredients on the bread making market. Consumption of bread and fermented bread by people with type 2 diabetes is lower due to the presence of resistant starch and slowly digestible starch (SDS), which lowers both rapidly digestible starch (RDS) and (eGI) values **(Demirkesen-Bicak *et al*., 2021)**.

Effect of Fats and Protein

Some studies indicate that there is no ideal amount of protein intake to improve blood glucose levels. However, people with diabetes and those with kidney disease should be careful to reduce the amount of dietary protein in their diet to a small extent to ensure its benefits in blood sugar control. In people with type 2 diabetes, protein intake increases insulin response without raising plasma glucose concentrations. However, high-protein carbohydrate foods should not be used to treat hypoglycemia, at least in this regard **(Usman *et al*., 2020)**. There have been several trials testing high-protein, low-carbohydrate diets for the treatment of type 2 diabetes, with positive effects on blood sugar regulation, including reducing fasting blood glucose, postprandial glucose, insulin responses, and glycated hemoglobin (HbA1c) **(Layman *et al*., 2008)**.

It has previously been known that adding fat and protein to carbohydrates reduces blood glucose responses by delaying gastric emptying and stimulating insulin secretion **(Pi-Sunyer, 2002)**. Lipids reduce starch digestibility in various ways, including acting as a physical carrier, enveloping starch particles, acting as inhibitors of digestive enzymes, or reducing starch swelling, a preliminary process that releases starch and prepares it for degradation **(Debet and Gidley, 2006). Meanwhile, Al-Qabati (2003)** indicated that the protein content of reshta, a local spaghetti-like product, is higher than that of regular spaghetti. This may be the reason for the lower glycemic index of reshta compared to spaghetti, as protein increases insulin secretion and thus reduces the blood glucose response. These effects have several potential implications for human nutrition, such as supporting the role of high-protein or high-fat diets in diabetes management **(Welch, 1987 and Gannon *et al*., 2003)**. Starch forms a matrix in natural foods with fats and proteins. However, research on this internal matrix and the interactions between these food components is relatively limited. **Parada and Santos (2016)** reviewed the fundamentals of the microstructure of the interaction between starch, lipids, and proteins in the diet, as well as their effects on the postprandial glycemic response, taking into account the differences in the human body's glycemic response. They indicated support for the theory that foods without rapidly digestible starch (RDS) do not produce a low postprandial glycemic response, highlighting that a complete understanding of the microstructure of food, which alters or modifies starch digestion, plays a role in nutritionally sound food design. **Koseoglu and Celikel (2021)** indicated that proteins increase insulin secretion and reduce the rate of starch digestion, while fats increase the transit time of food through the stomach to the intestine, leading to a lower glycemic index by forming complexes with starch. Furthermore, a typical high-fat diet enhances the effect of oral glucose on the secretion of several gastric inhibitory peptides **(Morgan *et al*., 1988a)**. Protein is known to produce one peptide, the gastric inhibitor peptide (GIP), which slows the rate of postprandial blood glucose rise and reduces the glycemic index of foods **(Morgan *et al*., 1988b and Gulliford *et al*., 1989)**.

Results from short-term studies have shown evidence of a number of beneficial effects of consuming foods high in protein (22 to 30% of energy intake) from various sources (animal or plant) on the glycemic index. However, long-term medical investigations are still necessary to increase knowledge about the effects of high protein consumption on kidney function, bone health, and the risk of developing cardiovascular disease (CVD). These researchers confirmed that consuming protein in biologically high quantities, such as parent proteins, primarily whey proteins, which are rich in branched-chain amino acids, has beneficial effects on blood glucose balance, resulting in increased insulin secretion and increased cellular uptake of glucose **(Esteves de Oliveira *et al*., 2021)**.

