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Review article

Continuous glucose monitoring in Korean pediatric patients with type 1 diabetes: current landscape and clinical implications

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Continuous glucose monitoring (CGM) has become a key component in the management of pediatric type 1 diabetes mellitus (T1DM) since it offers real-time glucose data that facilitate tighter glycemic control and reduce acute complications. Accumulating evidence and international guidelines highlight the clinical efficacy, safety, and feasibility of CGM use in children, particularly those with high adherence. Regular CGM use is associated with significant reductions in glycated hemoglobin, fewer hypo- and hyperglycemia episodes, and improved quality of life for both patients and their caregivers. Recent advances in CGM technology—including improved accuracy, extended sensor wear, factory calibration, and customizable alerts—have enhanced their usability in pediatric populations. In addition to established CGM metrics such as time in range, time below range, and glycemic variability, a novel parameter—time in tight range (also referred as time in normoglycemia), defined as the percentage of time with blood glucose readings within 70–140 mg/dL—has emerged as a potentially more sensitive marker of optimal glycemic control in children. This review provides a comprehensive overview of CGM technologies, including device types, performance metrics, and clinical evidence supporting their use for pediatric T1DM. It also examines recent advancements in Korea such as expanded insurance reimbursement and clinical integration. As CGM becomes more accessible and technologically advanced, it is expected to play an increasingly central role in optimizing long-term outcomes for children and adolescents with T1DM.

Key words: Continuous glucose monitoring, Type 1 diabetes mellitus, Child, Adolescent, Korea

Key message

Continuous glucose monitoring (CGM) has transformed pediatric type 1 diabetes care by facilitating tighter glycemic control, reducing hypoglycemia, and improving quality of life.

Recent advances in CGM technology and the expansion of insurance coverage in Korea have led to its broader adoption.

Emerging metrics such as time in tight range offer refined tools for individualized glycemic assessment, highlighting CGM's evolving role in personalized pediatric diabetes management.

Introduction

Type 1 diabetes mellitus (T1DM) is characterized by absolute insulin deficiency caused by the autoimmune destruction of pancreatic islet cells that results in chronic hyperglycemia.[1] Consequently, individuals with T1DM require lifelong insulin therapy to achieve glycemic control and prevent long-term complications.[2] The global prevalence of T1DM in children and adolescents is rising, posing a growing public health burden.[3,4] Although its incidence remains lower in youth in Korea versus Western countries, it has shown a steady increase over recent decades.[5,6] From 2007 to 2017, the incidence and prevalence of childhood-onset T1DM in Korea increased annually by approximately 3%–4%, with the most notable rise being observed among boys.[7] More recent nationwide data indicate that from 2008 to 2021, the incidence among Koreans under 30 years increased from 3.02 to 3.75 per 100,000 population, with the greatest increases observed

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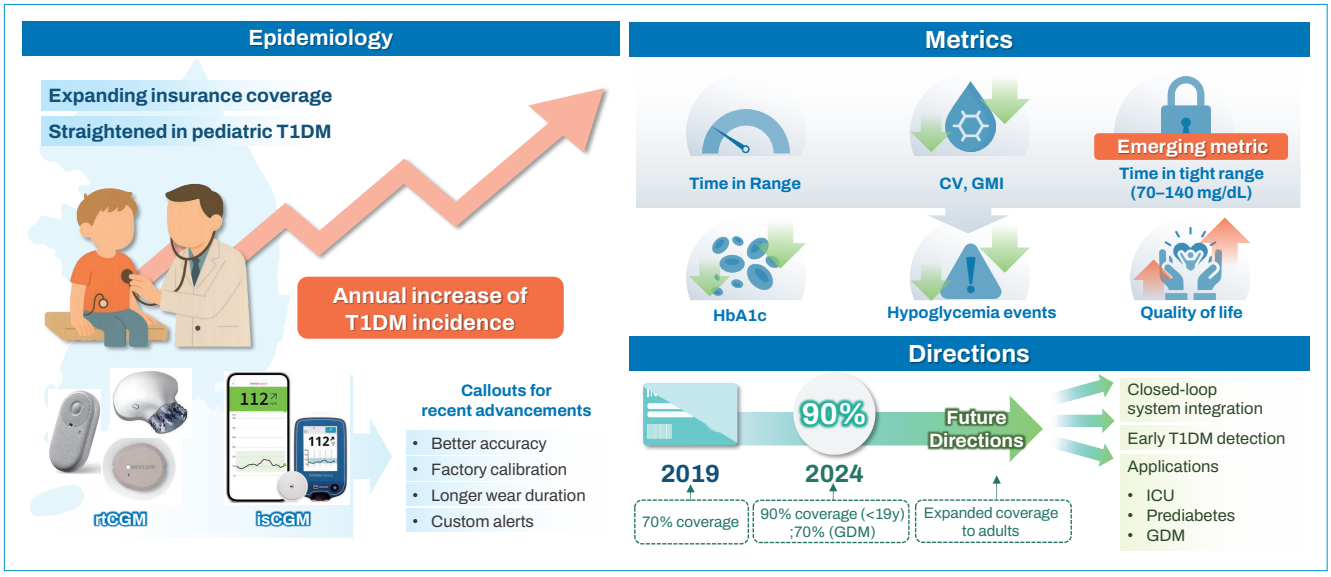

Graphic abstract. Summary of continuous glucose monitoring (CGM) in Korean pediatric type 1 diabetes mellitus (T1DM) highlighting the rising incidence, technological advances, and key metrics including time in tight range (70–140 mg/dL). Future directions encompass expanded insurance coverage, closed-loop integration, early detection, and applications in intensive care units, prediabetes, and gestational diabetes. CV, coefficient of variation; GMI, glucose management indicator; rtCGM, real-time CGM; isCGM, intermittently scanned CGM; HbA1c, glycated hemoglobin; GDM, gestational diabetes mellitus; ICU, intensive care unit.

in children aged 0–14 years; over the same period, the prevalence more than doubled from 21.82 to 46.41 per 100,000 population.[8]

Glucose monitoring has traditionally relied on fingerstick blood glucose meters (BGMs) and periodic glycated hemoglobin (HbA1c) assessments to guide treatment decisions and evaluate a patient's glycemic control.[9] Over the past 2 decades, the landscape of glucose monitoring has shifted significantly with the introduction and growing use of continuous glucose monitoring (CGM) systems. CGM systems measure interstitial glucose levels using subcutaneous enzyme- or fluorescence-based sensors that provide real-time data every 1–5 minutes and generate dynamic comprehensive glucose profiles. These technologies are broadly categorized into 3 types: retrospective (professional), real-time CGM (rtCGM), and intermittently scanned CGM (isCGM).[10]

CGM has transformed the management of T1DM in pediatric populations by improving glycemic outcomes, reducing the risk of hypoglycemia, and enhancing quality of life.[11,12] Current guidelines recommend the early initiation of CGM, ideally at or soon after diagnosis.[10] T1DM is now also being recognized as a progressive disease that advances through defined preclinical stages prior to clinical symptom onset.[13] Emerging evidence suggests that CGM may offer a non-invasive approach to identifying early glycemic abnormalities that indicate disease progression, particularly in presymptomatic stages.[14] This review aims to provide practical guidance for the clinical implementation of CGM, with a particular focus on the context of Korean healthcare, through a comprehensive overview of device characteristics, supporting clinical evidence, and future directions.

