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Racial disparities in treatment and outcomes of children with type 1 diabetes

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Abstract

Objective: The aim of this study was to assess racial disparities in treatments and outcomes between Non-Hispanic black (NHB), Hispanic and Non-Hispanic white (NHW) children with type 1 diabetes (T1D).

Methods: We reviewed electronic health records of children (<18 years) attending a large, pediatric tertiary care diabetes center in the United States between October 1, 2018, and December 31, 2019. Health care utilization (appointment attendance, ED visits, hospitalizations), technology use (insulin pumps, continuous glucose monitors [CGM]) and hemoglobin A1c (HbA1c) were examined for each race/ethnicity and stratified by insurance type (private/government) as a proxy for socioeconomic status (SES).

Results: Of 1331 children (47% female) with a median (IQR) age of 14.2 (11.5, 16.3) years and T1D duration of 5.8 (3.8, 9) years; 1026 (77%) were NHW, 198 (15%) NHB, and 107 (8%) Hispanic. Government insurance was used by 358 (27%) children, representing 60% of NHB and 53% of Hispanic, but only 18% of NHW children. NHB children had higher HbA1c, more ED visits and hospitalizations, and were less likely to be treated with insulin pumps or CGM than NHW children ($P < .001$ for all). There were no racial disparities with regard to the number of appointments attended.

Conclusions: Racial disparities in technology use and diabetes outcomes persist in children with T1D, regardless of insurance status. To ensure equitable care, pediatric healthcare providers should remain cognizant of racial disparities in diabetes treatment. The impact of provider and patient factors should be explored when studying the etiology of these health disparities.

KEYWORDS

diabetes, disparities, healthcare utilization, hemoglobin A1c, pediatric, race

1 | INTRODUCTION

Type 1 diabetes (T1D) is the third most common pediatric chronic disease in the United States, with more than 18 000 new cases diagnosed each year.[1,2] Data from the Philadelphia Pediatric Diabetes Registry has shown that the annual incidence of T1D in youth has increased from 13.4 in 1985 to 19.2 cases per 100 000 youths in 2005, a 43% increase in 20 years.[3,4]While T1D disproportionately affects non-Hispanic white (NHW) vs non-Hispanic black (NHB) children,[3,5] the SEARCH for Diabetes in Youth study[5] showed that between 2002 and 2015 the risk of T1D rose sharply in NHB children; with a 40% increase in incidence, compared to less than 15% in NHW children.[6]

Abbreviations: CDE, certified diabetes educator; CGM, continuous glucose monitor; DKA, diabetic ketoacidosis; HbA1c, hemoglobin A1c; MD, Medical Doctor; NHB, non-Hispanic black; NHW, non-Hispanic white; NP, nurse practitioner; SES, socioeconomic status; T1D, type 1 diabetes.

Ironically, the significant advances in T1D therapeutics over recent years, especially new technologies, may have exacerbated racial disparities in diabetes treatment and outcomes. Disparities in these treatments are of clinical significance, as both intensive insulin therapy and the incorporation of technology have been associated with improved glycemic control[7] and, consequently, reduced long-term complications.[17] NHW children are significantly more likely to be prescribed intensive insulin regimens, insulin pumps, and continuous glucose monitoring (CGM) systems than NHB or Hispanic children.[8-10] But while numerous studies have shown that NHB children have higher hemoglobin A1c (HbA1c) levels than both NHW and Hispanic children,[11-16] higher HbA1c levels in Hispanic compared with NHW children have not been demonstrated.

The majority of TID morbidity and mortality occurring in childhood results from diabetic ketoacidosis (DKA) and severe hypoglycemia. DKA accounts for 65% of all hospitalizations in pediatric patients with T1D and carries a mortality rate between 0.15% and 0.31%[8,17,18] per episode. Children with established T1D have an 8% annualized risk of developing DKA, and this risk increases during adolescence.[19] NHB children have higher rates of DKA than NHW or Hispanic children[12,20]; moreover, these children are more likely than their NHW counterparts to be hospitalized because of DKA.[12] Similarly, NHB children are more likely to have experienced a severe hypoglycemic episode in the past 12 months.[16] A study conducted using the Chicago Children's Diabetes Registry reported that, compared with NHW children, non-white race and ethnicity doubled the odds of re-hospitalization and tripled the odds of a hyperglycemia-related re-hospitalization.[21] All of these diabetes complications are associated with preventable harm, and lead to increased utilization of healthcare resources over the short and long-term.

