E C O N O M I C S B U L L E T I N

ARE RACIAL DISPARITIES IN DIABETES IN THE USA DRIVEN BY EDUCATION DISTRIBUTION?

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Abstract

Widespread health disparities have been found between different races in the USA. The precise reasons for racial health disparities are not well understood although various factors have been proposed. Using diabetes related data from the NHANES III (1988-1994) of the USA, this paper shows that (1) there are wide ranging variations in diabetes within and between races; (2) educational attainment is a strong marker that explains a large proportion of the diabetes related disparities both within and between races; (3) within and between race disparities are reduced or reversed if educational attainments are accounted for even when people are similarly genetically predisposed or faces comparable other risk factors like higher body weight. Racial health disparities are shown to be driven by the underlying disparities in educational attainment. To reduce or remove racial health disparities, removal of educational disparities may be needed.

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"Compelling evidence indicate that race and ethnicity correlate with persistent, and often increasing, health disparities among U.S. populations..... and demands national attention."

Centers for Disease Control and Prevention (2005)

1 Introduction

According to the American Diabetes Association's National Diabetes Fact sheet, over 18 million people in the USA suffer from Diabetes. Additionally, over 41 million could be labeled as pre-diabetic. Prevalence of Diabetes varies widely between racial and ethnic categories. 8.4% of the non-Hispanic Whites, 11.4% of the non-Hispanic Blacks, and 8.2% of the Hispanic/Latino Americans suffered from Diabetes in 2002.

Diabetes was the sixth leading cause of death in the USA. Diabetes is a major risk factor contributing towards heart disease, stoke, hypertension, blindness, kidney disease, nervous system disease, dental disease, lower limb amputation etc. It is estimated that diabetes cost over $132 billion to the nation. Furthermore, over 5 million people may have undiagnosed diabetes.

Given the large number of potential diabetes cases, some aggressive strategies are urgently needed to facilitate early diagnosis that reduces the chances of future complications. Individuals more likely to have diabetes should be advised about steps that may reduce the likelihood of having diabetes.

Preventative measures will reduce early death and disabilities and will also reduce complications usually associated with diabetes. Preventative measures might also enable us to stop progression of some of the pre-diabetic cases into full blown diabetes.

Prevention, screening, and delaying diabetes require identification of useful predictors that can be used as markers for clinical and public health policy related purposes. Genetic factors (related through the family history of diabetes) and overweight/obesity are two of the major risk factors for diabetes [Bazzano et al 2005, Bennett et al 1996, Cox et al 2001, Florez et al 2003, Gloyn et al 2003, Todd et al 1987.]

Lifestyle changes (like eating healthy, reducing weight problems and exercising more often) are stressed to prevent or delay diabetes [Bazzano et al 2005.] Given these knowledge, early diagnosis or delay in diabetes could be facilitated by targeting individuals with family history of diabetes and/or who live relatively unhealthy lifestyles.

Diabetes is a chronic disease. It is well known that the prevalence of most of the chronic diseases including diabetes is higher among people with low educational attainment. Higher educational status enhances self-management and reduces the chances of acute and chronic diseases [Pincus et al 1987, 1998.]

The purpose of this paper is to ascertain the relative importance of genetic, physical and socioeconomic status factors in predicting diabetes. By focusing on the strongest factor(s) that predict(s) diabetes, efficiency in diagnosis and prevention of diabetes may be made more efficient.

Using the National Health and Nutrition Examination III (NHANES III) data of non-Hispanic white and black adults, this paper establishes that socioeconomic status in general

and educational attainment (in terms of years of education) in particular are probably the strongest predictor of diabetes. Low education is found to be a comparable or stronger risk factor compared to family histories of diabetes.

Low education is as strong or stronger predictor of diabetes compared to physical factors like overweight and obesity. Low education is a stronger predictor of diabetes compared to race/ethnicity, gender, income, and behavior/habit (like smoking.) The strengths of these results are preserved for various socioeconomic groups defined along racial/ethnic and income lines.

Results in this paper underscore the importance of including educational attainment as a screen in standard clinical setting. By focussing on low educated individuals, early detection may be achieved since they are seriously under risk of getting diabetes.

From a public health policy perspective, large gains could be made by using individual educational attainment as an attribute to screen for diabetes. Also, public health policy programs aimed at reducing burden of diabetes may increase their effectiveness by targeting people with low educational attainment more aggressively. Furthermore, to reduce or remove racial health disparities, removal of educational disparities may be needed since a good proportion of the racial health disparities may be adequately explained by the underlying educational disparities.

Racial health disparities often occupy great public attention. Minority population is growing at a faster rate and healthcare costs are spiralling. If minority population is more burdened with disease then that would mean higher healthcare expenditure in the years to come. Besides, loss of income due to disability (total or partial) is going to staggering too.

