

Continuous Glucose Monitoring in Working Adults with Type 1 Diabetes: A Twelve-Month Comparative Cohort: Glycaemic Control, Hypoglycaemia, Work Productivity and Patient-Reported Outcomes

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Abstract — Continuous glucose monitoring (CGM) has transformed type 1 diabetes (T1DM) care in many high-income settings, but real-world uptake and outcomes among working adults in middle-income settings remain incompletely characterised. We prospectively followed 248 working adults with T1DM at a tertiary diabetes service over 12 months, comparing 128 patients using real-time CGM with 120 patients using conventional self-monitoring of blood glucose (SMBG). Mean HbA1c fell from 8.6% to 7.1% in the CGM cohort and from 8.5% to 8.1% in the SMBG cohort over 12 months. Time in range (70-180 mg/dL) at 12 months was 68.4% in CGM users compared with 54.8% in SMBG users. Severe hypoglycaemia requiring assistance occurred in 14.1% of CGM users and 38.3% of SMBG users (HR 0.32, 95% CI 0.18-0.57). Strongest independent predictors of achieving time-in-range $\geq 70\%$ included CGM use, insulin pump therapy, completion of diabetes education, and carbohydrate counting practice. The findings support broader CGM access for working adults with T1DM, with particular value in shift workers and those with hypoglycaemia unawareness

Keywords — Type 1 Diabetes; Continuous Glucose Monitoring; CGM; Time in Range; Severe Hypoglycaemia; Insulin Pump; Work Productivity.

1. Introduction

Type 1 diabetes places sustained metabolic demands on patients who must adjust insulin doses multiple times daily based on glucose values, anticipated meals, physical activity, illness, and stress. Working adults face particular challenges: shift work disrupts circadian glycaemic patterns; meetings and procedural commitments constrain meal timing; travel introduces unfamiliar foods and altered routines; and the workplace itself rarely accommodates frequent fingerprick monitoring. Despite these challenges, working adults often perceive their employment as central to their identity and economic security, and demand diabetes care models that accommodate rather than constrain working life. Continuous glucose monitoring has emerged as a transformative tool for T1DM management. Real-time CGM provides interstitial glucose values every 1-5 minutes, with trend arrows indicating the direction and rate of glucose change. Modern devices offer predictive low-glucose alarms, smartphone integration, and remote-monitoring capabilities for caregivers. Randomised trials have demonstrated improvements in HbA1c, time in range, and severe hypoglycaemia incidence with CGM compared with conventional SMBG, with effects particularly pronounced in patients with hypoglycaemia unawareness or frequent hypoglycaemia (Jha, Kumar, & Neha, 2026; Kumar, Gautam, & Maitiy, 2026; A S Aneeshkumar, 2022; Bhatnagar, Kumar, & Shivam, 2026). Real-world uptake

and outcomes among working adults in middle-income settings remain incompletely characterised. Cost and reimbursement remain the principal barriers, with monthly consumable expenses approaching INR 8,000-15,000 placing CGM out of reach for many patients without insurance coverage. We followed working adults with T1DM at our tertiary diabetes service prospectively for 12 months, comparing CGM users with SMBG users on glycaemic, hypoglycaemia, and work-related outcomes, to characterise real-world benefit in this specific population (Yatish, Khatoon, & Kumar, 2026; Jha, Kumar, & Neha, 2026).

2. Methods

We prospectively followed adult patients with type 1 diabetes attending the diabetes clinic at a tertiary medical centre between January and December 2024. Inclusion required documented T1DM (clinical onset typically before age 30 with insulin dependence from diagnosis), current insulin therapy (multiple daily injections or pump), current employment of at least 30 hours per week, age 18-65 years, and consent for 12-month follow-up. Patients with type 2 diabetes (including LADA classifications), active malignancy on cytotoxic therapy, dialysis-dependent renal failure, or pregnancy were excluded. The final cohort comprised 248 working adults with T1DM. Monitoring strategy was classified based on use during the 30 days before cohort entry and maintained for the duration of

