

Supplementary Online Content

Venkatraman S, Echouffo-Tcheugui JB, Selvin E, Fang M. Trends and disparities in glycemic control and severe hyperglycemia among US adults with diabetes using insulin, 1988-2020. *JAMA Netw Open*. 2022;5(12):e2247656. doi:10.1001/jamanetworkopen.2022.47656

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1: Trends in Insulin Use Among US Adults With Diabetes, NHANES 1988-2020

Percentage	1988-1994	1999-2004	2005-2012	2013-2020	P-Trend
Overall % (Weighted)	30.5%	25.7%	29.2%	28.2%	0.81
Unweighted Number	475	388	755	864	

eTable 2: Trends in Glycemic Control (HbA_{1c} <7%) and Severe Hyperglycemia (HbA_{1c} >10%) Among Adults With Diabetes Using Insulin, NHANES 1988-2020

Glycemic Control (A1c<7%)				
Characteristics	1988-1994 % (95% CI)	1999-2004 % (95% CI)	2005-2012 % (95% CI)	2013-2020 % (95% CI)
Overall	29.2 (22.6–36.8)	28.0 (21.5–35.7)	30.4 (26.1–35.1)	27.5 (21.7–34.2)
Race/Ethnicity				
Mexican American	25.1 (17.2–35.1)	23.9 (14.0–37.8)	20.7 (12.2–32.9)	9.9 (5.4–17.4)
Non-Hispanic Black	31.8 (21.9–43.6)	25.4 (18.6–33.6)	30.4 (22.7–39.4)	22.9 (16.6–30.7)
Non-Hispanic White	27.7 (19.9–37.1)	30.3 (21.0–41.5)	32.3 (26.9–38.1)	32.9 (24.3–42.8)
Education				
High School or less	28.5 (21.2–37.1)	25.3(17.3–35.5)	29.8 (24.8–35.4)	22.9 (15.3–32.9)
Some College	25.6 (7.8–58.5)	31.4 (19.1–46.9)	29.5 (21.5–38.9)	31.2 (22.2–41.9)
College Graduate or Above	39.9 (19.3–64.8)	34.4 (17.3–56.7)	33.5 (22.4–46.8)	33.9 (23.2–46.5)
Income-Poverty Ratio				
<130%	27.4 (17.8–39.7)	24.7 (13.8–40.2)	32.1 (25.3–39.6)	26.4 (18.3–36.5)
130-349%	34.5 (24.3–46.4)	33.9 (24.9–44.2)	28.7 (21.9–36.7)	24.3 (16.4–34.5)
