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THE IMPACT OF CGM ON GLYCEMIC CONTROL IN DIABETES PATIENTS – A REVIEW OF RECENT STUDIES

Karol Seweryn Błąd[1], ***Lena Merchel[1]***, ***Aleksandra Świerczewska[2]***, ***Piotr Komasara[3]***, ***Julia Nowakowska[4]***, ***Aleksandra Sędek[2]***, ***Ilona Bednarek[5]***, ***Kinga Kałuża[5]***, ***Katarzyna Czechowska[2]***, ***Sylwia Lach[1]***

[1]*Independent Public Health Care Institution of the Ministry of Interior Affairs and Administration in Kielce, Poland*
[2]*Provincial Combined Hospital in Kielce, Poland*
[3]*Faculty of Medicine, Medical University of Warsaw, Poland*
[4]*Faculty of Medicine, Jan Kochanowski University of Kielce, Poland*
[5]*Provincial Specialist Hospital in Czerwona Góra, Poland*

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blad.karol.4@gmail.com

ABSTRACT

BACKGROUND:

Continuous glucose monitoring (CGM) has advanced rapidly and is now used beyond type 1 diabetes (T1D). New randomized controlled trials (RCTs), meta-analyses, and updated international guidelines from 2020 to 2025 have reshaped clinical use, which warrants an updated narrative synthesis.

OBJECTIVE:

To provide a narrative review of recent clinical evidence on CGM, compare effectiveness across diabetes populations, appraise the strength and limitations of the evidence, and identify priorities for future research.

METHODS:

Thirty-five publications were included after targeted searches in PubMed, ClinicalTrials.gov, and official diabetes organization websites, with the last search on 1 August 2025. Eligible English language studies reported clinical outcomes, accuracy, usability, or implementation in adults with T1D or type 2 diabetes (T2D). Selection and data extraction were performed manually. Findings were synthesized descriptively. No meta-analysis or formal risk of bias assessment was performed.

RESULTS:

In T1D, randomized trials and reviews consistently showed improvements in hemoglobin A1c (HbA1c), time in range (TIR), and fewer hypoglycemic events, including a mean HbA1c reduction of 0.27 percent with closed loop systems. In insulin treated T2D, effects on HbA1c ranged from minus 0.74 to minus 0.20 percent, with variable improvements in TIR. Time spent in hypoglycemia decreased by about 0.66 percent. In one trial insulin dose fell by 10.6 units per day and weight by 3.3 kilograms. Evidence for non-insulin treated T2D, older adults, and pregnant women remains preliminary but suggests potential benefit. Patient reported outcomes indicated moderate gains in treatment satisfaction, sleep, and daily functioning, with high adherence in older adults reported at about 93 percent.

CONCLUSIONS:

The evidence is strongest for T1D and supportive though heterogeneous for insulin treated T2D. For non-insulin treated T2D, older adults, and pregnant women, current data are limited and do not yet support firm recommendations. Future studies should address long term outcomes, cost effectiveness, and the role of CGM in underrepresented populations to guide clinical practice.

KEYWORDS

CGM, glycemic control, T1D, T2D, TIR, HbA1c, diabetes mellitus

LIST OF ABBREVIATIONS

- CGM - Continuous glucose monitoring,
- TIR - time in range,
- HbA1c - hemoglobin A1c,
- RCTs - randomized controlled trials,
- T1D - type 1 diabetes,
- T2D - type 2 diabetes,
- rtCGM - real-time CGM,
- isCGM - intermittently scanned CGM,
- SMBG - self-monitoring of blood glucose,
- PROs - patient-reported outcomes,
- SMD - standardized mean difference.

INTRODUCTION

Diabetes mellitus is on the rise among different populations and healthcare systems, making it one of the most significant health challenges of today.[1,2] Estimates by the International Diabetes Federation for 2025, which put an estimated 588.7 million adults living with diabetes next year will number about 852.5 million by 2050 underscoring the growing global burden[3]. The resolution of this growing epidemic requires ongoing improvements in both monitoring and therapeutic technologies to minimize the risk of serious complications, such as retinopathy, nephropathy, neuropathy or cardiovascular disease.[1] Diabetes care has used fingerstick tests to monitor blood glucose as a standard practice for many years, which offers valuable insights into glycemic status, but it only occasionally provides glimpses into glucose variability, often neglecting important clinical episodes of hypoglycemia.[4,5] However, this method can also offer limited insight into the dynamic nature of glucose fluctuations.[4,6] CGM systems were created to capture interstitial glucose levels in near-real time, typically within 1 to 5 minutes.[7] Continuous innovation in sensor accuracy, wearability, and real-time data utilization has led to significant advancements in CGM technology over the last two decades. Earlier CGM systems were constrained by frequent calibrations and significant sensor delays. However, newer equipment displays greater precision and durability of sensors as well as novel features like accurate readings, longer sensor life, predictive glucose alerting, and easy integration with automated insulin delivery systems.[2,8,9]

