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Evaluating Factors Associated With Continuous Glucose Monitoring Utilization With the Type 1 Diabetes Exchange Registry

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Abstract

Background: The 2022 American Diabetes Association (ADA) Standards of Care recommends considering use of continuous glucose monitoring (CGM) for insulin-managed diabetes mellitus (DM), but equitable access remains challenging. This study evaluates socioeconomic and demographic metrics associated with CGM use.

Methods: RStudio 2021.09.1+372 was utilized to perform uni- and bivariable analysis, as well as binomial logistic regression modeling for categorical CGM use (yes/no) on the most recent cross-section from the Type 1 Diabetes Exchange (T1DX) Registry 2016-2018 cohort ($n = 22418$).

Results: Compared with White Non-Hispanic participants, Black Non-Hispanic (OR = 0.45, CI = 0.36-0.57, $P < 0.001$) and American Indian/Alaskan Native individuals (OR = 0.33, CI = 0.14-0.70, $P = 0.008$) had lower odds of CGM use. Compared with private insurance, government insurance had reduced odds of CGM use (OR = 0.59, CI = 0.52-0.66, $P < 0.001$). Individuals earning $100,000 or more were twice as likely to use CGMs (OR = 2.06, CI = 1.75-2.45, $P < 0.001$) compared with those earning <$25,000 annually. Subgroup analysis based on income bracket demonstrated that government insured individuals earning <$25,000 annually were the least likely to use CGMs (OR = 0.44, CI = 0.32-0.61, $P < 0.001$), as compared with private insurance.

Conclusions: T1DX Registry data demonstrate that CGM use follows the inverse care law, with health technology utilization inversely related to disease burden. Federal policies promoting CGM use in Medicare and Medicaid populations can facilitate the ADA's recommendation for patients with insulin-managed diabetes mellitus.

Keywords

Continuous Glucose Monitoring, Data Science, Diabetes Mellitus, Health Equity, Type 1 Diabetes Exchange Registry

Introduction

A promising development in the field of diabetes care has been the continuous glucose monitor (CGM), which is seen as an advancement in self-monitoring blood glucose (SMBG) techniques.[1-3] CGM technology has demonstrated significant improvement in glycemic management, higher glucose monitoring satisfaction, and reduced incidence of diabetes complications, such as severe hypoglycemia (SH) and diabetic ketoacidosis (DKA).[4-11] The increasing body of literature, both in randomized controlled trials (RCTs) and real-world evidence (RWE), supports CGM use for pediatric, adolescent, and adult persons with type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM).[8,12] The American Diabetes Association (ADA) Standards of Medical Care in Diabetes[13] recommends considering initiation of CGM technology for all patients with DM requiring insulin therapy, and to sustain CGM access across all third-payer insurance types.

The advancing standard of care for insulin-managed DM has been impacted by ongoing changes to insurance, especially the beginning of Medicare coverage for CGM technology in 2017.[12,14] In 2021, Medicare eligibility criteria allowed more patients with DM to initiate CGM use by removing the

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requirement for frequent SMBG monitoring four times daily.[14] Despite this progress, tenacious disparities persist. Reduced CGM utilization has been shown to correlate with socioeconomic status (SES), racial-ethnic disparities, and insurance type.[15-17] Progress on increasing CGM use is led by diabetes advocacy groups, who push for coverage expansion for Medicaid and private payers. To study the evolving influences on CGM use, this study aims to evaluate a large database of insulin-managed patients with DM, the Type 1 Diabetes Exchange (T1DX) Registry.

The T1DX Registry[18] is a longitudinal study of persons living with T1DM, collecting socioeconomic, demographic, and diabetes care metrics from 81 endocrinology centers across the US.[19] In this analysis, we utilized the most recent cross-section (2016-2018) of this publicly available, de-identified registry to evaluate socioeconomic and demographic metrics associated with CGM use.[7,10,16,20]

Methods

Study Population

Participants in the T1DX Registry[19] from January 1, 2016, to March 31, 2018 were included in this study, with descriptive statistics provided in Table 1. This cohort,[20] as well as the database's inclusion/exclusion criteria, consent process, and baseline data collection process[16,21] were previously described. Figure 1 outlines the study sample selection process. Unique patient ID's (n = 22,884) within the T1DX Registry were evaluated. Patient ID's which did not contain responses (n = 466) for the outcome of interest (categorical CGM use—yes/no) were excluded, providing the final analytic study population (n = 22,418). This study was deemed not human subjects research by the Case Western Reserve University Institutional Review Board.