Disparities in the treatment and outcomes of children with T1D outlined above have been described at the national level.[8,16] Philadelphia is racially and ethnically diverse, with a Hispanic population largely of Puerto Rican origin, and has the highest level of poverty of the 10 largest cities in the US.[22] Children's Hospital of Philadelphia is a hub for pediatric diabetes care, seeing over 2400 children and young adults with T1D each year. The aim of this study was to quantify racial and ethnic disparities in a large urban pediatric center, by comparing treatment modalities, clinical outcomes and appointment attendance in NHB, vs NHW and Hispanic children with T1D while examining the contribution of insurance status (as a proxy for socioeconomic status [SES]) to these disparities.

2 | METHODS

Electronic health records (EPIC Systems Corporation, Verona, Wisconsin) of all children attending the Diabetes Center at Children's Hospital of Philadelphia between October 2018 and December 2019 were reviewed. All children aged less than 18 years, with diabetes duration of 2 years or more (and therefore had sufficient duration of diabetes beyond the "honeymoon" period) on December 31, 2019, were included in this analysis. Patients with government provided military insurance were excluded, as government insurance status is not a proxy for SES in this population. The Institutional Review Board at Children's Hospital of Philadelphia approved this study as a retrospective chart review.

Demographic data including sex, self-identified race/ethnicity (NHW, NHB, Hispanic), age, and type of health insurance (government vs commercial) at most recent clinic appointment, as a surrogate for SES, were extracted from the demographics section of the electronic health record. Clinical data are entered manually in flowsheets by nurse practitioners and physicians at each clinic visit and various fields from these completed flowsheets; including diabetes type, health care utilization (distinct emergency department visits and hospitalizations, attended, and missed outpatient appointments), glycemic control (HbA1c at the most recent clinic visit) and treatment modalities (eg, insulin pump and CGM) were extracted electronically. HbA1c may have been measured as a point-of-care test at the clinic visit, or by a National Glycohemoglobin Standardization Program harmonized laboratory using a venous sample drawn in close temporal proximity to the clinic visit. Insulin pump or CGM use was defined as having current use of either of these devices documented at their latest clinical appointment in 2019. Diabetes related emergency department visits and hospital admissions to Children's Hospital of Philadelphia were also identified in the electronic health record and included if these were omitted from the clinical flowsheet.

2.1 | Standard diabetes care

In the Diabetes Center at Children's Hospital of Philadelphia, all children are assigned to a clinical team consisting of a nurse practitioner, certified diabetes educator, nutritionist, social worker and physician. The aim is for all children to be evaluated by their nurse practitioner every 3 months (with one of these substituted by a yearly physician appointment), and to see a certified diabetes educator, registered dietician, and social worker at least once annually. Patients are seen at six different clinical sites with a standardized multidisciplinary team approach. On the days of the diabetes clinic appointments, all members of the multidisciplinary team are in clinic seeing patients. Each diabetes team has a weekly multidisciplinary meeting where all patients (including no shows and late cancellations) are reviewed.

Issues that may arise between appointments are addressed through patient-initiated phone calls or electronic messages to their diabetes team members. Endocrine fellows, through an on-call rotation, address weekend and overnight emergent issues.

2.2 | Statistical analysis

Appointment attendance, treatment modalities, and clinical outcomes were stratified according to race (NHW, NHB, and Hispanic) and insurance status. Normally distributed data were described as mean ± SD and non-normally distributed data as median (IQR). Continuous variables were compared between NHB, NHW, and Hispanic children

using analysis of variance, and the Scheffe test was used for post hoc comparison between groups. Chi squared tests were used to assess differences in categorical variables.

