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Association Between Health Insurance and Undiagnosed Diabetes: NHANES 2013-2016

Komal Patel

ABSTRACT
ASSOCIATION BETWEEN HEALTH INSURANCE AND UNDIAGNOSED DIABETES: NHANES 2013-2016

By

KOMAL PATEL

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BACKGROUND: Given the insidious nature of type 2 diabetes, there is a percentage of the population that goes undiagnosed. Studies suggest that undiagnosed population may be at higher risk of developing diabetes-related macrovascular and microvascular complications. Therefore, it is crucial to identify factors that may be associated with undiagnosed diabetes. Access to healthcare and other socioeconomic factors have been researched in the past; however, little is known regarding the role of health insurance in the screening of undiagnosed diabetes.

AIM: The aim of this study is to determine the three most commonly used types of health insurance (Medicare, Medicaid, and Private) among American subjects with undiagnosed diabetes. The study also sought to determine the type of health insurance that is mostly associated with undiagnosed diabetes.

METHODS: Publicly available NHANES data files for the year 2013-2016 were used for the analysis. SAS survey procedures were used to estimate weighted frequencies of undiagnosed diabetes and types of health insurance in the target population. Multivariate logistic regression was carried out to estimate the association between health insurance and undiagnosed diabetes.

RESULTS: Overall, 6.18% of the target population had undiagnosed diabetes. The prevalence of undiagnosed diabetes was higher among males (3.19%) and adults aged 60 and above (2.17%). Among those who had undiagnosed diabetes, 5.33% had health insurance, and less than 1% reported a lack of health insurance. Medicare insurance was associated with undiagnosed diabetes (aOR 1.61, 95% 1.07 – 2.42) as compared to other health insurance. This finding was statistically significant at $p<0.05$.

DISCUSSION: The prevalence of undiagnosed diabetes was higher in older adults aged 60 and above. This could be attributed to the increased prevalence of diabetes in older adults in the US. Results also indicate that males have a higher percentage of undiagnosed diabetes as compared to females. Medicare was significantly associated with undiagnosed diabetes. This may indicate that some policy reforms are required to improve diabetes screening services in this program. More research is needed to understand other factors associated with undiagnosed diabetes and reduce its prevalence in the U.S.

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by

KOMAL PATEL

BACHELOR OF DENTAL SURGERY, PANDIT BD SHARMA UNIVERSITY

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30303

APPROVAL PAGE

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by

KOMAL PATEL

Approved:

Dr. Ike Okosun
Committee Chair

Dr. Shanta R Dube
Committee Member

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Author's Statement Page

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Komal Patel
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CHAPTER I- INTRODUCTION

1.1 Background

Impact of Diabetes on the U.S. healthcare

Type 2 diabetes is the seventh leading cause of death in the U.S.(Center for Disease Control and Prevention,2020). It is a metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both(American Diabetes Association,2009). Chronic hyperglycemia is often associated with "long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels"(Diagnosis and Classification of Diabetes Mellitus, 2003, p. s5). Type 2 diabetes accounts for approximately 90% to 95% of all diagnosed cases of diabetes, whereas type 1 diabetes accounts for approximately 5-10% of all diagnosed diabetes (CDC,2019). Bullard et al. estimated that 21.0 million adults (8.6%)of U.S. adults self-reported type 2 diabetes in the year 2016 (Bullard et al., 2016). The global prevalence of diabetes is also increasing with each passing year. For the year 2015, the International Diabetes Federation(IDF) reported that approximately 415 million people had diabetes worldwide. As this epidemic is growing worldwide, IDF also predicted that by 2034, the prevalence could reach up to 640 million (International Diabetes Federation,2016). For the U.S., a study by Huang, E.S. et al. have predicted that by 2034, the number of people with diagnosed and undiagnosed diabetes will reach up to 44.1 million (Huang, E. S. et al., 2009).

The Center for Disease Control and Prevention recently published the National Diabetes Statistics Report 2020, providing up-to-date statistics on diabetes. The crude estimates presented in this report state that the prevalence of diabetes has now reached 34.2 million people of all ages, making up to 10.5% of the US population (National Diabetes Statistics

Report, 2020). Compared with the previous findings, there has been an increase in the prevalence of diabetes in the U.S. population over the past three years.

Importance of early diagnosis of Type 2 diabetes

Type 2 diabetes is a severe chronic disease, and as previously mentioned, it can lead to life-threatening complications if not detected on time. The importance of well-regulated blood sugar levels in the body cannot be overemphasized, primarily when it affects the body vasculature and results in type 2 diabetes-related morbidities(Fowler,2008). Undiagnosed diabetes predisposes a person to various macrovascular diseases (coronary artery disease, peripheral arterial disease, and stroke) and microvascular diseases (retinopathy, nephropathy, and neuropathy) and cancers. (Fowler, 2008; Wu, Y. et al., 2014).

Lack of patient awareness about its diabetes status is an issue that needs to be addressed, as nearly half of the people with diabetes are not aware of their diabetes status. Globally, one in two (50.1%), or 231.9 million of the 463 million adults living with diabetes, are unaware that they have diabetes(Diabetes Atlas, IDF,2019). Early detection of type 2 diabetes is scientifically proven to control the extent of damage to the body resulting in lesser diabetes-related morbidities in the U.S. population (Kahn, R. et al., 2010). Therefore, well-implemented diabetes screening services may have a tremendous impact on identifying prediabetes and type 2 diabetes early in the stage and assist in diabetes management.

Cost Implications of Diabetes in the U.S.

Over a period of the past two decades, as the prevalence of diabetes has increased in United States (National Diabetes Statistics Report, 2020), the diabetes-related healthcare cost as also increased (Economic Costs of Diabetes in the U.S., 2018). The total estimated cost

of diagnosed diabetes in 2017 was $327 billion, which included $237 billion as direct medical costs and $90 billion for reduced productivity. Between 2012 and 2017, per-person medical costs associated with diabetes increased from $8,417 to $9,601(National Diabetes Statistics Report, 2020). A study conducted to make future projections about diabetes, and its healthcare expenditure predicted that the annual U.S. healthcare spending would soar from $113 billion to $336 billion by 2034. (Huang, E. S., Basu, et al., 2009).

