



State-wide Patterns In Diabetes Screening Service: Comparing 3 Medical Insurance Plans

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Abstract

In the U.S, diabetes has become one of the major health concerns. In like manner, health insurance coverage is vital to the health needs of individuals. Adults having elevated glucose levels are recommended to receive glycated hemoglobin (HbA1c) testing to determine the average blood sugar concentrations. Differences in insurance coverage has significant impact on recommended screenings.

The study analyzes secondary data from 2011 to 2013 for three different health plans being Medicaid, Blue Care Network (BCN) and Blue Cross Blue Shield (BCBS) of Michigan. Statistical methods were used to ascertain the best regression model for count data and the association between county specific health and socioeconomic factors and insurance plans associated with the HbA1c testing.

The study finds the negative binomial model is best in predicting count health data. Also, urban-rural interface and type of insurance plan are key in understanding patterns and frequency of diabetes service utilization. The BCBS plan has more people taking the required HbA1c test compared to the BCN and Medicaid. Across all plans, analysis indicate that interventions should be focused on the southern part of Michigan. Further, health and socioeconomic factors determine the rate and frequency of the HbA1c screening.

Introduction

- ~1.7 million people are newly diagnosed with diabetes each year in U.S.¹
- Based on current projections, one in three U.S adults will be diagnosed with diabetes by 2050²
- Diabetes was the seventh leading cause of death in the U.S in 2010^{4,5}
- Mismanaged diabetes could lead to several related issues including blindness, heart disease, stroke, and premature death⁵
- People with diabetes incur higher medical costs estimated to be 2-3 times higher than those without diabetes¹
- More than 1 in 5 healthcare dollars is spent on care for people diagnosed with diabetes¹
- In the U.S the total medical cost associated with diabetes management for 2012 is estimated to be 175.8 billion dollars with an indirect cost of 68.6 billion dollars¹
- Health insurance has been associated with the quality of care and management of diabetes, including receiving recommended A1C testing and the type of health insurance (public versus private) plays a key role in determining the level of care and management due to the cost burden of diabetes^{3,6}

Diabetes in Michigan

- 7.5 percent of the population in Michigan are diagnosed with diabetes each year³
- Costs: 5.76 billion dollars in direct cost and 2.43 billion dollars indirect cost to manage diabetes¹
- Diabetes is a primary cause of new cases of adult blindness, kidney failure and non-traumatic lower-limb amputation¹
- Death due to diabetes has been higher in MI than in the U.S. consistently from 1999 to 2012⁴