Effect of Dietary Fiber

Dietary fiber represents a group of diverse and heterogeneous plant materials. Their main components are polymerized carbohydrates, such as polysaccharides and oligosaccharides, such as cellulose, hemicellulose, beta-glucan, pectin, and gums, including gum Arabic, guar gum, inulin (beta-fructan), and resistant starch. Lignin, a woody phenolic substance, also differs in its functional properties and is often known for its physiological effects, such as laxative effects, lowering blood glucose, cholesterol, and lipids, and its effects on reducing the risk of cardiovascular diseases, diabetes, cancer, kidney stones, heavy metal poisoning, and others **(Li and Komarek, 2017 and Barclay *et al*., 2021)**. The AACC defines dietary fiber as the edible, non-starchy plant parts that resist digestion and absorption in the small intestine and undergo partial or complete fermentation in the human large intestine. Most soluble fibers ferment rapidly in the colon and are more easily enzymatically broken down **(AACC, 2000)**. There is a difference between dietary fiber and crude fiber. Dietary fiber is the fiber found in food that is eaten and resists digestion by enzymes in the stomach and small intestine, while crude fiber is the fiber that resists digestion by reduced acids and alkalis **(Al-Zuhairi, 2000)**. One of the most important classifications is based on their solubility. Soluble dietary fibers (SDF), which include non-cellulosic polysaccharides, oligosaccharides, pectin, beta-glucans, and gums, are classified as soluble dietary fibers (SDF), while other components, such as cellulose, hemicellulose, and lignans, are classified as insoluble dietary fibers (IDF). Each type has its own physiological functions based on its composition **(Li and Komarek, 2017)**. Soluble fibers are generally found in legumes such as beans and peas, barley, oats, and some fruits and vegetables, while insoluble fibers are found in whole grains, cereal brans such as wheat bran, and vegetables **(Slavin*et al*., 2013 and Nevara *et al*., 2021)**. Insoluble fibers, such as cellulose, hemicellulose, and lectin, found in foods such as wheat bran, whole grains, and vegetables, have a high capacity to absorb water in the intestine, increasing their volume to form a large, low-density mass. This makes them easier to move through the intestines and helps in normal bowel function, reducing constipation and reducing the risk of colon cancer, whether due to carcinogenic chemicals or metabolites formed in the intestines, especially steroids and cholesterol excreted in the bile, as well as increasing beneficial bacteria in the intestinal flora and preventing the growth of pathogenic bacteria. Soluble fibers, found in legumes, oats, barley, and some fruits and vegetables, play a role in lowering cholesterol and other lipid levels in the blood and regulating the normal and balanced utilization of blood sugar **(Nawirska and Uklanska, 2008 and Rana and Bachheti, 2011)**. **While Prasadi and Joye (2020)** reported that soluble dietary fiber increases the viscosity of the stomach and intestines, which leads to a general decrease in enzyme activity and, consequently, a decrease in post-prandial plasma glucose levels. Increasing fiber intake is associated with weight loss due to the feeling of satiety caused by the nutritional bulk of the food, at the expense of energy intake, and due to the technological and physiological properties of dietary fiber, which include water absorption, oil retention, viscosity, texture, stability, and gel-forming properties, along with antioxidant properties **(Elleuch *et al*., 2011)**. Both soluble and insoluble fibers contribute to low-energy diets, so high-fiber foods are often large in volume and low in energy, thus reducing the risk of obesity and helping to maintain weight **(Li and Komarek, 2017)**.

Nogal *et al*. (2021) demonstrated that the fermentation of dietary fiber in the large intestine by commensal beneficial bacteria produces short-chain fatty acids (SCFAs). These acids play a positive role in regulating blood sugar, reducing disease complications, and regulating blood lipid levels, including lowering low-density lipoprotein (LDL) and raising high-density lipoprotein (HDL), which are indicators associated with increased and decreased risk of cardiovascular disease, respectively. SCFAs also reduce the risk of cancer and lower intestinal pH, preventing the growth of harmful bacteria **(Dai and Chau, 2017 and Weickert and Pfeiffer, 2018)**. SCFAs have promising recent results in modulating cardio metabolic diseases (CMD), in addition to their potential to improve various risk factors associated with these diseases, such as dyslipidemia, cholesterol, insulin resistance, hyperglycemia, and inflammation. This is because it leads to the inhibition of the Histone deacetylase (HDAC) system, which removes the acetate group from histone proteins in DNA, making it less capable of being replicated, and activates the free fatty acid receptor (FFAR) system, which is a G protein-coupled receptor (GPCR), which plays an important role in regulating a number of physiological processes in metabolism **(Nogal *et al*., 2021)**. Most studies indicate that type 2 diabetes is inversely related to the consumption of certain foods, such as whole grains, seeds, nuts, and vegetables, while it is directly related to the consumption of other foods, such as starches, sugars, and sugar-sweetened beverages **(Nettleton *et al*., 2008)**.

