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# **BEYOND THE DATA: CONTINUOUS GLUCOSE MONITORING (CGM) TECHNOLOGIES, HEALTH EQUITY, AND THE DIGITAL DIVIDE IN DIABETES MANAGEMENT. A NARRATIVE REVIEW**

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**ABSTRACT**

Continuous glucose monitoring (CGM) represents a paradigm shift in diabetes management, transitioning care from reactive monitoring to proactive glycemic control; however, its adoption remains stratified by deep-seated socioeconomic and structural, and technological inequities. This narrative review synthesizes literature published between 2017 and 2025 to evaluate the clinical efficacy of CGM while interrogating the socio-technical barriers shaping its accessibility. A thematic analysis of current evidence confirms that while CGM significantly improves HbA1c, quality of life, and hypoglycemia reduction across Type 1 and Type 2 diabetes, access to these outcomes is severely constrained by systemic and digital obstacles. Key findings identify a “coverage patchwork” wherein high out-of-pocket costs and administrative hurdles disproportionately restrict access for Medicaid beneficiaries and low-income populations. Furthermore, the review highlights persistent racial disparities driven by provider implicit bias, alongside a “digital divide” where limited connectivity and low eHealth literacy impede effective utilization. Consequently, without intervention, CGM risks functioning as an “accelerator of disparities,” creating a two-tier healthcare system that privileges “data-rich” early adopters while leaving marginalized groups behind. The authors conclude that bridging this gap requires a multifaceted strategy integrating policy reform, inclusive device design, and literacy-centered education to ensure technological innovation advances health equity rather than reinforcing the “Matthew Effect” in diabetes management.

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**KEYWORDS**

Continuous Glucose Monitoring, Health Equity, Digital Divide, Social Determinants of Health, Diabetes Management, Healthcare Disparities

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**1. Introduction**

Diabetes mellitus represents one of the most pressing global public health challenges of the 21st century, affecting hundreds of millions of people worldwide and contributing substantially to morbidity, premature mortality, and escalating healthcare costs (AOTMiT, 2021). The disease’s long-term complications - including cardiovascular disease, nephropathy, neuropathy, and retinopathy - underscore the critical importance of effective glycemic control in mitigating individual and societal burdens (Heinemann, 2008; Tatoń, 2009). Despite advances in pharmacotherapy and patient education, achieving optimal glucose regulation remains challenging, largely due to limitations inherent in traditional self-monitoring of blood glucose (SMBG). Conventional SMBG relies on episodic finger-prick measurements, providing only isolated snapshots of glucose levels and failing to capture rapid fluctuations or nocturnal excursions. These methods impose significant physical and psychological burdens on patients, often resulting in suboptimal adherence and incomplete data for informed clinical decision-making (Tatoń, 2009).

Continuous glucose monitoring (CGM) technologies represent a paradigm shift in diabetes care by transforming glucose measurement from episodic and reactive to continuous and anticipatory. CGM devices provide real-time, dynamic glucose profiles, enabling patients and clinicians to identify trends, predict glycemic excursions, and implement timely interventions before adverse events occur. This shift from reactive to proactive management has the potential to improve glycemic outcomes, reduce hypoglycemic events, enhance patient engagement, and support individualized treatment strategies (Riddell et al., 2017; Rodbard, 2017). Beyond clinical benefits, CGM facilitates integration with telemedicine platforms, offering opportunities for remote monitoring and data-driven care, which has become particularly relevant in the context of disruptions to healthcare delivery during the COVID-19 pandemic (Polish Diabetes Association, 2023).

However, despite representing a significant innovation in care, CGM adoption remains uneven, constrained by cost, insurance coverage, and systemic barriers that disproportionately affect

socioeconomically marginalized populations. The resulting digital divide raises critical concerns regarding health equity, as access to this transformative technology is not universal (Kulińska, 2021). While CGM holds the promise of transforming diabetes management, there is a paucity of research exploring the intersection of technological innovation, social determinants of health, and equitable access. Understanding and addressing these barriers is essential to ensure that the benefits of CGM are realized broadly, rather than being confined to well-resourced or digitally literate populations.

While the clinical potential of CGM systems is well established, their benefits are not distributed equitably across populations. Both Type 1 (T1D) and Type 2 diabetes (T2D) are increasingly managed with CGM and other digital tools, reflecting a convergence in therapeutic strategies despite their differing pathophysiologies (Battelino et al., 2019; Beck et al., 2017). From a socio-technical and health policy perspective, however, patients across both diagnostic groups encounter shared barriers that limit access to these technologies - particularly cost, insurance coverage, and digital literacy (Walker et al., 2021). These constraints reveal that innovation alone does not ensure equitable healthcare delivery; rather, it may amplify pre-existing social and economic divides.

Two interrelated frameworks are particularly useful in understanding these disparities: health equity and the digital divide. Health equity refers to the fair and just opportunity for all individuals to achieve optimal health outcomes, requiring the removal of structural barriers such as socioeconomic disadvantage, geographic inaccessibility, and discriminatory health systems (Braveman et al., 2022). The digital divide, by contrast, highlights unequal access to and proficiency with digital tools that are increasingly integral to chronic disease management (van Dijk, 2020). In diabetes care, these dimensions intersect - patients with limited financial means, unreliable internet access, or low technological literacy are less likely to benefit from CGM data interpretation and integration into clinical decision-making. Thus, what was envisioned as a democratizing innovation has, paradoxically, risked reinforcing social inequities in chronic disease management.

