

Associations between HbA1c and Diabetes Management Practices: NHANES Data (2007 – 2018)

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Introduction

- According to the National Diabetes Statistics Report of 2020 (NDSR), approximately 34.2 million people (10.5%) of the US population had diabetes (1).
 - 7.3 million adults aged 18 years and older were not aware of their diabetes status.
- From 1999 to 2016, the prevalence of total diabetes (both diagnosed and undiagnosed) significantly increased in adults aged 18 and older (1).
 - 96 million adults aged 18 years and older had prediabetes.
- People with unmanaged diabetes are at a higher risk for serious health complications, such as kidney failure, heart disease, blindness, stroke, and the loss of toes, feet, or legs.
- In 2012, diabetes costed \$188 billion to treat diabetes, which increased to \$237 billion in 2017 (1).
- Previous studies using the NHANES data have shown relationships between hemoglobin A1c levels and mortality rates (2), differences in hemoglobin A1c levels between Hispanic Latinos and Non-Hispanic Whites (3), gaps and disparities in diabetes care between 2005 and 2016 (4).
- This study builds on the previous findings and further evaluates diabetes-related clinical practices, such as eye and foot exams, which are recommendations of the overall diabetes management/care strategies to identify and reduce future complications.

Methods and Materials

- NHANES is a nationally represented, cross-sectional study that is conducted across the nation to evaluate the health and nutritional status of both adults and children.
 - Participants are randomly chosen – initially by county, neighborhood, household, and then by person.
 - Two parts include the interview portion and the exam portion.
- Our study includes participants who fully completed/answered the questions in the survey regarding diabetes care practices and whose A1c levels were available at the time of data collection.
- The statistical platform STATA Basic Edition 17.0 was used to analyze the data.
- A logistic regression model was developed and adjusted for age, gender, race/ethnicity, education, health insurance, and the ratio of income to poverty.
- The adjusted odds ratios will reveal the associations of events occurring in the “lower A1c group” with A1c < 9% versus the “higher A1c group” with A1c ≥ 9%.
 - In this case, the associations, increasing or decreasing, between hemoglobin A1c levels and whether an individual engaged in the specific diabetes care practices.

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Results

Our analyses included 4,623 individuals’ data with an average age of 62 years (SD 0.19), representing 18,925,857 people. Of these individuals, 33.8% were non-Hispanic Whites, 26.9% non-Hispanic Blacks, 17.4% Mexican Americans, 10.7% other Hispanics, and 11.3% of other races.

- NHANES respondents who reported seeing their doctor within the last year versus respondents who saw their doctor more than 1 year ago were 0.876 times (OR) more likely to achieve a lower HbA1c level (<9%) (95% CI, 0.824-0.931; p = < 0.001).
- Those who reported checking their feet were 1.689 times (OR) more likely to achieve a lower HbA1c level (< 9%) (95% CI, 1.095 - 2.56; p = 0.018).
- Respondents who reported reducing intake of fat/calories were 2.39 times (OR) more likely to achieve a lower HbA1c level (< 9%) (95% CI, 1.25 - 4.55; p = 0.011). In addition, NHANES respondents who reported taking insulin were 32.45 times (OR) more likely to achieve a lower HbA1c level (95% CI, 25.0 - 42.07; p < 0.001).

Characteristic	2007-2018 (n = 4,623)	
Age -- % (95% CI)	20-44 yr	10.25 (9.41-11.2)
	45-64 yr	42.9 (41.5-44.3)
	≥ 65 yr	46.9 (45.4-48.3)
Mean (95% CI)	62.3 (61.9-62.6)	
Race or Ethnic Group --% (95% CI)	Mexican American	17.4 (16.3-18.5)
	Other Hispanic	10.7 (9.81-11.6)
	Non-Hispanic White	33.8 (32.5-35.2)
	Non-Hispanic Black	26.9 (25.6-28.2)
	Other Race	11.3 (10.4-12.2)
Sex -- % (95% CI)	Female	51.4 (49.9-52.8)
	Male	48.6 (47.2-50.1)
Educational Level -- % (95% CI)	Less than 9th	18.2 (17.1-19.4)
	9th-11th	17.2 (16.1-18.3)
	High School Grad/GED or Equivalent	22.4 (21.2-23.6)
	Some College or AA degree	26.6 (25.4-27.9)
	College Grad or above	15.5 (14.5-16.6)
Insurance -- % (95% CI)	Yes	87.6 (86.6-88.5)
	No	12.4 (11.5-13.4)
Ratio of Family Income to Poverty -- % (95% CI)	<1	22 (21.5-22.4)
	1.0-1.99	27.2 (26.7-27.7)
	2.0-2.99	15.2 (14.8-15.6)
	3.0-3.99	10.6 (10.3-11.0)
	4.9-4.99	7.68 (7.39-8.0)
	5	17.3 (16.8-17.7)
	Mean (95% CI)	2.47 (2.46-2.49)

