Who pays for obesity: A study of the obesity in America

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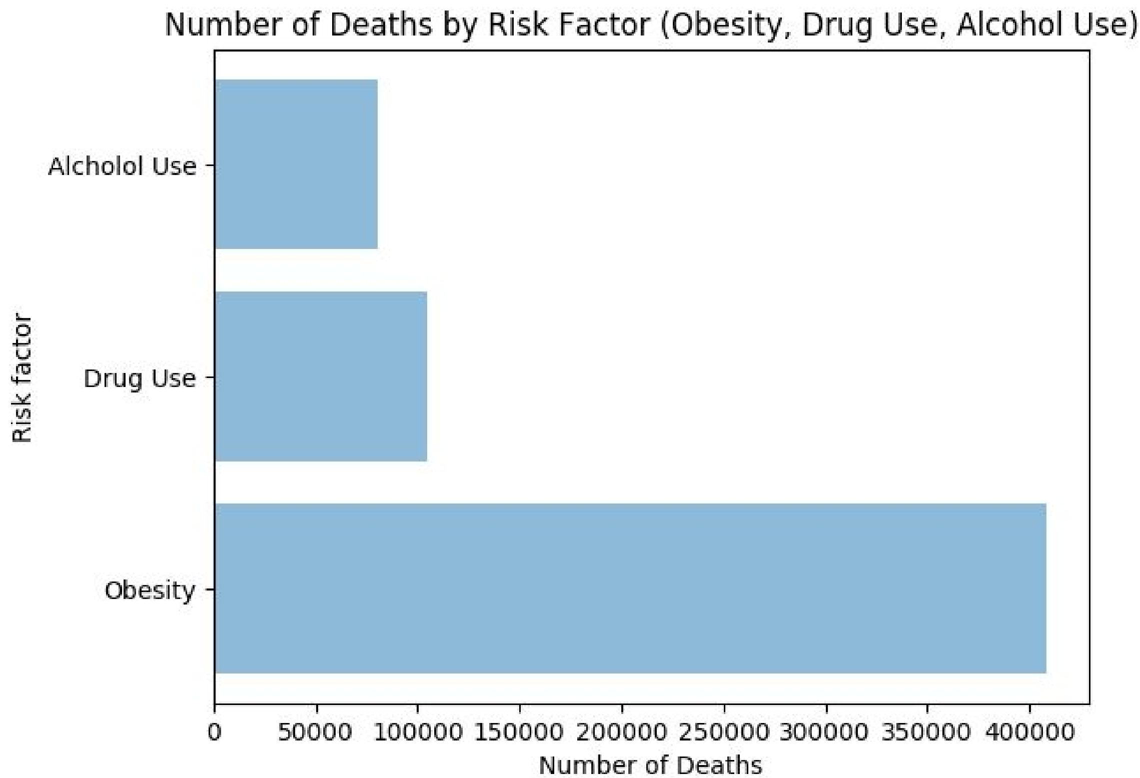
Abstract

This paper is a systematic study of the economic costs of obesity and obesity-related diseases across distinct demographic groups in the United States. For instance, obesity is associated with a $656 increase in annual individual healthcare costs, but one estimate has determined that the actual increase is $1,429. It is estimated that the actual cost of treating obesity in the United States is $147 billion in 2008 dollars. Since 1962, the percentage of Americans between ages 20 and 70 was 13.4 percent. By the year 2006, the obesity percentage in the population nearly tripled as it reached 35.1 percent. Consequently, the rising levels of obesity represent a costly public health issue. A holistic assessment of the costs of obesity will provide recommendations for policy makers and health officials to evaluate optimal public health policies that will minimize obesity-related externalities.

Introduction

Obesity (BMI > 30 kg/m^2) is a medical condition in which an excessive amount of fat accumulates in the body. This medical condition has become a global pandemic, as 4.7 million individuals from all nations died prematurely due to obesity in the year 2017. In 2017, 408,831 Americans died prematurely as a result of obesity. To put this into context, this was more than five times the number of Americans who died due to alcohol consumption, and close to four times the number of Americans who died from drug consumption (Figure 1)[1]. However, obesity is not an isolated condition, as it is associated with severe diseases such as hypertensions, distinct cancers, osteoarthritis, type II diabetes, coronary heart disease, stroke, high LDL cholesterol, low HDL cholesterol, and high levels of triglycerides (Dyslipidem). Thus, the most evident economic burdens of obesity are the diagnosis and the treatment of chronic conditions that go with it.

It is estimated that the annual medical cost of obesity in the United States is $147 billion in 2008 dollars. Correspondingly, the cost of medical care for people with obesity was $1429 higher than those with normal weight [2]. There are two costs associated with obesity and obesity-related conditions: direct and indirect costs. Direct costs are related to health services, radiology and laboratory tests, and drug prescription. Indirect costs are related to the resources lost due to the health conditions. The resources fargone include the value of fargone work, insurance payments, and lower wages. Recent studies have determined that there is a strong, positive gradient between increasing BMI and costs attributable to obesity [3,4,5,6].



Data source: Global Burden of Disease Study 2017 (GBD 2017)
Figure 1. Annual deaths by risk factor in the United States for the year 2017. In the x-axis the number of deaths caused by each factor are displayed. In the y-axis, the risk factors are displayed.

Furthermore, the obesity epidemic has affected distinct demographics unevenly. For example, African-Americans and Hispanics are affected the most as 49.6% and 44.8% suffer from obesity. By contrast, the prevalence of obesity among Asians is the lowest with 17.4%[6]. Likewise, the demographic groups with the lowest incomes are African-Amerians and Hispanics. In 2016, 62% of African Americans and 64% of Hispanics had an income less than $40000, whereas 40% whites had an income below the $40000 threshold[7]. Only Asians had a higher income percentage (26%) than whites (20%) for incomes above the $85000 threshold. Thus there is a clear relation between race, income and obesity.

