Research Article

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Journal of Clinical Medicine and Therapeutics

2017
Vol.2 No.2: 15

Health Equity and the Gini Index in the United States

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Received date: June 15, 2017; **Accepted date:** June 23, 2017; **Published date:** June 30, 2017

Citation: Sasagawa M, Amieux PS, Martzen MR (2017) Health Equity and the Gini Index in the United States. J Clin Med Ther. Vol. 2 No. 2: 15.

Abstract

Introduction: A rich repository of data containing information about social, economic, healthcare and other health-related variables can be found in the public domain. When mined appropriately by asking the right questions, this data can provide confirmation of results of many existing published studies and also provide exploratory information for future research hypotheses.

Objectives: Can state-level data in the U.S. provide information about the relationship between health equity and income inequality?

Methods: U.S. state-level data were compiled for Spearman's correlation analysis. Results are discussed in relation to the Gini index and additional variables.

Results: The state-based Gini index was significantly and positively correlated with population, Medicare expense per enrollee and diabetes rate. The index negatively correlated with the percent non-Hispanic white population and youth 10-17 years old of healthy weight.

Conclusion: The limitations of this study include different years in which data were collected; source data compiled by different institutions, geopolitical influences, environmental factors, and lifestyles choices of residents. The Gini index was not correlated to physician density, median household income, life expectancy or adult obesity rate.

Keywords: Gini index; Diabetes; Obesity; Cardiovascular disease; Medicare; Medicaid

Introduction

An Italian statistician Corrado Gini (1884-1965) developed the concept of disproportional dispersion of incomes in a population, which led to the creation of an index of income inequality [1]. A recent prospective study showed that the Gini coefficient (0-1) or normalized Gini index (0-100) derived from the income data of a population was found to be a predictor of heart attacks in a population after controlling for individual-level and state-level covariates [2]. We hypothesized that an analysis of various social, healthcare or health-related data by different U.S. states might provide interesting research questions for further investigation **(Figure 1).**

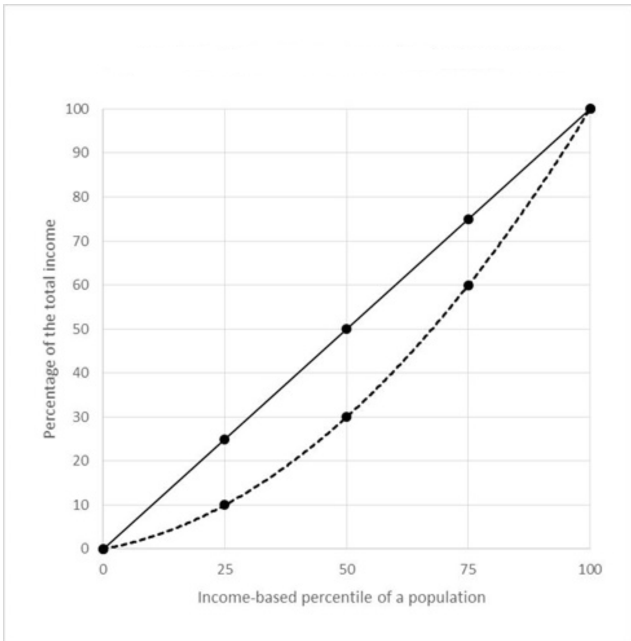

Figure 1: The solid line indicates perfect income equality of a hypothetical society where everyone makes an equal income. The dotted line describes the deviation from perfect income equality where fewer higher income earners contribute a greater percentage of the total income of a society.

The Gini index is depicted visually by the Lorenz curve that plots the proportion of the total income of a population on the Y axis and the income-based percentile of the population on the X axis. For example, the first quartile of income earners makes up 10% of the total income distribution (25, 10); the lower half (50%) of the population makes up 30% of the cumulative income (50, 30); and the third quartile (75%) of population makes up the 60% (75, 60) of cumulative income.

Table 1: Gini indices of selected countries.

