

A Dose-Response Relationship Between Time Spent In The U.S. And Risk Of Diabetes In Immigrants

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Background

Diabetes Mellitus, DM, is a chronic disease characterized by high blood sugar.^{2,3} The most common form of DM is type II, also known as non-insulin dependent. This type of diabetes is associated with sedentary lifestyle, poor diet and obesity.⁵ According to the National Diabetes statistics report published in 2017, approximately 30.3 million people, or 9.4 % of the U.S. population had diabetes in 2015⁴. Of the 30.3 million people with diabetes, 23.1 million, or 76.2%, were diagnosed and while the remaining 7.2 million (23.8%) were undiagnosed.⁴ An estimate of \$245-billion USD was indirectly associated with diagnosed diabetes, and a person with diagnosed diabetes contributes \$13,700 USD annually to the medical expenditures⁴.

There has been reports of variation in the risk of DM across races, with up to a two-fold increase in the risk of DM in minority population- Blacks, Hispanics, and Native Americans, when compared to Whites.^{2,6} Contextual factors associated with the difference in risk include insurance, diet, socioeconomic status, and age.^{6,7} DM is associated with an increased risk of microvascular diseases such as retinopathy, cardiovascular disease, stroke, neuropathy, disability, and the increased risk of cancer.^{5,8-10} The difference in risk across racial/ethnicities bring into question the validity of the immigrant paradox claim- which state immigrants are healthier when they first move to the U.S. and their risk for various disease increase as a result of time spent in the U.S.

Ford Et. Al found no significant effect on time spent in the U.S and the risk of diabetes among foreign-born blacks, but this study was limited to foreign-born and U.S born blacks.¹¹ Other studies reported greater odds of diabetes among foreign born blacks when compared to U.S. born blacks despite foreign-born blacks having lower odds of obesity than US born black.^{11,12} Schneiderman et al. found the prevalence of diabetes within the Hispanics/Latinos population varied based on the origin of the individual.¹³

Our literature search showed that this has not been studied extensively, although the impacts of "western living" - ie a higher carb diet and more sedentary living - have been tracked in other countries and have been shown to cause increased rates of diabetes.¹⁴

We hypothesize that there is a relationship between time spent in the US on an immigrant's risk of diabetes, and that this relationship is modified by a series of factors including age, income, education, and race.

Methods

A chi square analysis of the National Health and Nutrition Examination Survey (NHANES) 2013-2014 showed that there was a disparity between diabetes rates in immigrants and nonimmigrants. We then categorized immigrants by whether they had stayed in the US for more or less than 40 years, and found that there was difference in diabetes rates between these two populations as well.

NHANES is a cross sectional study design, so to use the data to establish an association, we compiled variables from 9 NHANES, between 1999 and 2016. Subjects are sorted by how they answered when asked if they had been diagnosed with diabetes, and if they were born in the US. This gave us 87,803 observations. We considered all results with a p value of less than 0.05 to be significant.

Results

	Immigrants	Non-immigrants
Diabetic	1,184	4,338
Prediabetic	155	815
Nondiabetic	11,361	66,224

Table 1. This is how our observations are distributed in the compiled dataset. Performing a chi square analysis on this distribution showed that there is a significant difference between rates of diabetes in Immigrants and Non-Immigrants ($\chi^2=262.5$, $p<0.0001^*$)

Race	Chi Square (χ^2)	p value
White	0.7664	0.6817
Black	1.4321	0.003*
Hispanic	336	<0.0001*
Asian	15.8447	<0.0001*
Other	32.03	<0.0001*

Table 2. After stratifying the data by race and running a chi square analysis for each group, we see that the disparity shown in Table 1 and Figure 1 is more applicable to non-white immigrants. This is since the p value for White individuals was 0.6817.