Materials and Methods

Statistical Analysis

The statistical analysis was performed using Numpy, Pandas and Matplotlib, and Scipy packages in Python 3.8, and all codes are given in [github].

Datasets

For this project I used the 2011-2018 National Health and Nutrition Survey (NHANES) for the years 2011-2018 and health insurance data from the CDC[8,9]. The information extracted from the data files were the race, BMI, income, blood pressure, and age. Using this limited array of information a thorough analysis of the relations between obesity, race, and income was performed. Lastly, the relation of obesity and health factors such as blood pressure was analyzed to further support the study.

Results

BMI Levels, Medical Charges, and Income.

Since obesity deteriorates the health of an individual and is related to severe diseases, medical diagnosis and treatment costs rise as the BMI of an individual increases. Based on the estimates of this study's regression model an obese individual pays $2166.29 more than an individual with normal weight (Figure 2). Additionally, the estimated total costs for medical care of an obese idividual begin at $1309.04. A moderate significant relation was found between BMI and medical charges, $r(1336) = .2$, $p = 2.5E\text{-}13$. Furthermore, the simple linear regression was calculated to predict medical charges based on BMI. A significant regression was found ($F(1,1336)= 54.71$, $p <.0001$), with R^2 of .039. Subjects' predicted medical charges are equal to 393.87 [BMI] + 1192.94 dollars when BMI is measured in kg/m^2. The medical charges are increased by 393.87 (95% CI = 289.41, 498.34]) dollars for each kg/m^2 of BMI. The model is significant but cannot account for much of the variability as the p-value is lower than .001 but R-squared is lower than 50%.

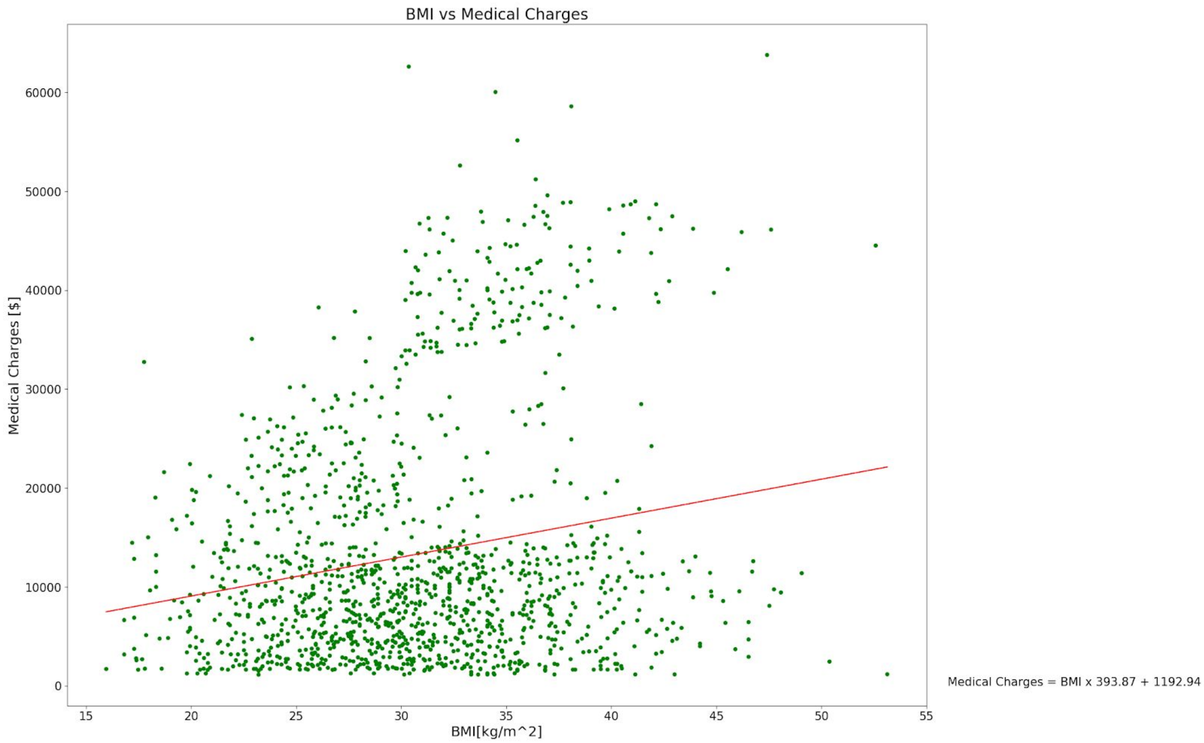


Figure 2. A linear regression model demonstrates the relationship between BMI and medical insurance charges. In the x-axis the values for BMI are displayed in kg/m^2, whereas in the y-axis the values for the medical charges are displayed in US dollars[8].

As aforementioned, this model may not account for the variability presented, but its results are significant and the increase of $1309.04 calculated by the model is supported by distinct studies[4,5,10] . Nevertheless, when the medical charges of the obese tier, overweight tier, normal tier, and underweight tier were compared, significant results that support the relationship between BMI and higher medical insurance charges were found. When the underweight tier ($M = 8852.2$, $SD = 7735.04$) was compared with the obese tier ($M = 15560.92$, $SD = 14563.06$), there was a significant difference of $6708.73 (95% CI = [3234.29, 10183.16]; $t(723) = 3.7$, $p = .001$; Likewise, when the medical charges of the obese tier ($M = 15560.92$, $SD = 14563.06$) were compared with the medical charges of the normal tier ($M = 10282.44$, $SD = 14563.06$) , there was a significant difference of $5278.70 (95% CI = [3851.38, 6706.01]. Lastly, when the medical charges of the obese tier (M = 8852.2, SD = 7735.04) were compared with medical charges of the overweight tier (M =10713.67, SD = 7843.54),there was a significant difference of $4874.26 (95% CI = [3611.15, 6083.87]); t(1334) = 7.68, p = 3.5E-14 (figure 3)[8].

