

Relationships between Obesity and Cardiovascular Diseases in four Southern States and Colorado

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Obesity and Cardiovascular Diseases

- In the US, nearly 70% of adults are classified as overweight or obese.
- A person with a Body Mass Index of 30 or more is generally considered obese.
- Obesity was found to be a major risk factor for the development of Type-2 Diabetes, Asthma, Hypertension, Stroke, Coronary Artery Disease, Cancer and Cancer-related mortality, Liver and Gallbladder Diseases, Sleep apnea, Osteoarthritis and Gynecological Complications.

Obesity and Cardiovascular Diseases

- Cardiovascular disease mortality and morbidity was shown to be elevated in individuals who are overweight or obese.

Objectives

- 1) To examine the associations between the increase in BMI rates and the increase rates of Cardiovascular Diseases and High Blood Pressure in the states of Mississippi (MS), Alabama (AL), Louisiana (LA), Tennessee (TN) and Colorado (CO) using a regression analysis;

Objectives

2. To create neural network models for obesity and high blood pressure in Mississippi using simulation and artificial intelligence approaches.

Data Collection

- BMI (weight in kg divided by the height²) data, Cardiovascular Disease and High Blood Pressure data were obtained from the CDC-Behavioral Risk Factor Surveillance System (BRFSS), for the gender males and females, and for the race of white and African American for the US, MS, AL, LA, TN and CO for the years 2005-2009.

Statistical Analysis

- Data were analyzed using PROC REG procedure of SAS software (SAS, Inc, v 9.1) with myocardial-infarction, stroke and hypertension-rates as dependent (response) variables and obesity- rate as independent (explanatory) variable.

Statistical Analysis

- PROC GLM was used to determine the significant difference in obesity, myocardial-infarction, stroke and hypertension among the states followed by TUKEY standardized test for further classification.

Results

- Analysis of variance showed a significant increase in obesity rates over the past five years in all states and in the US ($p < 0.001$).

Results

- Mississippi had the highest rate of obesity (31.75 ± 1.20 %), followed by LA ($30.75 \pm 0.07\%$), AL ($29.9 \pm 1.41\%$), and TN ($29.05 \pm 2.33\%$). All four southern states were significantly different from CO ($p < 0.0001$) that had the lowest rate of obesity (18.55 ± 1.06).

Results

- Cardiovascular disease including myocardial-infarction and stroke in addition to hypertension were significantly higher in the southern states ($P < 0.05$).

