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# Does insulin therapy matter? Determinants of diabetes care outcomes

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## Does insulin therapy matter? Determinants of diabetes care outcomes

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### Abstract

**Objective:** To evaluate adherence to care standards for people with diabetes (PWDs) on insulin therapy versus PWDs who are not on insulin therapy, controlling for social determinants.

**Research design and methods:** Utilizing the United States 2015 Behavioral Risk Factor Surveillance System Survey, this study used logistic regression analyses to estimate differences in self-care behaviors, healthcare provider quality of care, and diabetic complications for individuals on insulin therapy and individuals not on insulin therapy.

**Results:** PWDs on insulin therapy are more likely to adhere to self-care measures (self-glucose checks [OR: 7.57], self-foot checks [OR: 1.27], diabetes class participation [OR: 1.96]), adherence to provider care standards (diabetes-related doctor visits [OR: 1.24], comprehensive foot exam [OR: 1.80], dilated eye exam [OR: 1.34]), and to self-report diabetic complications (retinopathy [OR: 2.77], kidney disease [OR: 2.14]), controlling for sociodemographic variables.

**Conclusion:** PWDs on insulin and their healthcare providers are more likely to meet the treatment goals set by the American Diabetes Association. PWDs on insulin therapy may have better overall relationships with providers due to a reduction in stigmatization based on the social construction of diabetes.

**Keywords:** US, Diabetes, Standard of care, Social construction, Treatment outcomes, Insulin therapy

## 1. Introduction

More than 29 million Americans are living with diabetes, and an additional 89 million are living with prediabetes [1]. Diabetes is the seventh leading cause of death in the United States, and can lead to complications such as kidney failure, diabetic retinopathy, heart disease, and lower-limb amputations [1]. Diabetes care accounts for 20% of the national healthcare spending, a concern as costs to patients and taxpayers increase [1]. Research from the Centers for Disease Control and Prevention (CDC) [1] indicates that if current trends persist, one-third of Americans will develop diabetes in their lifetime and lose, on average, 10–15 years of life. Given these statistics it is important to understand how the social construction of diabetes, treatment types and social determinants affect how patients and their providers care for diabetes. From an agency perspective, people/person with diabetes (PWDs) have various daily self-management decisions to make and activities to undertake [2], which may be associated with low adherence to regimen [3]. Generally speaking, self-management of diabetes is a complex and important strategy to improve quality of life, which means taking into account the interactive effects diabetes has on not only health, but also relationships and other sociopsychological factors [4]. While self-management of diabetes is important for healthy lifestyle, the role and relationship between health care professionals are intricately linked in order to achieve quality well-being for PWDs. The American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) articulate this position in which they advocate for a patient-centered approach [5]. Research findings suggest that a positive association exist between patient-doctor communications in diabetes on patient outcomes, for example, good self-management behavior [6–8]. Rubin et al. [8] find that the patient-provider partnership is associated with more positive ratings on patient-reported outcomes including hyperglycemic symptoms, medical regimen adherence, overall wellbeing and perceived diabetes control. Other studies also indicate that patient-provider communication plays a critical factor in medical adherence [9,10]. Although insulin adherence rates among PWDs vary between two-thirds and three-quarters [11], we argue that the role of physicians may impact the overall wellbeing of PWDs based on insulin treatment. Therefore, this research examines the roles of PWDs and doctors in effectively managing diabetes for those on insulin treatment versus who are not on insulin therapy, holding all other factors constant.

## **1.1. Treatment guidelines**

Preventing extended high blood sugars is vital to preventing complications in PWDs. Additionally, routine physician visits and bloodwork can identify the beginnings of complications and prevent their worsening. Given this information, it is important to consider how treatment standards may vary based on not only the type of diabetes, but the form of treatment chosen for PWDs [12]. For example, those with type 1 diabetes and those receiving intensive insulin therapy must undergo self-monitoring of blood glucose levels before and after meals, before and after exercise, at bedtime, when low blood sugar is suspected or corrected for, and before activities such as driving. In those PWDs with type 2 diabetes and are not on intensive insulin therapy, the recommendations for self-monitoring blood glucose levels are not clear [12]. The frequency of home glucose testing is left to the discretion of the physician, and indirectly, the PWD's insurance company [12], which may not produce an adequate picture of glycemic control. Self-monitoring blood glucose levels can help to evaluate treatment efficacy and lower average blood sugar levels, leading to better patient outcomes (e.g. lower risk of cardiovascular disease).