Silva *et al*. (2015) indicated that lowering the glycemic index, increasing dietary fiber, or both, is a useful method for improving postprandial metabolism in people with type 2 diabetes. They confirmed that relying on a high-glycemic index, low-fiber breakfast resulted in unfavorable blood glucose, insulin, and ghrelin responses in these patients. Similarly, **Gaesser *et al*. (2019)** demonstrated that a low-glycemic index, high-fiber cereal meal in healthy adults improved postprandial endothelial function, resulting in reduced glucose and insulin responses after meals. **Al-Taie (2012)**, **Al-Tak (2017)**, and **Hussein (2020)** found that foods containing high fiber have a lowering effect on blood glucose response and glycemic index. Dietary fiber and cellulose extracted in the laboratory from some vegetables, the peels and pulp of some citrus fruits, and fiber extracted from some types of Iraqi dates, respectively, reduced blood glucose response and glycemic index by fortifying white bread with these extracted fibers. Clear and good acceptance of the produced bread quality was observed compared to white bread without added fiber.

Effect of Food Processing

The method of food preparation and processing and the use of heat affect the glycemic index of legume seeds. In addition, peeling, blending, grinding, milling, and purifying reduce the particle size, increasing the surface area and exposing the starch particles to amylolytic enzymes. This, in turn, is linked to the rapid digestion and absorption of legume carbohydrates, leading to a higher glycemic index. High temperatures or increased heat use significantly affect starch gelatinization, leading to a higher glycemic index **(Singh *et al*., 2020)**. To determine the effect of manufacturing processes on the glycemic index, **Cesbron-Lavau *et al*. (2021)** tested four different methods for manufacturing baked goods: extrusion, rusks, soft-baked cakes, and rotary-molded biscuits. They found that the rotary-block biscuit method preserved the intact natural starch form and low mass porosity. This led to an increase in the slowly digestible starch (SDS) content (28 g/100 g), which in turn led to a reduced blood glucose and insulin response. The results of other methods, however, were a significant decrease in slowly digestible starch (3 g/100 g) and an increase in blood glucose and insulin response. This decrease in slowly digestible starch is attributed to a deterioration in the starch structure, which translates into a change in the crystalline structure of the starch to an irregular, amorphous form. Adjusting blood glucose levels after a meal is a significant goal in the treatment of metabolic diseases, and this is achieved by modifying risk factors such as starch digestibility. Some grains (such as rice) are commonly consumed boiled without further processing, other than milling, but most other grains are typically processed for direct consumption. In many diets, the main processing feature is bread making, whether leavened or unleavened **(Fardet, 2010)**. **Scazzina *et al*. (2013)** noted that the presence of intact or cracked wheat kernels (50%) and the use of sourdough cultures, regardless of white or whole wheat flour, were effective in reducing the glucose response to bread. In addition, low pH, which may delay gastric emptying or create a barrier to starch digestion, was more effective than dietary fiber alone in improving glucose metabolism, regardless of the type of grain. In a study conducted by **Nayak *et al*. (2014)** on potato processing, they found that potato varieties, maturity level, starch structure, food processing techniques, and meal composition all influence the glycemic index. Domestic boiling, microwave cooking, oven cooking, extrusion, and frying all result in differences in the degree of gelatinization and crystallinity of potato starch. Extrusion conditions affect the physicochemical composition of starch, thereby altering its nutritional value. Extrusion results in greater starch gelatinization than conventional cooking methods. Similarly, food processing technologies such as extrusion and encapsulation have received increasing attention because of their ability to modify the physicochemical properties and stability of food systems **(Alani *et al*., 2026)**. Refrigeration and storage of potatoes after processing significantly reduces the glycemic index due to retrogradation of starch molecules. **Zhang *et al*. (2021)** investigated the effect of oat components on the glycemic index of processed oat products, focusing on oat starch, beta-glucans, proteins, and phenolic. They found that processing methods ranging from heat to biotechnological techniques affect starch digestibility and the activity of functional components, thus altering blood glucose response. Processing temperatures facilitate starch gelatinization and increase the glycemic index to varying degrees depending on the thermal conditions. Harsh conditions such as extrusion can cause the decomposition of active components such as beta-glucans, resulting in an increased glycemic index. Cooling of highly gelatinized oat products promotes starch recovery, leading to the formation of resistant starch 3, which in turn lowers the glycemic index. Biological processes such as germination and fermentation can facilitate the release of phenolic compounds with enzyme assistance, thus inhibiting digestive enzymes due to the highly active phenolic compounds. Cassava is a tuber crop native to Africa, particularly in sub-Saharan Africa. It has been found that the cultivars and processing methods used to prepare the cassava for consumption influence its nutritional content. The main factor influencing blood glucose response in in vitro and in vitro experiments is the nature of the starch properties of cassava-based products, which vary with each food **(Eyinla *et al*., 2021)**.

