



Trends in Insulin Use and Diabetes Control in the U.S.: 1988–1994 and 1999–2012

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Over the past two decades, many new treatment options have been introduced for type 2 diabetes. Increasingly, there is debate regarding the effectiveness of insulin as the last-line therapy. While diabetes control has improved over the past two decades (1–3), a substantial portion of patients is still not meeting the clinical targets. To examine national trends in glycemic control by insulin and oral diabetes medication use, we conducted a cross-sectional study of 4,947 adult participants with diagnosed diabetes (all types) in the National Health and Nutrition Examination Survey (NHANES) in the 1988–1994 and 1999–2012 cycles. The NHANES surveys are cross-sectional, complex probability samples of the U.S. civilian noninstitutionalized population. All NHANES protocols were approved by an institutional review board, and informed consent was obtained from participants. Hemoglobin A_{1c} (HbA_{1c}) was measured in whole blood samples using high-performance liquid chromatography methods performed on instruments certified by the NGSP and standardized to the reference method used in the Diabetes Control and Complications Trial (DCCT). We calibrated the HbA_{1c} values to account for changes in measurement methods over the 20 years of data collection in

NHANES (1). All statistical analyses accounted for the complex sampling design of the surveys and incorporated sampling weights to generate nationally representative estimates.

The proportion of patients with diabetes currently on any insulin (includes insulin only and insulin plus oral diabetes medications) was 29.1% (95% CI 26.7–31.5) in 2005–2012 and has been relatively stable since 1988 with 30.3% (95% CI 26.4–34.5) of patients in 1988–1994 and 24.8% (95% CI 21.2–28.8) in 1999–2004 (Table 1). Duration of diabetes was a strong, independent determinant of insulin use (data not shown), and over the past 24 years the duration of diabetes for those on any insulin has increased significantly (12.7 to 17.3 years, $P < 0.001$) compared with the duration of diabetes for those on oral medication only (7.0 to 8.5 years, $P = 0.36$). In 2005–2012, the prevalence of any insulin use among adults aged 65 years or older was almost identical to adults aged <65 years (27.8% vs. 29.8%, $P = 0.391$). Further, the current (2005–2015) prevalence of insulin-only use among adults 65 or older was 12.2% (95% CI 9.8–15.0) compared with 15.4% (95% CI 12.8–18.3) in adults <65 years ($P = 0.20$). Among whites in 2005–2012, the prevalence of any

insulin use was 31.8% (95% CI 28.5–35.3) compared with 30.8% (95% CI 26.8–35.0) in African Americans and only 22% (95% CI 17.4–27.3) in Mexican Americans. After adjustment for duration of diabetes, age, sex, BMI, and education, Mexican Americans were still significantly less likely to receive insulin therapy as compared with whites (data not shown). In 2005–2012, among patients who had any insulin use, 31.4% (95% CI 27.0–36.2) had an HbA_{1c} <7% and 61.7% (95% CI 56.5–66.6) had an HbA_{1c} <8%.

Insulin is the last-line therapy for many patients. Our results suggest improvements are needed in patient and professional education on insulin use, new insulin formulations and delivery technology, and/or systems of care to improve glycemic control in patients receiving insulin.

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Table 1—Trends in insulin use and glycemic control by insulin use, according to age, race, and education, for U.S. adults with diagnosed diabetes, NHANES 1988–1994, 1999–2004, and 2005–2012

