Social Determinants of Health Impact on Pediatric Type 1 Diabetes Outcomes Early After Diagnosis

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Intro

Approximately 200,000 youth in the U.S. have type 1 diabetes (T1D), with incidence rates increasing each year..[1,2] The early period after diagnosis is critical for shaping long-term glycemic control and establishing key diabetes management habits.[3] Maintaining a hemoglobin A1c (HbA1c) <7.0% is key to preventing complications[4], yet most U.S. youth do not meet glycemic targets.[5]

The growing use of diabetes technology, including continuous glucose monitors (CGMs), insulin pumps, and automated insulin delivery (AID) systems, has contributed to improved HbA1c levels in U.S. youth.[6] However, as technology use increases, inequalities in access may exacerbate existing disparities in HbA1c levels according to race/ethnicity, public insurance, and socioeconomic status.[7,8,9]

To examine the impact of social determinants of health (SDoH) on T1D management and outcomes in the first year after diagnosis, we utilized the Social Deprivation Index (SDI). The SDI is a multidimensional measure of neighborhood-level disadvantage, capturing systemic and social factors that contribute to health disparities.[11] We hypothesized that the most deprived group, according to their SDI, will utilize diabetes technology at a lower rate, and will have the highest HbA1c in the year following diagnosis.

Methods

We performed a single-site retrospective cohort analysis using electronic records from patients seen at the Barbara Davis Center and satellite clinics. The sample included 1,599 children diagnosed with T1D between July 2018-December 2022, yielding 6807 records over the 14-months following diagnosis. Patients were stratified into five SDI quintiles, each containing 320 participants. Quintile 1 (Q1) represented the least deprived patients, while Quintile 5(Q5) represented the most deprived.

To assess the timing of diabetes technology adoption, we performed time-to-event analyses. Kaplan-Meier survival curves right-censoring were generated for continuous event data, and the log-rank test was used to compare survival distributions across SDI quintiles. Cox proportional hazards models estimated hazard ratios (HRs) for CGM and pump adoption across quintiles. For HbA1c monitoring, we used logistic regression models to analyze frequency and trend over time, comparing differences across SDI quintiles.

Results

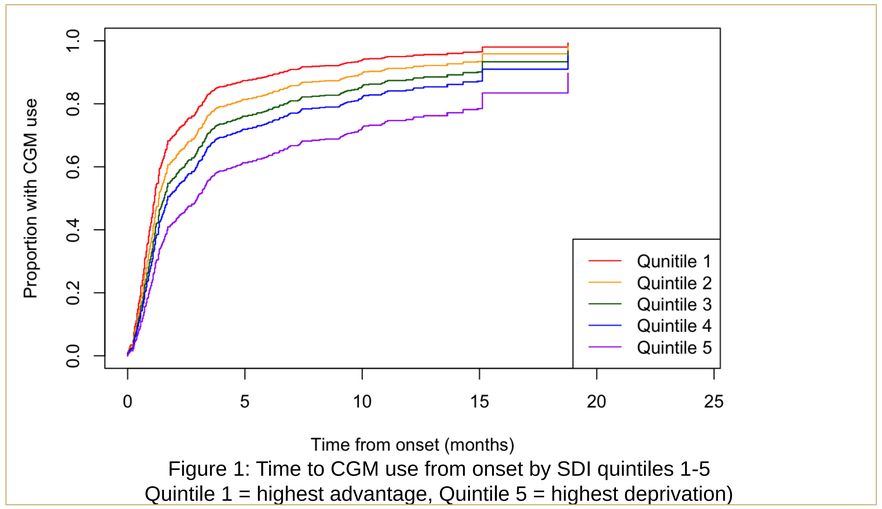

Figure 1: Time to CGM use from onset by SDI quintiles 1-5
Quintile 1 = highest advantage, Quintile 5 = highest deprivation)

Among the 1599 patients, the likelihood of CGM and insulin pump adoption varied significantly across SDI quintiles (CGM: p<0.025; Pump: p<0.01), with higher deprivation associated with lower technology adoption rates. Patients in Q5 were 55% less likely to use CGM compared to Q1 (HR =0.45, p<0.001). For insulin pump adoption, patients in Q5 were 61% less likely to initiate pump therapy, compared to Q1 (HR = 0.39, p<0.001).

Time-to-event analysis revealed that patients in Q1 had a median time to CGM initiation of 1.2 months, whereas patients in Q5 had a median time of 3 months. The probability of CGM use decreased progressively with increasing deprivation, as demonstrated by the Kaplan-Meier survival curves and confirmed by the log-rank test (p < 0.001).

When stratified by SDI quintile and CGM use, HbA1c improved with CGM use for all groups, but socioeconomic disparities persisted; indicating that CGM use alone did not eliminate glycemic control differences across quintiles.