This uneven adoption of CGM technologies can also be interpreted through Rogers' Diffusion of Innovations Theory (2003), which explains how new technologies spread through populations in stages - beginning with early adopters who are typically affluent, educated, and digitally literate. Within diabetes care, this diffusion model has favored well-resourced individuals, while structurally marginalized groups remain excluded due to systemic financial and technological barriers. Such inequitable diffusion perpetuates a digital stratification of care, where CGM use - and the associated improvements in outcomes - are concentrated among individuals already advantaged within healthcare systems.

Accordingly, this narrative review seeks to move beyond clinical efficacy and toward a critical socio-technical analysis of CGM adoption. Its objective is to synthesize current evidence on the clinical effectiveness of CGM in both T1D and T2D populations while interrogating the broader societal factors - economic, infrastructural, and digital - that shape access and utilization. By integrating biomedical data with social science perspectives, this review aims to illuminate how health technologies, when implemented without equity-oriented frameworks, may inadvertently deepen existing disparities. Understanding these dynamics is crucial for designing inclusive diabetes care models that ensure CGM technologies benefit all patients, rather than a digitally privileged few.

## 2. Methodology

This study was designed as a comprehensive narrative review to synthesize key literature regarding the intersection of Continuous Glucose Monitoring (CGM) technologies, health equity, and the digital divide. Unlike a systematic review focused purely on quantitative aggregation, this approach integrates clinical efficacy data with socio-technical perspectives to provide a holistic analysis of access barriers. To ensure a rigorous evaluation of the current evidence, a structured literature search was performed across three primary electronic databases: PubMed/MEDLINE, Scopus, and Google Scholar. The search parameters were restricted to literature published between January 1, 2017, and February 2025. This timeframe was specifically selected to capture the most contemporary findings regarding current-generation CGM devices and recent policy changes, such as Medicaid expansions, ensuring the review reflects the current technological landscape. However, seminal theoretical works and key historical references were included regardless of publication date to provide necessary context.

The search strategy employed a combination of Medical Subject Headings (MeSH) and free-text keywords organized into two thematic clusters. The first cluster focused on the technological and clinical domain, utilizing terms such as "Continuous Glucose Monitoring," "CGM," "Diabetes Technology," "Glycemic Control," and "Real-time CGM." The second cluster addressed the socio-economic and equity domain, including terms like "Health

Equity," "Healthcare Disparities," "Digital Divide," "Socioeconomic Status," "Social Determinants of Health," "Underserved Populations," and "Health Literacy." These terms were combined using standard Boolean operators to identify relevant studies situated at the intersection of these domains.

Eligibility was determined based on pre-defined criteria tailored to the narrative scope of the review. The selection process prioritized peer-reviewed original research, including randomized clinical trials, observational cohort studies, and cross-sectional surveys that assessed CGM efficacy or usage patterns. Additionally, systematic reviews, meta-analyses, economic evaluations regarding cost-effectiveness, and clinical consensus statements were included to provide high-level evidence. Articles were excluded if they were not published in the English language, were editorials lacking empirical data, or focused exclusively on distinct clinical contexts such as gestational diabetes or inpatient monitoring, which fall outside the scope of chronic disease self-management inequities.

Following the selection process, the included articles underwent a full-text review to verify methodological quality and relevance. Data were subsequently extracted and synthesized using a thematic analysis approach. The findings were organized into three structural domains corresponding to the review's objectives: the clinical evidence base, structural and socio-economic barriers, and the digital divide. This structure facilitates a critical evaluation of how technological innovation interacts with existing societal disparities, moving beyond simple clinical efficacy to a broader socio-technical understanding.

### 3. Results

#### 3.1 The Clinical Evidence Base for CGM

The reviewed literature consistently demonstrates that CGM systems provide high-resolution, near-continuous measurement of interstitial glucose concentrations, enabling identification of glycemic patterns not detectable with conventional self-monitoring. Across included studies, CGM devices sample interstitial glucose every 1-5 minutes via a subcutaneous enzymatic sensor, generating thousands of data points per day. Specifically, this technology typically delivers approximately 288 readings every 24 hours, providing a dynamic profile that vastly exceeds the data density of the 4-6 daily measurements obtained via standard self-monitoring (Rodbard, 2017). This continuous stream captures nocturnal glucose trends, postprandial excursions, and rapid fluctuations often missed by episodic fingerstick testing (Martens et al., 2021; Leelarathna et al., 2022). These operational principles are well established in contemporary CGM reviews, which highlight the technology's capacity to quantify real-time glucose dynamics and support therapy optimization (Mian et al., 2019). Standardized metrics derived from CGM data - including time in range (TIR), time below range (TBR), and time above range (TAR) - were consistently applied across trials, reflecting alignment with international consensus recommendations for wear-time, analytic standards, and thresholds of clinical relevance (Battelino et al., 2023).

Within this operational framework, CGM modalities include real-time CGM (rtCGM), which continuously transmits glucose values with predictive alarms, and intermittently scanned CGM (isCGM), which requires user-initiated scanning, with alerts varying by device generation. Evidence indicates that rtCGM more effectively reduces exposure to glycemic extremes due to real-time notifications, whereas isCGM enhances day-to-day visibility but exhibits outcomes influenced by scanning frequency (Battelino et al., 2023; Martens et al., 2021). Despite these differences, both approaches provide substantially more granular glucose information than fingerstick monitoring and support standardized research endpoints.