Binary logistic regression analyses were performed with treatment modalities (insulin pump use, continuous glucose monitor use), suboptimal glycemic control[23] (HbA1c ≥ 7.5%) and healthcare utilization over the study period (≥ 1 emergency department visit, ≥ hospital admission, ≥ 1 missed scheduled appointment) as separate dependent variables. With NHW children as the comparison group, odds ratios adjusted for age and duration of diabetes, and stratified by insurance status for each dependent variable were calculated for NHB vs NHW and for Hispanic vs NHW. Data analysis was performed using SPSS 24 (IBM, New York, New York).

3 | RESULTS

A total of 2865 patients were seen in the Diabetes Center between October 2018 and December 2019; 308 were excluded because of the diagnosis of non-type 1 diabetes, 587 were over 18 years old, while 467 had diabetes duration of less than 2 years. In addition, 156 were excluded due to non-NHW, -NHB or -Hispanic race/ethnicity and 16 were excluded due to government provided military insurance. Included in the study were 1331 children (47% female) with a median (IQR) age of 14.2 (11.5, 16.3) years and T1D duration of 5.8 (3.8, 9) years. This was a racially and ethnically diverse sample consisting of 1026 (77%) NHW, 198 (15%) NHB and 107 (8%) Hispanic children. Government insurance (a proxy for low SES) was used by 358 (27%) children and represented 60% of NHB, 53% of Hispanic and 18% of NHW children in the sample (NHW vs NHB; NHW vs Hispanic- $P < .001$ for both). There was no significant difference in age, sex, or duration of diabetes, by race or type of insurance in the overall sample. An overview of patient demographics, health care utilization, treatment modalities, and outcomes is shown in Table 1, and is further stratified by insurance status in Table 2.

3.1 | Health care utilization

More NHB children were hospitalized over the study period, followed by Hispanic and NHW children (18%, 10%, and 3%, respectively). The odds ratio for hospitalization was 7.7 (95% CI 4.6-12.8) times higher in NHB than NHW children and 4 (95% CI 2-8.4) times higher in Hispanic than NHW children (Table 3). These disparities were most

TABLE 1 Demographics, glycemic control, health care utilization, and technology use among non-Hispanic black (NHB), non-Hispanic white (NHW) and Hispanic children with type 1 diabetes who attended our center during the study period

				P value		
	NHB (n = 198)	NHW (n = 1026)	Hispanic (n = 107)	NHW vs NHB	NHB vs Hisp	NHW vs Hisp
Age	13.9 (11.2, 16.3)	14.3 (11.5, 16.4)	14.0 (11.6, 15.6)	.9	.9	.7
Female sex	106 (54%)	477 (47%)	49 (46%)	.08	.2	.9
Duration of T1D, years	5.6 (3.5, 8.0)	5.8 (3.7, 9.2)	5.9 (4.4, 9.0)	.5	.5	.9
Government insurance	120 (60.3%)	196 (18.8%)	58 (53.7%)	<.001	.3	<.001
Most recent HbA1c (%)	9.4 (8.2, 11.0)	7.8 (7.1, 8.7)	8.6 (7.7, 9.9)	*<.001*	*<.001*	*<.001*
HbA1c ≥ 7.5%	176 (88.4%)	645 (62%)	88 (81.4%)	*<.001*	*.1*	*<.001*
Number of attended MD/NP visits[a]	4.3 ± 1.5	4.2 ± 1.2	4 ± 1.6	.7	.1	.3
Number of missed MD/NP appointments[a]	1.3 ± 1.2	0.6 ± 0.7	1.2 ± 1.4	*<.001*	.8	*<.001*
Attended CDE visit[a]	152 (77%)	709 (69%)	89 (83%)	*.03*	.2	*.002*
Attended nutrition visit[a]	131 (66%)	572 (56%)	69 (65%)	*.008*	.8	.1
≥ 1 ED visit[a]	29 (15%)	46 (5%)	10 (9%)	*<.001*	.2	.035
≥ 1 Hospital admission[a]	36 (18%)	29 (3%)	11 (10%)	*<.001*	.1	*.001*
≥ 1 Missed appointment[a]	155 (78%)	535 (52%)	75 (70%)	*<.001*	.1	*<.001*
CGM used	78 (39%)	702 (68%)	57 (53%)	*<.001*	*.022*	*.002*
Insulin pump	68 (34%)	738 (72%)	50 (47%)	*<.001*	.037	*<.001*

Note: Values are median (IQR) or mean ± SD, as appropriate. Continuous variables were compared between NHB, NHW and Hispanic children using analysis of variance, and the Scheffe test was used for post-hoc comparison between groups. Chi squared tests were used to assess differences in categorical variables. Bonferroni $\alpha < 0.0167$ due to multiple comparisons.