Racial disparities in health may largely be determined by the disparities in access to healthcare resources and quality of living standards. In a landmark report titled "Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care" experts in the Institute of Medicine [Institute of Medicine, 2002] concluded that minority patients are less likely to receive quality healthcare services.

For example, patients coming from minority background are less likely receive appropriate medication for heart problems. They are also less likely to receive bypass surgeries or kidney transplants. On the other hand, minority patients are more likely to suffer extreme treatment or surgery options like lower limb amputation for diabetes related complications. Disparities in healthcare access and services received greatly influence subsequent health disparities.

Some researchers view that health disparities are embedded in larger economic, geographic, sociocultural, historical and political contexts [Williams and Jackson, 2005.] High residential concentration in poor neighborhood environments, deprived socioeconomic circumstances, inadequate access to quality healthcare all lead to worse health outcomes through detrimental psycho-social pathways.

Low socioeconomic status, discrimination, and residential segregation hamper minorities from taking advantage of the technological and scientific advancements [Mechanic, 2005.] Minorities also lag behind in terms of health insurance coverage [Lillie-Blanton and Hoffman, 2005.] Sustained coverage at the levels comparable to that of whites might reduce racial health disparities. Low economic status generally associated with the members of the minority communities might also mean higher chronic stress that might result in low health outcomes [Adler and Newman, 2002.]

The above mentioned studies point towards the overwhelming role that educational

achievement is capable of playing in the determination of health outcomes. Low education may result into low income, less stable jobs, fewer benefits etc. These may in turn lead to poorer access to healthcare system, poor housing, poor nutrition etc.

If higher fraction of the minority population falls in the low educational achievement categories compared to their white counterparts then overall health outcomes in the minority population would be worse compared to the majority population. In other words, reduction or removal of inter-racial health disparities would depend on our ability to improve the educational status of the minorities.

In a clinical study [van Ryn and Burke, 2000], researchers found that doctors believed their African American patients to be less intelligent. This may be a racial stereotyping but if this belief is scientifically true then removing racial disparities in health would involve interventions at the genetic level.

It is interesting to note that there could be a perfectly good explanation for the results of van Ryn and Burke (2000). If higher proportion of the minority people belong to lower educational categories then the doctors are more likely to come across low educated people when they are treating minorities.

Low educated people have difficulties reading, writing, and following instructions. These attributes may easily be interpreted as lack of intelligence. On a relevant note, the National Adult Literacy Survey of 1992 estimated that over 90 million American adults were very poorly educated or functionally illiterates.

Rest of the paper is organized as follows: Theoretical considerations necessary in any discussion on health disparity are discussed in Section 2. Section 3 reports some basic description of the data used in this paper. Section 4 reports the estimation results and discussions. Section 5 concludes this paper.

2 Theoretical Considerations

Suppose that there are N people in the economy indexed by $i = 1, 2, ..., N$. Health of individual i, h_i, is produced according to the production function $h_i = f_i(X_i)$ where X_i is the vector of health inputs used by individual i.

Health producing inputs could be described as diet, nutrition, immunization, access to healthcare system (determined by income/assets) etc. Furthermore, assume that the health production function satisfies the classic conditions of a production function including: (i) $\frac{\delta f_i}{\delta x_i} > 0$; (ii) $\frac{\delta^2 f_i}{\delta x_i^2} < 0$; (iii) $\lim_{x_i \longrightarrow 0} \frac{\delta f_i}{\delta x_i} \longrightarrow \infty$; and (iv) $\lim_{x_i \longrightarrow \infty} \frac{\delta f_i}{\delta x_i} \longrightarrow 0$.

Notice that each individual is assumed to have a distinct health production function. Hence, each individual is allowed to be differentially efficient in producing health given the same amount of health inputs. f_j is more efficient that f_k if $f_j(X_j) > f_k(X_k)$ and $X_j = X_k$.

Given the basic layout above, there may be three possibilities:

1. $f_1 = f_2 = ... = f_N$ and $X_1 \neq X_2 \neq ..... \neq X_N$. Notice that in this case, $f_1(X_1) \neq f_2(X_2) \neq ..... \neq f_N(X_N)$ and hence, $Var(h) > 0$. Although each individual is equally efficient in producing health,differential access to health inputs creates health disparities.

2. $f_1 \neq f_2 \neq ... \neq f_N$ and $X_1 = X_2 = ... = X_N$. Notice that in this case, $f_1(X_1) \neq f_2(X_2) \neq ..... \neq f_N(X_N)$ and hence, $Var(h) > 0$. Although each individual has equal access to health inputs, everybody produces different *quantity* of health given the efficiency of his health production function.