Data Processing

The variables of interest for this study were collected from the 2016 to 2018 Hemoglobin A1c and Subject information files. Unique patient IDs were used to merge variables for age, gender, race/ethnicity, current smoking status, body mass index (BMI), flags for DKA, flags for SH, insurance type, insulin delivery method, pump and CGM model and manufacturer, and the number of days in the past month a CGM was used.

For specific variables, data pre-processing required recoding to condense factors, collapse vectors, and create summary metrics. For HbA1c, self-reported values for each patient ID were averaged using the mean. In addition, the continuous variable for age was factored into three groups: $<$18 years old, 18-64 years old, and $\geq$65 years old. Level of education was also condensed from 15 factor levels to 6 (less than ninth grade, some high school, high school graduate or GED, some college, college graduate, postgraduate degree).

Five separate categorical vectors for insurance status were condensed to create two new variables. The first vector created was a categorical (yes/no) for whether the patient has any type of insurance. The second insurance vector was a leveled factor displaying the type of insurance for each patient. Nested if else logic was used, with values greater than 1 recoded as multiple insurance, and independent factor levels for government, private, single service, unknown, and uninsured insurance status.

Outcomes

CGM use. Categorical yes/no CGM use (the study's primary outcome) is a variable obtained from the 2016-2018 T1DX Registry Subject File and merged to the Hemoglobin A1c dataframe by unique patient ID. Unique Patient ID's that were missing responses for CGM use were excluded from analysis (n = 466). Logistic regression modeling for odds of CGM use is demonstrated in Table 2, with graphic visualization of the data provided as an odds plot in Figure 2. Patient self-reported insurance type based on CGM use is also reported in Figure 3.

Median sample HbA1c. Intra-participant mean HbA1c is a value that was calculated by the study team, which was determined from the raw data within the T1DX Registry of self-reported HbA1c values. Median sample HbA1c histogram and univariable analysis were done to evaluate measures of central tendency and dispersion, and bivariable analysis comparing median sample HbA1c between CGM users and non-CGM users. A frequency plot demonstrating this comparison is presented in Figure 4.

Statistical analysis. RStudio 2021.09.1+372 "Ghost Orchid" Release[22], and R packages[23-28] were used to perform statistical analysis. We compared descriptive characteristics of CGM users to non-CGM users, reporting the median (interquartile range; IQR) for continuous variables and percent for categorical variables. P-values were added based on data type, with Wilcoxon rank-sum testing used for non-parametric, continuous variables. Categorical variables used Fischer's exact testing and chi-squared testing for goodness of fit, homogeneity, and variance. Histograms were also created for continuous variables, overall and stratified by CGM use. Bivariable analysis of statistically significant factors was conducted to evaluate CGM use. Multivariable logistic regression modeling was conducted, modeling odds of CGM use (yes/no) as the dependent variable of interest. Odds plots were generated to visualize odds of CGM use in Figure 3. Effect modification was also performed by subgroup analysis. Odds of CGM use for subsets of age group and income bracket were stratified by insurance status in Tables 3 and 4.

Table 1. Descriptive Statistics of the T1DX Registry 2016-2018 Cohort.

