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Understanding the Influence of Digital Divide and Socio-Economic Factors on the Prevalence of Diabetes

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Abstract

More than 29 million Americans have diabetes and another 84 million are prediabetic costing the US health care system and employers \$245 billion annually. Factors such as overweight, sedentary behavior, and history of diabetes in the family have been commonly associated with the onset of type 2 diabetes. Extant literature now points to the effect of socio-economic factors such as education, income, ethnicity, and physical location on the prevalence of the disease. This research aims to investigate the impact of social determinants on diabetes with a particular emphasis on the digital divide. We use data from the Centers for Disease Control and Prevention (CDC) for diagnosed diabetes prevalence for the year 2013 by county. We contrast the diabetes prevalence data against social factors such as race, educational attainment, income, unemployment, and digital divide obtained from the census data. We use bivariate, multivariate and regression analysis to highlight the relation between diabetes prevalence and socio-economic and digital divide factors. The results can inform the design of diabetes intervention strategies with an emphasis on IT-based interventions for self-care and self-management.

Background

Chronic diseases are the leading causes of death and disability in the United States driving the nation's \$3.3 trillion in healthcare expenditure every year (CDC, 2018). People with diabetes are highly prone to heart disease, stroke, kidney disease, eye problems, dental disease, nerve damage, and foot problems ("What is Diabetes?," 2016). This necessitates the need for interventions at the self-care level to prevent diabetes and at the self-management level to manage the condition and maintain health while living with diabetes. Many current interventions address the more common and direct causative factors such as overweight and sedentary behavior. As socioeconomic factors show a significant effect on diabetes among other chronic conditions (Southerland, Wright, Payne, & Washington, 2018) and as digital divide prove to play a key role in the maintenance and management of health and wellness (Lustria, Smith, & Hinnant, 2011), it is important to further study their effect on the prevalence of diabetes.

Literature Review

The social life of a person plays a key role in determining the degree of susceptibility; risk of exposure, course, and outcome of a disease irrespective of the type of disease. Socio-economic factors are no longer viewed as secondary factors affecting the health of an individual, but as the primary research focus of today's health perspective (Cockerham, Hamby, & Oates, 2017). Studies show strong correlations between socio-economic factors and the prevalence of diabetes in United States as well as worldwide (Whiting, Unwin, & Roglic, 2010). The most common of these factors are age, educational level, job status, neighborhood, race, and income (Tol, Sharifirad, Shojaezadeh, Tavasoli, & Azadbakht, 2013; Walker, Smalls, Campbell, Strom Williams, & Egede, 2014). Digital divide proves to play a key role in affecting the health status of an individual (Wyatt, Henwood, Hart, & Smith, 2005). The most common attributes that can be employed to measure digital divide and its effect on the health and wellness include the availability of internet access or subscription, access to or ownership of a computer or laptop or mobile device, usage of internet for health information purposes, and e-healthcare usage (Chang et al., 2004; Denizard-Thompson, Feiereisel, Stevens, Miller, & Wofford, 2011; Powell, Darvell, & Gray, 2003; Sarkar et al., 2011). There is very little to no specific research on the effect of digital divide on the prevalence of diabetes. which creates the need for further study.

Methodology

The diagnosed diabetes prevalence data for the year 2013 by each county in the United States was obtained from the Centers for Disease Control and Prevention (CDC). The data was aligned with data on the social factors: race, income, education, internet subscription, access/ownership of laptop or computer or mobile phone, and unemployment for United States counties with a population of more than 65,000 obtained from the census for the same year 2013. Missing and forced values were removed from the data and all the attributes were standardized for processing. Bivariate, multivariate and regression analysis were employed to identify and understand the most important predictor variables that contribute to the accurate prediction of the prevalence of diabetes. The identification of the most important socio-economic factors was done based on the P values with 95% confidence. The significance of the relation between the predictors and the diabetes prevalence can be inferred from the P values and the coefficient values of each predictor variable obtained from the regression.

