LIFE Science Hub
JOURNAL OF SCIENCE
EXPANDING KNOWLEDGE ABOUT NUTRITION AND HEALTH

ORIGINAL RESEARCH

Glycemic variability: clinical applications and new research perspectives

M. Moscati[1]

1 Italy

1. ABSTRACT

The study analyzed is a narrative review dedicated to glycemic variability, i.e., blood glucose fluctuations throughout the day and between different days. The objective was to describe the indicators obtainable from continuous glucose monitoring and their potential clinical and research use. In the available material, consisting only of the abstract, the authors report that variability increases from prediabetes to type 2 diabetes and is even greater in type 1 diabetes; they also note a correlation between the coefficient of variation and the risk of hypoglycemia.In paragraph 3.1, “Glycemic variability,” of “The Choice to Live in Health or Illness” by Dr. A. Colonnese and R. Panzironi, the publication contributes primarily to explaining that HbA1c and mean blood glucose do not describe all daily glucose fluctuations and that continuous monitoring allows for the calculation of different parameters, such as standard deviation, coefficient of variation, MAGE, MODD, CONGA, and HBGI. Independent studies confirm that HbA1c may not adequately represent the individual glycemic profile and that the coefficient of variation is associated with a higher frequency of hypoglycemia. However, it remains important to interpret the values within the clinical context and using comparable measurement tools.

ONLINE ARTICLE

ARTICLE INFORMATION

Published: November 15, 2026
Updated: November 15, 2026

DOI 10.5281/zenodo.24256858

MISSION

LIFE Science Hub – Journal of Science was founded with the aim of making scientific knowledge accessible without giving up methodological rigour, quality of sources and authoritativeness of content. The journal promotes the dissemination of knowledge in the health, nutrition, medical and longevity sciences, building a bridge between the world of research and society.

Through articles, reviews, in-depth analyses and expert contributions, the Journal champions evidence-based medicine and science, fostering a correct interpretation of scientific data and countering misinformation. Every piece of content is developed with the aim of translating the complexity of research into understandable, useful and applicable information, while keeping intact the principles of accuracy, transparency and scientific independence.

Free from political, industrial and commercial influence, the journal stands as an authoritative and independent editorial space, dedicated to promoting scientific culture, professional development and the growth of health awareness among the public.

2. ANALYZED STUDY

The research question was how to usefully define and measure glycemic variability using data from continuous glucose monitoring. The underlying hypothesis is that average glycemia, and therefore also glycated hemoglobin or HbA1c, is not enough on its own to represent daily glucose trends: two people can have a similar average but very different fluctuations.The publication is relevant to the book's section because it describes the role of continuous glucose monitoring in making visible spikes, rapid drops, episodes of hypoglycemia, and differences between days that a single measurement or an average value cannot show. It also examines the main mathematical metrics used to synthesize this data.As it is a review, the study does not test a new hypothesis in a single cohort of participants and cannot demonstrate that a specific metric improves clinical outcomes. Its main contribution is conceptual and methodological: it clarifies which aspects of glycemic oscillations are described by the different indicators and why their interpretation requires an appropriate clinical context.

3. MATERIALS AND METHODS OF THE ORIGINAL STUDY

The publication is a review, meaning it is a summary of scientific literature rather than an experimental study conducted on a new group of people. In the available abstract alone, the authors discuss metrics of glycemic variability obtained primarily from continuous glucose monitoring records.Among the indicators described are the standard deviation or SD, which expresses how much values are dispersed relative to their mean, and the coefficient of variation or CV, which relates this dispersion to the mean glycemia. Also reported are MAGE, an indicator of the amplitude of major glycemic excursions; MODD, a measure of the differences between values recorded at the same time on consecutive days; CONGA, an index of oscillations over predetermined time intervals; and HBGI, an index that summarizes exposure to high glucose values.This information is not provided in the available material: bibliographic search strategy, databases consulted, period of included publications, study selection criteria, method for assessing the quality of evidence, and data extraction process. For this reason, it is not possible to determine from the available material whether the review was systematic or to quantify the number of studies examined.

