Glycemic index and glycemic load: Challenges and benefits of clinical applicability

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ABSTRACT
More than 40 years ago, studies about the glycemic index (GI) and glycemic load (GL) began. However, nowadays there is still no consensus regarding dietary prescription based on these indices in the main national and international guidelines. Paradoxically, there is a growing number of research studies pointing to the benefits of diets with low GI and GL. The literature shows that there are still limitations regarding determination protocols, gaps regarding regional foods and the GI's focus on the glycemic response two hours after ingestion. On the other hand, the interest of the scientific community is growing and further studies on the effect of different carbohydrate sources on blood glucose are quite attractive. Evidence of the harm caused by blood glucose and insulin spikes in the development of chronic non-communicable diseases is also an important justification for the emergence of new investigations, despite the limitations highlighted by health guidelines.

Keywords: Glycemic index, Glycemic load, Chronic non-communicable diseases.

1 INTRODUCTION

The use of adjuvant and complementary strategies to nutritional therapies for health promotion and prevention of various diseases is already common in the scientific literature and in the clinical practice of numerous professionals. The intention of applying these therapies is essentially to enhance and/or accelerate the results of traditional or classically adopted therapies, which may generate even better results in some cases (Ross et al., 2016).

The concept of Glycemic Index (GI) has more than 40 years of history (Jenkins et al., 1981), but the consolidation of its definition and the consensus regarding its clinical application are the subject of several discussions. As for the definition, there is little doubt. It is known that any food that contains carbohydrates in its composition can raise blood glucose after ingestion (Passos et al., 2015).

The speed and intensity of this rise translates into an index that is the GI. According to one of the most widely disseminated early definitions of GIs, this index is a categorization of GIs based on

the effect of a food's carbohydrate content and type on blood glucose. In other words, this elevation behavior is a reflection of the composition and cooking methods, for example, of each food (Brand-Miller et al., 1999).

In addition to the glycemic index, the amount of carbohydrate in a food is also considered an important determinant of fasting glucose tolerance and postprandial glycemic response (Atkinson et al., 2021). In this way, another indicator emerges, the glycemic load (GL), which was initially defined as the product of the GI of the food by its glycemic carbohydrate content, being, therefore, a measure that involves the quantity and quality (GI) of the dietary carbohydrate (Danone Vitapole/FAO, 2001).

The glycemic load (GL) reflects the impact of food on blood glucose, considering its quantity (translated into glycemic carbohydrate content) and its quality (characterized by GI). The glycemic load expresses the amount of glucose that must be consumed (in grams) to obtain the same glycemic response as the portion of food in question. It makes it possible to compare glycemic responses of portions consumed from different foods, while the glycemic index allows comparing glycemic responses of different foods, but of the same category and with the same glycidic load (Passos et al., 2015; Atkinson et al., 2021; Manta et al., 2023).

Elevation of blood glucose stimulates the release and production of postprandial insulin. This hormone has an anabolic effect and the overload in its use can favor weight gain, glycemic decompensation and other effects of oxidative stress and inflammation. As a result, several studies have, for many years, pointed to the relationship between low GI diets and the prevention and control of Chronic Non-Communicable Diseases (NCDs), such as Diabetes Mellitus, Obesity, Cancer, Cardiovascular Disease, in addition to improving mental and physical performance (Livesey et al., 2019; Jenkins et al., 2021; Du et al., 2022; Manta et al., 2023).

Most of the literature is focused on the study of the relationship between GA and Diabetes Mellitus (DM) due to its more "immediate" perception of blood glucose. However, there is a lot of research evidence revealing the potential of this index in the prevention and treatment of NCDs (Livesey et al., 2019).

The American Diabetes Association (ADA), an organization that has great repercussions in the world, took many years to endorse GI-based dietary prescription, believing that it does not have a great impact on glycemic control. It was only in 2009 that the ADA began to consider that the indicator deserved attention, although there were still no proposals for operational strategies for its inclusion in the therapeutic and control routine (ADA, 2009).