3. $f_1 \neq f_2 \neq ... \neq f_N$ and $X_1 \neq X_2 \neq ..... \neq X_N$. Notice that $Var(h) \geq 0$. Health disparities may or may not exist in this situation. Health disparities will exist if $f_1(X_1) \neq f_2(X_2) \neq ..... \neq f_N(X_N)$ and hence, $Var(h) > 0$. Health disparities will not exist if $f_1(X_1) = f_2(X_2) = ... = f_N(X_N)$ and hence, $Var(h) = 0$.

The third possibility could be illustrated by two examples.

Example 1: Consider a two-individual society. Let us assume that there is only one health input. Let $f_1 = \ln X_1$ and $f_2 = 2.015 + \ln X_2$. Let $X_1 = 15$ and $X_2 = 2$. Notice that $h_1 = f_1 = h_2 = f_2 = 2.708$ or, $Var(h) = 0$. Although the first individual enjoys more health input, the second individual is more efficient in producing health. There is no observed health disparity in the society.

Example 2: Consider a two-individual society. Let us assume that there is only one health input. Let $f_1 = \ln X_1$ and $f_2 = 2.015 + \ln X_2$. Let $X_1 = 15$ and $X_2 = 10$. Notice that $h_1 = f_1 = 2.708 < h_2 = f_2 = 4.318$ or, $Var(h) > 0$. Again, although the first individual enjoys more health input, the second individual is more efficient in producing health. Hence, the second individual is able to produce more health compared to the first individual even with less health inputs. This society suffers from health disparity.

2.1 Policy Implications of the Examples

The possibilities and examples discussed above raises some important questions about the sources of health disparity in the population. Just observing existing health disparity in the population is not enough to know if it was created by differences in the health production function across individuals, or differential access to health inputs, or both. Policy implications depending on the source of health disparities are very different.

If everybody shares the same health production function but enjoys different access to health inputs then removal of health disparities would warrant equalizing health inputs across individuals. If everybody enjoys the same access to healthcare inputs but differs in terms of the health production function then removal of health disparities would warrant a redistribution of health inputs across individuals in order to equalize everybody's health outcomes. However, in the second case, health disparities can also be removed if policies are directed towards making each individual's health production function equally efficient.

Notice that redistribution of health inputs across individuals and efforts towards making each individual's health production function equally efficient are not mutually exclusive policy options. They can be pursued together so as maximize both societal health outcomes and remove health disparities.

While access to healthcare inputs remains a well-discussed issue, factors that determine the efficiency of the health production function of an individual is not so often discussed. Therefore, discussions concerning health disparity often centers around the access to healthcare inputs as articulated in the Institute of Medicine report. Arguably, education is one

of the major factors that determines the efficiency of the health production function of an individual especially in the adulthood.

2.2 On the Causality from Education to Health

That a better educated person will enjoy a more efficient health production function can be articulated in a relatively straightforward manner. Better educated persons are more equipped to understand health consequences of health related behaviors. For example, higher educated people smoke less, drink responsibly, show less inclination towards narcotics, tend to eat more healthy diet, choose more healthy housing and neighborhoods etc. A number of these choices are influenced by higher income that usually accompanies higher education. Higher educated people also tend to exhibit better adherence to doctor's advises and actively seek health related information from public health sources.

There is a secondary externality related effect that might support why higher educated people are more likely to be more efficient producers of health. Higher educated people also tend to belong to higher educated peer groups. These peer groups may be sources of scores of health related information (like good doctors, better healthcare facilities, possible bad effects of food etc.) Simply by belonging to more enlightened peer groups, higher educated individuals get virtually free access to many useful health related information that boosts the efficiency of their health production function.

2.3 Potential for Reverse Causality

Michael Grossman concluded that *"years of formal schooling completed is the most important correlate of good health"* (Grossman, 2003, pp. 32.) Although educations seems to have a much more straightforward relationship with health outcomes, reverse causality remains a matter of persistent concern. Recently, in an excellent reflection, Victor Fuchs provided a nice summary of the over-arching concerns in the field (Fuchs, 2004, pp. $656 - 658$.)

Reverse causality is said to exist if health has a potential impact on educational attainment and hence, we observe positive correlation between health and education. This could be partly true if worse health especially in the earlier years of life hinder progress at school. This could be also true if individuals with high time discount (i.e. in greater need of immediate gratification) engage in unhealthy or potentially dangerous practices (like unprotected sex or substance abuse) at school and as a result drop out from the school earlier.

Performance of the health production function postulated above may be affected in the presence of reverse causality. People who suffer unfortunate health outcomes in earlier phases of lives and people who have high time discounts are both going to be less healthy in later phases of their lives. Low educational attainment may also interfere with their effort to augment their health stock. Moreover, preponderance of such cases might lead to a strongly positive correlation between worse health and low education in a cross-section data. This might affect the identification of a causal effect of education on health.