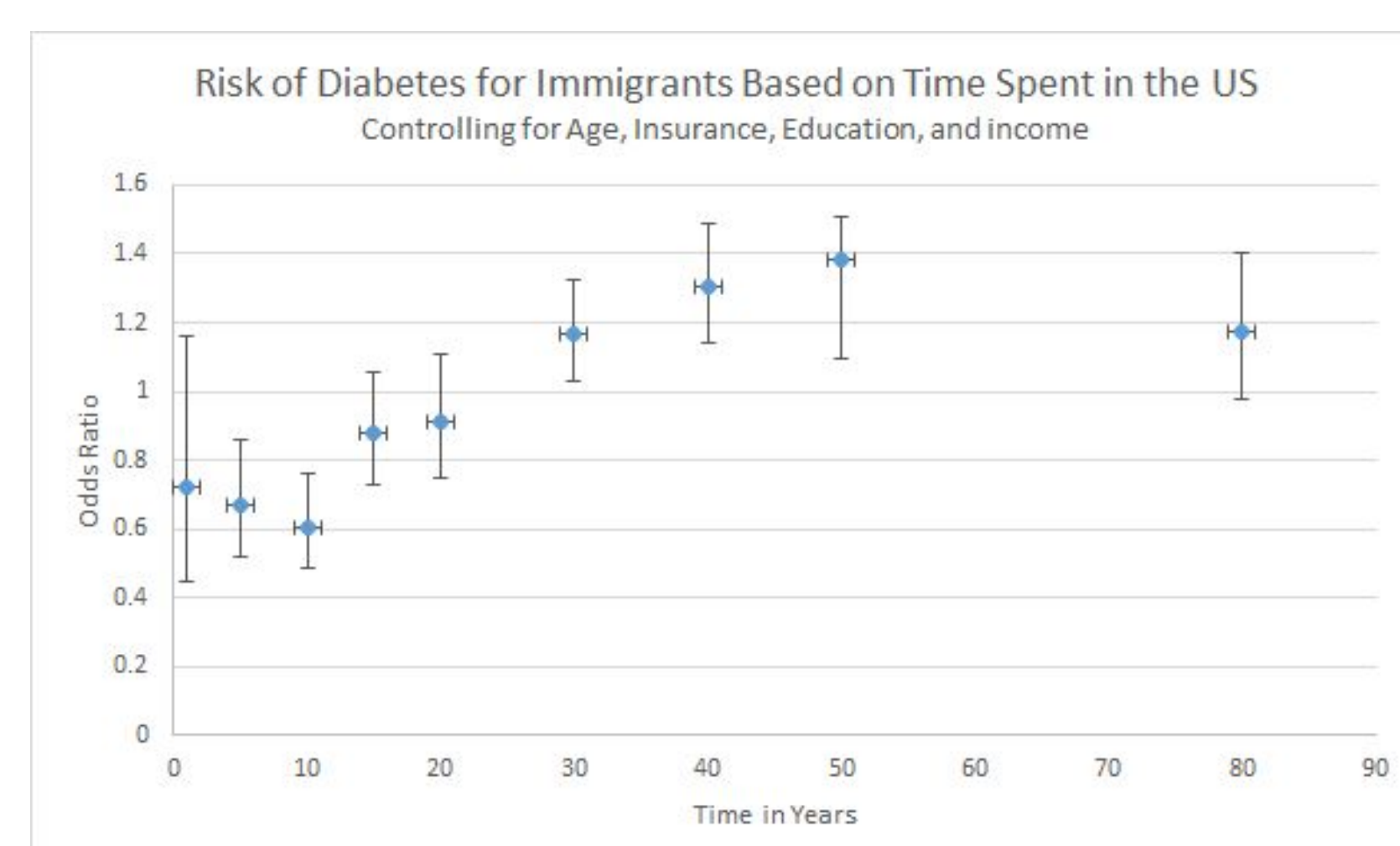


Figure 3. After controlling for age, insurance, education, and income, a logistic regression showed that immigrants have higher odds of becoming diabetic as they stay in the US longer. Based on previous chi squares, this result may be most relevant for Hispanic and Asian immigrants. Our data also suggests it is relevant for Black immigrants, unlike Ford's result.¹¹

TIME IN US	Odds Ratio	95% Confidence Interval	p-value
Less than 1 year in US	0.721	(0.448, 1.161)	0.178
Less than 5 years in US	0.67	(0.521, 0.862)	0.002*
Less than 10 years in US	0.879	(0.486, 0.758)	<0.0001*
Less than 15 years in US	0.879	(0.73, 1.059)	0.175
Less than 20 years in US	0.911	(0.75, 1.105)	0.344
Less than 30 years in US	1.17	(1.032, 1.327)	0.014*
Less than 40 years in US	1.305	(1.143, 1.489)	<0.0001*
Less than 50 years in US	1.386	(1.098, 1.507)	0.002*
More than 50 years in US	1.171	(0.98, 1.4)	0.082

Table 3. Odds ratios and their statistical significance are given from the same model as Figure 3. When developing this model we saw that age was the biggest confounder, and controlling for it removed much of the crude association between time spent in US by immigrants and diabetes risk.