Access to healthcare and Diabetes

In the U.S., a significant percentage(67.3%) of the total healthcare cost for diabetes care is provided by government insurance(mainly Medicare and Medicaid), and the rest is covered by private insurance(30.7%) (ADA's The Cost of Diabetes). The role of federal and state-funded insurance programs in promoting early diagnosis of diabetes cannot be overstated. Lack of health insurance coverage is often found to be one of the major obstacles for the population reaching for preventive or disease management services. In patients with diabetes, lack of health insurance also leads to poor glycemic control(Zhang et al., 2012; Casagrande & Cowie, 2012). Therefore, diabetes screening services have the potential to prevent the diabetes-related complications provided the health insurance programs to facilitate access to screening services. Reports have shown that individuals with health insurance coverage often utilize more preventive services than those who are uninsured. For instance, the Oregon Health Study, done to study the effects of Medicaid expansion on health outcomes, found that Medicaid coverage increased the probability of a diagnosis of diabetes and the use of diabetes medication in addition to other diabetes-related health services (Baicker et al., 2013). To diagnose diabetes in the early stages, the U.S. Preventive Services Task Force has also laid guidelines for diabetes screening wherein high-risk individuals are advised to get the blood sugar levels checked regularly. US Preventive Services Task Force recommends screening of “all adults aged 40 to

70 years who are overweight or obese, or who have one or more other known risk factors for diabetes, such as the family history of diabetes" (Siu AL, 2015). Incorporating these guidelines in recent health-reforms can potentially reduce the prevalence of undiagnosed diabetes in the U.S. population.

Social determinants of Health and Diabetes

With the increasing evidence on the relation between diabetes and socioeconomic factors, it is crucial not to overlook other risk factors, namely low educational attainment, low income, employment insecurity, and poor living conditions (Hill, 2013). Socioeconomic factors are the latest talking points in the public health field. Socioeconomic factors are often addressed as social determinants of health. "Social determinants of health are the conditions in which people are born, grow, live, work, and age."(About Social Determinants of Health, World Health Organization). Social determinants of health include above-stated social risk factors like education, socioeconomic status, education, income in addition to access to health care (Artiga & Hinton, 2019). Causal pathways of the association between social determinants of health and type 2 diabetes are still under research. However, they are considered as potential contributors to the development of type 2 diabetes. Weaker social groups with a lack of access to health care services, healthy foods, places to exercise, and occupational opportunities, are more likely to pursue unhealthy lifestyle practices (Brown, 2004).

1.2. Research Question and Aims

What percentage of the population with undiagnosed diabetes have private health insurance, Medicare, or Medicaid? Is there an association between health insurance coverage and undiagnosed diabetes?

Aim 1: To determine the distribution of types of health insurance amongst the undiagnosed diabetes population.

Null Hypothesis 1: Distribution of types of health insurance will not vary among the undiagnosed type 2 diabetes population.

Alternate Hypothesis 1: Distribution of types of health insurance will vary among the undiagnosed type 2 diabetes population.

Aim 2: To analyze the association between Health Insurance and undiagnosed type 2 Diabetes.

Null Hypothesis 2a: Health insurance status is not associated with undiagnosed type 2 diabetes.

Alternate Hypothesis 2a: Health insurance status is associated with undiagnosed type 2 diabetes.

Null Hypothesis 2b: Prevalence of undiagnosed type 2 diabetes will be more in population with no health insurance as compared to the population with health insurance.

Alternate Hypothesis 2b: Prevalence of undiagnosed type 2 diabetes will be the same in population with no health insurance as compared to the population with health insurance.

CHAPTER II – LITERATURE REVIEW

2.1 Health Insurance and Undiagnosed Diabetes

Health insurance plays an essential role in attaining good health and affects one's ability to avail preventative services like diabetes screening(Zhang et al., 2012; Casagrande & Cowie, 2012). The existing literature on health insurance and type 2 diabetes found that among the insured population, 6.9 million were undiagnosed, accounting for 27% of the total insured population (Dall et al., 2016). Dall and colleagues also found that among those who were diagnosed and insured (16.1 million), approximately 40% had poor control of diabetes. Patients with poor control had a $4860 higher average annual healthcare expenditure(Dall et al., 2016). Dall et al. study also found that this higher average of healthcare expenditure was attributed to a higher prevalence of neurological complications (+14%), renal complications (+14%), and peripheral vascular diseases (+11%) in people with diabetes. The survey data was collected from a national survey and medical claim analysis on medical expenditure, medications, recommended exams, and diabetes-related complications. The results from the Dall et al. study identified Alaska to have the highest estimated proportion of undiagnosed diabetes population (38%) in the total diabetes population. Also, the study found that 14% of the diagnosed diabetic population lacked medical insurance before the implementation of the Affordable Care Act. The authors(Dall et al.), therefore, emphasized that there is a need for improvement in diabetes screening and management, along with some policies that support these improvements(Dall et al., 2016).

A study from the pool of existing literature also examined an association between access to healthcare and type 2 diabetes (Zhang X. et al., 2008). Zhang X. et al. analyzed data from NHANES 1999-2004 and reported that among the people with diabetes, 42% (95% CL:36.7-47.7) of the total uninsured patients remained undiagnosed in that period(1999-2004),

and 25.9% (95%CI: 22.9 –28.9) of the total insured patients were left undiagnosed in the United States. Zhang X. et al. indicated an association between remaining undiagnosed and not having health insurance (OR=1.70;95%CI:1.0-2.9) and having health insurance> 1 year (OR=2.60;95%CI:1.40- 5.00) (Zhang X. et al., 2008).

More recent literature available on undiagnosed diabetes also elaborated that the prevalence of undiagnosed diabetes varied in different age groups and racial groups(Zhang.N et al.,2017). Zhang N. et al. researched to study 10-year trends in the prevalence of undiagnosed and diagnosed diabetes using NHANES 1999-2010. The highest proportion of undiagnosed diabetes was observed in Non-Hispanic Whites (72.43;p-value=0.0015) among the total undiagnosed diabetes population. Individuals aged< 30years observed a significantly lower proportion(2.58; p-value=0.0032) of undiagnosed diabetes in the total population undiagnosed diabetes(Zhang.N et al.,2017).

The National Diabetes Statistics Report(NDSR),2017 reported that overall, 9.4% of the total U.S. population had diabetes, but more than three times that percentage(23.8%) remained undiagnosed (NDSR,2017). In the light of healthcare service utilization, the American Diabetes Association highlighted that "people with undiagnosed diabetes who do not have health insurance have 60% fewer physician office visits and they have 168% more emergency department visits than people who have insurance"(Peterson M., 2018).

The growing body of literature on undiagnosed diabetes and health insurance has helped mold the new policies to improve healthcare access. The Affordable Care Act(ACA) provisioned free preventative services to its enrollees, helping improved utilization of diabetes screening services(Kaiser Family Foundation, 2015). This new provision of ACA also mandated that private insurance plans cover recommended preventive services without any patient cost-sharing (Kaiser Family Foundation, 2015). This provision, therefore, increased the

case detection rates and diagnosis of type 2 diabetes(or prediabetes) on time (Burge, M. R., & Schade, D. S.,2014).

Improving healthcare access was one of the critical goals of ACA. Some studies were done to understand the effects of its implementation confirmed improved insurance rates. For example, a cross-sectional study done by Myerson R. et al. focusing on health care coverage showed a reduction of the uninsured population in the diabetes population(diagnosed and undiagnosed both). The estimated percentage of uninsured and undiagnosed diabetes population in the U.S. significantly(p-value<0.01) plummeted from 25% (95% CI: 23–27) pre-ACA to 8%(95%CI: 5-7) post-ACA (Myerson R.et al.,2019). This group of researchers(Myerson R.et al.) concluded that increased health insurance coverage among undiagnosed patients could improve the health outcomes and help dissolve the disparities observed in healthcare access. The new health reforms could also help the neglected sections of our society (Myerson R.et al.,2019).

