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ASSESSING THE EFFECTS OF HEALTH INSURANCE STATUS ON COMPLIANCE WITH DIABETES CARE

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Diabetes is a treatable chronic disease that affects millions of people in the United States. Due to a variety of factors, many diabetics forgo recommended testing and other aspects of diabetes management and thus do not properly control their diabetes. Previous studies have shown that there is an association between health insurance status and diabetes care, with uninsured individuals being less likely to access care as well as control their diabetes symptoms. This study uses seven survey cycles of data from the National Health and Nutrition Examination Survey (NHANES) to assess whether the association between insurance status and diabetes care compliance persists among diabetic individuals in the United States. Demographics, health insurance, and diabetes-related data from the respective NHANES questionnaire databases were utilized. All data used in this study were self-reported by NHANES survey participants. The sociodemographic variables of age, sex, race/ethnicity, education level, and poverty-income ratio were used to describe the study population. The exposure variable for the study was health insurance status, and the outcome of interest was compliance with diabetes care as evidenced by self-report of four NHANES compliance indicators. The findings reveal insured diabetic patients having a greater mean age compared to uninsured patients. Moreover, a higher percentage of uninsured participants were non-Hispanic black or Mexican American and Other Hispanic (38.5% vs. 12.2%) when compared to participants who were insured. Similarly, a higher percentage of uninsured participants had less than a high school education or had a family income below the federal poverty level compared to insured participant. Uninsured diabetic participants were also less active in compliance to their healthcare, showing a lower likelihood of having their A1C checked by a doctor in the past year, taking insulin, and having seen a diabetes specialist in the last 2 years. The study results indicate that health insurance status is associated with compliance in diabetes care and management, and uninsured individuals were more likely to be minorities such as Hispanic or non-Hispanic black. Additional prospective data and analyses would be needed to further support the conclusions drawn from this study. The results from this study can help medical and public health professionals to understand the barriers that diabetic individuals face with their diabetes care.

Background | Diabetes is a treatable chronic disease that affects millions of people in the United States. As of 2018, 26.9 million people in the United States had been diagnosed with some form of diabetes.¹ Uncontrolled diabetes can have severe complications including non-traumatic limb amputations, retinopathy, nephropathy, and cardiovascular disease.² However, due to a variety of factors, many diabetics forgo recommended testing and other aspects of diabetes management and thus do not properly control their diabetes.³ Diabetes care and treatment focus on meeting diabetes control targets in order to prevent complications of the disease.² The standard targets of diabetes control are achieving specific hemoglobin A1c (A1C), blood pressure, and cholesterol levels, with treatment target levels varying for each individual. Achieving and maintaining target A1C levels are often seen as the hallmark of effective diabetes control in the medical community.^{4,5} Kazemian et al. (2019) reported that in 2013-2016, while 70% of adults with diabetes were linked with a source of diabetes care, only 20% of diabetic adults met their composite target goals for diabetes control.⁴ For proper diabetes management, it is also recommended that individuals regularly visit a general practitioner as well as healthcare specialists to monitor their blood-glucose levels and screen for complications of the disease.^{3,6} Low frequency of

doctor visits often results in negative control outcomes, including poor glycemic and blood pressure control, as well as increased risk of complications.³ It has been shown that financial barriers, such as lack of health insurance coverage, can prevent individuals from accessing diabetes care and meeting their control targets.⁷ While the majority of adults with diabetes have some type of health insurance coverage, it is estimated that there are over 2 million diabetic adults 18-64 years of age who are uninsured.⁸ Thus, there are large number of people with diabetes in the United States who are uninsured, contributing to poor diabetes outcomes and billions in diabetes-related medical costs.⁷ Patients not complying with diabetes care and treatment are more likely to have poor diabetes control, such as not achieving their target A1C levels, and are thus more likely to experience complications of the disease. Complications from uncontrolled diabetes not only decrease quality of life but also pose a significant financial burden on both the individual and the healthcare system.⁷ In 2017, direct healthcare costs associated with diabetes care and complications accounted for 237 billion dollars.⁴ The implications of uncontrolled diabetes highlight the importance of understanding barriers to diabetes care and treatment as well as management of the disease.