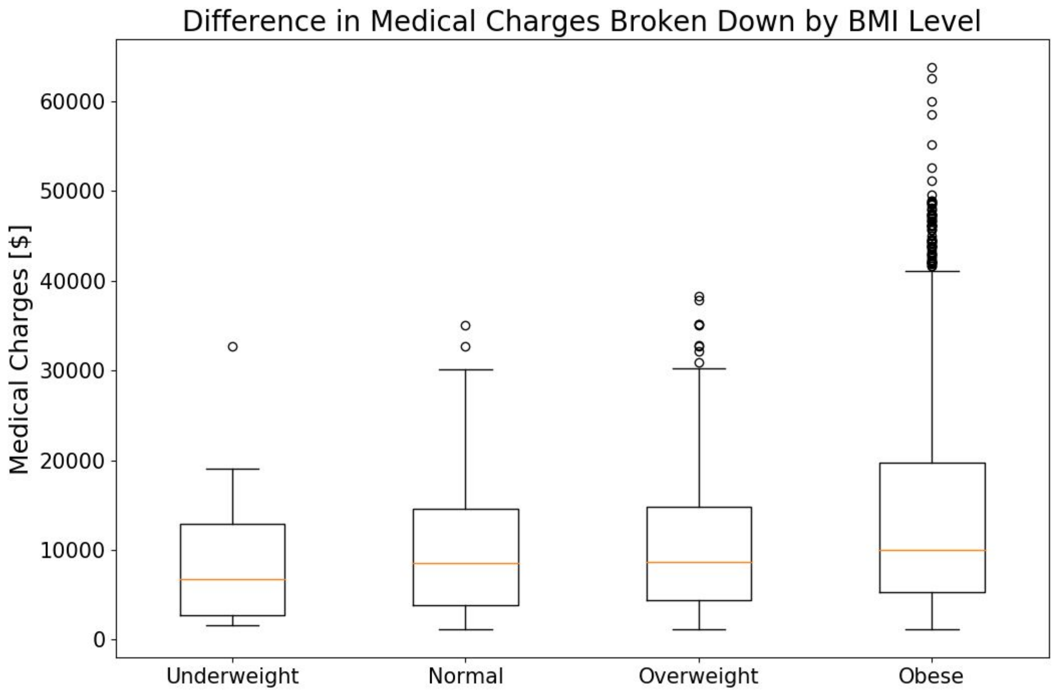


Figure 3. This box plot compares the medical costs of the BMI levels. In the x-axi, the values for BMI are displayed in kg/m^2, whereas in the y-axis the values for the medical charges are displayed in US dollars[8].

One clear example of the reason why obesity can be so costly is the surge in blood pressure levels. A chi-square test of independence was performed to examine the relation between BMI and blood pressure. The relation between these variables was significant, X^2 (6, N = 8852) = 62.81, p = 2.1E-32. Of all BMI levels, obese had the highest proportion of individuals with stage 2 hypertensions. The largest difference in the proportion of stage 2 hypertension was between obese income tier and underweight with a value of 0.12 (95% CI = [0.07, 0.16]). By contrast, the smallest difference in the proportion of individuals with stage 2 hypertension was between obese and overweight with a value of 0.004 (95% CI = [-0.017, 0.026]), as you can see in figure 4.

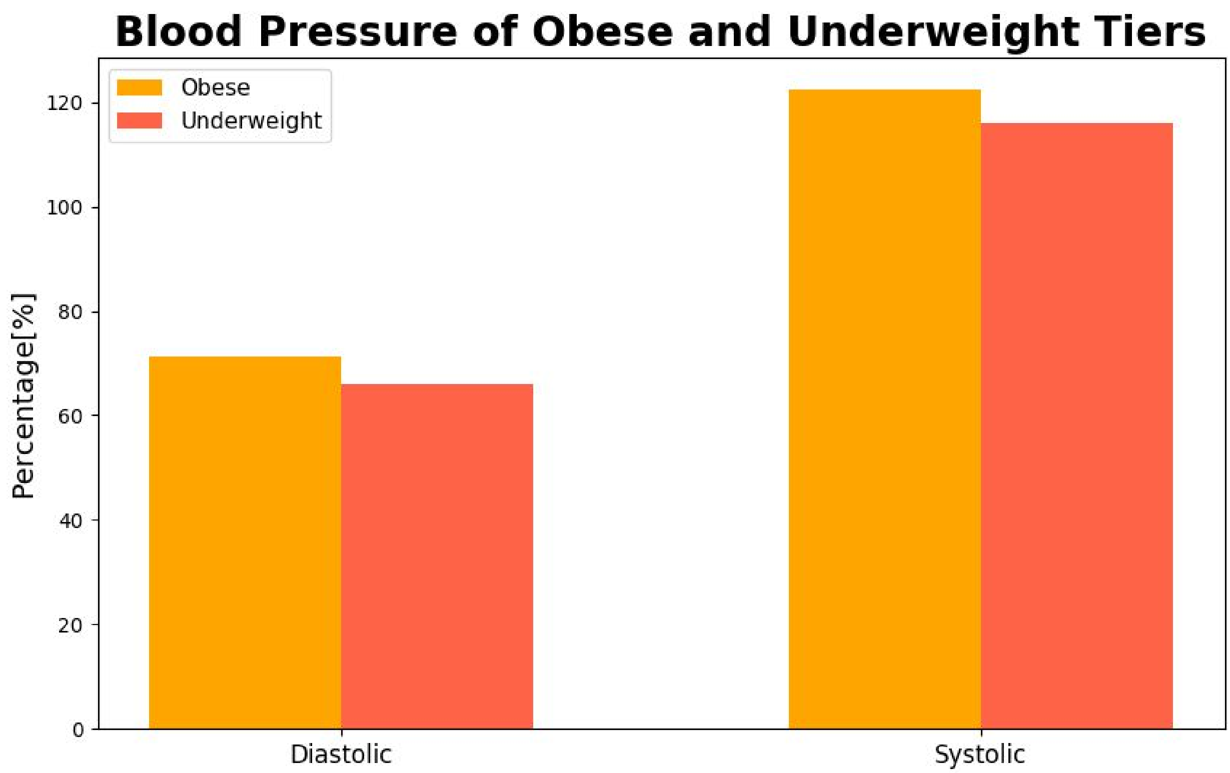


Figure 4. Grouped bar chart that compares the blood pressure of the categories of most interest: obese and underweight. In the x-axis the categories of blood pressure (systolic and diastolic) are displayed. In the y-axis, the percentages are displayed.