Table 1. Characteristics of NHANES participants who were ages 20 and older, non-pregnant, and with a self-reported diagnosis of diabetes.

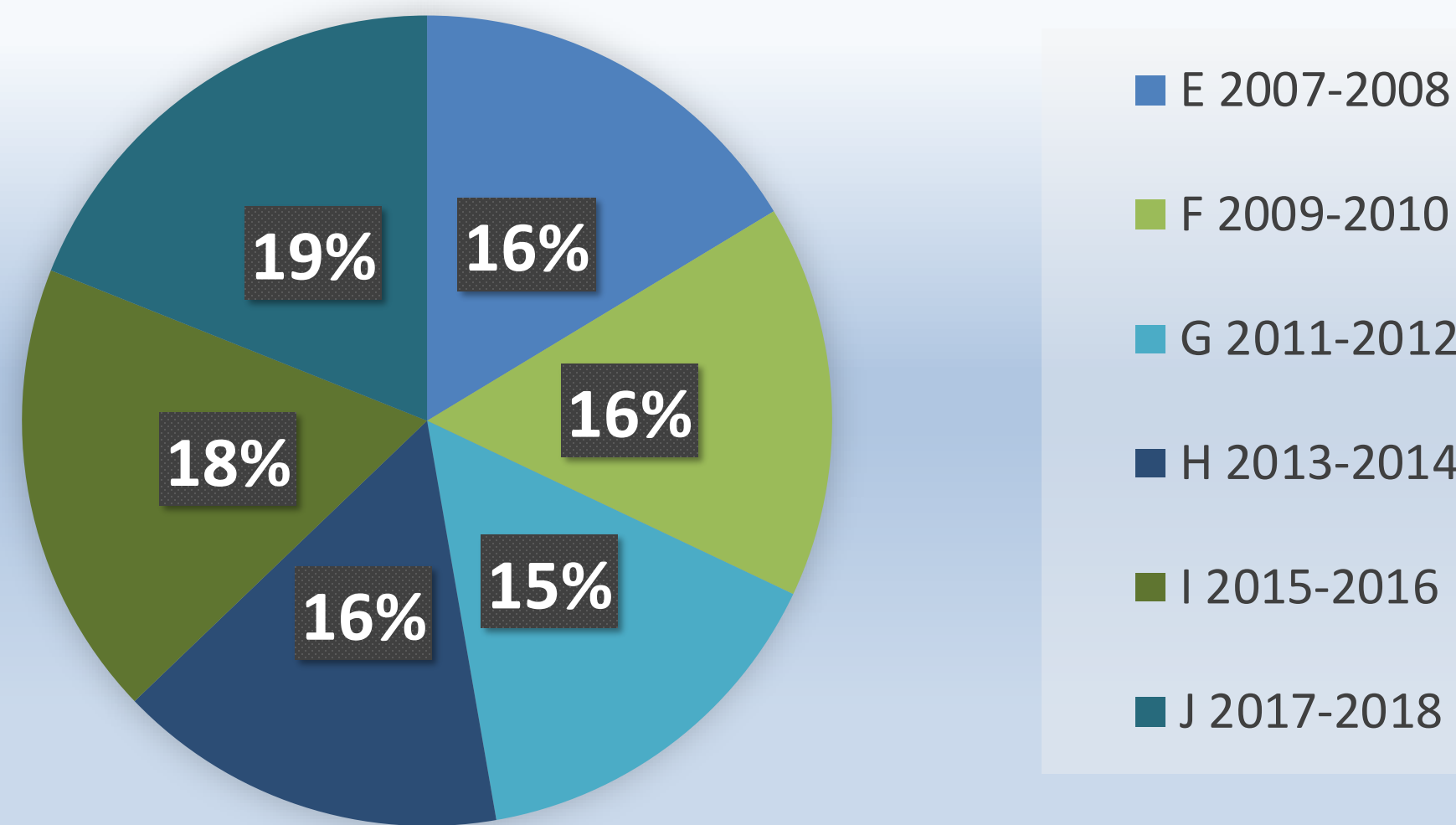
DID350	Number of Observations	Odds Ratio	95% Confidence Interval	P-Value
2007-2008	545	1.03	0.365-2.92	0.946
2009-2010	598	3.05	1.32-7.06	0.012
2011-2012	567	2.86	1.47-5.57	0.004
2013-2014	624	1.55	0.423-5.7	0.482
2015-2016	696	0.892	0.383-2.08	0.778
2017-2018	693	1.95	0.54-7.06	0.285

