FEATURE ARTICLE

Association Between Health Insurance Type and Adverse Outcomes for Children and Young Adults With Type 1 Diabetes and Coronavirus Disease 2019

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BACKGROUND | Health insurance coverage type differs significantly by socioeconomic status and racial group in the United States. The aim of this study was to determine whether publicly insured children and young adults with type 1 diabetes were more likely to experience adverse outcomes compared with privately insured patients with acute coronavirus disease 2019 (COVID-19) infections.

METHODS | Data from 619 patients with previously established type 1 diabetes who were <24 years of age with acute COVID-19 infections were analyzed from the T1D Exchange COVID-19 surveillance registry. Data for the registry was collected from 52 endocrinology clinics across the United States using an online survey tool. Each site completed the survey using electronic health record data between April 2020 and December 2021.

RESULTS | Of the 619 patients included in this study, 257 had public insurance, and 362 had private insurance. Of the 257 publicly insured patients with COVID-19, 57 reported severe adverse outcomes (22%), defined as diabetic ketoacidosis (DKA) or severe hypoglycemia. In comparison, there were 25 reported adverse outcomes (7%) among the 362 privately insured patients.

CONCLUSION | Our data reveal high rates of hospitalization and DKA among publicly insured racial/ethnic minority children and young adults with type 1 diabetes and COVID-19.

Since early 2020, the emergence of the severe acute respiratory syndrome coronavirus 2 and resulting coronavirus disease 2019 (COVID-19) cases have posed challenges to the global health care community. Preexisting diabetes has been identified as a significant comorbidity for severe COVID-19 complications (1–3). Diabetes-related ketoacidosis (DKA) is an acute, potentially life-threatening complication of diabetes that can occur in people with type 1 diabetes. Studies have shown an increased correlation between COVID-19 and DKA, for individuals with either existing or new-onset diabetes, although the mechanism remains unclear (4–6).

One potential explanation is health care inequity in the United States. In July 2022, the White House issued a briefing that examined the role of health insurance coverage in excess mortality (7). The report revealed that, in 2019, there was an association between a 10 percentage point increase in uninsured status and a 4.8 percentage point increase in mortality rate. Before the COVID-19 pandemic, studies showed that youth with public or no insurance had a higher incidence and greater severity of DKA than those with private health insurance (8,9). Older studies have also shown a negative association between public health insurance, quality of care (10), and morbidity and mortality (11).

The T1D Exchange Quality Improvement (T1DX-QI) Collaborative brings together clinics across the United States that share clinical data to improve the lives of individuals with type 1 diabetes. To understand the impact of COVID-19 on people with type 1 diabetes, the collaborative formed a registry to collect outcome data. This study aimed to determine whether publicly insured children and young adults with

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type 1 diabetes and acute COVID-19 infection were more likely than privately insured individuals to experience hospitalization and adverse outcomes, defined as DKA or severe hypoglycemia.

Research Design and Methods

The T1DX-QI Collaborative sponsored a secondary analysis of a cross-sectional study of 52 adult and pediatric endocrinology clinics across the United States (12). The Western Institutional Review Board deemed the study as exempt. For this study, COVID-19 status occurred before hospital admission and was confirmed with a positive COVID-19 test. Hospitalization was defined as patients admitted to an inpatient unit of a hospital. Both DKA and hypoglycemia were defined using International Society for Pediatric and Adolescent Diabetes definitions (13,14). Each participating site conducted simple chart reviews and submitted data using online survey software via Qualtrics between April 2020 and October 2021 to identify patients with established type 1 diabetes and COVID-19. Details of the questionnaire (Supplementary Material) have been previously reported (15).

