**The Effects of Obesity on Average Life Expectancy**



**Abstract:** In this passage, a regression model will be utilized to measure the effects of obesity on average life expectancy. Independent controlled variables will be discussed such as poverty, no physical activity, low nutrition, and unemployment. Using county level data from the U.S., we observe a significant negative relationship between obesity and average life expectancy.

# **Key words:** obesity, life expectancy, mortality, comorbidity

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**Introduction**

Americans have always been known for their consumption habits, especially when it comes to the consumption of food. In the last century, obesity has increased significantly for Americans and worldwide, causing concern for the quality of life and longevity. According to the CDC (2017), obesity is related to several other serious conditions such as heart disease, stroke, type 2 diabetes, and other types of cancers (CDC, 2017). Furthermore, obesity is widespread affecting nearly 40% of Americans. Further research indicates that obesity is developing in much of the rest of the world. Obesity is defined as a disease that exhibits an excessive amount of body fat that produce negative health effects and externalities. Obesity is commonly measured by BMI. A BMI equal to or above 30 is considered obese. Obesity increases the risk of various chronic diseases in all age groups and is quite complex. There is a direct link between type 2 diabetes and obesity. This comorbid relationship is important as a good percentage of the population is affected by type 2 diabetes and it is a costly disease. Obesity also inflicts additional healthcare costs to everyone. We are still in the beginning stages of determining the underlying effects of obesity, but we know for sure obesity has become a product of our physical and social environment, encouraging negative behaviors in society. Obesity contributes to socioeconomic inequalities in society with regard to inequality, the underutilization of our energy source, and destructive habits of our most important resource of all – our bodies. In the last few decades our civilization has managed to significantly increase life expectancy due to technology and advances in medicine to fend off diseases. For that reason, obesity is becoming a major public health concern. As we evolve as a species, our core fundamental objectives in life is to live longer and be prosperous; obesity interferes with these objectives. Therefore, it is important to understand the implications of obesity and its relationship to average life expectancy for society. We explore this relationship through the use of ordinary least squares regressions taking data from the county level in the U.S. and determining the relationship between average life expectancy and the obesity rate in the county.