CGM system types and features

A typical CGM system consists of a subcutaneous sensor, wireless transmitter, and receiver or smart device that displays glucose readings and trends at frequent intervals. Technological advancements—such as improved sensor accuracy, nonadjunctive use, factory calibration (eliminating the need for a BGM), compact design, remote monitoring, and integration with insulin delivery systems—have supported the widespread adoption of these systems, particularly in pediatric populations.[15] The latest generations of rtCGM and isCGM systems—including the Dexcom G7 (Dexcom Inc., USA); Medtronic Guardian 4 and Medtronic Simplera (Medtronic Inc., USA); and Abbott FreeStyle Libre 3 and FreeStyle Libre 2 (Abbott Diabetes Care Inc., USA)— are factory calibrated and do not require user calibration using a capillary BGM. However, manual calibration remains an option on some rtCGM devices if persistent discrepancies between CGM and capillary blood glucose readings are observed. Modern CGM sensors are minimally invasive, designed for transdermal self-application, and worn for 6–15 days.

The CGM systems that are currently approved in Korea include the Guardian 4 (Medtronic Inc.), Dexcom G7 (Dexcom Inc.), FreeStyle Libre 2 (Abbott Diabetes Care Inc), and Caresens Air (i-SENS Inc., Seoul, South Korea) (Table 1). All 4 are classified as rtCGM systems that

provide continuous glucose data without requiring active scanning, although they differ in terms of technical and regulatory characteristics such as device dimensions, approved age, sensor wear sites, transmitter integration, wear duration, warm-up time, and mean absolute relative difference (MARD). Device sizes vary slightly, and the minimum approved user age ranges from 2 to 19 years depending on the product. Sensor application sites differ by device and age group, with approved locations including the upper arm, abdomen, and upper buttocks. The Dexcom G7 (Dexcom Inc.), FreeStyle Libre 2 (Abbott Diabetes Care Inc), and Caresens Air (i-SENS Inc.) systems incorporate integrated transmitters, whereas the Guardian 4 (Medtronic Inc.) system requires a separate transmitter. Sensor wear duration ranges from 7 to 15 days, while warm-up times vary from 30 minutes to 2 hours. Reported MARD values in pediatric populations range from 8.1% to 12.3% depending on device, attachment site, and age group.

New-generation CGM systems already available in other countries are expected to be introduced in Korea in the near future. These include the Simplera (Medtronic Inc.), which features an all-in-one integrated sensor and is approved for younger children (≥2 years), and the FreeStyle Libre 3 (Abbott Diabetes Care Inc.), which offers a smaller and thinner sensor with improved accuracy. A 15.5-day

Table 1. Key features of current CGM systems

Model	Currently available in Korea				Future introduction	
	Guardian 4	Dexcom G7	FreeStyle Libre 2	Caresens Air	Simplera	FreeStyle Libre 3
Manufacturer	Medtronic	Dexcom Inc.	Abbott Diabetes Care	i-SENS, inc.	Medtronic	Abbott Diabetes Care
Type	Real time	Real time	Real time	Real time	Real time	Real time
Size (cm)	2.9×3.6×1.0	3.4×3.7×0.5	1.4×1.4×0.2	3.5×1.9×0.5	2.9×2.9×0.5	0.8×0.8×0.1
Age (yr)	≥7	≥2	≥4 (2[b])	≥19 (overseas: ≥18)	≥2	≥4 (2[c])
Attachment area	7–17 Yr: upper arm, upper buttocks 18–80 yr: upper arm, abdomen	2–6 Yr: upper arm, abdomen, upper buttocks ≥7 yr: upper arm, abdomen	Upper arm	upper arm	2–17 Yr: upper arm, upper buttocks ≥18 yr: upper arm	Upper arm
Transmitter	Reusable (12 months)	Integrated sensor/ transmitter	Integrated sensor/ transmitter	Integrated sensor/ transmitter	Integrated sensor/ transmitter	Integrated sensor/ transmitter
Display device	Smartphone	Smartphone or receiver	Smartphone or receiver (reader)	Smartphone or receiver	Smartphone	Smartphone or receiver (reader)
Sensor duration (day)	7	10 (15[a])	14 (15[b])	15	7	14 (15[c])
Calibration	No (factory-calibrated)	No (optional)	No (factory-calibrated)	No (optional)	U.S.: first 8 hr/ OUS: No	No (factory-calibrated)
Measurement range (mg/dL)	40–400	40–400	40–400	40–500	40–400	40–400
MARD, adult (%)	Upper arm 10.6, abdomen 10.8	Upper arm 8.2, abdomen 9.1	≥18 Yr: 9.2 Pregnant woman: 11.6	9.4	10.2	7.8
MARD, child (%)	Upper arm 11.7, upper buttocks 12.3	2–6 Yr: overall 9.3 7–17 yr: upper arm 8.1, abdomen 9.0	4–5 Yr: 11.8 6–17 yr: 9.7	–	Upper arm 10.9, upper buttocks 10.2	7.8
Warm-up time (min)	120	30	60	30	120	60
Alarm	High, low, predictive high/low	High, low, urgent low, urgent low soon (predict), falling/rising fast, delayed 1st	High, low, signal loss	High, low, very low, predictve high/low, rate of change, signal loss	High, low, urgent low, high/low predicted, fall/rise alert	High, low, signal loss
FDA-approved for insulin dosing	Yes	Yes	Yes	No	Yes	Yes
Application (smartphone)	CareLink	Dexcom CLARITY, Follow, Pasta	LibreView	Caresens Air App	CareLink	LibreView
Website	https://carelink.medtronic.eu/login	https://clarity.dexcom.eu/	https://libreview.com	https://sens365.i-sens.com	https://carelink.medtronic.eu/login	https://libreview.com
Medication interference	Acetaminophen, hydroxyurea	Acetaminophen, hydroxyurea	High dose vitamin C	High dose vitamin C	Acetaminophen, hydroxyurea	High dose vitamin C
Interworking with other medical devices	Yes	Yes	Yes	No	Yes	Yes
Other features	Predictive alarm (up to 60 min in advance)	Temporary silencing for up to 6 hr, very low lag time averaging 3.5 min	IBOA-/MBPA-free (improved dermatologic tolerability)	-	High predictive alarm (10–60 min in advance)	-

