



T1D
Exchange

State of Type 1 Diabetes 2023

Osagie Ebekozen, MD, MPH, CHPQ
Chief Medical Officer

Disclosures

- Member of the Medtronic Diabetes and Sanofi Advisory Board.
- Research support from Medtronic Diabetes, MannKind Pharmaceutical, Dexcom, Eli Lilly Diabetes, Abbott, Vertex Pharmaceutical, Janssen Pharmaceutical.
- Consultation and speaker fees from Medtronic Diabetes, Sanofi and Vertex.
- All financial support from Industry through my organization T1D Exchange

- T1D Exchange is supported by grants from Leona M and Harry B Helmsley Charitable Trust and JDRF – Thank you!

Objectives

1. Demonstrate the importance of collaboration and quality improvement to improve outcomes for people with type 1 diabetes (PwT1D)
2. Highlight recent data on the glycemic and adverse outcome for PwT1D.
3. Describe practical strategies for improving population-based and reducing inequities for PwT1D.
4. Share lessons from a large network for T1D centers (T1DX-QI) committed quality improvement and practice transformation.

The State of Type 1 Diabetes in 2023


- **Engaging:** QI collaboration is supporting culture change!
- **Encouraging:** Inequities persists but gaps are reducing!
- **Exciting:** Outcomes are improving for everyone!



Engaging Collaboration to contribute, benchmark and transform

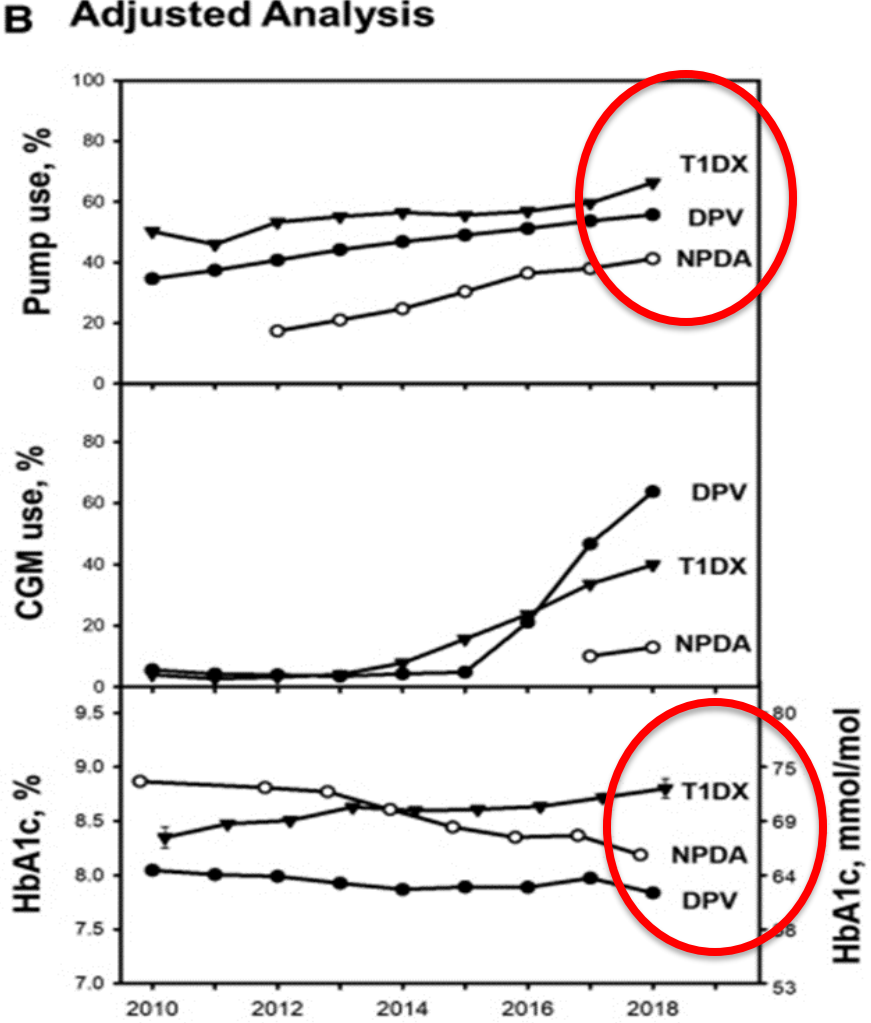
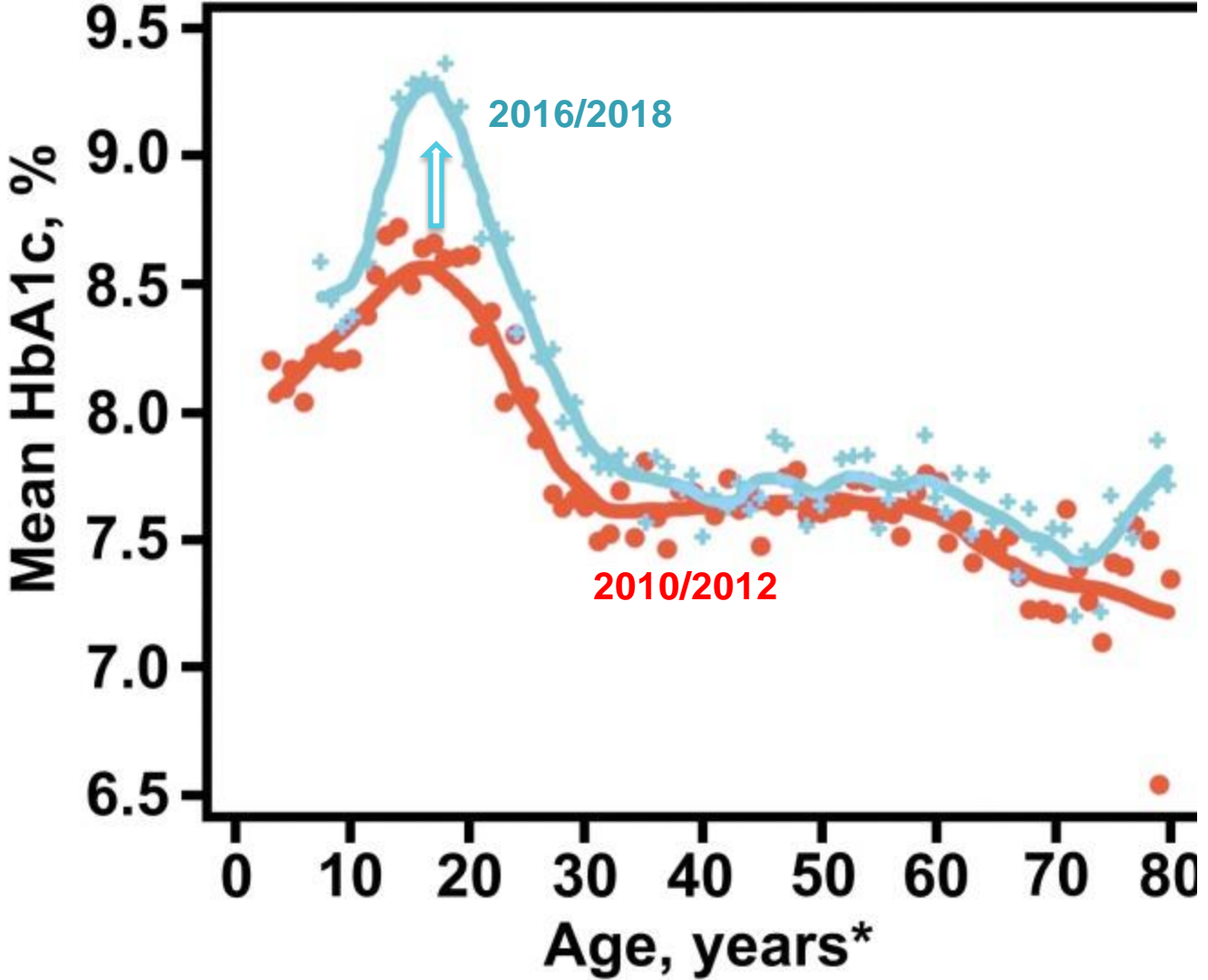
Driving Equity and Innovation in the T1D Exchange Quality Improvement Collaborative: Advancing Outcomes Through Collaborative Change **FREE**

Shivani Agarwal   ; Shideh Majidi; Nicole Riales; Osagie Ebeozien; T1D Exchange Quality Improvement Collaborative

Evolution of the T1D Exchange Quality Improvement Collaborative (T1DX-QI): Using Real-World Data and Quality Improvement to Advance Diabetes Outcomes 

Shideh Majidi   ; Nicole Riales; Shivani Agarwal; Osagie Ebeozien; T1D Exchange Quality Improvement Collaborative

Worsening HbA1c outcomes – T1DX Registry 2010/2012 vs 2016/2018



Foster NC, Beck RW, Miller KM, et al. State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016-2018. *Diabetes Technol Ther* 2019;21(2):66-72, doi:10.1089/dia.2018.0384