4. RESULTS

The key finding is that glycemic variability does not coincide with mean glycemia. In simple terms, an average may appear acceptable even when actual values alternate between significant spikes and rapid drops. According to the abstract, variability increases progressively from prediabetes to advanced type 2 diabetes and is higher in type 1 diabetes.The authors report that the coefficient of variation is correlated with the risk of hypoglycemia, i.e., glucose values that are too low. The direction of the association indicated is therefore clear: greater variability, expressed by a higher CV, is accompanied by a higher risk of hypoglycemia. The abstract does not report numerical correlation values, confidence intervals, P-values, or the characteristics of the populations from which these observations are derived.The standard deviation is described as strongly correlated with numerous other indicators, including interquartile range, MAGE, MODD, and Average Daily Risk Range. The practical significance is that different formulas can capture, at least in part, the same general phenomenon of glucose instability, while focusing on different aspects: the amplitude of spikes, the speed of oscillations, or the repeatability of the profile over subsequent days.The paper also notes that graphical representations by time of day, day of the week, and percentage of time spent in specific glycemic ranges provide clinically useful information. However, from the abstract alone, it is not possible to know which results derive from individual studies, nor to quantitatively compare the performance of the different metrics.

5. INTERPRETATION

For the reader, the essential message is that HbA1c and mean glycemia primarily describe the average level of glucose exposure, while continuous monitoring adds information regarding the stability or instability of that level. This difference is relevant because episodes of hyperglycemia and hypoglycemia can cancel each other out in the average, despite being very different in a person's daily life.The narrative segment documented directly by the publication subject to the Evidence Review is: continuous glucose monitoring calculation of different metrics

description of oscillations that do not emerge from the glycemic average or HbA1c alone. In particular, SD and CV describe the overall dispersion of values; MAGE focuses on the widest excursions; MODD evaluates how the profile changes between consecutive days; CONGA considers variations within a specific interval; HBGI is oriented toward the risk component linked to high values.The reported association between a higher CV and an increased risk of hypoglycemia is biologically and clinically plausible, but it does not mean that the CV is a cause of hypoglycemia. The coefficient of variation is an indicator of glycemic profile instability and can help identify situations in which low episodes are more frequent. The publication, being a narrative review and not a clinical intervention, does not demonstrate that reducing a single metric automatically improves individual prognosis.

6. INDEPENDENT CONFIRMING EVIDENCE

Initial confirmation of the first part of the narrative concerns the limitation of interpreting HbA1c as a complete snapshot of an individual's glycemic control. Beck and colleagues analyzed continuous glucose monitoring data and laboratory HbA1c from 387 participants across three randomized trials. For the same HbA1c value, they observed a wide range of estimated mean glucose: for example, with an HbA1c of 7%, the estimated range was 128–190 mg/dL. This result does not directly measure all metrics of variability, but it confirms that a single HbA1c value does not uniquely identify a person's glycemic profile [1].The relationship between glycemic fluctuations and hypoglycemia was directly evaluated by Monnier and colleagues in 376 people with diabetes undergoing continuous monitoring. The CV, calculated as the standard deviation divided by the mean glucose and multiplied by 100, increased from the group treated with diet and/or insulin-sensitizing drugs to those with type 1 diabetes. In groups treated with sulfonylureas or insulin, and in type 1 diabetes, the frequency of hypoglycemia was higher when the CV exceeded 36% compared to when it was equal to or less than 36%. This observational study therefore supports the direction reported in the review: a higher CV is associated with more hypoglycemia, without proving that the CV is the cause [2].A second retrospective study evaluated 60 people with type 1 diabetes and 100 with type 2 diabetes, who underwent continuous monitoring for 3–6 days and capillary blood glucose recordings. In type 1 diabetes, the frequency of hypoglycemia was higher compared to type 2 diabetes, 53.3% versus 24%, and the CV obtained from continuous monitoring was higher, 40.1% versus 29.4%. HbA1c was a weak predictor of hypoglycemia, while the CV from continuous monitoring discriminated risk well in type 1 diabetes, with an area under the curve of 0.88. The area under the curve here indicates a good ability of the index to distinguish between those who do and do not experience hypoglycemia in the studied sample [3].Overall, these independent publications support the choice to supplement HbA1c with dynamic information obtained from continuous monitoring. The confirmation is more robust regarding the descriptive value of monitoring and the association between high variability and hypoglycemia, while it is less direct for every single formula cited in the book's paragraph. SD, CV, MAGE, MODD, CONGA, and HBGI are not, in fact, perfectly overlapping measures and must be selected based on the clinical or research question.