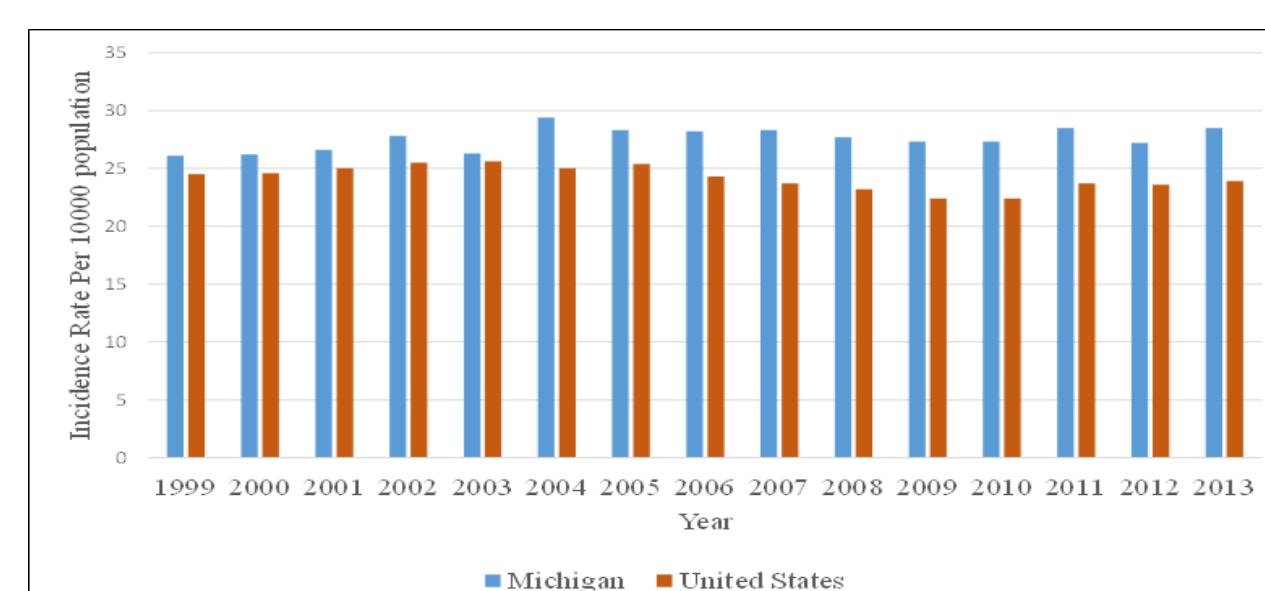


Figure1 showing diabetes death rates per 10,000 populations between Michigan and U.S from 1999 to 2013

Objectives

- Identify the best model for predicting count secondary health data
- The association between screening rates and socioeconomic/health factors.
- HbA1c testing rates in Michigan on county level to identify areas with lower testing rates and geographic patterns
- Does HbA1c testing rates vary by insurance type (public or private)

Methods

Study Design

- Secondary data analysis of 2011-2013 Michigan Medicaid, BCN and BCBS (non-governmental operated health insurance provider) recipients with diagnosed diabetes

Population

- Cases were analyzed Medicaid, BCN and BCBS was n=427,737

Eligibility:

- 18 years or older and be
- Had previous been screened with diabetes
- in the insurance plan for at least 12 consecutive months during the 3 year study period

Measures

- A1C testing at least once per year (yes/no)

County of residence

Analysis

- Statistical analysis was conducted in R
 - Poisson regression
 - Negative binomial regression
 - Model selection (using AIC, Vuong test and Residual Deviance)
 - Residual analysis