Obesity and High Blood Pressure Rates among Whites and African American

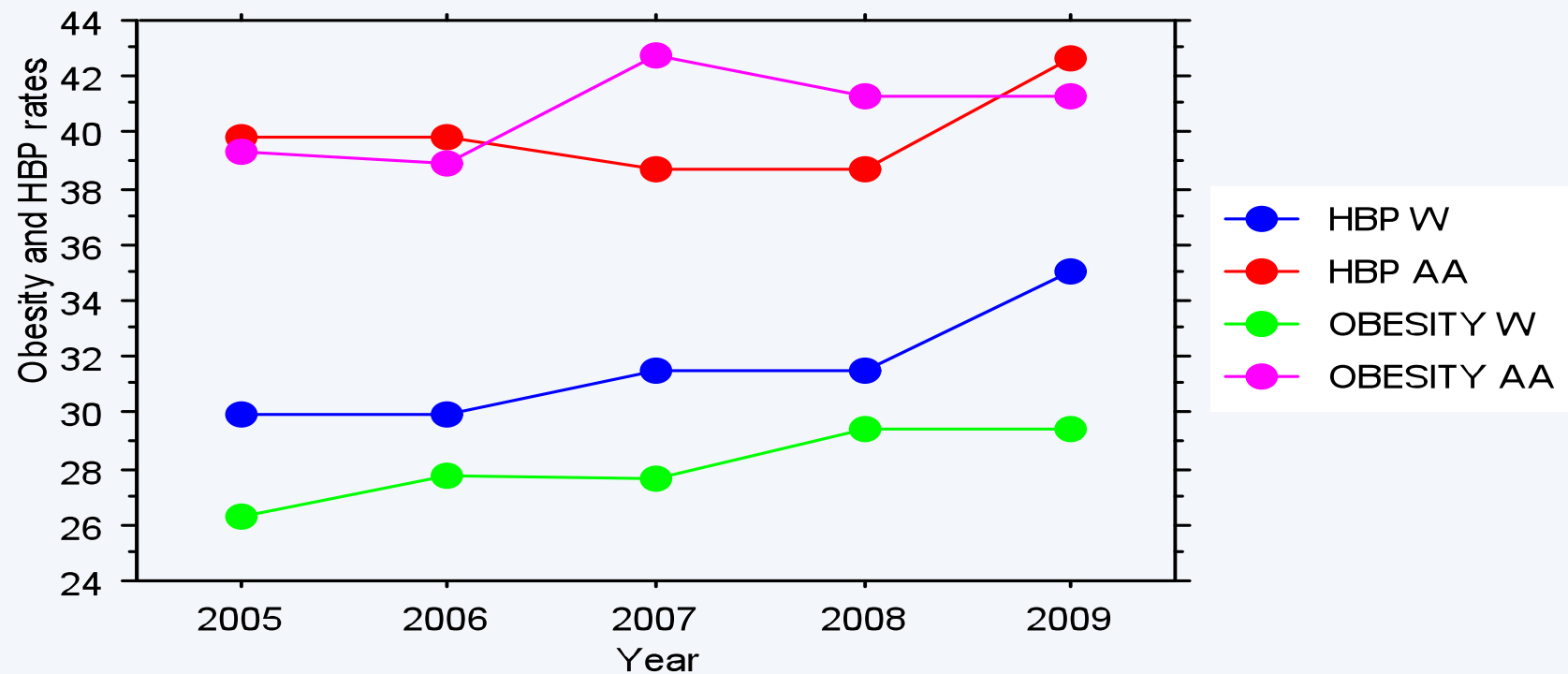
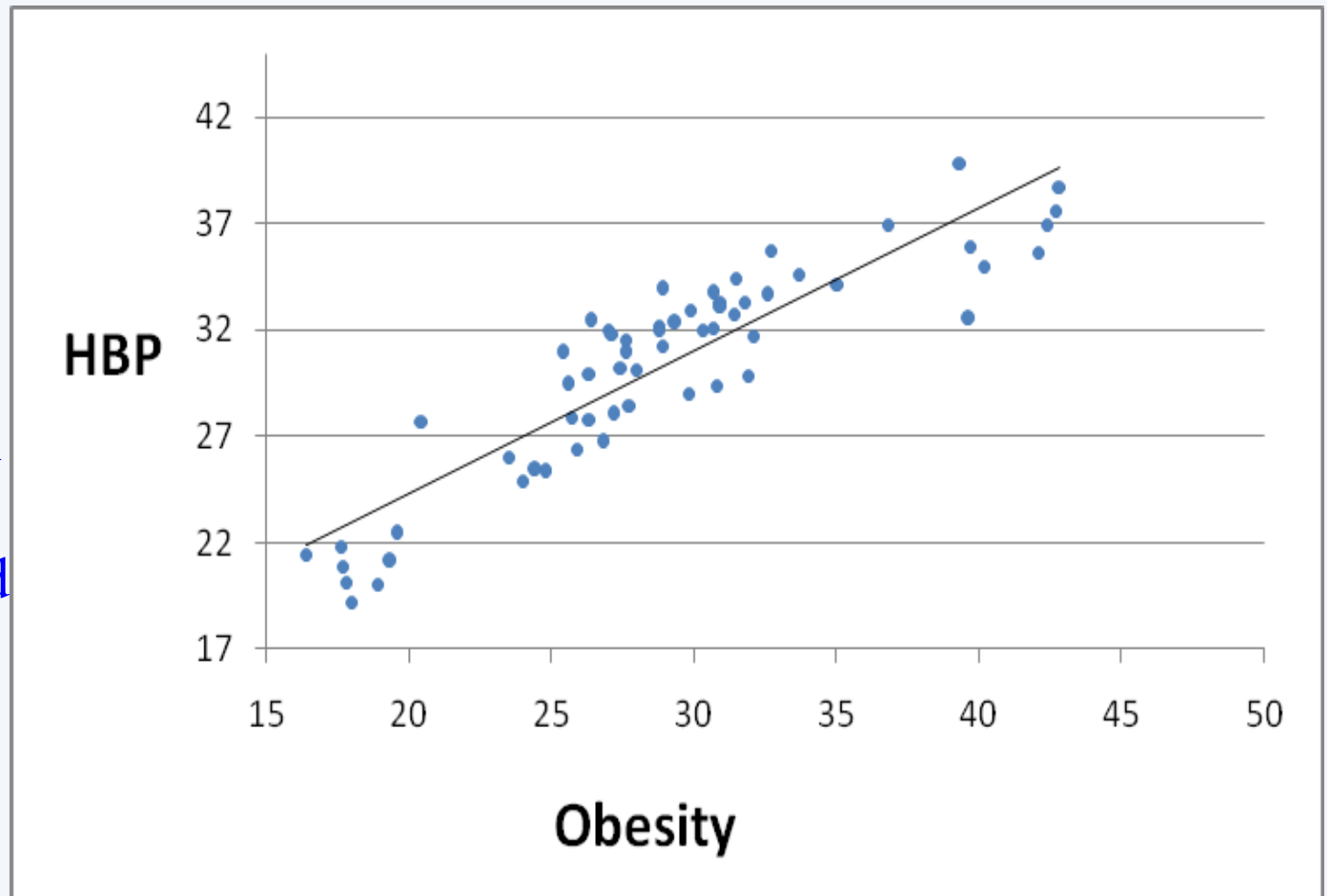