≥350%	23.2 (12.7–38.6)	24.4 (13.5–39.9)	30.9 (24.3–38.5)	30.9 (21.6–42.0)
Insurance Status				
Uninsured	30.5 (8.8–66.4)	24.4 (8.4–53.3)	13.6 (7.4–23.7)	18.1 (6.2–42.4)
Private Insurance	29.7 (21.6–39.3)	29.3 (20.1–40.6)	31.6 (25.8–38.1)	25.8 (17.8–35.8)
Public/Other Insurance	27.2 (17.9–39.0)	26.8 (17.6–38.7)	33.5 (26.3–41.5)	30.8 (24.4–38.3)
Severe Hyperglycemia (A1c>10%)				
Characteristics	1988-1994 % (95% CI)	1999-2004 % (95% CI)	2005-2012 % (95% CI)	2013-2020 % (95% CI)
Overall	18.2 (13.0–24.8)	14.0 (8.9–21.4)	14.6 (10.8–19.6)	14.6 (12.0–17.5)
Race/Ethnicity				
Mexican American	21.0 (12.0–34.2)	13.6 (7.1–24.7)	22.4 (15.0–32.1)	23.9 (13.6–38.7)
Non-Hispanic Black	24.1 (15.7–35.0)	19.6 (12.0–30.4)	20.3 (15.5–26.2)	22.7 (17.4–29.0)
Non-Hispanic White	13.3 (7.2–23.2)	10.2 (4.6–20.9)	7.2 (4.0–12.7)	9.1 (6.0–13.7)
Education				
High School or less	17.1 (10.6–26.5)	13.9 (7.0–25.5)	10.2 (7.3–14.0)	15.1 (11.8–19.3)
Some College	18.3 (5.7–45.3)	15.2 (5.5–35.7)	12.7 (7.1–21.6)	21.5 (8.8–17.6)
College Graduate or Above	14.6 (4.4–39.0)	6.4 (1.6–21.9)	14.9 (7.5–27.5)	11.9 (5.5–23.9)
Income-Poverty Ratio				
<130%	30.5 (16.8–48.9)	18.0 (9.8–30.9)	14.7 (10.9–19.5)	23.4 (18.1–29.7)
130-349%	13.3 (6.8–24.4)	10.9 (5.3–21.0)	12.7 (7.8–20.0)	13.8 (9.0–20.6)
≥350%	8.8 (3.8–19.0)	11.8 (4.4–28.0)	9.2 (4.9–16.8)	7.0 (3.7–13.0)
Insurance Status				
Uninsured	53.9 (22.6–82.4)	36.7 (13.6–68.1)	26.4 (15.1–41.8)	39.7 (24.5–57.2)
Private Insurance	12.3 (7.2–20.3)	10.7 (5.6–19.5)	7.7 (4.8–12.1)	11.6 (8.4–15.8)
Public/Other Insurance	16.6 (8.5–30.0)	10.9 (5.0–22.2)	14.8 (9.4–22.4)	13.7 (10.0–18.5)