BMI and Income

It is clear the previous data was statistically significant data that implied that the costs of medical care rise as an individual's BMI increases. For that reason, it has to be determined whether individuals with the most financial resources tend to have a higher BMI or a lower BMI. A simple linear regression was calculated to predict income based on BMI. A significant regression was found ($f(1,8850)= 35.89$, $p <.0001$), with R^2 of 0.004. Subjects' predicted income is equal to 69470 - 282.56 [BMI] dollars when BMI is measured in kg/m^2. Income is decreased by -282.56 (95% CI = -375.026, -190.102]) dollars for each kg/m^2 of BMI (Figure 5)[8]. The model is significant but cannot account for much of the variability as the p-value is lower than 0.05 but R-squared is lower than 50%. Therefore, this weak but statistically significant evidence suggests that individuals in the middle and lower income tiers tend to experience decreases in their salary as their BMI.

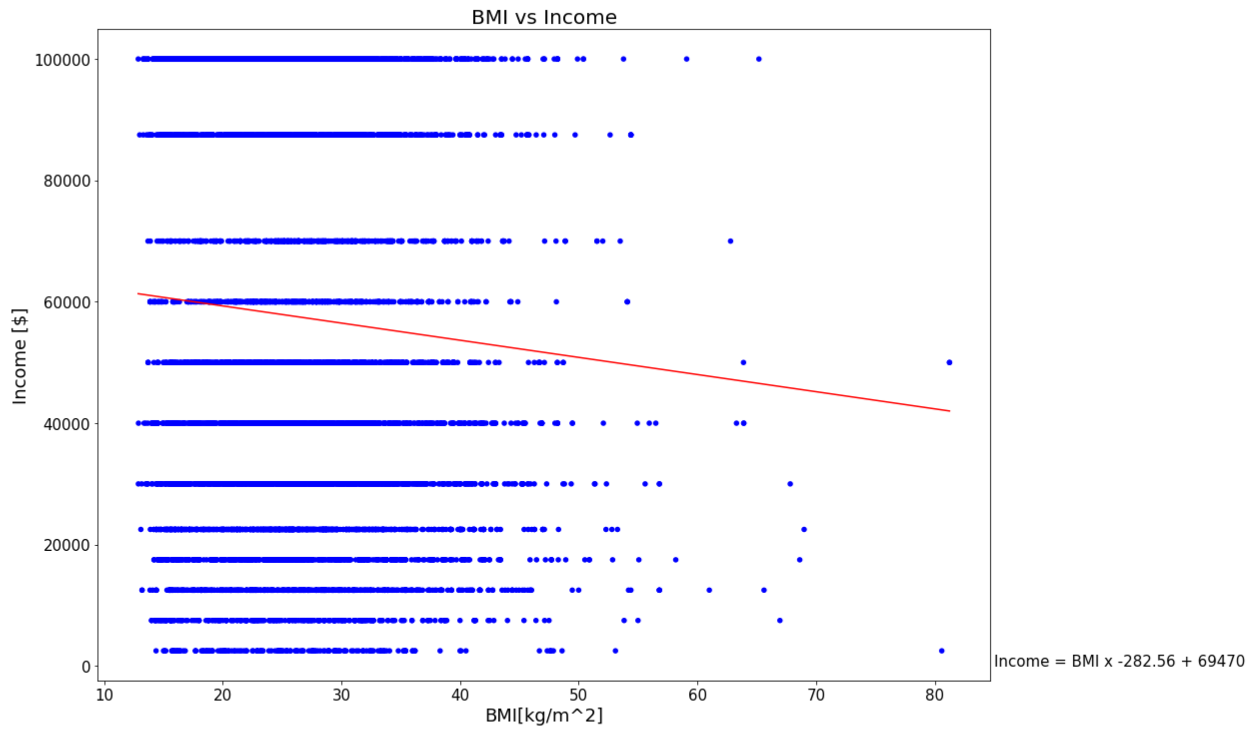


Figure 5. This regression line model shows an inverse relation between BMI and income. In the x-axis, the values for BMI are displayed in kg/m^2, whereas in the y-axis the values for the medical charges are displayed in US dollars[8].

To provide more conclusive evidence, a chi-square test of independence was performed to examine the relation between BMI and income. The relation between these variables was significant, X^2 (6, N = 8852) = 62.81, p = 1.2E-11. Of all income tiers, middle income had the highest proportion of obese individuals (Figure 5)[8]. The largest difference in the proportion of obese individuals was between the middle income tier and the high income tier with a value of 0.109 (95% CI = [0.087, 0.131]). By contrast, the smallest difference in the proportion of obese individuals was between the low income tier and the middle income tier with a value of 0.049 (95% CI = [0.023, 0.075]).