follow-up. CGM users (n=128) used a real-time CGM device (Dexcom G6 or Libre 2 with real-time alerts) for at least 70% of the monitoring period. SMBG users (n=120) relied on capillary blood-glucose monitoring with no concurrent CGM use during the study period. Patients who initiated CGM during the follow-up year were analysed separately; reported analyses focus on the 240 patients who maintained their initial monitoring strategy through 12 months. Primary outcomes were HbA1c at 12 months and time in range (70-180 mg/dL) at 12 months, the latter assessed by 14-day blinded CGM in all participants at the 12-month visit. Secondary outcomes included severe hypoglycaemia (defined as an event requiring third-party assistance for glucose administration), time below range, diabetic ketoacidosis events, work productivity loss, hypoglycaemia unawareness (Clarke score), and patient-reported diabetes-related quality of life on the DQOL questionnaire. Severe hypoglycaemia events were captured prospectively through patient diaries, clinical encounter records, and structured 3-monthly interviews. Continuous outcomes are summarised by mean (SD) or median (IQR) and compared between groups by t-test or Wilcoxon rank-sum test. Time-to-event outcomes used Kaplan-Meier estimation with log-rank testing. Multivariable logistic regression identified independent predictors of achieving TIR $\geq 70\%$ at 12 months, incorporating monitoring strategy alongside clinical and demographic covariates.

3. Results

3.1 Cohort Characteristics

Table 1. Baseline characteristics by monitoring strategy

Characteristic	CGM users (n=128)	SMBG users (n=120)
Age, mean (SD), years	34.2 (10.8)	36.4 (12.6)
Female sex, n (%)	68 (53.1)	56 (46.7)
Diabetes duration, median (IQR), years	16 (10-24)	18 (12-26)
Age at diagnosis, mean (SD), years	18.4 (8.6)	18.8 (9.2)
BMI, mean (SD), kg/m ²	24.6 (4.2)	25.4 (4.6)
Baseline HbA1c, mean (SD), %	8.6 (1.4)	8.5 (1.4)
Insulin pump therapy, n (%)	48 (37.5)	12 (10.0)
MDI with 4+ daily injections, n (%)	80 (62.5)	108 (90.0)
Daily insulin dose, mean (SD), U/kg	0.62 (0.18)	0.68 (0.22)
Carbohydrate counting practised, n (%)	98 (76.6)	62 (51.7)
History of severe hypoglycaemia (lifetime), n (%)	42 (32.8)	58 (48.3)
Hypoglycaemia unawareness at baseline (Clarke ≥ 3), n (%)	18 (14.1)	38 (31.7)
History of DKA in past 12	6 (4.7)	14 (11.7)

months, n (%)		
Microvascular complications present, n (%)	48 (37.5)	58 (48.3)
Macrovascular complications present, n (%)	8 (6.3)	14 (11.7)
Occupation: office-based, n (%)	68 (53.1)	42 (35.0)
Occupation: shift work, n (%)	32 (25.0)	48 (40.0)
Occupation: travel-intensive, n (%)	16 (12.5)	22 (18.3)
Occupation: manual labour, n (%)	12 (9.4)	8 (6.7)
Years of formal education, mean (SD)	14.6 (3.8)	11.4 (4.2)

3.2 HbA1c Trajectory

Mean HbA1c declined substantially in the CGM cohort and modestly in the SMBG cohort over 12 months (Figure 1). The CGM cohort achieved a mean reduction of 1.5 percentage points (8.6% to 7.1%), compared with a 0.4-percentage-point reduction in the SMBG cohort (8.5% to 8.1%). The HbA1c difference between groups at 12 months was 1.0 percentage points (95% CI 0.7-1.3), a clinically substantial effect given the established relationship between sustained HbA1c reduction and microvascular complication risk.