It is almost impossible to provide a completely satisfactory resolution to the reverse causality problem. Ideally speaking, a more satisfactory resolution of the reverse causality problem will have to rely heavily on individual level panel data. Our major hope is that

people who engage in deviant health behavior or suffer major health obstacles in earlier years of lives are relatively minority.

Furthermore, even if the magnitude of the reverse causality is non-zero, at least, education suffers from lesser degree of reverse causality (Fuchs, 2004.) Education, unlike income, is acquired mostly in the earlier parts of one's life-span. Education acquired in the earlier periods of time may be considered as stock that results in a lifetime of benefit both economically and health-wise. Health capital formation in the earlier parts of life often depends on an individual's parents' income, education etc.

In the adulthood, a person has to be more self reliant in earning, choosing health related behaviors, collecting and assimilating health related information. Thus education can the thought of having an impact through economic channels like earning potential and also through direct channels like behavioral modification, and practice of healthy lifestyle through good information collection and assimilation.

Conceptualizing education as the major determinant of the efficiency of the health production function of an individual is different from treating income as the predominant source of variation. While higher income enhances one's access to healthcare system, good health is also necessary to earn higher income. Bad health reduces productivity thus reducing income. It may also be hypothesized that people who acquired higher education have low time discounts and hence, are more patient in practicing healthy lifestyles.

3 Data & Methods

This paper uses data from the Third National Health and Nutrition Examination Survey (henceforth, NHANES III.) NHANES III was conducted between 1988 and 1994 on nationwide probability sample. Approximately $33,994$ individuals aged 2 months and over were surveyed in NHANES III.

I included only adult white and black people with non-Hispanic ethnicity people with age 18 and over in this study. To minimize the effect of potential reverse causality, this paper analyzes data only for the adult individuals. It is hoped that in majority of the cases, individuals had a fair chance of completing their high school education by the age of 18. All the pregnancy related diabetes cases are omitted.

Individual level variables that are included in this study are age, race, ethnicity, gender, marital status, income and poverty status, family diabetes history, personal diabetes history, smoking, height, and weight. Individuals with missing or unknown educational attainment, marital status, and personal diabetes history are excluded from the analysis.

According to the years' of education, individuals were divided into four non-overlapping categories: ≤ 8 years, > 8 but < 12 years, ≥ 12 but < 16 years, and ≥ 16 years. There could be a concern whether higher educational attainment continues to have health impact or education looses its significance beyond some high levels (Fuchs, 2004.) This extensive partitioning of the educational attainment variable is done to tease out as much effect of education on health as possible.

An individual is considered to be a smoker if s/he smoked at least 100 cigarettes (5 packs) in life. An individual is considered to be married if the person is currently married (spouse in or not in the household) or living as married.

A person is treated to have a positive family history of diabetes if at least one individual from among the person's parents and grandparents were found have diabetes. Also, a person is considered to belong to low income family if the ratio of family income and poverty threshold is ≤ 2 (or, the person belongs to a family with income no more than twice the poverty threshold.)

From the weight (in pounds) and height (in inches) of an individual, Body Mass Index (BMI) was calculated using the following formula: $BMI = [(\text{weight in pounds})/\{(\text{height in inches})\text{x}(\text{height in inches})\}]x703$. A person is considered above healthy weight or overweight if $BMI > 25$ and obese if $BMI \geq 30$.

NHANES III recommends use of the population based weights to make calculations consistent at the population level. Individual level population based frequency weights provided by NHANES III are used in all calculations in this study. Therefore, all the results reported in this paper are representative of the respective populations at the National level (for the $1988 - 1994$ period.) All odds ratios reported in this article are calculated using the maximum likelihood logistic regression. $Z-$Statistics and 95% confidence intervals are reported to highlight statistical significance of the reported odds ratios.

This study includes $13,471$ (out of a total of $20,050$) individual level observations that through population based frequency weights represented $158,423,387$ adult individuals in the nation.

4 Results and Discussion

Table 1 reports the summary statistics for the data used in this paper. About 12.6% of the sample is comprised of non-Hispanic blacks while about 4.9% of the people reported as having diagnosed with non-pregnancy related diabetes. 63.7% of the people of the people were married or living as married and 32.8% of the people reported family history of diabetes. 55.5% people reported having smoked at least 5 packs of cigarette in their lives while 50.2% of the people reported a BMI of more than 25. 22.6% of people did not have at least a high school diploma or equivalent education and 52.4% were females. About 10.2% of the population were classified as poor and 28.8% were classified low income.