**Literature**

According to Mitchell, Catenacci, Wyatt, & Hill (2011) using various sources of data, obesity rates have been systematically increasing over the last three decades, meanwhile obesity rates in younger groups ranging from 2 to 19 have also been climbing (Mitchell et al., 2011). Obesity adversely effects our entire body. It is connected with the most common and most costly medical problems in the United States, such as type 2 diabetes, hypertension, coronary artery disease, other forms of cancer and cognitive dysfunction (Mitchell et al., 2011). These healthcare costs contribute largely to our government spending and the national welfare. Latent factors like BMI, abdominal fat allocation, and higher weight are all key for the progression of type 2 diabetes. It is presumed that 90% of people with type 2 diabetes are obese. In fact, children are now being identified as having type 2 diabetes (Mitchell et al., 2011). They found several studies that have shown a link between obesity and cognitive dysfunction, such as poor directive functioning and memory lapses. A meta study that reviewed BMI in adulthood and dementia showed underweight, overweight and obesity were all connected with developing dementia later. In addition, a longitudinal study concluded that a higher BMI is likely a risk factor for developing dementia (Mitchell et al., 2011). As mentioned by Mitchell et al. (2011), obesity affects some sub groups more than others in the populace. For instance, African American and Mexican women have a higher commonality of obesity than White women. Obesity has risen in all gender-ethnic groups and income levels. Those in a lower income and lower education group have seen greater rates of obesity compared to those better off. This indicates a divide among socioeconomic status in relation to obesity rates. This relationship is explained by Mitchell et al. (2011) in that the lowest costing foods usually have high levels of fat and sugar and are the most attainable. The fastest way to accumulate the greatest number of calories is to consume a high amount of fat and sugar which is known to contribute to obesity more so than other diets (Center for Disease Control). In addition, groups that have more financial resources, are likely more physically active than those with less resources (Mitchell et al., 2011). Similar connections have been made to socioeconomic factors influencing obesity. According to Ahmad and Akil (2011), who studied the relationship with BMI and socioeconomic factors (e.g. income level, % below poverty line, unemployment, food stamps) with government data from BRFSS, also concluded a strong relationship (=.77) with obesity and socioeconomic variables (Ahmad et al, 2011). They found the highest rates of obesity in Mississippi and Alabama, and the highest ethnicity group was in African Americans. They noted obesity as having connections to lifestyle behaviors such as low exercise levels and large consumption of high calorie foods. In that, a substantial effect of consumption of low-quality food, as a result of economic factors, elevated BMI (Ahmad et al, 2011). Additionally, more than thirty three percent of food stamps are distributed to African Americans. As this issue concerns the entire population; they advocate for preventative health measures (Ahmad et al, 2011). Abdelaal, Le Roux, & Docherty (2017) also believe obesity inflicts disastrous health and financial costs on the population. But, despite preventative policy measures, obesity continues to grow at a disturbing rate. They found the issue to be more of a health obstacle, rather than socioeconomic or inequality driven. Using KOSC in their study, they found over 50% of Europeans are obese and the global predominate rate of obesity has risen to 30%. Furthermore, obesity is linked with greater rates of mortality by comorbidities like type 2 diabetes, dyslipidemia, hypertension, sleep apnea, certain types of cancer, steatohepatitis, gastroesophageal reflux, arthritis, polycystic ovary syndrome and infertility (Abdelaal et al., 2017). They reported obesity to be linked with greater risks of progressing insulin resistance, once thought to be a large metabolic abnormality in patients with type 2 diabetes by inflated levels of flowing insulin (Abdelaal et al., 2017). Previous empirical analysis has uncovered insulin resistance and hyperinsulinemia as an important risk factor for endometrial cancer (Abdelaal et al., 2017). As mentioned by Abdelaal et al. (2017) approximately 25-30% of obese individuals show signs of depression. Depression is believed to be one of the main factors of disability (World Health Organization). It is also known that decreased physical activity can create depression in individuals. Lower productivity, unemployment, and healthcare costs were also influenced by obesity. However, healthcare costs are harder to determine given direct and indirect costs. They concluded that obesity is linked with a greater risk of ailment or mortality from cardiovascular disease and cancer (Abdelaal et al., 2017). Another study by (Flegal et al., 2013) reported grade 2 and 3 obesity being linked with undoubtedly higher all-cause death, implying higher levels of death at higher BMI levels. The risks often come from elevated mass of fat tissue, increased adipocytes and metabolic changes. Psychological impairment, obstructive sleep apnea, and osteoarthritis are directly connected with higher fat mass. In conclusion, they found the life expectancy of an extremely obese person was shortened by roughly 5-20 years, and that in general, obesity increases mortality (Abdelaal et al., 2017). Similarly, researchers from the National Institutes of Health (2015) found individuals with extreme obesity (level III), had a drastic decrease in life expectancy in contrast to the general population of typical weight (National Institute of Health, 2015). The large study utilized numerical data from three different continents that showed the surplus of deaths largely relating to heart disease, cancer and diabetes. They noted the lost years of life extended from 6 to 14 years. Lastly, when comparing the loss of years, these researchers equated level III obesity as near to or greater than that of tobacco smokers (NIH, 2015). These results highlight the need for more preventative and proactive approaches against obesity; as it may soon become a leading indicator of mortality. To get a better understanding of obesity, we will analyze the data to obtain useful predictive theories and we will incorporate socioeconomic factors into our model.

**Data Sources**

Using the current population survey as a base to determine metrics of health and safety at the county level, this data is aggregated and reported by the CDC on 3,141 counties in the United States. Information was collected on 6 variables. Those are Average Life Expectancy, Obesity, Poverty, No Physical Activity, Low Nutrition and Unemployment. Average Life Expectancy represents the average number of years that a baby born in 1990 is expected to live if current mortality trends continue to apply. Obesity is calculated percentage of adults at risk for health problems related to being overweight, based on body mass index (BMI). Poverty is the percentage of individuals living below the poverty level data in 1995 and are from the U.S. Bureau of the Census’ Small Area Income Poverty Estimates (SAIPE), U.S. Bureau of the Census. No Physical Activity is determined by the percentage of individuals in the county who reported no physical activity in a given week on the CPS. Unemployment is the number of persons who had no employment, were available for work, and had made specific efforts to find employment were obtained, the number of unemployed compiled from the 1998 CPS. Low Nutrition is the percentage of adults reporting an average fruit and vegetable consumption of less than 5 times per day. The CHSI data set was formed to disclose correlations between variables in order to assist with public health. The CHSI dataset can be found at: <https://catalog.data.gov/dataset/community-health-status-indicators-chsi-to-combat-obesity-heart-disease-and-cancer>