Table1: Mean and standard deviation for all variables for USA, Mississippi, Alabama, Louisiana, Tennessee and Colorado from 2005-2009.

	<i>USA</i> Mean $\pm$ Std Dev	<i>MS</i> Mean $\pm$ Std Dev	<i>AL</i> Mean $\pm$ Std Dev	<i>LA</i> Mean $\pm$ Std Dev	<i>TN</i> Mean $\pm$ Std Dev	<i>CO</i> Mean $\pm$ Std Dev
Obesity rate	25.35 $\pm$ 1.34	31.75 $\pm$ 1.20	29.9 $\pm$ 1.41	30.75 $\pm$ 0.07	29.05 $\pm$ 2.33	18.55 $\pm$ 1.06
Obesity male	26.0 $\pm$ 1.69	30.85 $\pm$ 0.77	28.95 $\pm$ 1.34	32.00 $\pm$ 0.14	30.20 $\pm$ 3.53	18.65 $\pm$ 1.34
Obesity female	24.95 $\pm$ 1.34	32.60 $\pm$ 1.55	30.30 $\pm$ 2.12	29.55 $\pm$ 0.35	27.95 $\pm$ 1.20	18.45 $\pm$ 0.63
Obesity white	24.6 $\pm$ 1.55	26.95 $\pm$ 0.91	26.20 $\pm$ 1.31	27.20 $\pm$ 0.56	27.25 $\pm$ 2.33	17.00 $\pm$ 0.84
Obesity Af Am	35.9 $\pm$ 1.27	41.05 $\pm$ 2.47	41.15 $\pm$ 2.19	39.95 $\pm$ 0.35	42.25 $\pm$ 0.21	23.40 $\pm$ 4.24
Myocardial Infarction rate	4.10 $\pm$ 0.14	4.90 $\pm$ 0.42	5.15 $\pm$ 0.35	4.75 $\pm$ 0.21	5.30 $\pm$ 0.28	2.95 $\pm$ 0.07
MI male	6.45 $\pm$ 0.07	6.10 $\pm$ 0.42	6.90 $\pm$ 0.70	5.85 $\pm$ 0.21	6.40 $\pm$ 0.42	3.65 $\pm$ 0.07
MI female	3.00 $\pm$ 0.14	3.80 $\pm$ 0.42	4.08 $\pm$ 0.80	3.80 $\pm$ 0.28	4.2 $\pm$ 0.14	2.16 $\pm$ 0.167
MI white	4.35 $\pm$ 0.07	5.10 $\pm$ 0.28	5.90 $\pm$ 0.42	4.70 $\pm$ 0.14	5.55 $\pm$ 0.21	3.10 $\pm$ 0.07
MI Af Am	3.8 $\pm$ 0.14	4.3 $\pm$ 0.98	2.6 $\pm$ 0.42	4.05 $\pm$ 0.21	3.75 $\pm$ 2.19	1.60 $\pm$ 0.56
Stroke rate	2.56 $\pm$ 0.08	3.80 $\pm$ 0.56	3.50 $\pm$ 0.14	3.36 $\pm$ 0.25	3.40 $\pm$ 0.28	1.60 $\pm$ 0.28
Stroke male	2.55 $\pm$ 0.07	3.7 $\pm$ 0.42	3.30 $\pm$ 0.14	2.95 $\pm$ 0.49	3.50 $\pm$ 0.98	1.40 $\pm$ 0.42
Stroke female	2.62 $\pm$ 0.08	4.00 $\pm$ 0.70	3.75 $\pm$ 0.07	3.35 $\pm$ 0.35	3.30 $\pm$ 0.28	1.80 $\pm$ 0.14
Stroke white	2.52 $\pm$ 0.08	3.70 $\pm$ 0.56	3.82 $\pm$ 0.45	3.00 $\pm$ 0.84	3.40 $\pm$ 0.28	1.60 $\pm$ 0.28
Stroke Af Am	3.5 $\pm$ 0.14	4.0 $\pm$ 0.28	3.35 $\pm$ 1.20	4.20 $\pm$ 0.28	2.90 $\pm$ 0.14	2.50 $\pm$ 2.54
High Blood Pressure rate	26.65 $\pm$ 1.62	33.50 $\pm$ 0.28	32.15 $\pm$ 1.34	30.75 $\pm$ 1.90	32.00 $\pm$ 2.54	20.65 $\pm$ 0.77
HBP M	26.75 $\pm$ 1.90	32.35 $\pm$ 0.49	31.50 $\pm$ 1.97	30.75 $\pm$ 1.34	32.05 $\pm$ 5.16	21.70 $\pm$ 1.13
HBP F	25.65 $\pm$ 1.06	34.5 $\pm$ 0.14	32.75 $\pm$ 0.77	30.70 $\pm$ 2.40	31.90 $\pm$ 0.14	19.6 $\pm$ 0.56
HBP W	26.95 $\pm$ 1.34	30.70 $\pm$ 1.31	31.50 $\pm$ 0.70	28.90 $\pm$ 2.97	31.75 $\pm$ 3.18	21.60 $\pm$ 0.28
HBP Af Am	35.5 $\pm$ 1.97	39.25 $\pm$ 0.77	35.10 $\pm$ 3.53	35.45 $\pm$ 0.63	36.25 $\pm$ 0.91	30.1 $\pm$ 3.39