Table 2 reports the prevalence of diabetes in different socioeconomic groups. 6.2% of the non-Hispanic blacks and 4.8% of the non-Hispanic whites reported diabetes. Prevalence of diabetes was 7.5% among those who had family history of diabetes compared to 3.7% among those who did not have any family history of diabetes. Smokers and non-smokers reported diabetes rates of 5.4% and 4.4% respectively. 7.2% of the overweight people and 10.8% of the obese people reported diabetes. Males and females reported about the same prevalence of diabetes (4.9%.)

According to the income levels, poor reported highest prevalence (7%) followed by those belonged to low income group but were not poor (6.4%), and not-low income people (4.3%.) Prevalence of diabetes exhibited a strict gradient according to the years of education. Among the lowest education group (≤ 8 years), prevalence of diabetes was found out to be the highest (12.8%.) Strictly lower prevalences of diabetes were found in higher educational categories. People who had more than 8 years of education but did not complete high school reported 6.6% prevalence rate of diabetes. High school graduates and people who had some college

education reported a diabetes prevalence rate of 4.1%. College graduates and other higher educated people reported a 2.7% prevalence rate.

Table 3 reported the unadjusted odds ratios for reporting diabetes. An individual with family history of diabetes is 2.078 times more likely to have diabetes compared to an individual who does not have family history of diabetes. Non-Hispanic blacks and females are 1.333 and 1.008 times more likely to report diabetes compared to non-Hispanic whites and males respectively. Ceteris paribus., an individual with ≤ 8 years' of education 3.372 times more likely to report diabetes. It is easy to see from table 3 that the relative risk factor of reporting diabetes strictly goes down with higher levels of educational attainment. Poverty, low income, smoking, overweight and obesity are all found to be significant risk factors of diabetes.

Table 3 also shows that very low education (≤ 8 years' of education) poses more risk than race, gender, unhealthy body weight, smoking, poverty, low income, and family history of diabetes. Higher education, and marital status (currently married) found to be protective of one's health. These factors reduce the chances of reporting diabetes.

Tables $4A$, $4B$, and $4C$ report the adjusted odds ratios of reporting diabetes for entire population and also for many different socioeconomic groups. Overall, very low education (≤ 8 years' of education) poses more risk than family history of diabetes. This is true for non-Hispanic blacks, non-Hispanic whites, people belonging to low income and also for people who do not belong to low income categories.

Higher education significantly reduces the chances of having diabetes across all socioeconomic groups considered (non-Hispanic blacks, non-Hispanic whites, people belonging to low income, and people who do not belong to low income categories.) Overweight and obesity are significant risk factors of diabetes. Very low education (≤ 8 years' of education) poses more risk compared to a body mass index > 25.

The effect of additional years' of education in reducing the chances of reporting diabetes seems to vary across socioeconomic groups. Low income people and non-Hispanic blacks tend to benefit more with rising levels of education. The effects are almost dramatic for the low income people. Even a little high school education greatly reduces their chances of getting diabetes. Furthermore, note that while low educated non-Hispanic blacks are more likely to report diabetes, higher educated non-Hispanic blacks are less likely to report diabetes compared to non-Hispanic whites.

Given the results presented in Tables 1 through $4C$, it seems that lack of high education is a significant risk factor for diabetes. If different socioeconomic groups have very different educational attainment then prevalences of diabetes will be different between them. While at the outset it might seem that a particular socioeconomic group is more vulnerable to diabetes, in actuality, this results may be driven by the distribution of educational attainment between different groups. For example, non-Hispanic blacks may seem to more vulnerable to diabetes compared to non-Hispanic whites but this risk may be explainable through the differential educational attainment across different races.

Table 5 presents the distribution of educational attainment across different socioeconomic groups. Different socioeconomic groups vary widely in terms of educational attainment. While about 21% of the non-Hispanic whites do not have at least a high school diploma or equivalent, the corresponding figure is about 33% for the non-Hispanic blacks. Significant low educational attainment exists among smokers, poor, non-poor low income, overweight,

and obese people. Pervasive low education may be a contributive factor that can enhance the risk of reporting diabetes for relatively disadvantaged groups like non-Hispanic blacks.

Tables 6, $7A$, and $7B$ show that racial disparities in health may be an artefact of low educational attainment. Overall, non-high school graduate non-Hispanic blacks are 1.232 times more likely than the non-Hispanic whites to report diabetes. Among the high school and college educated people, non-Hispanic blacks are 7.4% less likely to report diabetes compared to their non-Hispanic white counterparts. The same basic observation holds true for people belonging to different groups.

Among all the people who reported a family history of diabetes and no high school diploma, non-Hispanic blacks are 1.225 times more likely than the non-Hispanic whites to report diabetes. On the other hand, among all the people who reported no family history of diabetes and at least a high school diploma or more years' of education, non-Hispanic blacks are about 7.3% less likely than the non-Hispanic whites to report diabetes. The comparable figures are 1.25 and 10.1% for all those who reported some family history of diabetes.