## **1.2. Obstacles to care**

### *1.2.1. Social construction of diabetes*

The social construction of illness is now a major line of research in the medical sociology field. Berger and Luckman [13] defines the phenomenon of social constructionism as individuals and groups examining different ideas based on their social realities and knowledge. Similarly, Eisenberg [14] postulated that a social constructionist perspective explores the dissimilarity between disease, a biological condition and illness, a social condition. We employ this conceptual tool to discuss how the differences in diabetes type can be impacted by its social construction.

The differentiation by type of diabetes (e.g. type 1 vs. type 2) raises concerns about how the disease is socially constructed and how this may affect care outcomes. Because of the associated links of lifestyle (e.g. obesity), those with type 2 diabetes may face higher levels of stigmatization. The feelings of stigmatization noted by those with type 2 diabetes is often due to the widespread belief that type 2 diabetes can be prevented or 'cured' through lifestyle changes [15,16], even though research shows a genetic predisposition [17,18]. The perceived stigma of type 2 diabetes may lead to undesirable outcomes, such as attempted concealment of the disease and suboptimal self-care [15,16]. Moreover, the social construction of

type 2 diabetes as a consequence of poor lifestyle can harm relationships with care providers. For example, if the PWD is unable to lower blood glucose levels with physician directed lifestyle changes, the perceived non-compliance of the patient by the medical provider may damage the PWD's trust and ability to communicate with the provider [15,16,19]. There is also evidence that those with type 2 diabetes perceive that medical providers give more help to, and feel more concern for, those with type 1 diabetes [16]. Additionally, the social construction of diabetes is further reinforced by healthcare providers and insurance companies setting different standards for the use of medical devices (e.g., glucose monitoring strips, pumps, continuous glucose monitors) by type of diabetes, rather than for optimal disease management [16].

### *1.2.2. Social determinants of diabetes care outcomes*

Diabetes places a good deal of financial pressure on PWDs and their families. Studies have shown that PWDs who come from lower socioeconomic conditions struggle more with food insecurity [20] and lower compliance rates [21]. Even with the Affordable Care Act in place, diabetes care and supplies are expensive and insurance companies do not always provide adequate coverage, even when the technology improves outcomes for PWDs (e.g. continuous glucose monitors) [22–25]. PWDs have reported reducing insulin and medication dosing, as well as reducing the number of physician visits to cut costs [21]. Many physicians and insurance companies believe that insulin therapy requires much more intensive self-management than for those not on insulin therapy, which may reduce referrals to specialists, lead to prescriptions for fewer blood glucose test strips, and a lower number of preventative tests [22–25].

The purpose of the current study is to better understand the impact of insulin therapy on diabetes care outcomes, while controlling for socioeconomic factors, healthcare access, and self-reported physical and mental health. We propose the following hypothesis that PWDs on insulin therapy will have greater access to self-monitoring blood glucose testing (H1), perform more self-checks of their feet (H2), be more likely to attend diabetes education classes (H3), more likely to see their physician (H4), have their A1C tested (H5), have diabetic foot checks in the physician's office (H6) and be more aware of their complications of diabetes, including diabetic retinopathy and kidney disease (H7) than those who were not on insulin therapy.

## **2. Methods**

### **2.1. Data and participants**

This study utilizes the Behavioral Risk Factor Surveillance System Survey (BRFSS) data collected in 2015. The BRFSS collects behavioral risk factors from survey participants throughout the United States, and is one of the most powerful tools in targeting and building health promotions activities [26]. The telephone based BRFSS coordinated by the Centers for Disease Control (CDC) is completed by health departments in all fifty states, and includes Puerto Rico, D.C., and Guam. The BRFSS collects information from adults 18 years of age and older utilizing both core and optional supplemental survey modules to fit a specific state's needs. The supplemental survey module for Diabetes was collected by 32 states in 2015.

### **2.2. Measures**

#### *2.2.1. Insulin therapy*

The primary predictor variable, self-reported use of insulin, was measured with the question 'Are you now taking insulin?' Those considered to be on insulin therapy responded yes to this question. The BRFSS does not distinguish between the types of diabetes diagnosed.