CGM, continuous glucose monitoring; FDA, U.S. Food and Drug Administration; IBOA, isobornyl acetate; MARD, mean absolute relative difference; MBPA, 2,2'-methylenebis(6-tert-butyl-4-methylphenol) monoacrylate.
[a]A 15.5-day wear version of the Dexcom G7 has been approved for adult use in the United States and is expected to become more widely available in the near future; [b]FreeStyle Libre 2 plus (not yet available in Korea); [c]FreeStyle Libre 3 plus (not yet available in Korea).

wear version of the Dexcom G7 (Dexcom Inc.) was recently approved for adult use in the United States and is expected to become more widely available.[16] The FreeStyle Libre 2 Plus and Libre 3 Plus (Abbott Diabetes Care Inc.), which offer extended wear durations of up to 15 days and revised minimum age indications as young as 2 years, have also been developed.

Key CGM metrics

The Advanced Technologies & Treatments for Diabetes consensus, first established in 2017 and revised in 2019, recommends the use of standardized CGM metrics to optimize diabetes management. These include the number of days of CGM use (≥14 days), time percentage of active CGM use (≥70%), mean glucose, glucose management indicator (an estimate of HbA1c based on CGM data), glycemic variability measured by the coefficient of variation (CV ≤36%), time above range (TAR) >250 mg/dL (<5%), TAR 181–250 mg/dL (<5%), time in range (TIR) 70–180 mg/dL (>70%), time below range (TBR) 54–69 mg/dL (<4%), and TBR <54 mg/dL (<1%) (Table 2).[17,18] Standardized reports such as the ambulatory glucose profile (AGP), currently in version 5.0, provide visual summaries of these 10 key metrics to support informed decision-making by both patients with diabetes and their healthcare providers (Fig. 1).[19] Each CGM manufacturer offers proprietary software used to visualize and interpret the CGM data—such as Dexcom CLARITY (Dexcom Inc.), which can be integrated with the Pasta app (Kakao Healthcare Corp., Korea); CareLink (Medtronic Inc.); LibreView® (Abbott Diabetes Care Inc); and the Caresens Air App (i SENS Inc.)—that facilitate AGP report generation and core metric reviews (Table 1).

Time in tight range (TITR; also referred to as time in normoglycemia [TING])—defined as the percentage of time that blood glucose remains within 70–140 mg/dL—has recently emerged as a promising metric for evaluating optimal glycemic control.[20] Although a TITR of >55% may be required to achieve an HbA1c ≤6.5%, a more widely accepted threshold is >50%.[21] Although further research is warranted in pediatric populations, an increased TITR is thought to reflect reduced glycemic variability and a lower risk of complications. Importantly, the effective interpretation and use of CGM metrics must be supported by comprehensive education of both children and their caregivers to address the broader health needs beyond glycemic targets.

CGM efficacy in pediatric T1DM

Multiple randomized controlled trials (RCTs) have demonstrated the clinical utility of CGM in pediatric patients with T1DM by reporting improvements in glycemic control and reductions in hypoglycemia (Table 3). In the Juvenile Diabetes Research Foundation (JDRF; renamed Breakthrough T1DM in 2024) CGM study, children aged 8–14 years using an rtCGM experienced significant reductions in HbA1c compared to those receiving standard care, with greater benefits observed in those with higher adherence.[22] Similarly, the ONSET (Paediatric Onset) study reported no overall difference in HbA1c levels between children who initiated sensor-augmented insulin pump therapy at diagnosis and those who used pump therapy with BGM. However, regular (≥1/wk) sensor users—particularly adolescents—showed significantly lower HbA1c levels, reduced glycemic variability, and better C-peptide preservation. No severe hypoglycemia was reported in the sensor group, which also supports CGM safety and metabolic benefits.[23]

In one multicenter RCT, rtCGM use reduced the time spent in hypoglycemia (<63 mg/dL) by 48% among pediatric participants and produced a modest but significant

Table 2. Standardized and novel CGM metrics for clinical care in pediatric type 1 diabetes

Metric	Interpretation	Goals
Period of CGM use		≥14 Day
Active usage time percentage of CGM		≥70%
Mean glucose	Simple average of glucose values	<154 mg/dL
Glucose management indicator	Calculated value approximating HbA1c (not always equivalent)	<7%
Glycemic variability (%CV) target	Spread of glucose values	≤36%
TAR: % >250 mg/dL	Level 2 hyperglycemia	<5%
TAR: % 181–250 mg/dL	Level 1 hyperglycemia	<25%
TIR: % 70–180 mg/dL	In range	>70%
TITR, % 70–140 mg/dL[a]	In tight range	>50%
TBR: % 54–69 mg/dL	Level 1 hypoglycemia	<4%
TBR: % <54 mg/dL	Level 2 hypoglycemia	<1%

CGM, continuous glucose monitoring; CV, coefficient of variation; HbA1c, glycated hemoglobin; TAR, time above range; TBR, time below range; TIR, time in range; TITR, time in tight range.
[a]Also referred to as time in normoglycmiea (TING), an emerging metric for optimal glycemic control.