The basic results are same for overweight and obese people too. Overweight and obese but higher educated non-Hispanic blacks are $11.2\% - 29.6\%$ less likely than non-Hispanic whites to report diabetes. Reversing of the racial disparity of health with higher levels of education seems to be a startling yet profoundly informative result that requires close policy attention.

The results in this paper point towards the possibility that higher education in itself plays a great protective role against diabetes. Probably, this protective role is not only derived from the usual observation that higher educated individuals also tend to earn higher amounts. Some of the effects are direct in nature. They may be in terms of behavioral modifications. For example, Table 5 indicates that higher educated people are more likely to maintain healthy weight (may be through better diet and more exercise) compared to less educated people. Higher educated people are also less likely to smokers.

It is also conceivable that higher educated people with known family history of diabetes will watch their diets more carefully and actively seek to maintain a healthy weight. A balanced diet, and regular exercise along with a healthy body weight are also contributive towards reduced likelihoods of developing diabetes. People without any family history of diabetes but with higher education may also engage in similar healthy activities. In each situation, higher educated people (with or without family history of diabetes) may take necessary steps that reduces their likelihoods of developing diabetes.

That higher educated non-Hispanic blacks are less likely than their non-Hispanic white counterparts to report diabetes presents a unique view of reverse racial disparity contrary to the opening quote from CDC. It seems that racial disparity is diabetes does not have the same gradient across all segments of the educational distribution.

5 Conclusion

Racial health disparities are shown to be largely driven by the underlying disparities in educational attainments. Using diabetes related data from the Third National Health & Nutrition Examination Survey $(1988 - 1994)$ of the USA, this paper shows that (1) there are wide ranging within and between group variations in diabetes within and between races; (2)

educational attainment is a strong marker that explains a large proportion of the diabetes related disparities both within and between races; (3) within and between race disparities are reduced or reversed if educational attainments are accounted for even when people are similarly genetically predisposed or faces comparable other risk factors like higher body weight.

The results of this paper point towards few very sensible policy directions. Firstly, educational attainments may be used as credible screening criteria in a clinical set up for ordering tests towards diabetes diagnosis. This will help enhance early diagnosis and may contribute towards stopping pre-diabetic patients from acquiring full blown diabetes. Secondly, education policies can be treated as complimentary to health policies. Increasing the educational attainment of especially lowly educated young adults may contribute towards lower future burden of diabetes and may also contribute towards lowering racial health disparities.

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Table 1
Summary Statistics*

Variable	**Mean (Standard Error)**
Dummy for race/ethnicity[1]	0.126(0.332)
Dummy for diabetes[2]	0.049(0.217)
Dummy for marital status[3]	0.637(0.481)
Dummy for family diabetes history[4]	0.328(0.469)
Dummy for smoking[5]	0.555(0.497)
Dummy for overweight/obese[6]	0.502(0.499)
Dummy for non high school attainment[7]	0.226(0.418)
Dummy for gender[8]	0.524(0.499)
Dummy for poverty[9]	0.102(0.302)
Dummy for low income[9]	0.288(0.453)

Notes

*. Weighted using the population weights provided in the original data.

1. Non-Hispanic black= 1; Non-Hispanic white= 0. 2. Ever diagnosed by a doctor as having diabetes: Yes= 1, No= 0. 3. Marital status= 1 if currently married or living as married; 0 otherwise. 4. Family diabetes history= 1 if at least one person among mother, father, grandmother, and father has/had diabetes; 0 otherwise. 5. Smoking= 1 if smoked at least 100 cigarettes in life; 0 otherwise. 6. Overweight/obese= 1 if Body Mass Index > 25; 0 otherwise. 7. = 1 if Years of education< 12, 0 otherwise. 8. Female= 1, Male= 0. 9. poverty=1 if living on or below poverty line; low income=1 if living on or below 200% of the poverty line.

Table 2

Prevalences of Diabetes among different groups*

Socioeconomic Group	Prevalence (standard deviation)
Non-Hispanic Black	0.062(0.242)
Non-Hispanic White	0.048(0.213)
With Family history of Diabetes	0.075(0.263)
Without Family history of Diabetes	0.037(0.189)
Smoker	0.054(0.226)
Non-smoker	0.044(0.205)
Body-mass index > 25	0.072(0.259)
Body-mass index ≥ 30	0.108(0.311)
Females	0.049(0.217)
Males	0.049(0.216)
Poor	0.070(0.256)
Low Income but not poor	0.064(0.245)
Not low income	0.043(0.202)
Education ≤ 8 years	0.128(0.335)
Education > 8 but < 12 years	0.066(0.249)
Education ≥ 12 but < 16 years	0.041(0.199)
Education ≥ 16 years	0.027(0.162)

*. Weighted using the population weights provided in the original data.