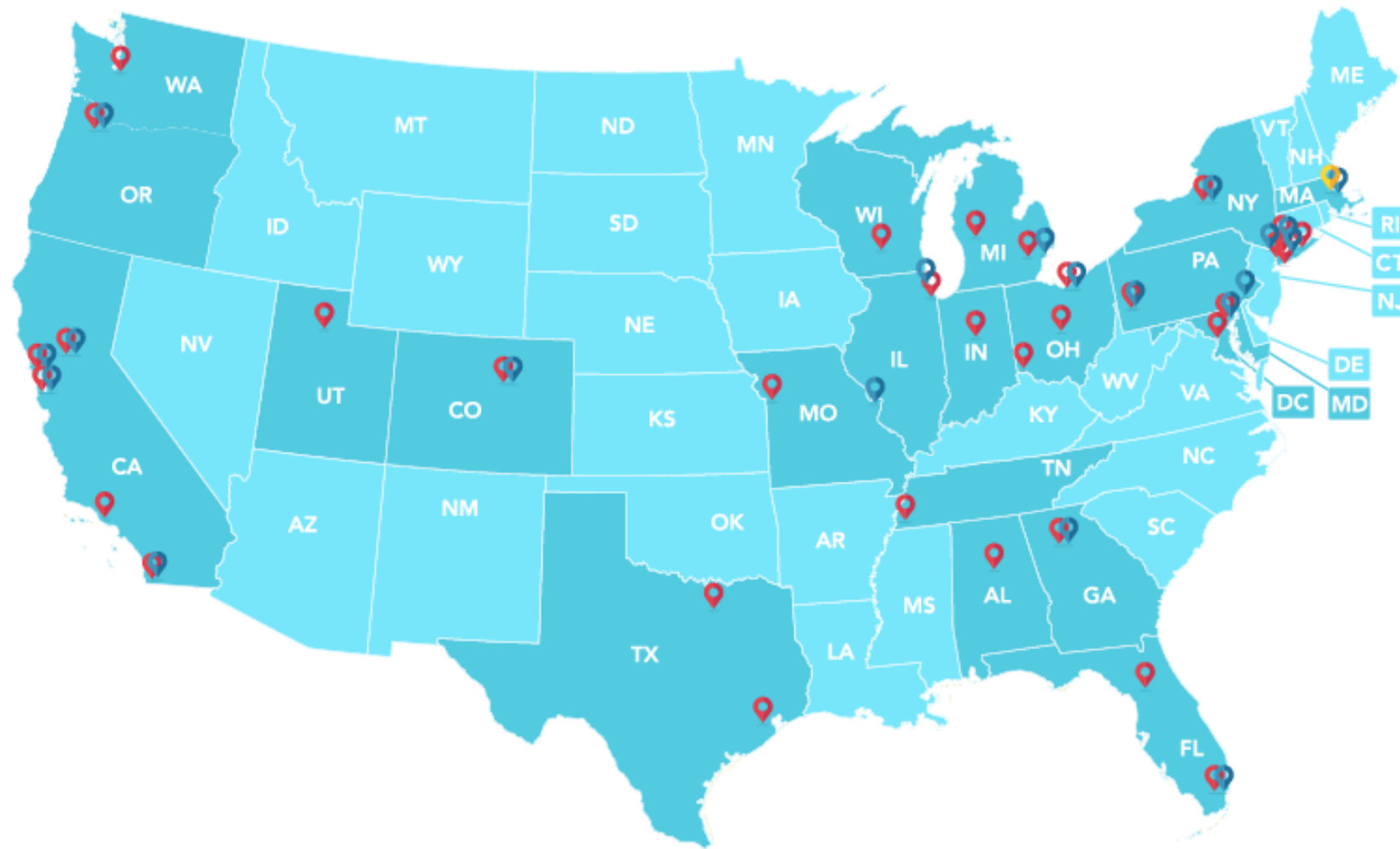
Lal RA, Robinson H, Lanzinger S, et al. Temporal Changes in Hemoglobin A1c and Diabetes Technology Use in DPV, NPDA, and T1DX Pediatric Cohorts from 2010 to 2018. *Diabetes Technol Ther* 2022;24(9):628-634, doi:10.1089/dia.2022.0095



T1DX-QI was established in 2016 to address this challenge



T1D Exchange (T1DX-QI) Network of 55 T1D Centers in 22 States



 Pediatric  Adult  T1D Exchange HQ

Shivani Agarwal, Shideh Majidi, Nicole Rioles, Osagie Ebekoziem. Driving Equity and Innovation in the T1D Exchange Quality Improvement Collaborative: Advancing Outcomes Through Collaborative Change Clinical Diabetes 2023.



Engage with PwT1D

- Advisory group
- Quality Improvement (QI) Team
- Insights on workflows
- Barriers and concerns
- Communication feedback



Engage to share operational insights

Institutional Barriers to the Successful Implementation of Telemedicine for Type 1 Diabetes Care **FREE**

Joyce M. Lee; Emma Ospelt   ; Nudrat Noor; Ann Mungmode; Osagie Ebekoziem; Meenal Gupta; Faisal S. Malik; Naomi R. Fogel; Siham Accacha; Susan Hsieh; Meredith Wilkes; Anna Neyman; Francesco Vendrame;
T1D Exchange Quality Improvement Collaborative

Study Aims:

1. Describe rate of telemedicine practice among pediatric and adult type 1 diabetes centers 18 months after the start of the COVID19 Pandemic.
2. Assess Institutional barriers to telemedicine implementation.



Key Results:

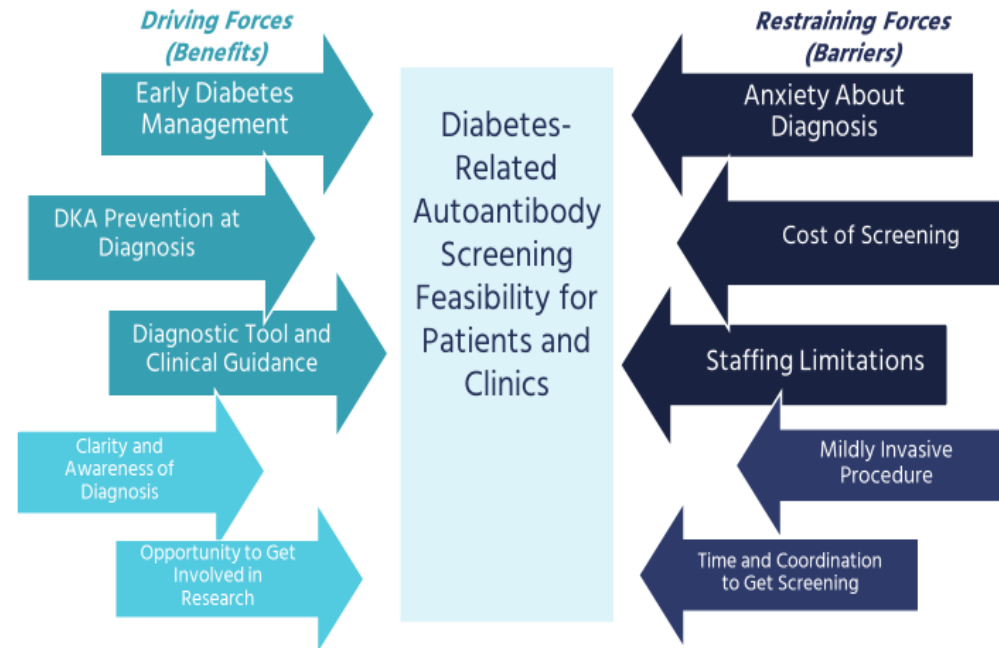
1. Telemedicine rate as of September 2021 was 20% higher than pre-pandemic levels.
2. Telemedicine visit decreased by 17% from September 2021 to September 2020.
3. Higher institution capacity for supporting telemedicine associated with higher telemedicine use.

Conclusion: A strong institution capacity which includes tested workflows, assigned staff, upload support and institutional goals are associated higher level of telemedicine use by diabetes centers.

Engage to share clinical perspectives

Understanding Providers' Readiness and Attitudes Toward Autoantibody Screening: A Mixed-Methods Study **FREE**

Emma Ospelt   ; Holly Hardison; Nicole Riales; Nudrat Noor; Ruth S. Weinstock; Kristina Cossen; Priyanka Mathias; Allison Smego; Nestoras Mathioudakis; Osagie Ebekozen; T1D Exchange Quality Improvement Collaborative



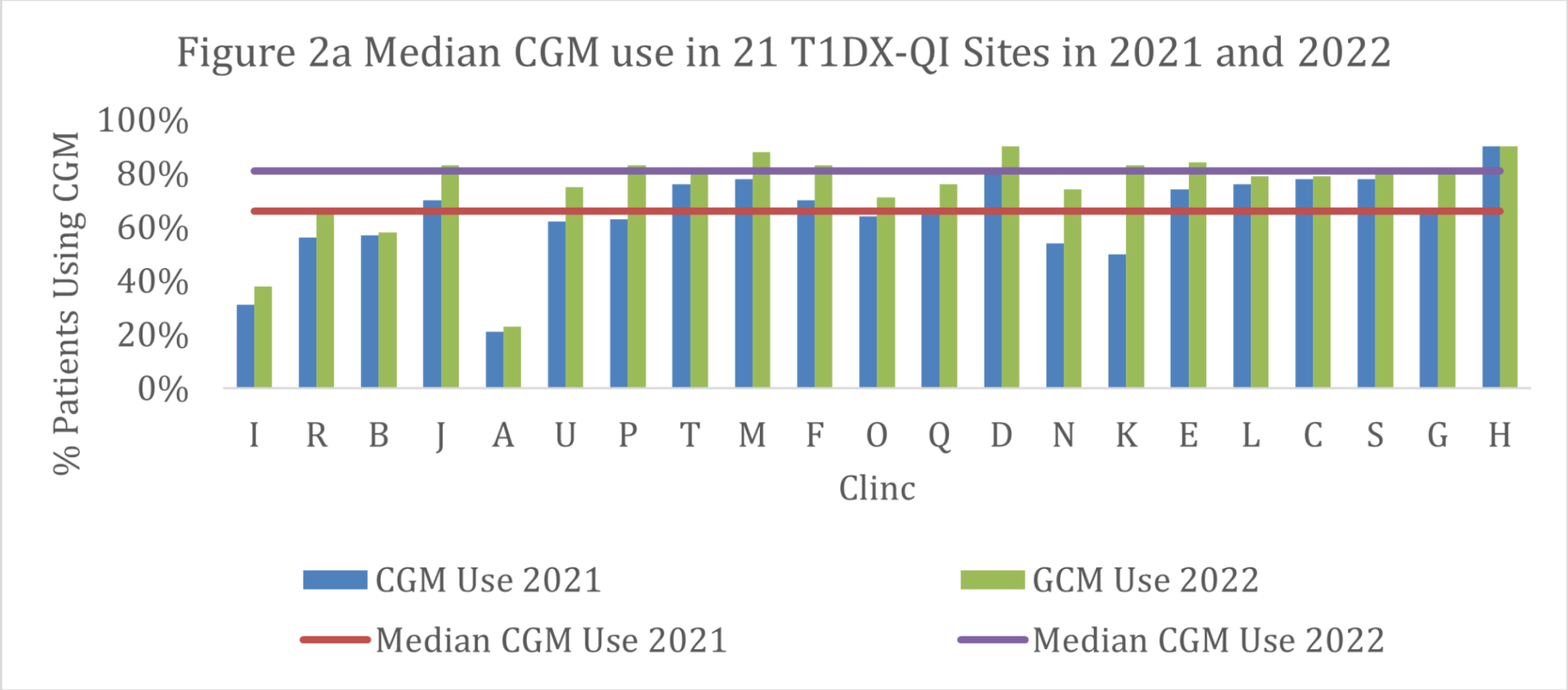
Engage to share routine clinical data

T1DX-QI centers contributing EMR PwT1D Data (N=82,138)