Effect of Organic Acids and Acidity

Recently, it was found that organic acids such as acetic acid and propionic acid reduced blood glucose and insulin responses when added to white bread meals in normal individuals **(Liljeberg and Bjorck, 1998 and Ostman *et al*., 2005)**. Furthermore, adding vinegar to carbohydrate-rich diets significantly reduced blood glucose and insulin responses in diabetic individuals only after meals with a high glycemic index **(Liatis *et al*., 2010)**. **Scazzina *et al*. (2013)** reported that low pH, which may delay gastric emptying or create a barrier to starch digestion, appears to be more effective than dietary fiber in improving glucose metabolism, regardless of the grain type. Furthermore, incorporating technically extracted cereal fiber fractions, or adding specially developed legume, viscous, or non-viscous fiber fractions, are also effective strategies. In a study by **Demirkesen-Bicak *et al*. (2021)**, fermentation type and temperature affect the estimated glycemic index (eGI), texture, and sensory properties of bread dough, and these factors should be taken into account in bread manufacturing. These findings support the consumption of bread and whole meal fermented bread produced in this way by people with type 2 diabetes, due to the presence of resistant starch and slowly digestible starch (SDS) at the expense of rapidly digestible starch (RDS), which leads to a lower eGI.

Liljeberg and Björck (1996) found that the consumption of sourdough bread reduces postprandial blood glucose and insulin responses. This mechanism confirms that organic acids such as lactic and acetic acid produced in sourdough lower the estimated glycemic index (eGI). This is because acetic acid is associated with delayed gastric emptying, while lactic acid promotes the interaction of starch and gluten during dough baking, reducing the starch's ability to be hydrolyzed.