In adults with T1D, the multicenter FLASH-UK randomized clinical trial (Leelarathna et al., 2022) provides high-quality contemporary evidence. Over 24 weeks, HbA1c decreased from 8.7% to 7.9% in the isCGM group versus 8.5% to 8.3% with conventional monitoring (adjusted difference -0.5%; 95% CI -0.7 to -0.3;  $p < .001$ ). TIR increased by 9 percentage points ( $\approx 130$  minutes/day), while time  $< 70$  mg/dL decreased by 3 percentage points ( $\approx 43$  minutes/day). These improvements were consistent across baseline HbA1c levels, including in individuals with prior hypoglycemia.

Across the broader T1D literature, CGM consistently improves glucose stability, reduces glycemic variability, and lowers hypoglycemia exposure. FLASH-UK reported significant reductions in nocturnal and daytime hypoglycemia (Leelarathna et al., 2022). Consensus standards further confirm that CGM metrics capture meaningful reductions in hypoglycemia and variability, underscoring CGM's superiority for identifying excursions undetected by SMBG (Battelino et al., 2023). Evidence from insulin-treated T2D trials parallels these findings, demonstrating that continuous data identify abnormalities systematically missed by fingerstick monitoring (Martens et al., 2021). Patient-reported outcomes generally favor CGM, with reduced diabetes distress and improved treatment satisfaction, while adverse events remain minimal and primarily

limited to minor sensor-site reactions (Leelarathna et al., 2022; Martens et al., 2021). Moreover, real-world evidence demonstrates that CGM initiation is associated with a significant reduction in hospitalizations for acute diabetes complications and sustained improvements in health-related quality of life (Roussel et al., 2021).

In adults with T2D, a growing evidence base supports CGM effectiveness across a range of treatment intensities. The MOBILE randomized clinical trial (Martens et al., 2021) showed that rtCGM reduced HbA1c from ~9.1% to 8.0%, compared with a reduction to 8.4% in the control group (adjusted difference -0.4%; 95% CI -0.8 to -0.1;  $p = .02$ ). TIR was higher in rtCGM users (59% vs. 43%), with significantly less time >250 mg/dL, indicating meaningful reductions in sustained hyperglycemia.

Across multiple T2D studies, CGM enhances recognition of dietary and behavioral contributors to glucose excursions and supports more precise insulin titration. Improvements in TIR often precede or exceed changes in HbA1c, highlighting CGM's sensitivity to day-to-day glycemic fluctuation. Reductions in TBR are also reported - particularly with rtCGM due to alarm-mediated prevention of hypoglycemia. Patient-reported outcomes show reduced diabetes-related distress and improved perceived management, though these remain secondary endpoints.

Long-term follow-up of the MOBILE cohort provides insight into the durability of CGM benefits. Aleppo et al. (2022) reported that discontinuing CGM led to deterioration of glycemic control, with declines in TIR and increases in HbA1c after sensor withdrawal, despite unchanged insulin regimens. This pattern indicates that continuous feedback is critical for sustaining prior improvements.

Across the included studies in type 1 and type 2 diabetes, CGM consistently improves glycemic outcomes without evidence of harm (Leelarathna et al., 2022; Martens et al., 2021). Specifically, data indicate that rtCGM produces the most robust reductions in glycemic extremes due to real-time alerts (Battelino et al., 2023), whereas isCGM provides substantial benefit when used consistently, as evidenced by the FLASH-UK trial (Leelarathna et al., 2022). Taken together, the convergence of evidence confirms that continuous glucose data - whether accessed automatically or via scanning - enable more precise glycemic assessment than fingerstick monitoring alone (Rodbard, 2017; Battelino et al., 2023).

## 3.2. The Health Equity Gap: Structural & Socio-Economic Barriers

### 3.2.1. Cost & Insurance: The Role of Financial Burden & Coverage Structure

Direct costs and insurance type remain among the most powerful determinants of CGM access, particularly in populations with lower socioeconomic status (SES). Findings from Miyazaki et al. (2024), based on a cohort of 1,770 patients (n=878 in 2021; n=892 in 2022), demonstrate that Medicaid expansion drove an increase in CGM use from 41% to 58%, whereas utilization among privately insured individuals remained consistent at 84% throughout the study period. The authors emphasize, however, that administrative barriers persist: public insurance was the strongest negative predictor of CGM use (OR = 0.23), indicating that Medicaid beneficiaries remained substantially less likely to use CGM than those with private coverage (Miyazaki et al., 2024).

This issue reflects a broader phenomenon in the U.S. healthcare system described by the American Diabetes Association (2025) as a national "coverage patchwork" - a mosaic of state-specific Medicaid rules. Many states impose restrictive CGM eligibility criteria, including documentation that patients perform self-monitoring of blood glucose at a mandated daily frequency. Consistent with this, Miyazaki et al. (2024) reported that publicly insured patients - particularly children - were required to show proof of at least three daily glucose checks to qualify for CGM. Reflecting this regulatory landscape, Smith et al. (2023) demonstrated how such SMBG requirements appear in policy and economic modeling: in their discrete choice experiment, the standard finger-prick test was explicitly defined as four daily measurements, reflecting how these expectations are embedded in technology-assessment frameworks. These requirements are minimal or absent in many private insurance plans, generating a systemic advantage for patients with higher socioeconomic status. A further mechanism exacerbating inequities involves differences in device acquisition pathways determined by insurance benefit design. Depending on plan structure, CGM can be dispensed either through the pharmacy benefit - allowing direct pickup at pharmacies - or through the durable medical equipment (DME) channel, which involves different cost-sharing rules and administrative steps (Allaire et al., 2024). This structural variation directly influences patient burden, disproportionately affecting those with limited capacity to navigate bureaucratic hurdles.