Previous studies have shown that there is an association between health insurance status and diabetes care, with uninsured individuals being less likely to access care as well as control their diabetes symptoms. This study uses seven survey cycles of data from the National Health and Nutrition Examination Survey (NHANES) to assess whether the association between insurance status and diabetes care compliance persists among diabetic individuals in the United States. Whether individuals diagnosed with diabetes had their annual A1C checked, saw a diabetes specialist within the past two years, were taking diabetic pills to lower their blood sugar, and were taking insulin were the indicators of compliance with diabetes care in this study.

Methods |

Study Design & Data Source

This study was a secondary analysis using 2005-2018 data from NHANES, a cross-sectional national population-based survey.⁹ Demographics, health insurance, and diabetes-related data from the respective NHANES questionnaire databases were utilized. All data used in this study were self-reported by NHANES survey participants.

Study Population

Adult participants ages 18 years and older who responded “yes” to the NHANES question “Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?” and had reported information on insurance status were included in the study (n = 5,152). The full sample size for each survey year and the selection process for the final study population are presented in Table 1. Of those who reported having diabetes, both males and females and participants of all races/ethnicities were included in the analyses.

Study Variables

The sociodemographic variables of age, sex, race/ethnicity, education level, and poverty-income ratio were used to describe the study population. Thresholds for the poverty-income ratio are determined by the United States Census Bureau based on family size and composition. Information for the NHANES poverty-income variable is specific for each survey year and accounts for geographic variation in the guidelines since the thresholds differ by state.¹⁰ The variable is calculated as the ratio of income to the established threshold with a value ≥ 1.00 indicating that the income is at or above the poverty level and a value of <1.00 indicating that the family lives in poverty.¹¹

The exposure variable for the study was health insurance status, determined by participant response to the NHANES question “Are you covered by health

insurance or some other kind of health plan?” The outcome of interest was compliance with diabetes care as evidenced by self-report of four NHANES compliance indicators: (1) Doctor checked hemoglobin A1C in the past year, (2) Saw a diabetes specialist in the past two years, (3) Taking diabetic pills to lower blood sugar or (4) Taking insulin. These markers are consistent with prior literature and general standards for diabetes care.^{4,6} For example, having A1C checked was included as an indicator because monitoring A1C is considered a standard of care for diabetes⁵ and seeing a diabetes specialist was included as it is recommended that those with diabetes see a doctor regularly.⁶ For all variables, any NHANES responses designated as “refused” or “don’t know” were re-coded as “missing” and not included in the analysis.

Data Analysis

Statistical analyses were conducted using SAS 9.4 software.¹² Interview survey weights were generated and applied to all analyses to account for differential participant selection and response across the seven cycles of the NHANES surveys. Information on whether a doctor had tested for hemoglobin A1C in the past year was not available for the 2009-2010 survey wave; therefore, 12-year survey weights were applied in analyses of that specific outcome measure. Descriptive statistics were calculated for all variables and were examined in total and separately by health insurance status. The SAS procedures SURVEYFREQ and SURVEYREG were respectively used to calculate chi-square tests for categorical variables and differences in means for continuous variables, allowing for survey weights to be included. P-values < 0.05 were considered to be significant.

Weighted multivariable logistic regression using the SAS procedure SURVEYLOGISTIC was used to analyze associations between health insurance status and diabetes care compliance. Participants who reported that they were covered by health insurance served as the reference group. To adjust for potential confounding, the sociodemographic variables of age, sex, race/ethnicity, and poverty-income ratio were included as covariates in the models; in addition, to account for secular trends occurring over time, survey year was included as a covariate. Specific subgroup effects were explored through the use of stratification for each aforementioned sociodemographic variable as well as for education level, which serves as an additional marker for socioeconomic status.

Results |

Study Population Demographics

A total of 5,152 NHANES participants ≥ 18 years were diagnosed with diabetes. Of these participants, the number who had met the diabetes compliance outcomes were as follows: doctor checked hemoglobin A1C in the past year ($n = 2,947$), saw a diabetes specialist in the past two years ($n = 2,233$), taking diabetic pills to lower blood sugar ($n = 3,698$), and taking insulin ($n = 1,470$). As seen in Table 2, the mean age of participants with diabetes who were insured was 63.3 (SE = 0.2) years. In comparison, the mean age of participants with diabetes who were uninsured was 52.6 (SE = 0.4) years ($p = 0.01$). The study also found that a higher percentage of uninsured participants were non-Hispanic black (19.3% vs. 15.4%) or Mexican American and Other Hispanic (38.5% vs. 12.2%) when compared to participants who were insured ($p < 0.0001$). Similarly, a higher percentage of uninsured participants had less than a high school education (42.1% vs. 22.4%) or had a family income below the federal poverty level (34.0% vs. 15.1%) compared to insured participants ($p < 0.0001$).