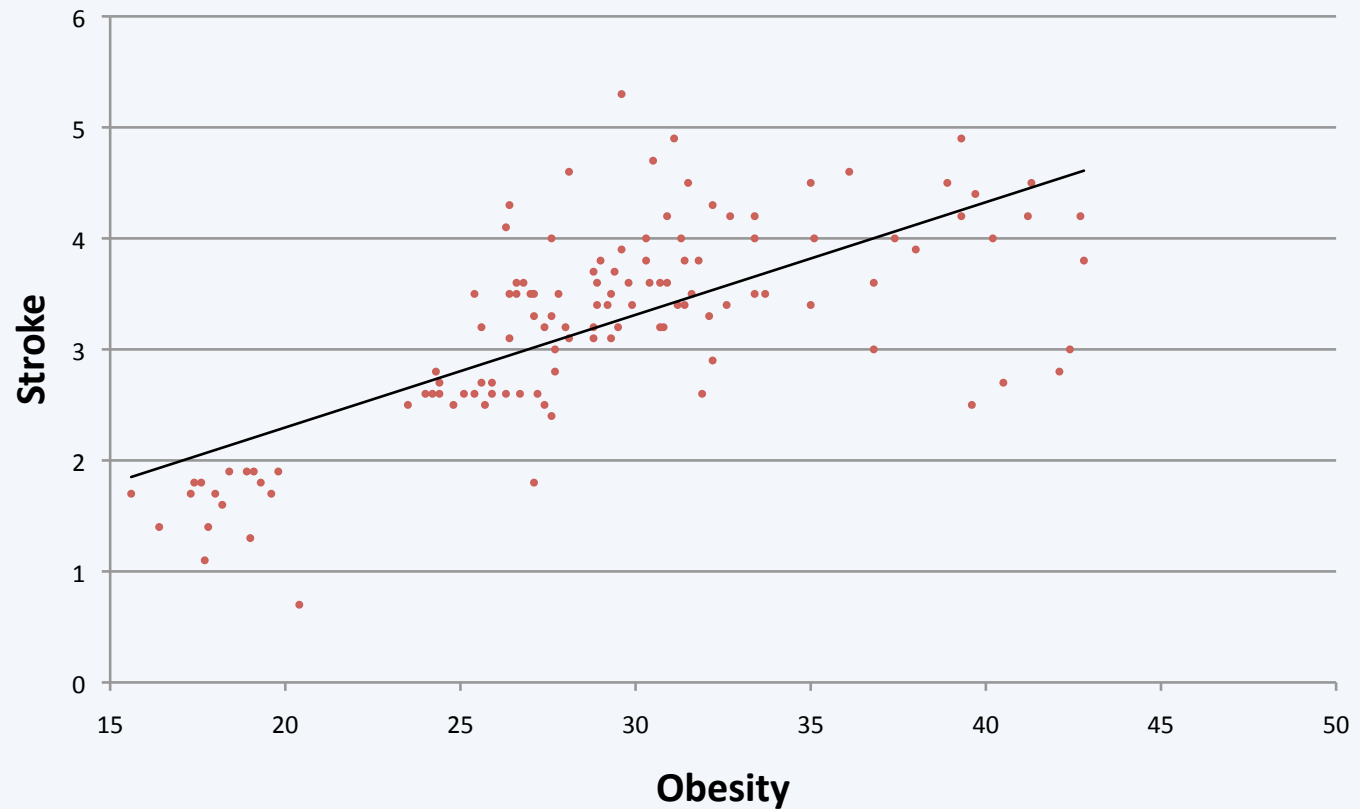
Regression Results

- Results from regression analysis showed a strong association between obesity and high blood pressure rates.
- $R^2 = 0.811$



