

A1C LEVELS AND FACTORS ASSOCIATED WITH GLYCEMIC CONTROL AMONG PATIENTS WITH DIABETES MELLITUS IN THE US

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BACKGROUND

- It has been estimated that 29.1 million Americans had diabetes mellitus in 2014¹. Epidemiologic studies suggest that this figure will increase to 37.9 million by 2020².
- Well-controlled blood glucose can significantly reduce the risk of cardiovascular events in patients with diabetes.³⁻⁶ In addition, lipid control is also associated with decreased incidence of macrovascular disease in diabetic patients⁷.
- According to clinical guidelines, optimal diabetic care involves a comprehensive approach including glycemic control and hypertension and lipid management. Specific glycemic goals vary slightly by guideline and are also dependent on patient and disease features:
 - The American Association of Clinical Endocrinologists (AACE) recommends a glycemic target of hemoglobin A1C (A1C) $\leq 6.5\%$,⁸ while the American Diabetes Association (ADA) recommends A1C $< 7.0\%$ for many adults with diabetes⁹.
 - The ADA recommends $< 8\%$ A1C as the less stringent target for diabetes patients with extensive comorbidities and/or advanced microvascular or macrovascular complications⁹.
- Given the increasing public awareness for diabetes, several studies have investigated and evaluated diabetes care by using national surveillance data.^{10,11} Recent results based on national data from 1988 to 2010 suggest that nearly half of United States (US) adults with diabetes did not meet the recommended treatment goals. However, to the best of our knowledge, no studies have been conducted to analyze these trends since 2010.
- There is a need to update the percentage of patients with diabetes who meet treatment goals based on national estimates and explore which patient factors are associated with glycemic control.

OBJECTIVE

- To investigate the proportion of patients with diabetes mellitus who achieve treatment goals in the US
- To describe and explore patient characteristics associated with achievement of glycemic goals

METHODS

- Study Design:** Cross-sectional analysis
- Data source:** National Health and Nutrition Examination Survey (NHANES) data from 2011 to 2014
 - NHANES is designed to assess health and nutrition status of adults and children in the US
 - NHANES has been constructed by a series of health information, including demographic, socioeconomic, dietary, and health-related information
 - A stratified, multistage, probability cluster method was used to make sure all patient samples are nationally representative, and its findings often are used to estimate prevalence of major diseases
- Patient selection**
 - Patients had to be aged ≥ 18 years at the interview
 - Patients were classified as having diabetes by a doctor or other health professional
 - Patients should have valid glycemic results
 - Patients with missing A1C results were excluded
- Baseline characteristics**
 - Demographic characteristics: Age, gender, race, insurance coverage, education level, annual income
 - Clinical and other characteristics: Current smoker status, body mass index (BMI) level, insulin use, time since diabetes diagnosis, and cardiovascular (CV) comorbidities (defined as coronary heart disease [CHD], congestive heart failure [CHF], angina, heart attack, or stroke)
- Primary outcomes**
 - Glycemic control targets: $< 7\%$ A1C and $< 8\%$ A1C
 - Blood pressure target: $< 130/80$ mmHg
 - Lipid target: < 100 mg/dL
- Statistical analysis**
 - Chi square and t-tests were used to compare patient characteristics between A1C level groups (Model 1: $< 7\%$ vs $\geq 7\%$; Model 2: $< 8\%$ vs $\geq 8\%$)
 - Eligible predictors ($P < 0.2$) were included in a multivariate logistic regression model to determine the association between glycemic control and patient characteristics
 - All statistical analyses were conducted using SAS version 9.4.

Table 1. Patient Demographic Characteristics

Diabetes Patients	Total (N=1,326)	2011–2012 (N=642)	2013–2014 (N=684)
Age (mean \pm SD)	61.2 \pm 13.3	61.2 \pm 13.5	61.1 \pm 13.0
Age, %			
18–44	12.5%	12.5%	12.6%
45–64	44.6%	45.3%	43.9%
≥ 65	42.9%	42.2%	43.6%
Female, %	49.8%	48.3%	51.2%
Education level, %			
Less than high school	33.6%	35.3%	32.0%
High school graduate	23.1%	22.3%	23.8%
At least some college	43.3%	42.3%	44.3%
Annual household income $< \$20,000$, %	29.3%	33.8%	25.2%
Race or ethnic group, %			
Non-Hispanic white	34.5%	31.3%	37.4%
Non-Hispanic black	29.1%	34.4%	24.1%
Hispanic	9.3%	10.0%	8.6%
Mexican American	14.0%	10.4%	17.4%
Other	13.1%	13.9%	12.4%
Covered by insurance, %	86.1%	84.4%	87.7%

Key: SD – standard deviation.