Impact of Phytochemicals

Plants are known as a source of traditional herbal medicine due to their effective role in lowering blood sugar and blood lipids. They are often used due to their accessibility, tissue-specific effects, low cost, and ease of use and handling **(Rahman *et al*., 2021)**. Phytochemicals are secondary metabolites classified according to the metabolic pathways from which they are derived. Their most important sources are berries, nuts, and colorful fruits such as grapes, citrus fruits, and pomegranates, as well as beans, soy, seaweeds, cinnamon, tea, and herbal extracts. The compounds responsible for their activity are phenylpropanoid-derived phenolic, predominantly flavonoids and phenolic acids **(Russell *et al*., 2016)**. Among the foods rich in phytochemicals whose effects on postprandial metabolism have been studied are cherries, nuts, and refreshing beverages such as coffee and tea. **Brasnyo *et al*. (2011)** reported that compounds found in grape pericarps reduced plasma glucose and improved insulin resistance in people with type 2 diabetes. The bran, or outer husk, also contains fiber, vitamin B, and some minerals. The germ contains phytochemicals, vitamin E, and vitamin B, while the endosperm contains carbohydrates and protein. Both the husk and germ contain antioxidants, which play a key role in protecting against many chronic diseases, such as type 2 diabetes **(Miller *et al*., 2000)**. **Ardalani *et al*. (2021)** confirmed that flavonoids, phenolic compounds, alkaloids, and phytosteroids are the most prevalent compounds in root plants that possess ant diabetic activity. They have various mechanisms for controlling diabetes, including inhibiting alpha-amylase and alpha-glycosidase, reducing oxidative stress, increasing insulin secretion, improving retinopathy and nephropathy, in addition to slowing starch digestion and their role in treating hyperglycemia. In a review of the importance of these substances, **Kong *et al*. (2021)** stated that one of the products of tannin analysis, ellagic acid, as an antioxidant found predominantly in cherries, pomegranates, and dried fruits, is a promising substance in the treatment of a number of metabolic diseases such as cardiovascular diseases, neurodegenerative diseases, and kidney disorders, and its role as an anti-diabetic, anti-hyperglycemic, and insulin resistance, in addition to reducing the complications of diabetes.

Mastication Effects

Through mechanical processes such as exfoliation, grinding, extrusion, and flaking, food is subjected to preparatory processes to make it more palatable. Chewing, a process that encompasses all other processes, occurs in the mouth and helps change the size of food particles and molecules, leading to cell wall disruption, facilitating access for digestive enzymes to digest starch and carbohydrates **(Singh *et al*., 2020)**.

Tan *et al*. (2016) reported that various mastication parameters significantly influence blood glucose response. Eating slowly, taking large bites before swallowing, and reducing chewing are inherently effective variables that are generally beneficial for blood glucose control. **Ranawana *et al*. (2010)** confirmed that the rate of chewing and eating behavior varies from person to person, causing variation in glycemic response after eating. The number of chews increases significantly with increasing mouthful size for a number of foods, such as boiled rice. The number of chews per unit weight of food in grams varies significantly between different foods. It is common for food hardness and consistency to vary with increasing mouthful size. The need for chewing varies, leading to increased digestion and starch breakdown, which ultimately leads to higher blood sugar levels after eating. Chewing depends on several external factors, such as solidity, cohesiveness, and moisture content. Decreasing mouthful volume results in an increase in the number of chews per unit weight of food, resulting in a bolus with appropriate swallowing characteristics. Therefore, changing mouthful size may be a useful behavioral modification in regulating energy intake and blood glucose response **(Golo *et al*., 2015)**. Chewing food effectively contributes to changing the glycemic variability of foods. Therefore, there is a need for research into the effect of chewing on blood glucose. It is also possible to leverage eating and chewing behaviors to reduce the glycemic load of foods. In an experiment conducted by **Ranawana *et al*. (2015)**, they found that the glycemic index of some foods, such as rice, is affected by the degree of mastication. Chewing a meal of rice for 15 times compared to 30 times significantly reduced the glycemic index of cooked rice. A study by **Sun *et al*. (2015)** also demonstrated a significant relationship between the number of mouthfuls (mouthfuls) of rice consumed, the amount of rice consumed per mouthful during chewing, and blood glucose response when the rice was eaten with a spoon and chopsticks, but not with the fingers. The study concluded that eating rice using different utensils, such as spoons and chopsticks, results in different chewing times and the amount of food consumed in one mouthful, which, in turn, alters the glycemic index. **Tan *et al*. (2016)** reported that various mastication parameters significantly influence blood glucose response. Eating slowly, taking large boluses before swallowing, and reducing chewing are inherently effective variables that are generally beneficial for blood glucose control.