Associations between Insurance Status and Diabetes Care Compliance

Table 3 displays the results of the weighted multivariable logistic regression. The odds of having A1C checked by a doctor in the past year (aOR = 0.25, 95% CI = 0.18-0.35) and taking insulin (aOR = 0.58, 95% CI = 0.43-0.80) were lower for individuals without health insurance coverage. These associations were significant for individuals aged 18-44 years and 45-64 years, but not for participants aged 65 years and older. Overall, there were differences in the likelihood of having seen a diabetes specialist in the past 2 years between those with and without health insurance (aOR = 0.77, 95% CI = 0.60-0.99), but these findings did not differ by age groups. When examined by additional subgroups, the likelihood of having seen a diabetes specialist in the past 2 years was lower for uninsured males (aOR = 0.57, 95% CI = 0.41-0.78) and for uninsured participants with incomes below the federal poverty level (aOR = 0.65, 95% CI = 0.45-0.94).

Taking diabetic pills to lower blood sugar was not found to be significantly associated with health insurance status for the overall population (aOR = 0.86, 95% CI = 0.67-1.11) or for any subgroup. For both genders, being uninsured resulted in a lower likelihood of taking insulin (Females: aOR = 0.57, 95% CI = 0.35-0.93; Males: aOR = 0.60, 95% CI = 0.41-0.88). Among racial/ethnic groups, taking insulin was less likely for uninsured Mexican American and Other Hispanic participants (aOR = 0.49, 95% CI = 0.32-0.76) compared to those who were insured. The education level of uninsured participants impacted

whether they were currently taking insulin, with those who had less than high school education (aOR = 0.56, 95% CI = 0.36-0.88) or high school/GED equivalent (aOR = 0.47, 95% CI = 0.23-0.97) being less likely to take insulin compared to their insured counterparts. Uninsured individuals were less likely to currently take insulin regardless of their income status.

Discussion | The study results indicate that health insurance status is associated with compliance in diabetes care and management. For the overall study population, of the four NHANES compliance indicators examined, annual A1C check by a doctor, seeing a diabetes specialist in the past two years, and taking insulin were significantly associated with insurance status. Taking diabetic pills was not significantly associated with the overall population or for any investigated subgroup. Overall, the association between insurance status and diabetes care is consistent with results of previous studies.

Prior studies have shown that health insurance status is associated with better access to diabetes care and achieving diabetes control targets.^{13,14} A study by Nelson et al. (2005) examined the relationships between health insurance coverage and utilization of preventative care, including annual A1C check and recommended doctor visits.¹⁴ The study analyzed cross-sectional data from a survey conducted annually by the Centers for Disease Control and Prevention. The results showed that those who were uninsured reported the lowest rates of diabetes care compliance. Uninsured individuals were less likely than insured individuals to have their A1C tested and to visit doctors for annual eye and foot exams.¹⁴ The study supports our findings that having insurance coverage leads to individuals being more compliant with having their annual A1C check by a doctor to help inform the control of their diabetes.

A cross-sectional study by Kazemian et al. (2019) indicated that having health insurance coverage is a strong indicator not only of access to diabetes care but also treatment outcomes like glycemic control.⁴ The study analyzed NHANES data divided into three 4-year intervals and showed that those insured were more likely to be linked with a source of diabetes care and were better able to achieve glycemic control, measured by having an A1C level at or below their individual target level.⁴ A recent large cohort study by Gold et al. (2021) also examined the association between insurance status and glycemic control.¹⁵ It was shown that diabetic individuals who were uninsured had higher fasting blood glucose levels than those who were insured. These studies indicate that not having health insurance is a barrier to diabetes management, which relates to our study's variables of care compliance.^{4,15}

Our study also showed that uninsured individuals were more likely to be Hispanic or non-Hispanic Black. Additionally, a higher percentage of uninsured participants had a family income below the federal poverty level. Similar disparities in health insurance coverage for diabetics has been reported in previous studies.¹⁶⁻¹⁸ For example, the study by Nelson et al. (2005), indicated that uninsured adults with diabetes were more likely to be African American or Hispanic and to have low income.¹⁴ Stark Casagrande and Cowie (2012) also found that health insurance coverage rates were lower for minorities and individuals of lower socioeconomic status.⁸ It follows that diabetics of these races/ethnicities are less likely to access diabetes care services and to be able to control their diabetes.