		<6 yrs	6-13 yrs	13-18 yrs	19-26 yrs	26-50 yrs	50-65 yrs	>65 yrs
N		2,618	14,902	30,829	18,026	9,917	3,823	2,023
Sex (Male)	42,078 (51)	1,380 (53)	7,441 (50)	16,371 (53)	9,364 (52)	4,757 (48)	1,817 (48)	948 (47)
Race/Eth								
NH White	51,065 (62)	1,599 (61)	8,929 (60)	18,872 (61)	11,700 (65)	6,021 (61)	2,439 (64)	1,505 (74)
NH Black	10,553 (13)	311 (12)	2,004 (13)	4,338 (14)	2,078 (12)	1,155 (12)	505 (13)	162 (8)
Hispanic	9,966 (12)	279 (11)	1,751 (12)	3,751 (12)	2,057 (11)	1,426 (14)	534 (14)	168 (8)
Asian	1,655 (2)	88 (3)	381 (3)	629 (2)	319 (2)	151 (2)	39 (1)	48 (2)
Other	8,899 (11)	341 (13)	1,837 (12)	3,239 (11)	1,872 (10)	1,164 (12)	306 (8)	140 (7)
Private Insurance	41,110 (50)	1,268 (48)	7,144 (48)	15,495 (50)	9,980 (55)	5,165 (52)	1,821 (48)	237 (12)
Mean HbA1c	8.2 (2)	8.1 (1.7)	8.1 (1.8)	8.5 (2.2)	8.3 (2)	7.5 (1.8)	7.6 (1.5)	7.2 (1.2)
CGM use*	36,204 (80)	1,470 (85)	8,973 (85)	14,694 (82)	5,325 (78)	3,598 (70)	1,436 (69)	708 (62)

^a Missing data; column totals may not add up to 100%; ^b Device information available on a subset of the population

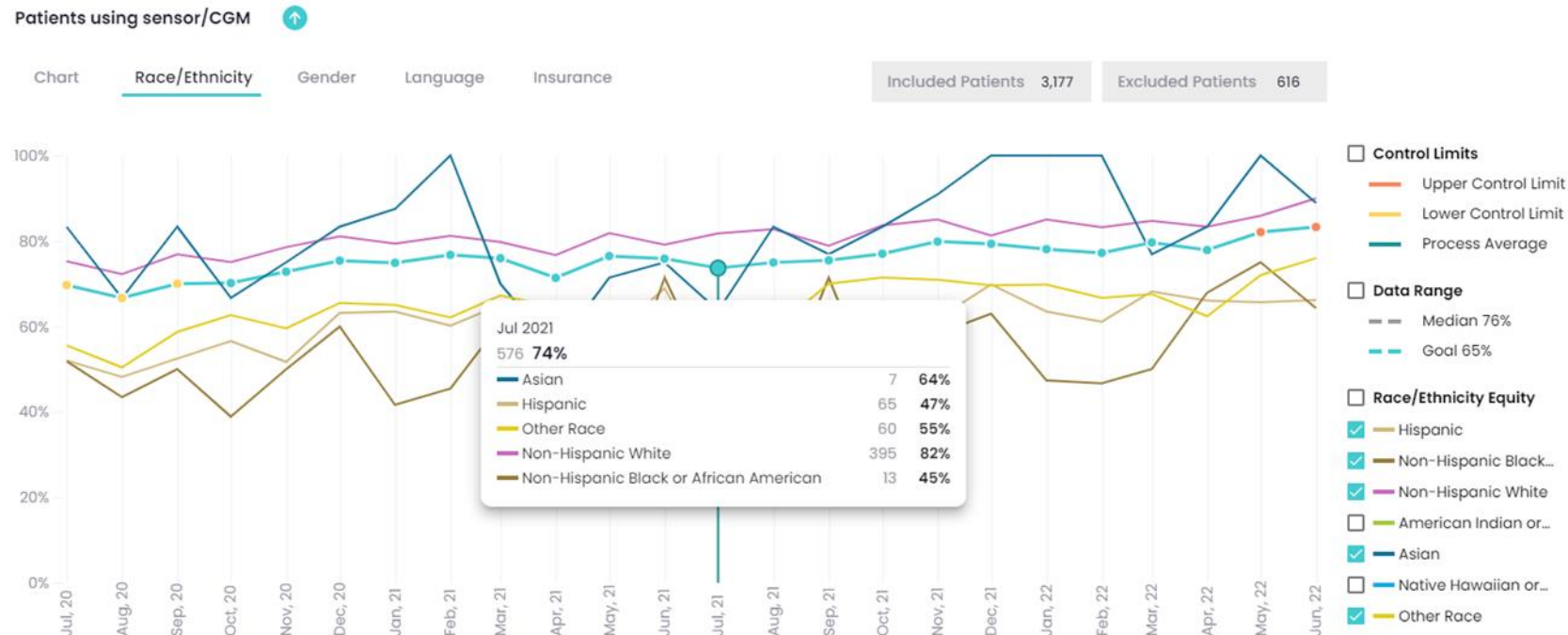
Engage with EMR Data for benchmarking to understand variations



Engage with EMR data for clinic specific data insights

Making Diabetes Electronic Medical Record Data Actionable: Promoting Benchmarking and Population Health Improvement Using the T1D Exchange Quality Improvement Portal

Ann Mungmode,¹ Nudrat Noor,¹ Ruth S. Weinstock,² Roberto Izquierdo,² Justin A. Indyk,³ Daniel J. DeSalvo,⁴ Sarah Corathers,⁵ Carla Demeterco-Berggen,⁶ Susan Hsieh,⁷ Laura M. Jacobsen,⁸ Allison Mekhoubad,⁹ Halis Kaan Akturk,¹⁰ Anton Wirsch,¹ Mary Lauren Scott,¹¹ Lily C. Chao,¹² Brian Miyazaki,¹² Faisal S. Malik,¹³ Osagie Ebekezien,^{1,14*} Mark Clements,^{15*} and G. Todd Alonso^{10*}



Engage with EMR data to understand real world associations

Example – technology use and outcomes

	MDI With CGM (N=4825)	MDI Without CGM (2796)	P
HbA1C, %	8.7 ± 2.1	9.2 ± 2.3	<0.001
Diabetic Ketoacidosis	396 (8)	316 (11)	<0.001
Severe hypoglycemia	137 (3)	115 (4)	0.003

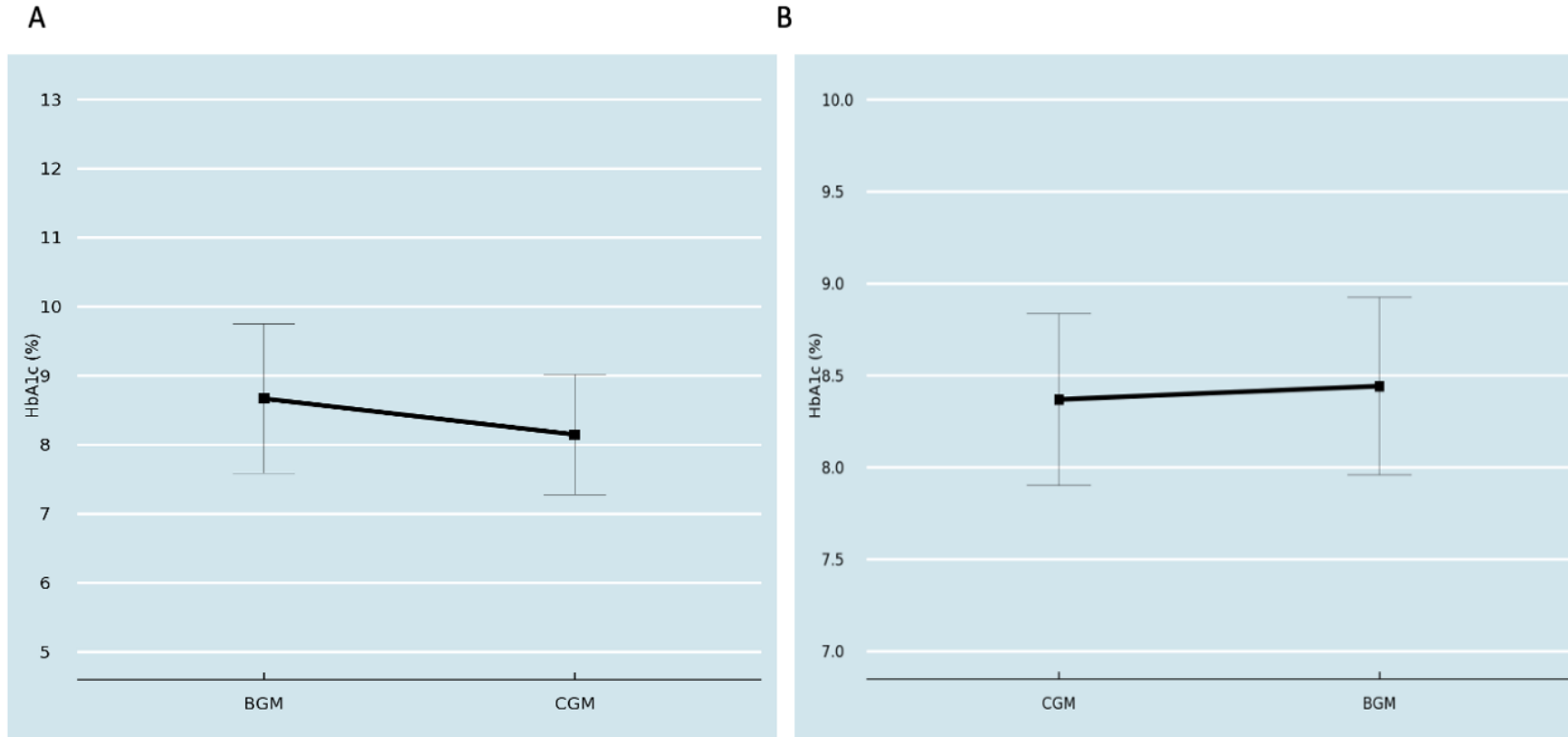
	Insulin Pump With CGM (N=11695)	Insulin Pump Without CGM (N=3127)	P
HbA1C, %	8.1 ± 1.7	8.6 ± 1.8	<0.001
Diabetic Ketoacidosis	556 (5)	322 (10)	<0.001
Severe hypoglycemia	180 (2)	76 (2)	0.004

Gandhi, K, Ebekozi, O, Noor, N, McDonough, R, Hsieh, S, Miyazaki, B, Dei-Tutu, Golden, L, Desimone, M, Hardison, H, Rompicherla, S, Akturk, H.K., Kamboj, M. Insulin Pump Utilization 2017-2021 for over 22,000 Children and Adult with Type 1 Diabetes: Multi-Center Observational Study. Clinical Diabetes 2023.