Effect of Physical Form of Food

Most starchy Traditionally, people eat solid or semi-solid foods. and their degradation during digestion in the mouth and stomach plays an important role in the physical breakdown of food before further digestion in the small intestine. Compared to chewing, the contribution of intestinal digestion to blood glucose is low due to the limited chemical breakdown of starch **(Cassidy *et al*., 2018)**. The particle size of the food ingested and entering the stomach affects the rate of gastric emptying and blood glucose response. This, in turn, is influenced by the processes of grinding, rolling, mashing, cracking, fracturing, and pressing food into fine powders with small particles, as well as by the process of chewing food, which is an important step in the gastric digestion of starchy foods. Some experimental studies in humans have confirmed that increased chewing increases the rate of gastric emptying, but altering the rate of gastric emptying may affect the blood glucose response to food **(Pi-Sunyer, 2002 and Nadia *et al*., 2021).** The refining of seeds and food materials usually results in an increased blood glucose and insulin response, which is evident when comparing whole grains with their refined components. The milling process removes most of the bran and a large proportion of the germ. As a result, refined grains have a higher starch content than whole grains, resulting in lower levels of dietary fiber, vitamins, minerals, essential fatty acids, and other compounds **(Al-Qabati, 2003 and Mete *et al*., 2021)**. The response of blood glucose is significantly altered by the processes of converting grains and raw materials into flour and then processing grains into products compared to whole grain seeds **(Pandolfo *et al*., 2021)**. Similarly, changing the particle size of food leads to changes in glycemic index (GI) values **(Pi-Sunyer, 2002)**. For example, mashed potato pieces to the size of an inch cubed increased their GI by 25% **(Wolever *et al*., 2001)**. Previously, when whole apples, apple puree, and apple juice were compared, the GI and insulin values increased. The index values increased successively as the particle size and components of the food changed as a result of this process **(Haber *et al*., 1977)**. **Mete *et al*. (2021)** demonstrated that differences in the size of different flour particles affected postprandial Insulin and blood glucose levels in individuals with type 2 diabetes. However, there is no clear evidence that flour particle size affects postprandial blood glucose and insulin levels in elderly people with this disease, most of whom are normal for their age. Adding dietary fiber to liquid carbohydrate foods and other foods resulted in lower postprandial blood glucose, although the palatability of these foods was determined by their use as highly important functional foods. Furthermore, changing the physiochemical properties of dietary fibers during manufacturing processes negatively affects the fiber's viscosity, which in turn reduces its efficiency and glucose-lowering ability. The focus is usually on screening the manufacturing steps in order to reduce the parameters of physicochemical properties such as temperature changes, molecular weight, and contact times **(Cassidy *et al*., 2018)**.

Author Contributions

The concept of the study was developed by Yuosra A. Ali, Abdullah A. Alani, Sumyia K. Badawi and Shaimmaa R. Abdulsalaam. Abdullah A. Alani., Sumyia K. Badawi, and Shaimmaa R. Abdulsalaam participated in the investigation and manuscript review. Yuosra A. Ali prepared the first draft of the manuscript, which was reviewed and edited by Abdullah A. Alani, Sumyia K. Badawi, and Shaimmaa R. Abdulsalaam. All authors read and approved the final version of the manuscript.

Funding

No funding was received for this study.

Conflicts of Interest

The authors have declared that they have no competing interests

Conclusion

Currently, there is no authorized worldwide diet plan that targets individuals with type 2 diabetes. For this reason, studies that advance our knowledge of how meal composition influences postprandial glucose will be crucial in the future for individuals with type 2 diabetes. It doesn't seem to be possible to manage PPG by following a low-GI diet without taking into account the energy intakes and carbohydrate content of people with type 2 diabetes. When creating dietary recommendations for people with type 2 diabetes, it is important to take into account both the quantity and kind of carbohydrates in the diet. Reduced carbohydrate intake from a low-GI diet is expected to benefit T2D patients and is a proven strategy for improving postprandial glucose levels.