2.2 Gap in the literature

Although a vast number of researches has been carried out in the past, the literature is scarce in including undiagnosed diabetes in the study. In order to improve the availability of preventive screening services for diabetes, it is crucial to understand how different types of insurance plans are associated with undiagnosed diabetes. Understanding the accessibility to screening services in these insurance plans may be a starting point to bring evidence-based health-reforms. Historically, the epidemiological studies have primarily used the "diagnosed" diabetic population as their focal point. However, this study aims to be centered on the "undiagnosed" diabetes in the U.S. population to bolster diabetes screening services.

CHAPTER III- DATA SOURCE AND METHODS

3.1 Data source

This study used most recently available (2013-2014 and 2015-2016) from the National Health and Nutrition Examination Survey. The data was sorted by sequence number and merged before the analysis. Center of Disease Control and Prevention(CDC) explains the National Health and Nutrition Examination Survey (NHANES) as “a complex stratified multistage probability sample of the civilian noninstitutionalized population” of the United States. NHANES is conducted in partnership with the National Center for Health Statistics and the Center for Disease Control and Prevention.

3.2 Sample Size

In 2013-2014, 14,332 persons were selected for NHANES from 30 different survey locations. Of those selected, 10,175 completed the interview, and 9,813 were examined. In 2015-2016, 15,327 persons were selected for NHANES from 30 different survey locations. Of those selected, 9,971 completed the interview, and 9,544 were examined. Hispanic persons, Non-Hispanic black persons, Non-Hispanic Asian persons, Non-Hispanic white and other persons at or below 130 percent (2013-2014), and 185 percent (2015-2016) of the poverty level, Non-Hispanic white and other persons aged 80 years and older were oversampled in both the cycles. (CDC, 2020)

The advantage of using NHANES data over other nationally representative surveys for this study is that it collects laboratory, questionnaire data, as well as examination data. NHANES's researchers collect biospecimens for laboratory analysis to provide detailed information about participants' health and nutritional status. For this cycle of data collection, the whole blood samples were tested by the Diabetes Diagnostic Laboratory at the University of Missouri-Columbia using the Tosoh Automated Glycohemoglobin Analyzer HLC-723G8.

3.3 Inclusion and Exclusion Criteria

Inclusion: Adults aged 20 years and above who completed both, interview and examination, were included.

Exclusion: Female participants between ages 20- 44 who tested positive in the laboratory pregnancy test or self-reported pregnant at exam were excluded to prevent gestational Diabetes from being mistakenly counted as Type 2 diabetes. Variable used "Pregnancy status at exam" (RIDEXPRG).

3.4 Main Dependent and Independent Variables

Undiagnosed Type 2 Diabetes was the main dependent variable for this study, and health insurance was the main independent variables studied in this study. The sample was analyzed for the distribution of "type of health insurance" among the undiagnosed Type 2 diabetes population and association between the main dependent and independent variables.

Undiagnosed Type 2 Diabetes definition

Undiagnosed type 2 diabetes was defined using NHANES question: "Have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?" and using the following criteria:

Fasting plasma glucose (FPG) of 125 mg/dl or greater

Oral glucose tolerance test (OGTT) value of 200 mg/dl or greater

Glycated hemoglobin (A1c) 6.5% or greater.

Participants who answered negatively to the above question and met at least one of the above-stated criteria were defined as having undiagnosed type 2 diabetes.

Health Insurance

Under the health insurance questionnaire, participants who answered **yes** to the variable **HIQ011** which is

"Are you covered by health insurance or some other kind of health care plan?" were categorized to be "Have health insurance coverage," and those who answered **no** were categorized as "No health insurance coverage."

Types of health insurance were categorized using the following variables: covered by private insurance (HIQ031AC), covered by Medicare(HIQ031B) and covered by Medicaid (HIQ031D)

Three new variables were created to define self-reported insurance type: Private Insurance, Medicare, and Medicaid.

3.5 Other covariates

The demographic characteristics of the targeted population were defined using variables: age (RIDAGEYR), gender(RIAGENDR), race(RIDRETH3), education (DMDEDUC2), and Annual Family income (INDFMIN2).

Age(RIDAGEYR): Age was recorded in years at the time of screening. New categories were code as follows: 20- 39 years, 40- 59 years, and 60 and above.

Gender (RIAGENDR): Gender was recorded as male and female, as reported.

Race (RIDRETH3): Reported race and Hispanic origin information derived from this variable were recoded into Non-Hispanic Whites, Non-Hispanic blacks, Non-Hispanic Asians, Hispanics and Others.

Education(DMDEDUC2): This variable provides information on participants aged 20 and above recording, the highest grade or level of school completed, or the highest degree received. The categories provided were recoded to the following: Less than high school diploma;

High school diploma and Associates Degree; College graduate and above.

Annual Family Income Level (INDFMIN2): Annual Family income were recoded into the following levels: Below 25,000; 25,000-44,999; 45,000-64,999; 65,000- 99,999; 100,000 and above.

Potential confounding variables controlled in the analysis

Current Smokers, obesity, physical activity, history of any other medical conditions (Hypertension, high cholesterol, coronary heart disease, and stroke)

Current Smokers: Participants who answered "yes" to "Smoked at least 100 cigarettes in life(**SMQ020**)" and "Every day or Some days" to "Do you now smoke cigarettes? (**SMQ040**)" were classified as "current smokers." Those who replied "no" to the above-mentioned question(SMQ020) and "not at all" to SMQ040 were classified as "Past smokers."

Body Mass Index (BMI): Data on BMI was gathered from the "Body measure examination" data file using variable "**BMXBMI**" expressed in units of kg/m^2. Participants were categorized by BMI as follows: Below 30.0 as "Not obese" and above 30.0 as "Obese."

Vigorous Physical activity: The Physical Activity questionnaire (variable name prefix PAQ) is based on the Global Physical Activity Questionnaire (GPAQ) and provides respondent-level interview data on physical activities. Variable **PAQ605** is used to record a respondent's answer for "Vigorous work activity." The response to the question asked in the questionnaire, "Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for at least 10 minutes continuously?" helps provide insight about participant's physical activity status.

Participants who answered "yes" were recoded as "Physically active" and "no" were recoded as "Not physically active."

History of medical conditions

NHANES questionnaire also covers the questions related to the history of medical conditions. Pre-existing medical conditions can confound the relationship between Type 2 diabetes and health insurance; therefore, these variables were also included in the analysis. Medical Conditions Questionnaire (MCQ) data file provides self-reported personal interview data on a broad range of health conditions and medical history. Medical conditions included in the analysis were: History of hypertension, history of high cholesterol, coronary heart disease, and stroke.