	1988–1994 (N = 1,205)				1999–2004 (N = 1,317)				2005–2012 (N = 2,425)			
	Insulin only	No insulin (oral only)	Insulin and oral	No medication	Insulin only	No insulin (oral only)	Insulin and oral	No medication	Insulin only	No insulin (oral only)	Insulin and oral	No medication
Overall												
% (unweighted n)	26.8 (323)	43.3 (540)	3.5 (50)	26.4 (292)	15.0 (183)	56.7 (799)	9.8 (134)	18.5 (201)	14.1 (324)	56.9 (1,437)	14.9 (347)	14.1 (317)
Age (years)												
20 to <50	27.3 (6.4)	39.4 (5.6)	5.0 (2.5)	28.3 (4.2)	17.0 (3.2)	52.2 (4.2)	6.3 (2.1)	24.5 (3.4)	21.8 (2.4)	47.3 (3.1)	8.8 (1.5)	22.0 (2.6)
50 to <65	21.2 (2.8)	47.3 (4.5)	3.9 (1.2)	27.6 (3.7)	10.8 (1.8)	58.5 (3.1)	13.1 (2.2)	17.6 (2.1)	11.5 (1.6)	58.6 (2.5)	17.8 (1.6)	12.1 (1.4)
≥65	31.1 (2.5)	42.2 (2.7)	2.3 (0.8)	24.4 (2.4)	17.8 (2.2)	57.8 (2.6)	8.9 (1.3)	15.5 (2.2)	12.2 (1.3)	60.8 (2.1)	15.7 (1.5)	11.4 (1.3)
Race												
Non-Hispanic white	26.4 (2.9)	43.0 (3.3)	2.9 (0.8)	27.7 (2.9)	16.7 (2.4)	55.7 (2.8)	8.9 (1.6)	18.8 (2.8)	15.8 (1.5)	55.1 (2.2)	16.0 (1.2)	13.1 (1.7)
Non-Hispanic black	36.9 (3.1)	35.5 (3.0)	6.6 (1.6)	21.0 (2.1)	18.7 (2.2)	54.0 (3.1)	13.4 (2.3)	13.9 (2.6)	15.7 (1.7)	56.1 (2.2)	15.1 (1.4)	13.1 (1.4)
Mexican American	18.6 (2.2)	52.2 (2.4)	3.8 (0.9)	25.4 (2.3)	9.4 (2.3)	66.5 (2.2)	8.8 (2.1)	15.3 (2.1)	10.0 (1.9)	60.6 (2.6)	12.0 (2.0)	17.4 (2.2)
Education												
High school or less	27.4 (1.9)	44.8 (3.0)	3.4 (1.0)	24.5 (2.4)	16.4 (2.1)	56.7 (2.2)	9.8 (1.4)	17.1 (1.8)	12.7 (1.5)	58.9 (2.0)	14.2 (1.4)	14.1 (1.5)
Some college	28.3 (9.7)	38.5 (7.5)	4.7 (3.1)	28.5 (7.4)	12.7 (2.1)	59.0 (3.8)	9.9 (2.1)	18.4 (3.3)	16.3 (2.1)	51.9 (3.2)	16.6 (2.0)	15.1 (2.1)
College or more	21.4 (5.1)	39.7 (8.1)	1.2 (1.0)	37.7 (8.0)	13.9 (4.4)	52.1 (5.2)	9.6 (2.4)	24.4 (4.4)	14.8 (2.6)	58.6 (3.8)	14.5 (2.8)	12.1 (2.3)
Duration of diabetes, mean (SE)	13.0 (0.7)	7.0 (0.5)	10.0 (2.0)	9.9 (0.7)	18.6 (1.2)	10.4 (0.6)	15.6 (1.5)	8.7 (1.0)	19.3 (1.0)	8.5 (0.3)	15.4 (0.7)	8.7 (0.8)
Glycemic control												
Calibrated HbA _{1c} <7% (unweighted n)	34.7 (111)	43.9 (243)	25.2 (13)	82.0 (236)	29.8 (54)	49.4 (383)	28.2 (34)	78.3 (153)	34.0 (111)	65.7 (907)	29.0 (106)	80.8 (241)
Age (years)												
20 to <50	21.0 (6.5)	35.4 (10.2)	29.1 (24.9)	85.3 (7.1)	11.1 (4.6)	35.4 (5.0)	28.2 (11.9)	73.4 (8.2)	30.3 (6.9)	56.2 (5.0)	12.2 (5.1)	79.0 (4.6)
50 to <65	35.4 (7.4)	40.9 (5.2)	17.3 (9.1)	78.3 (8.8)	36.2 (8.3)	47.8 (4.2)	27.9 (7.4)	75.1 (8.0)	30.4 (6.5)	63.5 (2.5)	22.9 (5.3)	72.8 (5.8)
≥65	41.4 (5.3)	51.4 (3.6)	31.5 (15.4)	83.4 (5.8)	37.2 (7.0)	58.6 (3.2)	28.8 (8.7)	86.4 (4.0)	41.0 (5.2)	72.1 (2.2)	41.1 (5.0)	90.9 (2.5)
Race												
Non-Hispanic white	33.0 (4.9)	45.2 (4.5)	29.2 (15.4)	81.4 (6.0)	30.3 (6.6)	56.7 (2.6)	34.7 (6.6)	84.4 (4.9)	34.9 (4.6)	69.9 (2.4)	30.8 (4.7)	89.9 (3.1)
Non-Hispanic black	36.9 (6.1)	37.5 (5.4)	22.8 (11.0)	83.4 (4.4)	28.4 (6.8)	41.8 (3.7)	21.1 (6.6)	63.9 (8.2)	36.4 (5.6)	62.7 (2.6)	28.6 (4.7)	69.0 (4.9)
Mexican American	27.7 (7.2)	38.4 (4.6)	28.7 (12.3)	69.9 (5.8)	26.3 (10.4)	30.9 (2.6)	26.5 (8.2)	66.2 (8.5)	22.1 (6.4)	49.8 (3.4)	26.1 (8.0)	60.7 (8.3)
Education												
High school or less	37.1 (4.7)	47.2 (4.2)	15.4 (6.6)	84.2 (4.4)	28.3 (6.4)	46.5 (2.4)	25.3 (5.9)	79.9 (5.2)	28.5 (3.8)	65.5 (2.4)	34.7 (4.1)	73.7 (3.7)
Some college	20.8 (12.8)	28.2 (8.0)	55.3 (34.2)	89.0 (6.3)	34.5 (10.6)	51.5 (4.4)	27.3 (9.3)	69.9 (8.5)	35.2 (6.1)	62.4 (4.0)	24.1 (6.0)	91.0 (3.6)
College or more	41.4 (12.8)	33.4 (11.1)	11.9 (14.0)	73.3 (17.5)	28.8 (15.0)	58.2 (5.3)	42.5 (13.3)	85.8 (8.1)	45.8 (8.8)	71.1 (4.0)	20.9 (7.0)	86.3 (4.4)
Duration of diabetes, mean (SE)	12.9 (1.0)	6.3 (0.7)	9.3 (1.5)	10.7 (0.9)	18.9 (1.6)	10.9 (0.9)	14.6 (2.3)	8.7 (1.1)	19.8 (1.6)	8.2 (0.4)	16.1 (1.2)	9.1 (1.0)
Calibrated HbA_{1c} <8% (unweighted n)												
Age (years)												
20 to <50	50.9 (168)	63.5 (325)	63.1 (28)	89.5 (259)	55.9 (106)	73.8 (578)	50.8 (71)	84.6 (170)	62.4 (195)	83.2 (1,168)	60.9 (207)	88.5 (273)
50 to <65	31.1 (9.0)	50.9 (7.6)	70.8 (22.1)	87.7 (7.1)	31.4 (8.6)	58.2 (5.5)	37.7 (13.5)	80.1 (7.6)	54.8 (6.3)	70.6 (4.7)	24.5 (8.6)	85.1 (4.0)
≥65	51.6 (7.0)	61.6 (5.7)	64.2 (14.0)	82.7 (8.2)	57.5 (8.6)	71.7 (3.5)	47.0 (9.2)	81.8 (7.3)	60.7 (7.0)	81.0 (2.5)	56.4 (5.1)	83.0 (5.3)
Duration of diabetes, mean (SE)	60.6 (5.3)	72.3 (3.6)	51.8 (20.2)	97.2 (1.5)	69.3 (5.5)	84.3 (2.8)	61.7 (8.3)	91.7 (3.5)	71.9 (5.1)	90.9 (1.0)	77.6 (5.1)	97.8 (0.9)