Out-of-pocket (OOP) costs remain a critical barrier to adoption of diabetes technology. Evidence shows that many patients, despite interest in CGM, discontinue or refuse the technology due to financial strain, reverting to traditional SMBG (Smith et al., 2023). Market estimates suggest monthly CGM sensor costs of

USD 160-500 without comprehensive coverage, translating to an annual expense of USD 2,000-4,500 depending on model and replacement frequency (Frank et al., 2024). Scientific evidence confirms that CGM utilization is strongly dependent on OOP cost; financial barriers reduce uptake among lower-income populations and disrupt regular glucose monitoring, undermining metabolic control (Smith et al., 2023).

From a broader economic perspective, Frank et al. (2024) demonstrated that, over a 10-year horizon, CGM is cost-saving for Medicaid compared with SMBG, generating approximately USD 1,700 in savings per patient due to reductions in hospitalizations and micro- and macrovascular complications. These findings suggest that restrictive coverage and administrative requirements may lack economic justification while reinforcing inequities in access. Collectively, the reviewed evidence identifies insurance - both type (public vs. private) and structural design (pharmacy benefit vs. DME) - as a critical determinant that differentially shapes access to CGM, creating disproportionate barriers for patients with the lowest SES.

### 3.2.2. Racial & Ethnic Disparities

A substantial and expanding body of evidence demonstrates that racial and ethnic inequities in CGM access arise from three interconnected mechanisms: communication gaps in clinical encounters, systemic racism, and clinician implicit bias. In a systematic review of 36 studies, Patel et al. (2024) reported that Black and Hispanic patients did not achieve CGM recommendation or utilization rates comparable to White patients in any included study. Reported odds ratios were consistently lower: for Black patients, OR 0.38-0.55; for Hispanic patients, OR 0.52-0.68 - corresponding to 35-62% lower odds of CGM use despite comparable clinical indications. These patterns are described as “first-step disparities,” in which clinicians are less likely to initiate discussions about CGM with minority patients (Patel et al., 2024).

Strong corroboration comes from Kanbour et al. (2023), who analyzed a cohort of 1,258 patients in a safety-net setting - healthcare facilities mandated to serve vulnerable populations regardless of ability to pay. Black patients had a CGM-related discussion in only 7.9% of visits (vs. 30.3% for White patients) and exhibited significantly lower adjusted odds of both discussing CGM (aOR = 0.51) and receiving a CGM prescription (aOR = 0.61). These differences persisted after adjustment for SES, insurance type, HbA1c, visit frequency, and hospitalizations - confirming provider-patient communication gaps as an independent mechanism of disparity (Kanbour et al., 2023). These clinical disparities operate within a broader framework of structural racism. In a narrative review, Agarwal et al. (2023) highlighted that systemic features - resource allocation, availability of diabetes educators, clinic geography, and uneven institutional funding - consistently advantage majority populations. The authors note that even in systems with uniform clinical guidelines, the organization of services and resource distribution systematically disadvantage racial and ethnic minorities (Agarwal et al., 2023). Patel et al. (2024) further report that the clinics serving the highest proportions of Black and Hispanic patients have fewer educators, reducing opportunities for technology counseling and indirectly lowering CGM adoption.

A third key mechanism involves clinician implicit bias. In a vignette-based study of 225 clinicians, Odugbesan et al. (2022) found that recommendations varied according to patient name - serving as a proxy for race/ethnicity - despite identical clinical information. The study revealed that 34% of clinicians exhibited measurable implicit bias, and race/ethnicity was among the two most influential factors in decisions to recommend CGM or insulin pumps (Odugbesan et al., 2022). Patel et al. (2024) similarly note that assumptions about “anticipated engagement” or “adherence” among minority patients constitute recurring mechanisms of provider-level gatekeeping.

### 3.2.3. Socioeconomic Status: The Impact of Education, Geography & Income

Socioeconomic status remains one of the most consistent determinants of CGM utilization. Its influence manifests through education level, geographic location, and income. In a systematic review, Been et al. (2024) reported that individuals with lower educational attainment had significantly lower probabilities of CGM use, attributed to limited health literacy, challenges in interpreting glucose data, and the cognitive burden associated with technology management. Higher education was found to moderate the effects of other SES components - those with more education were more likely to initiate discussions about technology and to use devices effectively (Been et al., 2024).

Geographic location represents another key SES dimension. Foss et al. (2023) found that rural patients had significantly poorer access to endocrinology care: only 5.5% attended an endocrinology visit versus 9.3% of urban residents. These differences translated into fewer follow-up visits (3.2 vs. 3.9 annually) and lower

odds of achieving the composite D5 diabetes care metric (aOR = 0.93, 95% CI [0.88–0.97]), indirectly reflecting more limited access to diabetes technology and related support (Foss et al., 2023).

The most compelling evidence regarding income and material deprivation comes from a national analysis by Sebastian-Valles et al. (2024). In a healthcare system offering fully subsidized flash CGM, patients in the lowest SES quartile - a marker for the lowest income bracket - nevertheless demonstrated poorer glycemic outcomes (mean time-in-range 57.8% vs. 64.9% in the highest SES quartile;  $p < .001$ ). These findings suggest that low income imposes barriers beyond the direct cost of devices, such as competing life priorities or unstable living conditions. Low-SES patients also had more than twice the odds of failing to achieve glycemic targets (OR = 2.27) and over three times the risk of cardiovascular events (OR = 3.80), despite identical access and cost (Sebastian-Valles et al., 2024).