Characteristic	CGM use			
Overall, $N = 22418$	No, $N = 15379$	Yes, $N = 7039$	Total cohort, $N = 22418$	*P*-value[a]
Mean Hemoglobin A1c, Median (IQR)	8.15 (7.48, 8.93)	8.32 (7.64, 9.15)	7.80 (7.25, 8.43)	<.001
Gender, *n* (%)				.009
F	11315 (51%)	7658 (50%)	3657 (52%)	
M	11064 (49%)	7695 (50%)	3369 (48%)	
T	12 (<0.1%)	8 (<0.1%)	4 (<0.1%)	
Age group, *n* (%)				<.001
<18 years old	10549 (47%)	7320 (48%)	3229 (46%)	
18-64 years old	10660 (48%)	7187 (47%)	3473 (49%)	
≥65 years old	1209 (5.4%)	872 (5.7%)	337 (4.8%)	
Race/ethnicity, *n* (%)				<.001
White Non-Hispanic	18147 (82%)	11931 (78%)	6216 (89%)	
Black Non-Hispanic	1265 (5.7%)	1137 (7.4%)	128 (1.8%)	
Hispanic or Latino	1851 (8.3%)	1457 (9.5%)	394 (5.6%)	
Asian	239 (1.1%)	161 (1.1%)	78 (1.1%)	
Native Hawaiian/other Pacific Islander	32 (0.1%)	27 (0.2%)	5 (<0.1%)	
American Indian/Alaskan Native	96 (0.4%)	82 (0.5%)	14 (0.2%)	
More than one race	626 (2.8%)	472 (3.1%)	154 (2.2%)	
Patient annual income, *n* (%)				<.001
Less than $25,000	1,791 (11%)	1549 (14%)	242 (4.5%)	
$25,000-$35,000	1329 (8.1%)	1089 (9.9%)	240 (4.4%)	
$35,000-less than $50,000	1927 (12%)	1477 (13%)	450 (8.3%)	
$50,000-less than $75,000	2774 (17%)	1900 (17%)	874 (16%)	
$75,000-less than $100,000	2911 (18%)	1867 (17%)	1044 (19%)	
$100,000 or more	5686 (35%)	3123 (28%)	2563 (47%)	
Level of education, *n* (%)				<.001
Less than ninth grade	722 (3.4%)	509 (3.5%)	213 (3.2%)	
Some high school	814 (3.9%)	725 (5.0%)	89 (1.3%)	
High school graduate or GED	2625 (12%)	2163 (15%)	462 (6.9%)	
Some college	4,018 (19%)	3,121 (22%)	897 (13%)	
College graduate	8233 (39%)	5278 (37%)	2955 (44%)	
Postgraduate degree	4651 (22%)	2581 (18%)	2070 (31%)	
Patient is a current smoker, *n* (%)	633 (3.0%)	541 (3.7%)	92 (1.4%)	<.001
BMI, median (IQR)	23.9 (20.5, 27.8)	24.0 (20.8, 27.9)	23.7 (19.8, 27.6)	<.001
Self-reported DKA episode in the past year, *n* (%)	1001 (4.5%)	839 (5.5%)	162 (2.3%)	<.001
Self-reported severe hypoglycemia Episode in the past year, *n* (%)	310 (1.4%)	239 (1.6%)	71 (1.0%)	.001
Type of insurance, *n* (%)				
Private insurance	15,224 (68%)	9526 (62%)	5698 (81%)	
Government insurance	5297 (24%)	4441 (29%)	856 (12%)	
Single service (vision, dental)	0 (0%)	0 (0%)	0 (0%)	
Multiple insurance	612 (2.7%)	440 (2.9%)	172 (2.4%)	
Unknown	1040 (4.6%)	771 (5.0%)	269 (3.8%)	
Uninsured	245 (1.1%)	201 (1.3%)	44 (0.6%)	

Abbreviations: CGM, continuous glucose monitoring; IQR, interquartile range; GED, general educational development; BMI, body mass index; DKA, diabetic ketoacidosis.

[a]Wilcoxon rank-sum test; Fisher's exact test; Pearson's chi-squared test.

Results

Descriptive Data

Table 1 displays the descriptive characteristics for comparing CGM use. The median age of T1DX Registry participants was 18.0 (IQR = 14.0-36.0), 82% are White Non-Hispanic, 75% of households earned a college degree or higher, 47% earned $100,000 or more, and 68% were privately insured. Gender is roughly proportional (51% female vs 49% male), without significant difference based on CGM use. Self-reported incidence of SH occurred in 1.4% of the entire cohort, with 1.0% in CGM users, and 1.6% in

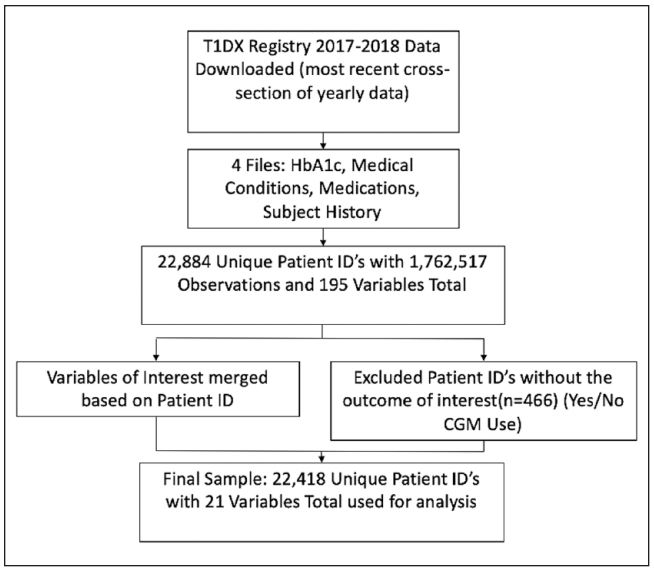

Figure 1. Sample selection for statistical analysis. Abbreviation: CGM, continuous glucose monitoring.

non-CGM users. Self-reported incidence of DKA occurred in 4.5% of the entire cohort, with 2.3% in CGM users and 5.5% in non-CGM users.