- **Hypertension**: was defined using the question "Ever told you had high blood pressure **(BPQ020)".** Those who answered "yes" were recoded as "Hypertensive" and "no" recoded as "Not hypertensive."
- **High Cholesterol**: was defined using the question, "Doctor told you have high cholesterol level **(BPQ080)**". Those who answered "yes" were recoded as "High Cholesterol" and "no" recoded as "No High Cholesterol."
- **Coronary heart disease**: was defined using the question "Has a doctor or other health professional ever told you that you had coronary heart disease? **(MCQ160c)"**

  Those who answered "yes" were categorized as "Yes" for that disease/condition, and those who "no" were categorized as "No."
- **Stroke**: was defined using the question "Has a doctor or other health professional ever told you that you had stroke? **(MCQ160f)"** Those who answered "yes" were categorized as "Yes" for that disease/condition, and those who "no" were categorized as "No."

3.6 Statistical procedures

OGTT Subsample 4 Year MEC weights were applied to the analysis in order to adjust for the effects of the sampling design, yielding the total sample(n) of 4,138 participants. Missing values [HbA1C (1101), FPG (136), and OGTT (136)] in the blood sugar tests were recoded to '0' result observations.

Descriptive statistics were conducted to determine demographics characteristics (age, gender, race, education, annual family income) of the target population for undiagnosed diabetes and health insurance status. The prevalence of undiagnosed diabetes was also noted in private health insurance, Medicaid, and Medicare. Significance between the variables was determined by bivariate analysis (PROC SURVEYFREQ) using the chi-squared test in categorical variables. Based on the results of the above-mentioned bivariate analysis, multivariable logistic regression was carried out using PROC SURVEYLOGISTICS.

The variables that demonstrated a statistically significant association with the primary dependent variable and independent variable were controlled in all the models. Model 1 was constructed for undiagnosed diabetes and health insurance controlling for the potential confounders. Model 2 was constructed using undiagnosed diabetes and 'private insurance' along with other covariates. Model 3 used Medicare, and Model 4 used Medicaid along with other covariates against undiagnosed diabetes. A two-sided p-value< 0.05 was considered statistically significant for all analyses.

All the statistical procedures were carried out using the Statistical Analysis System (SAS) 9.4.

CHAPTER IV – RESULTS

4.1 Descriptive Statistics

After applying sample weights, inclusion, and exclusion criteria, 4138 participants were eligible for this study. Among those, 535 (9%) participants had elevated HbA1C levels (6.5% or higher); 585 (10%) had elevated fasting plasma glucose levels (126 mg/dL or higher) and 229 (4.45%) had elevated oral glucose tolerance test levels (200 mg/dL or higher). For the self-reported diabetes status, 632 (10%) participants were never told by any health professional/ doctor that they have diabetes as compared to 3,506(90%) participants who were told by health professional/doctor that they diabetes. After combining the laboratory results and self-reported diabetes status, it was determined that 304 (6.18%) participants had undiagnosed diabetes.

Undiagnosed Diabetes and participant's characteristics

The weighted descriptive statistics of participants' characteristics are displayed in Table 1. Participants who had health insurance coverage had a higher percentage of undiagnosed diabetes (5.33%) than those without health insurance (0.86%). The prevalence of undiagnosed diabetes was marginally higher in males (3.19%) as compared to females (2.98%), and adults aged 60 and above (2.74%) had a slightly higher prevalence of undiagnosed diabetes as compared to those between 40 to 60 years old (2.58%). The percentage of undiagnosed diabetes was highest in Non-Hispanic Whites (4.12%) followed Hispanics (0.93%), and Non-Hispanic Blacks (0.63%) among the total undiagnosed diabetes population. The percentage of undiagnosed diabetics was also higher in participants with college degree education (2.16%) in comparison to participants with education less than high school (1.17%). Participants who had an annual family income of less than 25,000 (1.77%) had a higher percentage of undiagnosed diabetes than those who had an annual family income of 65,000 and above (0.89%) among the total undiagnosed diabetes population.

Health Insurance and participant's characteristics

The prevalence of insured was 83.6% (3316), and uninsured was 16.4% (812) among the total sample population. The percentage of uninsured participants was highest in adults aged 20-39 years (9.26%) followed by adults aged 40-59years (5.99%) and adults aged 60 and above (1.13%) among the total sample population. Males (8.50%) were more likely to be uninsured as compared to females (7.88%). Health Insurance coverage was also found to be the highest in Non-Hispanic Whites (6.70%), followed by Hispanics (5.66%) and Non-Hispanic Blacks (2.89%). Participants who attained college graduate degree or higher had the highest percentage of health insurance coverage (29.45%), followed by those who attained College or Associates degree (27.28%), high school graduate (16.82%) and education less than high school (10.03%) among the total sample population. The percentage of health insurance coverage also increased as the annual family income increased. Among those with no health insurance (16.40%), the percentage was highest in participants with family income less than 25,000 (6.86%) and the least in those with annual family income above 100,000 (0.43%). (See Table 2)

4.2 Results of Bivariate Analysis

Undiagnosed Diabetes and participants' characteristics

Statistically significant association was found between undiagnosed diabetes and participants' demographics variables: age ($p<0.0001$), education ($p=0.03$), an annual family income ($p=0.01$). No statistically significant association was found between undiagnosed diabetes and: gender ($p=0.405$), race ($p=0.926$), and health insurance($p=0.2668$). Among the type of insurances, undiagnosed diabetes was associated with Medicare ($p<0.0001$).

Other covariates that were significantly associated with undiagnosed diabetes were: Obesity ($p=0.0002$), history of hypertension ($p<0.0001$), history of high cholesterol

(p<0.0001), history of coronary heart disease (p=0.02) and history of stroke (p=0.02). No statistically significant association was found between undiagnosed diabetes and physical activity (p=0.263) and smoking(p=0.403).

Health Insurance and participant's characteristics

Statistically significant association were found between health insurance and all demographics variables: age (p<0.0001), gender (p= 0.03), race (p<0.0001), education (p<0.0001) and annual family income (p<0.0001). Other covariates that had a statistically significant association with health insurance were: Smoking (p<0.0001), physical activity (p<0.0001), history of hypertension (p<0.0001), history of high cholesterol (p<0.0001), history of coronary heart disease (p<0.0001), history of stroke (p< 0.04). No statistically significant association was found between health insurance status and obesity (p=0.901).

Unadjusted Odds Ratio

In the unadjusted univariate models, the population aged between 20 and 40 was less likely to remain undiagnosed with diabetes compared to the population aged 60 and above (OR= 0.2; 95%CI:0.13-0.34). The analysis also revealed that the population with education less than high school had increased odds of remaining undiagnosed with diabetes as compared to the population with college graduates and above (OR=1.84;95%CI: 1.13-2.97). The odds of remaining undiagnosed with diabetes among those with annual family income below 25,000 was 2.14 the odds of remaining undiagnosed with diabetes among those with annual family income 100,000 and above: 95% of the time, the odds ratio was between 1.21-3.01. For health insurance coverage, the population with no health insurance had lower odds of remaining undiagnosed with diabetes as compared to the population with health insurance (OR, 0.81 95% CI, 0.54-1.21).