Results

The data represents 769 United States counties. There is a statistically significant relation between the prevalence of diabetes and digital divide (computer or laptop usage and broadband subscription of household percentages), race, education, income and unemployment rate ($P < 0.001$) when the data was fitted with linear regression using ordinary least squares. The digital divide, education, and income had a negative correlation with diabetes prevalence. The unemployment rate was positively correlated with diabetes prevalence, while the race attributes provided mix results (White and African American population percentage had a positive relation while other race population percentage was negatively related to the diabetes prevalence).

OLS Regression Results

Dep. Variable:	Dia_prev_perc	R-squared:	0.563
Model:	OLS	Adj. R-squared:	0.560
Method:	Least Squares	F-statistic:	163.9
Date:	Fri, 15 Mar 2019	Prob (F-statistic):	1.64e-133
Time:	02:21:17	Log-Likelihood:	-772.46
No. Observations:	769	AIC:	1559.
Df Residuals:	762	BIC:	1591.
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
const	-2.299e-17	0.024	-9.6e-16	1.000	-0.047	0.047
HH_Comp_Percent	-0.3991	0.035	-11.449	0.000	-0.468	-0.331
Perc_Esti_White	0.1776	0.048	3.730	0.000	0.084	0.271
Perc_Esti_BlK AfrAmer	0.3691	0.043	8.511	0.000	0.284	0.454
Perc_Esti_OthRace	-0.1300	0.029	-4.407	0.000	-0.188	-0.072
Unemprate_Estimate_Popu>16	0.1053	0.031	3.388	0.001	0.044	0.166
principal_edu_income 1	-0.2010	0.029	-6.913	0.000	-0.258	-0.144

Omnibus:	5.469	Durbin-Watson:	1.482
Prob(Omnibus):	0.065	Jarque-Bera (JB):	6.274
Skew:	0.102	Prob(JB):	0.0434
Kurtosis:	3.393	Cond. No.	4.46

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Fig 1. Multiple Linear Regression results