**Data Extracted**

The dependent variable is Average Life Expectancy (Y), and the five independent variables are Poverty, Obesity, No Physical Activity, Low Nutrition, and Unemployment. Labeled in Table 1. The data was collected with the mind set that obesity could also contribute to larger socioeconomic issues.

Table 1. Unit of Variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Y | X1 | X2 | X3 | X4 | X5 |
| Average Life Expectancy | Poverty | Obesity | No Physical Activity | Low Nutrition | Unemployment |

**Data Statistics**

The summary statistics includes 1,812 observations, the mean, standard deviation, maximum and minimum of each variable. Labeled in Table 2.

Table 2. Simple Statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Obs. | Mean | Std. Dev. | Min | Max |
| Average Life Expectancy | 1812 | 76.46286 | 2.039655 | 66.6 | 81.3 |
| Poverty | 1812 | 12.89735 | 4.768843 | 2.2 | 35.6 |
| Obesity | 1812 | 24.43703 | 4.562463 | 8.7 | 40.2 |
| No Physical Activity | 1812 | 26.65099 | 6.618052 | 8.3 | 50 |
| Low Nutrition | 1812 | 78.61264 | 4.991991 | 63.1 | 93.7 |
| Unemployment | 1812 | 2.512492 | 1.418023 | 0 | 6.664938 |

**Correlation Analysis**

The correlation coefficients between Y and X variables are calculated in Table 3. There is a large correlation between all the variables. Obesity is highly correlated with Poverty and No Physical Activity as stated by Mitchell et al. (2011).

Table 3. Correlation Analysis

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | ALE | Poverty | Obesity | No Physical Activity | Low Nutrition | Unemployment |
| ALE | 1 |  |  |  |  |  |
| Poverty | -0.698 | 1 |  |  |  |  |
| Obesity | -0.5699 | 0.441 | 1 |  |  |  |
| No Physical Activity | -0.6575 | 0.6028 | 0.5877 | 1 |  |  |
| Low Nutrition | -0.3426 | 0.2938 | 0.3928 | 0.4097 | 1 |  |
| Unemployment | -0.1299 | 0.1459 | 0.1112 | 0.0884 | 0.0372 | 1 |

**Regression Analysis**

In order to determine the potential relationship with the variables, and to make certain hypotheses about our relationship; we will test several models with different variables.

Estimated Model

The estimated model tested additional variables such as Low Nutrition, Unemployment and Uninsured. Based on the results of the regression, as you can see in Table 4, there isn’t a strong significance level when compared to the 5% level for Low Nutrition and Unemployment. Therefore, moving forward we will omit these variables. We also omit Uninsured due to the positive relationship between ALE and Uninsured being inconsistent and for the purpose of validity.

Table 4. Estimated Model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ALE | Coef. | Std. Err. | T | P>t | [95% Conf. | Interval] |
| Poverty | -0.24314 | 0.012729 | -19.1 | 0 | -0.2681056 | -0.2181747 |
| Obesity | -0.089195 | 0.008425 | -10.59 | 0 | -0.1057199 | -0.0726707 |
| No Physical Activity | -0.07698 | 0.006455 | -11.93 | 0 | -0.0896391 | -0.0643204 |
| Low Nutrition | -0.011317 | 0.006704 | -1.69 | 0.092 | -0.0244651 | 0.001832 |
| Unemployment | -0.020541 | 0.021327 | -0.96 | 0.336 | -0.0623678 | 0.0212868 |
| Uninsured | 0.066188 | 0.011979 | 5.53 | 0 | 0.0426942 | 0.0896818 |
| \_Cons | 83.89206 | 0.482426 | 173.9 | 0 | 82.94588 | 84.83823 |