Overall, these findings confirm that SES functions as a multidimensional set of overlapping barriers: lower education limits capacity to interpret CGM data, rural residence restricts access to specialist consultations and diabetes education, and financial instability reduces the ability to engage consistently in care. Even in systems with full reimbursement, individuals with the lowest SES remain underrepresented among CGM users and achieve poorer clinical outcomes.

### 3.2.4. Provider-Level Barriers

Provider-level barriers - particularly in settings serving low-income populations - play a significant and often underrecognized role in limiting CGM access. Wallia et al. (2024) reported that in Federally Qualified Health Centers (FQHCs), which predominantly care for low-income patients, CGM utilization was extremely low: only 11% of patients with T1D and 1% with T2D received a CGM prescription. The authors emphasize that FQHCs operate under substantial resource constraints, which systematically limit the implementation of new technologies (Wallia et al., 2024).

Similar patterns were documented by Vimalananda et al. (2025) in their nationwide study of 1,373 clinicians across 122 Veterans Health Administration primary care clinics. Only 20% of clinicians reported adequate knowledge of CGM, 15% felt they had sufficient time capacity, 8% reported access to appropriate resources, and just 5% perceived leadership or interdisciplinary support as adequate. The study also identified major workflow challenges, including limited time for CGM data review and difficulties integrating CGM data with electronic health records, both of which constrain real-world implementation (Vimalananda et al., 2025).

Administrative barriers further exacerbate these workflow challenges. As highlighted in the previously discussed findings by Miyazaki et al. (2024), bureaucratic hurdles - such as prior authorization requirements - function as an “administrative gatekeeper,” restricting access even when CGM is clinically justified and placing additional burden on providers attempting to prescribe technology.

Collectively, the reviewed evidence identifies staffing shortages, inadequate clinician knowledge, limited organizational resources, and administrative burden as structural factors that reduce the likelihood of CGM implementation, particularly in clinics serving patients with the lowest SES.

### 3.3 The Digital Divide: Technological & Literacy Barriers

The growing role of digital technologies in diabetes care - particularly CGM systems and mobile applications - has highlighted a set of non-cost barriers. These challenges, encompassing infrastructure, device usability, and patient competencies, fundamentally shape access, usability, and clinical outcomes. Although smartphone ownership is high even in resource-limited populations - 95% in one cohort of safety-net hospital patients - digital exclusion barriers persist (Sabben et al., 2024). In this cohort, 88% of participants reported daily smartphone use, and the majority (84% of identified models) owned devices released within the last 5 years, suggesting that hardware compatibility may be less of a barrier than previously assumed for this specific group. However, access to hardware does not equate to effective utilization; in the same study, despite high ownership, only 27% of participants used mobile apps for general health management, indicating a gap between possessing technology and leveraging it for clinical benefit (Sabben et al., 2024).

Connectivity constraints form a parallel barrier. Digital literacies, stable internet access, and adequate data plans - often collectively described as a “super” social determinant of health - remain disproportionately low among people with lower income, rural residence, or lower education, falling under the broader framework of digital determinants of health (Sieck et al., 2021). Socioeconomic factors further restrict access, as many patients rely on minimal-capacity data plans. Critically, this lack of sufficient data plans and stable connection directly compromises the safety and efficacy of CGM use: it prevents the real-time transmission of glucose data (e.g., via Share/Follow functions) from the patient's device to caregivers or healthcare providers (Joubert

et al., 2019). This loss of continuous data flow delays essential remote monitoring and timely interventions required for dose titration or mitigating acute hypoglycemic events, which is particularly vital for high-risk patients, such as adolescents or those with nocturnal hypoglycemia (Tanenbaum et al., 2017). This digital exclusion reduces engagement with digital health tools, including patient portals and diabetes apps, and inactive portal status is associated with higher material deprivation (Parker et al., 2022). This systemic exclusion culminates in “health data poverty”: a lack of representativeness (e.g., racial or ethnic) in datasets used to train innovation, which effectively prevents marginalized groups from benefiting from future technological advancements (Ibrahim et al., 2021).

Beyond infrastructure, eHealth literacy - the ability to operate, interpret, and apply digital health information - varies significantly across patient groups and is a critical predictor of perceived usefulness and intention to use digital tools (Van Rhoon et al., 2022). Clear generational gradients are pronounced: confidence in app use reached 93% among adults aged <45 (n=25/27), in sharp contrast to 61% among those aged >59 (n=14/23) (Sabben et al., 2024). Practical barriers encompass not only initial setup friction but also ongoing “technology hassles” - such as device malfunctions or intrusive alarms - which are frequent points of frustration leading to discontinuation (Tanenbaum et al., 2017). Furthermore, this constant intrusiveness and cognitive burden imposed by continuous monitoring can have paradoxical effects: while some patients find the data flow reassuring, others report that it increases anxiety and obsessive behavior, leading to “data burnout” (Bober et al., 2025). Users consistently prefer simple, low-burden tools that minimize user effort; for example, 85% of users expressed interest in automated blood sugar tracking, while 76% favored passive SMS notifications. In sharp contrast, interest dropped significantly for features requiring manual data entry - such as dietary logging - which participants identified as burdensome and a barrier to sustained use (Sabben et al., 2024).

Data indicate that health literacy - specifically the ability to accurately interpret CGM-generated information - remains a critical barrier to effective use. Research contexts highlight that standard CGM outputs are dense and can overwhelm users, creating a context where unclear alerts increase misinterpretation risk. Addressing this issue, Kongdee et al. (2025) reported that the inclusion of textual explanations significantly increased interpretation accuracy for alarms and sensor errors, including low-glucose warnings. Specifically, in ambiguous scenarios such as “compression lows” (false low readings caused by pressure on the sensor), participants without textual guidance frequently misidentified false readings as genuine hypoglycemia and decided to consume carbohydrates, potentially causing hyperglycemia. In contrast, the group provided with textual support correctly identified the sensor error, thereby avoiding unnecessary intervention.