7. CONFLICTING EVIDENCE

No directly conflicting evidence of sufficient relevance has been identified; this does not prove the absence of contrary results. However, there is significant evidence of a methodological limitation: values derived from continuous monitoring can depend on the device and even the individual sensor used.In an analysis of 20 people with type 1 diabetes, each of whom wore two Dexcom G5 sensors and two FreeStyle Libre sensors in parallel for 14 days, Pleus and colleagues compared time in different glycemic ranges, glucose management indicator, and CV. Significant differences emerged both between different systems and between sensors of the same model. Among different systems, the 75th percentile of absolute differences was 5.0 percentage points for time below 70 mg/dL, 9.2 percentage points for time above 180 mg/dL, and 0.42 percentage points for the glucose management indicator [4].This observation does not deny that continuous monitoring makes glycemic oscillations visible. However, it indicates that a value for CV, time in range, or other metrics should not be interpreted as an absolute measure that is perfectly interchangeable between devices. The sample was

small, included exclusively people with type 1 diabetes, and the duration was limited to 14 days; the result therefore calls for caution, consistency in the instrument used for longitudinal comparisons, and standardization of methods.

8. QUADRO COMPARATIVO E SINTESI DELLE EVIDENZE

The table distinguishes the publication subject to the Evidence Review from the independent research used to confirm or contextualize the narrative of the paragraph.

Quadro comparativo

Reference	Study type	Population or model	Main result	Direction of evidence	Strength of evidence
Original study	Narrative review	Literature on continuous glucose monitoring	Describes metrics of glycemic variability and reports that a higher CV is correlated with a greater risk of hypoglycemia.	biologically consistent evidence	moderate
[1]	Descriptive analysis of data from randomized trials	387 participants from three randomized trials	The same HbA1c value corresponded to a wide range of estimated average glucose.	indirect confirmation	moderate
[2]	Observational	376 people with diabetes undergoing continuous monitoring	CV greater than 36% associated with higher frequency of hypoglycemia, especially in groups treated with insulin.	direct confirmation	moderate
[3]	Retrospective observational	60 people with type 1 diabetes and 100 with type 2 diabetes	In type 1 diabetes, the CV from continuous monitoring effectively discriminated the presence of hypoglycemia; HbA1c was a weak predictor.	direct confirmation	moderate
[4]	Post hoc technical comparison analysis	20 people with type 1 diabetes; four sensors worn in parallel for 14 days	Continuous monitoring metrics, including CV, varied between devices and between sensors of the same model.	discordant evidence	low

9. SINTESI EDITORIALE E CONCLUSIONI

CONCLUSIONS

The analyzed publication consistently supports the idea that glycemic variability represents a distinct dimension from mean glycemia and HbA1c alone. Its most relevant contribution to the book chapter concerns the utility of continuous monitoring to visualize and quantify fluctuations that average indicators do not describe. Independent evidence moderately confirms that HbA1c does not always summarize an individual's glycemic profile and that a higher CV is associated with a greater frequency of hypoglycemia. A cautious interpretation of the values remains necessary, as metrics have different functions and may vary depending on the device used.

Aggiornato al 17/11/2026. Questo contenuto riflette una sintesi divulgativa delle evidenze scientifiche al momento della pubblicazione e non sostituisce il parere medico.

10. TRANSPARENCY AND SCIENTIFIC RESPONSIBILITY

Artificial Intelligence was used solely as a tool for editorial and documentary support. All content, interpretations, bibliographic citations and conclusions have been verified, reviewed and approved by the author, who assumes full scientific responsibility for them.

The manuscript was also subjected to independent peer review prior to publication.

To ensure the greatest transparency, the complete history of the article, including the dates of submission, revision, acceptance and publication, as well as information on the peer review process, is available on the dedicated Article History page.

11. RIFERIMENTI BIBLIOGRAFICI

[1] **The Fallacy of Average: How Using HbA1c Alone to Assess Glycemic Control Can Be Misleading**
Beck et al., 2017
Diabetes Care
DOI: https://doi.org/10.2337/dc17-0636

[2] **Toward Defining the Threshold Between Low and High Glucose Variability in Diabetes**
Monnier et al., 2017
Diabetes Care
DOI: https://doi.org/10.2337/dc16-1769

[3] **Beyond HbA1c: Comparing Glycemic Variability and Glycemic Indices in Predicting Hypoglycemia in Type 1 and Type 2 Diabetes**
Rama Chandran et al., 2018
Diabetes Technology & Therapeutics
DOI: https://doi.org/10.1089/dia.2017.0388

[4] **Time in Specific Glucose Ranges, Glucose Management Indicator, and Glycemic Variability: Impact of Continuous Glucose Monitoring (CGM) System Model and Sensor on CGM Metrics**
Pleus et al., 2021
Journal of Diabetes Science and Technology
DOI: https://doi.org/10.1177/19322968209318 25