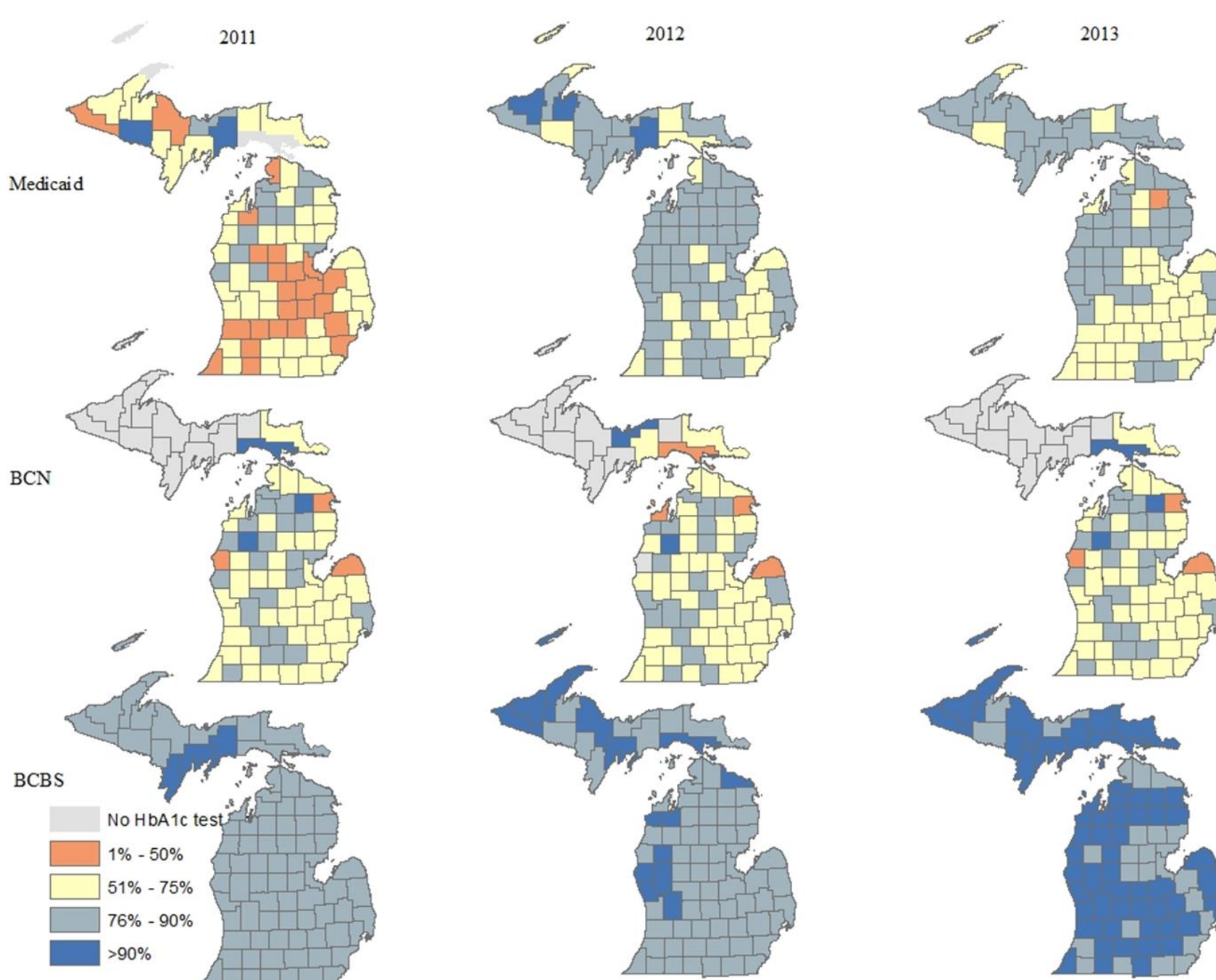
- ArcGIS 10.4 used for mapping

- Individual cases were aggregated into county of residence

- County Hb1c screening rates computed by insurance type

Results

Screening Rates for all three plans



Model Selection

Table 4. Parameter Estimates and Goodness of Fit Statistics for Poisson and Negative Binomial Models (Medicaid)

Variables	2011		2012		2013	
	Poisson	Negative Binomial	Poisson	Negative Binomial	Poisson	Negative Binomial
(Intercept)	5.474 ***	4.800 ***	5.743 ***	5.174 ***	5.664 ***	8.295 ***
Diag_Prev	-0.034 ***	-0.138 *	-0.019 **	-0.098 *	-0.099 ***	-0.183 **
Leisure_Inactivity_Prev	0.098 ***	0.103 **	0.070 ***	0.064 *	0.124 ***	0.088 **
Poverty	-0.009 ***	0.039 *	0.006 **	0.052 *	-0.003	-0.030
Population	0.001 ***	0.002 ***	0.001 ***	0.002 ***	0.001 ***	0.002 ***
Percent_Minority	3.078 ***	2.732 *	2.844 ***	1.887	3.323 ***	1.739
high	-0.069 ***	-0.052 **	-0.069 ***	-0.053 **	-0.073 ***	-0.059 ***
Residual deviance:	8405	91.956	9595.8	89.949	9160.5	88.211
AIC:	8958.5	986.4	10157	1002.6	9724	1157.6
Log Likelihood		-970.397		-986.569		-1141.559
Vuong Statistic	4.632		5.086		4.321	

***Significant at the 0.001 significance level,**Significant at the 0.01,*Significant at the 0.05 significance level.

Table 5. Parameter Estimates and Goodness of Fit Statistics for Poisson and Negative Binomial Models (Blue Care Network)

Variables	2011		2012		2013	
	Poisson	Negative Binomial	Poisson	Negative Binomial	Poisson	Negative Binomial
(Intercept)	8.251 ***	8.180 ***	8.492 ***	9.231 ***	8.487 ***	9.126 ***
Diag_Prev	-0.098 ***	-0.091 **	-0.125 ***	-0.087 *	-0.166 ***	-0.007 *
Leisure_Inactivity_Prev	0.065 ***	0.052 **	0.029 ***	0.006 *	0.076 ***	0.018 **
Poverty	-0.075 ***	-0.038	-0.048 ***	-0.014	-0.053 ***	-0.011
Population	0.001 ***	0.002 ***	0.001 ***	0.002 ***	0.001 ***	0.002 ***
Percent_Minority	3.121 ***	3.618	3.024 ***	1.908	3.149 ***	0.741
high	-0.092 ***	-0.113 **	-0.079 ***	-0.121 ***	-0.091 ***	-0.145 ***
Residual deviance:	9757	99.86	10570	100.17	11721	100.39
AIC:	10177	858.61	10993	869.68	12155	891.38
Log Likelihood		-842.61		-853.68		-875.38
Vuong Statistic	5.470		5.469		5.814	