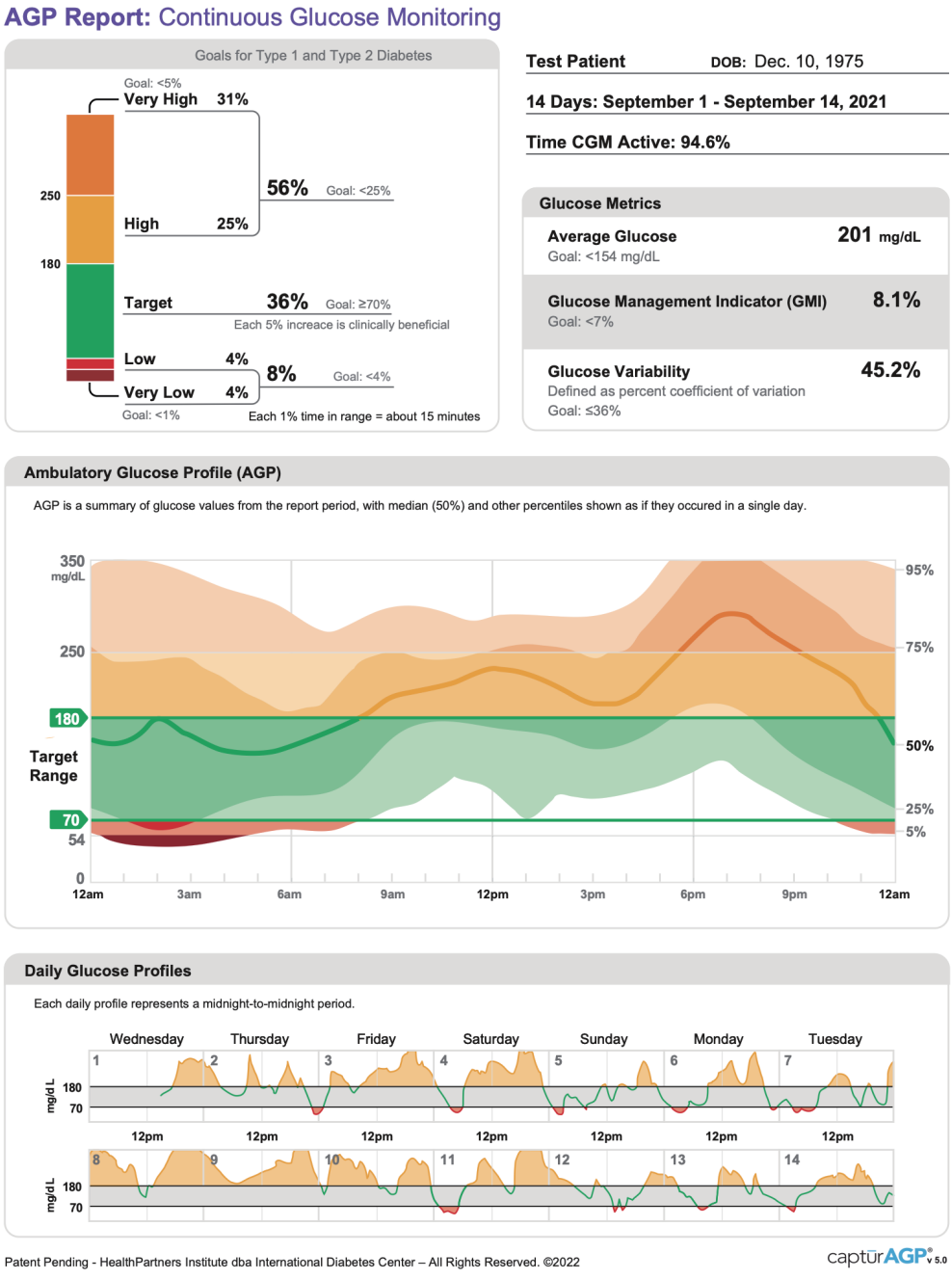

Fig. 1. Ambulatory glucose profile report (v5.0) for continuous glucose monitoring, produced by the International Diabetes Center (available at: http://www.agpreport.org/agp/agpreports). ©2025 International Diabetes Center, Minneapolis, MN. Used with permission. Visit AGPreport.org for more information.

reduction in HbA1c—particularly among those who were already within near-target glycemic ranges.[24] An additional analysis of the JDRF data showed that rtCGM use significantly reduced glycemic variability markers, reinforcing CGM's role in mitigating acute glucose excursions.[25] The CITY (CGM Intervention in Teens and Young Adults with Type 1 Diabetes) study reported a small but statistically significant reduction in HbA1c levels (-0.37%) over 26 weeks in adolescents using CGM versus BGM along with increased TIR and reduced hypoglycemia; these benefits were observed as soon as 13 weeks.[26]

In younger children (aged 2 to <8 years), the Strategies to Enhance New CGM Use in Early Childhood (SENCE) study showed that rtCGM use did not improve TIR, but it significantly reduced hypoglycemia and severe hypoglycemic events compared to BGM.[27] In a study of do-it-yourself rtCGM use, rtCGM use lead to significant improvements in TIR and reductions in hyperglycemia compared to isCGM without increasing hypoglycemia. Although it did not reduce parental fear of hypoglycemia, caregiver satisfaction and quality of life improved, supporting the short-term feasibility and psychosocial bene-

Table 3. Randomized controlled trials of the efficacy of continuous glucose monitoring in pediatric type 1 diabetes