#### *2.2.2. Outcomes*

Three outcomes were assessed for this paper; selfmanagement of diabetes, diabetes care quality, and complications related to diabetes. Compliance to treatment standards, and therefore the cutoff points for the variables, are done in accordance to the American Diabetes Association's guidelines for treatment standards [12].

#### *2.2.3. Self-management of diabetes*

Three questions measured the quality of self-management of a respondent: self-monitoring of blood glucose level and self-administered foot examinations (daily vs. weekly or more) and if the respondent had ever attended a diabetes education course (yes vs. no).

#### *2.2.4. Diabetes care quality*

Four questions were used in assessing quality of diabetes care provided to the respondent in the past twelve months: number of primary care visits related to diabetes (2–5 vs. other), foot exams administered by provider (more than 2 vs. 0–1), number of times an HbA1c was drawn (1–4 vs. other), and time since last dilated eye exam (less than a year vs. more than a year).

### *2.2.5. Diabetes complications*

Two questions were used to assess the presence of diabetic complications. The first asked the respondent if they had been told they had kidney disease, and the second asked if the respondent had been told that they had diabetic retinopathy.

### *2.2.6. Covariates*

Diabetes outcomes are influenced by sociodemographic factors, as well as the ability to access healthcare services and not only the physical, but mental health of the PWDs. Because of this, these factors were included and controlled for in the models.

### *2.2.7. Sociodemographic factors*

Race was measured as a dichotomous variable of white versus non-white due to the small sample sizes of other racial and ethnic groups. Education, used as a proxy for social class, was measured as a dichotomous variable of high school or less versus some college or more. Age was measured as a dichotomous variable of either under 65 or over 65.

### *2.2.8. Self-reported health*

Self-reported health status was measured as a dichotomous variable of either good or better health versus fair or worse health. Mental health was measured as the count of the number of days a PWDs reported poor mental health. Comorbidities including hypertension, hyperlipidemia, previous myocardial infarction, coronary heart disease, and previous stroke were each measured by answering in the affirmative to the diagnosis of the condition. Body Mass Index (BMI) was measured as a dichotomous variable of either under 25 (under or normal weight) or over 25 (overweight or obese).

### *2.2.9. Access to care*

Access to care was measured in two ways; a dichotomous variable of having insurance coverage or not, and a separate dichotomous variable reflecting whether the respondent had faced medical hardship in the past 12 months.

## **2.3. Data analysis**

First, descriptive statistics were run to determine the composition of the sample after the listwise deletion of any participant missing data. Then, logistic regression analysis was completed describing associations with insulin therapy and self-management of diabetes (i.e. self-checks of blood glucose), diabetes care quality (i.e. number of HbA1c tests performed every 12

months), and diabetes-related complications (i.e. kidney disease and diabetic retinopathy). Each hypothesis was tested with each of the nine variables under the larger headings, rather than as an aggregate variable. The models were adjusted for the following variables: 1) sociodemographic factors (age, sex, race and education), 2) access to healthcare (insurance coverage and medical hardship), and 3) self-reported physical and mental health. Each set of variables were modeled independently and the overall model was built in steps (i.e., Model 1 including only sociodemographic factors and Model 2 including sociodemographic factors and access to healthcare and Model 3 including sociodemographic factors, access to healthcare and self-reported physical health). The aim of the models is to understand if the method of treatment (insulin therapy vs. non-insulin therapy) has an effect on outcomes when controlling for the typical contributors to poor diabetes outcomes. Statistical significance was determined at the  $p \leq 0.05$  level.

### **3. Results**

#### **3.1. Sample characteristics**

Of those respondents in the BRFSS who answered yes to having been diagnosed with diabetes, more than one-third (38.6%) are insulin users. Almost three-quarter of the sample is white (72.2%) and females comprise more than half (53.9%) of the respondents. Respondents over 65 years of age accounted for 51.7% of the sample and almost 60% of respondents obtained a college education or higher. Slightly more than three-quarters (76.8%) of the respondents reported having hypertension, and two-thirds (66.7%) reported having hyperlipidemia. The respondents who reported having had a myocardial infarction and coronary heart disease were in the minority with 14.9% and 15.9% respectively. Almost one in ten (9.5%) respondents reported having experienced a stroke and nearly nine in ten respondents have a Body Mass Index (BMI) of over 25. A little more than two-fifth (41%) respondents selfreported that their health status was good or better and most respondents (96%) have health insurance and only 10% report having any medical hardship (**Table 1**).