Outcome Data

Table 2 and Figure 2 outline the logistic regression model used to evaluate the odds of CGM use based on co-variables, with odds ratios and 95% confidence intervals reported. Reference levels for comparison are age <18 years old, female gender, White Non-Hispanic race/ethnicity, <$25,000 annual income, Less than ninth-grade education, no self-reported episode of DKA, no self-reported episode of SH, private insurance, and insulin pump user. Compared with individuals <18 years old, adults 18-64 years old (OR = 0.89, CI = 0.82-0.96) and ≥65 years old (OR = 0.73, CI = 0.61-0.88) had lower odds of CGM use. Compared with White Non-Hispanic individuals, Black Non-Hispanic individuals had lower odds of CGM use (OR = 0.45, CI = 0.36-0.57, $P < .001$), with similar trends among American Indian/Alaskan Native individuals (OR = 0.33, CI = 0.14-0.71, $P = .008$). Individuals in higher income brackets had greater odds of CGM use as compared with people earning <$25,000 annually, with individuals earning $100,000 or more showing the greatest difference (OR = 2.06, CI = 1.75-2.45, $P < .001$). An increase in mean HbA1c was associated with lower odds of CGM use (OR = 0.71, CI = 0.68-0.74, $P < .001$). Individuals on government insurance (Medicaid, Medicare, etc.) had less likelihood of CGM use (OR = 0.59, CI = 0.52-0.66, $P < .001$). When adjusting for confounders, incidence of self-reported DKA events were associated with statistically significant lower odds of CGM use (OR = 0.78, CI = 0.63-0.96, $P = .024$).

Figure 3 outlines the type of insurance that was self-reported based on CGM use. In the overall 2016-2018 T1DX Registry study cohort, 24% of individuals self-reported having government insurance. Proportionally less CGM users (12.16%) report having government insurance, while 28.88% of non-CGM users are government insured.

Figure 4 demonstrates the median sample HbA1c for T1DX Registry participants based on CGM use. The median HbA1c for the entire 2016-2018 study cohort is 8.15 (IQR = 7.48-8.93), while CGM users had a median value of 7.80 (IQR = 7.25-8.43), and non-CGM users had a median value of 8.32 (IQR = 7.64-9.15) with a statistically significant difference indicated ($P < .001$).

Tables 3 and 4 demonstrate subgroup analyses for the odds of CGM use based on insurance type, as compared with self-reported annual income and age group, respectively. Compared with private insurance, government insurance consistently demonstrated decreased odds of CGM use across subgroups, with 15% increased odds for CGM use among government insured individuals ≥ 65 years old. The population with the lowest likelihood of CGM use was government insured individuals earning <$25 000 annually.

Additional Analysis

Regarding CGM use, T1DX Registry participants were asked "Which CGM device/model does/did the participant use?" during clinic exams.[18] Of the total cohort (n= 7039), 31.4% reported CGM use throughout the 2016-2018 cross-section. For CGM manufacturer, 5147 CGM users (73.1%) reported using Dexcom (San Diego, CA), 1596 CGM users (22.7%) reported using Medtronic (Minneapolis, MN), and 41 CGM users (0.6%) reported using Abbott (Abbott Park, IL). The most frequently used CGM models for Dexcom in 2016-2018 were the G5 Platinum (n = 2962) and G4 Platinum (n = 1103). The most frequently used CGM models for Medtronic were the Enlite Sensor (n = 676), Minimed 530 g (n = 280), and Minimed 670 g (n = 216). The most frequently used CGM Model for Abbot was the Freestyle Navigator (n = 28). Out of 3777 participants who reported the number of days, a CGM was used in the past month, 2493 (66.0%) reported using the CGM for all 30 days. Some CGMs reported, such as the Freestyle Navigator, were discontinued during the 2016-2018 study period, which may indicate self-report of models previously used by the participant.

Discussion

T1DX Registry is a robust sample of Persons living with T1DM across the United States. The 2016-2018 cohort demographics are 82% White Non-Hispanic, 75% of households earned a college degree or higher, 47% earned $100,000 or more, and 68% were privately insured. These estimates

Table 2. Logistic Regression Model for Odds of CGM Use.