Source (study)	Study design (duration)	Treatment	Population	Baseline glycemic status	CGM device	Key outcomes	Main findings
Tamborlane et al., 2008 (JDRF CGM study)[22]	Multicenter RCT (26 wk)	MDI, CSII	Children (8–14 yr); n=114 (E/C 56/58), Adolescents (15–24 yr); n=110 (E/C 57/53)	Mean HbA1c: 7.9–8.0%	rtCGM: Dexcom G7, MiniMed Paradigm, FreeStyle Navigator	HbA1c change, CGM adherence, severe hypoglycemia	Children (8–14 yr): significant HbA1c reduction in CGM group with high adherence, Adolescents (15–24 yr): no significant HbA1c difference due to lower adherence
Kordonouri et al., 2010 (ONSET study)[23]	Multicenter RCT (12 mo)	CSII	Children with newly diagnosed T1D (1–16 yr), n=160	NA	rtCGM: Enlite	HbA1c, glycemic variability, C-peptide, sensor usage	No overall HbA1c difference between groups; however, regular sensor users had significantly lower HbA1c (7.1% vs. 7.6%), reduced glycemic variability, and better C-peptide preservation (esp. in 12–16 yr subgroup)
Battelino et al., 2011[24]	Multicenter RCT (6 mo)	MDI, CSII	Children (10–17 yr); n=53 (E/C 27/26)	Mean HbA1c 6.9% (all <7.5%)	rtCGM: FreeStyle Navigator	Hypoglycemia (<63 mg/dL), HbA1c, TIR	Hypoglycemia <63 mg/dL reduced by 48%, HbA1c reduction (0.23%)
El-Laboudi et al., 2016 (JDRF CGM study)[25]	RCT (26 wk)	MDI, CSII	Children (8–14 yr); n=142 (E/C 74/68), Adolescents (15–24 yr); n=141 (E/C 71/70)	Mean HbA1c: 7.4%	rtCGM: Dexcom G7, Enlite, FreeStyle Navigator	Glycemic variability (CV, LBGI, %GRAD$_{Ehypoglycemia}$, MAG), HbA1c	CGM significantly reduced most glycemic variability indices, especially CV, LBGI, %GRAD$_{Ehypoglycemia}$. Glycemic variability better predicted hypoglycemia than HbA1c. Greater benefit in those with high baseline HbA1c, high baseline GV, frequent SMBG, and pump use
Laffel et al., 2020 (CITY study)[26]	RCT (26 wk)	MDI, CSII	Adolescents (14–19 yr); n=101 (E/C 48/53)	Mean HbA1c 8.9%	rtCGM: Dexcom G5	HbA1c change, CGM metrics, satisfaction	Modest HbA1c reduction (–0.37%); 44% had ≥0.5% HbA1c drop
Laffel et al., 2021 (SENCE study) (2021)[27]	RCT (6 mo)	MDI, CSII	Children (2–8 yr), n=143	Mean HbA1c 8.2%	rtCGM: Dexcom G5	TIR, hypoglycemia, QoL	CGM did not improve TIR significantly vs BGM; however, CGM significantly reduced hypoglycemia (<70 mg/dL)
Elbalshy et al., 2022 (DIY RT-CGM study)[28]	RCT, Cross-over (17 wk)	MDI	Children (2–13 yr); n=55 (DIY-rtCGM/isCGM 28/27)	Mean HbA1c: 7.6%	DIY-rtCGM: isCGM +xDrip+, isCGM: FreeStyle Libre 1	Parental FOH, TIR, treatment satisfaction	No FOH change; TIR increased 5.7%, parental satisfaction improved
Messaaoui et al., 2022[29]	RCT (8 wk)	MDI, Free-mix, CSII	Children, adolescents, young adults (4–20 yr), n=37 (E/C 19/18)	Median HbA1c 7.8%	rtCGM: Guardian™ Connect, isCGM: FreeStyle Libre 1	TBR, severe hypoglycemia, HbA1c, glycemic variability	No HbA1c change; however significant reduction in severe hypoglycemia in rtCGM group
Van Name et al., 2023 (SENCE 1-year follow-up)[30]	RCT+extension (12 mo total)	MDI, CSII	Children (2–8 yr), n=143	Mean HbA1c 8.2%	rtCGM: Dexcom G5	TIR, hypoglycemia, QoL	CGM did not improve TIR significantly vs BGM; however, CGM significantly reduced time <70 mg/dL (hypoglycemia)
Jefferies et al., 2023[31]	Multicenter RCT (12 wk)	MDI, CSII	Children 4–13 yr, n=100 (E/C 49/51)	Mean HbA1c: 9.1%	isCGM: FreeStyle Libre 2	HbA1c, TBR	No change in HbA1c or TIR; reduced TBR in isCGM group

C, control; CGM, continuous glucose monitoring; CSII, continuous subcutaneous insulin infusion; CV, coefficient of variation; DIY, do-It-yourself; E, experiment; FOH, fear of hypoglycemia; GRADEhypoglycemia, glycemic risk assessment diabetes equation score attributable to hypoglycemia; HbA1c, glycated hemoglobin; isCGM, intermittently scanned; LBGI, low blood glucose index; MAG, mean absolute glucose change per unit time; MDI, multiple daily injection; NA, not available; QoL, quality of life; RCT, randomized controlled trials; rtCGM, real-time CGM; T1D, type 1 diabetes; TBR, time below range; TIR, time in range.

fits of rtCGM.[28]

An 8-week RCT that compared rtCGM to isCGM in children and adolescents revealed that rtCGM significantly reduced severe hypoglycemia. Among those with higher risks of hypoglycemia (baseline TBR, ≥5%), rtCGM use further reduced both TBR and glycemic variability, indicating greater benefits in high-risk pediatric populations.[29] A follow-up study of the SENCE confirmed that rtCGM use in children aged 2 to <8 years resulted in sustained reductions in hypoglycemia and consistently high device adherence regardless of behavioral interventions. However, TIR and HbA1c remained unchanged, highlighting persistent challenges in managing hyperglycemia in this age group.[30]

In a multicenter RCT conducted in children aged 4–13 years with elevated HbA1c levels, isCGM (via the FreeStyle Libre 2.0 system) increased glucose monitoring frequency and reduced time in hypoglycemia compared to BGM, although no significant improvements were seen in terms of HbA1c, TIR, or psychosocial measures.[31] A recent meta-analysis of 5 RCTs involving 92 children and adolescents found that rtCGM versus isCGM use led to a greater increase in TIR, primarily by reducing hypo- and hyperglycemia. However, the TIR benefit was more pronounced in adults, and no significant difference in HbA1c was observed in the pediatric subgroup.[32]

The superior glycemic outcomes with rtCGM versus isCGM are supported by recent nationwide cohort data showing greater and sustained HbA1c reductions and larger decreases in CV over 24 months in both adults and children with T1DM.[33] These benefits are likely attributable to rtCGM's real-time data transmission and pre-

dictive alerts, which facilitate prompt corrective action, whereas isCGM requires intermittent scanning that may delay the detection and management of rapid or asymptomatic glucose excursions. Moreover, evidence from the coronavirus disease 2019 pandemic in Korean pediatric patients with T1DM indicates that CGM enabled effective glucose monitoring and supported timely insulin adjustments during periods of acute illness and restricted healthcare access, helping mitigate short-term glycemic deterioration and underscoring its value in maintaining metabolic stability during the public health crisis.[34] Newer-generation CGM devices that feature improved accuracy, ease of use, and integration with insulin pumps or decision-support algorithms are expected to further enhance their utility in young children and high-risk populations with T1DM.