#### **3.2. Insulin therapy and self-management of diabetes**

As shown in **Table 2**, approximately three-fourths of the respondents reported checking their blood glucose and their feet on a daily basis, and two-thirds of respondents reported having attended a diabetes education program (**Table 2**). Respondents' who report using insulin to treat their diabetes

**Table 1. Sample demographics of respondents with diabetes.**

	<i>Total (n = 15,409)</i>	<i>Proportion</i>
Insulin use		
Yes	5,957	38.66
No	9,452	61.34
Race		
White	11,130	72.23
Non-white	4,279	27.77
Sex		
Male	7,092	46.03
Female	8,317	53.97
Age		
Under 65	7,441	48.29
Over 65	7,968	51.71
Education		
High school or less	6,311	40.96
College or more	9,098	59.04
Hypertension		
Yes	10,703	76.82
No	3,229	23.18
Hyperlipidemia		
Yes	9,292	66.70
No	4,640	33.30
Myocardial infarction		
Yes	2,076	14.90
No	11,856	85.10
Coronary heart disease		
Yes	2,223	15.96
No	11,709	84.04
Stroke		
Yes	1,327	9.52
No	12,605	90.48
Body mass index (BMI)		
Under 25	1,830	13.14
Over 25	12,102	86.86
Health status		
Good or better	9,087	41.03
Fair or worse	6,322	58.97
Health insurance status		
Insured	14,844	96.33
No insurance	565	3.67
Medical hardship		
Yes	1,596	10.36
No	13,813	89.64

**Table 2. Bivariate associations between insulin therapy and diabetes health outcomes.**

	<i>Compliance level</i>	<i>Proportion meeting compliance levels</i>	<i>Unadjusted odds ratio</i>	<i>P-value</i>	<i>95% confidence interval</i>
<b>Self-management of diabetes</b>					
Self-monitoring of blood glucose	(Daily vs. weekly or more)	.725	7.74	***	(6.99, 8.59)
Self-administered foot examinations	(Daily vs. weekly or more)	.710	1.23	***	(1.15, 1.33)
Attended diabetes class	(Yes vs. no)	.639	1.91	***	(1.78, 2.05)
<b>Diabetes care quality (previous 12 months)</b>					
Number of primary care visits	(2–5 times per year vs. other)	.677	1.13	***	(1.05, 1.21)
Provider-administered foot examinations	(More than 2 vs. 0–1)	.610	1.84	***	(1.72, 1.97)
Number of times HbA1c drawn	(1–4 vs other)	.897	0.88	**	(0.79, 0.97)
Dilated eye exam	(Less than vs more than 1 year)	.746	1.22	***	(1.13, 1.31)
<b>Proportion reporting condition</b>					
Diabetes complications					
Kidney disease	(Yes vs. no)	.111	2.53	***	(2.28, 2.80)
Diabetic retinopathy	(Yes vs. no)	.200	3.04	***	(2.80, 3.29)

+  $p < .10$  ; \*  $p < .05$  ; \*\*  $p < .01$  ; \*\*\*  $p < .001$

were more likely to check blood glucose levels daily at home (OR 7.57,  $p < .001$ ), check their feet on a daily basis (OR 1.27,  $p < .001$ ), and attend a diabetes education class (OR 1.96,  $p < .001$ ), when controlled for sociodemographic information, self-reported health, and access to care (**Table 3**).

### 3.3. Insulin therapy and diabetes care quality

In **Table 2**, approximately two-thirds of respondents reported seeing their primary care provider two to five times a year in regards to diabetes as well as report having provider administered foot checks within the recommended compliance standards. A majority of respondents (89.7%) reported having their HbA1c drawn at the recommended care guidelines. Three-fourths of the respondents reported having a dilated eye exam within the past twelve months (**Table 2**). Respondents who reported insulin use were more likely to meet care guidelines for doctor visits (OR 1.24,  $p < .001$ ), provider administered foot examinations (OR 1.80,  $p < .001$ ), and dilated eye examinations

(OR 1.34,  $p < .001$ ). In regards to the HbA1c tests, however, there were no significant differences found between the two groups (OR 1.02,  $p = .49$ ) when controlled for sociodemographic information, self-reported health, and access to care (**Table 3**).