Table 3
Unadjusted odds ratios of reporting diabetes (Full Sample)*

Variable	Odds Ratio (Z-value, 95% CI)
Family Diabetes History	$2.078(994.89, 2.075 - 2.081)$
Non-Hispanic Black	$1.333(285.24, 1.329 - 1.335)$
Gender (Female)	$1.008(11.38, 1.007 - 1.009)$
Education ≤ 8 years	$3.372(1346.99, 3.366 - 3.378)$
Education > 8 but < 12 years	$1.447(388.31, 1.444 - 1.449)$
Education ≥ 12 but < 16 years	$0.676(-532.43, 0.675 - 0.677)$
Education ≥ 16 years	$0.475(-653.77, 0.474 - 0.476)$
Body mass index > 25	$2.845(1270.67, 2.841 - 2.850)$
Body mass index ≥ 30	$3.192(1519.48, 3.187 - 3.197)$
Smoking	$1.233(279.73, 1.231 - 1.235)$
Currently married or living as married	$0.967(-44.36, 0.965 - 0.968)$
Poor	$1.530(404.27, 1.527 - 1.533)$
Low income	$1.599(622.21, 1.597 - 1.602)$

*. Weighted using the population weights provided in the original data.

Table 4A
Adjusted odds ratios for reporting diabetes: All People*
(Z-value, and 95% CI inside parentheses)

Variable	**All People**
Family Diabetes History	$2.067(980.90, 2.064 - 2.070)$
Education ≤ 8 years	$3.074(1194.34, 3.068 - 3.080)$
Education > 8 but < 12 years	$1.273(247.89, 1.271 - 1.276)$
Education ≥ 12 but < 16 years	$0.685(-512.890.684 - 0.686)$
Education ≥ 16 years	$0.539(-526.48, 0.538 - 0.541)$
Body mass index > 25	$2.890(1272.95, 2.886 - 2.895)$
Body mass index ≥ 30	$3.111(1472.38, 3.107 - 3.116)$

*. Weighted using the population weights provided in the original data. Adjusted for gender, race, smoking, and marital status.

Table 4B
Adjusted odds ratios for reporting diabetes: By Races*
(Z-value, and 95% CI inside parentheses)

Variable	Non-Hispanic **White**	Non-Hispanic **Black**
Family Diabetes History	$2.149(949.10, 2.146 - 2.153)$	$1.677(273.55, 1.670 - 1.683)$
Education ≤ 8 years	$2.956(1024.34, 2.950 - 2.962)$	$3.548(608.90, 3.534 - 3.563)$
Education > 8 but < 12 years	$1.273(221.34, 1.270 - 1.276)$	$1.317(125.63, 1.311 - 1.322)$
Education ≥ 12 but < 16 years	$0.748(-361.67, 0.747 - 0.749)$	$0.418(-451.94, 0.416 - 0.420)$
Education ≥ 16 years	$0.536(-509.58, 0.535 - 0.537)$	$0.552(-143.51, 0.548 - 0.556)$
Body mass index > 25	$2.976(1205.06, 2.971 - 2.981)$	$2.435(412.32, 2.425 - 2.446)$
Body mass index ≥ 30	$3.361(1445.55, 3.355 - 3.366)$	$2.083(377.14, 2.075 - 2.091)$

*. Weighted using the population weights provided in the original data.

Table 4C
Adjusted odds ratios for reporting diabetes: By Income Groups*
(Z-value, and 95% CI inside parentheses)

Variable	Low Income Only	Not Low Income
Family Diabetes History	$1.689(432.31, 1.685 - 1.693)$	$2.368(915.81, 2.363 - 2.372)$
Education $\leq$ 8 years	$3.122(905.08, 3.114 - 3.129)$	$3.013(770.49, 3.005 - 3.022)$
Education $>$ 8 but $<$ 12 years	$0.940(-42.16, 0.938 - 0.943)$	$1.670(401.12, 1.666 - 1.674)$
Education $\geq$ 12 but $<$ 16 years	$0.509(-551.34, 0.508 - 0.511)$	$0.810(-224.16, 0.809 - 0.812)$
Education $\geq$ 16 years	$0.347(-270.02, 0.3446 - 0.350)$	$0.575(-445.97, 0.574 - 0.576)$
Body mass index $>$ 25	$2.811(775.83, 2.804 - 2.818)$	$2.833(969.12, 2.827 - 2.839)$
Body mass index $\geq$ 30	$2.540(747.20, 2.534 - 2.546)$	$3.433(1257.46, 3.427 - 3.440)$

*. Weighted using the population weights provided in the original data.