The relevance of this topic is determined by the rapid development of CGM technologies in recent years and the expansion of their use in clinical practice.[4,6] The emergence of new RCTs and meta-analyses from 2022 to 2025, as well as updated international diabetes guidelines, has significantly changed the understanding of CGM's role in disease management.[1–4] While only a few years ago continuous monitoring was primarily considered a tool for patients with T1D, today it is actively implemented in insulin-treated T2D and is also being discussed for populations previously excluded from research, such as elderly patients, pregnant women, and individuals with non–insulin-treated T2D.[1,2,10,11] These changes require a systematic analysis to determine the clinical significance, limitations, and directions for further development of the technology. [1,4,6]The novelty of this review lies in the integration of the latest data from randomized trials, meta-analyses, and consensus statements, including studies published between 2022 and 2025, with a particular focus on the practical aspects of CGM implementation across different clinical groups.[1,2,7,8,10–12] Unlike previous reviews, which were mainly focused on T1D or on the technical characteristics of the systems, this work analyzes the effectiveness and limitations of CGM in a wide range of patients, addressing issues of adherence, cost-effectiveness, and the potential of this technology in new clinical scenarios. This approach makes it possible to identify gaps in the evidence base and outline directions for future research.[1,4,7,8,13,14]

The aim of this review is to systematically analyze clinical evidence published between 2020 and 2025 on the effectiveness of CGM, to compare its impact across different diabetes populations (T1D, insulin-treated and non–insulin-treated T2D, elderly patients, and pregnant women), and to highlight current limitations and directions for future research.[1–4,6–8,10–13,15–19]

METHODS

This article is a narrative review based on a targeted literature search. A total of 35 publications were included, covering RCTs, systematic reviews and meta-analyses, clinical guidelines, ongoing trials, observational studies, and methodological papers. Sources were identified through PubMed, ClinicalTrials.gov, and official websites of diabetes organizations, with the last search conducted on 01.08.2025. Only English-language studies addressing clinical outcomes, accuracy, usability, or implementation of CGM in adults with T1D or T2D were considered.

The selection and data extraction were performed manually by the authors without the use of automation tools. Extracted information included study type, patient population, CGM device, key outcomes (HbA1c, TIR, hypoglycemia, patient-reported outcomes), study duration, and funding source. Due to the heterogeneity of designs and endpoints, no quantitative synthesis or meta-analysis was conducted. Findings are presented descriptively, and no formal risk-of-bias assessment was performed; certainty of evidence was considered qualitatively.

FINDINGS

1. TYPES OF CGM SYSTEMS

The three main types of modern CGM systems are: real-time CGM (rtCGM), intermittently scanned CGM (isCGM or "flash" monitoring) and closed-loop systems. rtCGM systems provide continuous glucose readings every 1 to 5 minutes and contain alerts for hypoglycemia and hyperglycemia.[2,9,20] Commonly used rtCGM models include the Dexcom G6 and Medtronic Guardian Connect. The use of rtCGMs, which are often connected to insulin pumps, allows for automated insulin delivery through closed-loop control.[9] isCGM systems require manual scanning of the sensor to obtain glucose data. Unlike traditional isCGMs, which do not have real-time alert function anymore, newer models are starting to incorporate optional alarms. The FreeStyle Libre is one of the most well-known isCGM devices and is typically more affordable than rtCGM alternatives.[9] Closed-loop Systems also known as artificial pancreas systems, these integrate rtCGM with algorithm-controlled insulin pumps to autonomously adjust insulin delivery. Examples include Tandem Control-IQ, Medtronic 780G, and CamAPS FX, representing the forefront of automated diabetes management.[9,12] These key features of the three main CGM categories are summarized in Table 1.