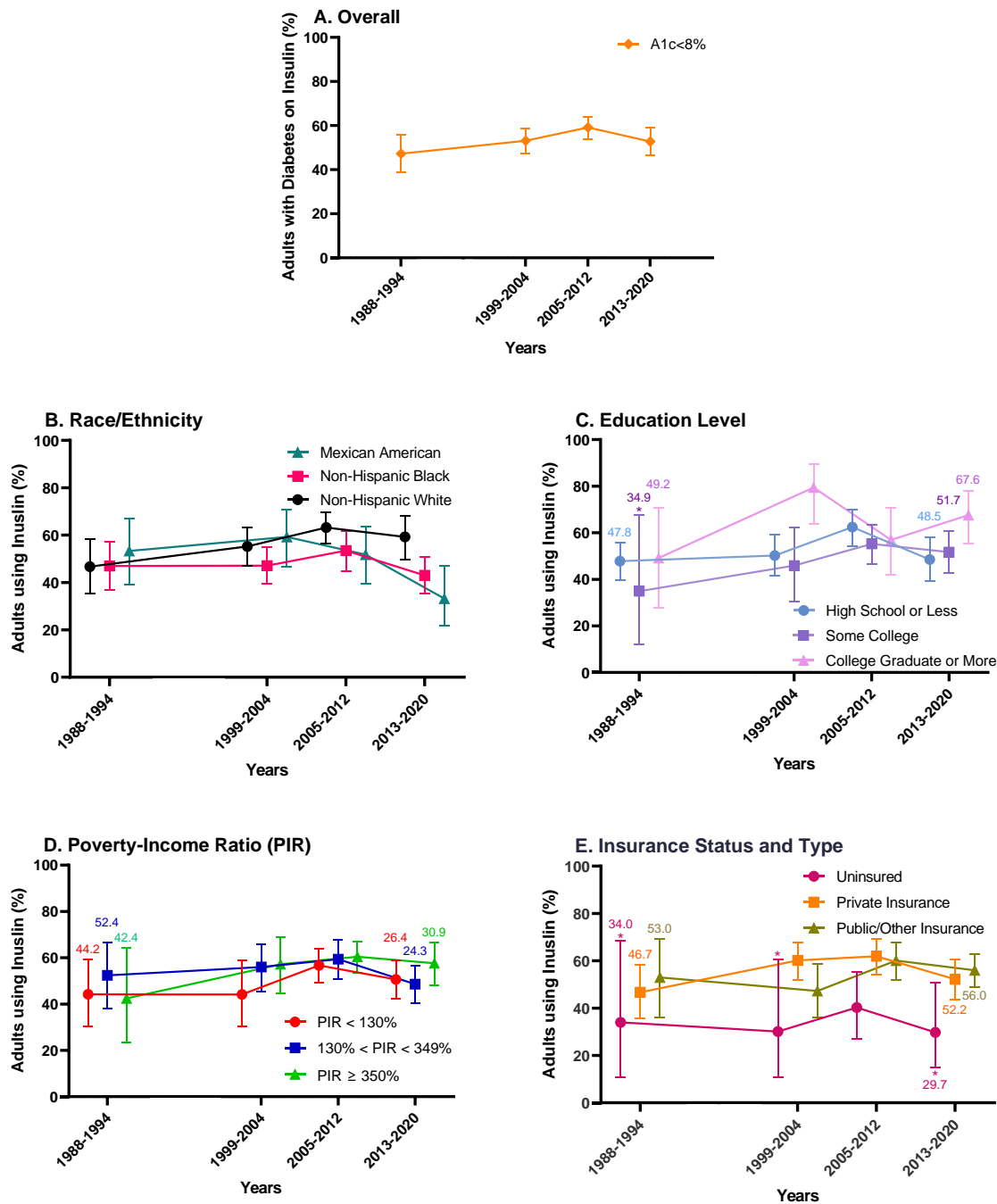
eTable 3: Glycemic Control Among Adults With Diabetes Using Insulin, Unadjusted and Age-adjusted Based on Age Cutoff Recommendations.