Odds of CGM use			
Characteristic	OR	95% CI	*P*-value
Mean hemoglobin A1c	0.71	0.68, 0.74	**<.001**
Age group			
<18 years old	–	–	
18-64 years old	0.89	0.82, 0.96	**.002**
≥65 years old	0.73	0.61, 0.88	**<.001**
Gender			
F	–	–	
M	0.85	0.79, 0.91	**<.001**
T	0.8	0.11, 3.89	.8
Race/ethnicity			
White Non-Hispanic	–	–	
Black Non-Hispanic	0.45	0.36, 0.57	**<.001**
Hispanic or Latino	0.88	0.76, 1.02	.1
Asian	0.78	0.54, 1.11	.2
Native Hawaiian/other Pacific Islander	0.77	0.24, 2.13	.6
American Indian/Alaskan Native	0.33	0.14, 0.70	**.008**
More than one race	0.85	0.67, 1.06	.14
Patient annual income			
Less than $25 000	–	–	
$25 000-$35 000	1.08	0.88, 1.33	.5
$35 000-less than $50 000	1.25	1.04, 1.50	**.02**
$50 000-less than $75 000	1.53	1.28, 1.82	**<.001**
$75 000—less than $100 000	1.63	1.37, 1.94	**<.001**
$100 000 or more	2.06	1.75, 2.45	**<.001**
Level of education			
Less than ninth grade	–	–	
Some high school	0.34	0.21, 0.54	**<.001**
High school graduate or GED	0.54	0.37, 0.78	**<.001**
Some college	0.64	0.45, 0.92	**.014**
College graduate	0.89	0.63, 1.27	.5
Postgraduate degree	1.01	0.71, 1.45	>.9
Self-reported DKA episode in the past year			
No	–	–	
Yes	0.78	0.63, 0.96	**.024**
Self-reported severe hypoglycemia episode in the past year			
No	–	–	
Yes	0.91	0.65-1.26	.6
Type of insurance			
Private insurance	–	–	
Government insurance	0.59	0.52, 0.66	**<.001**
Multiple insurance	0.87	0.69, 1.09	.2
Unknown	0.76	0.64, 0.89	**.001**
Uninsured	0.56	0.36, 0.84	**.007**

Abbreviations: CGM, continuous glucose monitoring; OR, odds ratio; CI, confidence interval; GED, general educational development; DKA, diabetic ketoacidosis.

for the 2016-2018 T1DX Registry cohort differ from the estimated national prevalence from the SEARCH for Diabetes in Youth Study[29] conducted by the Center for Disease Control (CDC), with estimated T1DM prevalence for 2001-2016 per 1000 youth <19 y/o is 0.93 for white, 0.59 for Hispanic, 0.89 for black, 0.25-0.26 for American Indian/Pacific Islander/Asian. This may reflect differences in sampling methodology among United States endocrinology centers, as well as varying access to subspecialty care for adult versus pediatric patients with T1DM.