When looking at the type of health insurance, the population with Medicare had increased odds of remaining undiagnosed with diabetes as compared to the population with other types of health insurance (OR, 2.50 95% CI, 1.83-3.42). On the contrary, the population covered by private health insurance had lower odds of remaining undiagnosed with diabetes as compared to the population covered by other types of health insurance (OR, 0.78 95% CI, 0.59-1.03). The population covered by Medicaid also had approximately the same odds of remaining undiagnosed with diabetes as compared to the population covered by other types of health insurances (OR, 0.99 95% CI, 0.57-1.74). (See Table 3)

4.3 Results of Multivariable logistic regression analysis

Adjusted Odds Ratio

In the adjusted models, the odds of remaining undiagnosed with diabetes in participants with no health insurance was 1.11 the odds of remaining undiagnosed with diabetes in participants with health insurance (OR=1.11;95% CI:0.76-1.66). After controlling for all the independent variables, the odds of remaining undiagnosed with diabetes in participants with private insurance were 0.82 the odd of remaining undiagnosed with diabetes in participants with other types of health insurance (OR=0.82;95%CI: 0.60-1.12). After controlling for all the independent variables, the odds of remaining undiagnosed with diabetes in participants with Medicaid was 0.89 the odds of remaining undiagnosed with diabetes in participants with other types of health insurance (OR=0.89;95%CI: 0.50-1.58). Using a similar model, after controlling for all the independent variables, the odds of remaining undiagnosed in participants with Medicare was 1.61 the odds of remaining undiagnosed in participants with other types of health insurance (OR=1.61;95%CI:1.07-2.42). The association between undiagnosed diabetes and Medicare was found to be statistically significant (p-value= 0.021) In all the above models, annual family income was excluded from the models due to collinearity. In the adjusted models, the odds of remaining undiagnosed with diabetes in participants who were obese were

1.79 the odds of remaining undiagnosed with diabetes in participants with health insurance (OR=1.79;95%CI:1.23-2.61) (p-value=0.003). (See table 4,5,6 and 7)

CHAPTER V- DISCUSSION

5.1 Discussion

The purpose of this thesis was to determine the prevalence of private health insurance, Medicare, and Medicare in the population with undiagnosed diabetes. The second aim of this study was to analyze the association between undiagnosed diabetes and health insurance status. This study also aimed to understand the association between undiagnosed diabetes and the three types of health insurance coverage mentioned above. Combining two cycles of NHANES, this thesis study used data from the year 2013-2016. Undiagnosed diabetes was defined using NHANES question 'Ever told by a doctor that you have diabetes' and blood sugar levels using three tests: Glycohemoglobin (HBA1C), fasting plasm glucose (FPG) or oral glucose tolerance test (OGTT). Those who answered 'no' to the question but had elevated blood sugar levels based on the cutoffs mentioned, were defined as having undiagnosed diabetes. This study focused primarily on undiagnosed diabetes and compared the findings from this group (undiagnosed diabetes) to the total sample population

Overall, the results of the study suggest that participants with no health insurance have increased odds of remaining undiagnosed with diabetes as compared to participants with health insurance (aOR=1.11;95% CI: 0.73-1.69). However, the result was not statistically significant (p-value=0.609). Literature has shown mixed results for the association between health insurance coverage and undiagnosed diabetes. A previous study found evidence of the association between health insurance status and undiagnosed diabetes (Zhang et al., 2017). Zhang et al. reported ten- year trends (1999-2010) using NHANES data and found that participants with undiagnosed diabetes were more likely to be without health insurance (Zhang et al., 2017).

Findings from this thesis study also determined that participants belonging to low-income groups (annual family income 25,000 and below) had an increased probability of remaining undiagnosed as compared to the more affluent population. Non-Hispanic Whites comprised of the highest percentage (4.2%) of undiagnosed diabetes among all races and ethnicities (6.18%) in the total undiagnosed population. These findings were comparable to the demographics characteristics of undiagnosed diabetes described in *Diabetes in America* for NHANES 2005-2010 (Appendix 8.32, Diabetes in America, 3rd edition). Participants with education below college graduate degree were more likely to remain undiagnosed with diabetes as compared to those with education college graduate or higher. However, after controlling for confounding, the association between education and undiagnosed diabetes was not statistically significant (p-value=0.132). The previous study exploring the relationship between education and diabetes have found an inverse association between education and diabetes (Borrell, Dallo, & White, 2006). Education level is one of the social determinants of health and previously associated with diabetes. However, this did not find a significant association between education and undiagnosed diabetes. Participants who were young adults and middle-aged (20 to 40) were significantly less likely to remain undiagnosed with diabetes as compared to participants aged 60 and above (OR=0.26;95% CI: 0.15-0.44; p-value<0.0001). This finding may be explained by the association found between Medicare and undiagnosed diabetes in this sample. According to the U.S. Department of Health & Human Services (H.H.S.), Medicare is only available for people aged >65 and those with disabilities. Therefore, some correlation between age and Medicare is suspected.

As for other types of health insurance coverage, this thesis study found that participants who had private health insurance or Medicaid had lower odds of remaining undiagnosed with diabetes as compared to those with other types of health insurance. Medicare, on the contrary, was significantly associated with undiagnosed diabetes. After controlling for all the

independent variables, the odds of remaining undiagnosed with diabetes in participants with Medicare was 1.61 the odds of remaining undiagnosed with diabetes in participants with other types of health insurance (OR=1.61;95%CI:1.07-2.42). As this study is one of a kind, literature is scarce to support this finding. However, patient and physician satisfaction from Medicare has been questionable, according to some literature (Davis K.et al, 2001). Many policymakers have suggested remodeling this federal program in order to improve the experiences for Medicare beneficiaries and lighten the administration burden on physicians accepting Medicare.

The Centre of Medicare and Medicaid says Medicare is a federal health insurance program that has two parts: Part A and Part B. Medicare Part A covers hospital insurance, whereas Medicare Part B covers medical insurance. Preventative services like diabetes screening fall under Medicare Part B, available at a monthly premium, and is not free of cost. It is a limitation of the data used for this thesis that no details were available on which Medicare (Part A, Part B, or both) the participants possessed. Medicare has been investing in bolstering its preventative services. In 2005, in order to increase the utilization of preventive services, those who enrolled in Medicare Part- B were allowed to get 'One-Time Initial Preventive physical examination (IPPE).' Although diabetes screening was not included in this one-time examination. Overall, this provision failed to increase preventative healthcare utilization (Ng, Jensen & Fritz, 2017). Other healthcare-related factors may potentially explain the increased prevalence of undiagnosed diabetes in Medicare beneficiaries. Recent studies have shown that there has been a decline in the number of primary care physicians accepting new Medicare patients. A survey conducted by Kaiser Family Foundation in 2015 found that most primary care physicians preferred accepting new privately insured patients (80%) as compared to new Medicare patients (72%) (Boccuti et al., 2015). The press also highlighted the issue of new-patient acceptance. According to an article in the Wall Street Journal in 2013, it was published

that fewer American doctors were treating patients with Medicare due to low reimbursement rates that do not consider economic inflation (Beck, 2013).