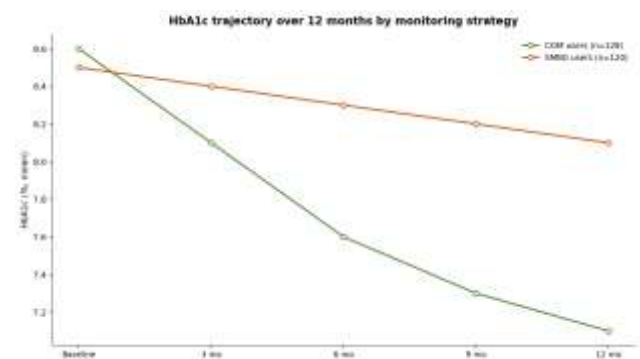


Fig.1: Mean HbA1c trajectory over 12 months by monitoring strategy

3.3 Time-in-Range Metrics

Time-in-range metrics at 12 months differed substantially between groups (Figure 2). CGM users achieved a mean time in range of 68.4% — within the recommended consensus target of $\geq 70\%$, with the difference between groups partly reflecting the systematic capture of nocturnal values that CGM provides but SMBG typically does not. Time above range at the level 2 threshold (>250 mg/dL) was 6.8% in CGM users and 7.6% in SMBG users — a smaller absolute difference. Time below range (<70 mg/dL) was 2.4% in CGM users and 4.8% in SMBG users, with the difference largely attributable to the CGM predictive-low alarm preventing prolonged hypoglycaemia episodes.

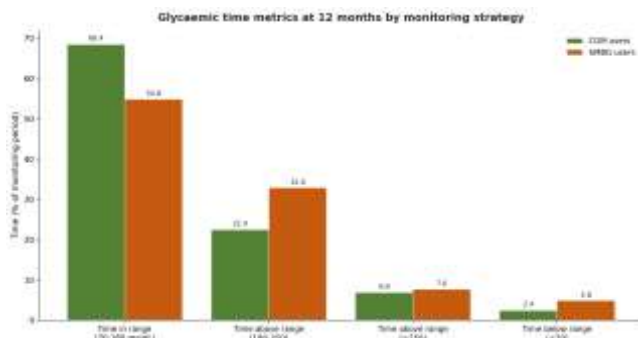


Fig.2: Glycaemic time metrics at 12 months by monitoring strategy

Table 2. Detailed glycaemic outcomes at 12 months

Metric	CGM users (n=128)	SMBG users (n=120)	Difference
HbA1c at 12 months, mean (SD), %	7.1 (0.8)	8.1 (1.2)	-1.0
HbA1c reduction from baseline, mean	-1.5	-0.4	-1.1
HbA1c <7.0% achieved at 12 mo, n (%)	58 (45.3)	18 (15.0)	+30.3
HbA1c <7.5% achieved at 12 mo, n (%)	98 (76.6)	52 (43.3)	+33.3
Time in range 70-180 mg/dL, mean, %	68.4	54.8	+13.6
Time above range 180-250 mg/dL, mean, %	22.4	32.8	-10.4
Time above range >250 mg/dL, mean, %	6.8	7.6	-0.8
Time below range 54-70 mg/dL, mean, %	1.8	3.2	-1.4
Time below range <54 mg/dL, mean, %	0.6	1.6	-1.0
Coefficient of variation, mean, %	36	42	-6
Glucose management indicator, mean, %	7.0	8.0	-1.0
Sensor wear time, mean, %	84	-	-

3.4 Severe Hypoglycaemia

Freedom from severe hypoglycaemia over 12 months differed substantially between groups (Figure 3). CGM users experienced 18 severe hypoglycaemia events across the year (14.1% of users), compared with 46 events in 38.3% of SMBG users (adjusted HR 0.32, 95% CI 0.18-0.57). The protective effect of CGM was particularly pronounced in patients with hypoglycaemia unawareness at baseline, where the 12-month event rate fell from 47% in SMBG users with unawareness to 12% in CGM users with similar baseline characteristics. The predictive low alarms enable correction before glucose falls to a clinically

significant threshold a function impossible with point-in-time SMBG.