Table 3. Associations between hemoglobin A1c levels and responses to DID350 (“how often do you check your feet”) shown per cycle.

DIQ	Number of Observations	Odds Ratio	95% Confidence Interval	P-Value
DIQ230: How long ago saw a diabetes specialist	3,788	0.876	0.824-0.931	<0.001
DIQ240: Is there one Dr you see for diabetes?	3,788	0.851	0.639-1.13	0.264
DID250: Past year how many times seen doctor	2,893	1	0.9998-1.0	0.394
DID260: How often check blood glucose/sugar	3,780	0.9992	0.997-1.002	0.524
DID270: Past year times checked for A1C	3,780	0.9997	0.9988-1.001	0.428
DID340: Past year times Dr. check feet for sores	546	1.005	0.385-2.6	0.999
DID350: How often do you check your feet	3,723	1.679	1.095-2.56	0.018
DIQ360: Last time had pupils dilated for exam	3,788	1.012	0.895-1.14	0.845
DIQ200a: Are you controlling weight	4,831	1.72	0.915-3.22	0.087
DIQ200b: Are you increasing physical activity	4,831	1.29	0.93-1.797	0.118
DIQ200c: Are you reducing fat/calories in diet	4,831	2.39	1.25-4.55	0.011
DIQ050: Taking Insulin now	28,382	32.45	25.0-42.07	<0.001
DID070: Taking diabetic pills to lower blood sugar	868	3.93	1.90-8.11	0.001
DIQ300s: What was your recent SBP	2,043	1.196	0.800-1.79	0.378
DIQ300d: What was your recent DBP	1,987	1.03	0.4896-2.168	0.936

Table 2. Associations between hemoglobin A1c levels and responses to the various diabetes survey questions. This logistic regression model was adjusted for age, gender, race/ethnicity, education, health insurance, and the ratio of income to poverty.

Self-Reported Diabetes Diagnosis, n = 4,623



Discussion

- This study included a large sample size.
- Relatively similar number of participants expressed having diabetes in each of the six cycles.
- NHANES participants who checked their feet, reduced in their diet, followed up with their diabetes specialists, took insulin were shown to achieve lower HbA1c levels.
- Reducing caloric intake has been shown to have a significant association with achieving a better glycemic management.
 - Checking their feet for potential problems has been shown to have a significant association with achieving a better glycemic management.
- Regarding to the question on checking feet, not every cycle has been shown to have a significant association between performing the recommendation and achieving lower levels of A1c.
- Data collected was subjective in nature, responding to survey questions.
 - Limitations: There could have been recall bias and/or procedural bias.
 - Participants may have omitted answers or failed to accurately recall events or information.

Future Directions

- Conducting further subgroup analyses:
 - A “Table 2” with various associations can be constructed for each of the six cycles to identify trends;
 - A “Table 3” with multiple cycles can be constructed with each of the four positive associations in Table 2.
 - A “Table 2” with various associations can be constructed for each of the baseline characteristics in Table 1.

Conclusions

Each of these significant findings points to a key component in diabetes management (e.g., nutrition and medication), reinforcing the continuous large-scale public health campaigns are needed to strengthen the existing messages to patients with diabetes for effective disease management. Diabetes Care and Education Specialists (CDCES) are at the heart of this work.

Figure 1. This figure shows the distribution of NHANES participants’ self-reported diabetes diagnosis among the six cycles.

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