Prevalence	1988-1994	1999-2004	2005-2012	2013-2020	P-Trend
Unadjusted	29.2 (22.6–36.8)	28.0 (21.5–35.7)	30.4 (26.1–35.1)	27.5 (21.7–34.2)	0.87
Age-adjusted	29.2 (22.7–36.7)	28.3 (21.9–35.6)	30.8 (26.4–35.4)	27.4 (21.5–34.2)	0.92
Age-specific cutoff at 75 years ^a	30.8 (24.0–38.6)	28.7 (22.4–36.0)	34.6 (30.2–39.2)	31.7 (25.9–38.2)	0.39
Age-specific cutoff at 65 and 75 years ^b	35.3 (27.7–43.8)	30.7 (24.5–37.7)	38.4 (33.7–43.2)	36.4 (30.1–43.3)	0.35

^a Age-specific A1c goals specified by the ADA 2022 Standard of Care of <7% (53 mmol/mol) for nonpregnant adults and <8% (64 mmol/mol) for patients with “limited life expectancy”. This was chosen to be an age of 75 years in other literature and for our study.

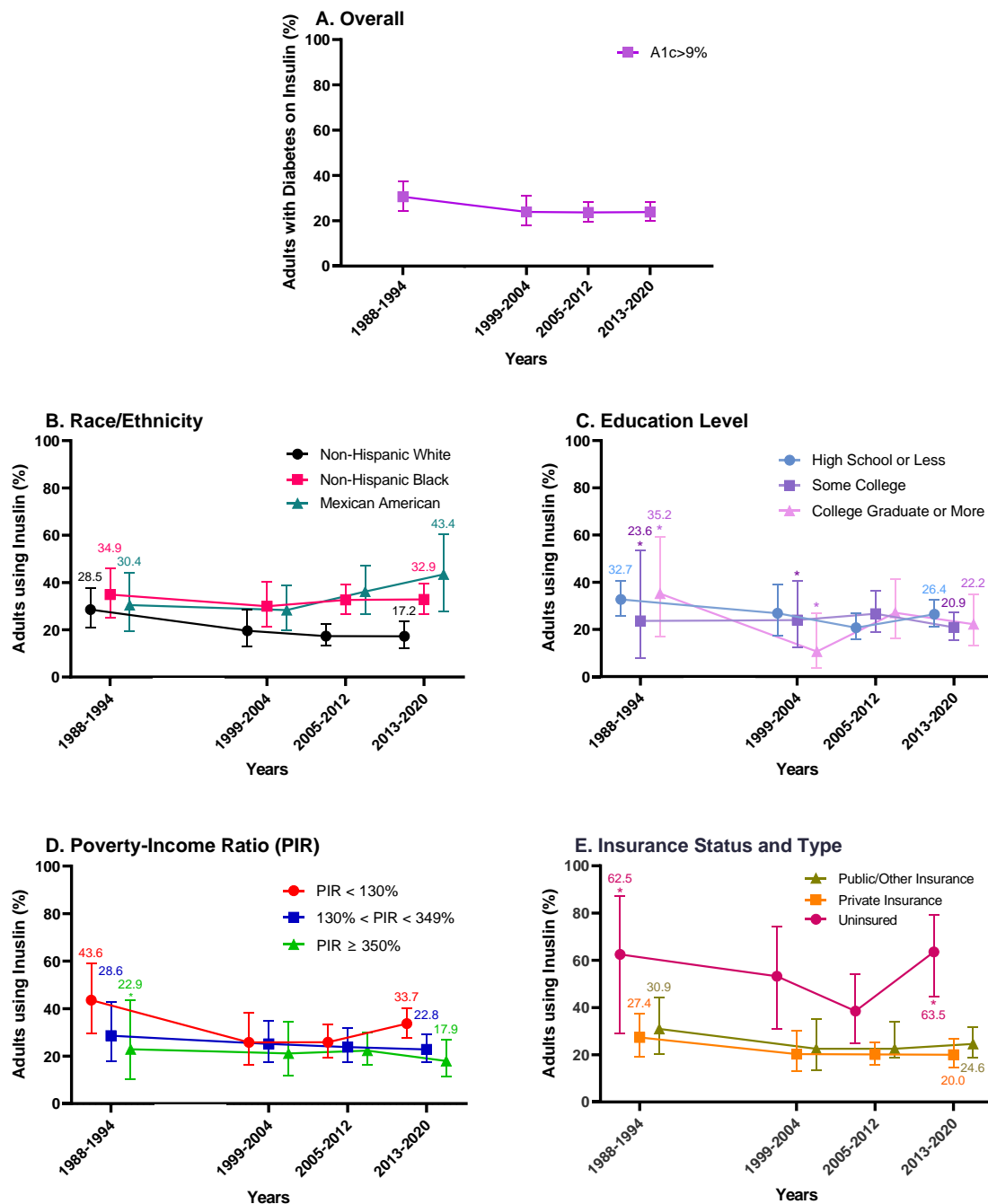
^b Age-specific A1c goal of <7% (53 mmol/mol) for nonpregnant adults younger than 65 years, a goal of <7.5% (58 mmol/mol) for adults aged 65-74 years, and a goal of <8% (64 mmol/mol) for adults aged 75 years and older.