EMR data for real world population health studies

Example - Crossover Study on switching from CGM to Blood Glucose Monitoring (BGM)

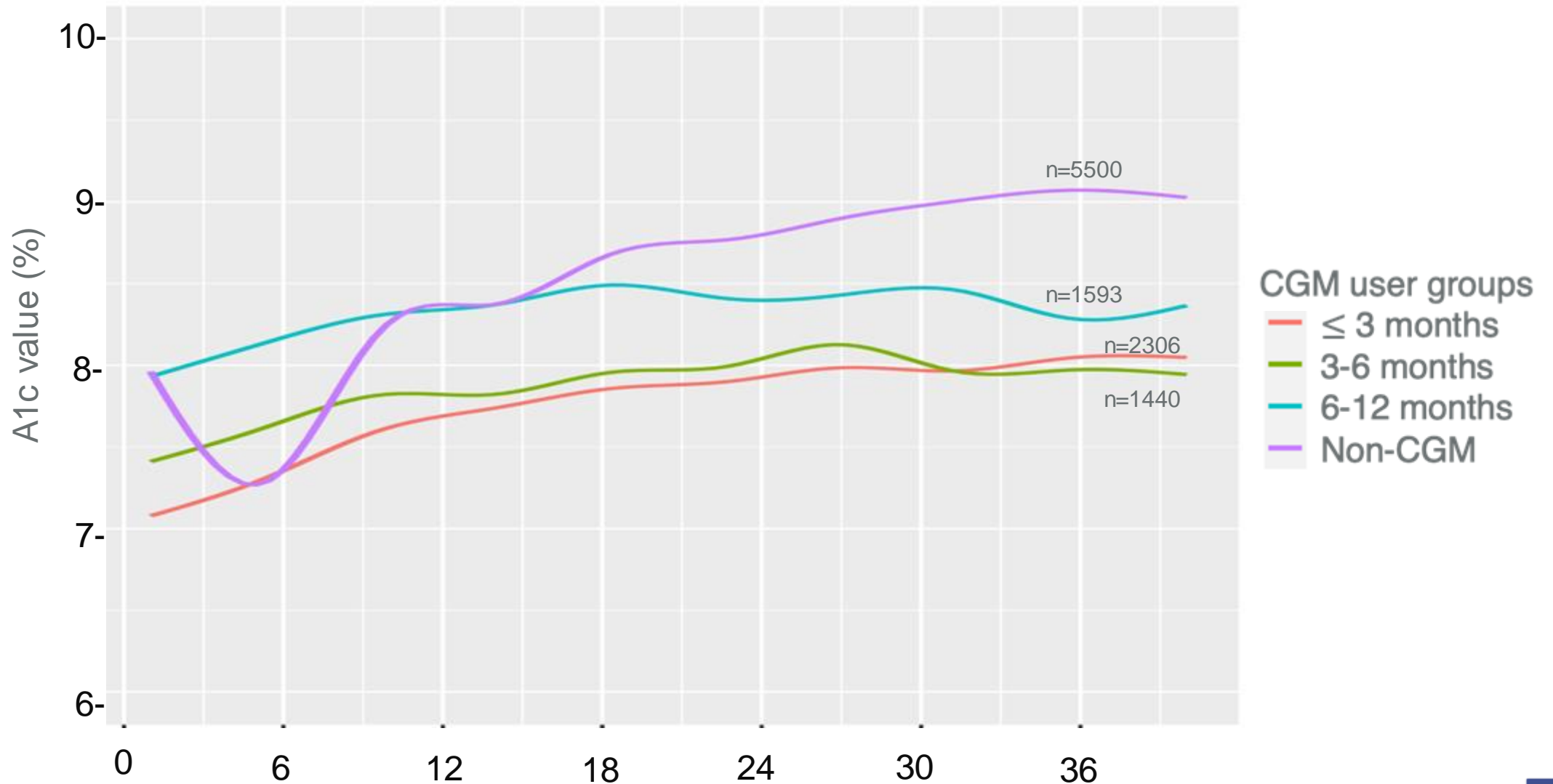


Nudrat Noor. An Observational Crossover Study of People Using Real-Time Continuous Glucose Monitors Versus Self-Monitoring of Blood Glucose: Real-World Evidence Using EMR Data From More Than 12,000 People With Type 1 Diabetes. Journal of Diabetes Science and Technology 2023



EMR data can support routine clinical changes

Ex - Beginning CGM early post diagnosis associated with better HbA1c



Unpublished data, presented at ADA Scientific Sessions 2023. Recipient of the ADA President Award 2023



EMR Data for benchmarking with other countries

Ex - CGM Use (%) across different regions for children less than 18 years.

Year	Czech Republic (CENDA)	German/Austria (DPV)	Australia (ADDN)	Denmark (DanDiab kids)	United States (T1DX-QI)
2018	49	60	54	57	26
2019	73	71	64	81	41
2020	84	79	71	90	52
2021	91	83	74	94	68
2022	93	86	74	95	79

Unpublished data, courtesy of respective networks.



The State of T1D is encouraging Inequities continue to exist, but gaps are reducing.

Achieving Equity in Diabetes Research: Borrowing From the Field of Quality Improvement Using a Practical Framework and Improvement Tools

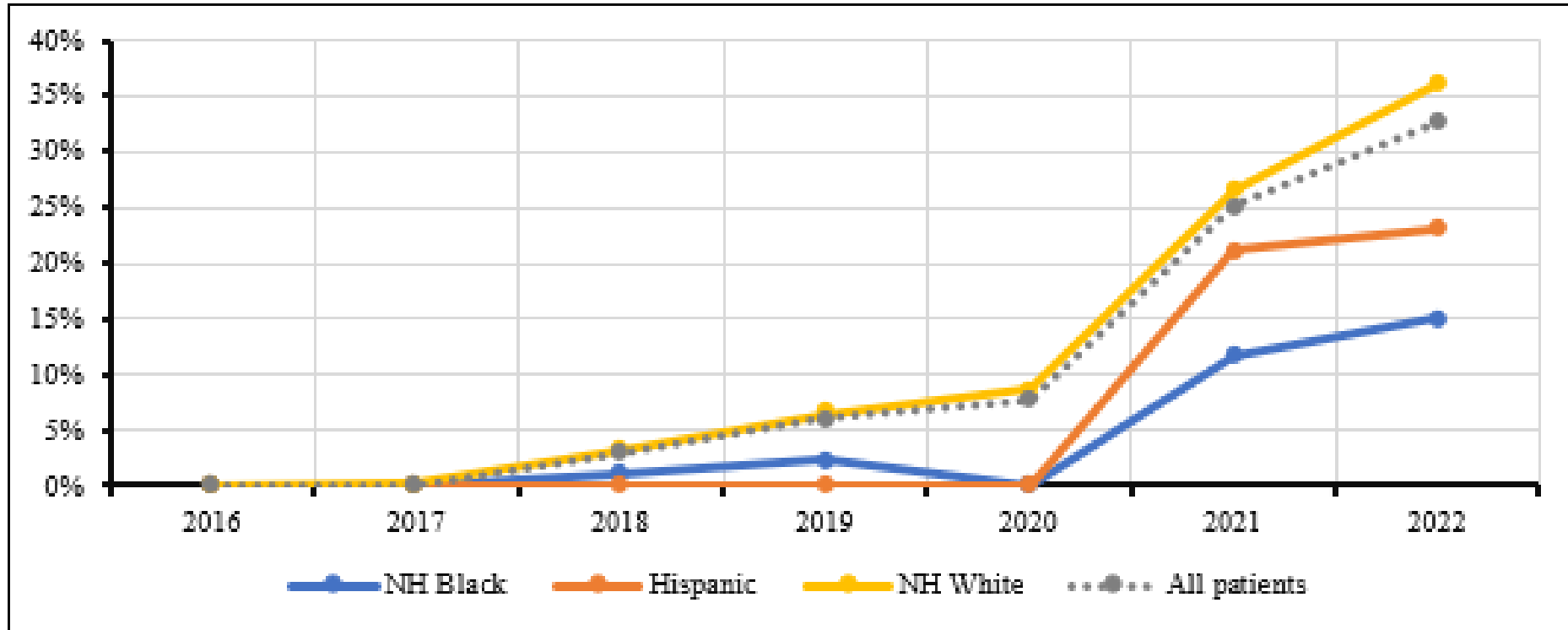
Osagie Ebeozien,^{1,2} Ann Mungmode,¹ Don Buckingham,³ Margaret Greenfield,⁴ Rashida Talib,⁵ Devin Steenkamp,⁶ J. Sonya Haw,⁷ Ori Odugbesan,¹ Michael Harris,⁸ Priyanka Mathias,⁹ Jane K. Dickinson,¹⁰ and Shivani Agarwal⁹

Addressing type 1 diabetes health inequities in the United States: Approaches from the T1D Exchange QI Collaborative

Osagie Ebeozien ✉, Ann Mungmode, Oriyomi Odugbesan, Shideh Majidi, Priya Prahalad, Nudrat Noor, Nicole Riales, Shivani Agarwal, Ruth S. Weinstock, Robert Rapaport, Manmohan Kamboj, T1DX-QI Collaborative

Inequities start early and persist without Intention efforts

C. Trends in HCLS Use



	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)
NH White	0	0	3	6	9	27	36
Hispanic	0	0	0	0	0	21	23
NH Black	0	0	1	2	0	12	15
All patients	0	0	3	6	8	25	33

Note: Percentages are calculated based on a subset of the population for whom HCLS data was available.



Race/Ethnicity and Insurance are independent contributors to glycemic outcomes

Table 3: Glycemic Outcomes After Propensity Score Matching

A. Among Minority vs. Non-Hispanic White PwT1D 2021/2022*			
	Minority (Non-Hispanic Black + Hispanic)	Non-Hispanic White	p-value
N	6607	6607	
Mean HbA1c (SD)	9.2 (2.5)	8.4 (1.9)	<0.001
Median HbA1c (IQR)	8.8 (3.5)	8.0 (2.4)	<0.001
HbA1c <7% [N (%)]	1257 (19)	1584 (24)	<0.001
HbA1c <8% [N (%)]	2314 (23)	3222 (32)	<0.001
HbA1c >9% [N (%)]	3048 (31)	1938 (19)	<0.001
Odds Ratio HbA1c <7% (95% CI)	Ref	1.34 (1.23, 1.45)	<0.001
B. Among Privately vs. Publicly Insured PwT1D 2021/2022 **			
	Publicly insured	Privately insured	p-value
N =	9948	9948	<0.001
Mean HbA1c (SD)	9 (2.3)	7.9 (1.7)	<0.001
Median HbA1c (IQR)	8.6 (3.1)	7.5 (2.0)	<0.001
HbA1c <7% [N (%)]	1918 (19)	3180 (32)	<0.001
HbA1c <8% [N (%)]	3778 (38)	6101 (61)	<0.001
HbA1c >9% [N (%)]	4129 (42)	2997 (29)	<0.001
Odds Ratio HbA1c <7% (95% CI)	Ref	1.96 (1.84, 2.09)	<0.001

*Matched for age (years), gender (female/male), insurance (public/private)

** Matched for age (years), gender (female/male), race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic)



Diabetes providers' implicit bias contributes to inequities.

