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From data analysis to action: how continuous glucose monitoring can become an ally in the prevention of type 2 diabetes

Our traditional understanding of glucose behavior has been limited to obtaining static information about something that is deeply dynamic. Conventional tests such as capillary glucose, fasting glucose, or glycated hemoglobin A1c (HbA1c) provide values, averages, or isolated time points which, although useful and widely validated, omit information about the mag-

nitude of changes that occur in glucose behavior. These fluctuations, often invisible to standard tests, are responsible for some of the complications related to diabetes. The emergence of continuous glucose monitoring (CGM) has represented a revolution in the way we understand and manage diabetes by showing continuous and detailed glucose fluctuations instead of isolated measurements (1).

Although the main use of CGM remains the control and monitoring of people with diabetes, in recent years it has begun to be used in other contexts, such as in the prevention of type 2 diabetes mellitus (T2DM).

WHY ARE WE SO CONCERNED ABOUT PREVENTING T2DM?

Recent data on diabetes describe a health problem that already affects millions of people worldwide. According to the latest Diabetes Atlas of the International Diabetes Federation, around 11.1% of the adult population aged 20 to 79 years currently lives with diabetes, and a significant proportion are unaware of it (2). If the trend is not reversed, by 2050 it is estimated that 1 in 8 adults—approximately 853 million people—could be living with this disease.

The most common form of diabetes is T2DM, accounting for approximately 90% of cases. Genetic factors, environment, and lifestyle all play a role in this type of diabetes. Urbanization, population aging, reduced physical activity, overweight, and obesity are risk factors that contribute to the development of T2DM (3).

Therefore, **a substantial proportion of T2DM cases can be prevented or delayed through healthier lifestyles and early diagnosis that allows timely intervention.** However, to achieve this, it is essential to understand how glucose behavior changes over time, how to identify alterations that may indicate a risk of developing diabetes, and which lifestyle modification strategies may be most effective. In this context, CGM is a fundamental tool.

CGM IN OTHER CONTEXTS: NEW OPPORTUNITIES IN POPULATIONS WITHOUT DIABETES

Due to its characteristics (reliability, the information it provides, and ease of use), **CGM opens new possibilities in the study of glucose dynamics**, especially in populations without diabetes. This technology provides three key contributions in this context:

1. **Detecting “subtle”** alterations before the clinical diagnosis of diabetes appears.

2. **Understanding glucose** behavior in different daily life situations and how it changes with aging.

3. **Acting as an educational support** to improve adherence to healthy lifestyle habits.

In this way, CGM becomes a valuable ally for early identification of individuals at higher risk of developing diabetes, understanding how our body responds in different situations (for example, diet and exercise), and addressing healthy habits from a more effective and individualized perspective (4, 5).

WHAT DOES CGM TEACH US ABOUT THE RISK OF DEVELOPING DIABETES?

If we want to understand how CGM can contribute to diabetes prevention, we must first understand how glucose evolves from a healthy state to disease development. In recent years, several research projects have used CGM data from populations without diabetes to study how glucose profiles change with aging and how these patterns relate to the risk of developing diabetes (5, 6).

In a population-based study conducted in our setting, using CGM data from more than 500 individuals without diabetes, it was observed that those who had more than 10% of time with glucose above 130 mg/dL had a significantly higher risk of developing T2DM in the following decade (5). This suggests that CGM can help identify “apparently healthy” individuals with a high-risk glucose profile, offering an opportunity to intervene before diabetes develops. In other words, small repeated glucose alterations that are barely visible in conventional testing appear to provide additional information about diabetes risk. **These findings support the idea that CGM can become a highly useful tool to improve T2DM prevention.**

WHAT DOES CGM TEACH US ABOUT THE EFFECT OF MEALS IN POPULATIONS WITHOUT DIABETES?

Furthermore, CGM allows observation of the effect of diet on glucose curves. In a study analyzing the glucose response to more than 2,000 dinners in individuals without diabetes, it was observed that the response varied »

DUE TO ITS CHARACTERISTICS, CGM OPENS NEW POSSIBILITIES IN THE STUDY OF GLUCOSE DYNAMICS, ESPECIALLY IN POPULATIONS WITHOUT DIABETES

IN PEOPLE WITH T2DM OR PREDIABETES, REAL-TIME VISUALIZATION OF GLUCOSE DATA ACTS AS A POWERFUL DRIVER FOR EFFECTIVE LIFESTYLE CHANGE

» depending on the type of dinner (7). Large meals rich in starch (bread, pasta, potatoes, rice, etc.) were associated with higher and more prolonged glucose peaks over the following six hours. In contrast, dinners that included fruit, although producing a slightly higher initial peak, were associated after 2–3 hours with lower glucose levels compared to dinners without fruit. Additionally, eating dinner after prolonged fasting (for example, skipping lunch) was associated with more pronounced peaks, and going to bed very late after dinner was associated with slightly higher glucose levels during the final part of the night. Although further research is still needed on postprandial glucose responses, these findings demonstrate how **CGM allows analysis of meal effects, opening the door to more precise and personalized nutritional recommendations.**

CGM AS A TOOL TO IMPROVE LIFESTYLE: MAKING THE EFFECTS OF OUR DAILY DECISIONS VISIBLE

Beyond the analysis of CGM data, another important question is whether viewing glucose in real time facilitates sustained lifestyle changes. A behavior change technique aligned with new technologies is biological feedback. This technique, known as “biofeedback,” consists of using real-time biological data obtained through wearable devices (for example, heart rate or calories burned from smartwatches) to observe the immediate impact of our actions. For instance, during running, one can observe how heart rate increases when accelerating pace or decreases when reducing intensity, allowing real-time adjustment of effort and improved performance.