eFigure 1: Trends in Glycemic Control (HbA_{1c} <8%) Among Adults With Diabetes Using Insulin, (A) Overall, (B) Race/Ethnicity, (C) Education, (D) Poverty-Income Ratio, (E) Insurance status, the National Health and Nutrition Examination Survey, 1988 to 2020, N = 2,482^a



^a Adults who responded “Other” were excluded in the race/ethnicity analysis but were included for all other subgroups.

eFigure 2: Trends in Glycemic Control (HbA_{1c} >9%) Among Adults With Diabetes Using Insulin, (A) Overall, (B) Race/Ethnicity, (C) Education, (D) Poverty-Income Ratio, (E) Insurance status, the National Health and Nutrition Examination Survey, 1988 to 2020, N = 2,482^a



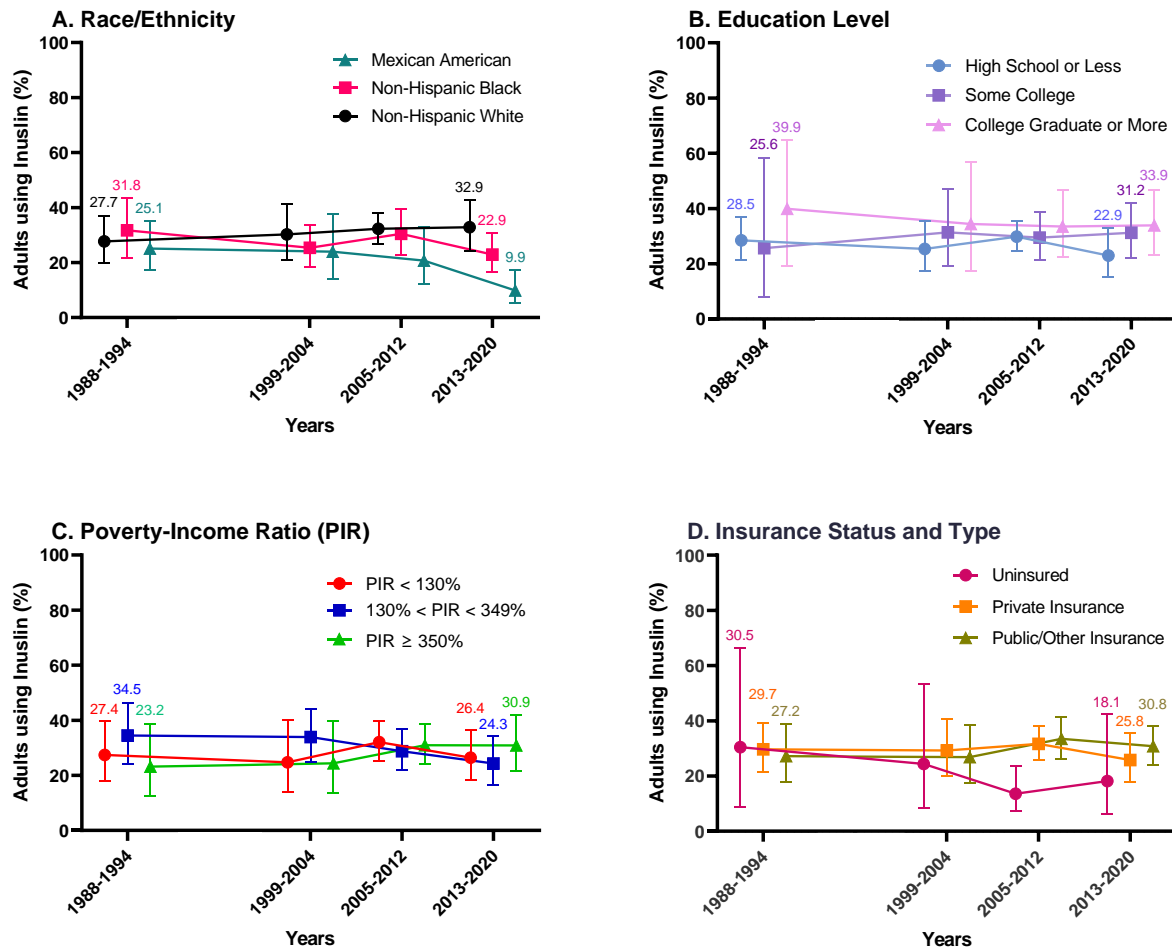
^a Adults who responded “Other” were excluded in the race/ethnicity analysis but were included for all other subgroups.

eTable 4: Characteristics of Adults Diagnosed With Type 2 Diabetes Using Insulin, National Health and Nutrition Examination Survey, 1988-2020, N = 2,386^a