***Significant at the 0.001 significance level,**Significant at the 0.01,*Significant at the 0.05 significance level.

Table 6. Parameter Estimates and Goodness of Fit Statistics for Poisson and Negative Binomial Models (Blue Cross Blue Shield of Michigan)

Variables	2011		2012		2013	
	Poisson	Negative Binomial	Poisson	Negative Binomial	Poisson	Negative Binomial
(Intercept)	8.676 ***	8.043 ***	9.291 ***	8.325 ***	9.191 ***	8.295 ***
Diag_Prev	-0.164 ***	-0.204 ***	-0.138 ***	-0.162 ***	-0.194 ***	-0.183 **
Leisure_Inactivity_Prev	0.081 ***	0.081 ***	0.053 ***	0.061 *	0.108 ***	0.088 **
Poverty	-0.055 ***	-0.015	-0.045 ***	-0.019	-0.057 ***	-0.020
Population	0.001 ***	0.002 ***	0.001 ***	0.002 ***	0.001 ***	0.002 ***
Percent_Minority	1.166 ***	1.905	3.990 ***	1.764	3.454 ***	1.739
high	-0.059 ***	-0.058 ***	-0.076 ***	-0.055 ***	-0.080 ***	-0.059 ***
Residual deviance:	15518	87.498	15522	88.175	15389	88.211
AIC:	16161	1123.6	16175	1151.3	16044	1157.6
Log Likelihood		-1107.553		-1135.283		-1141.559
Vuong Statistic	5.813		6.563		6.410	