Years later, in 2015, the discourse evolved, already evidencing the importance of adjuvant therapies, such as the glycemic index and glycemic load in individuals with diabetes, still pointing to the indexed literature as complex and controversial (ADA, 2016). Currently, the guidelines of the ADA (2023) and the Brazilian Society of Diabetes (SBD, 2023) put the GI on the agenda, with less criticism

and considering it as a recommended adjuvant therapy, but not neglecting to emphasize the complexity of the subject, its limitations, and the fact that they should be treated as adjuvants. In other words, basic diet therapy, following the prerogatives of a healthy diet, remains the main objective of nutritional therapy.

Despite the measured recommendations of the aforementioned guidelines, several studies are emphatic in emphasizing significant correlations in their findings and evidence reaffirmed in systematic reviews (Livesey et al., 2019; Jenkins et al., 2021; Du et al., 2022; Manta et al., 2023). Apparently, there is a trend towards updates of the guidelines in this regard as well.

At the time of the emergence of the GI concept, fats were pointed out as great villains of the diet and, therefore, there was a tendency to restrict them and increase the consumption of carbohydrates. As a result, new doubts have arisen regarding the management of carbohydrates in the diet (Brand-Miller et al., 1999).

In the same way that many concepts have evolved since the initial studies on GA and GC (Jenkins et al., 1981) to the present day, the applicability of these tools has been evidenced in a diversified way and positively demonstrated in studies published in important international journals (Manta et al., 2023)

At the beginning of the investigations, the idea would be to better understand how the body could behave after the consumption of different sources of carbohydrates, simple or complex, with high or low fiber content, with a greater or lesser degree of processing. At the time, these were common doubts that should be clarified so that the prescription of carbohydrates could be safer.

As it is a categorization based on carbohydrate response, it is important to note that this evaluation of post-ingestion behavior focuses on the 2 hours post-consumption, since this is the average time needed for carbohydrate digestion and absorption to be completed. With this particularity, it is understood that the protein and fat content of the ingested food does not have a direct evaluation (Passos, 2015; Kim, Kim, & Lim, 2019).

Despite this, it is notorious that the presence of these in foods, in significant quantities, modifies the glycemic curve, response time, peaks in blood glucose, etc. Thus, the behavior generated by the presence of protein and fat in food can influence the glycemic curve of the first 2 postprandial hours, but it will also bring a continuity of this curve after this period (Kim, Kim, and Lim, 2019).

One of the most cited protocols for determining GA and GC is the FAO/Who Expert Consultation (1998), which consists of checking the blood glucose of healthy volunteers in fasting and at 6 moments after ingestion of the test food: at 15, 30, 45, 60, 90 and 120 minutes. In this way, what happens to blood glucose after 120 minutes will no longer be considered.

The facts mentioned in the previous paragraphs, the limitation with the evaluation time and the focus only on carbohydrates, make evident some of the restrictions of the GI and contribute to the difficulties in reaching a consensus regarding its applicability.

On the other hand, these same characteristics can be understood not as limitations, but as potentialities depending on the type of analysis that wishes to be carried out. The specificity of the carbohydrate assessment and the emphasis on the immediate post-ingestion glycemic response may translate the GI as a tool with a higher degree of refinement and focus on the critical moments of peak insulin response after consumption.

Thus, there is a more punctual and accurate glycemic assessment of the immediate behavior after meals, but for this reason, it lacks common sense in its interpretation. It should not be inferred that the performance observed in the first 2 hours post-ingestion will be definitive or will not continue after this period. It is essential to broaden the view of the digestive and absorbed process as a whole, based on the nutritional composition of the food (Kim, Kim, and Lim, 2019).

Having made these reflections, it is reinforced that there is still no consensus regarding the main national and international guidelines regarding the application of the GI (ADA, 2023; SBD, 2023). However, this concept has been frequently suggested in these guides for years, so the discussion still persists and is valid.

Several studies point to positive results regarding the use of this method in dietary assessment and prescription, strengthening the suggestion of its applicability in diet therapy and justifying its mention in the main Brazilian and global guidelines (Livesey et al., 2019; Jenkins et al., 2021; Du et al., 2022; Manta et al., 2023).

The SBD highlighted the methodological limitations of the GI, which generates controversy regarding its recommendation. Although interesting in theory, the practical application is still a challenge. There are many influencing factors, such as origin, climate, soil, preparation, cooking time, and other components of the meal, such as fat content, protein, temperature, and acidity.