Usage patterns indicate a persistent reliance on immediate data over analytical features. In the cohort studied by Sabben et al. (2024), 86% of users (n=19/22) cited checking real-time glucose values as their primary reason for use, while long-term trends remained significantly underutilized. Literature suggests that this narrow focus heightens misinterpretation risk during rapid glucose changes. Specifically, deficits in “trend arrow literacy” have been identified as a major barrier contributing to “insulin stacking” - a phenomenon driven by anxiety about high readings rather than an informed understanding of glucose trajectories (Ajjan et al., 2019; Aleppo et al., 2017).

Evidence indicates that healthcare providers play a decisive role in shaping access to and effective use of CGM systems. Achieving optimal outcomes requires not only operational skills but also interpretive competence, making structured education essential. Despite this necessity, analysis of educational models reveals a dichotomy between technical instruction and therapeutic education that directly impacts utilization outcomes. Current literature highlights the prevalence of purely technical instruction - often termed “button pushing” - a trend reinforced by provider-level constraints such as insufficient time for education and low clinician self-efficacy in technology training (Lanning et al., 2020; Oser et al., 2022). Consequently, such training prioritizes physical device operation (e.g., sensor insertion, alarm settings) over data interpretation. Heinemann et al. (2020) identify this focus on procedural mechanics as a limiting factor, restricting patients to a functional user role while neglecting therapeutic decision-making.

Moreover, data indicate that the uncompensated expectation to provide comprehensive training contributes to workflow strain and therapeutic inertia, forcing providers to deprioritize such education. Consequently, physicians cited the technical aspects of device setup - rather than clinical interpretation - as a primary consultation need required to effectively support patients (Oser et al., 2022). In contrast to this prevailing model, data from structured educational interventions, such as the SPECTRUM program, demonstrate that shifting the curriculum from device operation to pattern analysis enables patients to transition from passive reactions to informed therapeutic adjustments (Heinemann et al., 2020). Consequently, the lack of interpretive training has been identified as a key factor contributing to misinterpretation and alarm fatigue. Studies indicate that users lacking the skills to customize alerts report viewing them as intrusive nuisances, leading to device abandonment unrelated to patient compliance (Bober et al., 2025; Tanenbaum et al., 2017).

## 4. Discussion

### 4.1. Interpreting the Gap: Ethical & Social Implications

The evidence synthesized in this review demonstrates that CGM offers substantial improvements in glycemic outcomes and quality of life across both types of diabetes, with benefits consistently reported in randomized clinical trials and real-world studies (Martens et al., 2021; Leelarathna et al., 2022; Battelino et al., 2023). However, the parallel analysis of access patterns reveals a stark contrast between clinical potential and real-world distribution. Structural, socioeconomic, racial, technological, and provider-level barriers persist across the healthcare landscape, shaping not only who receives CGM but also who stands to benefit from its transformative capabilities. These barriers represent more than incidental obstacles; they reflect deeply rooted inequities that generate ethical, social, and psychological consequences with direct implications for health outcomes.

An overarching ethical concern arises from the paradoxical manner in which CGM diffuses across populations. Although designed to enhance self-management and reduce the burden of diabetic complications, CGM appears to function as an “accelerator of disparities.” Individuals with robust insurance, higher socioeconomic status, stronger digital competencies, and more stable interactions with the healthcare system are consistently positioned as the primary beneficiaries of CGM adoption (Miyazaki et al., 2024; Been et al., 2024). Conversely, structurally marginalized groups continue to encounter both financial and non-financial obstacles - such as limited broadband access, administrative delays, and racialized patterns of medical decision-making - that hinder adoption even when clinical need is high (Patel et al., 2024; Kanbour et al., 2023). This distributional pattern aligns closely with Rogers’ Diffusion of Innovation Theory, wherein advantaged individuals assume the role of early adopters, while disadvantaged groups are relegated to late adoption or non-adoption due to systemic constraints rather than personal choice (Rogers, 2003). The phenomenon echoes Merton’s “Matthew Effect,” whereby those who possess resources accrue disproportionate additional benefits, while those without fall progressively further behind (Merton, 1968).

These findings indicate an emerging two-tier system of diabetes care, with significant social implications. Patients with access to CGM become “data-rich,” benefiting from glucose trends, predictive alerts, and more precise therapeutic adjustments. They enter clinical encounters with comprehensive datasets that facilitate more informed, interactive decision-making. In contrast, patients without CGM remain “data-poor,” reliant on episodic fingerstick measurements that provide limited insight into glycemic variability. Their care is inherently constrained by the absence of actionable data, rendering management decisions more difficult and increasing the likelihood of adverse outcomes. This informational asymmetry reshapes the patient-provider relationship: patients equipped with CGM may be perceived as easier to manage, while those lacking technology may be implicitly viewed as less engaged or less capable, thus perpetuating prescribing bias. As recent studies suggest, clinicians inadvertently act as gatekeepers of technological diffusion, with implicit judgments about digital competence or adherence shaping access to CGM (Sabben et al., 2024). Such dynamics further entrench inequities in a manner consistent with both diffusion theory and the Matthew Effect, reinforcing a cycle in which health advantages accumulate among those already privileged.