Abbreviations: CDE, certified diabetes educator; CGM, continuous glucose monitor; ED, emergency department; MD, medical doctor; NP, nurse practitioner; T1D, type 1 diabetes.

[a]During study period (October 1, 2018 to December 31, 2019).

Statistically significant values are provided in italic.

TABLE 2 Demographics, glycemic control, and health care and technology utilization in non-Hispanic black (NHB), non-Hispanic white (NHW) and Hispanic children with type 1 diabetes during the study period

	Government Insurance						Commercial Insurance					
	NHB (n = 119)	NHW (n = 182)	Hispanic (n = 57)	*P* value			NHB (n = 79)	NHW (n = 844)	Hispanic (n = 50)	*P* value		
				NHW vs NHB	NHB vs Hispanic	NHW vs Hispanic				NHW vs NHB	NHB vs Hispanic	NHW vs Hispanic
Age	14.2 (11.2, 16.5)	13.4 (10.9, 16)	14.2 (11, 15.6)	.5	.6	.9	13.8 (11.7, 16.5)	14.5 (11.7, 16.5)	13.9 (12, 15.6)	.5	.8	.9
Female Sex	59 (50%)	84 (46%)	24 (42%)	.6	.4	.6	47 (59%)	393 (47%)	25 (50%)	*.03*	.4	.7
Duration of T1D (years)	5.6 (3.5, 8.1)	5.9 (3.8, 9.2)	6.1 (4.5, 9.6)	.7	.6	.9	5.6 (3.8, 7.9)	5.8 (3.6, 9.2)	5.8 (4.2, 8.8)	.6	.8	.9
Most recent HbA1c (%)	9.8 (8.5, 11.6)	8.3 (7.5, 9.5)	9 (8, 10.2)	*<.001*	*.015*	*.09*	8.8 (8, 10.2)	7.7 (7.1, 8.5)	8.1 (7.3, 9.6)	*<.001*	*.04*	*.003*
HbA1c ≥ 7.5%	107	150	52	*.005*	*.9*	*.04*	69	495	36	*<.001*	*.037*	*.08*
Number of attended MD/NP visits[a]	4.2 ± 1.5	3.9 ± 1.3	4 ± 1.7	.4	.6	.9	4.4 ± 1.5	4.3 ± 1.2	4 ± 1.6	.4	.1	.4
Number of missed MD/NP appointments[a]	1.5 (1.3)	0.87 (0.8)	1.5 (1.5)	*<.001*	.9	*.001*	1 (1)	0.6 (0.7)	0.9 (1)	*<.001*	.5	.007
Attended CDE Visit[a]	88 (74%)	137 (75%)	48 (84%)	.8	.2	.2	64 (81%)	572 (68%)	41 (82%)	*.02*	*.9*	*.04*
Attended nutrition visit[a]	77 (65%)	100 (55%)	34 (60%)	*.04*	.6	.5	54 (68%)	472 (56%)	35 (70%)	*.03*	.9	.06
≥ 1 ED visit[a]	20 (17%)	18 (10%)	7 (12%)	.08	.9	.2	9 (11.4%)	28 (3.3%)	1 (2%)	*.003*	.09	.9
≥ 1 hospital admission[a]	27 (23%)	15 (8%)	7 (12%)	*.003*	.2	.4	9 (11.4%)	14 (1.7%)	4 (8%)	*<.001*	.8	.2
Missed ≥1 appointment[a]	97 (82%)	125 (69%)	42 (74%)	*.004*	.2	.5	58 (73.4%)	410 (48.6%)	33 (66%)	*<.001*	.4	.2
CGM used	42 (35%)	105 (58%)	27 (47%)	*<.001*	.1	.2	36 (46%)	597 (71%)	30 (60%)	*<.001*	.2	.11
Insulin Pump	33 (28%)	103 (57%)	20 (35%)	*<.001*	.4	*.006*	35 (44%)	635 (75%)	30 (60%)	*<.001*	.1	*.02*

Note: Values are median (IQR) or mean ± SD, as appropriate. Continuous variables were compared between NHB, NHW and Hispanic children using analysis of variance, and the Scheffe test was used for post-hoc comparison between groups. Chi squared tests were used to assess differences in categorical variables. Bonferroni $\alpha < 0.0167$ due to multiple comparisons.