- 2022 T1DX-QI published study with 109 providers
- 34% of cohort with implicit bias mediated by race/ethnicity
- 66% of cohort with implicit bias mediated by insurance

TABLE 3. UNADJUSTED ODDS RATIO FOR RACE/ETHNICITY-MEDIATED AND INSURANCE-MEDIATED PROVIDER BIAS

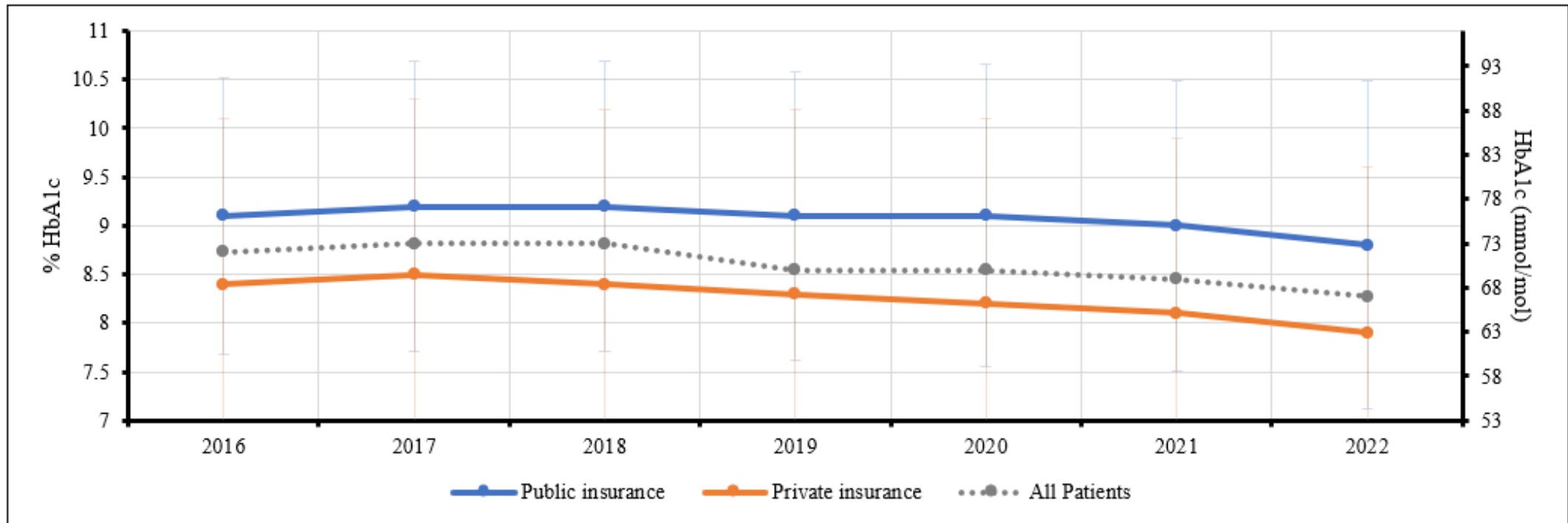
	<i>Insurance bias</i>	<i>P</i>	<i>Race/ethnicity bias</i>	<i>P</i>
Age	1.03 (0.99, 1.08)	0.06	0.99 (0.96, 1.04)	0.9
Race/ethnicity (NH White)	1.11 (0.48, 2.52)	0.8	0.76 (0.32, 1.79)	0.5
Clinic type (adult)	1.29 (0.56, 3.05)	0.5	1.09 (0.45, 2.53)	0.8
Practice years	1.08 (1.02, 1.16)	0.02[#]	1.00 (0.95, 1.06)	0.8
Recognize own bias (agree/strongly agree)	1.54 (0.66, 3.57)	0.3	5.25 (1.83, 19.01)	0.004[#]

[#]*P*-value <0.05.

Bold values indicate statistical significance.

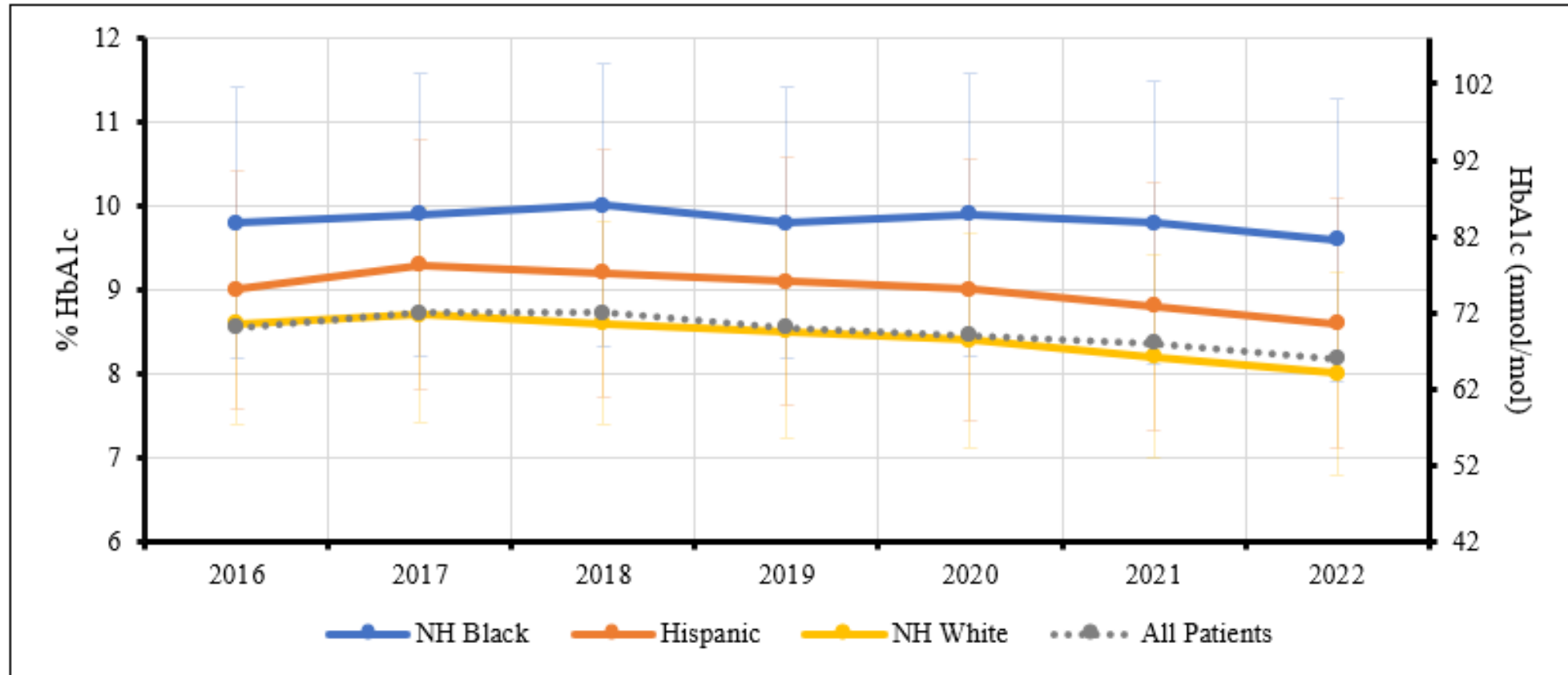
Improving HbA1c private and public insured PwT1D but inequities persist.

Supplemental Figure S4 HbA1c by Insurance Type



Improving HbA1c for all racial/ethnic group but inequities persist

Supplemental Figure S3: Trends in HbA1c by Race-Ethnicity 2016-2022



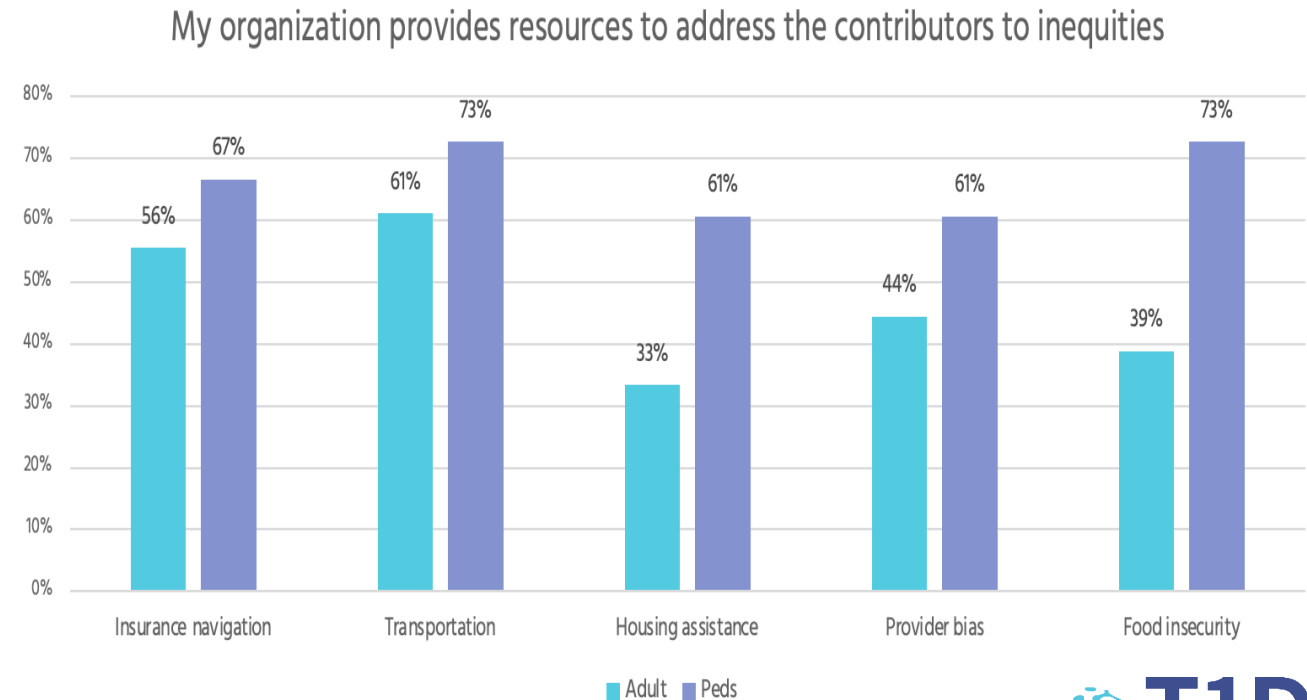
Expanding T1D Centers' Capacity to Address Inequities