5.2. Study Limitations

Using data from a large national survey has some limitations. Given the cross-sectional study design and data source, no causal inferences can be made. To handle missing values in the blood test reports, missing values were recoded to 0. This may have resulted in misclassification bias and, therefore, underestimation of undiagnosed diabetes cases. On the contrary, clinical recommendations require a second positive test to confirm elevated blood sugar level as with-in person variability in glycemic measures may affect the results. However, NHANES conducts laboratory tests only once as a part of this survey. Moreover, undiagnosed diabetes was defined using self-reported diabetes status. Therefore, the presence of recall bias also cannot be ruled out when considering the limitations.

For future researches, it may be beneficial to study some other factors that can explain why people are staying undiagnosed even after having health insurance. Subsequent studies may also benefit by focusing on collecting primary data, especially if the study involves rare variables, i.e., undiagnosed diabetes. This finding will help the researchers identify 'undiagnosed type 2 diabetes' cases with more accuracy. Qualitative studies aimed to understand health literacy and cultural barriers may also help understand the gap between diagnosed and undiagnosed diabetes.

5.3 Policy Implications

Like several other chronic diseases, diabetes poses a substantial economic burden on the U.S. healthcare system. Moreover, these direct and indirect costs associated with Type 2 diabetes will only surge in the coming years. The clinical complications caused due to diabetes are preventable if the disease is detected on time. This calls for a robust healthcare system focused on prevention and better policies to run federal health insurance programs. In order to

make government insurance like Medicare and Medicaid more efficient in screening services, innovative policies may be put in place. Incentivizing doctors and primary care physicians may also revolutionize the healthcare sector and push the future towards value-based care rather than fee-for-service concept. Prioritizing preventative services across all types of health insurance is also another key to achieve good health for all. The focus should also be placed to address the prevailing health disparities in the country.

5.4 Conclusion

The results of this study suggest that a population with no health insurance has increased odds to remain undiagnosed as compared to those with health insurance. However, the association between health insurance and undiagnosed diabetes was not statistically significant. On the contrary, Medicare and undiagnosed diabetes were significantly associated. Moreover, the population with Medicare had increased odds of remaining undiagnosed as compared to the population with other types of insurance. This finding may prove useful when considering reforms in federal insurance programs like Medicare. Obesity was also found to be significantly associated with undiagnosed diabetes; therefore, improving awareness about diabetes screening in this group can be useful for future health programs.

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APPENDIX

Table 1. Demographics Characteristics of Target Population Stratified by Undiagnosed Diabetes Prevalence: Non-pregnant Adults age 20 and above, NHANES 2013-2016

	UNDIAGNOSED DIABETES (+) N=304 (6.18%)		**UNDIAGNOSED DIABETES (-) N=3834 (93.8%)**		
Variable	**N**	**Col Percent (%)**	**N**	**Col Percent (%)**	**p-value***
Age Groups					**<0.0001**
20–39	32	0.85	1254	35.07	
40-59	110	2.58	1341	34.06	
60 and above	162	2.74	1239	24.68	
Sex					0.4057
Males	171	3.19	1871	44.99	
Females	133	2.98	1963	48.82	
Annual Family Income					**0.0139**
Below 25,000	98	1.77	1069	20.59	
25,000- 44,999	69	1.70	792	18.58	
45,000-64,999	43	0.98	540	15.68	
65,000-99,999	37	0.77	531	16.73	
100,000 and above	26	0.89	609	22.26	
Race/ethnicity					0.9267
Non-Hispanic White	129	4.12	1540	61.05	
Non-Hispanic Black	50	0.63	720	10.85	
Non-Hispanic Asian	29	0.33	436	5.20	
Hispanic	89	0.93	1027	13.94	
Other/Multi	7	0.14	111	2.76	
Education					**0.0319**
Less than High School	79	1.17	856	14.32	
HS Graduate/GED	78	1.51	828	19.91	
College/Associates Deg.	93	2.16	1130	29.71	
College Grad and above	54	1.32	1018	29.87	
Health Insurance					0.2975
Has health insurance	258	5.33	3058	78.27	
No health insurance	46	0.86	766	15.53	
Private Insurance					
Has private Insurance	149	3.40	1961	57.29	0.0699
Other/No private insurance	154	2.77	859	36.52	
Medicare					
Has Medicare	121	2.18	832	16.80	**<0.0001**
Other/No Medicare	183	3.99	3002	77.01	
Medicaid					0.9949
Has Medicaid	31	0.48	417	7.39	
Other/No Medicaid	273	5.69	3417	86.42	

	UNDIAGNOSED DIABETES (+)		UNDIAGNOSED DIABETES (-)		
Variable	**N**	**Col Percent (%)**	**N**	**Col Percent (%)**	**p-value**
Obesity	151	3.26	1435	35.40	**0.0002**
Obese	153	2.91	2399	58.41	
Not Obese					
Physical Activity					
Yes	53	1.13	787	20.80	0.2632
No	251	5.04	3046	73.01	
Ever told you have HTN					**<0.0001**
Yes	166	3.23	1407	30.49	
No	138	2.94	2427	63.32	
Ever told you have high					**<0.0001**
CHL	141	3.16	1390	31.59	
Yes	163	3.01	2444	62.22	
No					0.4030
Smoking	62	1.28	730	17.54	
Current Smoker	242	4.90	3100	76.27	
Past Smoker					**0.0290**
Ever told you have CHD	20	0.4	162	3.23	
Yes	283	5.74	3660	90.58	
No					**0.0261**
Ever told you have stroke	19	0.30	134	2.66	
Yes	284	5.86	3699	90.15	
No					

HTN =Hypertension
CHL= Hypercholesteremia
CHD= Coronary Heart Disease
N= Unweighted frequencies
* p-value obtained using Chi-Squared Test

Table 2. Demographics Characteristics of Target Population Stratified by Health Insurance: Non-pregnant Adults age 20 and above, NHANES 2013-2016