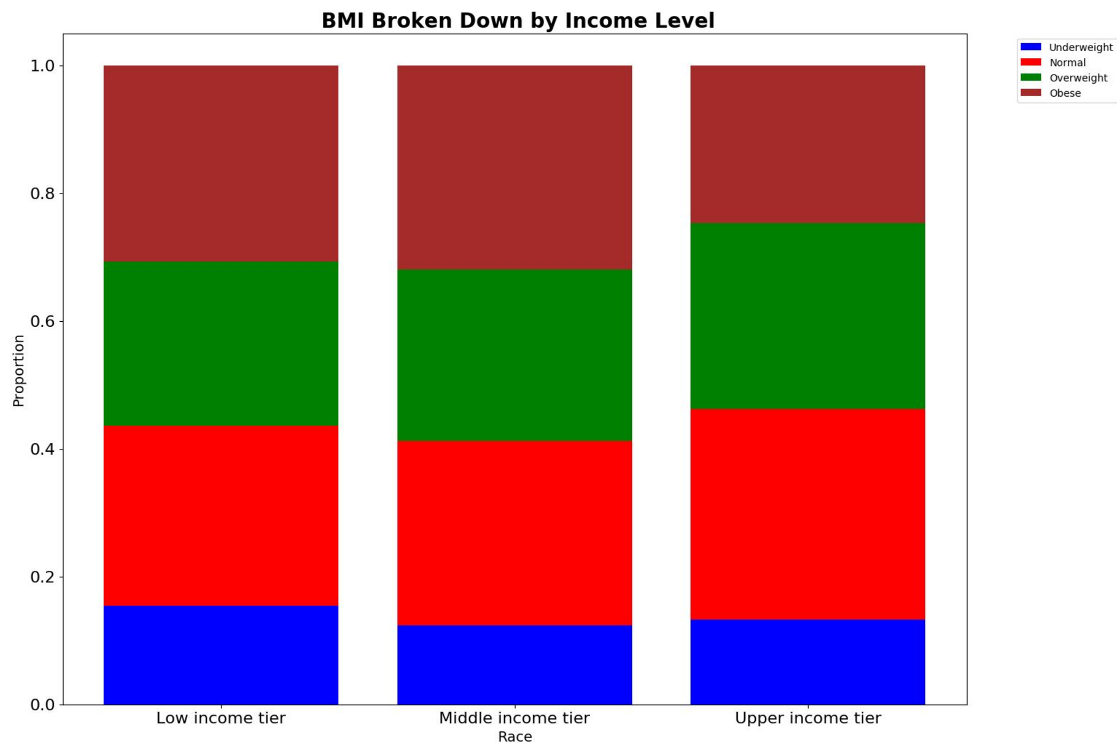


Figure 6. This stacked bar chart shows the relationship between BMI and Income. In the x-axis, the categories for income tiers are displayed whereas in the y-axis the proportion for obesity levels are displayed[8].

When the incomes for each BMI tier were compared, more evidence in favor of the relationship between BMI and income levels was found (Figure 7). The income of the obese tier, overweight tier, normal tier, and underweight tier were compared. When the income of the underweight tier (M = 55468.35, SD = 33849.2) was compared with the obese tier (M = 53761.24, SD = 31982.27), there was a statistically insignificant difference of $1707.11 (95% CI = [-583.61, 3997.84]; t(3740) = 1,46, p = 0.14. By contrast, when the average income of the normal tier (M = 58394.25 , SD = 33472.65) was compared with the medical charges of the obese tier (M = 53761.24, SD = 31982.27), there was a significant difference of $4633 (95% CI = [3004.66, 6261.35]; t(6413) = 5.58, p = 2.6E-8. Likewise, when the average income of the overweight tier (M =58903.26, SD = 33472.64) was compared with medical charges of the obese tier (M = 53761.24, SD = 31982.27), there was a significant difference of $5142.02 (95%

CI = [3654.17, 6629.87]); t(8835) = 6.77, p =1.4E-11. This evidence implies that there is no decrease in salary due to an increase BMI, as the difference in salary between the overweight and obese tiers was large and the overweight tier had the largest median salary. Nevertheless, there is a statistically significant difference between overweight and obese tiers and the normal and obese tiers.

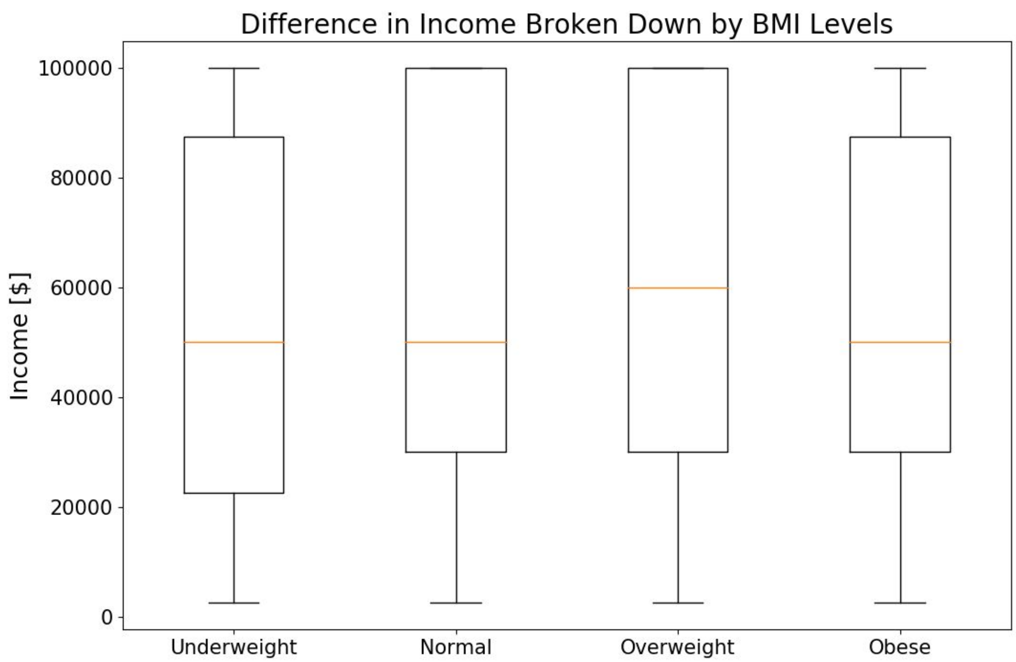


Figure 7. The boxplots show the differences in income across the BMI levels. In the x-axis the BMI tiers are displayed, whereas in the y-axis the income, in US dollars, is displayed.