Table 5
Distribution of educational attainments* (Figures in Percentages)

Group	Education $\leq$ 8 years	Education $>$ 8 but $<$ 12 years	Education $\geq$ 12 but $<$ 16 years	Education $\geq$ 16 years
Non-Hispanic White	8.19	12.87	56.43	22.51
Non-Hispanic Black	12.92	20.01	57.14	9.93
With Family history of Diabetes	7.26	13.81	58.02	20.91
Without Family history of Diabetes	9.53	13.75	55.79	20.93
Smoker	9.56	17.27	56.68	16.48
Non Smoker	7.82	9.40	56.32	26.46
Body Mass Index $>$ 25	9.51	14.32	57.88	18.30
Body Mass Index $\geq$ 30	10.51	16.85	59.08	13.56
Male	8.70	14.27	53.13	23.89
Female	8.86	13.32	59.60	18.22
Poor	21.86	22.88	50.89	4.37
Low Income but not poor	15.80	22.40	55.00	6.79
Not low income	5.08	10.21	57.72	26.99
Total Populatio (Age $\geq$ 18)	8.78	13.77	56.52	20.92

*. Weighted using the population weights provided in the original data.

Table 6
Within educational group racial disparity in diabetes*
(Non-Hispanic blacks compared to non-Hispanic whites)
(Z-value, and 95% CI inside parentheses)

Educational Group	**Odds ratio of reporting diabetes**
Education $\leq$ 8 years	$1.344(145.34, 1.338 - 1.349)$
Education $>$ 8 but $<$ 12 years	$1.319(122.20, 1.313 - 1.325)$
Education $\geq$ 12 but $<$ 16 years	$0.874(-80.88, 0.871 - 0.877)$
Education $\geq$ 16 years	$1.192(41.73, 1.182 - 1.202)$
Education $<$ 12 years	$1.232(139.52, 1.229 - 1.236)$
Education $\geq$ 12 years	$0.926(-49.56, 0.923 - 0.929)$

*. Weighted using the population weights provided in the original data.

Table 7A
Within socioeconomic but between educational group racial disparity in diabetes*
(Non-Hispanic blacks compared to non-Hispanic whites)
(Z-value, and 95% CI inside parentheses)

Educational Group	Odds ratio of reporting diabetes
With Family History of Diabetes	
Education ≤ 8 years	$1.384(87.77, 1.374 - 1.394)$
Education > 8 but < 12 years	$1.440(105.03, 1.430 - 1.449)$
Education ≥ 12 but < 16 years	$0.934(-28.57, 0.930 - 0.939)$
Education ≥ 16 years	$1.045(7.18, 1.032 - 1.057)$
Education < 12 years	$1.225(81.98, 1.219 - 1.231)$
Education ≥ 12 years	$0.947(-25.04, 0.942 - 0.950)$
Without Family History of Diabetes	
Education ≤ 8 years	$1.336(118.37, 1.329 - 1.342)$
Education > 8 but < 12 years	$1.260(77.10, 1.253 - 1.268)$
Education ≥ 12 but < 16 years	$0.796(-97.29, 0.792 - 0.800)$
Education ≥ 16 years	$1.608(81.18, 1.59 - 1.627)$
Education < 12 years	$1.250(118.08, 1.245 - 1.254)$
Education ≥ 12 years	$0.899(-49.09, 0.895 - 0.902)$

*. Weighted using the population weights provided in the original data.

Table 7B
Within socioeconomic but between educational group racial disparity in diabetes*
(Non-Hispanic blacks compared to non-Hispanic whites)
(Z-value, and 95% CI inside parentheses)

Educational Group	Odds ratio of reporting diabetes
Body Mass Index > 25	
Education ≤ 8 years	$1.161(61.54, 1.156 - 1.167)$
Education > 8 but < 12 years	$1.353(119.21, 1.347 - 1.360)$
Education ≥ 12 but < 16 years	$0.852(-83.31, 0.849 - 0.856)$
Education ≥ 16 years	$1.103(18.72, 1.092 - 1.114)$
Education < 12 years	$1.166(88.62, 1.162 - 1.170)$
Education ≥ 12 years	$0.888(-66.22, 0.885 - 0.891)$
Body Mass Index ≥ 30	
Education ≤ 8 years	$0.981(-5.73, 0.974 - 0.987)$
Education > 8 but < 12 years	$1.521(125.90, 1.511 - 1.531)$
Education ≥ 12 but < 16 years	$0.580(-187.96, 0.577 - 0.584)$
Education ≥ 16 years	$0.871(-15.83, 0.856 - 0.886)$
Education < 12 years	$1.140(55.60, 1.135 - 1.145)$
Education ≥ 12 years	$0.604(-184.21, 0.601 - 0.607)$

*. Weighted using the population weights provided in the original data.