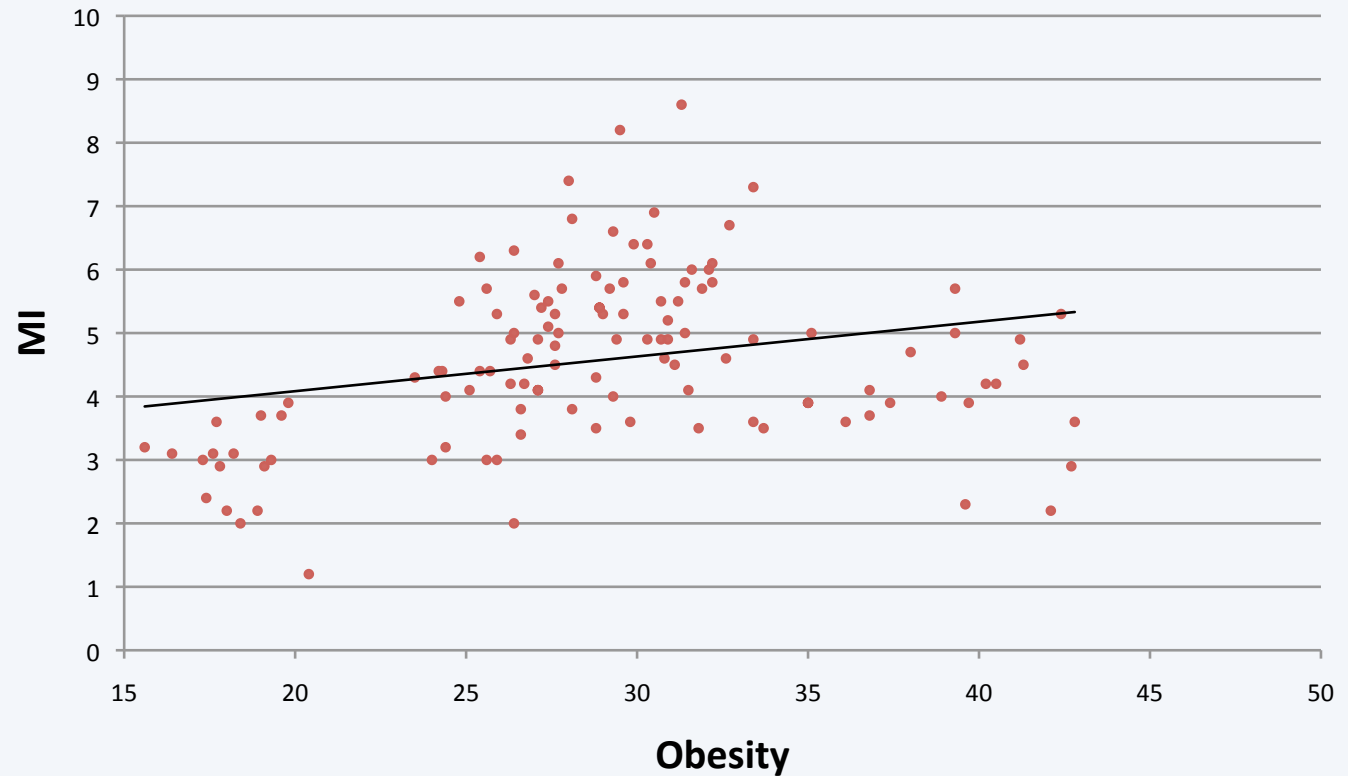
Obesity and Stroke

- A moderate association between obesity and stroke rates.
- $R^2 = 0.462$



Obesity and MI

- A low association between obesity and myocardial infarction rates.
- $R^2 = 0.027$



Regression and Neural Network in MS

- *Neural Network Model:* In addition to Regression Analysis, neural network models were created for obesity and high blood pressure in Mississippi.
- The Data of BRFSS from 2000-2009 for obesity and HBP was used to calculate the means and the standard deviation, which were then used to generate 200 simulated data points using @RISK 5.5 software.

Sample of simulated data used for NN training; mean,
standard deviation and Risk Normal value for Obesity
and High blood pressure

Sample	Obesity Input	HBP Output
1	31.378415	32.92848
2	28.49519	33.3682
3	32.656952	32.03656
4	22.870368	34.24982
5	31.981525	37.42984
6	27.451025	34.16271
7	19.226521	33.35962
8	29.187303	33.2364
9	28.598695	33.60046
10	31.941129	33.89166
11	28.143317	33.58107
12	24.002756	35.26133
13	21.706451	34.82364
14	21.319447	31.96378
15	38.119348	35.72525
Mean	30.082492	33.89758
SD	4.9354215	1.537426
RISK	30.082492	33.89758

Neural network

- The simulate data of obesity and HBP were used to train several neural networks with NeuroShell2 software.
- In these training of neural network models obesity was used as an input and high blood pressure as an output.
- Then the original data of obesity and HBP were used to create test examples for neural network predictions. After several iterations best neural network models were produced with corresponding statistical results and predicted values.