Statistical Analyses

Patient outcomes and demographics were analyzed as categorical variables when appropriate. Race/ethnicity was categorized as Non-Hispanic White, Non-Hispanic Black, Hispanic, or other (16). Health insurance type was classified as public, private, or unknown. Use of an insulin pump and use of continuous glucose monitoring (CGM) were analyzed as categorical (yes/no) variables. Patients' age, limited to <24 years, and last reported A1C values were collected and analyzed as continuous variables, using mean ± SD or median (interquartile range [IQR]) as appropriate based on data distribution. *P* values were calculated using Fisher exact or χ^2 tests to examine the association between the categorical variables.

A post hoc power analysis was performed using G*Power to determine the minimum sample size required to achieve a sufficient level of power needed to avoid a type II error. Power calculations demonstrated that a minimum sample size of 210 was needed to achieve a power of 0.95 for an effect size of 0.5. Our study included 619 individuals in the analysis.

Results

Data for a total of 619 individuals were analyzed. Selected patient characteristics are displayed in Table 1. Publicly insured patients were more likely to be younger and female compared with privately insured patients (14.8 vs. 16.3 years of age [$P > 0.001$] and 57 vs. 48% female [$P = 0.02$]). There was a statistically significant difference in reported race/ethnicity; fewer patients with public insurance identified as non-Hispanic White (35 vs. 81%, $P < 0.001$) and more identified as non-Hispanic Black (23 vs. 5%, $P < 0.001$) or Hispanic (36 vs. 9%, $P < 0.001$). Median A1C values were higher in those with public insurance (9.5 vs. 7.9%, $P < 0.001$). There were fewer

TABLE 1 Selected Characteristics of Individuals With Public Versus Private Insurance With Laboratory-Confirmed COVID-19 and Previously Established Type 1 Diabetes ($N = 619$)

	Public Insurance ($n = 257$)	Private Insurance ($n = 362$)	*P*
Age, years	14.8 ± 4.4	16.3 ± 3.9	<0.001
Female sex	147 (57)	172 (48)	0.02
Race/ethnicity			<0.001
Non-Hispanic White	89 (35)	294 (81)	
Non-Hispanic Black	58 (23)	17 (5)	
Hispanic	92 (36)	34 (9)	
Other	18 (7)	17 (5)	
Median A1C (Q1, Q3), %	9.5 (8.1, 11.7)	7.9 (7, 9.1)	<0.001
Mean A1C, %	10 ± 2.5	8.3 ± 1.9	<0.001
CGM use	133 (52)	282 (78)	<0.001
Insulin pump use	77 (30)	225 (62)	<0.001
Level of care			<0.001
Intensive care unit	36 (14)	13 (3.5)	
In-patient hospitalization	31 (12)	20 (5.5)	
Nonhospitalized	190 (74)	329 (91)	
Adverse outcomes			<0.001
DKA	53 (20.6)	21 (6)	
Severe hypoglycemia	4 (1.6)	4 (1)	
None	200 (77.8)	312 (86)	

Data are mean ± SD, *n* (%), or median (Q1, Q3). Patients with unknown insurance type accounted for <3% of cases and were not included in the analysis.

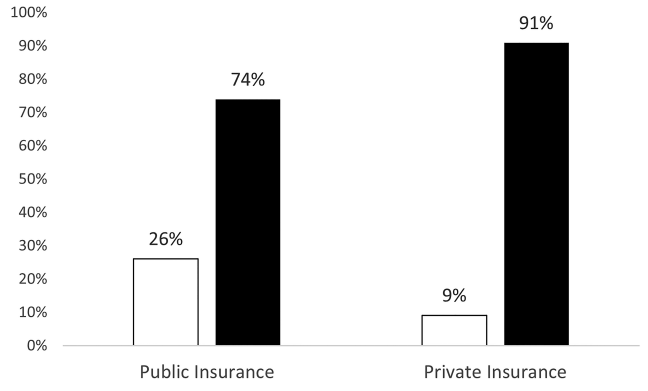

FIGURE 1 Hospitalizations by insurance type. White box = hospitalized; black box = nonhospitalized.

publicly insured patients using diabetes technology such as insulin pumps (30 vs. 62%, $P < 0.001$) and CGM (52 vs. 78%, $P < 0.001$) for their baseline diabetes management compared with those with private insurance.