Table 1. Main types of CGM systems

CGM type	Key Features	Examples
rtCGM	provides continuous glucose reading every 1-5 minutes	Dexcom G6, Medtronic Guardian Connect
	includes alerts or hypo/ hyperglycemia	
	can integrate with pumps for closed-loop control	
isCG or "Flash monitoring"	requires manual scanning of the sensor to obtain glucose data	FreeStyle Libre
	traditional models lack real-time alerts	

	newer ones have optional alarms	
	typically more affordable than rtCGM	
Closed-loop system	integrates rtCGM with algorithm-controlled insulin pumps	Tandem Control-IQ, Medtronic 780G, CamAPS FX
	automatically adjusts insulin delivery based on glucose reading	

CGM - continuous glucose monitoring; rtCGM - real-time CGM; isCGM - intermittently scanned CGM

1.1 Technical Characteristics

Modern CGMs have common technical characteristics that contribute to their usability and clinical use:

Sensor longevity: Most sensors last 10 to 14 days, but some can extend up to 6 months.[9]

Warm-up period: Time required to activate sensors has been reduced from 2 hours to 30 minutes.[9]

Accuracy: Best-in-class CGMs report a Mean Absolute Relative Difference (MARD) of 9-10%.[9]

Connectivity: Devices are Bluetooth-enabled for smartphone use.[9]

Data visualization: Includes trend arrows, graphs, and cloud-based data sharing.[1,9]

1.2 Time in range

The measurement of TIR has become a crucial tool for monitoring short-term glycemic control, as it measures the percentage of times blood glucose levels remain within the target range of 3.9 to 10.0 mmol/L (70–180 mg/dL). Various global consensus boards have now approved it as an alternative to HbA1c, affording greater attention to the fluctuation of glucose levels and their potential for acute complications. [21–23] The use of rtCGMs has been shown to significantly improve TIR in individuals with T1D. Pooled analysis reported a mean increase of 6.36% in TIR (95% CI: 2.48–10.24) when compared to Self-Monitoring of blood glucose (SMBG). Furthermore, the utilization of rtCGM in closed-loop insulin delivery systems has revealed even greater benefits, increasing TIR by 10-15% compared to sensor-augmented pump therapy.[2,23,24] Evidence suggests that CGMs can enhance TIR in the context of T2D. The average T2D increase in patients treated with insulin was found to be 6.36% ($p = 0.001$) in a meta-analysis conducted by Kong and Cho (2024). While data is more limited in non-insulin treated individuals, some studies have shown modest improvements of about 3.5%. In the Steno2Tech trial, participants who used rtCGM showed a 15.2% increase in TIR, which highlights the technology's potential to be utilized by various T2D populations.[1,25]

1.3 Hemoglobin A1c Reduction

Despite limited research, HbA1c remains the primary clinical indicator of long-term glycemic control, and CGM has been demonstrated to decrease HbA1c in both type T1D and T2D populations.[1,9,24] In patients with T1D, the use of closed-loop insulin delivery systems that incorporate rtCGMs has been associated with a mean decrease of 0.27% in HbA1c. The greatest benefits are typically seen in individuals with higher baseline HbA1c levels, suggesting a particular advantage for those with inadequate glycemic control.[9] A recent systematic review and meta-analysis of 17 RCTs in T2D by Kong and Cho (2024) revealed that HbA1c reductions following CGM interventions ranged from −0.74% to −0.20% .These reductions were most pronounced in patients who had insulin and baseline HbA1c levels above 8%, as well as the elderly (≥60 years old).[1]

1.4 Hypoglycemia Reduction

One of the primary clinical advantages of CGM is its ability to decrease the frequency and duration of hypoglycemic episodes. Clinical trials have demonstrated that CGMs can reduce hypoglycemia episodes by as much as 50%, particularly in individuals with T1D who use alerts and alarms in real-time systems.[9,24,26] Time spent in hypoglycemia, defined as glucose levels below 3.9 mmol/L, was reduced by approximately 0.66%, a statistically and clinically meaningful improvement.[23,24] In patients with T2D and especially for those with comorbid cardiovascular disorders like post-myocardial infection status, CGM has been found to reduce the approximately 80 minutes per day spent in hypoglycemia while not increasing total blood sugar levels. CGM has been shown to improve both safety and therapeutic decisions for vulnerable groups.[1,9,23] Overall, modern CGM systems have real-time feedback and predictive alert capabilities that are instrumental in preventing hypoglycemia, making them particularly useful for individuals with intensive insulin regimens or at high risk of hypoglycemia unawareness.[2,9,26]