Conclusions

Our analysis of NHANES so far has suggested that (1) In the US, immigrants are more likely to become diabetic than nonimmigrants, (2) when comparing immigrants and nonimmigrants by race, white immigrants and nonimmigrants do not have statistically different diabetes rates, and (3) spending more time in the US leads to a higher risk of diabetes in immigrants (almost double based on Figure 3 and Table 3).

This result creates many questions, primarily: why does this relationship exist? If the result is due to a unique American lifestyle, then future analysis should also create statistical models based on diet. There are also researchers who suggest that maternal nutrient levels impact glucose sensitivity - and that children from developing countries may have a stronger diabetic risk when exposed to high carbohydrate diets.¹⁵ Understanding this relationship may hold the key to understanding underlying causes of diabetes as well.

These research questions push up against the limits of using NHANES to explore the causal pathway for diabetes. As a series of cross sectional surveys, this dataset does not allow tracking mother-to-child exposures. However, B12 levels are collected, and some modeling may be done with that.

Ultimately, this result points to the need for more studies. Future studies will utilize more variables from NHANES like diet. Other studies will also need to utilize longitudinal data in order to better understand whether there is any biomedical sensitivity in immigrants, or if there is a behavioral cause that increases risk for diabetes in this way.

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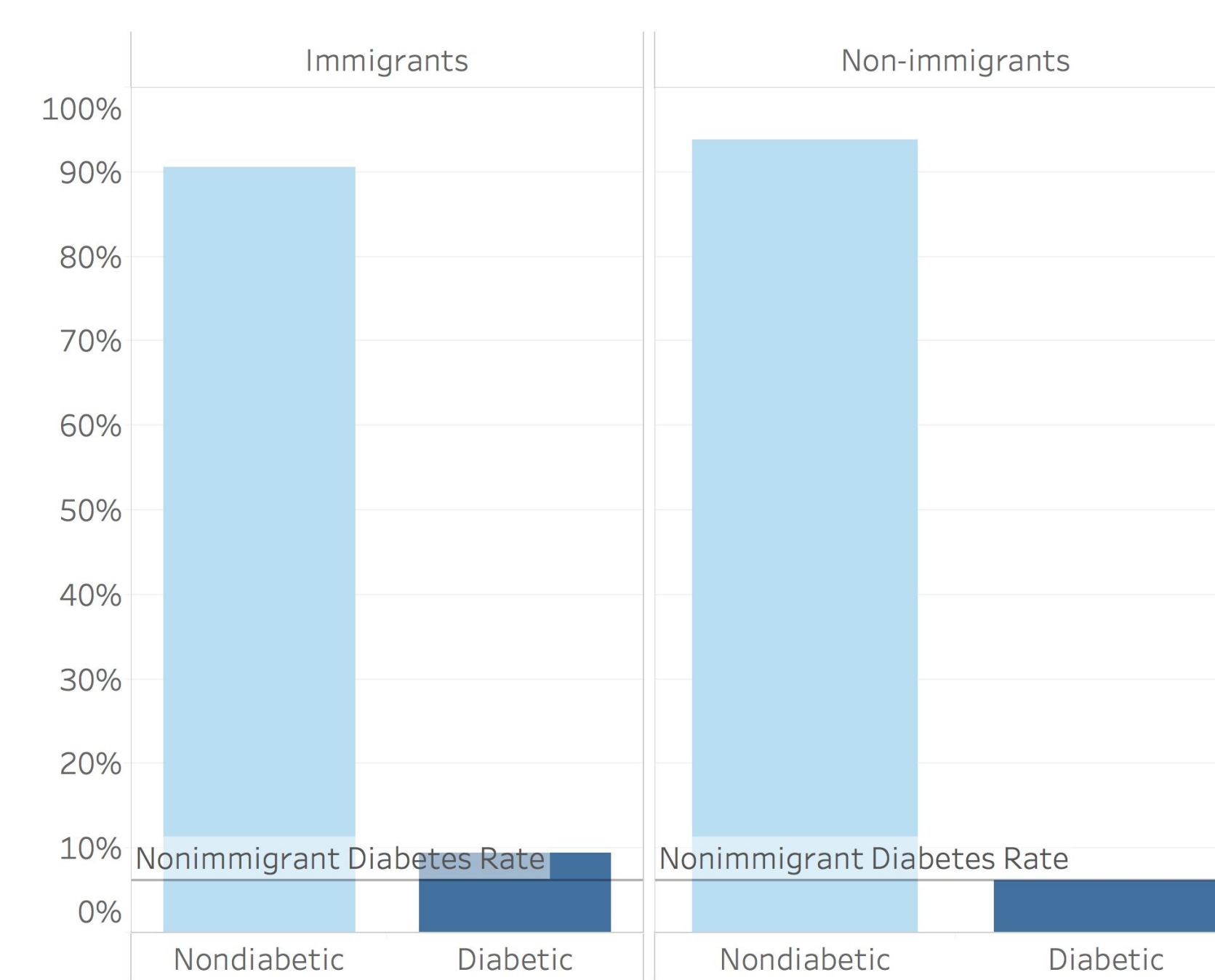