In people with T2DM or prediabetes, real-time visualization of glucose data acts as a powerful driver for effective lifestyle change. The real-time information provided by CGM allows users to establish a connection between what they eat or the exercise they perform and the immediate glucose response (8).

However, there is still limited experience with CGM use in individuals without diabetes. Although CGM may help promote healthy habits, more studies are needed to demonstrate that its widespread use in populations without diabetes clearly reduces disease incidence (9). Therefore, at present,

CGM as an educational tool for prevention should be reserved for individuals at high risk (for example, prediabetes, obesity, family history, etc.) and used in a guided manner within structured therapeutic education and lifestyle intervention programs.

CGM AS A WINDOW TO THE FUTURE: INTEGRATING INFORMATION WITH ARTIFICIAL INTELLIGENCE

The true revolution of CGM as a tool for predicting T2DM lies not in isolated data, but in its ability to integrate information (combining glucose profiles with nutritional, metabolic, and longitudinal follow-up data) and predict disease progression. Through artificial intelligence, models trained on millions of CGM measurements from thousands of adults (mainly without diabetes) have improved the prediction of developing diabetes or cardiovascular complications.¹ These advances point toward more personalized prevention.

TOWARDS MORE PERSONALIZED PREVENTION: THE GLUCOTYPES PROJECT

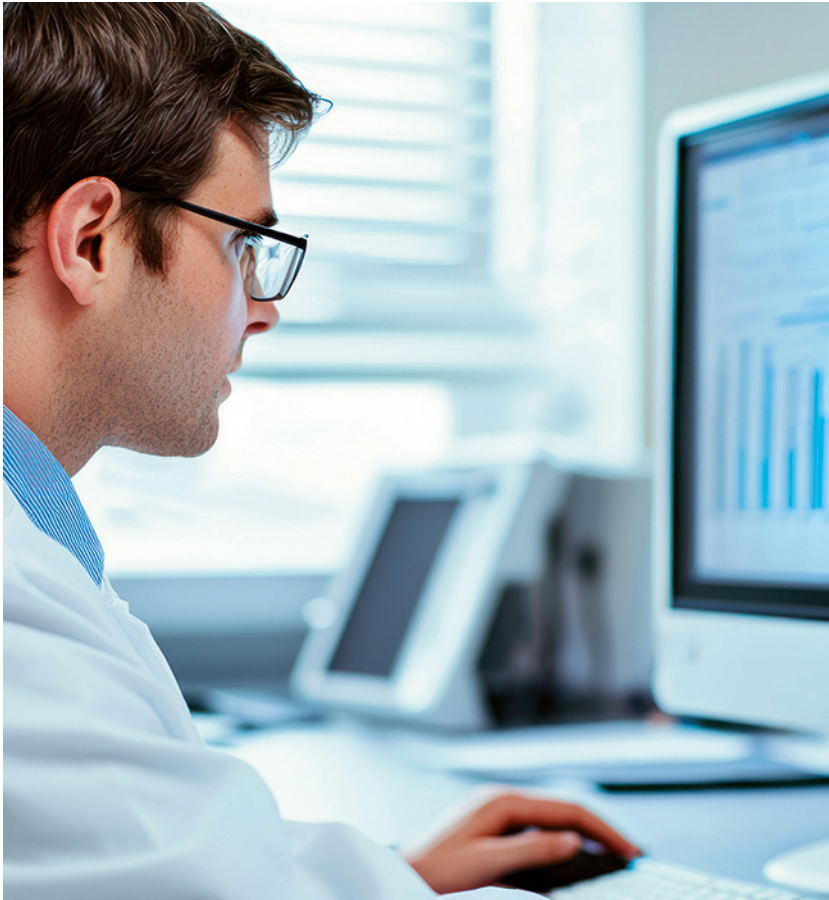
In this context, the European GLUCOTYPES project is being developed, involving researchers from various fields across 5 European countries (10).

The main objective of the project is to identify early patterns of glucose alterations (so-called “glucotypes”) using CGM data combined with dietary information, gut microbiota, and other molecular parameters to:

- Predict how each individual will respond to different foods or dietary patterns using artificial intelligence models trained on CGM profiles.
- Understand the “why” behind these differences by linking CGM data with specific biological mechanisms (genes, microbiota, glycoproteomics, etc.).
- Analyze in clinical studies whether individualized nutrition adapted to each person’s “glucotype” is more effective than general recommendations.

These findings will lay the foundation for personalized nutrition aimed at better preventing and controlling T2DM. **D** »

CGM CAN BECOME A HIGHLY USEFUL TOOL TO IMPROVE THE PREVENTION OF T2DM



CONCLUSIONS

Continuous glucose monitoring has revolutionized diabetes management and is beginning to emerge as a tool to better understand and prevent T2DM.

Available studies show that CGM can help detect glucose alterations before diagnosis, provide highly specific insights into the effects of diet and lifestyle on glucose behavior, and, in certain contexts, promote healthier lifestyle changes.

CGM combined with artificial intelligence is expected to transform T2DM prevention by creating personalized strategies tailored to each individual, enabling early risk detection and timely intervention to prevent disease development.

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