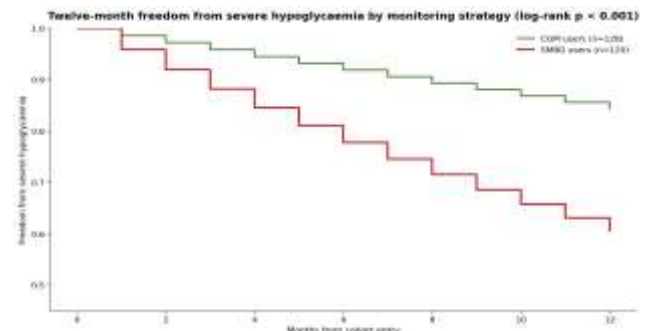


Fig.3: Twelve-month freedom from severe hypoglycaemia by monitoring strategy

3.5 Work and Quality of Life

Table 3. Work productivity and quality of life outcomes at 12 months

Outcome	CGM users (n=128)	SMBG users (n=120)
DKA events during follow-up, n (%)	4 (3.1)	12 (10.0)
ED visit for diabetes-related cause, n (%)	12 (9.4)	32 (26.7)
Hospital admission for diabetes, n(%)	6 (4.7)	18 (15.0)
Days off work for diabetes-related issues, mean	2.4	6.8
Work productivity loss (% of workdays), mean	4.2	11.6
Self-reported presenteeism, mean (%)	8.4	16.4
DQOL total score, mean (SD)	78 (12)	62 (16)
Diabetes-related distress score, mean	2.1	3.6
Hypoglycaemia unawareness improved (Clarke score)	12/18 (66.7)	6/38 (15.8)
Patient satisfaction with monitoring (1-10), mean	9.2	6.4
Continued initial monitoring strategy at 12 mo	124 (96.9)	98 (81.7)

3.6 Predictors of TIR Achievement

Multivariable logistic regression identified ten independent predictors of achieving time in range $\geq 70\%$ at 12 months. CGM use carried the strongest single positive association (adjusted OR 3.84), reflecting the cumulative effect of continuous data on patient self-management. Insulin pump therapy and completion of structured diabetes education each independently improved odds of achieving target. Shift work, frequent travel, hypoglycaemia unawareness, and comorbid mental health disorder all reduced odds of achieving target identifying patient subgroups for whom additional support may be particularly valuable.

Table 4. CGM-specific use patterns and barriers

Metric	Value, n (%)
CGM cost reported as a financial burden	78/128 (60.9)
Insurance coverage for CGM consumables	42/128 (32.8)
Skin reaction to sensor adhesive (any)	48/128 (37.5)
Skin reaction requiring discontinuation	6/128 (4.7)
Sensor early failure (replaced under warranty)	32/128 (25.0)
Alarm fatigue reported	42/128 (32.8)
Smartphone-app data review at least weekly	98/128 (76.6)
Family/spouse remote monitoring set up	48/128 (37.5)
Discussed CGM data with clinician at every visit	82/128 (64.1)
Used CGM data to adjust insulin dosing autonomously	104/128 (81.3)
Patient-reported time to confidence with CGM, mean, weeks	4
Annual out-of-pocket cost, mean, INR	94,000

4. Discussion

Among working adults with T1DM followed for 12 months, continuous glucose monitoring was associated with substantially improved HbA1c, higher time in range, markedly reduced severe hypoglycaemia, fewer DKA episodes and hospital admissions, and substantially better patient-reported quality of life. The effect sizes observed in this real-world cohort match or exceed those reported in pivotal randomised trials, with the additional value of including work-related outcomes rarely captured in trial cohorts. Three observations have practical implications. First, the HbA1c reduction of 1.1 percentage points and the time-in-range improvement of 13.6 percentage points are clinically substantial. The benefit accumulated steadily over the first 6 months and then stabilised, consistent with the time required for sustained behaviour change. Patient education and clinical engagement during the first three months of CGM initiation appear to be particularly important; patients who completed structured CGM training showed the largest subsequent improvements (Jha, Kumar, & Neha, 2026; Bhatnagar, Kumar, & Shivam, 2026; Yatish, Khatoon, & Kumar, 2026).