For individuals with public versus private insurance, COVID-19 was associated with higher rates of hospitalization ($P < 0.001$) (Figure 1) and adverse acute diabetes-related outcomes ($P < 0.001$) (Figure 2). Although individuals with public insurance were three times more likely to be hospitalized than those with private insurance (odds ratio [OR] 3.4, 95% CI 2.1–5.4), the odds were reduced and no longer significant after adjusting for baseline A1C (OR 1.7, 95% CI 0.99–2.85). Of the 257 individuals with public insurance, 53 (21%) presented in DKA and 4 (2%) presented with severe hypoglycemia. In comparison, of the 362 individuals with private insurance, 21 (6%) presented in DKA and 4 (1%) had severe hypoglycemia. Rates of adverse outcomes were also higher among publicly insured individuals when controlling for race/ethnicity (10% publicly insured non-Hispanic White vs. 6% privately insured; 40% publicly insured non-Hispanic Black vs. 24% privately insured; 20% publicly insured Hispanic vs. 6% privately insured, $P < 0.001$) (Figure 3). The odds for adverse outcomes were increased among individuals on public insurance (OR 3.6, 95% CI 2.17–6.03). After adjusting for baseline A1C, the odds were still significant (OR 1.8, 95% CI 1.01–3:15, $P = 0.04$) (Tables 2 and 3).

Discussion

This secondary analysis revealed that publicly insured children and young adults with type 1 diabetes and COVID-19 were more likely to be hospitalized and experience adverse outcomes. This higher rate of adverse outcomes was correlated with public insurance status regardless of reported race/ethnicity. The increased odds were persistent even after adjusting for baseline A1C. Our findings are consistent with previous studies that have demonstrated socioeconomic inequities contributing to adverse outcomes such as DKA among individuals with type 1 diabetes and COVID-19 (15,17–19). Differential access to health care is a possible explanation for the higher rate of adverse outcomes.

At baseline, those with public insurance had higher median (9.5 vs. 7.9%) and mean (10 vs. 8.3%) A1C values compared with those with private insurance. One possible explanation is decreased access to diabetes technology, which has been associated with fewer adverse outcomes (20). Within our study population, 52% of publicly insured patients were using CGM and 30% were using an insulin pump compared with 78% of privately insured patients using CGM and 62% using an insulin pump. Access to diabetes technology, which can be affected by insurance type (21), may be another contributing factor to the differences in diabetes outcomes found in this study.

Our findings expand and are consistent with earlier work by Alonso et al. (15) demonstrating that baseline A1C was a major contributor to hospitalization. However, because of an extended data collection period, this secondary analysis had an updated dataset with more people, new COVID-19 variants, and a broader age range (0–25 years). This study adds to the literature crucial information on the impact of public insurance status on adverse outcomes, which was still a significant determinant despite adjusting for baseline A1C. One possible explanation for this finding is that, in the later stage of the COVID-19 pandemic, there were fewer hospitalizations because more people could access virtual care for adverse outcomes.

For at least two decades, evidence has linked insurance to health outcomes (10,11). Racial/ethnic minority and low-income people with type 1 diabetes are more likely to be on public health insurance. An important contribution of this study is its

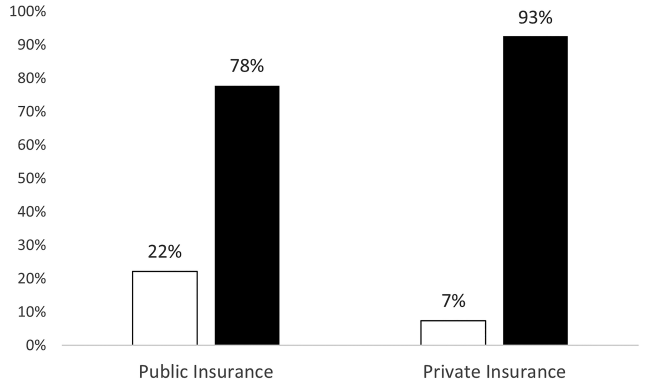

FIGURE 2 Adverse outcomes (DKA and severe hypoglycemia) by insurance type. White box = adverse outcomes; black box = no adverse outcomes.