Figure 1. The basic difference in diabetes rates observed in our compiled NHANES dataset - 9.4% versus 6.2% diabetes rates between immigrants and nonimmigrants respectively.

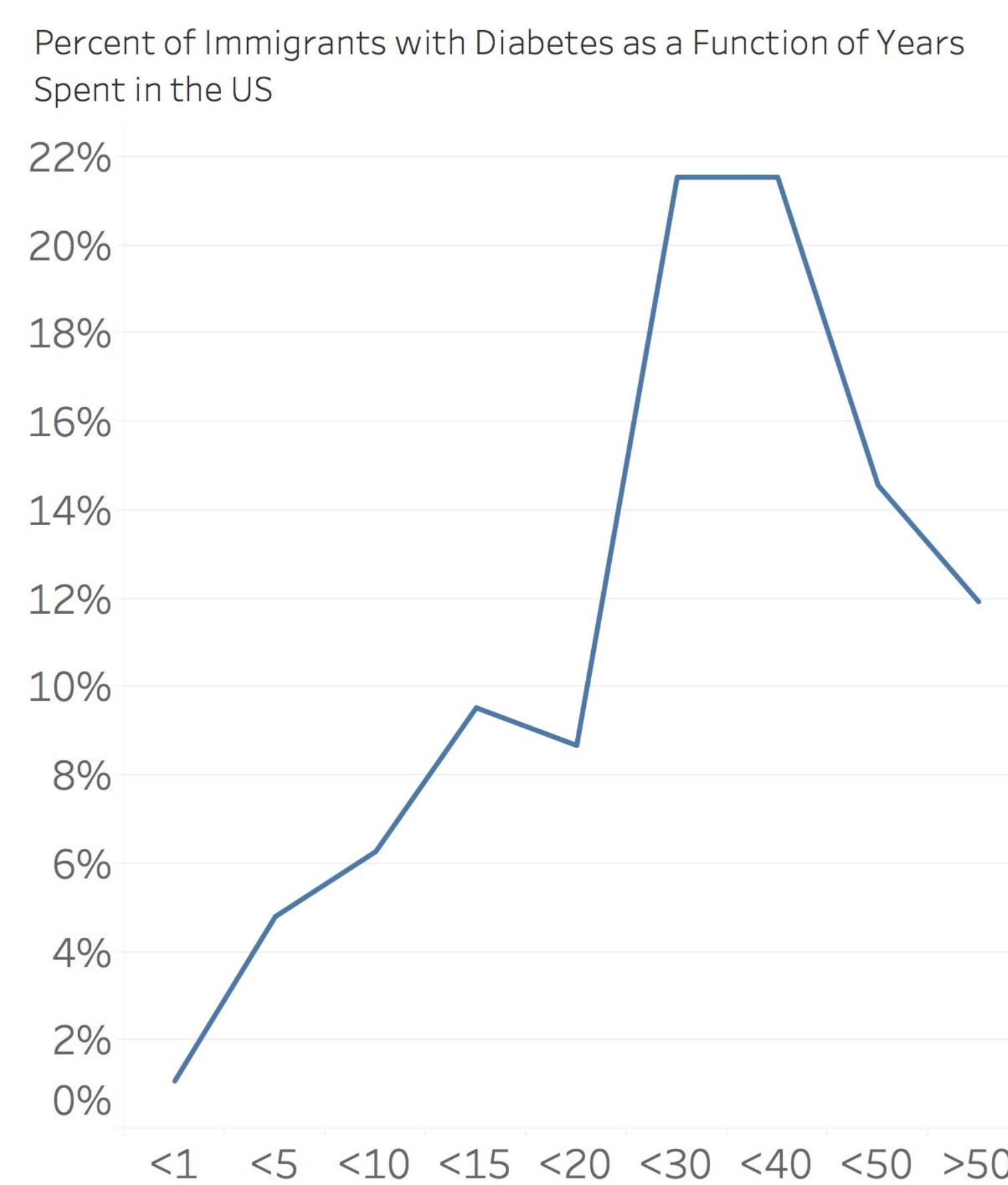


Figure 2. The distribution diabetes cases in immigrants over time within our data. There is a noticeable peak at 40 years spent in the US, which is the subject of our current inquiry. We believe the drop is due to mortality at old age ie a survivor's bias.