Second, the severe hypoglycaemia reduction may be the single most important clinical outcome of CGM in this population. The 76% relative reduction in event rates from 38% to 14% over 12 months reflects the unique value of predictive alarms in catching falling glucose before it crosses clinical thresholds. The effect is particularly pronounced in patients with hypoglycaemia unawareness, who often experience severe episodes without warning symptoms; CGM effectively provides external warning systems for patients who have lost their physiological ones. Third, the work-related outcomes deserve particular

emphasis in the context of working-age patients. CGM users experienced approximately one-third the work days lost to diabetes-related issues compared with SMBG users. From an employer or societal perspective, the productivity benefits substantially offset the device costs. For individual patients, the predictability and control offered by continuous data translate directly into less anxiety about workplace hypoglycaemia and fewer disruptions to work performance (Catherine, Gupta, Gopi, & Swadhi, 2025; Vettriselvan, Ramya, et al., 2026; Rasi, & Ashifa, 2019; Aneeshkumar A. S. & C JothiVenkateswaran, 2012; Yatish, Khatoon, & Kumar, 2026). Implementation considerations include the substantial cost burden, which 61% of CGM users described as financially significant.

Insurance coverage for CGM consumables remains uneven, with 33% of users in our cohort having any coverage. Programmes that subsidise CGM access for working adults particularly those at high risk such as shift workers and those with hypoglycaemia unawareness would substantially expand the population able to benefit. Digital tools for remote data review, structured patient education programmes, and tele-consultation models all support broader CGM deployment (Deepa et al., 2026; Vijayalakshmi et al., 2025; Vinodh, Subramani, & Vettriselvan, 2026; Subramani, Chillagattu, et al., 2026; Selvi et al., 2026; Jha, Kumar, & Neha, 2026). Limitations include the non-randomised design with potential confounding by motivation, education, and income (although we adjusted for these covariates in multivariable analysis); the single-centre setting; the 12-month follow-up which captures most early benefits but may not address long-term sustainability of effects; and the working-adult sample which specifically excludes important populations (children, older adults, those without employment) for whom CGM benefits may differ. The cohort is also self-selected to the extent that patients able to afford CGM may differ in unmeasured ways from those who cannot.

5. Conclusion

Continuous glucose monitoring in working adults with type 1 diabetes produced substantial improvements in HbA1c, time in range, severe hypoglycaemia incidence, DKA events, hospital admissions, work productivity, and quality of life over 12 months compared with conventional SMBG. Effect sizes matched or exceeded those reported in pivotal trials, with particular value in patients with hypoglycaemia unawareness. The principal barrier to broader benefit is cost, with insurance coverage and structured access programmes the most tractable operational targets. Working adults with T1DM should be considered a priority group for CGM access given the productivity and quality-of-life implications that extend beyond glycaemic outcomes.