Gini Index (2010)	
Country	**World Bank Estimate**
U.S.	40.5
Germany	31.1
UK	34.8
France	33.8
Sweden	26.8
Netherlands	28.7
Canada	33.7
Australia	34.9

The line connected to (0, 0), (25, 10), (50, 30), (75, 60), and (100, 100) shows a curve that is below the reference line. The diagonal line is a hypothetical line where everyone in the population makes an equal income (perfect equality or 0). When one person earns all the income in a population; the Gini index will be 100 or perfect inequality. The higher the Gini index, the more that the income distribution line (dotted line) will deviate from the straight diagonal line, indicating income inequality. Gini index data from several countries can be found on data.worldbank.org **(Table 1)**. In this paper, we searched publically available data from U.S. states and performed correlation analyses. Our research questions explored what were the social, economic, healthcare and health-related variables that correlated with the Gini index at the state level.

Methods

Public domain data from each U.S. state were searched for selected social, economic, healthcare and health-related variables and a correlation matrix was created. The results (below) are discussed not only in relation to the Gini index, but also in relation to other health-related concepts and between other variables (**Table 2)**.

Table 2: The list of selected variables searched and sources.

Variables	Reasons	Sources
Population	Social parameter	US Census (2013)
Non- Hispanic White (%)	Social parameter	US Census (2012)
Median household income	Economic parameter	US Census (2015)
Gini index	Economic parameter	Census American Community Survey (2014)
Physician per 100000	Healthcare parameter	State Physician Data (2015)
Primary Care per 100000	Healthcare parameter	State Physician Data (2015)
Medicare Expense per enrollee	Healthcare parameter	Kff.org (2009) and Census 2010
Medicaid Expense per enrollee	Healthcare parameter	Kff.org/Medicaid (2011)
Age adjusted drug OD death	Health parameter	CDC drug overdose death data (2015)
Life expectancy	Health parameter	Worldlifeexpectancy.com (2013)
Adult obesity BMI>30	Health parameter	Stateofobesity.org (2015)
Diabetes rate	Health parameter	Stateofobesity.org (2015)
Healthy weight youth rate	Health parameter	Childhealthdata.org (2010)
CVD death per 100000	Health parameter	CDC data (2015)

These data were collated for correlation analysis using the SPSS version 24 (IBM Corp, Armonk, NY) statistical package. A limitation of this study was inconsistency in the year of data source compilation and data collection by different institutions. There were 51 correlation data points. Due to multiple correlation analyses and the risk of type I error due to multiple tests, the alpha level was considered at 0.01.

Results

Some data values from the District of Columbia such as the Gini index, active physicians per 100,000 population, and primary care physicians per 100,000 population were shown to be outliers by the Grubbs test ($p<0.05$). Thus the District of Columbia was excluded from our correlation analyses **(Table 3)**.

Table 3: The correlation matrix reports the non-parametric Spearman's coefficient that is appended with a single or double asterisk. The double asterisk refers to the significance level at 0.01. The numbers on the first row refer to the corresponding number for the variables.

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Population	–	–	–	–	–	–	–	–	–	–	–	–	–
2	Non-hispanic White resident	-0.464**	–	–	–	–	–	–	–	–	–	–	–	–
3	Median household income	0.004	-0.115	–	–	–	–	–	–	–	–	–	–	–
4	Gini index	0.549**	-.506**	-0.273	–	–	–	–	–	–	–	–	–	–
5	Active physician per 100000	0.196	-0.002	0.583**	0.136	–	–	–	–	–	–	–	–	–
6	Primary Care per 100000	-0.022	0.122	0.589**	-0.071	0.939**	–	–	–	–	–	–	–	–
7	Medicare expense per enrollee	0.494**	-0.186	-0.164	0.652**	0.235	0.073	–	–	–	–	–	–	–
8	Medicaid expense per Enrollee	-0.264	0.327*	0.436**	-0.121	0.525**	0.568**	0.017	–	–	–	–	–	–
9	Age adjusted drug OD death	-0.033	0.135	-00.107	0.143	0.281*	0.186	0.307*	0.197	–	–	–	–	–
10	Life expectancy	0.02	0.051	0.734**	-0.181	0.551**	0.549**	-0.280*	0.354*	-0.212	–	–	–	–
11	Adult obesity rate (BMI>30)	0.025	0.134	-0.669**	0.1	-0.520**	-0.491**	0.363**	-0.334*	-0.068	-0.774**	–	–	–
12	Diabetes rate	0.317*	-0.295*	-0.682**	0.589**	-0.249	-0.354*	0.570**	-0.371**	0.224	-0.757**	0.697**	–	–
13	Healthy weight youth	-0.154	0.388**	0.498**	-0.427**	0.368**	0.413**	-0.355*	0.276	-0.018	0.555**	-0.525**	-0.693**	–
14	CVD death 100000	0.184	-0.072	-0.598**	0.293*	-0.388**	-0.463**	0.606**	-0.318*	0.241	-0.787**	0.680**	0.691**	-0.519**
**Correlation is significant at the 0.01 level (2-tailed)														
*Correlation is significant at the 0.05 level (2-tailed)														

Discussion and Conclusion

A rich array of information was derived from the above correlation matrix; however, these results are limited by available data sources and should be interpreted conservatively. The results of correlation analyses do not directly address causation.