Current Practices in Operationalizing and Addressing Racial Equity in the Provision of Type 1 Diabetes Care: Insights from the T1DX-QI Health Equity Advancement Lab

Ananta Addala, DO, MPH • Ann Mungmode, MPH • Emma Ospelt, MPH • Janine Sanchez, MD • Faisal Malik, MD, MSHS • Carla Demeterco-Berggren, MD, PhD • Ashley Butler, PhD • Colette Edwards, MD, MBA • Makaila Manukyan, MPP • Margarita Ochoa-Maya, MD • Margaret Zupa, MD • Osagie Ebekozen • [Show less](#)

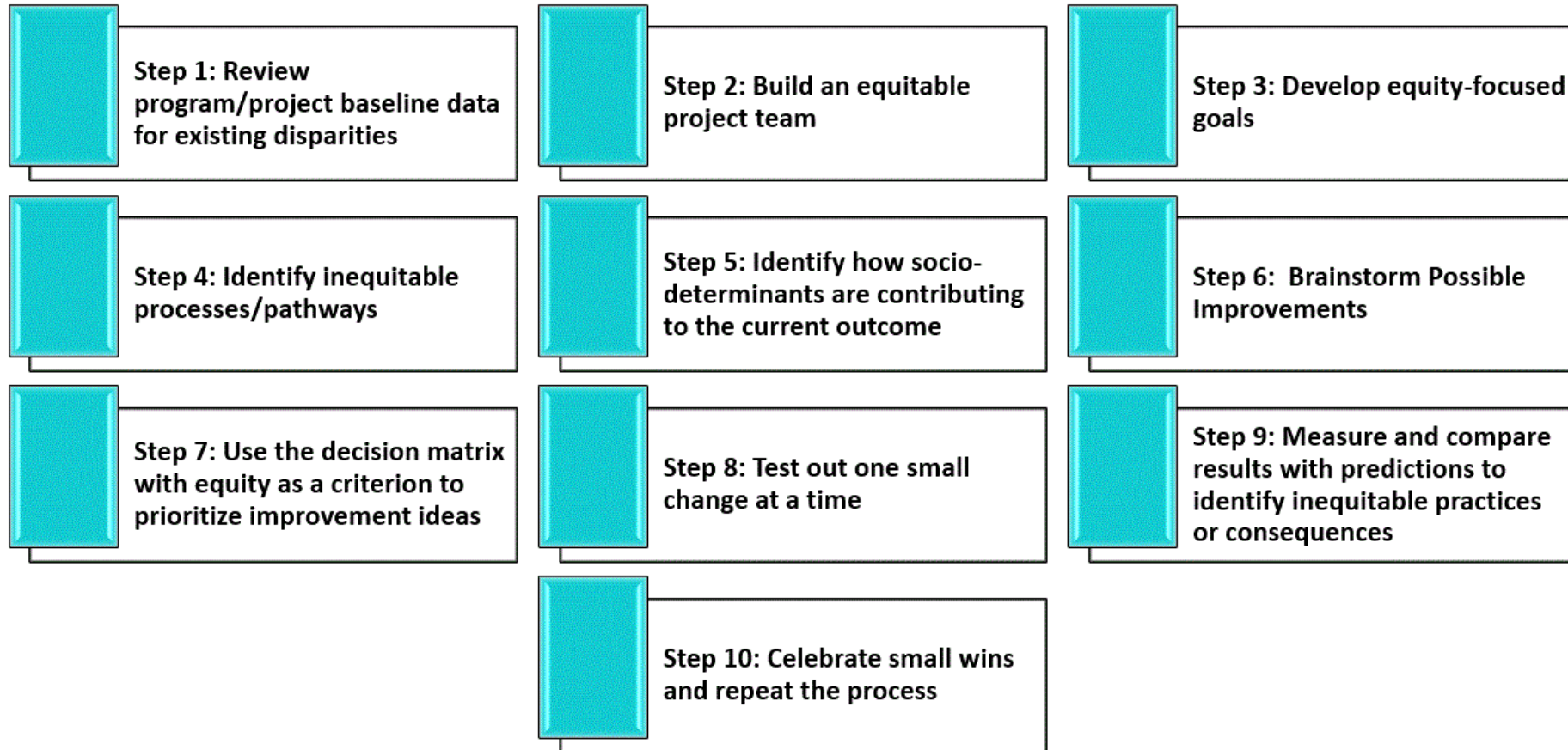


- T1DX-QI survey data demonstrate that a majority of pediatric and adult clinical centers have undertaken some level of institutional efforts to promote racial equity.
- Pediatric centers (as compared to Adult) were better equipped to address social determinants of health and broader health inequities from an institutional viewpoint.
- We propose a theoretical framework for institutional health equity grounded in the T1D Clinical leadership.



Strategies to reduce inequities and optimize outcomes

Figure 3: Equity Framework

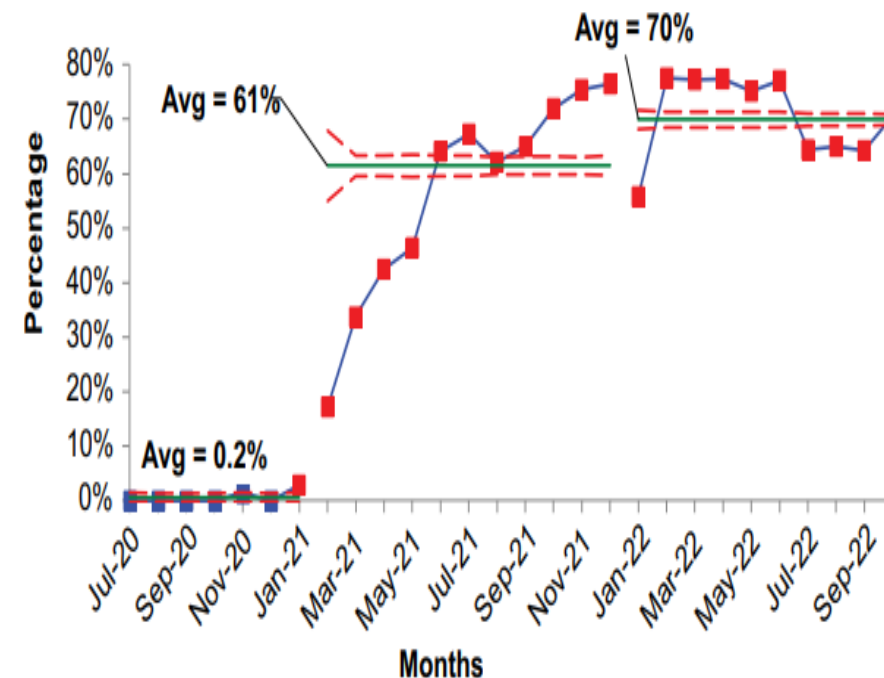


Improved screening for social determinants of health

Increasing Social Determinants of Health Screening Rates Among Six Endocrinology Centers Across the United States: Results From the T1D Exchange Quality Improvement Collaborative **FREE**




Ori Odugbesan ; Trevon Wright; Nana-Hawa Yayah Jones; Selorm Dei-Tutu; Mary Pat Gallagher; Emily DeWit; Roberto E. Izquierdo; Marisa Desimone; Nicole Rioles ; Osagie Ebekoziem ; T1D Exchange Quality Improvement Collaborative

- Social determinants of health (SDOH) are strongly associated with outcomes for people with type 1 diabetes.
- Six T1DX-QI centers used QI principles to test and expand interventions to improve SDOH screening rates.
- The interventions tested include staff training, a social risk index, an electronic health record patient-facing portal, partnerships with community organizations, and referrals to community resources.
- All centers were successful in improving SDOH screening rates by 70%.

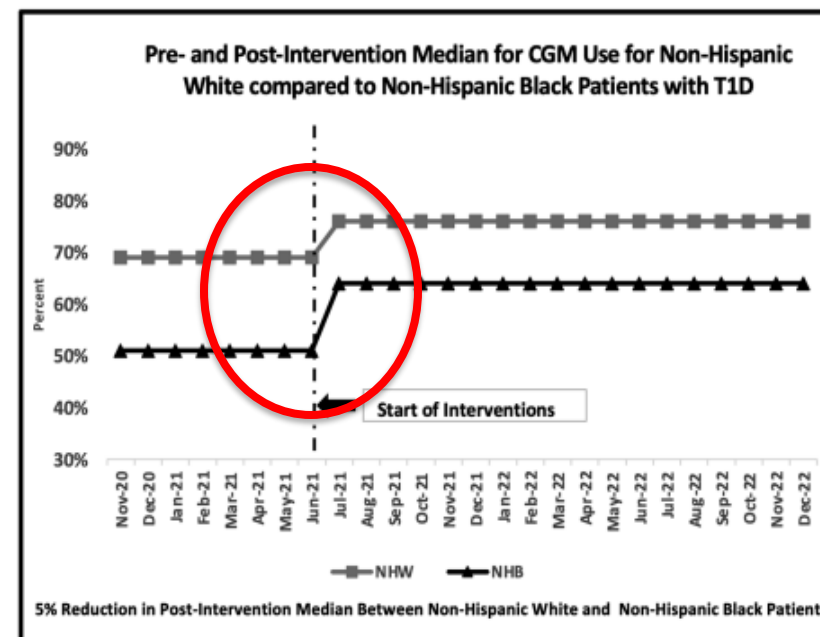
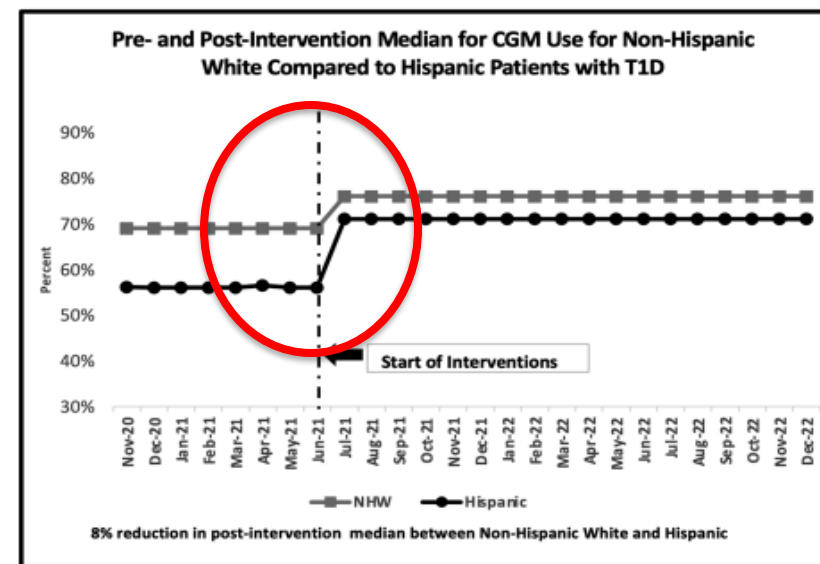