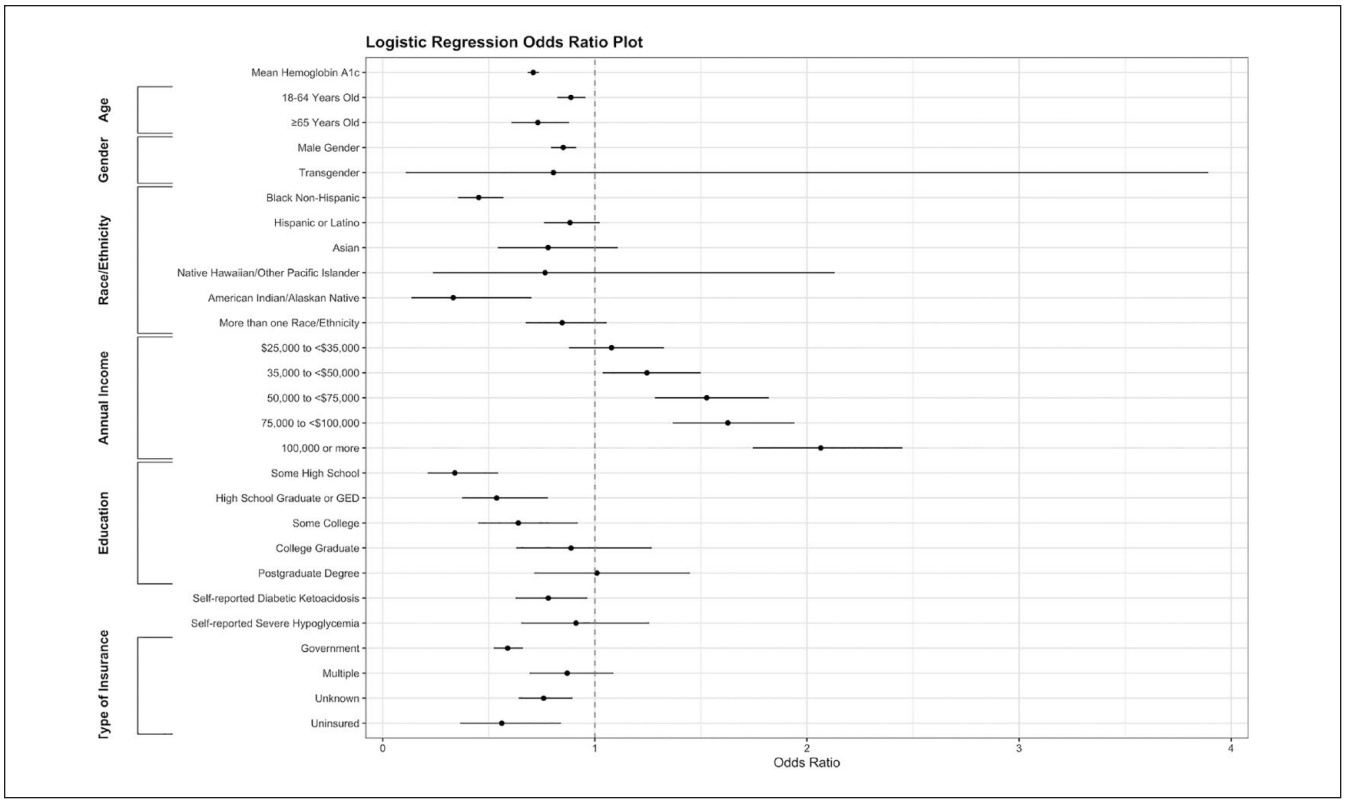

Figure 2. Odds plot (aka forest plot) for continuous glucose monitoring use. Abbreviation: GED, general educational development.

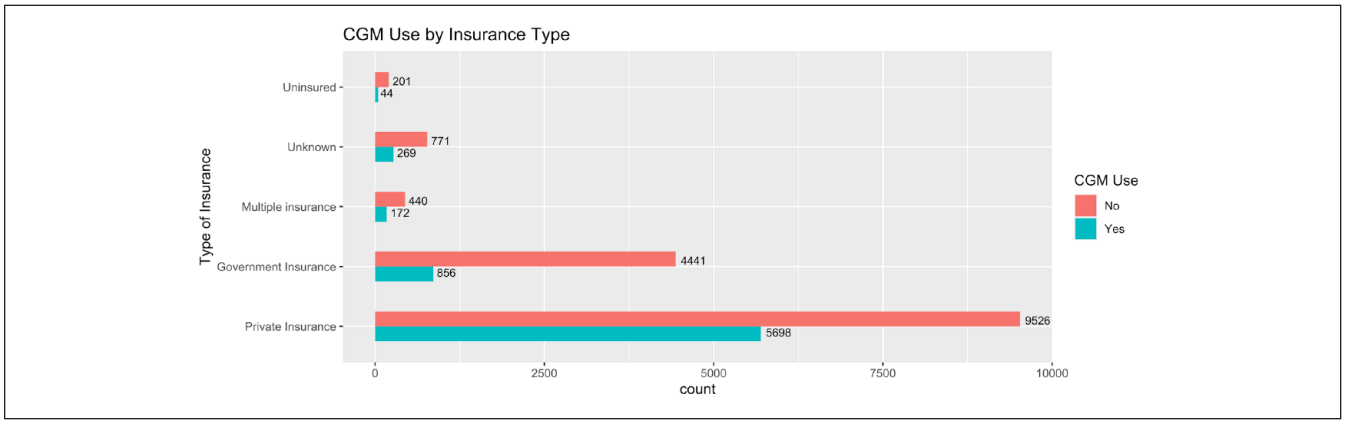

Figure 3. Patient self-reported insurance type based on CGM use. Abbreviation: CGM, continuous glucose monitoring.

Compared with initial descriptions of the T1DX Registry Database,[21] CGM use in the cohort increased from 6% in 2012 to 31.4% in the 2016-18 cohort. This demonstrates a significant increase in diffusion and uptake over time. The current study demonstrates that White Non-Hispanic, age <18 years, privately insured and higher income bracket groups had the greatest odds of CGM use based on logistic regression modeling.