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Table 1—Continued

	1988–1994 (N = 1,205)			1999–2004 (N = 1,317)			2005–2012 (N = 2,425)		
	Insulin only	No insulin (oral only)	Insulin and oral	Insulin only	No insulin (oral only)	Insulin and oral	Insulin only	No insulin (oral only)	Insulin and oral
Race									
Non-Hispanic white	49.0 (6.1)	67.6 (4.5)	76.7 (15.1)	57.3 (5.0)	78.2 (2.6)	54.2 (72.4)	66.5 (4.5)	87.5 (1.7)	66.2 (4.7)
Non-Hispanic black	54.3 (6.3)	48.9 (5.1)	53.3 (15.1)	46.6 (7.2)	68.1 (3.9)	48.8 (7.9)	53.5 (5.4)	78.9 (2.3)	56.2 (5.5)
Mexican American	53.8 (8.7)	57.6 (5.1)	51.3 (11.6)	61.0 (7.7)	55.3 (4.1)	58.9 (9.1)	49.9 (6.9)	71.3 (4.1)	56.1 (8.5)
Education									
High school or less	52.5 (4.4)	67.3 (4.1)	56.8 (14.6)	52.5 (5.9)	71.1 (2.3)	46.9 (6.1)	60.3 (4.4)	82.8 (1.9)	68.3 (4.4)
Some college	32.9 (16.5)	60.9 (10.1)	55.3 (34.2)	47.3 (10.7)	76.4 (3.5)	50.2 (10.1)	60.9 (6.4)	81.3 (3.1)	50.2 (6.0)
College or more	51.2 (12.0)	45.2 (15.3)	88.7 (13.3)	73.5 (17.5)	80.3 (4.9)	68.7 (13.6)	70.1 (8.4)	87.0 (2.8)	58.3 (10.7)
Duration of diabetes, mean (SE)	13.2 (0.9)	6.9 (0.6)	9.4 (2.6)	20.1 (1.0)	10.8 (0.7)	16.8 (1.7)	20.4 (1.3)	8.5 (0.4)	16.5 (0.8)
									8.9 (0.9)

Data are presented as weighted percent (SE), unless otherwise noted. Results for “Other” race/ethnicity are not included here because of small numbers. A total of 77 people were missing education level (for analyses stratified by education level, overall, N = 4,870; 1988–1994, n = 1,134; 1999–2004, n = 1,316; 2005–2012, n = 2,420).

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