2. BENEFITS IN SPECIAL POPULATIONS

2.1 T1D

The utilization of CGMs in treating T1D has revolutionized clinical outcomes by enhancing glycemic control while minimizing the risk of hypoglycemia. Additionally, patients can achieve near-normal glucose levels with CGM by receiving real-time data feedback and pattern recognition, which improves the safety and efficacy of insulin therapy.[9,26,27] Closed-loop systems that combine CGM with algorithm-driven insulin pumps, such as Tandem Control-IQ and Medtronic 780G, are now recognized as the new standard of care for T1D patients. These systems automatically adjust insulin delivery based on real-time glucose readings, thereby reducing both hyperglycemia and hypoglycemia.[9] CGM is particularly beneficial for subgroups within the T1D population which include children and adolescents, pregnant women with pre-existing T1D and individuals with hypoglycemia unawareness. Real-time feedback helps caregivers and young patients better manage glycemic variability and avoid nocturnal.[2,26] CGM helps to achieve tighter glucose targets during pregnancy, which is crucial for reducing risks to both mother and fetus. The occurrence of severe hypoglycemic events can be significantly reduced by using predictive alerts from CGM.[9] GM is not only a monitoring tool but also viewed as enabling the therapeutic platform for personalized diabetes care.[2,9,11,19,24,26,28]

2.2 T2D

The implementation of CGMs in managing T2D has become increasingly prevalent, particularly among patients receiving insulin therapy. Studies conducted in multiple controlled trials indicate that CGM has the potential to enhance glycemic outcomes and promote behavioral changes among both insulin- and noninsulin-treated T2D populations.[1,24]

2.2.1 Insulin-Treated T2D

A systematic review and meta-analysis found significant clinical benefits of CCG in patients treated with insulin. Kong and Cho's (2024) findings revealed an average reduction of HbA1c of 0.37%, with even greater reductions in those treated by insulin alone. A subgroup analysis revealed that older adults (60 years) and those using rtCGM devices had better outcomes. Moreover, the review highlighted that CGM usage can result in reduced insulin requirements and weight loss, particularly within structured intervention programs.[1] The Steno2Tech study reported a reduction in daily insulin requirements by 10.6 unit/day and an average weight reduction of 3.3 kg. These findings demonstrated the additional metabolic and therapeutic value of CAMP integration.[2]

2.2.2 Non–Insulin-Treated T2D

For non–insulin-treated patients, the evidence is still emerging but promising. According to Kong and Cho (2024), while the HbA1c reductions in this group are less pronounced than in those on insulin, CGM use contributes to improved glucose awareness, especially in detecting postprandial glycemic excursions. This functionality supports individualized dietary adjustments and enhances self-management behaviors. CGM can also serve as a motivational tool by providing immediate feedback that encourages lifestyle changes, such as physical activity and improved nutrition choices.[1] Steno2tech study further emphasized that CGM may be particularly valuable for non–insulin-treated T2D patients at risk of complications but not yet eligible for intensive pharmacotherapy, suggesting a preventative role for CGM in this population.[2]

2.3 Elderly Patients

The utilization of CGM in elderly patients has demonstrated significant improvements in glycemic control, reflected by meaningful HbA1c reductions, thus lowering the risk of diabetes-related complications.[9,10,24] For instance, Pratley et al. (2020) reported significant reductions in both HbA1c levels and hypoglycemia incidence among CGM users aged ≥60 years compared to traditional glucose monitoring. Given the heightened vulnerability of older adults to hypoglycemia, which may lead to falls, cognitive impairment, or cardiovascular events, CGM's real-time alerts significantly enhance safety by enabling early intervention.[9,24] Effective approaches have been found to address concerns about CGM complexity in elderly patients, as evidenced by studies such as Leite et al. (2023) reporting high adherence (93.1%) and user satisfaction among elderly FreeStyle Libre users.[10] The introduction of user-friendly interfaces by manufacturers has aimed to reduce complexity and increase adoption, which could potentially improve the management of diabetes in elderly patients.[2,10]