Abbreviations: CDE, certified diabetes educator; CGM, continuous glucose monitor; MD, medical doctor; NP, nurse practitioner; T1D, type 1 diabetes.

[a]During study period (October 1, 2018 to December 31, 2019).

Statistically significant values are provided in italic.

significant among commercially insured children. NHW children were less likely than NHB children to present to the emergency department ($P < .001$).

As Table 1 demonstrates, more Hispanic (83%) and NHB (77%) children attended diabetes education appointments than NHW children (69%)(Hispanic vs NHW $P = .002$, NHB vs NHW $P = .03$), while more NHB than NHW children attended nutrition visits (66% vs 56%, $P = .008$) during the study period. In contrast, the number (mean ± SD) of attended nurse practitioner and physician visits in NHB (4.3 ± 1.5), NHW (4.2 ± 1.2) and Hispanic (4 ± 1.6) children was comparable over the 15-month observation period. However, among the NHB and Hispanic children, there were twice as many missed appointments as with NHW children (1.3 ± 1.2; $P < .001$, and 1.2 ± 1.4; $P < .001$ vs 0.6 ± 0.7, respectively). When compared with NHW children, the odds of NHB and Hispanic children having missed an appointment over the 15 months were significantly higher (3.3 (95% CI 2.3, 4.8) and 2.1 (95% CI 1.4, 3.3) respectively) (Table 3).

3.2 | Technology utilization

Of the overall cohort, 64% were treated with an insulin pump during the study period. NHW children were treated with insulin pumps (72%) more than twice as frequently as NHB (34%) and 1.3 times more often than Hispanic (47%) children ($P < .001$ for both). Far fewer children (44%) with government insurance were treated with insulin pumps and, in those with government insurance, NHW children used this technology more than twice as often as NHB (57% vs 28%, $P < .001$) and 1.6 times more often than Hispanic children (37%, $P = .006$). In contrast, children with commercial insurance used insulin pumps at a markedly higher rate (72%) and the proportion was much higher in NHW (75%) than NHB (44%) or Hispanic (60%) children ($P < .001$ and $P = .02$, respectively). In fact, insulin pump usage was higher in NHW children with government insurance, than in NHB children with commercial insurance (57% vs 44%, $P < .05$).

A total of 63% of all children were using CGM during the study period. Overall, NHW children were significantly more likely to have used CGM than NHB or Hispanic children ($P < .001$ and $P = .002$, respectively). The disparity in CGM use between NHB and NHW children was present, regardless of insurance status, while the disparity between NHW and Hispanic children no longer reached statistical significance after stratifying our cohort by insurance status. Once again, a higher proportion of NHW children with government insurance used CGM than commercially insured NHB children (58% vs 47%, $P < .05$).

The odds of not using an insulin pump were 4.9 (95% CI 3.5-6.8) times higher in NHB and 3 (95% CI 2-4.5) times higher in Hispanic than in NHW children and, again, this pattern was seen both in government and commercially insured children (Table 3). Similar patterns were observed in CGM use, with the odds of not using this technology being 3.4 (95% CI 2.5-4.7) times and 1.9 (95% CI 1.3-2.9) times higher in NHB and Hispanic children, respectively (Table 3).

3.3 | Diabetes outcomes

Overall, NHW children had markedly lower HbA1c levels (7.8%) than NHB (9.4%; $P < .001$), while Hispanic children were intermediate between these two (8.6%; $P < .001$ when compared with NHW or NHB). This pattern was observed in both government and commercially insured patients. NHB children had the highest odds of having HbA1c measurement ≥7.5% (OR 4.9 [95% CI 3.1-7.7] compared with NHW). And, when stratified according to insurance status, this disparity was greatest among the commercially insured, with NHB children 5.1 (95% CI 2.6-10.1) times less likely to reach this goal than commercially insured NHW children.