These findings demonstrate that populations with increased access to resources have the highest odds of utilizing CGM technology. This is in line with a previously described trend known as the inverse care law,[30,31] where health technology diffusion and uptake is inversely related to disease burden. The social determinants leading to these disparities are complex. Cost has been identified as one of the most important factors for persons with T1DM to utilize CGM technology.[32,33] However, studies within health systems that provide universal coverage found that disparities still exist across racial-ethnic subgroups, independent of insurance status or household income.[15,34] A 2015-2018

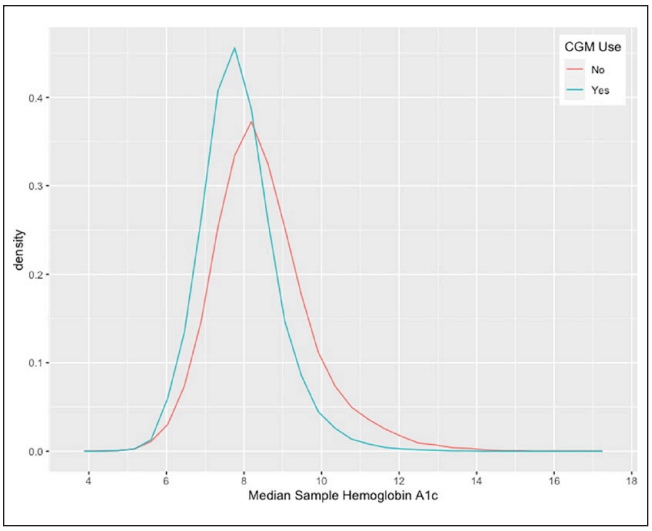

Figure 4. Median sample HbA1c percent comparison based on CGM use. Abbreviation: CGM, continuous glucose monitoring.

study found that CGMs are initiated at higher rates in Non-Hispanic White children, and Non-Hispanic Black children were more likely to discontinue CGM use within the first year, when controlling for insurance status.[35] Similarly, a 2019 study on children and adults with T1DM found that racial-ethnic disparities in CGM use persisted independent of household income.[16] The Young Adult Racial Disparities in Type 1 Diabetes (YARDD) study[34] found that SES has a significant effect, but is not the main driver, of disparities in CGM use. While these social determinants likely have complex inter-dependent influences on the ability to utilize CGM technology, clear modifiable risk factors are also demonstrated within the data.

Data from our research study presented in Tables 3 and 4 demonstrate that CGM use is significantly impacted by insurance status in the United States. Government insurance consistently showed a negative correlation with CGM use when compared across age groups and income status. Proportionally less CGM users (12.16%) report having government insurance, while 28.88% of non-CGM users are government insured. Individuals ≥65 years old on government insurance had 15% higher odds of CGM use when compared with adults 18-64 years old on government insurance, which is at least partially explained by the emerging role of Medicare coverage for CGM technology during the study period. These data support focusing on the actionable goal of advocating for increased access to CGM use across third-payer insurance plans.

This study has several limitations. First, the observational, cross-sectional design prevents analysis of temporality trends and would require additional timepoint comparisons. Furthermore, data quality in a rapidly evolving biomedical device market from the 2016-2018 study period includes discontinuation of many products and introduction of emerging devices and software, such as closed-loop insulin pump/CGM systems. Self-reported data indicate whether research participants currently or previously used CGMs, without a way to identify exactly when the CGM was utilized during the study period. In addition, the shifting insurance coverage during the study period for government programs, such as Medicaid and Medicare, cannot be fully represented within the data alone. Data granularity of the database determined the ability to draw correlations, especially for variables, such as income bracket and insurance type (Medicaid and Medicare are categorized together under government insurance). Possible sources of bias include recall bias, as well as the potential for systematic bias due to data missingness. In addition, pediatric T1DX Registry participants report household education and income instead of individual measures. These variables may change across T1DX Registry yearly cross-sections as participants report individual data instead of their parent's income and education.

Study strengths include the utilization of a public database with a large sample size of confirmed T1DM cases almost exclusively involving insulin management. T1DX Registry data also provide robust information not collected in National Health and Nutrition Examination Survey (NHANES), allowing for unique insights on a large amount and diversity of information collected with a standardized methodology. The T1DX Registry database provides a unique opportunity to test the implementation of the 2022 ADA Standards of Care as CGM utilization evolves. Once newer data become available, further research would provide additional insight about CGM use trends.

Conclusion

The results demonstrate that utilization of CGM technology follows the inverse care law,[30,31] where CGM utilization is inversely related to disease burden. While all patients with insulin-managed DM should have access to CGM technology, disparities exist socioeconomically, racial-ethnically, and by third-payer insurance.[13] There is a critical need to increase access to DM technology to decrease the risk of diabetes-related complications and reduce healthcare costs among racial-ethnic minority, low-income, and marginalized communities within the United States.[15,35,36] Promoting federal government policies that counter prevailing barriers to CGM utilization will foster health equity and reduce disparities. Some policy stances that can address the issue are to increase Medicaid and Medicare coverage of CGM technology. Additionally, prescriber training on the impact of insurance coverage and reimbursement for diabetes technology[33] allows clinicians to become advocates for CGM utilization.