3. PATIENT-REPORTED OUTCOMES AND QUALITY OF LIFE

Besides improving glycemic metrics, CGM has also yielded significant benefits in patient-reported outcomes

(PROs), in terms of treatment satisfaction and emotional well-being as well as sleep quality and daily functioning. These factors play a vital role in diabetes self-management and long-term adherence to therapy.[1,2,9]

3.1 Treatment Satisfaction

Treatment satisfaction has been consistently recognized as a significant benefit of CGM use. Kong and Cho (2024) have found evidence of improved satisfaction scores in patients who were isCGM over those who received SMBG. The standardized mean difference (SMD) for isCGM was reported as 0.44, indicating a moderate positive effect. While results for rtCGM were more variable, satisfaction levels improved substantially when CGM use was accompanied by structured diabetes education and clinical support.[1] Lind et al. (2024) found that the combination of CGM with feedback and coaching significantly enhanced patient confidence and satisfaction with their diabetes management.[2]

3.2 Diabetes Distress

CGM contributes to reducing the emotional burden associated with diabetes-related issues, particularly in individuals with anxiety related to hypoglycemia. Kong and Cho (2024) studies utilizing validated tools like the Diabetes Distress Scale have revealed decreases in diabetes distress. In populations with T2D that received insulin and CGM This effect was particularly noted where CGM facilitated the proactive prevention of glucose excursions.[1] Lind et al. emphasized that rtCGM alerts play a pivotal role in lowering anxiety, especially among patients with hypoglycemia unawareness, by offering reassurance and greater control.[2]

3.3 Sleep Quality

Nocturnal hypoglycemia remains a significant difficulty for patients living with diabetes, often disrupting sleep and lowering overall quality of sleep. CGM systems, particularly rtCGM, have been associated with improved sleep quality through reduced nighttime hypoglycemia exposure and better overnight glucose stability.[1,26] However, the benefit may be tempered by alarm fatigue or disrupted sleep due to frequent alerts, particularly in systems without personalized alarm thresholds.[1,9]

3.4 Daily Functioning

CGM has also been shown to improve patients' sense of autonomy and reduce the cognitive challenge of diabetes self-care. The use of real-time glucose data enables people to adjust their meals, physical activity, and insulin treatment while simplifying management in everyday routines.[1,2,9] Besides improved glycemic control, CGM also improves quality of life by reducing the psychological and logistical demands of chronic glucose monitoring.[2]

4. ECONOMIC AND PRACTICAL CONSIDERATIONS

The use of CGM not only does provide clinical advantages in diabetes management, but it is also economically and practically useful. Even though device costs may be higher initially than with conventional monitoring methods, the long-term advantages of fewer complications, reduced hospital visits and improved patient care make adoption more feasible.[1,2,9]

4.1 Cost-Effectiveness

The effectiveness of rtCGM and isCGM in treating high-risk populations has been demonstrated by health economic analyses, particularly in high-risk populations.[2] This approach was found to be cost-efficient solution for patients with T2D after myocardial infarction, resulting in a £318 net benefit per patient. Largely due to reduced hypoglycemia-related events and hospital admissions.[2] CGM systems present higher upfront costs, these are often offset by downstream savings through fewer acute events, improved glycemic control, and reductions in long-term complications. In addition, rtCGM is particularly provides high value relative to patients with T1D who experience hypoglycemia unawareness or lack of glycemic control.[1]

4.2 Adherence Challenges

Optimal CGM outcomes are closely tied to user adherence. Kong and Cho (2024) emphasized that greater than 80% sensor wear time is often necessary to realize significant clinical benefits.[1] However, several barriers continue to limit the sustained use of CGM. Common challenges include skin irritation from adhesive patches, sensor discomfort during daily wear, alarm fatigue caused by frequent glucose alerts, and financial obstacles such as insufficient insurance coverage or high out-of-pocket expenses.[1] Edelman et al. (2018) further observed that the frequency of CGM alarms, especially among older adults and the first-time users of the technology, can contribute to a gradual decline in adherence. These insights highlight the need for personalized device settings and thorough patient education to maintain user comfort over time and sustained engagement with CGM use.[9]