It is possible to enhance postprandial hyperglycemia without altering the macronutrient composition of the remaining meals of the day by significantly reducing the amount of carbohydrates at breakfast. Teaching patients how to eat a low-GI diet can lead to a lower consumption of carbohydrates, which is known to enhance glycemic management in general. Giving advice to merely divide the most recent meal of the day can improve overall glycemic control in people with poor control, where nutrition education regarding macronutrient composition is impractical or impossible. Furthermore, the notion of substituting meals, in situations when nutrition counseling and supervision are not practical, a meal substitute consisting of specific macronutrient composition that will produce low glycemic reactions, particularly for breakfast, may be a beneficial intervention.

Postprandial glucose excursions are positively impacted by either increasing soluble fiber intake or decreasing the amount of carbohydrates in a meal. The effects of increasing consumption of high-fiber foods are comparable to those of adding a high soluble fiber supplement to meals. This is a useful tactic for lowering postprandial hyperglycemia in people with type 2 diabetes.

In conclusion, it is sensible to conclude that patients with T2D should be encouraged to reduce the carbohydrate content of a meal, that is, to consume a lower GL meal as well as increase soluble fiber content in meals.

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أهمية المؤشر الكلوكوزي والحمولة الكلوكوزية لوزن الجسم والاصابة بالأمراض المزمنة

الخلاصة

تهدف هذه المراجعة إلى استعراض الأدلة العلمية المتعلقة بدور المؤشر الكلوكوزي (Glycemic Index) في تطور الأمراض المزمنة الشائعة في المجتمعات الغربية، ومناقشة أهميته في إدارة هذه الأمراض والوقاية منها. ويُعد المؤشر الكلوكوزي نظامًا لتصنيف الأغذية وفقًا لاستجابة سكر الدم بعد تناولها، إذ يعكس مدى تأثير الكربوهيدرات الموجودة في الغذاء في رفع تركيز الغلوكوز في الدم بعد الوجبة مقارنةً بغذاء مرجعي. وقد ارتبطت مسببات العديد من الأمراض المزمنة، بما في ذلك داء السكري، وأمراض القلب التاجية، وبعض أنواع السرطان، بفرط أنسولين الدم (Hyperinsulinemia)، ومقاومة الإنسولين (Insulin Resistance)، والعوامل المؤدية إليهما، مثل الإفراط في استهلاك السعرات الحرارية، والسمنة، وقلة النشاط البدني. وفي السنوات الأخيرة، حظيت الكربوهيدرات باهتمام متزايد بوصفها أحد أهم العوامل الغذائية المرتبطة بهذه الأمراض، وذلك بسبب اختلاف أنواعها في إحداث استجابات متفاوتة لكل من سكر الدم وإفراز الإنسولين. وأظهرت العديد من الدراسات أن الأغذية ذات المؤشر الكلوكوزي المنخفض، والتي تتميز ببطء هضم وامتصاص الكربوهيدرات، تمتلك تأثيرات أيضية وصحية إيجابية، تشمل تحسين مستويات دهون الدم، والحد من مقاومة الإنسولين وفرط أنسولين الدم، وتحسين تنظيم تركيز الغلوكوز في الدم، فضلًا عن تعزيز الشعور بالشبع، الأمر الذي قد يسهم في التحكم بوزن الجسم وتقليل خطر الإصابة بالأمراض المزمنة. وتستعرض هذه المراجعة نتائج الدراسات التي تناولت التأثيرات الأيضية قصيرة وطويلة الأمد للأنظمة الغذائية ذات المؤشرات الكلوكوزية المختلفة، مع بيان انعكاساتها على الصحة. كما تركز بصورة رئيسية على العوامل المؤثرة في قيمة المؤشر الكلوكوزي للأغذية، إلى جانب تقديم عرض موجز للنتائج المختبرية المتعلقة بالآليات البيولوجية المحتملة التي قد يساهم من خلالها المؤشر الكلوكوزي في التأثير في نشأة الأمراض المزمنة وتطورها.