Reduced racial inequities in CGM Use

Increasing Continuous Glucose Monitoring Use for Non-Hispanic Black and Hispanic People With Type 1 Diabetes: Results From the T1D Exchange Quality Improvement Collaborative Equity Study **FREE**

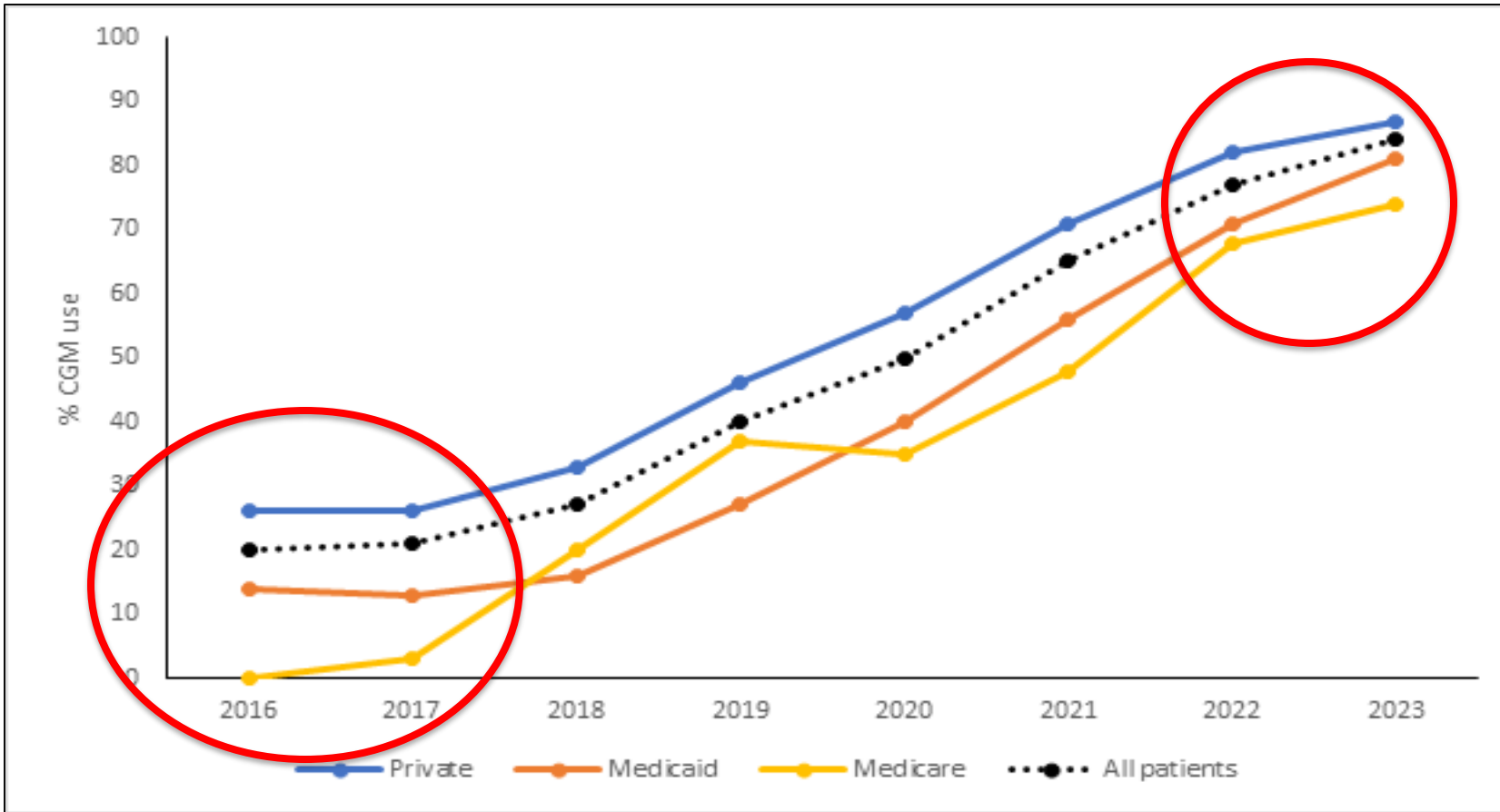
Ori Odugbesan ; Ann Mungmode ; Nicole Riales; Don Buckingham; Grace Nelson; Shivani Agarwal ; Amy Grant; Trevon Wright; Emilie Hess; Osagie Ebeozien; T1D Exchange Quality Improvement Collaborative

- The centers used rapid QI cycles to test and expand interventions such as bias training, screening for social determinants of health, and shared decision-making etc.
- After implementation of these interventions, median CGM use increased by 7% in non-Hispanic White, 12% in non-Hispanic Black, and 15% in Hispanic PwT1D.
- The gap between non-Hispanic White and non-Hispanic Black patients decreased by 5%.
- The gap between non-Hispanic White and Hispanic PwT1D decreased by 8%.



Trend in CGM Use by Insurance Type 2016 – 2023*

Inequities gap reducing

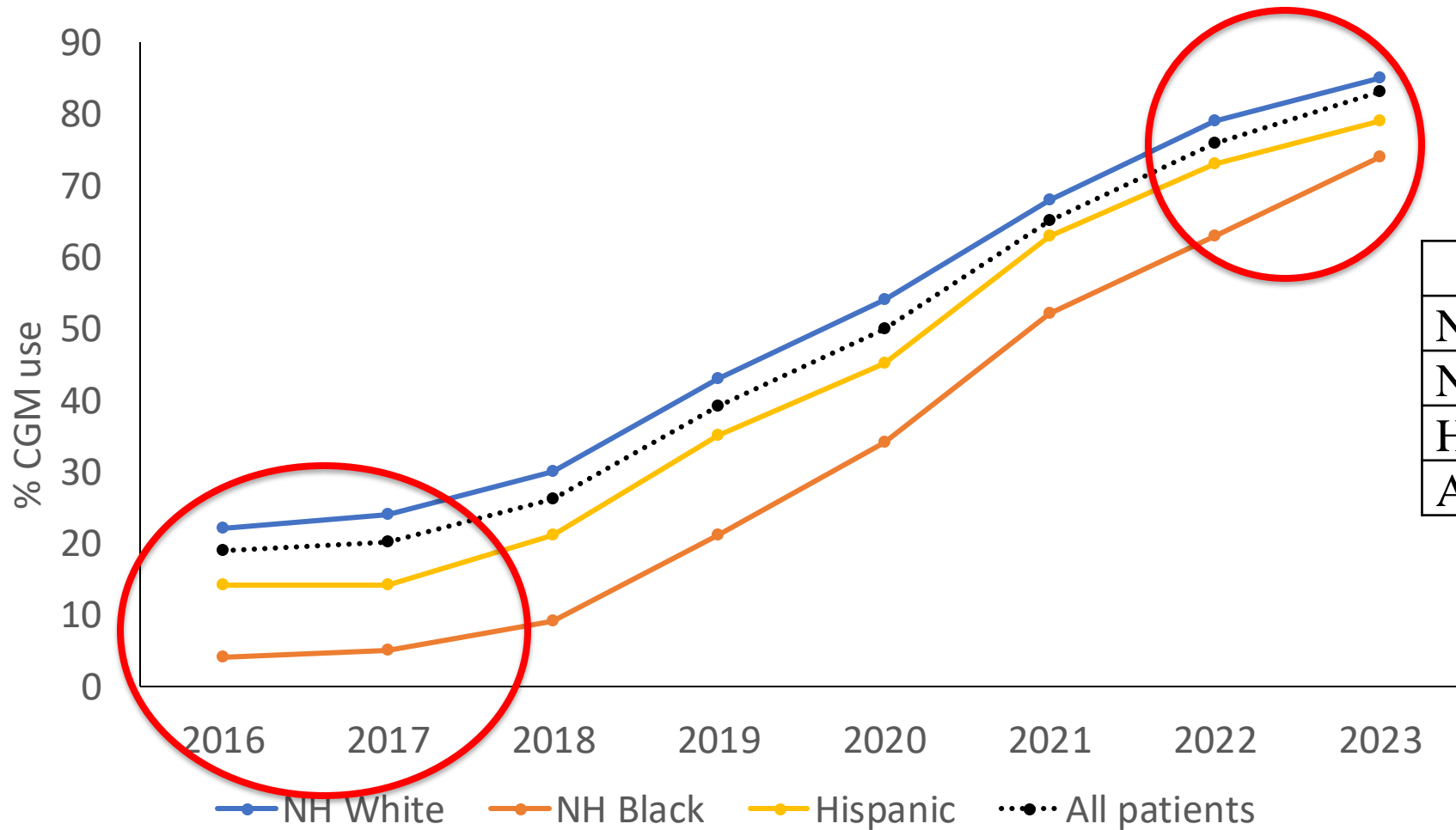


	2016 (%)	2023 (%)
Private	26	87
Medicaid	14	81
Medicare	0	74
All patients	20	84

Unpublished data, *2016 – October 2023

Trend in CGM Use by Race/Ethnicity 2016 – 2023*


Inequities gaps reducing



	2016 (%)	2023 (%)
NH White	22	85
NH Black	4	74
Hispanic	14	79
All patients	19	84

The State of T1D is exciting Outcomes are improving for everyone.