Table 2. Patient Clinical Characteristics

Diabetes Patients, %	Total (N=1,326)	2011–2012 (N=642)	2013–2014 (N=684)
Insulin use (yes)	29.3%	29.4%	29.1%
Current smoker (yes)	15.9%	16.5%	15.5%
BMI (kg/m ²)			
< 25.0	14.9%	16.4%	13.4%
25.0–29.9	29.0%	27.4%	30.4%
≥ 30.0	56.2%	56.2%	56.2%
Time since diabetes diagnosis (years)			
0–4	28.8%	30.9%	26.7%
5– < 15	40.3%	38.5%	42.1%
≥ 15	30.9%	30.6%	31.2%
CV comorbidities	27.3%	27.4%	27.2%
CHF	10.3%	11.1%	9.7%
CHD	11.2%	11.2%	11.3%
Angina	6.7%	7.6%	5.9%
Heart attack	11.2%	10.6%	11.7%
Stroke	9.2%	8.9%	9.5%

Key: BMI – body mass index; CV – cardiovascular; CHD – coronary heart disease; CHF – congestive heart failure.

Figure 1. Range of A1C Levels From 2011 to 2014

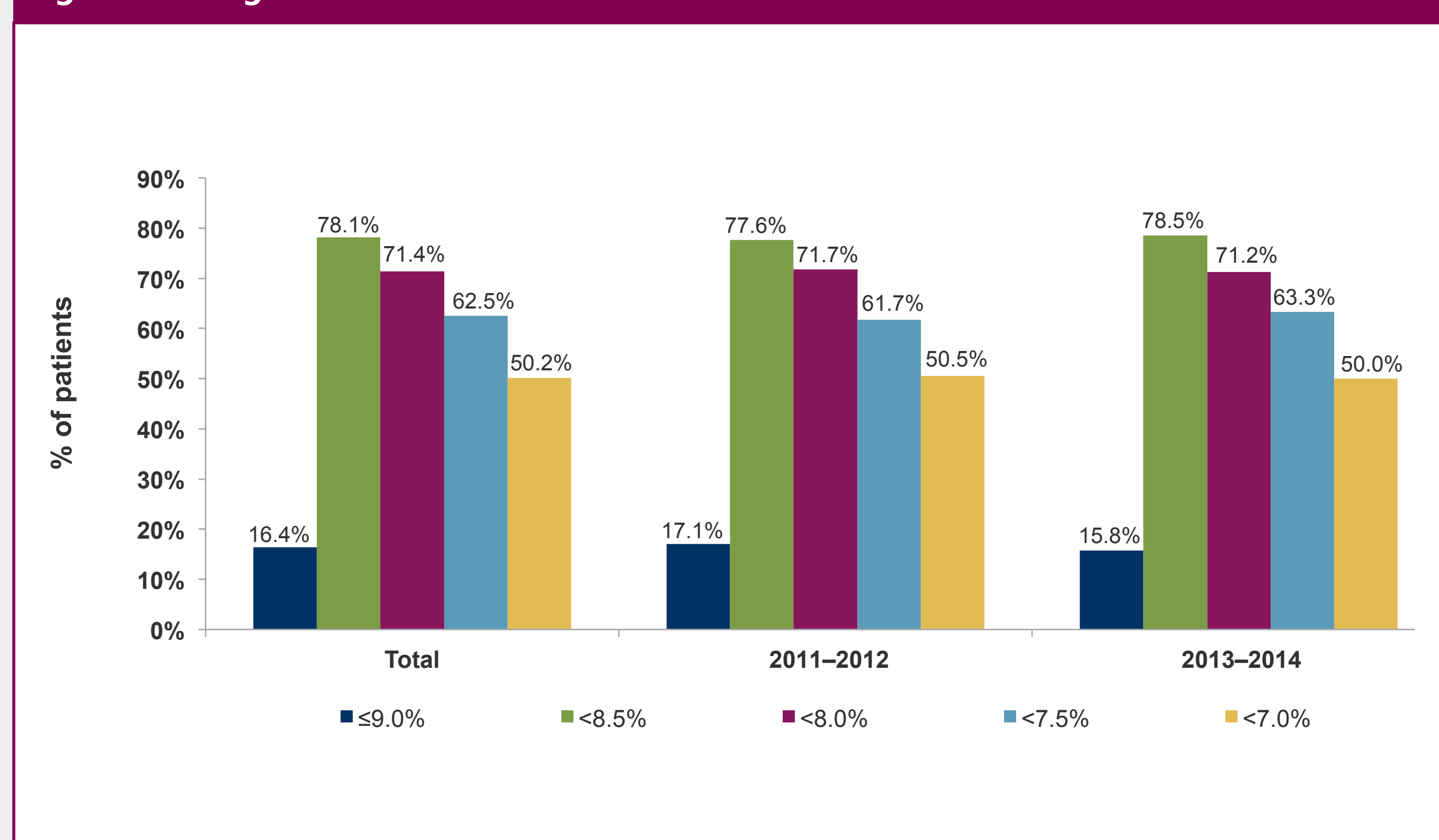


Table 3. Patients Who Met A1C, Blood Pressure, or Lipid Treatment Goal

Diabetes Patients, %	Total (N=1,326)	2011–2012 (N=642)	2013–2014 (N=684)
A1C $< 7.0\%$	50.2%	50.5%	50.0%
A1C $< 8.0\%$	71.4%	71.7%	71.2%
Blood pressure $< 130/80$ mmHg (%)	41.7%	39.3%	44.0%
LDL cholesterol (mg/dL)			
< 100	54.3%	53.4%	55.2%
100–129	26.0%	22.6%	29.5%
130–159	13.7%	16.7%	10.4%
≥ 160	6.1%	7.2%	4.9%
Achieved ABC goals (A1C $< 7.0\%$, blood pressure $< 130/80$ mmHg, LDL < 100 mg/dL)	5.4%	4.2%	6.6%

A1C – glycated hemoglobin; ABC – A1C, blood pressure, and LDL cholesterol; LDL – low-density lipoprotein.