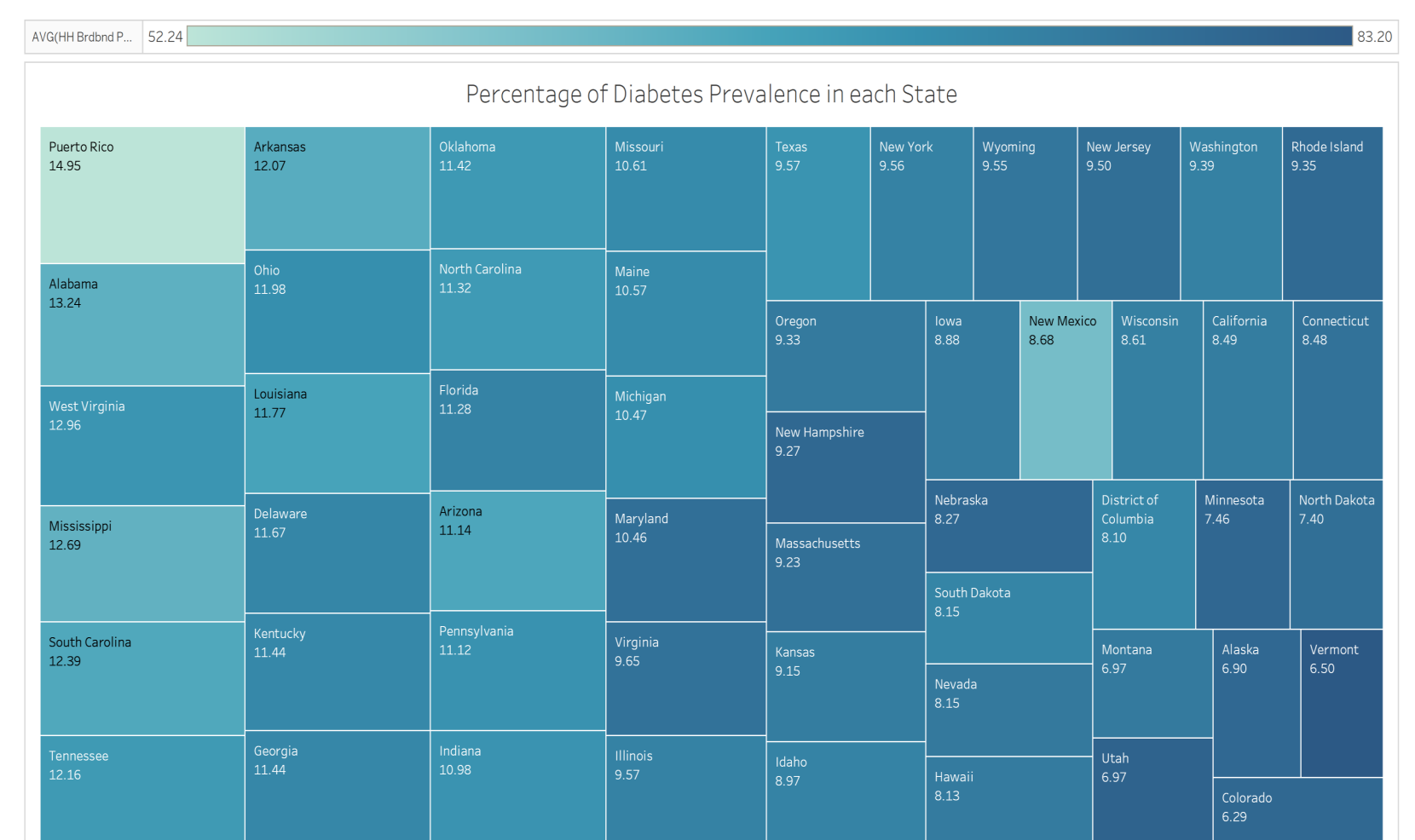


Fig 2. Diabetes Prevalence of each state with heat map associated by Digital Divide (Household percentage of broadband subscription)

Discussion

Computer usage has a negative and significant effect on diabetes prevalence. One possible explanation is that the usage of a laptop or computer indirectly reduces the prevalence of diabetes by facilitating self-care, access to health information, promotion of good health and wellness all leading to prevention of diabetes. Similarly, income and education have a negative effect on diabetes prevalence, which indicates that a higher level of education and a higher income reduce the risk for diabetes. Educated people tend to be more health conscious while income can be said to be correlated with education. On the other hand, unemployment rate shows a positive and significant effect on diabetes prevalence. Interestingly, White and Black African American population percentage are positively related to diabetes prevalence implying these race populations are more prone to diabetes than 'other' races. Prior research supports the notion of social factors being crucial in influencing diabetes prevalence (Hill, Nielsen, & Fox, 2013). This research emphasizes the importance of variables associated with the digital divide as additional factors contributing to diabetes prevalence. Most of the diabetes interventions are focused on glycemic control, obesity control, physical activity, stress and anxiety reduction as major direct factors when designing a diabetes self-care and self-management intervention. Based on the observed results, it is necessary to consider the socio-economic factors when designing a robust intervention. Of particular importance is addressing (and accounting for) the digital divide when designing IT-based self-management interventions.

Conclusions

The socio-economic factors are no longer considered secondary or tertiary factors in influencing health outcomes, especially diabetes. The digital divide not only plays a key role in influencing the social factors but also the health and wellness of the population. Income, education, race, and unemployment rate prove to be significant influencing factors for the prevalence of diabetes indicating the importance of life style and social aspects in better healthcare management. The results indicate the relationship between computer usage (as a proxy for the digital divide) and diabetes prevalence. Future research is needed to further investigate the inter-play across various socio-economic factors of health issues and to incorporate the results in the design of diabetes intervention strategies, particularly those relying on access to information technology for self-care and self-management.