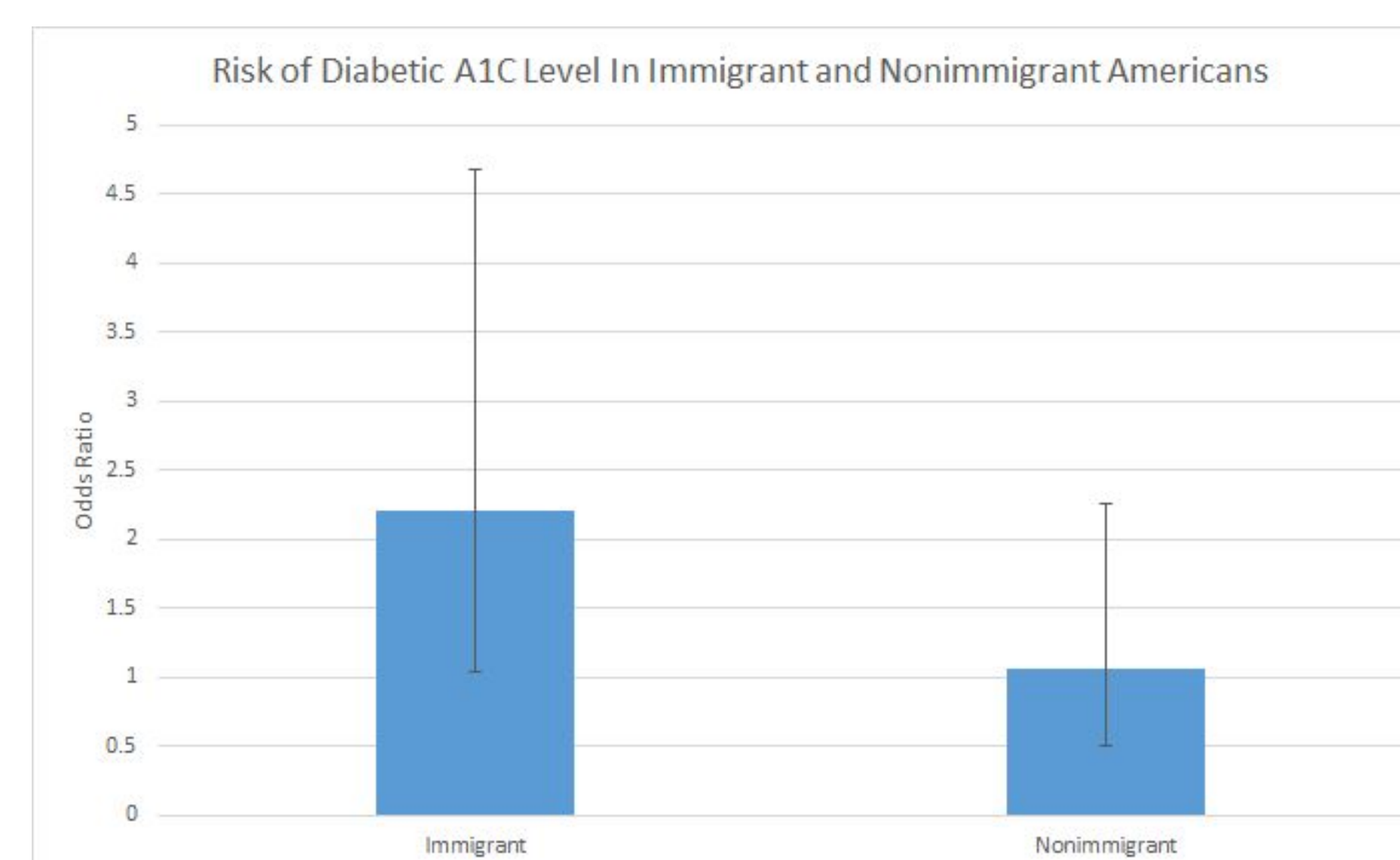


Figure 4. After creating a logistic model based on survey answers to categorize study subjects, we substituted a categorical variable for blood glycohemoglobin. With controls for education, age, income, and race, immigrants are twice as likely to have a diabetic amount of glycohemoglobin as nonimmigrants.