**Final Model I**

The second regression will show how this model will progress without the previous variables (Low Nutrition, Unemployment, Uninsured) and for the purpose of obtaining a more tractable model. See

Table 5. Descriptive Regression Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ALE | Coef. | Std. Err. | T | P>t | [95% Conf. | Interval] |
| Poverty | -0.18977 | 0.007977 | -23.79 | 0 | -0.205415 | -0.174125 |
| Obesity | -0.098994 | 0.008223 | -12.04 | 0 | -0.115121 | -0.082867 |
| No Physical Activity | -0.080114 | 0.006376 | -12.56 | 0 | -0.092619 | -0.067609 |
| \_Cons | 83.46462 | 0.167174 | 499.27 | 0 | 83.13675 | 83.7925 |

**Robustness Test**

To correct for trueness and stressful environments; we have performed a robustness test on our previous model. See Table 6. As we can see, the standard errors were only slightly increased, and all of these independent variables are significant at the 5% level with T Values well beyond the Critical Value, therefore will use this model to interpret our results on the dependent variable. From our results we see that an increase in Obesity by 10% would cause a decrease in a towns life expectancy of 10\*.10 = 1 year holding all other variables constant. An increase in Poverty by 10% would cause a decrease in a towns life expectancy of 10\*.18 = 1.8 years, and an increase in No Physical Activity by 10% would cause a decrease in a towns life expectancy of 10\*.08 = .8 of a year holding all other variables constant.

Table 6. Descriptive Regression After Robustness Test

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ALE | Coef. | Std. Err. | T | P>t | [95% Conf. | Interval] |
| Poverty | -0.18977 | 0.013722 | -13.83 | 0 | -0.216683 | -0.162857 |
| Obesity | -0.098994 | 0.008869 | -11.16 | 0 | -0.116387 | -0.0816 |
| No Physical Activity | -0.080114 | 0.00797 | -10.05 | 0 | -0.095745 | -0.064482 |
| \_Cons | 83.46462 | 0.174608 | 478.01 | 0 | 83.12217 | 83.80708 |

**Regression Function**

From these variables we can formulate the regression function below:

= 83.46 – 0.19 \* Poverty - 0.10 \* Obesity - 0.08 \* No Physical Activity

SE (0.17) (0.01) (0.00) (0.00)

The Coefficient of Determination is R-squared = 0.61, Adj R-squared = 0.61

This means 61% of the variation in Average Life Expectancy is explained by the regression model and the rest is unexplained. Therefore, this indicates an admirable goodness of the fit in the model. The F Value of this model is 734.85, and the P Value is 0.000. The Critical F is F (3, 1808,.05) =2.60, since the Calculated F > Critical F, the variables are jointly significant.

Table 7. Results of Regression on Average Life Expectancy

|  |  |
| --- | --- |
| Variable | Coefficients |
|  |  |
| Poverty | -0.190\*\*\* |
|  | (0.01) |
| Obesity | -0.0990\*\*\* |
|  | (0.01) |
| No Physical Activity | -0.0801\*\*\* |
|  | (0.01) |
| \_Cons | 83.46\*\*\* |
|  | (0.18) |
|  |  |
| N | 1812 |
| R-squared | 0.607 |

Standard errors in parentheses

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

**Heteroskedasticity Test**

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of ALE

chi2(1) = 154.49

Prob > chi2 = 0.0000

The Breusch-Pagan test shows that there is substantial heteroskedasticity present with the average life expectancy. As OLS fails to produce the best estimators, we will have to come up with some other ideas to fix this issue. Since it’s a decent amount, it could indicate that I have a few sample complications where my whole estimate is directed by a few high variance observations. OLS is essentially giving more weight to high variance observations than ideal. In order to correct for this, we will run a robustness test (robust standard errors) in the last model to condense these variances.