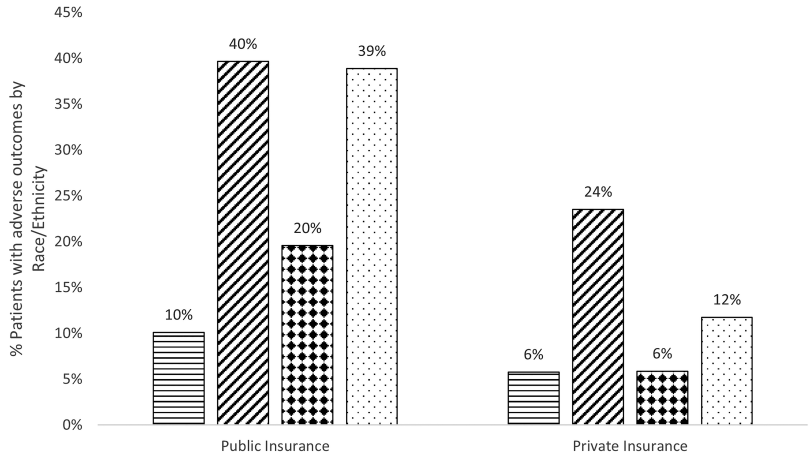

FIGURE 3 Adverse outcomes in COVID-19–positive patients with type 1 diabetes by race/ethnicity and insurance type. Horizontal lines = Non-Hispanic White; diagonal lines = Non-Hispanic Black; diamonds = Hispanic; dots = other.

call for a stronger and more effective public insurance system, especially because this system serves as a lifeline for some of our nation's most vulnerable people.

A limitation to our study is that it was cross-sectional and cannot establish causality. Hence, the associations between DKA and public insurance are strictly correlational. Data were collected via questionnaire, and there may have been underreporting of COVID-19 cases. It would be helpful to know the baseline insurance status of the study sample because type of insurance can have an impact on type of treatments covered. This study also did not include data on baseline health status or comorbidities between insurance groups.

TABLE 2 Logistic Regression for Adverse Outcomes Among Patients With Confirmed COVID-19 and Type 1 Diabetes

	OR (95% CI)	*P*
Unadjusted model		
Private insurance (ref)	–	
Public insurance	3.57 (2.17–6.03)	<0.001
Model adjusted for A1C		
Private insurance (ref)	–	
Public insurance	1.78 (1.01–3.15)	0.04

TABLE 3 Logistic Regression for Hospitalization Among Patients With Confirmed COVID-19 and Type 1 Diabetes

	OR (95% CI)	*P*
Unadjusted model		
Private insurance (ref)	–	
Public insurance	3.39 (2.15–5.41)	<0.001
Model adjusted for A1C		
Private insurance (ref)	–	
Public insurance	1.70 (0.99–2.85)	0.05

Conclusion

In this study, rates of hospitalization and adverse outcomes were higher in individuals <24 years of age with type 1 diabetes and COVID-19 who had public versus private health insurance, across races/ethnicities. There is a need for further research that explores the impact of health insurance on quality of care, health care utilization, and outcomes.

DUALITY OF INTEREST

O.E. is the principal investigator for research projects funded through his institution by Dexcom, Eli Lilly, and Medtronic, he is also a member of the Medtronic Diabetes Health Inequity Advisory Board. No other potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

B.M. and J.K.D. wrote the manuscript. O.E. researched data and contributed to the discussion. S.R. researched and analyzed data and contributed to the methodology. A.O., I.G-B., A.M., A.G., V.R., and A.S. contributed to discussion and reviewed/edited the manuscript. S.R. is the guarantor of this work and, as such, has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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