### 3.4. Insulin therapy and complications

Approximately 11% of respondents reported having kidney disease and 20% reported having been diagnosed with diabetic retinopathy (**Table 2**). It is more likely for a respondent using insulin to report kidney disease (OR 2.14,  $p < .001$ ) and/or diabetic retinopathy (OR 2.77,  $p < .001$ ) when controlled for sociodemographic information, health status, and access to care (**Table 3**).

**Table 3. Multivariate associations between insulin therapy and diabetes health outcomes.**

	<b>Model 1:</b> socio- demographic factors	95% confidence interval	<b>Model 2:</b> socio- demographic factors and health status	95% confidence interval	<b>Model 3:</b> socio- demo- graphic factors, health status, and healthcare access	95% confidence interval
<b>Diabetes self-management</b>						
Self-monitoring of blood glucose	7.87***	(7.05, 8.78)	7.57***	(6.78, 8.45)	7.57***	(6.78, 8.45)
Self-administered foot examinations	1.27***	(1.18, 1.37)	1.27***	(1.17, 1.37)	1.27***	(1.17, 1.37)
Attended diabetes class	1.90***	(1.77, 2.06)	1.96***	(1.82, 2.12)	1.96***	(1.81, 2.18)
<b>Diabetes care quality (previous 12 months)</b>						
Number of primary care visits	1.14***	(1.06, 1.23)	1.24***	(1.15, 1.34)	1.24***	(1.15, 1.34)
Provider-administered foot examinations	1.83***	(1.70, 1.97)	1.80***	(1.67, 1.94)	1.80***	(1.67, 1.94)
Number of times HbA1c drawn	.91	(.81, 1.02)	1.02	(.91, 1.15)	1.02	(.90, 1.15)
Dilated eye exam	1.27***	(1.17, 1.38)	1.35***	(1.24, 1.46)	1.34***	(1.24, 1.46)
<b>Diabetes complications</b>						
Kidney disease	2.56***	(2.30, 2.86)	2.15***	(1.92, 2.40)	2.14***	(1.91, 2.40)
Diabetic retinopathy	3.07***	(2.81, 3.35)	2.77***	(2.53, 3.02)	2.77***	(2.53, 3.02)

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

#### 4. Discussion

This study shows that even with the small reductions in the statistical associations when accounting for sociodemographic factors and health status, the use of insulin was associated with better care outcomes for those with diabetes. The findings of this study support the majority of the hypothesized results. Those who are on insulin therapy are more likely to do self-checks of their blood glucose levels and feet on a daily basis, and are more likely to have taken a recommended diabetes education class. Furthermore, those on insulin therapy are more likely to meet recommended numbers of physician visits and provider-administered foot checks, however, little difference was seen for HbA1c tests. Finally, there is a higher likelihood of self-reporting complications of diabetes, such as kidney disease and diabetic retinopathy, among respondents using insulin to treat their diabetes.

One theory of preventing poor outcomes in PWDs is the adequate co-involvement of the PWDs, their support system, and the healthcare team [27]. These results show that there is a higher likelihood of PWDs on insulin to be more invested in their self-care and to have more involvement with their providers. The reason behind this may be two-fold; PWDs who are on insulin therapy may have had higher HbA1c levels, requiring more intensive care [27], and those on insulin therapy may have more access to and better coverage for diabetes supplies and associated care. In addition, PWDs who are type 1, or on intensive insulin therapy, may have better overall relationships with their providers due to a reduction in stigmatization. The reduction in stigmatization felt by the PWDs may lead to more trust in and better communication with their provider as well as less reluctance to engage in self-care. Overall, a benefit to having this access is PWDs on insulin are more likely to be aware of and self-report their complications.

There are a few limitations to this study. First, the type of diabetes that has been diagnosed is unclear. PWDs treated with insulin may be either type 1, or type 2 who have not had a good response to oral medications, changes in diet, or developed a reduction in insulin production as a consequence of time and higher glucose levels. Previous studies have shown that people with type 2 diabetes may have different beliefs about their health risks from diabetes and resulting complications, which may adversely affect their health (i.e. diabetic foot ulcers) [28]. Additionally, there is no information on one of the more common complications of diabetes, neuropathy, and its associated risk of amputation of the lower limbs. This, in combination with the type of diabetes, may give a broader picture of the importance of having care guidelines that are the same across all PWDs, regardless of type and treatment choice.

**Conflict of interest** — The authors state that they have no conflict of interest.

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