Novel CGM applications

Beyond its established role in glycemic management, CGM is increasingly being explored for the early detection and risk stratification of T1DM in its presymptomatic stages. In one prospective study of 91 children (median age, 11.5 years) with persistent islet autoantibodies identified through general population screening, achieving glucose levels of >140 mg/dL >10% of the time was associated with an 80% risk of progression to clinical T1DM within 12 months.[35] Similarly, in a study of 46 asymptomatic children and young adults (aged 4–25 years) with human leukocyte antigen–conferred genetic susceptibility to developing T1DM who were enrolled in the Finnish Type 1 Diabetes Prediction and Prevention (DIPP) study, a 10-day CGM assessment effectively identified individuals with asymptomatic stage 3 T1DM and stage 2 dysglycemia.[36] In the TrialNet study, which involved 105 first- or second-degree relatives of individuals with T1DM (aged 5–42 years) who tested positive for ≥2 islet autoantibodies, achieving glucose levels of ≥140 mg/dL ≥5% of the time was linked to a 40% risk of progressing to clinical T1DM within 2 years.[37] A longitudinal study of 34 nonoverweight first-degree relatives (aged 5–39 years) further demonstrated that CGM-derived metrics—particularly time spent above 120 and 140 mg/dL—had predictive value regarding progression to stage 3 T1DM. In this context, CGM combined with HbA1c may represent a practical alternative to oral glucose tolerance tests (OGTTs) for long-term monitoring.[14]

Beyond early T1DM detection, CGM is being explored in various other clinical settings as well. In critically ill patients, CGM has demonstrated potential for real-time glucose monitoring in intensive care units, supporting insulin titration and reducing hypoglycemia risk.[38] In a Korean retrospective study of 18 critically ill pediatric patients with diabetic ketoacidosis (mean age, 11.0±4.2 years), CGM showed acceptable clinical accuracy (overall MARD, 13.0%), with performance improving as diabetic ketoacidosis resolved and accuracy negatively correlating with lower serum bicarbonate levels.[39] However, certain challenges remain, including variable accuracy, limited evidence of mortality benefits, and practical barriers such as sensor lag and cost.[40-43] Furthermore, CGM is also being evaluated as a screening tool for prediabetes because of its capacity to detect postprandial glucose excursions and glycemic variability that are not captured by fasting plasma glucose or HbA1c levels. Although CGM offers greater sensitivity and facilitates lifestyle modifications through real-time feedback, it currently serves as a supplemental rather than standalone diagnostic tool.[44] Emerging evidence supports the use of CGM in the diagnosis and management of gestational diabetes mellitus (GDM) as well. CGM can uncover glycemic excursions that may be missed by standard OGTTs, promote healthier behaviors, and enable earlier interventions.[45-47] It also aids the prediction of adverse maternal and neonatal outcomes, particularly when integrated with education and clinical support.[48,49] Collectively, these expanded applications underscore the evolving role of CGM as a minimally invasive and dynamic tool that can be used for diabetes management as well as diagnostics, staging, and risk stratifications of a broad range of other disorders related to glucose metabolism.

Looking ahead, the integration of CGM with automated insulin delivery system is expected to further transform diabetes care. These systems use rtCGM data to automatically adjust insulin delivery, reducing both hypo- and hyperglycemia while minimizing the burden of frequent manual insulin dose adjustments.[50,51] Advances in algorithm development, interoperability standards, and device miniaturization are anticipated to enhance the accessibility and effectiveness of closed-loop technology in pediatric populations in inpatient settings.

Current healthcare coverage and CGM usage trends in Korea

In Korea, the National Health Insurance Service (NHIS) began offering partial reimbursement for rtCGM sensors in January 2019. This coverage was expanded in January 2020 to include rtCGM transmitters and isCGM sensors for individuals with T1DM.[52] Transmitters are reimbursed at 70%, up to 210,000 Korean won (KRW) per 3-month period, while sensors are supported at a rate of 70% for a daily cost of up to 10,000 KRW; the remaining 30% is paid

by the patient. These policy changes marked a pivotal step toward improving access to diabetes technology, particularly among pediatric patients and those at higher risk of glycemic instability. In 2021, the Committee of the Health Insurance and Government Relation of the Korean Diabetes Association released a position statement advocating for broader reimbursement criteria. The statement emphasized the importance of covering both CGM hardware and sensors and the associated consumables and services such as patient and caregiver education, data interpretation, and clinical management support.[53] As of February 2024, NHIS coverage was further expanded to cover up to 90% of the annual cost of CGM devices and sensors for individuals aged <19 years. Coverage was also extended to pregnant women with GDM, who now receive the same support as adult patients with T1DM (i.e., 70% coverage for a daily cost of up to 10,000 KRW).

According to NHIS claims data, 1,434 of 19,730 individuals with T1DM (7.3%) were prescribed CGM sensors between January and December 2019; of them, 751 (52.4%) were <20 years of age.[52] A more recent analysis of NHIS data showed that between 2019 and 2022, 1,911 individuals aged <19 years with T1DM used CGM; of them, 59.3% used rtCGM.[33] Although CGM adoption in Korea remains relatively low compared with that in other high-income countries, this increasing trend—particularly among pediatric users—reflects growing clinical acceptance and highlights the need for continued policy support and infrastructure development to enhance equitable access. However, despite expanded NHIS reimbursement since 2019, substantial barriers persist. These barriers include the financial burden from remaining out-of-pocket costs, lack of structured long-term education for patients and clinicians, adherence challenges (particularly in younger users), device-related discomfort and skin problems, complex data interpretation, psychological burden, and incomplete integration of CGM metrics into routine clinical care.[54] Overcoming these multi-faceted barriers will be essential to the promotion of broader and more effective CGM adoption in Korean pediatric T1DM. Moreover, given the clinical benefits of CGM across all age groups, a gradual expansion of NHIS coverage to include adults with T1DM should be considered. Such an approach would ensure continuous technology use during the transition from pediatric to adult care and help optimize long-term glycemic outcomes.

Conclusion

CGM has transformed the management of T1DM in pediatric populations, offering significant benefits for glycemic control, hypoglycemia prevention, and overall quality of life. Robust evidence from RCTs supports the use of rtCGM, particularly when initiated early and used consistently, with additional advantages being demonstrated in high-risk and younger children. Although isCGM also confers certain benefits, rtCGM generally provides superior outcomes in TIR and hypoglycemia reduction. In Korea, recent expansions in national health insurance coverage have improved access to CGM technologies, but uptake remains suboptimal compared to global benchmarks. Continued efforts are warranted to broaden reimbursement for these systems, support education and data interpretation services, and promote equitable access. As CGM devices become more accurate, user-friendly, and interoperable with insulin delivery systems, they hold increasing promise for improving long-term outcomes in Korean children and adolescents with T1DM.

Footnotes

Conflicts of interest: JK received honorarium from Abbott, Dexcom, and Medtronic. Except for that, no potential conflict of interest relevant to this article was reported.