The psychological implications of this divide are equally significant. For CGM users, the continuous flow of personal health data can generate both empowerment and burden. While many experience improved confidence and reduced distress, others encounter data-related anxiety, alarm fatigue, a sense of being constantly monitored, device wearability and discomfort caused by adhesive materials (Barchiesi et al., 2025). False or ambiguous alerts, including compression-induced lows, have been shown to produce confusion and unnecessary corrective behavior, underscoring the cognitive load associated with interpreting continuous data streams (Kongdee et al., 2025). For individuals excluded from CGM technology, the psychological impact is fundamentally different but no less consequential. Patients who remain reliant on traditional monitoring often report feeling left behind by a rapidly modernizing healthcare system. The perception of receiving “second-tier” care may erode trust, reduce engagement, and diminish motivation for self-management, ultimately contributing to poorer adherence and worse glycemic control. These psychological burdens are layered on top of existing social and economic disadvantage, compounding risk.

Taken together, the findings illustrate that the diffusion of CGM occurs within - and is shaped by - existing structural inequities. Financial limitations, digital exclusion, occupational constraints, racial disparities, and institutional resource deficits collectively modulate access long after coverage policies are expanded (Isaacs et al., 2021). Administrative burdens and limited digital health training among providers further restrict patient access to innovative medical technologies (Barchiesi et al., 2025). The cumulative effect is a system in which CGM adoption not only reflects pre-existing inequalities but also contributes to their

amplification. Furthermore, maintaining these administrative hurdles represents a fiscally short-sighted strategy; by prioritizing immediate cost containment over evidence-based prevention, healthcare systems ignore the documented long-term savings associated with CGM use, effectively choosing to fund preventable complications rather than the technology that averts them (Frank et al., 2024). This dynamic has direct implications for both population health and health equity. Without targeted interventions to address structural and technological determinants of access, the widening gap between data-rich and data-poor patients risks becoming a defining feature of modern diabetes care.

As this analysis demonstrates, the presence of persistent barriers to CGM access generates intertwined ethical, social, and psychological consequences. Ethically, the inequitable distribution of CGM challenges core principles of justice and fairness, particularly given the technology's documented clinical value. Socially, the resulting two-tier system stratifies patients according to their access to data and digital tools, reinforcing and magnifying health disparities. Psychologically, CGM adoption produces dual burdens - digital stress for users and a sense of therapeutic inferiority among the excluded. These findings underscore the need for systemic strategies that address not only cost but also digital literacy, technology access, provider training, and structural inequities that govern the diffusion and utilization of CGM. Without such efforts, technological innovation may continue to function less as a clinical equalizer and more as a mechanism for the reproduction of inequality.

## **4.2. Bridging the Gap: Solutions & Future Directions**

The present review demonstrates that while CGM markedly improves glycemic outcomes across diabetes populations, persistent inequities in access, uptake, and sustained use continue to undermine its full clinical potential. The results highlight that structural, socioeconomic, technological, and literacy-related barriers remain deeply embedded within current healthcare systems. Bridging this gap requires a coordinated, multilevel strategy that integrates policy reform, strengthened clinical infrastructure, inclusive technological design, and patient-centered educational initiatives.

### **4.2.1 Policy and System Solutions: Strengthening the Foundations of Equitable Access**

Policy-level interventions remain central to advancing equitable CGM access, particularly for populations historically excluded from diabetes technology. As demonstrated in the Results, Medicaid expansion has already produced meaningful improvements in CGM utilization, with uptake rising significantly following broadened coverage policies. Miyazaki et al. (2024) further reinforce this trend, showing that states implementing Medicaid CGM coverage experienced substantial increases in adoption among beneficiaries. These findings highlight the strong potential of insurance reforms to expand access to evidence-based diabetes management tools for low-income populations.

Yet, the Results also show that coverage alone is not sufficient. Miyazaki et al. (2024) report that administrative hurdles - such as prior authorization requirements, delays in processing, inconsistent eligibility criteria, and burdensome documentation - continue to restrict timely CGM initiation. These structural obstacles diminish the practical impact of Medicaid coverage and can disproportionately affect patients with limited resources. Policy reforms that streamline authorization workflows, standardize approval criteria across payers, and reduce clinic-level administrative burden would help ensure that Medicaid's expanding coverage translates into real-world, equitable access and sustained use.

Federally Qualified Health Centers (FQHCs) represent another critical system-level opportunity. While the Results indicate that CGM utilization remains low within FQHCs, external evidence demonstrates the considerable gains achievable when these settings are adequately supported. A recent urban FQHC pilot (Thakur et al., 2025) achieved HbA1c reductions of 1.66-1.68 percentage points ( $p < .001$ ) through a care model that integrated culturally competent education, language support, digital literacy coaching, and expanded staffing. Given that FQHCs serve more than 32 million patients - many facing barriers related to income, insurance, and technology access - these findings underscore their potential as focal points for equitable CGM deployment.

Scaling such initiatives will require sustainable reimbursement mechanisms, targeted investments in care-team training, and dedicated funding streams to support CGM workflow integration in resource-constrained settings. Strengthening FQHC capacity represents a policy pathway with broad public health impact, particularly for populations at highest risk for diabetes complications.