Longitudinal Trends in Glycemic Outcomes and Technology Use for Over 48,000 People with Type 1 Diabetes (2016-2022) from the T1D Exchange Quality Improvement Collaborative

Dr. Osagie Ebekoziem , Ms. Ann Mungmode, Dr. Janine Sanchez, Mr. Saketh Rompicherla, Dr. Carla Demeteroo Berggren, Dr. Ruth S. Weinstock, Dr. Laura Jacobsen, Dr. Georgia M. Davis, Dr. Alexis M McKee, Dr. Halis Kaan Akturk, Dr. David M Maahs, and Dr. Manmohan K Kamboj

Improving Outcomes for People with Type 1 Diabetes Through Collaboration Summary of Type 1 Diabetes Exchange Quality Improvement Collaborative Studies

Osagie Ebekoziem, MD, MPH, CPHQ^{a,b,*}, Ann Mungmode, MPH^a, Holly Hardison, BS^a, Robert Rapaport, MD^c



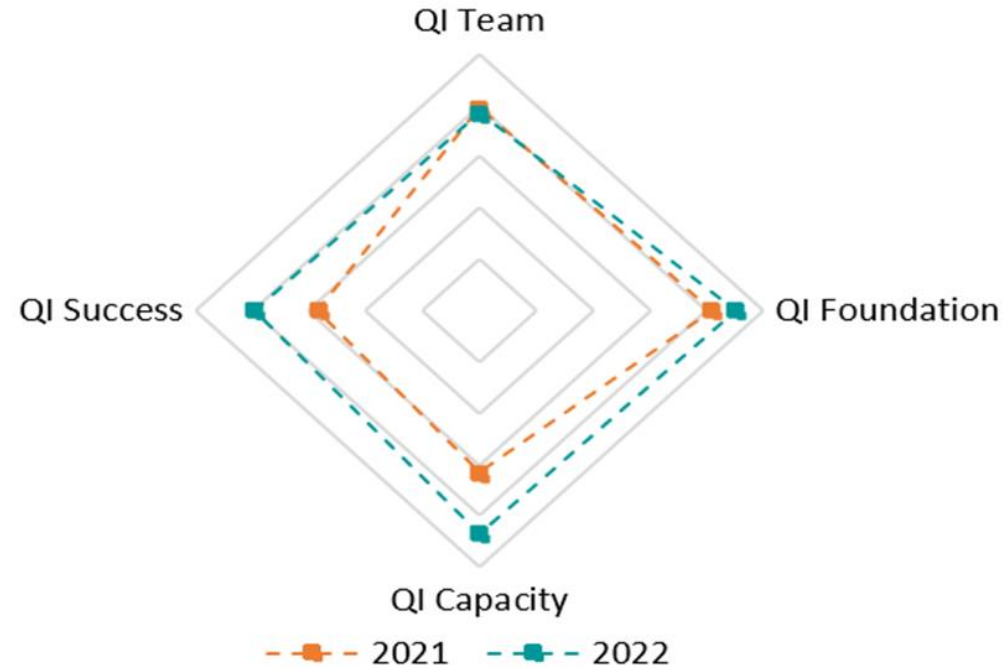
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T1DX-QI Centers increasing culture and capacity to drive improvement and practice transformation.



	2021	2022	Overall difference
QI Team	79	77	-2
QI Foundation	82	90	+8*
QI Capacity	63	87	+24*
QI Success	57	79	+22*
Overall QI Culture	70	84	+14*

Data are in %; * indicates p-value ≤ 0.05 .

Decrease in adjusted adverse outcomes

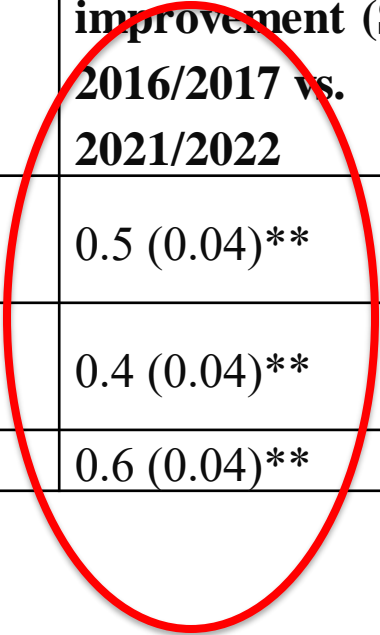
	2016/2017	2022/2023	P-value
N	18302	34549	
DKA events per 100 person years	1.82	1.45	<0.001
SH events per 100 person years	0.4	0.34	0.2

Improvement in HbA1c across all age groups

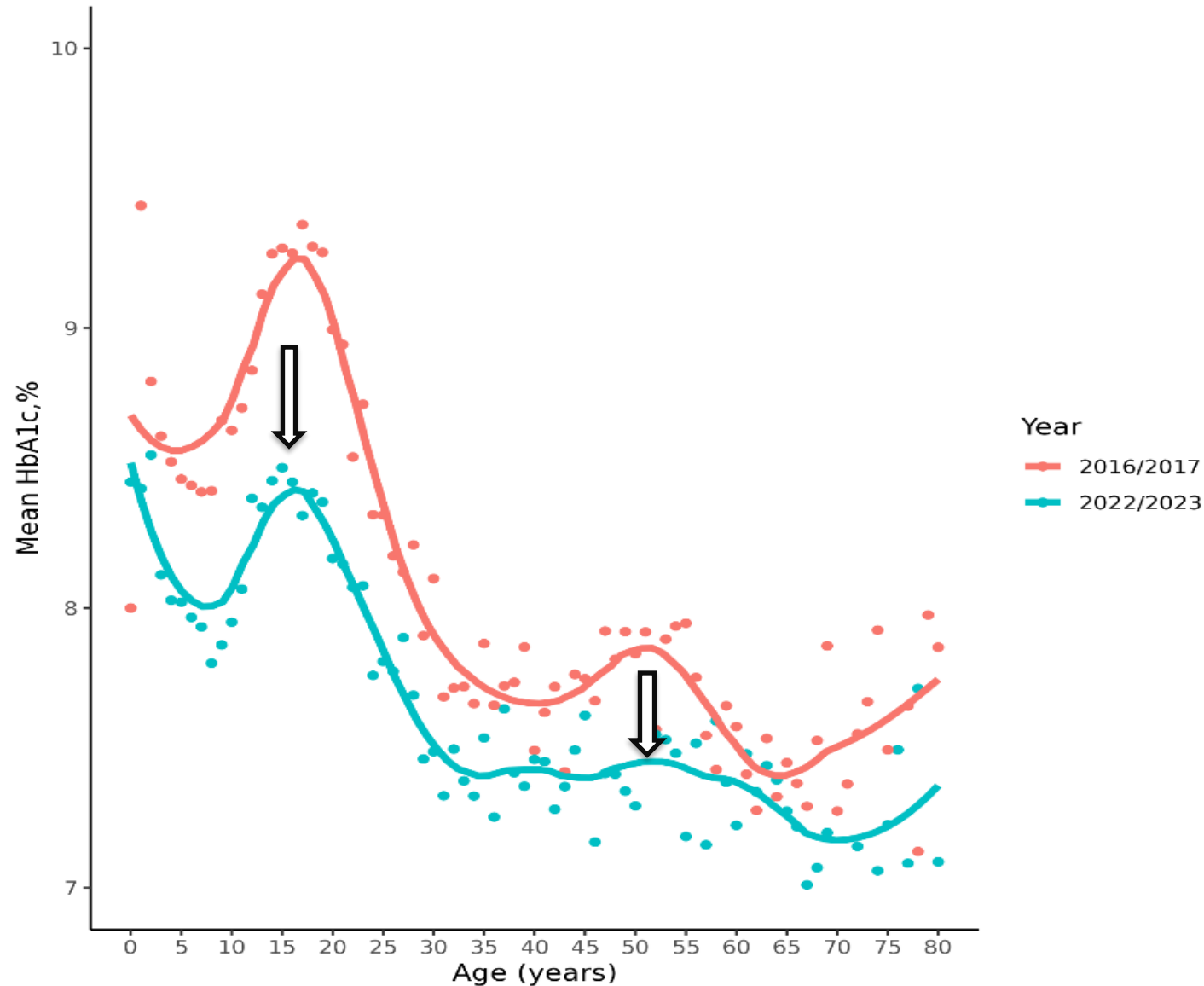
B. Mean differences in HbA1c by Age and Insurance								
	Public Insurance				Private Insurance			
Age Group	Mean HbA1c (SD) 2016/2017	Mean HbA1c (SD) 2021/2022	Difference (SE)	P-value	Mean HbA1c (SD) 2016/2017	Mean HbA1c (SD) 2021/2022	Difference (SE)	P-value
1 to 15 years	9.1 (2.0)	8.9 (2.2)	0.2 (0.01)	<0.001	8.5 (1.7)	8.0 (1.7)	0.5 (0.02)	<0.001
16 to 25 years	9.6 (2.4)	9.1 (2.4)	0.5 (0.01)	<0.001	8.8 (2.0)	8.3 (1.9)	0.5 (0.01)	<0.001
26 to 40 years	8.9 (2.0)	8.4 (1.9)	0.5 (0.01)	<0.001	7.6 (1.5)	7.3 (1.5)	0.3 (0.01)	<0.001
40+ years	8.1 (1.6)	7.8 (1.7)	0.3 (0.02)	<0.001	7.6 (1.2)	7.3 (1.2)	0.3 (0.01)	<0.001

Improvement in Outcomes across all race/ethnic group

A. Adjusted for Age, Gender, Duration of Diabetes, Insurance, Technology (CGM, pump, or HCLS) use			
Race/Ethnicity	2016/2017 Adjusted Mean [95% CI]	2021/2022 Adjusted Mean [95% CI]	Mean improvement (SE) 2016/2017 vs. 2021/2022
Non-Hispanic White	8.7 [8.7-8.8]	8.2 [8.2-8.5]	0.5 (0.04)**
Non-Hispanic Black	9.9 [9.8-9.9]	9.5 [9.3-9.5]	0.4 (0.04)**
Hispanic	9.2 [9.1-9.4]	8.6 [8.4-8.7]	0.6 (0.04)**



Meaningful and Significant Improvement across the life span



	16/17	22/23
N	49537	49537
Mean HbA1c (SD)	8.7 (2.1)	8.2 (2.0)
% with HbA1c <7% [N (%)]	6161 (18)	15130 (30)
% with HbA1c >9% [N (%)]	12064 (35)	12665 (26)
P-value		<0.01

Ebekozien O. Improving Outcomes for people with diabetes through collaboration. Endo Clinics 2023

Ebekozien O. Longitudinal Trends in Glycemic Outcomes and Technology Use for Over 48,000 People with Type 1 diabetes (2016-2022) from the T1D Exchange Quality Improvement Collaborative. Diabetes Technology and Therapeutics 2023



Type 1 Diabetes in 2023 is...

- **Engaging:** QI collaboration is supporting culture change!
- **Encouraging:** Inequities persists but gaps are reducing!
- **Exciting:** Outcomes are improving for everyone!

Thank you PwT1D, Helmsley Charitable Trust, JDRF, Industry Partners, T1DX-QI Sites, leaders, team members, Committee Leaders, T1DX Staff



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