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References

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2014;37 Suppl 1:S81-90.
2. DiMeglio LA, Evans-Molina C, Oram RA. Type 1 diabetes. Lancet 2018;391:2449-62.
3. Wagenknecht LE, Lawrence JM, Isom S, Jensen ET, Dabelea D, Liese AD, et al. Trends in incidence of youth-onset type 1 and type 2 diabetes in the USA, 2002-18: results from the population-based SEARCH for Diabetes in Youth study. Lancet Diabetes Endocrinol 2023;11:242-50.
4. Gong B, Yang W, Xing Y, Lai Y, Shan Z. Global, regional, and

national burden of type 1 diabetes in adolescents and young adults. Pediatr Res 2025;97:568-76.
5. Kim JH, Lee CG, Lee YA, Yang SW, Shin CH. Increasing incidence of type 1 diabetes among Korean children and adolescents: analysis of data from a nationwide registry in Korea. Pediatr Diabetes 2016;17:519-24.
6. Kim JH, Shin CH, Yang SW. History of insulin treatment of pediatric patients with diabetes in Korea. Ann Pediatr Endocrinol Metab 2021;26:237-41.
7. Chae HW, Seo GH, Song K, Choi HS, Suh J, Kwon A, et al. Incidence and prevalence of type 1 diabetes mellitus among Korean children and adolescents between 2007 and 2017: an epidemiologic sudy based on a national database. Diabetes Metab J 2020;44:866-74.
8. Kim HY, Ji E, Kim J. Increasing diabetes incidence and prevalence among Koreans aged under 30 years: socioeconomic disparities. J Korean Med Sci 2025;40:e241.
9. American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: standards of care in diabetes-2024. Diabetes Care 2024;47:S111-25.
10. American Diabetes Association Professional Practice Committee. 7. Diabetes technology: standards of care in diabetes-2024. Diabetes Care 2024;47:S126-44.
11. Mann EA, Rompicherla S, Miyazaki B, Rioles N, Hardison H, Golden L, et al. Early continuous glucose monitor use in children and adolescents with type 1 diabetes: rates of initiation and impact on glycemic outcomes. Diabetes Care 2025;48:768-75.
12. Tauschmann M, Cardona-Hernandez R, DeSalvo DJ, Hood K, Laptev DN, Lindholm Olinder A, et al. International Society for Pediatric and Adolescent Diabetes Clinical Practice Consensus Guidelines 2024 Diabetes Technologies: glucose monitoring. Horm Res Paediatr 2024;97:615-35.
13. Besser REJ, Bell KJ, Couper JJ, Ziegler AG, Wherrett DK, Knip M, et al. ISPAD clinical practice consensus guidelines 2022: stages of type 1 diabetes in children and adolescents. Pediatr Diabetes 2022;23:1175-87.
14. Desouter AK, Keymeulen B, Van de Velde U, Van Dalem A, Lapauw B, De Block C, et al. Repeated OGTT versus continuous glucose monitoring for predicting development of stage 3 type 1 diabetes: a longitudinal analysis. Diabetes Care 2025;48:528-36.
15. de Bock M, Codner E, Craig ME, Huynh T, Maahs DM, Mahmud FH, et al. ISPAD clinical practice consensus guidelines 2022: glycemic targets and glucose monitoring for children, adolescents, and young people with diabetes. Pediatr Diabetes 2022;23:1270-6.
16. Garg SK, Bailey TS, Castorino K, Christiansen MP, Liljenquist DR, Salazar H, et al. Accuracy of the 15.5-Day G7 iCGM in adults with diabetes. Diabetes Technol Ther 2025;27:430-8.
17. Danne T, Nimri R, Battelino T, Bergenstal RM, Close KL, DeVries JH, et al. International consensus on use of continuous glucose monitoring. Diabetes Care 2017;40:1631-40.
18. Battelino T, Danne T, Bergenstal RM, Amiel SA, Beck R, Biester T, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care 2019;42:1593-603.
19. Kroger J, Reichel A, Siegmund T, Ziegler R. Clinical recommendations for the use of the ambulatory glucose profile in diabetes care. J Diabetes Sci Technol 2020;14:586-94.
20. de Bock M, Agwu JC, Deabreu M, Dovc K, Maahs DM, Marcovecchio ML, et al. International Society for Pediatric and Adolescent Diabetes Clinical Practice Consensus Guidelines 2024: glycemic targets. Horm Res Paediatr 2024;97:546-54.
21. Castaneda J, Arrieta A, van den Heuvel T, Battelino T, Cohen O. Time in tight glucose range in type 1 diabetes: predictive factors and achievable targets in real-world users of the MiniMed 780G system. Diabetes Care 2024;47:790-7.
22. Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group. Continuous glucose monitoring and intensive treatment of type 1 diabetes. N Engl J Med 2008;359:1464-76.
23. Kordonouri O, Pankowska E, Rami B, Kapellen T, Coutant R, Hartmann R, et al. Sensor-augmented pump therapy from the diagnosis of childhood type 1 diabetes: results of the Paediatric Onset Study (ONSET) after 12 months of treatment. Diabetologia 2010;53:2487-95.
24. Battelino T, Phillip M, Bratina N, Nimri R, Oskarsson P, Bolinder J. Effect of continuous glucose monitoring on hypoglycemia in type 1 diabetes. Diabetes Care 2011;34:795-800.
25. El-Laboudi AH, Godsland IF, Johnston DG, Oliver NS. Measures of glycemic variability in type 1 diabetes and the effect of real-time continuous glucose monitoring. Diabetes Technol Ther 2016;18:806-12.
26. Laffel LM, Kanapka LG, Beck RW, Bergamo K, Clements MA, Criego A, et al. Effect of continuous glucose monitoring on glycemic control in adolescents and young adults with type 1 diabetes: a randomized clinical trial. JAMA 2020;323:2388-96.
27. Strategies to Enhance New CGM Use in Early Childhood (SENCE) Study Group. A randomized clinical trial assessing continuous glucose monitoring (CGM) use with standardized education with or without a family behavioral intervention compared with fingerstick blood glucose monitoring in very young children with type 1 diabetes. Diabetes Care 2021;44:464-72.
28. Elbalshy MM, Styles S, Haszard JJ, Galland BC, Crocket H, Jefferies C, et al. The effect of do-it-yourself real-time continuous glucose monitoring on psychological and glycemic variables in children with type 1 diabetes: a randomized crossover trial. Pediatr Diabetes 2022;23:480-8.
29. Messaaoui A, Tenoutasse S, Hajselova L, Crenier L. Comparison between continuous versus flash glucose monitoring in children, adolescents, and young adults with type 1 diabetes: an 8-week prospective randomized trial. Diabetes Ther 2022;13:1671-81.
30. Van Name MA, Kanapka LG, DiMeglio LA, Miller KM, Albanese-O'Neill A, Commissariat P, et al. Long-term continuous glucose monitor use in very young children with type 1 diabetes: one-year results from the SENCE Study. J Diabetes Sci Technol 2023;17:976-87.
31. Jefferies CA, Boucsein A, Styles SE, Chamberlain B, Michaels VR, Crockett HR, et al. Effects of 12-week Freestyle Libre 2.0 in children with type 1 diabetes and elevated HbA1c: a multicenter randomized controlled trial. Diabetes Technol