References

- [1] Agarwal, A., Kumar, D., & S, P. M. (2026). Optimizing clinical effectiveness of enhanced recovery after surgery (ERAS): Multidisciplinary pathways, patient-centered outcomes, and data-driven performance analytics. *International Innovations & Scholarly Trends Journal*, 2(2).
- [2] Bhatnagar, M., Kumar, N., & Shivam. (2026). Quality improvement frameworks in modern surgical practice: Evidence-based models, implementation science, and outcome-oriented performance evaluation. *International Journal of Scientific Research and Engineering Development*, 9(2).
- [3] Catherine, S., Gupta, N., Gopi, E., & Swadhi, R. (2025). Enhancing patient engagement and outcomes through digital transformation: Machine learning in medical marketing. In *Impact of digital transformation on business growth and performance* (pp. 285–312). IGI Global.
- [4] A S Aneeshkumar (2022), Blemish identification in Co-variance of Disease using Data Mining Techniques, *Mathematical Statistician and Engineering Applications*, 71(4), pp. 4354-4362.
- [5] Deepa, R., Swadhi, R., Udayavani, V., Lakshmi, R., & Rafiq, S. (2026). Motion-controlled wearables for physiological monitoring and predictive diagnostics. In R. Vettriselvan & N. Suresh (Eds.), *Intelligent motion control for human-centered systems* (pp. 1–28). IGI Global.
- [6] Gautam, M., Samyal, M., & Chaudhary, S. (2026). Preoperative risk stratification and surgical outcome prediction: Integrating clinical scoring systems, data-driven models, and patient-centered optimization. *International Innovations & Scholarly Trends Journal*, 2(3).
- [7] Jha, S. C., Kumar, P., & Neha. (2026). Artificial intelligence-assisted decision support in internal medicine: Enhancing clinical judgment, precision care, and health system performance. *International Journal of Scientific Development and Research*, 11(2).
- [8] Kumar, P., Gautam, S., & Maitiy, S. (2026). Diagnostic utility of biomarkers in early disease stratification: Clinical applications, predictive value, and emerging innovations. *Journal of Emerging Technologies and Innovative Research*, 13(2).
- [9] Aneeshkumar A.S., C JothiVenkateswaran (2012), Estimating the surveillance of liver disorder using classification algorithms, *International Journal of Computer Applications*, 57(6), pp. 39-42.
- [10] Kumar, R., Sharma, K., & Gupta, S. K. (2026). Multimorbidity patterns and therapeutic complexity in adult medical practice: Implications for polypharmacy and patient-centred care. *International Journal of Creative Research Thoughts*, 14(2).
- [11] Rasi, R. A., & Ashifa, K. M. (2019). Role of community-based programmes for active ageing: Elders self-help group in Kerala. *Indian Journal of Public Health Research & Development*, 10(12).
- [12] Sahu, R. L., Sharma, K., & Gupta, S. K. (2026). Biological and mechanical determinants of fracture healing: An integrated mechano-biological, systemic, and translational framework. *International Journal of Recent Development in Engineering and Technology*, 15(3).
- [13] Selvi, K., Anbarasan, P., Madhumita, G., Janaki, L., & Devi, K. K. (2026). Governance, security, and ethical considerations in AI-driven motion control systems. In *Methodologies and applications of intelligent motion control systems* (pp. 217–242). IGI Global.
- [14] Sharma, S., Sharma, K., & Tyagi, N. (2026). Geriatric psychiatry and cognitive decline: Clinical evaluation, neuropsychological determinants and evidence-based management. *International Journal of Management Research and Social Science*, 13(2).
- [15] Subramani, M., Chillagattu, V., Gayathri, K., Rastogi, V., & Ranganathan, S. (2026). Digital twin integration for predictive and real-time motion control in infrastructure engineering. In *Methodologies and applications of intelligent motion control systems* (pp. 189–216). IGI Global.
- [16] Swadhi, R., Gayathri, K., Suresh, N. V., Catherine, S., & Velmurugan, P. R. (2025). Leveraging machine learning for enhanced patient engagement and outcomes: Revolutionizing healthcare marketing. In *Impact of digital transformation on business growth and performance* (pp. 313–340). IGI Global.
- [17] Vettriselvan, R., Ramya, R., Selvalakshmi, V., Jyothi, P., & Velmurugan, P. R. (2026). Empowering patients through knowledge: Educational strategies in rehabilitation. In *Holistic approaches to health recovery* (pp. 263–290). IGI Global.
- [18] Vettriselvan, R., Velmurugan, P. R., Varshney, K. R., EP, J., & Deepika, R. (2025). Health impacts of smartphone and internet addictions across age groups: Physical and mental health across generations. In *Impacts of digital technologies across generations* (pp. 187–210). IGI Global.
- [19] Vijayalakshmi, M., Subramani, A. K., Vettriselvan, R., Velmurugan, P. R., & Hasine, J. (2025). Strategic collaborations in medical innovation and AI-driven globalization: Advancing healthcare startups. In *Navigating strategic partnerships for sustainable startup growth* (pp. 85–110). IGI Global.
- [20] Vinodh, N., Subramani, A. K., & Vettriselvan, R. (2026). Transforming the future of management and medical education: AI-driven innovations in curriculum design. In *AI education strategies for future-proofing curriculum design* (pp. 459–476). IGI Global.
- [21] Yatish, Khatoon, N., & Kumar, A. (2026). Advancing preventive strategies for chronic disease management: Clinical, behavioral, and population-level perspectives. *International Journal of Novel Trends and Innovation*, 4(2).