4.3 Implementation Strategies

To promote successful CGM adoption, effective implementation strategies must be in place. Key elements include Structured education programs that train patients on device use and data interpretation, clinical training to ensure CGM data is meaningfully incorporated into treatment decisions, ongoing support, including telemedicine follow-ups and digital coaching and integration of CGM into care pathways, allowing seamless use alongside other diabetes technologies.[14,29] Lind et al. (2024) argued that without tailored support, even technologically advanced tools like CGM may fail to deliver optimal outcomes. Education, personalization, and coordinated follow-up are critical for long-term effectiveness.[2]

5. FUTURE DIRECTIONS

CGMs remain an evolving field with ongoing technological progress, expanded clinical applications, and a growing focus on long-term outcomes.[2,13] Even though CGMs are now firmly established in the field of T1D control and being increasingly used in T2D, it still requires constant innovation and solid evidence to fully utilize its potential.[9] Ongoing clinical trials are investigating the use of CGMs across diverse diabetes populations and clinical settings. The CGM-AGE Study (NCT05337826) is investigating the benefits of CGM in elderly patients with T2D, a population particularly vulnerable to hypoglycemia and glycemic variability.[15] Another significant trial (NCT06296550), evaluates CGM's efficacy in T2D patients not treated with insulin, filling an important evidence gap regarding the expanded use of CGM.[17] In the inpatient arena, the study (NCT06060483) aims to determine whether CGM-guided glucose management can reduce the incidence of major adverse cardiovascular events in patients with T2D and moderate to severe coronary artery stenosis.[18] Special populations are also being studied, as shown by the Flash Glucose Monitoring in GDM trial (NCT06490874), which explores CGM in gestational diabetes management.[16] Additionally, the effectiveness of hybrid closed-loop systems in treating pediatric patients is being studied, as evidenced by the MiniMed 780G/DS5 study (NCT06604871), which evaluates this technology at home in children with T1D aged 2-6 years.[19] Collectively, these trials will provide critical data to inform the next generation of CGM guidelines and therapeutic strategies.[15–19] Ongoing research in these areas is illustrated in Figure 1.

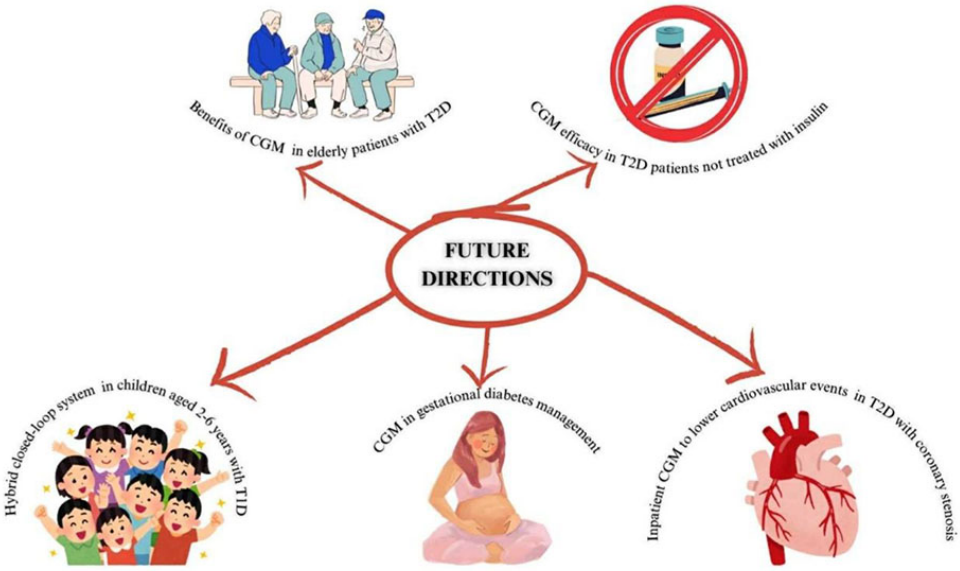

Figure 1. Future directions for CGM

5.1 Technological Advancements

Future CGM technologies are expected to focus on extended use period, non-invasive monitoring, algorithm optimization, and integration with digital health tools Those efforts are expected to continue.[14] Lind et al. (2024) highlighted initial efforts to develop extended-wear sensors, with the potential to increase device lifespan to several months.[2] Furthermore, the aspiration for non-invasive CGM technologies persists, with studies focusing on transdermal sensors and optical biosensors.[30,31] The focus is on developing improved algorithms for closed-loop insulin delivery systems. Edelman et al. (2018) emphasized that refining these algorithms will enhance the responsiveness and safety of automated insulin delivery, particularly in hybrid systems that integrate CGM data with real-time insulin adjustments.[9] Finally, the integration of CGM with digital health platforms, such as smartphone applications, telehealth systems, and data-sharing platforms, offers new opportunities to optimize self-management and clinical decision-making.[9,32]