***Significant at the 0.001 significance level,**Significant at the 0.01,*Significant at the 0.05 significance level.

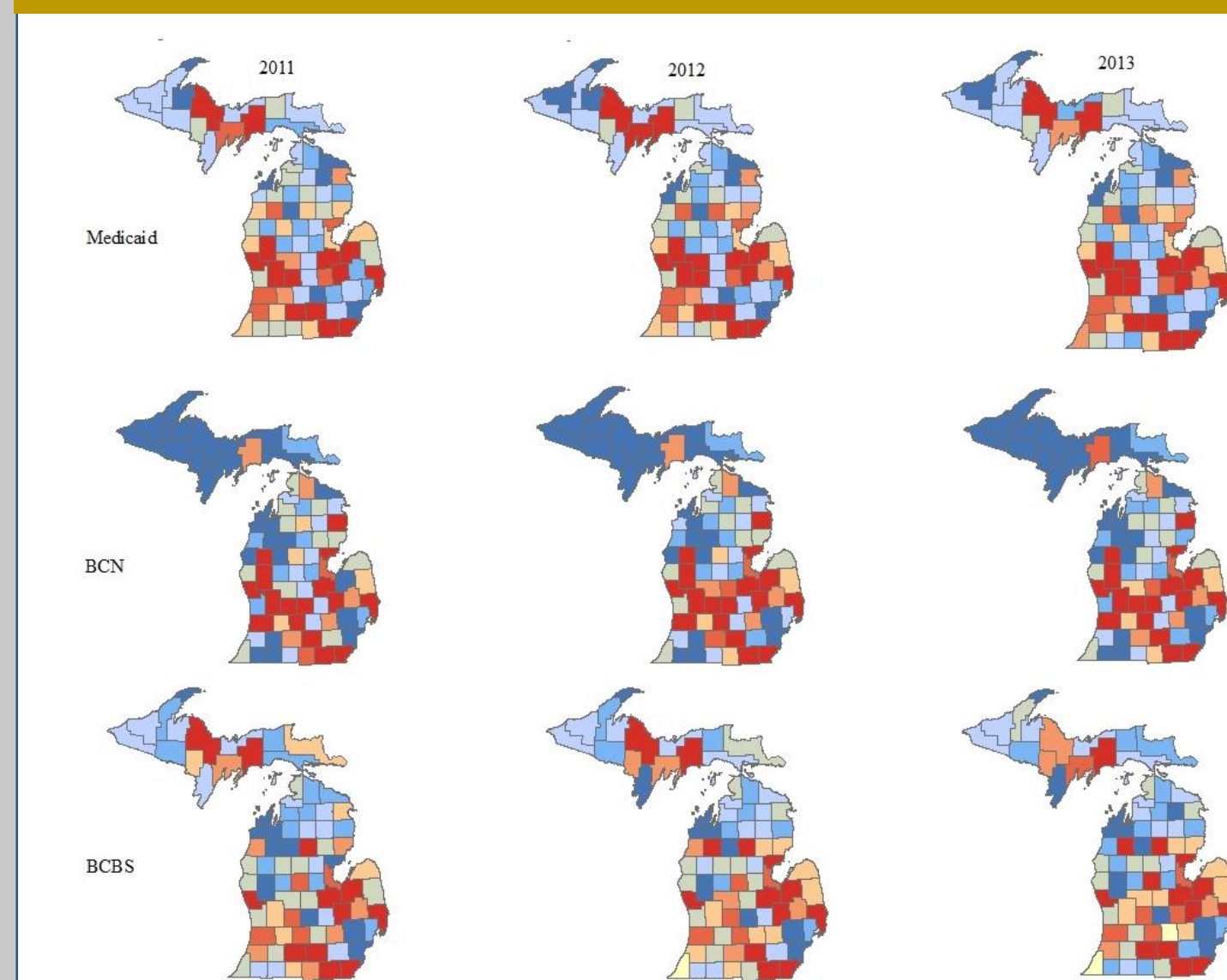
Model Selection Highlight

- The Poisson model yielded higher AIC values and over-stated the significance of all the covariates.
- Ignoring over dispersion leads to wrong statistical inference which further leads to an inaccurate conclusion
- Thus, prior to selecting statistical model to be used for count health data analysis, it is essential to consider the distribution of the data to ascertain the dispersion of the data.

Key Similarities Across Insurance Plans

- Less people within each county get the HbA1c testing as education increases
- Counties with higher physical inactivity record higher screening rates (more people taking the test)
- Socioeconomic and health factors have similar associations for both BCN and BCBS though the parameter estimates

Residual Analysis



The red areas are locations where the actual values are larger than the model estimated.

The blue areas are locations where the actual values are smaller than the model estimated.

Comparing All Three Plans

- Spatial patterns vary across plans and within plans
- BCBS has higher number of people as well as recording the highest turnout rates
- Socioeconomic and health factors that influence similar though the parameter estimates vary for BCN and BCBS
- All plans have the southern counties and regions having relatively low turnout rates

Discussion and Conclusions

- Noticeable variations across the counties of Michigan (southern MI)
- Exercising and engaging in any physical activity does not influence a person's decision to take the required HbA1c testing
- Socioeconomic and health factors are associated with screening rates and patterns
- The patterns for all the plans differ

Strengths

- Data for selection criteria was available for entire states
- Multiple years were examined
- No missing data was identified

Limitations

- Could not examine causality
- Secondary data
- Differences in population across plans was not examined

References

- American Diabetes Association (2013). Economic costs of diabetes in the US in 2012. *Diabetes care*, 36(4), 1033-1046
- Boyle, J. P., Thompson, T. J., Gregg, E. W., Barker, L. E., & Williamson, D. F. (2010). Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. *Population Health Metrics*, 8(1), 29
- Brown, D. S., & McBride, T. D. (2014). Impact of the Affordable Care Act on Access to Care for US Adults with diabetes, 2011-2012. *Preventing Chronic Disease*, 12, E64
- Centers for Disease Control and Prevention (2014). National Diabetes Statistics Report, 2014. Accessed on April 10, 2015 from <http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf>
- Centers for Disease Control and Prevention, National Center for Health Statistics (2013). Number (in Millions) of Civilian, Non-Institutionalized Persons with Diagnosed Diabetes, United States, 1980-2011. Accessed on April 10, 2015 from <http://www.cdc.gov/diabetes/statistics/prev/national/figpersons.htm>
- Smith, J. C., & Medalia, C. (2015). Health Insurance Coverage in the United States: 2014. US Department of Commerce, Economics and Statistics Administration, Bureau of the Census.

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