Gini index

The Gini index will be higher when more income inequality is present in a state. In our analyses, the Gini index of the states was significantly and positively correlated to population, Medicare expense per enrollee and diabetes rate; and negatively correlated to the percent non-Hispanic white population and youth 10-17 years old of healthy weight. In other words, the Gini index tends to be higher (inequality) in states with a larger population, higher Medicare expense per enrollee and a higher diabetes rate. Income inequality was also correlated with a lower percent non-Hispanic white population in a state and a lower percent of youth of healthy weight. The state-level Gini index did not correlate with cardiovascular death rate without controlling for other variables.

Life expectancy

The results of the correlation analysis confirmed previous well-established observations, specifically that life expectancy was negatively correlated with adult obesity (BMI>30), with diabetes rate, and with cardiovascular death rate per 100,000. Life expectancy was positively correlated with median household income and physicians or primary care physicians per 100,000.

Physicians per 100,000 and healthcare variables

According to the developed matrix, the number of clinicians in the population was consistently correlated with selected health-related variables including: life expectancy, Medicaid expenses per enrollee and youth of healthy weight. A higher number of physicians in the population were negatively correlated with adult obesity and cardiovascular death rate. Intriguingly, higher Medicaid expense was correlated with a lower diabetes rate, while higher Medicare expense was correlated with a higher diabetes rate. It is unclear what the drivers are in the above observation; however, healthcare policymakers should be aware of the contradictory correlation of higher diabetes rates with higher Medicare expense per enrollee versus lower diabetes rate and higher Medicaid expense per enrollee.

Median household income

Smith et al. reported that financial resources can buffer subjective well-being after the onset of disability. Wealth may be an important resource for people who have experienced a decline in their health compared to healthy individuals [3]. In our matrix, the Gini index and the median household income were not correlated. Median household income was consistently correlated with healthcare-related variables such as the number of physicians per population, Medicaid expense per enrollee, and all health-related variables (life expectancy, diabetes, obesity, healthy youth and CVD death). The association of socio-economic status with diabetes prevalence has been reported [4]. Coronary artery disease related to diabetes is also associated with median household income [5] and it was confirmed in our matrix. Our correlation matrix also demonstrated that median household income was negatively correlated with the prevalence of diabetes.

Age-adjusted drug overdose death

Although the Centers for Disease Control and other healthcare authorities have been sounding the alarm about the recent and growing epidemic of opioid-related deaths, none of the variables in our list were correlated with drug overdose death rate. Investigating the relationship between opioid-related deaths and other social, healthcare, and health-related variables may require further statistical analysis to control for additional variables.

Limitations and Future Plan

As mentioned earlier, the data years and sources were not consistent. The methods used by different institutions to compile the aggregate data create additional variability that could introduce bias. On the other hand, this variability of data sources may be considered random effects in the same way that multivariate analyses are used to control covariates. Geopolitical biases, environmental factors, lifestyle, major industries and tendency toward natural disasters of each state add additional variability that may or may not influence the variables of interest. It will be challenging and require a complex interactive model to normalize these types of data in order to investigate a single variable.

As for the socioeconomic variable, we were not able to determine a direct association between the median household income and income disparity. Low median household income in a particular state was not directly related to income disparity, but simply reflected the limited financial resources of the residents in that state. How wealthier residents of those states are disbursing financial resources may be reflected in different economic variables that we did not include in our analysis. However, from our matrix, the economic status of the average resident of a state appears to be a more influential factor for individual health than income inequality per se. Income equality may be related to the perception of fairness, which may be a prerequisite for happiness. In our analysis, health status may be mediated not only by emotional satisfaction and happiness, but more strongly by the amount of financial resources available to individuals.

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