Therefore, the clinical application of the glycemic index is controversial, although there is agreement that the quantity and quality of the carbohydrate consumed affect the glycemic response, as well as that the glycemic index and load can bring additional benefits when the total carbohydrates of the meal are accounted for (Atkinson et al., 2021).

Following this thought, researchers have advanced their studies of food GI identification, finding interesting data (Paiva; File; Sousa, 1998; Carreira, 2001; Lemos et al., 2002; Cardoso, 2003; Brand-Miller; Foster-Powell, 2011; Passos, 2015; Kim, Kim, & Lim, 2019).

Passos et al. (2015) refer to several existing tables, which contain the glycemic index produced by foods from different parts of the world and under different physiological conditions, which are the result of several studies carried out in this field of research. These tables are updated as new GI and

GL determinations occur in different foods. Thus, those initially elaborated by Foster-Powell and Brand-Miller (1995) can be cited; Brand-Miller *et al.* (1999); Sydney University Glycemic Index Research Service (2001); Foster-Powell, Holt and Brand-Miller (2002), Brand-Miller and Foster-Powell (2011), among others.

Atkinson et al. (2021), in their systematic review, emphasize that GI and GL tables are essential for research examining the relationship between the glycemic qualities of carbohydrates in foods, diets, and health. They also highlight the importance of renewing studies and discussing this theme, given that in the survey that new values of known foods were modified. Some by new methods of manufacture and others by investigations of other variations and species of the same food.

From the tables, it is possible to determine the GI and GL of the diets usually consumed by healthy individuals with Chronic Non-Communicable Diseases (NCDs), in order to identify a risk consumption for the emergence or loss of control of these diseases. This is, in fact, one of the most used lines of study within the theme of glycemic index and load. The evaluation of diets in terms of indices, comparing the findings with clinical outcomes, has shown that low GI and GL diets have beneficial effects on disease promotion and prevention (Chang et al., 2020).

However, this assessment requires the consultation of the already discovered values of GI and GL in the published tables and the presence of regional foods is a challenge for this analysis. In Brazil, this obstacle exists due to the great diversity of regional foods, even varying between regions of the country (Passos et al., 2015).

Although the available tables are broad and include several foods from different countries (Atkinson et al., 2021), there are still large gaps regarding the GI and GL of regional foods, such as the Brazilian ones, especially considering the varied availability according to each region of the country.

In Brazil, there are many typical foods, whether from the group of cereals, fruits or vegetables. Some Brazilian scholars have already determined the glycemic index of some regional foods, such as Passos et al. (2015), Paiva, Lima and Sousa (1998), Carreira (2001), Lemos et al. (2002) and Cardoso (2003), but several gaps still remain. Passos et al. (2015) identified a relationship of several regional foods, including tropical fruits.

Thus, there is a significant interest of the scientific community in the subject, but the focus of the analysis and the gaps in the tables seem to slow down the evolution of the studies. For this reason, the IG and GC, understood as more specific tools, continue to have limitations pointed out in the main guidelines and are still awaiting more consensual positions.

Still in this paradoxical line represented by the more conservative guidelines, in view of the positive and beneficial findings of numerous recent articles (Livesey et al., 2019; Jenkins et al., 2021;

Du et al., 2022; Manta et al., 2023), it is essential to point out another critical point in the methodology for determining GA and GC.

GI determination protocols have two foods as a reference: either glucose or white bread (FAO, 1998). Depending on the chosen standard, different results (values) are generated, which in practice is considered by some scholars as another obstacle to methodological standardization and the achievement of a consensus in the *guidelines*.

In view of the above, an important historical evolution of these concepts is evident, but there are still shortcomings of standardization that hinder a clearer consensus in the main national and international guidelines. There is strong evidence of the benefits of adopting low-glycemic index and low-glycemic load diets in preventing diseases and improving numerous ailments.

Advances in research and significant findings have allowed these tools to be considered as adjuvant strategies in clinical and nutritional treatment. The expansion of GI and GL determination studies in foods, especially regional ones, has increased the possibility of more comprehensive and democratically verifiable scientific results in different parts of the world. Apparently, it is a scenario of continuous evolution, with its beginning in the 1980s and new perspectives observed today.

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