This study provides insights on the rapidly evolving field of CGM technology, highlighting the importance of equitable access for all patients with insulin-managed DM. T1DX Registry data can guide policies that promote health equity and reduce chronic disease burden in the United States. The improving standard of care for diabetes management

Table 3. Association Between Insurance Type and CGM Use Stratified by Income.

Subgroup analysis by reported annual income			
Characteristic	OR	95% CI	*P*-value
Total cohort			
Type of insurance			
Private insurance	–	–	
Government insurance	0.58	0.52, 0.64	<.001
Multiple insurance	0.84	0.68, 1.05	.14
Unknown	0.76	0.65, 0.90	.002
Uninsured	0.56	0.37, 0.84	.007
<$25 000			
Type of insurance			
Private insurance	–	–	
Government insurance	0.43	0.31, 0.58	<.001
Multiple insurance	1.15	0.51, 2.39	.7
Unknown	0.52	0.24, 1.03	.075
Uninsured	0.1	0.01, 0.46	.023
$25 000-35 000			
Type of insurance			
Private insurance	–	–	
Government insurance	0.44	0.31, 0.62	<.001
Multiple insurance	0.58	0.23, 1.28	.2
Unknown	0.47	0.22, 0.92	.038
Uninsured	0.44	0.07, 1.69	.3
$35 000-50 000			
Type of insurance			
Private insurance	–	–	
Government insurance	0.69	0.53, 0.89	.005
Multiple insurance	0.75	0.41, 1.33	.3
Unknown	0.56	0.32, 0.92	.028
Uninsured	0.14	0.01, 0.69	.057
$50 000-75 000			
Type of insurance			
Private insurance	–	–	
Government insurance	0.64	0.50, 0.81	<.001
Multiple insurance	1.03	0.66, 1.57	.9
Unknown	1.23	0.86, 1.76	.3
Uninsured	1.32	0.51, 3.20	.5
$75 000-100 000			
Type of insurance			
Private insurance	–	–	
Government insurance	0.67	0.50, 0.89	.006
Multiple insurance	1.14	0.67, 1.91	.6
Unknown	0.76	0.53, 1.08	.13
Uninsured	0.45	0.15, 1.15	.12
>$100 000			
Type of insurance			

Abbreviations: CGM, continuous glucose monitoring; OR, odds ratio; CI, confidence interval.

Table 4. Association Between Insurance Type and CGM Use Stratified by Age.

Subgroup analysis by age group			
Characteristic	OR	95% CI	*P*-value
Total cohort			
Type of insurance			
Private insurance	–	–	
Government insurance	0.57	0.51, 0.63	<.001
Multiple insurance	0.83	0.66, 1.03	.093
Unknown	0.77	0.66, 0.91	.003
Uninsured	0.56	0.37, 0.84	.007
<18 years old			
Type of insurance			
Private insurance	–	–	
Government insurance	0.75	0.64, 0.88	<.001
Multiple insurance	1.06	0.77, 1.44	.7
Unknown	0.74	0.60, 0.92	.006
Uninsured	0.6	0.33, 1.03	.072
18-64 years old			
Type of insurance			
Private insurance	–	–	
Government insurance	0.41	0.33, 0.51	<.001
Multiple insurance	0.78	0.48, 1.23	.3
Unknown	0.78	0.58, 1.04	.1
Uninsured	0.53	0.27, 0.95	.043
≥65 years old			
Type of insurance			
Private insurance	–	–	
Government insurance	0.56	0.37, 0.84	.005
Multiple insurance	0.66	0.38, 1.15	.15
Unknown	1.34	0.42, 4.25	.6
Uninsured	0		>.9

Abbreviations: CGM, continuous glucose monitoring; OR, odds ratio; CI, confidence interval.

provides an optimistic outlook, with progress occurring despite tenacious disparities that must be addressed. Proactively working on a population health level against prevailing socioeconomic, racial, and cultural barriers to increase CGM utilization can improve health outcomes for underserved populations who need care most.

Abbreviations

ADA, American Diabetes Association; BMI, body mass index; CDC, Center for Disease Control; CGM, continuous glucose monitor; DKA, diabetic ketoacidosis; DM, diabetes mellitus; GED, general educational development; HbA1c, hemoglobin A1c; IQR, interquartile range; NHANES, National Health and Nutrition Examination Survey; RCT, randomized controlled trial; RWE, real-world evidence; SES, socioeconomic status; SH, severe hypoglycemia; SMBG, self-monitored blood glucose; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; T1DX Registry, Type 1 Diabetes Exchange Registry; YARDD, Young Adult Racial Disparities in Type 1 Diabetes study.

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