TABLE 3 Odds ratios of technology use, suboptimal glycemic control and increased healthcare utilization in non-Hispanic black (NHB) and Hispanic children, compared with non-Hispanic white (NHW), adjusted for age and duration of diabetes

	Injections (no insulin pump)	Finger stick glucose (no CGM)	HbA1c ≥ 7.5%	≥ 1 ED visit	≥ 1 admission	≥ 1 missed appointment
All children (reference group NHW)						
NHB	4.9 (3.5, 6.8)	3.4 (2.5, 4.7)	4.9 (3.1, 7.7)	3.6 (2.2, 5.9)	7.7 (4.6, 12.8)	3.3 (2.3, 4.8)
Hispanic	3 (2, 4.5)	1.9 (1.3, 2.9)	2.7 (1.6, 4.4)	2.2 (1.1, 4.5)	4 (2, 8.4)	2.1 (1.4, 3.3)
Government insurance (reference group NHW)						
NHB	3.2 (2, 5.4)	2.5 (1.6, 4.1)	2.7 (1.4, 5.4)	1.8 (0.9, 3.5)	3.2 (1.6, 6.4)	2.1 (1.2, 3.6)
Hispanic	2.5 (1.3, 4.6)	1.5 (0.8, 2.7)	2.5 (1, 6.5)	1.8 (0.7, 4.2)	1.6 (0.6, 4.1)	1.3 (0.7, 2.5)
Commercial insurance (reference group NHW)						
NHB	3.9 (2.4, 6.2)	3 (1.9, 4.9)	5.1 (2.6, 10.1)	3.7 (1.7, 8.1)	7.8 (3.3, 18.8)	3.1 (1.8, 5.2)
Hispanic	2.1 (1.1, 3.7)	1.6 (0.9, 2.9)	1.8 (0.97, 3.5)	0.6 (0.1, 4.5)	5.3 (1.7, 16.9)	2.1 (1.1, 3.8)

Note: Presented are odds ratios with 95% CI.

Abbreviations: CGM, continuous glucose monitor; ED, emergency department; HbA1c, hemoglobin A1c.

4 | DISCUSSION

In this study, we have demonstrated racial disparities in urgent health care utilization, technology application, and diabetes outcomes in a large tertiary pediatric center. This center had sufficient numbers of children with government vs private insurance (a proxy for SES) and varied racial/ethnic backgrounds to distinguish the influence of SES from race/ethnicity on their findings. It is somewhat surprising that these disparities in hospitalizations, ED visits and diabetes outcomes were not accompanied by disparities in routine multidisciplinary diabetes appointment attendance (eg, CDE, nutrition, and MD/NP appointments). While missed appointment rates were higher in NHB and Hispanic patients, the proportion of minority patients attending recommended annual nutrition and diabetes education visits was somewhat higher than for NHW children. We hypothesize that our teams' persistent, efficient rescheduling efforts resulted in similar attendance rates in NHB children despite more missed appointments than NHW children. Thus, even in a single center where appointment attendance is similar across racial and ethnic groups, significant disparities in treatments and outcomes are seen.

In our center, higher HbA1c levels were seen in NHB children with government and commercial insurance. Although it has been shown that NHB patients with T1D have slightly higher HbA1c levels than NHW patients with similar average glucose readings,[24] the magnitude of increase observed in our NHB children far exceeds this physiological difference. This racial disparity is further evident from the observation that NHW children with government insurance have lower HbA1c levels than NHB children with commercial insurance. In addition to higher HbA1c, we observed higher rates of ED visits and hospital admissions in NHB children, especially among those with government insurance. Larger multicenter studies have also demonstrated similar trends toward higher acute healthcare utilization in NHB children.[13,16]

The reasons for health disparities in pediatric T1D are multiplex.[25] Reduced engagement of minority patients with a poorly representative endocrine workforce[26] has been proposed as a cause of poorer glycemic control and increased rates of adverse outcomes. Using provider appointment attendance as a proxy for engagement, we did not observe a difference between NHB, NHW and Hispanic children in our center. In fact, attendance at annual diabetes education and nutrition appointments was higher among our minority children, suggesting that education delivery was not a crucial factor in determining these disparities in outcomes.[27] It is important to note that NHB and Hispanic children had twice as many scheduled appointments that were unattended, suggesting that a disparity in emotional engagement, or disproportionate barriers to appointment attendance may be present.