5.2 Expanded Indications

As the clinical utility of CGM becomes better understood, its application is expanding beyond conventional diabetes care.[9] Lind et al. (2024) discussed the potential for CGM use in prediabetes, where early detection of postprandial glucose excursions could guide lifestyle interventions before pharmacotherapy is needed.[2] Moreover, interest is growing in using CGM in hospitalized patients, particularly in intensive care units and perioperative settings, where glycemic variability is linked to poor outcomes.[7,33,34] Edelman et al. (2018) proposed that the use of real-time glucose data could enhance glycemic control and minimize complications. Other potential uses include perioperative monitoring, critical illness, and other metabolic conditions where glucose regulation is inadequate.[9] Additional future applications may include perioperative monitoring, critical illness, and other metabolic conditions where glucose regulation is compromised. These expanded indications require validation through large-scale trials.[33–35]

5.3 Research Needs

Despite the rapid acceptance of CGM, several research gaps remain. To determine the sustainability of CGM benefits and its role in preventing complications, long-term outcomes data are necessary, particularly in T2D populations.[1] Further studies will be required to determine optimal implementation strategies, including education models, follow-up protocols, and device selection criteria across different populations. Additionally, economic evaluations assessing cost-effectiveness in under-resourced settings or in non-insulin-treated patients are critical for informing health policy.[1,2] The impact of CGM on complications related to diabetes, such as cardiovascular events, retinopathy, and quality of life measures needs further investigation. A more comprehensive study is required.[23,24]

6. OUTCOMES

Thirty-five studies were included in this review. Reported outcomes included HbA1c, TIR, hypoglycemia, insulin dose, weight, treatment satisfaction, sleep quality, daily functioning, and adherence. HbA1c reductions following CGM use ranged from −0.74% to −0.20%, with the most significant improvements observed in insulin users, individuals with baseline HbA1c above 8%, and older adults; in patients with T1D, closed-loop systems with rtCGM yielded a mean HbA1c reduction of 0.27%. Time spent in hypoglycemia was reduced by approximately 0.66%. In insulin-treated T2D, CGM use led to a mean daily insulin reduction of 10.6 units and a weight decrease of 3.3 kg. High adherence (93.1%) and strong satisfaction were reported in elderly users of CGM systems, supported by simplified device interfaces. Patient-reported outcomes showed moderate improvements in treatment satisfaction (effect size 0.44), as well as in sleep quality, emotional distress, and daily functioning. No formal assessment of risk of bias, reporting bias, heterogeneity, sensitivity, or certainty of evidence was conducted. Due to variation in study types and outcomes, results were synthesized narratively without meta-analysis or structured effect estimates.

Evidence was most consistent in patients with T1D, where multiple RCTs and meta-analyses demonstrated clear improvements in HbA1c, time in range, and hypoglycemia reduction. In insulin-treated T2D, results were more heterogeneous, while data for non–insulin-treated T2D, elderly patients, and pregnant women remain limited and preliminary.

DISCUSSION

The results of this review indicate that CGM, particularly real-time systems and closed-loop insulin delivery, significantly improves glycemic outcomes across various diabetes populations.[4,7,9,12,28] Increases in TIR with the greatest improvements observed in patients using hybrid systems or those with insulin-treated T2D.[1,2,23,24] Reductions in HbA1c and time spent in hypoglycemia were also consistently reported, along with benefits for special populations such as pregnant women, young children, and older adults.[9–12,23,24,26] High adherence and satisfaction among elderly users further support CGM's practical usability.[9,10,24] However, the included studies varied in design and quality, with limited data on non–insulin-treated patients and special populations, and some evidence based on short-term outcomes.[1,2,4]