Table 1: Patient Demographics by SDI quintile

	Quintile 1 (n=320)	**Quintile 2** (n=320)	**Quintile 3** (n=320)	**Quintile 4** (n=320)	**Quintile 5** (n=320)
Age at diabetes onset (years)					
Median (IQR)	10.4 (7.1- 14.0)	10.0 (6.2- 12.7)	10.6 (7.0-13.0)	10.2 (6.7-13.7)	10.5 (7.3-13.7)
Range	0.9-18.9	1.2-19.8	0.9-19.5	0.7-22.0	0.4-19.5
Sex					
Female / Male	145 (45.3%) / 175 (54.3%)	139 (43.4%) / 181 (56.6%)	148 (46.2%) / 173 (53.8%)	145 (45.0%) / 176 (55.0%)	145 (45.3%) / 175 (54.5%)
Race/Ethnicity					
Non-Hispanic White	264 (82.5%)	226 (70.6%)	220 (68.8%)	179 (55.9%)	131 (40.9%)
Hispanic	15 (4.7%)	37 (11.6%)	47 (14.7%)	72 (21.9%)	110 (34.4%)
Non-Hispanic Black	3 (0.9%)	12 (3.8%)	11 (3.4%)	16 (5.0%)	36 (11.2%)
Other/Unknown	38 (11.9%)	45 (14.1%)	42 (13.1%)	55 (17.2%)	43 (13.4%)
Insurance Group					
Private	249 (83.8%)	216 (74.5%)	180 (59.0 %)	163 (52.4%)	94 (32.5%)
Medicaid	36 (12.1%)	60 (20.4%)	110 (35.8%)	136 (44.3%)	190 (65.7%)
Military Plans	12 (4.0%)	14 (4.8%)	16 (5.2%)	8 (2.6%)	5 (1.7%)
DKA at Onset					
Yes	150 (47.9%)	163 (51.4%)	175 (55.7%)	175 (55.4%)	186 (58.9%)
No	163 (52.1%)	154 (48.6%)	139 (44.3%)	141 (44.6%)	130 (41.1%)

Discussion

Our findings indicate that greater social deprivation (higher SDI score) is associated with delayed initiation and lower utilization of diabetes technology, contributing to poorer glycemic control. These disparities according to SDI quintile align with existing evidence linking diabetes technology access and HbA1c outcomes to socioeconomic status, insurance type, and race/ethnicity. Addressing these systemic barriers through policies that ensure equitable, timely access to CGMs and insulin pumps for all youth with T1D—regardless of social disadvantage—is essential for improving health outcomes and reducing disparities.

Although CGM use was associated with HbA1c improvement across all quintiles, it did not eliminate disparities, suggesting that technology access alone is insufficient to close the gap in diabetes outcomes. Broader interventions targeting structural and social determinants of health are needed to achieve true health equity in T1D management.

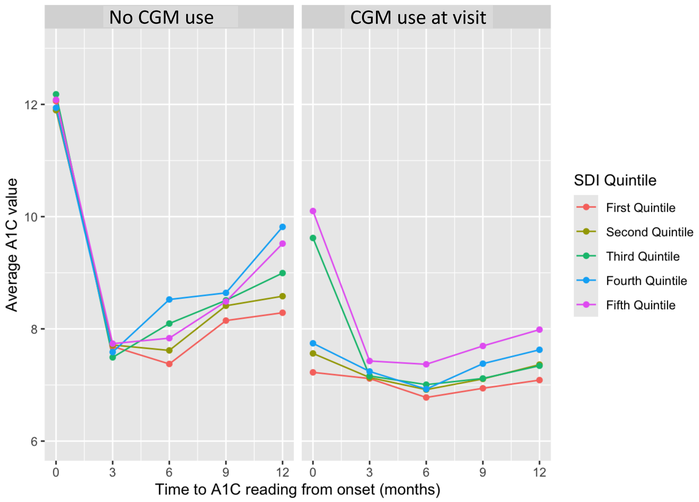

Figure 2: Line plots illustrating average a1c over time from onset, stratified by CGM use at visit, and SDI quintiles

Study Strengths:
- Novel application of SDI in pediatric T1D research
- Focus on early disease trajectory
- Real-world clinical relevance

Study Weaknesses:
- Single-center design limits generalizability
- Retrospective nature precludes causal inference
- Limited individual-level socioeconomic data

Conclusion

Higher social deprivation is associated with delayed diabetes technology adoption and disparities in glycemic control. While CGM use improves HbA1c across all groups, it does not eliminate these disparities according to social deprivation, underscoring the need for broader structural interventions.

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The Colorado Multiple IRB (20-2686) has determined this retrospective study to meet the criteria for exemption from IRB review (category 4, secondary research). All criteria were met for a full waiver of Health Insurance Portability and Accountability Act of 1996 authorization. We thank Bing Wang for database support.