	HEALTH INSURANCE (+) N=3316 (83.60%)		**NO HEALTH INSURANCE (-) N=812 (16.40%)**		
Variable	**N**	**Col Percent (%)**	**N**	**Col Percent (%)**	**p-value**
Age Groups					**<0.0001**
20–39	875	26.68	408	9.26	
40-59	128	30.63	320	5.99	
60 and above	1313	26.29	84	1.13	
Sex					**0.040**
Males	1610	39.69	428	8.50	
Females	1706	43.91	384	7.88	
Annual Family Income					**<0.0001**
Below 25,000	827	15.46	335	6.86	
25,000- 44,999	629	15.63	232	4.68	
45,000-64,999	492	14.37	91	2.32	
65,000-99,999	511	15.87	57	1.66	
100,000 and above	615	22.66	18	0.43	
Race/ethnicity					**<0.0001**
Non-Hispanic White	1452	58.45	213	6.70	
Non-Hispanic Black	607	8.60	162	2.89	
Non-Hispanic Asian	396	4.76	67	0.74	
Hispanic	761	9.22	352	5.66	
Other/Multi	100	2.54	18	0.37	
Education					**<0.0001**
Less than High School	634	10.03	298	5.39	
HS Graduate/GED	689	16.82	215	4.61	
College/Associates Deg.	1006	27.28	215	4.61	
College Grad and above	985	29.45	84	1.77	
Obesity					0.901
Obese	1287	32.31	294	6.27	
Not Obese	2029	51.29	518	10.11	
Physical Activity					**<0.0001**
Yes	599	17.15	238	4.71	
No	2717	66.44	574	11.67	
Ever told you have HTN					**<0.0001**
Yes	1385	30.33	184	3.33	
No	1931	53.26	628	13.05	
Ever told you have high CHL					**<0.0001**
Yes	1366	31.85	160	2.83	
No	1950	51.74	652	13.55	

Smoking	568	13.94	224	4.92	**<0.0001**
Current Smoker	2744	69.65	588	11.47	
Past Smoker					
Ever told you have CHD					**0.0001**
Yes	168	3.48	12	0.16	
No	3136	80.10	799	16.23	
Ever told you have stroke					**0.040**
Yes	137	2.70	15	0.26	
No	3177	80.89	797	16.13	

Abbreviations
HTN =Hypertension
CHL= Hypercholesteremia
CHD= Coronary Heart Disease
CHL= Cholesterol
N= Unweighted frequencies
* p-value obtained using Chi-Squared Test

Table 3. Bivariate Analysis of the association of participant characteristics with main outcome variable, Undiagnosed diabetes in Non-Pregnant Adults ages 20-and above, NHANES (2013-2016)

Participant Characteristics	Unadjusted Odds Ratio	95% Confidence Interval	p-value*
Age group (years)			
20-39	0.21	0.13 - 0.34	**<0.0001**
40-59	0.68	0.48 - 0.95	**0.027**
60 and above	Reference	Reference	Reference
Sex			
Male	1.16	0.80-1.69	0.412
Female	Reference	Reference	Reference
Race			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.86	0.57 – 1.30	0.471
Non-Hispanic Asians	0.94	0.54 – 1.61	0.816
Hispanics	0.99	0.68 – 1.43	0.973
Others	0.79	0.37 – 1.72	0.554
Education			
Less than High School	1.84	1.13 – 2.97	**0.014**
High School Graduate/GED	1.71	1.08 - 2.72	0.023
College/Associates Degree	1.63	0.96 – 2.72	0.065
College Graduate and above	Reference	Reference	Reference
Annual Family Income			
Below 25,000	2.15	1.20 – 3.85	**0.012**
25,000-44,999	2.30	1.37 – 3.85	**0.002**
45,000-64,999	1.57	0.78 – 3.12	0.201
65,000- 99,999	1.17	0.55 – 2.42	0.683
100,000 and above	Reference	Reference	Reference
Health Insurance			
No health insurance	0.81	0.54 – 1.21	0.304
Has health insurance	Reference	Reference	Reference
Private Insurance			
Has private insurance	0.78	0.59 – 1.03	0.083
Other/No private Insurance	Reference	Reference	Reference
Medicare			
Has Medicare	2.50	1.83 – 3.43	**<0.0001**
Other/No Medicare	Reference	Reference	Reference
Medicaid			
Has Medicaid	1.00	0.57 – 1.74	0.994
Other/No Medicaid	Reference	Reference	Reference

Obesity			
Obese	1.84	1.30 – 2.61	**0.001**
Not obese	Reference	Reference	Reference
Smoking			
Current Smoker	1.13	0.83-1.55	**0.411**
Past Smoker	Reference	Reference	Reference
Ever told you have Hypertension			
Yes	0.43	0.33 – 0.59	**<0.0001**
No	Reference	Reference	Reference
Ever told you have high CHL			
Yes	0.48	0.34 – 0.68	**0.0002**
No	Reference	Reference	Reference
Ever told you have CHD			
Yes	2.10	1.03 – 4.30	**0.0409**
No	Reference	Reference	Reference
Ever told you had a stroke			
Yes	1.78	1.03 – 3.07	**0.0371**
No	Reference	Reference	Reference

Abbreviations:
GED= General Educational Development
CHD= Coronary Heart Disease
CHL= Cholesterol
*p-value from Maximum Likelihood Estimates

Table 4. Multivariate Logistic Regression Analysis for Undiagnosed Diabetes and Health Insurance with other participant characteristics: Non-Pregnant Adults Age 20 and above, NHANES (2013-2016)

Participant Characteristics	Adjusted Odds Ratio	95% Confidence Interval	p-value*
Age group (years)			
20-39	0.26	0.15- 0.44	**<0.0001**
40-59	0.70	0.48- 1.02	0.066
60 and above	Reference	Reference	Reference
Sex			
Male	1.29	0.86-1.94	0.203
Female	Reference	Reference	Reference
Race			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.84	0.54 – 1.37	0.523
Non-Hispanic Asians	1.51	0.80 – 2.85	0.187
Hispanics	1.18	0.72 – 1.92	0.487
Others	0.76	0.33 – 1.71	0.496
Education			
Less than High School	0.99	0.52 – 1.90	0.132
High School Graduate/GED	1.19	0.71 – 1.97	0.064
College/Associates Degree	1.16	0.64 – 2.06	0.118
College Graduate and above	Reference	Reference	Reference
Health Insurance			
No health insurance	1.11	0.73 – 1.69	0.605
Has health insurance	Reference	Reference	Reference
Obesity ǂ			
Obese	1.79	1.23 – 2.61	**0.003**
Not obese	Reference	Reference	Reference
Smoking			
Current Smoker	1.27	0.88 – 1.84	0.177
Past Smoker	Reference	Reference	Reference
Ever told you have Hypertension			
Yes	1.37	1.00 – 1.88	**0.044**
No	Reference	Reference	Reference
Ever told you have high cholesterol			
Yes	1.30	0.91– 1.86	0.135
No	Reference	Reference	Reference
Ever told you have CHD			
Yes	1.09	0.545– 2.13	0.791
No	Reference	Reference	Reference
Ever told you had a stroke			
Yes	1.10	0.63 – 1.93	0.722
No	Reference	Reference	Reference