Results of Neural Network

- The Artificial neural networks were used to compare the association of obesity and hypertension with the simulated data.
- A strong association was found between obesity and HBP ($R^2 = 0.76$).

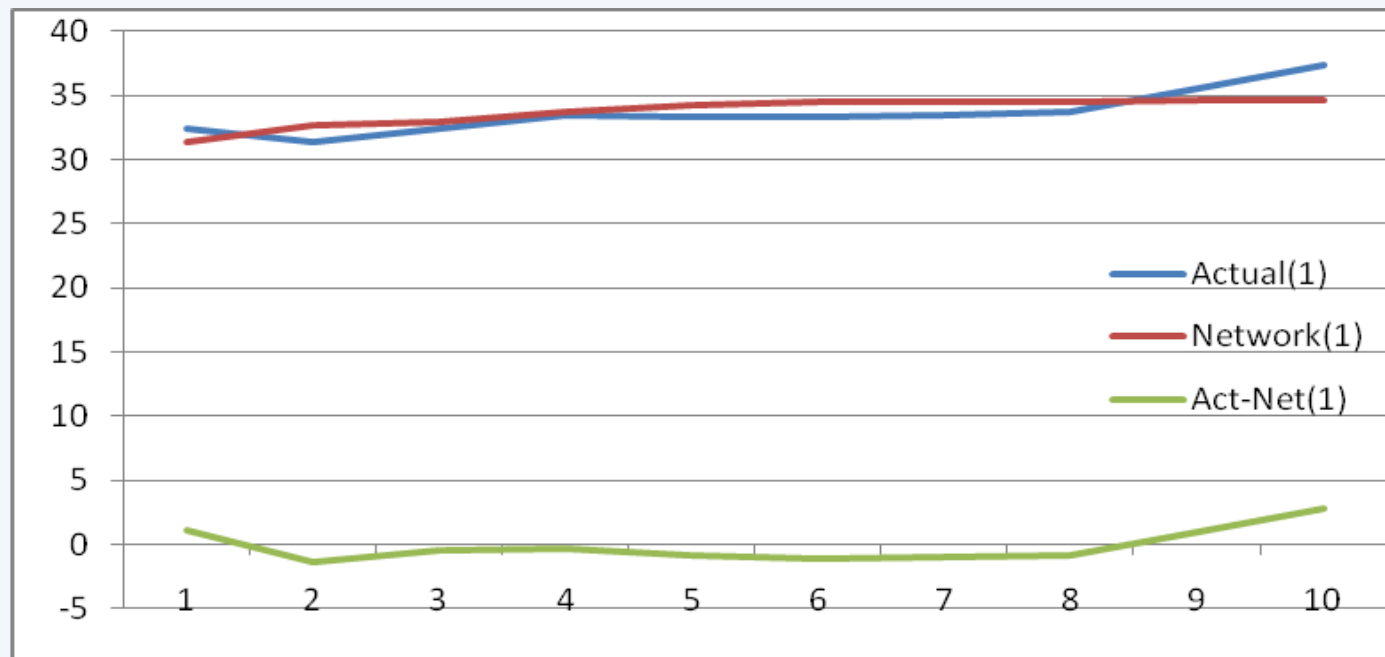
Neural Network results

R squared:	0.4044
r squared:	0.4101
Mean squared error:	1.574
Mean absolute error:	1.081
Min. absolute error:	0.342
Max. absolute error:	2.799
Correlation coefficient r:	0.6404

- One of the neural network models for obesity and HBP, The R^2 value for this prediction, that measures the degree of fit between the actual and the predicted valued, is 0.41.