**Multicollinearity**

Table 8. Multicollinearity Test

|  |  |  |
| --- | --- | --- |
| Variable | VIF | 1/VIF |
| No Physical Activity | 1.97 | 0.508075 |
| Poverty | 1.6 | 0.625173 |
| Obesity | 1.56 | 0.642816 |
| Mean VIF | 1.71 |  |

As shown in Table 8. This shows a value of the VIF < 10, therefore it indicates there is little to no multicollinearity. This is great as the assumption was there would be some level of multicollinearity. It is also advantageous as it indicates some level of reliability.

**Robustness with Other Controlled Variables – Final Model II**

To test the robustness of our relationship between obesity and average life expectancy, we will need to manipulate the model to include demographic factors such as the percentage of a county’s population is White, Black and Asian. This can also assist with endogeneity issues that are present. See Table 9.

Table 9. Regression with Demographics and Robustness

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ALE | Coef. | Std. Err. | T | P>t | [95% Conf. | Interval] |
| Poverty | -0.175331 | 0.025276 | -6.94 | 0 | -0.225082 | -0.12558 |
| Obesity | -0.068461 | 0.026508 | -2.58 | 0.01 | -0.120638 | -0.016284 |
| No Physical Activity | -0.087455 | 0.01979 | -4.42 | 0 | -0.126409 | -0.048502 |
| Asian | 0.0527764 | 0.01449 | 3.64 | 0 | 0.0242546 | 0.0812983 |
| White | 0.0159324 | 0.009098 | 1.75 | 0.081 | -0.001975 | 0.0338394 |
| Black | -0.042592 | 0.010107 | -4.21 | 0 | -0.062486 | -0.022697 |
| \_Cons | 81.72916 | 1.009791 | 80.94 | 0 | 79.74154 | 83.71678 |

We see that once demographics are controlled for; the effect of obesity is still negative on the average life expectancy. See Table 9. With the new model the R-squared is now approaching 73%. This means that 73% of the variation in Average Life Expectancy is explained by the regression model. The Null Hypothesis: B2 = 0, T Value = [-.068-0)/.026] = -2.58, T Critical = 1.65, Test Results = |T Value|>T Critical. Therefore, we reject the null hypothesis and conclude that the model is jointly statistically significant. The T levels indicate a certain level of severity, when we control for these, we see we changed the structure of the T level from past regressions (Table 6). The highest levels were Poverty and Obesity, now they are Poverty and No Physical Activity. In addition, the coefficient on Obesity decreased, signaling demographic information is highly important to changing the death rates relating to obesity.

**Rerun for Heteroskedasticity**

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of ALE

chi2(1) = 1.59

Prob > chi2 = 0.2072

We can now see that we have a more optimal constant variance.

**Limitations**

While the results do have some significance, it is important to understand the limitations. The CHSI data set was designed by the U.S. Department of Health, and shows county-level data on population demographics and health factors. This data set did not reveal data on every single county; therefore, some counties do not accurately reflect in the data set. This is called sample selection bias. This also contains selection bias, wherein individuals are not randomly chosen. In addition, certain counties have different risk preferences towards heavy drinking, drug use, and insufficient healthcare which can cause more obesity and these factors do not have accurate numerical methods of measurement. Furthermore, obesity is largely related to other health diseases, which could also reduce average life expectancy, or create creative destruction (dual causes). Meta data analysis provides for correlations between variables but does not imply causal relationship. Certain socioeconomic categories were derived for the model from an educated economics major that focused on inequality measures, which slightly skewed the data. For future consideration, several other factors of social dynamics or the social stratification should be included in the data set in order to reduce bias and create more of a narrative.

**Conclusions**

We have shown using various regression models that there is a negative relationship between obesity and average life expectancy. We have controlled for several other socioeconomic factors that could influence obesity, and still found a negative relationship. This relationship indicates a strong need for further research on obesity to prevent significant health externalities on society in the future and to maintain our healthy growing economy. Obesity is still considered a stereotype, rather than what it is, deadly. It effects our mind, body, and most importantly our health. With regard to public policy, there has been minimal efforts to combat obesity and reduce the progression to other diseases. However, with further research and statistics we can conclusively make an argument to advise policy makers that this should be of importance. Given the fact, that we are already paying for it.

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