It has been shown that financial barriers to care, such as lack of health insurance, impact diabetes care

compliance.¹⁹⁻²¹ Piette et al. (2004) examined the link between cost-related medicine underuse among diabetics and health insurance status.²¹ Based on survey data, adults with diabetes were grouped based on their insurance status and type. Results showed that individuals who were uninsured were more likely to underuse their diabetes medication than those with health insurance. Underuse of medication negatively impacted patients' health status as measured by their A1C levels and other symptoms.²¹ These results are consistent with our findings, as taking insulin was significantly associated with insurance status in younger age groups. Better education about options for health insurance coverage is also needed for individuals who have not yet reached the point of Medicare eligibility at age 65 years.²² Understanding factors impacting diabetes care compliance can help better address issues with diabetes control and thus prevent complications of the disease.

Table 1. Selection process for study population (n = 5,152), ages ≥18 years with diabetes, National Health and Nutrition Examination Survey (NHANES), 2005-2018

Survey Years	Sample size	After exclusion of persons <18 years	After exclusion of persons without diabetes	After exclusion of persons without insurance information
2005-2006	10,348	5,563	511	511
2007-2008	10,149	6,228	761	761
2009-2010	10,537	6,527	727	727
2011-2012	9,756	5,864	706	705
2013-2014	10,175	6,113	726	726
2015-2016	9,971	5,992	845	844
2017-2018	9,254	5,856	878	878
TOTAL SAMPLE	70,190	42,143	5,154	5,152

Table 2. Characteristics of adult study population with diabetes by health insurance status, ages ≥ 18 years, National Health and Nutrition Examination Survey (NHANES), 2005-2018

Characteristic	Total	Insured	Uninsured	P-Value
N (weighted %)	5,152 (100)	4,514 (90.0)	638 (10.0)	
Age (years)				
Mean (SE)	60.0 (0.3)	63.3 (0.2)	52.6 (0.4)	0.01
Sex				
Female	49.6	49.5	50.7	0.69
Race/Ethnicity				
Non-Hispanic White	60.6	63.7	32.5	<0.0001
Non-Hispanic Black	15.8	15.4	19.3	
Mexican American and Other Hispanic	14.8	12.2	38.5	
Other Race, Including Multi- Racial	8.8	8.7	9.7	
Education level^a				
Less than high school	24.4	22.4	42.1	<0.0001
High school graduate/GED equivalent	25.2	25.3	23.6	
Some college/college graduate	50.4	52.2	34.2	
Poverty-income ratio^b				
<1.00 (below federal poverty level)	17.0	15.1	34.0	<0.0001
≥ 1.00	83.0	84.9	66.0	

^aData not available for 29 participants

^bData not available for 571 participants

Table 3. Adjusted Odds Ratios (aOR) for associations between health insurance status and diabetes care compliance outcomes among ages ≥ 18 years in the National Health and Nutrition Examination Survey (NHANES), 2005-2018^a

	No Health Insurance (vs. Covered by Health Insurance)			
	Doctor checked A1C in past year^b	Saw diabetes specialist in past 2 years	Take diabetic pills to lower blood sugar	Take insulin
Characteristic	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Total	0.25 (0.18-0.35)	0.77 (0.60-0.99)	0.86 (0.67-1.11)	0.58 (0.43-0.80)
Age				
18-44 years	0.31 (0.18-0.52)	0.76 (0.46-1.24)	0.65 (0.39-1.10)	0.54 (0.31-0.94)
45-64 years	0.21 (0.14-0.32)	0.87 (0.64-1.20)	0.87 (0.60-1.26)	0.64 (0.42-0.97)
≥ 65 years	0.52 (0.17-1.65)	1.01 (0.48-2.14)	1.76 (0.80-3.89)	0.93 (0.43-1.99)
Sex				
Female	0.32 (0.22-0.47)	1.04 (0.74-1.47)	0.89 (0.67-1.18)	0.57 (0.35-0.93)
Male	0.20 (0.12-0.33)	0.57 (0.41-0.78)	0.82 (0.57-1.19)	0.60 (0.41-0.88)
Race/Ethnicity				
Non-Hispanic White	0.23 (0.11-0.48)	0.55 (0.31-0.98)	1.11 (0.65-1.90)	0.64 (0.36-1.13)
Non-Hispanic Black	0.27 (0.14-0.52)	0.94 (0.62-1.42)	0.83 (0.56-1.24)	0.61 (0.35-1.08)
Mexican American and Other	0.37 (0.25-0.53)	0.95 (0.66-1.36)	0.77 (0.55-1.08)	0.49 (0.32-0.76)