Table 4. Results of Multivariate Logistic Regressions

Variables	Model 1 ($< 7\%$ vs $\geq 7\%$)		Model 2 ($< 8\%$ vs $\geq 8\%$)	
	OR	95% CI	OR	95% CI
Age	1.014	1.004, 1.025	1.027	1.016, 1.039
Gender				
Male	Ref	Ref	NA	NA
Female	1.364	1.074, 1.734	NA	NA
Insurance status				
No	Ref	Ref	NA	NA
Yes	1.713	1.203, 2.440	1.617	1.114, 2.346
BMI (kg/m ²)				
< 25	Ref	Ref	Ref	Ref
25–29.9	1.131	0.775, 1.652	1.053	0.675, 1.642
≥ 30	0.896	0.631, 1.273	0.891	0.589, 1.348
Insulin use				
No	Ref	Ref	NA	NA
Yes	0.227	0.170, 0.304	0.237	0.178, 0.317
Ethnicity				
Other races	NA	NA	Ref	Ref
Mexican	NA	NA	0.733	0.441, 1.218
Non-Hispanic black	NA	NA	1.023	0.646, 1.619
Non-Hispanic white	NA	NA	1.115	0.705, 1.763
Other Hispanic	NA	NA	0.657	0.378, 1.144
Current smoker				
No	Ref	Ref	Ref	Ref
Yes	0.838	0.603, 1.165	0.772	0.546, 1.092
Time since diabetes diagnosis (years)				
0–5	Ref	Ref	Ref	Ref
5–14	0.512	0.383, 0.686	0.646	0.462, 0.904
≥ 15	0.590	0.420, 0.828	0.684	0.465, 1.008

Key: BMI – body mass index; CI – confidence interval; NA – not applicable; OR – odds ratio; Ref=reference group.

RESULTS

- As indicated in Table 1, 1,326 patients were identified with diabetes mellitus from 2011 to 2014 (mean age, 61.2 years; 49.8% female)
- Overall, 27.3% of patients with diabetes mellitus were also identified as having CV disease (Table 2)
- Half (50.2%) achieved the ADA A1C target of $< 7\%$ (as shown in Figure 1). Similarly, 41.7% and 54.3% of patients with diabetes mellitus achieved blood pressure ($< 130/80$ mmHg) and lipid targets (< 100 mg/dL), respectively (Table 3)
- Univariate analysis suggested that age, gender, health insurance status, BMI, current smoker status, and time since diabetes mellitus diagnosis may significantly predict A1C level in Model 1, while gender was excluded ($P=0.573$) and ethnicity ($P=0.079$) was included as a potential predictor in Model 2.
- Results of logistic regression models (1 and 2) with odds ratios (ORs) and 95% confidence intervals (CIs) for selected predictors are summarized in Table 4.
 - Both models suggest that patients with diabetes mellitus who met A1C goals (A1C $< 7\%$ or A1C $< 8\%$) were more likely to be older, females, covered by health insurance, less likely to use insulin, and diagnosed with diabetes mellitus for less than 5 years

DISCUSSION

- In a previous study evaluating diabetes care using NHANES from 1999 to 2010, it was reported that 52.2% of patients achieved the ADA A1C target of $< 7\%$, while 51.3% and 56.8% achieved blood pressure ($< 130/80$ mmHg) and lipid targets (< 100 mg/dL), respectively, from 2007 to 2010¹⁰
- Similarly, in another study evaluating national trends of diabetes care using NHANES data from 1988 to 2010, it was reported that 52.5% of patients with diabetes achieved the ADA A1C target of 7%, while 51.1% and 56.2% achieved blood pressure ($< 130/80$ mmHg) and lipid targets (< 100 mg/dL), respectively, from 2007 to 2010¹¹
- Interestingly, the percentage of patients reported in this study reaching A1C ($< 7\%$), blood pressure ($< 130/80$ mmHg), and lipid (< 100 mg/dL) targets all decreased from 2011 to 2014 in comparison to the percentages reported in 2007 to 2010

CONCLUSIONS

- This current study adds to the existing body of literature that suggests that there are continued challenges with respect to optimal diabetes care management in the US, including achievement of glycemic and other diabetes-related goals
- Our findings highlight the importance of integrated, comprehensive care in diabetes mellitus, given that almost half of patients with diabetes still do not achieve A1C, blood pressure, or lipid target levels suggested by ADA guidelines
- Limitations of this analysis include the use of NHANES questionnaire data, which is self-reported and therefore subject to recall bias, misunderstanding of the question, and other factors that may affect results

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