Notes

Abbreviations: GED= General Educational Development, CHD= Coronary Heart Disease

Multivariate Logistic Regression Model significance level p<0.0001

*p-value from Maximum Likelihood Estimates

ǂ Participants considered obese when body mass index (BMI in kg/m^2) of >30 and not obese when BMI<30

Table 5. Multivariate Logistic Regression Analysis for Undiagnosed Diabetes and Private Health Insurance with other participant characteristics: Non-Pregnant Adults Age 20 and above, NHANES (2013-2016)

Participant Characteristics	Odds Ratio	95% Confidence Interval	p-value*
Age group (years)			
20-39	0.26	0.16 - 051	**<0.0001**
40-59	0.72	0.53- 1.22	0.083
60 and above	Reference	Reference	Reference
Sex			
Male	1.29	0.83-1.95	0.22
Female	Reference	Reference	Reference
Race			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.84	0.53 – 1.33	0.458
Non-Hispanic Asians	1.48	0.78 – 2.80	0.213
Hispanics	1.13	0.70 – 1.82	0.588
Others	0.75	0.32 – 1.98	0.486
Education			
Less than High School	1.46	0.82 – 2.59	0.182
High School Graduate/GED	1.51	0.92 – 2.47	0.095
College/Associates Degree	1.47	0.86 – 2.52	0.147
College Graduate and above	Reference	Reference	Reference
Private Insurance			
Has private insurance	0.82	0.6 – 1.18	0.204
Other/No private Insurance	Reference	Reference	Reference
Obesity‡			
Obese	1.80	1.23 – 2.62	**0.003**
Not obese	Reference	Reference	Reference
Smoking			
Current Smoker	1.25	0.87 – 1.78	0.205
Past Smoker	Reference	Reference	Reference
Ever told you have Hypertension			
Yes	1.35	0.99 – 1.85	0.056
No	Reference	Reference	Reference
Ever told you have high cholesterol			
Yes	1.31	0.91– 1.88	0.135
No	Reference	Reference	Reference
Ever told you have CHD			
Yes	1.06	0.53 – 2.11	0.851
No	Reference	Reference	Reference
Ever told you had a stroke			
Yes	1.077	0.61 – 1.80	0.786
No	Reference	Reference	Reference

Notes
Abbreviations: GED= General Educational Development, CHD= Coronary Heart Disease
Multivariate Logistic Regression Model significance level p<0.0001
*p-value from Maximum Likelihood Estimates
‡ Participants considered obese when body mass index (BMI in kg/m^2) of >30 and not obese when BMI<30

Table 6. Multivariate Logistic Regression Analysis for Undiagnosed Diabetes and Medicare with other participant characteristics: Non-Pregnant Adults Age 20 and above, NHANES (2013-2016)

Participant Characteristics	Odds Ratio	95% Confidence Interval	p-value*
Age group (years)			
20-39	0.35	0.18 – 0.67	**0.002**
40-59	0.92	0.60 - 1.45	0.732
60 and above	Reference	Reference	Reference
Sex			
Male	1.30	0.86-1.98	0.199
Female	Reference	Reference	Reference
Race			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.89	0.56 – 1.39	0.605
Non-Hispanic Asians	1.59	0.85 – 2.95	0.135
Hispanics	1.22	0.77 – 1.95	0.377
Others	0.74	0.33 – 1.66	0.464
Education			
Less than High School	1.50	0.84 – 2.69	0.156
High School Graduate/GED	1.52	0.94 – 2.45	0.083
College/Associates Degree	1.50	0.89- 2.54	0.121
College Graduate and above	Reference	Reference	Reference
Medicare			
Has Medicare	1.61	1.07 – 2.42	**0.021**
Other/No Medicare	Reference	Reference	Reference
Obesityǂ			
Obese	1.82	1.14 – 2.52	**0.002**
Not obese	Reference	Reference	Reference
Smoking			
Current Smoker	1.29	0.89 – 1.87	0.169
Past Smoker	Reference	Reference	Reference
Ever told you have Hypertension			
Yes	1.34	0.98 – 1.83	0.061
No	Reference	Reference	Reference
Ever told you have high cholesterol			
Yes	1.28	0.89 – 1.83	0.169
No	Reference	Reference	Reference
Ever told you have CHD			
Yes	1.02	0.52 – 2.02	0.933
No	Reference	Reference	Reference
Ever told you had a stroke			
Yes	1.05	0.59 – 1.8	0.861
No	Reference	Reference	Reference

Notes

Abbreviations: GED= General Educational Development, CHD= Coronary Heart Disease

Multivariate Logistic Regression Model significance level $p<0.0001$

*p-value from Maximum Likelihood Estimates

ǂ Participants considered obese when body mass index (BMI in kg/m^2) of >30 and not obese when BMI<30

Table 7. Multivariate Logistic Regression Analysis for Undiagnosed Diabetes and Medicaid with other participant characteristics: Non-Pregnant Adults Age 20 and above, NHANES (2013-2016)

Participant Characteristics	Odds Ratio	95% Confidence Interval	p-value*
Age group (years)			
20-39	0.26	0.16 - 051	**<0.0001**
40-59	0.71	0.53- 1.22	0.069
60 and above	Reference	Reference	Reference
Sex			
Male	1.28	0.83-1.95	0.215
Female	Reference	Reference	Reference
Race			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.88	0.50 – 1.42	0.589
Non-Hispanic Asians	1.53	0.77 – 2.94	0.171
Hispanics	1.21	0.73– 1.83	0.399
Others	0.77	0.32 – 2.03	0.515
Education			
Less than High School	1.50	0.89 – 2.75	0.113
High School Graduate/GED	1.57	0.97 – 2.55	0.063
College/Associates Degree	1.53	0.89– 2.61	0.115
College Graduate and above	Reference	Reference	Reference
Medicaid			
Other/No Medicaid	0.89	0.49 – 1.58	0.682
Has Medicaid	Reference	Reference	Reference
Obesity ǂ			
Obese	1.78	1.22 – 2.55	**0.003**
Not obese	Reference	Reference	Reference
Smoking			
Current Smoker	1.30	0.91 – 1.85	0.136
Past Smoker	Reference	Reference	Reference
Ever told you have Hypertension			
Yes	1.37	1.00 – 1.87	**0.047**
No	Reference	Reference	Reference
Ever told you have high cholesterol			
Yes	1.29	0.90– 1.85	0.151
No	Reference	Reference	Reference
Ever told you have CHD			
Yes	1.09	0.55 – 2.13	0.794
No	Reference	Reference	Reference
Ever told you had a stroke			
Yes	1.11	0.64 – 1.92	0.691
No	Reference	Reference	Reference

Notes

Abbreviations: GED= General Educational Development, CHD= Coronary Heart Disease

Multivariate Logistic Regression Model significance level $p<0.0001$

*p-value from Maximum Likelihood Estimates

ǂ Participants considered obese when body mass index (BMI in kg/m^2) of >30 and not obese when BMI<30