Hispanic				
Other Race, Including Multi-Racial	0.16 (0.06-0.41)	0.94 (0.44-2.01)	0.67 (0.30-1.52)	0.93 (0.39-2.24)
Education level				
Less than high school	0.48 (0.32-0.73)	1.00 (0.68-1.46)	0.81 (0.55-1.19)	0.56 (0.36-0.88)
High school graduate/GED	0.31 (0.16-0.63)	0.54 (0.30-1.00)	0.60 (0.35-1.02)	0.47 (0.23-0.97)
Some college/college grad	0.17 (0.10-0.31)	0.80 (0.49-1.30)	0.97 (0.64-1.46)	0.85 (0.51-1.43)
Poverty-income ratio				
<1.00 (below federal poverty level)	0.47 (0.29-0.76)	0.65 (0.45-0.94)	0.76 (0.53-1.10)	0.52 (0.32-0.85)
≥1.00	0.19 (0.12-0.29)	0.83 (0.61-1.12)	0.94 (0.68-1.30)	0.64 (0.43-0.95)

^aAdjusted for survey year, age (continuous), sex, race/ethnicity, and poverty-income ratio

^bData not available for 2009-2010 survey wave: 12-year survey weights applied

Strengths & Limitations | This study examined cross-sectional insurance status and diabetes care data from seven survey cycles of NHANES, covering the 14 years between 2005 and 2018. Potential confounding by sociodemographic variables was considered and adjusted in the weighted logistic regression models. Four separate outcomes were measured to ensure a robust perspective of the impacts of health insurance status on diabetes care compliance. However, there are limitations to these findings. The study population was determined by participant responses to a self-reported NHANES survey question that did not specify differences between diagnoses of type 1 and type 2 diabetes. Although compliance targets are similar for both type 1 and type 2 diabetes,⁴ the inability to differentiate between diabetes types may have influenced one outcome of this study, which was taking diabetic pills to lower blood sugar because insulin is required to manage type 1 diabetes; oral medications are insufficient.²³ In this case, the inclusion of participants with type 1 diabetes would bias estimates downward. However, type 1 diabetes only accounts for roughly 6% of all diabetes cases among U.S. adults;²⁴ as such, impacts would likely be minimal.

In addition, this study provided an overview of U.S. population-based diabetes care compliance in pre-pandemic times; therefore, the results are likely to be conservative estimates of the current impacts of insurance status on diabetes care measures. For example, job interruption and job loss during the COVID-19 pandemic²⁵ may have impacted access to health insurance for people who had been covered in past years. In addition, these data were collected through cross-sectional surveys, and thus the findings cannot be causally interpreted. Additional prospective data and analyses would be needed to further support the conclusions drawn from this study. Factors such as access to transportation and location of residency, which were not measured in the available data, may also impact diabetes care compliance and warrant further assessment.

Implications for Public Health Practice | The results from this study can help medical and public health professionals to understand the barriers that diabetic individuals face with their diabetes care. Acknowledging these barriers allows health professionals to create individualized care plans for more attainable diabetes care compliance. Additionally, accessible and affordable health insurance is crucial to diabetes care compliance, and changes in health insurance policies may be the biggest factor in improving overall diabetes morbidity.

Conclusion | This study shows that health insurance status continues to be an important indicator of compliance with diabetes care and management in the United States. While further evidence is needed to support this association, the current results highlight the need for improved access to diabetes care services and affordable insurance options for those with diabetes. Reducing barriers to care will not only prevent life-threatening complications of the disease but also mitigate financial burdens for diabetic individuals and the national healthcare system.

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