Comparative analysis across patient groups the strength of evidence regarding CGM varies substantially across patient populations. In T1D, data from multiple randomized controlled trials and meta-analyses consistently demonstrate significant improvements in HbA1c, time in range, and reduction of hypoglycemia, providing robust support for routine CGM use.[4,7,12,23,24] In insulin-treated T2D, evidence is more heterogeneous: some studies confirm clear benefits in glycemic control, while others report only modest improvements, highlighting variability in patient response and study design. For non–insulin-treated T2D, the number of available studies remains limited, and current findings are insufficient to establish strong clinical recommendations.[1,2] In elderly patients and during pregnancy, early results suggest potential benefits of CGM, but these data are based on small cohorts and short-term outcomes.[10,11,15] Overall, CGM demonstrates the strongest evidence in T1D, moderate but variable evidence in insulin-treated T2D, and only preliminary findings in non–insulin-treated T2D, older adults, and pregnant women.[4,7,10,11,15,16]

A critical appraisal of the available literature indicates that the evidence base is not uniform across patient groups. Randomized controlled trials in T1D consistently demonstrate significant improvements in HbA1c and TIR, whereas findings in insulin-treated T2D are more heterogeneous, and data in non–insulin-treated T2D remain limited. [2,4,6,12,17,23,24]Meta-analyses generally support the benefits of CGM for reducing hypoglycemia and improving TIR, but their conclusions are constrained by study heterogeneity.[1,4,6,7] Observational and real-world studies provide valuable insights into patient satisfaction and usability, though they are prone to bias and confounding.[8,10,29] Taken together, these considerations suggest robust evidence for T1D, moderate but variable results for insulin-treated T2D, and insufficient data for other populations, which should be acknowledged when interpreting the overall effectiveness of CGM.[4,7,10,11,24]

7.1 Limitations

This review has several important limitations. First, the included studies were heterogeneous in terms of design, duration, and patient populations, which makes direct comparisons difficult.[1,4,6,14] Second, many of the randomized controlled trials were of short duration, limiting the ability to draw conclusions about long-term outcomes. Third, no formal risk-of-bias assessment or structured grading of the certainty of evidence was performed, so the strength of the conclusions should be interpreted with caution.[4,6,14] Finally, the evidence for specific subgroups such as non–insulin-treated T2D, elderly patients, and pregnant women remains limited, and further research is needed to establish the effectiveness of CGM in these populations.[6,10,11,17]

Despite the outlined limitations, the findings of this review align with current clinical interest in the integration of CGM and emphasize its potential for personalized, safe, and adaptive diabetes care. Several ongoing trials are expected to expand the evidence base, including studies in inpatient settings, pediatric and elderly populations, and among patients with gestational or non–insulin-treated T2D.[4,7,15–19] In addition, future technological advances such as extended-wear sensors, non-invasive monitoring, algorithm improvements, and digital integration are likely to shape the next stage of CGM development and its implementation in routine practice.[13,30–32]

LIMITATIONS

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CONCLUSIONS

Continuous glucose monitoring has demonstrated the strongest and most consistent evidence of benefit in patients with T1D, where multiple RCTs and meta-analyses confirm improvements in HbA1c, time in range, and reduction of hypoglycemia. In insulin-treated T2D, results are supportive but more heterogeneous, while data for non–insulin-treated T2D, elderly patients, and pregnant women remain limited and preliminary.

These findings emphasize the clinical value of CGM in routine practice, particularly for T1D and insulin-dependent T2D, where its integration can improve safety, personalization of therapy, and patient quality of life. At the same time, the current evidence base highlights important gaps that must be addressed. Future research should focus on long-term outcomes, cost-effectiveness, and the role of CGM in special populations such as older adults, pregnant women, and patients with non–insulin-treated T2D.

DISCLOSURES

AUTHOR CONTRIBUTIONS

Conceptualization: Karol Seweryn Błąd, Lena Merchel, Julia Nowakowska, Piotr Komasara

Methodology: Karol Seweryn Błąd

Software: Lena Merchel, Sylwia Lach

Validation: Julia Nowakowska

Formal Analysis: Ilona Bednarek, Aleksandra Świerczewska,

Investigation: Karol Seweryn Błąd,

Resources: Katarzyna Czechowska

Data Curation: Lena Merchel

Writing – Original Draft: Aleksandra Sędek

Writing – Review & Editing: Kinga Kałuża

Visualization: Karol Seweryn Błąd, Piotr Komasara

Supervision: Karol Seweryn Błąd

Project Administration: Karol Seweryn Błąd

All authors have read and agreed to the published version of the manuscript.

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