Characteristics	1988-1994 (n= 458)	1999-2004 (n= 374)	2005-2012 (n= 716)	2013-2020 (n= 838)
Mean Age	63.1 (60.8–65.5)	60.5 (58.3–62.7)	60.8 (59.4–62.2)	61.7 (60.2–63.1)
Age Categories				
20 to 49	15.8 (9.1–25.9)	19.7 (14.2–26.5)	19.2 (15.3–23.8)	18.5 (15.1–22.3)
50 to 64	32.7 (26.9–39.1)	34.9 (28.5–42.0)	39.6 (35.2–44.1)	36.3 (31.9–41.0)
≥65	51.5 (44.2–58.8)	45.3 (38.4–52.4)	41.2 (36.8–45.8)	45.2 (40.0–50.6)
Sex				
Male	36.2 (29.0–44.0)	45.3 (38.3–52.4)	51.2 (46.8–55.6)	53.9 (48.2–59.4)
Female	63.8 (56.0–71.0)	54.7 (47.6–61.7)	48.8 (44.4–53.2)	46.1 (40.6–51.8)
Race/Ethnicity				
Mexican American	4.7 (3.6–6.3)	5.3 (3.3–8.4)	7.0 (4.4–10.8)	9.2 (6.8–12.3)
Non-Hispanic Black	23.1 (18.3–28.8)	20.2 (13.7–28.8)	20.4 (16.4–25.1)	15.3 (12.1–19.1)
Non-Hispanic White	68.8 (62.3–74.6)	64.2 (55.8–71.9)	63.3 (57.0–69.3)	62.3 (56.7–67.6)
Body Mass Index (BMI)				
Mean BMI (kg/m ²)	30.7 (29.6–31.8)	32.7 (31.5–34.0)	34.5 (33.7–35.3)	33.7 (32.9–34.4)
<25	20.6 (14.2–29.0)	15.1 (10.0–22.2)	8.5 (6.4–11.1)	8.1 (6.0–10.7)
25-29	36.6 (28.7–45.2)	20.9 (17.0–25.5)	19.6 (15.8–24.0)	23.5 (18.9–28.9)
>30	42.8 (35.5–50.5)	64.0 (57.3–70.1)	71.9 (67.3–76.1)	68.4 (62.8–73.5)
Education				
College or Above	81.3 (73.0–87.5)	65.2 (58.8–71.2)	52.3 (46.4–58.1)	52.4 (47.6–57.2)
Some College	10.3 (5.9–17.1)	22.5 (16.6–29.6)	31.1 (26.4–36.2)	31.4 (27.3–35.8)
High School or less	8.4 (5.3–13.1)	12.3 (8.5–17.5)	16.6 (12.3–22.0)	16.2 (12.9–20.1)
Insurance Status				
Insured	93.1 (86.8–96.6)	91.3 (85.4–94.9)	91.5 (88.2–94.0)	95.7 (93.9–97.0)
Private Insurance	68.1 (58.3–76.6)	54.8 (47.3–62.0)	54.5 (49.1–59.7)	52.1 (46.9–57.3)
Public/Other Insurance	25.0 (18.9–32.3)	36.5 (31.1–42.2)	37.1 (32.1–42.3)	43.6 (38.5–48.8)
Uninsured	6.9 (3.4–13.2)	8.7 (5.1–14.6)	8.5 (6.0–11.8)	4.3 (3.0–6.1)
Number of Hospital Visits				
None	2.6 (1.2–5.6)	No Observations	1.8 (0.7–4.2)	0.9 (0.6–1.5)
1	5.8 (3.3–10.1)	3.6 (1.7–7.6)	2.9 (1.5–5.3)	3.1 (1.8–5.4)
2-3	16.8 (12.5–22.1)	17.1 (12.2–23.5)	13.8 (10.8–17.4)	19.9 (15.8–24.8)
4+	74.8 (69.5–79.5)	79.3 (72.6–4.6)	81.6 (77.6–85.0)	76.0 (70.8–80.5)
Immigration Status				
US-Born	94.1 (90.2–96.4)	89.3 (84.8–92.7)	90.5 (87.9–92.5)	84.6 (81.1–87.6)
Not US-Born	5.9 (3.6–9.8)	10.7 (7.3–15.2)	9.5 (7.5–12.1)	15.4 (12.4–18.9)
Income-Poverty Ratio				
Mean PIR	2.4 (2.1–2.8)	2.4 (2.2–2.6)	2.6 (2.4–2.7)	2.6 (2.4–2.9)
<130% of the FPL	26.3 (19.6–34.3)	27.7 (22.3–33.9)	24.9 (20.9–29.4)	28.2 (23.5–33.4)
130%–349% of the FPL	46.4 (39.2–53.9)	37.7 (32.0–43.9)	38.3 (33.4–43.4)	32.9 (27.2–39.1)
≥350% of the FPL	27.3 (21.2–34.3)	34.5 (28.4–41.2)	36.8 (32.3–41.6)	38.9 (31.5–46.8)
Calibrated A1c (%)	8.1 (7.9–8.4)	8.2 (7.9–8.5)	8.0 (7.9–8.2)	8.1 (7.9–8.3)
Duration of Diabetes (Yr.)	12.8 (11.2–14.4)	16.7 (14.9–18.6)	16.3 (15.2–17.4)	17.1 (16.2–18.1)