Obesity, Race, and Income

In the previous section, the medical costs of obesity and the income tiers that have the highest medical costs were studied. However, an analysis of the BMI and income tiers of racial cleavages has to be elaborated on to provide a thorough analysis of the obesity epidemic. For that reason, A chi-square test of independence was performed to examine the relation between race and obesity. The relation between these variables was significant, X^2 (15, N = 9634) = 115.6, p = 1.4E-17. Of all races, African-Americans were more likely to be obese, The biggest difference in porpotion of obese individuals was between African Americans and Asians with a value of 0.26 (95% CI = [0.21, 0.31]). Contrastingly, the smallest diffrence in the proportion of obese individuals was between African-Americans and Mexicans since the difference in proportion was 0.07 (95% CI = [0.02, 0.13]) (Figure 8).

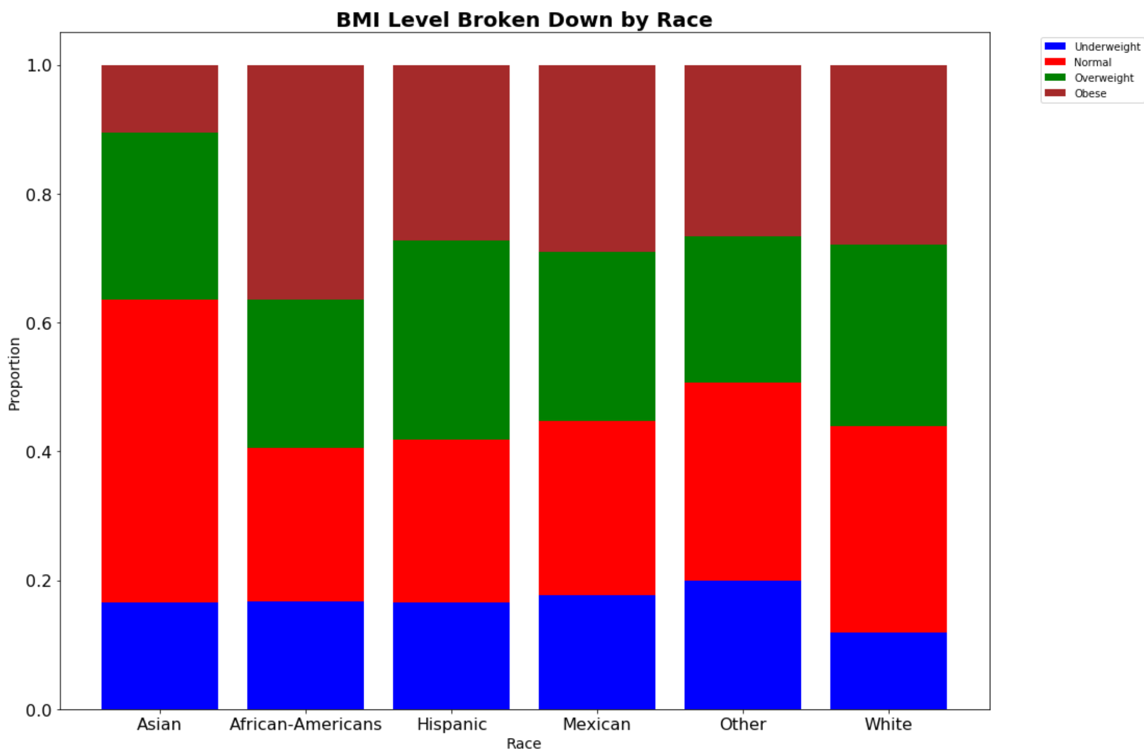


Figure 8. The stacked bar chart displays the proportions of BMI across races. The x-axis shows the races, whereas the y-axis the proportions of obesity.

Furthermore, the BMI of African-Americas, Asians, Hispanics, and Whites was compared. African-Americans (M = 27.75, SD = 8.87) had a higher BMI than whites (M = 26.63, SD = 7.07), as there was a statistically significant difference of 1.2 (95% CI = [0.3, 1.94]); t(3380) = 2.98, p = .008. African-Americans (M = 27.75, SD = 8.87) also had a higher BMI than Hispanics (M = 26.1, SD = 6.79), as there was a statistically significant difference of 1.65 (95% CI = [0.55, 12.74]); t(804) = 2.98, p = .003. Lastly, African-Americans (M = 27.75, SD = 8.87) had a higher BMI than Asians (M = 23.67, SD = 5.76), as there was a statistically significant difference of 4.07 (95% CI = [3.01, 5.14]); t(732) = 7.46 , p = 2.8E-13 (figure 9).