Despite similar rates of outpatient appointment attendance, significant disparities in CGM and insulin pump use were observed. Thus, differences in treatments prescribed, as have been described elsewhere,[8-10,28] were not determined by the quantity of patient-provider interactions. The expanded state Medicaid programs in our area provide near universal coverage for diabetes technologies during childhood, so insurance status is unlikely to have contributed to these disparities. Further study is required to explicate the factors responsible for disparities in diabetes treatments, and may lead to an improved understanding of the etiology of racial differences in clinical outcomes. Patient SES is commonly proposed as a factor to explain the racial disparities in the outcomes of these patients.[29] Social determinants of health such as food insecurity and unemployment present significant obstacles to a family's ability to care for the complexities of diabetes and contribute to poor diabetes control and outcomes. However, even when patients with government and commercial insurance were analyzed separately, disparities in treatment regimen and outcomes existed between NHB children when compared with Hispanic and NHW.[16]

Implicit racial/ethnic bias among health care professionals may contribute to disparities in the treatment and outcomes of minority patients,[30] and may account for some of the disparities noted in this study.[9] For example, one study found that the family's perception of medical costs and healthcare providers' perceptions of family competence were important factors associated with prescribed treatment regimens.[9] Cultural factors such as differences in the perception of what constitutes good disease management may also contribute. We have previously demonstrated that NHW families preferred a child-centered approach, whereas NHB families valued a family centered approach more highly.[31]

Limitations of this study include its retrospective design and incomplete assessment of SES. As this was a retrospective study, it was not possible to explore the etiology of the observed disparities. We do not know, for example, if CGM or insulin pump treatment was offered but refused. SES is not routinely assessed in clinical care, and we were unable to account for SES in more detail than by insurance status. As this is a single-center study, there may be concerns regarding generalizability of these results. However, many of the disparities highlighted in this large center have been shown elsewhere[16,32] indicating that this is a national issue. Recruitment to multicenter studies may also be at risk for selection bias as minority patients may be less likely to participate. A strength of this study was the inclusion of all patients in our clinic, thus providing real-world data. We hope that this single-center study prompts other centers to review their own data in relation to these disparities and consider strategies to understand and address any disparities identified.

5 | CONCLUSION

Remedying the deep-rooted healthcare disparities in this country will require a concerted effort on several fronts. Prescribing practices for diabetes technology might be rendered more equitable by developing standardized protocols related to diabetes treatments. Strategies to identify and address social determinants of health, which contribute to adverse outcomes among marginalized patient populations, should be explored.[33] For example, the addition of community health workers to the multidisciplinary team has been shown to be a cost-effective, strategy to improve diabetes control in vulnerable populations.[34,35] Programs which target the development of a diverse clinical workforce that mirrors the nation's demographics may improve

clinician-patient relationships and lead to enhanced patient engagement.[36] Disparities in healthcare cannot be eliminated without a societal effort to address structural racism. The underlying etiologies of healthcare disparities, including the impact of patient and provider bias, should be fully investigated and strategies developed to mitigate these contributing factors. The unique role of pediatric healthcare providers, as child advocates, demands that we take a leadership role in the study and alleviation of racial disparities.

CONFLICT OF INTEREST

All authors have indicated that they have no potential conflicts of interest to disclose. All authors have no financial relationships relevant to this article to disclose.

AUTHOR CONTRIBUTIONS

Terri H Lipman, Steven M Willi, and Colin P Hawkes conceptualized and designed the study, drafted the initial manuscript and revised the manuscript. Oona Patil and Jennifer A Smith conceptualized the study, assisted with data extraction and analysis, and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

PEER REVIEW

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