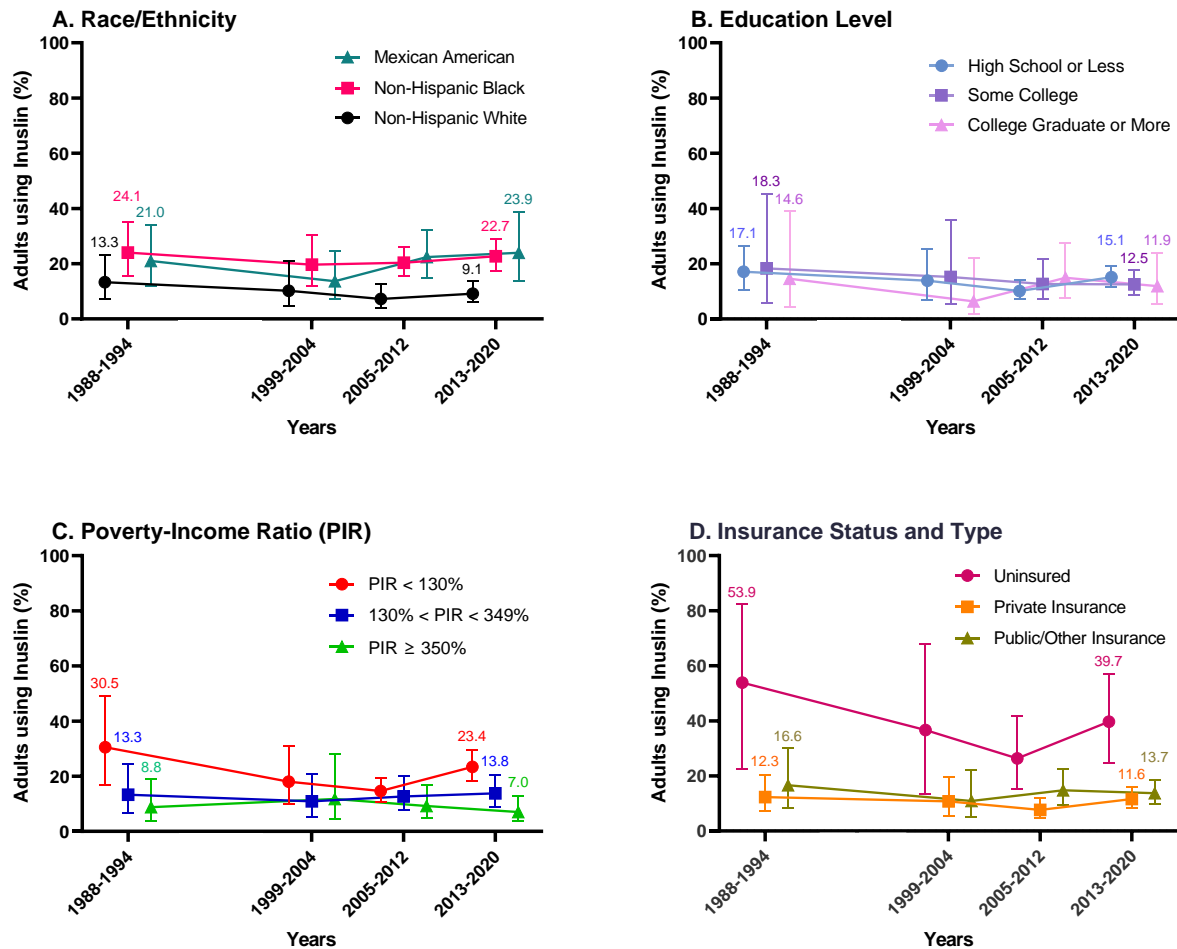
^a We excluded 96 participants who may have type 1 diabetes, defined as diagnosed with diabetes at age 30 or under, currently taking only insulin medication, and initiating insulin therapy within 1 year of their diabetes diagnosis.

eFigure 3: Trends in Glycemic Control (HbA_{1c} <7%) Among Adults With Type 2 Diabetes Using Insulin, by (A) Race/Ethnicity, (B) Education, (C) Poverty-Income Ratio, (D) Insurance status, the National Health and Nutrition Examination Survey, 1988 to 2020, N = 2,458^a



^a We excluded 96 participants who may have type 1 diabetes, defined as diagnosed with diabetes at age 30 or under, currently taking only insulin medication, and initiating insulin therapy within 1 year of their diabetes diagnosis. Adults who responded “Other” were excluded in the race/ethnicity analysis but were included for all other subgroups.

eFigure 4: Trends in Severe Hyperglycemia ($\text{HbA}_{1c} > 10\%$) Among Adults With Type 2 Diabetes Using Insulin, by (A) Race/Ethnicity, (B) Education, (C) Poverty-Income Ratio, (D) Insurance status, the National Health and Nutrition Examination Survey, 1988 to 2020, $N = 2,458^a$



^a We excluded 96 participants who may have type 1 diabetes, defined as diagnosed with diabetes at age 30 or under, currently taking only insulin medication, and initiating insulin therapy within 1 year of their diabetes diagnosis. Adults who responded “Other” were excluded in the race/ethnicity analysis but were included for all other subgroups.