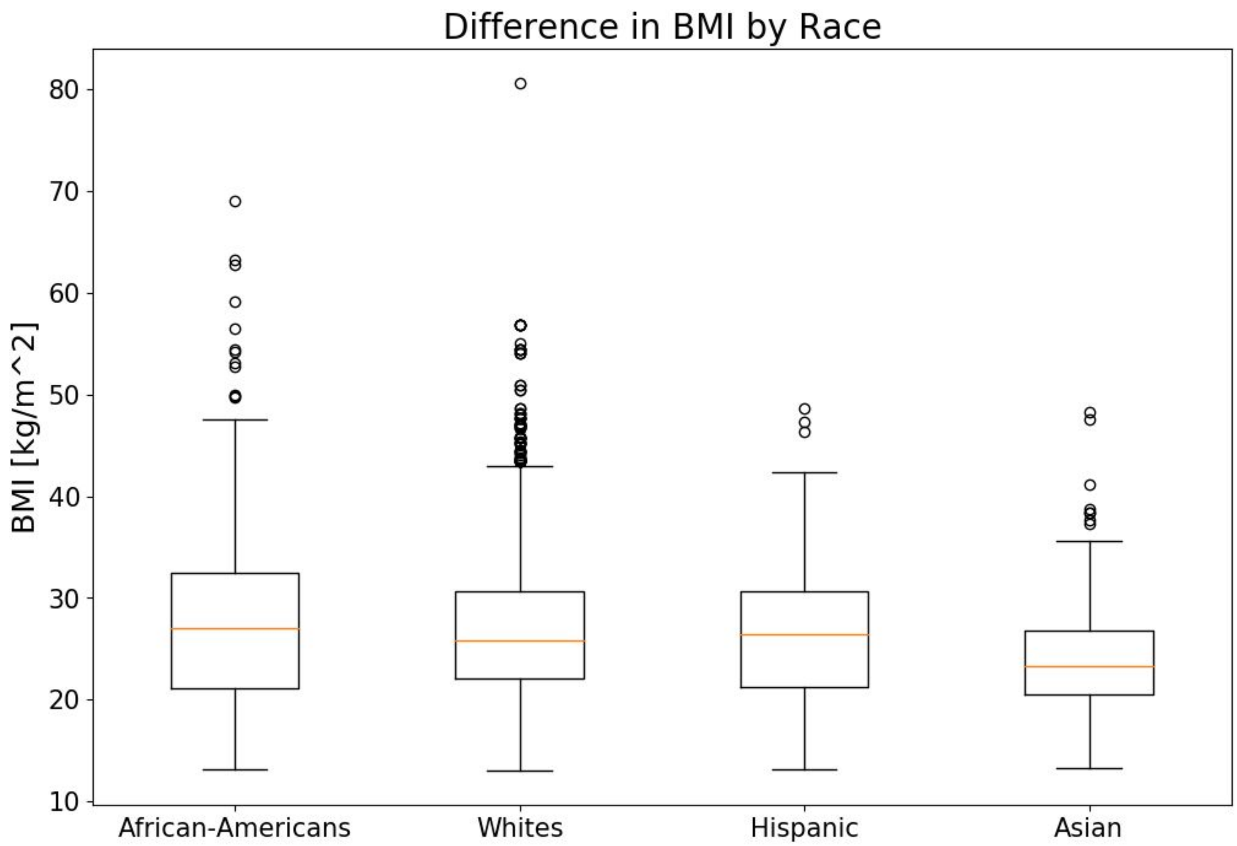


Figure 9. The box plot compares BMI across racial groups. The x-axis shows the races, whereas the y-axis the BMI in kg/m^2.

This data demonstrates that marginalized and vulnerable racial cleavages such as the African-Americans, and Hispanics have higher levels of obesity. This is problematic as they also are in the lowest groups of income. A chi-square test of independence was performed to examine the relation between race and income. The relation between these variables was significant, X^2 (10, N = 8852) = 352.06, p = 1.5E-69. Of all races, African-Americans were more likely to be on the lower tier for income, meaning that the null hypothesis is rejected in favor of the alternative hypothesis. The largest difference in the proportion of low income individuals was between African-Americans and white Americans with a value of 0.21 (95% CI = [0.168, 0.258]). By contrast, the smallest difference in the proportion of low income individuals was between African-Americans and Hispanics with a value of 0.0125 (95% CI = [-0.057, 0.082]) (figure 10).

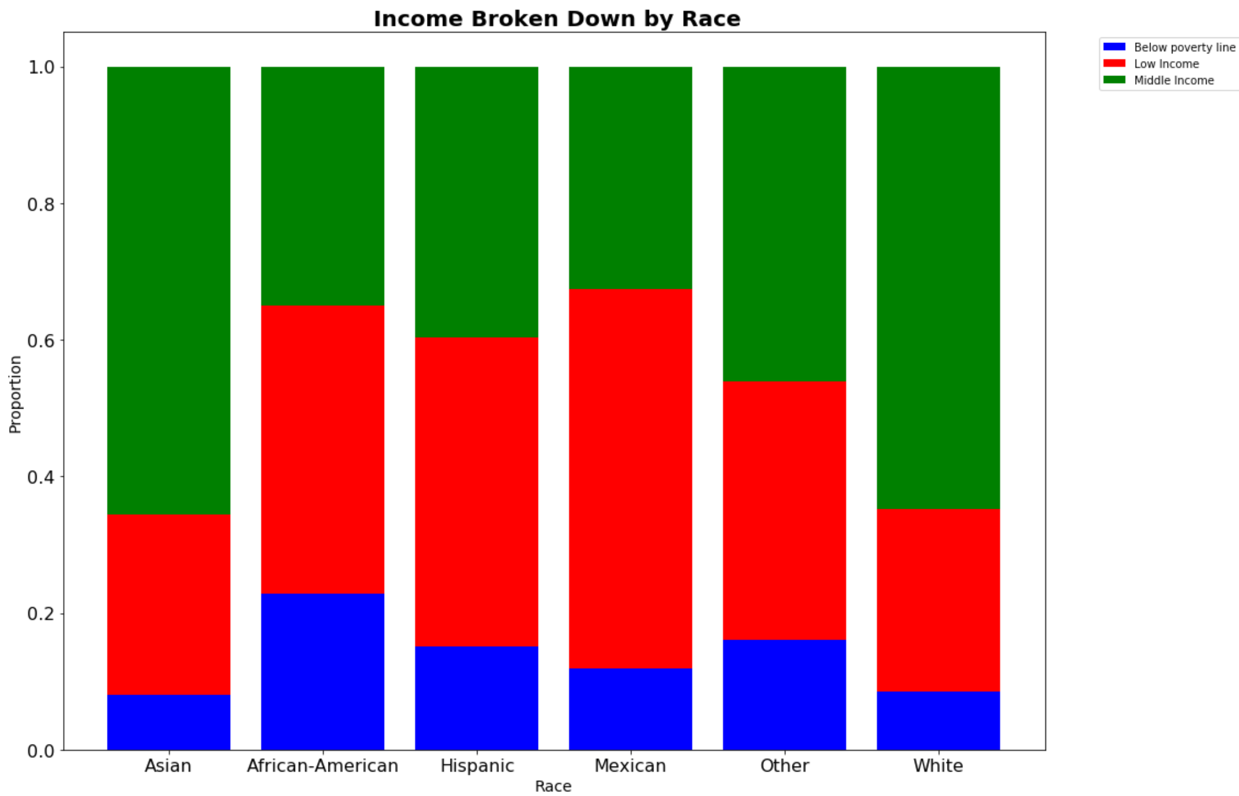


Figure 10. The stacked bar chart shows the proportion of individuals in each income tier for each race. The x-axis shows the races, whereas the y-axis the proportions of the economic tiers.