Ther 2023;25:827-35.
32. Zhou Y, Sardana D, Kuroko S, Haszard JJ, de Block MI, Weng J, et al. Comparing the glycaemic outcomes between real-time continuous glucose monitoring (rt-CGM) and intermittently scanned continuous glucose monitoring (isCGM) among adults and children with type 1 diabetes: a systematic review and meta-analysis of randomized controlled trials. Diabet Med 2024;41:e15280.
33. Kim JY, Kim S, Kim JH. Comparison of real-time and intermittently-scanned continuous glucose monitoring for glycemic control in type 1 diabetes mellitus: nationwide cohort study. Diabetes Metab J 2025;49:436-47.
34. Kim HY, Shin SH, Lee H, Kim J. Changes in metrics of continuous glucose monitoring during COVID-19 in Korean children and adolescents with type 1 diabetes mellitus. Ann Pediatr Endocrinol Metab 2025;30:38-44.
35. Steck AK, Dong F, Geno Rasmussen C, Bautista K, Sepulveda F, Baxter J, et al. CGM metrics predict imminent progression to type 1 diabetes: autoimmunity screening for Kids (ASK) study. Diabetes Care 2022;45:365-71.
36. Kontola H, Alanko I, Koskenniemi JJ, Loyttyniemi E, Itoshima S, Knip M, et al. Exploring minimally invasive approach to define stages of type 1 diabetes remotely. Diabetes Technol Ther 2022;24:655-65.
37. Wilson DM, Pietropaolo SL, Acevedo-Calado M, Huang S, Anyaiwe D, Scheinker D, et al. CGM metrics identify dysglycemic states in participants from the TrialNet pathway to prevention study. Diabetes Care 2023;46:526-34.
38. Krinsley JS, Chase JG, Gunst J, Martensson J, Schultz MJ, Taccone FS, et al. Continuous glucose monitoring in the ICU: clinical considerations and consensus. Crit Care 2017;21:197.
39. Park E, Kim M. Clinical use of continuous glucose monitoring in critically ill pediatric patients with diabetic ketoacidosis. Diabetes Technol Ther 2023;25:529-37.
40. Sun MT, Li IC, Lin WS, Lin GM. Pros and cons of continuous glucose monitoring in the intensive care unit. World J Clin Cases 2021;9:8666-70.
41. Nielsen CG, Grigonyte-Daraskeviciene M, Olsen MT, Moller MH, Norgaard K, Perner A, et al. Accuracy of continuous glucose monitoring systems in intensive care unit patients: a scoping review. Intensive Care Med 2024;50:2005-18.
42. Chu C, Li J, Yang X, Zhao H, Wu Z, Xu R, et al. Continuous glucose monitoring versus conventional glucose monitoring in the ICU: a randomized controlled trial. J Crit Care 2024;84:154894.
43. Wallia A, Umpierrez GE, Nasraway SA, Klonoff DC, Investigators P. Round table discussion on inpatient use of continuous glucose monitoring at the international hospital diabetes meeting. J Diabetes Sci Technol 2016;10:1174-81.
44. Liu X, Zhang J. Continuous glucose monitoring: a transformative approach to the detection of prediabetes. J Multidiscip Healthc 2024;17:5513-9.
45. Kestila KK, Ekblad UU, Ronnemaa T. Continuous glucose monitoring versus self-monitoring of blood glucose in the treatment of gestational diabetes mellitus. Diabetes Res Clin Pract 2007;77:174-9.
46. Castorino K, Durnwald C, Ehrenberg S, Ehrhardt N, Isaacs D, Levy CJ, et al. Practical considerations for using continuous glucose monitoring in patients with gestational diabetes mellitus. J Womens Health (Larchmt) 2025;34:10-20.
47. Lim BSY, Yang Q, Choolani M, Gardner DSL, Chong YS, Zhang C, et al. Utilizing continuous glucose monitoring for early detection of gestational diabetes mellitus and pregnancy outcomes in an Asian population. Diabetes Care 2024;47:1916-21.
48. Bitar G, Cornthwaite JA, Sadek S, Ghorayeb T, Daye N, Nazeer S, et al. Continuous glucose monitoring and time in range: association with adverse outcomes among people with type 2 or gestational diabetes mellitus. Am J Perinatol 2024;41:e1370-7.
49. Quah PL, Tan LK, Lek N, Tagore S, Chern BSM, Ang SB, et al. Continuous glucose monitoring feedback in the subsequent development of gestational diabetes: a pilot, randomized, controlled trial in pregnant women. Am J Perinatol 2024;41:e3374-82.
50. Breton MD, Kanapka LG, Beck RW, Ekhlaspour L, Forlenza GP, Cengiz E, et al. A randomized trial of closed-loop control in children with type 1 diabetes. N Engl J Med 2020;383:836-45.
51. Ware J, Allen JM, Boughton CK, Wilinska ME, Hartnell S, Thankamony A, et al. Eighteen-month hybrid closed-loop use in very young children with type 1 diabetes: a single-arm multicenter trial. Diabetes Care 2024;47:2189-95.
52. Kim JH. Current status of continuous glucose monitoring among Korean children and adolescents with type 1 diabetes mellitus. Ann Pediatr Endocrinol Metab 2020;25:145-51.
53. Kim WJ, Kim JH, Yoo HJ, Son JW, Khang AR, Kwon SK, et al. A position statement of the utilization and support status of continuous glucose monitoring in Korea. J Korean Diabetes 2021;22:225-37.
54. Chen HC, Lai YH, Jiang YD. Overcoming barriers in continuous glucose monitoring: challenges and future directions in diabetes management. J Diabetes Investig 2025;16:769-74.

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