#### 4.2.2 Technological Solutions: Designing Devices for Real-World Constraints

Even when CGM is covered and prescribed, technological barriers often impede effective adoption - particularly for individuals with limited digital resources. Results indicate that although smartphone ownership is high across diverse populations, limited data plans, and unstable connectivity continue to constrain app use and real-time monitoring (Sabben et al., 2024). CGM manufacturers can help address this gap by developing simplified, lower-cost sensors and applications that function reliably on low-end smartphones, allow offline data storage, and provide streamlined, intuitive interfaces. Such adaptations respond directly to documented usability challenges reflected in a System Usability Scale score of 66/100 (Manzoni et al., 2025), driven by alarm fatigue, information overload, and navigation difficulties. Confirming the clinical impact of design, our review highlighted that simple interface modifications - specifically textual explanations for alerts - can directly prevent therapeutic errors such as inappropriate carbohydrate consumption during false lows (Kongdee et al., 2025).

Advanced analytic tools such as artificial intelligence (AI) also hold promise for enhancing personalization and reducing clinical burden. AI-enabled CGM systems can detect subtle glucose patterns, support individualized therapeutic adjustments, and facilitate remote monitoring (Ji et al., 2025). Clinical trial evidence confirms meaningful improvements in glycemic outcomes, with AI-guided insulin titration improving time in range by 2.8 percentage points compared with standard care, without additional adverse events (Ying et al., 2025). Importantly, however, AI-driven tools must be designed to be accessible, interpretable, and usable for patients with varying levels of digital and health literacy. Without such considerations, technological innovation risks widening - rather than narrowing - the equity gap.

#### 4.2.3 Educational Solutions: Building Digital & Health Literacy to Support Effective CGM Use

The expansion of CGM technology presents substantial opportunities to enhance diabetes management, yet persistent disparities in access and effective utilization remain closely tied to educational, digital literacy, and health literacy barriers. Evidence consistently shows that simply providing devices does not ensure long-term use or clinical benefit - patients must also be equipped with the skills, confidence, and support needed to interpret and apply CGM data.

Addala et al. (2025) emphasize that provider-led education, simplified training materials, and sustained support are foundational to improving both CGM initiation and durable use. Incorporating health literacy principles into CGM education - such as clear explanations, visual aids, and stepwise instructions - reduces the risk of misinterpretation and data overload, challenges that disproportionately affect low-literacy populations. Importantly, co-developing educational interventions with vulnerable communities enhances cultural and linguistic relevance and allows programs to directly address structural and contextual barriers. Addala et al. further recommend pairing patient education with broader digital literacy initiatives and policy reforms to ensure that individuals not only receive CGM devices but are also empowered to use them effectively.

The University of Florida's Division of Pediatric Endocrinology provides an example of how structured CGM education can be organized to support families beginning diabetes technology use. Albanese-O'Neill et al. (2023) describe a multifaceted program developed to help children with diabetes and their caregivers build the knowledge and practical skills needed to navigate CGM devices. The initiative includes in-person and virtual training sessions, opportunities for hands-on practice, troubleshooting guidance, and individualized instruction on understanding CGM readings, alerts, and data-sharing features. While the study does not assess glycemic outcomes or long-term device use, it highlights key components that families identified as valuable during the onboarding process. This approach demonstrates how thoughtfully designed education - focused on clarity, accessibility, and ongoing support - can address common challenges encountered during early CGM adoption (Albanese-O'Neill et al., 2023).

Additional insights from Sabben et al. (2024) highlight the importance of addressing digital barriers alongside educational ones. Although smartphone ownership was nearly universal in their safety-net cohort, many patients struggled with incompatible devices, limited data plans, and difficulties navigating app interfaces. Targeted digital literacy coaching, hands-on demonstrations, and simplified app designs were identified as key facilitators of effective CGM use, underscoring the need for interventions that bridge both technological and educational gaps.

Collectively, these findings reinforce that culturally tailored, literacy-sensitive education - paired with practical digital support - is essential for ensuring equitable CGM uptake and maximizing the clinical benefits of continuous glucose monitoring across underserved populations.

## 5. Conclusions

Continuous Glucose Monitoring (CGM) has fundamentally reshaped diabetes care by enabling real-time, data-driven insights that improve glycemic outcomes, reduce hypoglycemia, and enhance quality of life for individuals with both Type 1 and Type 2 diabetes. Clinically, the evidence confirms CGM's capacity to deliver precise, continuous information with the dynamic fidelity required to transition self-management from reactive corrections to proactive therapeutic adjustments.

However, this transformative promise remains undermined by significant and intersecting barriers of inequity. As demonstrated across socioeconomic, structural, and technological dimensions, access to CGM is unevenly distributed. Cost constraints, restrictive insurance policies, provider-level limitations, and disparities in digital and health literacy perpetuate a digital divide that mirrors - and amplifies - existing social inequities. The result is a stratified landscape of diabetes care, in which well-resourced populations become "data-rich" beneficiaries of innovation, while economically vulnerable groups remain excluded by structural disadvantage.

The synthesis of evidence reveals that technological progress alone cannot guarantee fair distribution of benefit. While policy reforms such as Medicaid expansion have improved coverage, adoption remains constrained by persistent administrative complexity, infrastructural gaps, and disparities in digital literacy. Achieving true equity in CGM utilization demands more than reimbursement; it requires a systemic, inclusive approach that addresses financial, structural, and educational determinants simultaneously.

To realize CGM's full societal potential, stakeholders must move beyond the data - implementing coordinated policy reforms, inclusive device design, and literacy-centered education that collectively ensure technology functions as a bridge toward equity rather than a barrier. Ensuring that its benefits are distributed justly will demand sustained commitment from policymakers, manufacturers, clinicians, and educators alike. Only through intentional, equity-centered strategies can continuous glucose monitoring fulfill its dual promise: advancing both metabolic control and social justice in the digital era.

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