Further evidence is encountered when the Income of African-Americas, Asians,Hispanics, and Whites was compared (Figure 11). African-Americans (M = 41920.36, SD = 31175.28) had lower incomes than whites (M = 63332.18, SD = 33027.76), as there was a statistically significant difference of $21411.82 (95% CI = [18417.93, 24405.70]); t(3380) = 14.01, p = .1.8E-39. Likewise, African-Americans (M = 41920.36, SD = 31175.28) had a lower income than Asians (M = 65094.54, SD = 32913.49), as there was a statistically significant difference of 23174.17 (95% CI = [18181.72, 28166.63]); t(732) = 9.08, p = .3.5E-18. Lastly, African-Americans (M = 41920.36, SD = 31175.28) did not have a significant income difference when compared with Hispanics (M = 44629.03 , SD = 30504.51). Although the difference was of $2708.67 (95% CI = [-1650.97, 7068.31]), the p-value was over the significance level of 0.05; $t(804) = 1.22$, $p = 0.22$. For that reason, this significant statistical data demonstrate that African-Americans and Hispanics are in grave danger due to obesity, as they have the highest population proportions in the lowest income tiers and the highest population proportions in the BMI tiers.

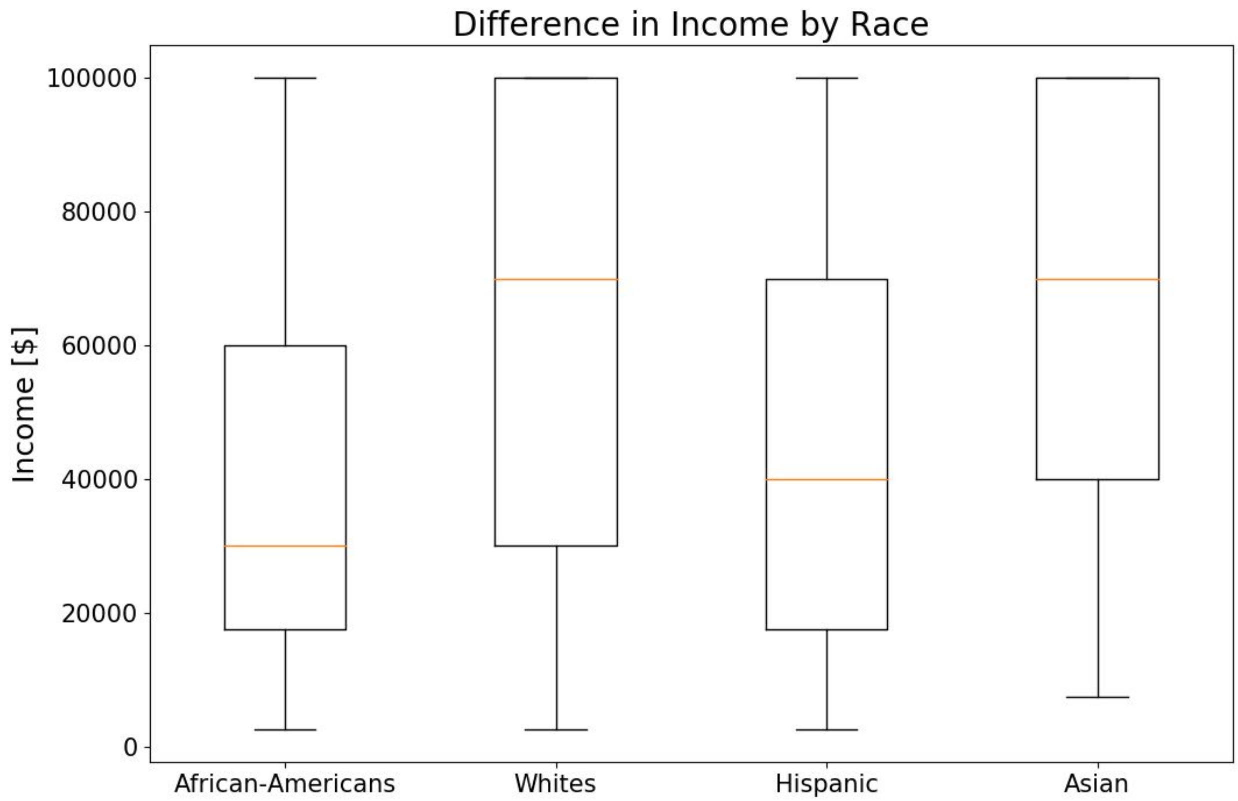


Figure 11. The ox plot shows the differences in income between races. The x-axis represents the races, whereas the y-axis represents the income in US dollars.

Conclusion

Obesity is a grave danger for many people as it deteriorates their health, is associated with severe diseases, and increases medical costs significantly. This study demonstrated that medical costs and BMI are positively associated and that African-Americans and Hispanics are the race cleavages that health policy makers ought to target to reduce obesity levels significantly. The 147 billion dollars that the United States employs to cure the grave conditions and diseases this preventable condition causes are numerous. However, the systematic racism hinders the progress in the reduction of obesity levels in marginalized and vulnerable populations. Ultimately, this study not only demonstrated that there is a strong gradient between BMI and medical costs, but also that inequalities propagate the epidemic of obesity.

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Citations

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