The detailed neural network results

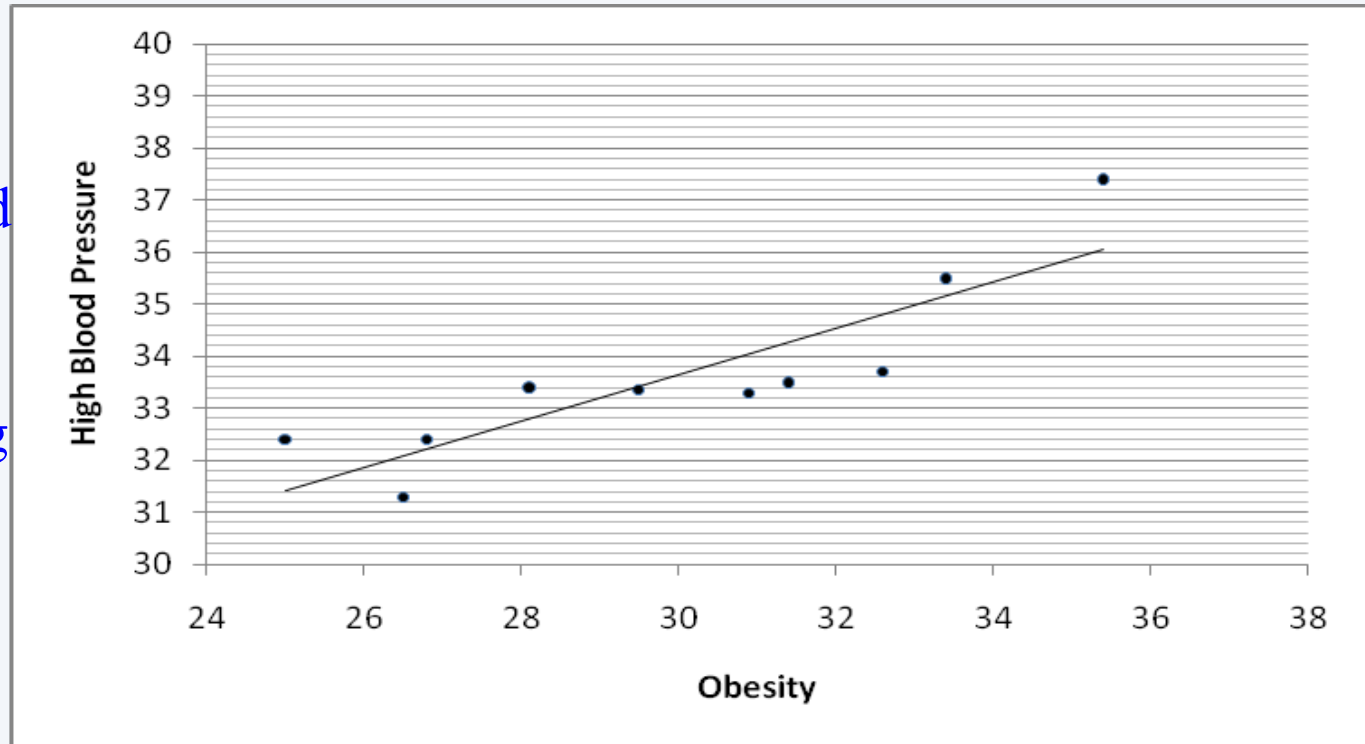
Neural network Model



Neural Network Model actual and the predicted data of obesity as input and HBP as an output. R^2 : 0.4101

Regression Analysis

Regression analysis for obesity rates and high blood pressure rates in MS from 2000-2009 shows a strong association
 $R^2 = 0.7622$
 $y = 0.4453x + 20.284$



Conclusion

- Obesity prevalence has been increasing world wide. A low association between obesity and myocardial-infarction was found, while a moderate association was found between the increase in BMI and stroke.

Conclusion

- Hypertension was found to be more frequent in obese people. The rates of obesity and hypertension were higher among African American groups, with Mississippi having the highest rates of obesity and hypertension.

Conclusion

- In this study, modeling the relationship of obesity and high blood pressure with Artificial Neural Network may provide a reliable alternative for predicting the rates of obesity and its effect on high blood pressure.

Acknowledgement

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