# Adult Obesity Trends in the United States from 1997-2016.

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Summary:

This paper uses National Health Interview Survey (NHIS) data from 1997 to 2016 to analyze the relationships between obesity, defined as having a Body Mass Index (BMI) greater than 30, and several demographic and economic factors. These factors include age, gender, race and ethnicity, education, income, citizenship, and participation in the food stamps program. Results indicate that while the prevalence of obesity among American adults has increased considerably from 1997 to 2016, this increase has been uneven across various sub-populations. There is a significant association between increased obesity, and poverty, gender, and race.

## Literature Review:

The U.S Center for Disease Control and Prevention (CDC) defines obesity using the Body Mass Index (BMI), which is a person's weight in kilograms divided by the square of their height in meters. An individual with BMI of 30 or higher is considered obese. Obesity is increasingly seen as a "global epidemic," and some research indicates that the worldwide rate of obesity doubled between 1980 and 2008, from 4.8% to 9.8%.[1] Among developed countries, the

[1] Finucane, M. M., et al. (2011). National, regional, and global trends in body mass index since 1980: Systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet (London, England)*, *377*(9765), 557–567.

United States has the highest rates of overweight and obesity. According to data from the National Health and Nutrition Examination Survey (NHANES), the prevalence of obesity among US adults was 36.5% from 2011-2014.[2] In other words, more than one in three US adults are obese.

Obesity has significant medical, social, and economic costs, both at the individual and the societal levels. Obesity leads to negative health outcomes, due to mechanical strain on the body as well as complex changes in metabolism and hormonal balances. Obese individuals are at greater risk of serious health issues, including heart disease, type 2 diabetes, stroke, hypertension, and certain types of cancer.[3] Obesity is also associated with mental illnesses such as anxiety and clinical depression.[4] Studies have found associations between obesity and infertility among women,[5] and between obesity and reduced sexual function among men and women.[6] Overall, obesity affects nearly all aspects of health, and reduces individuals' quality of life.

There are considerable economic costs related to obesity. These include the monetary value of healthcare resources devoted to managing the obesity-related disorders mentioned above. One study calculated that, compared to normal-weight individuals, obese individuals incurred 46% higher inpatient costs, had 27% more physician visits and outpatient costs, and 80% higher prescription drug costs. The added annual medical cost of obesity was estimated to

[2] National Center for Health Statistics Data Brief. No. 219, November 2015. https://www.cdc.gov/nchs/data/databriefs/db219.pdf
[3] Managing Overweight and Obesity in Adults: Systematic Evidence from Obesity Expert Panel (2013). *National Heart, Lung, and Blood Institute Evidence Report*. https://www.nhlbi.nih.gov/sites/www.nhlbi.nih.gov/files/obesity-evidence-review.pdf
[4] Luppione, Floriana S., et al. (2010) Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Archives of general psychiatry* 67.3: 220-229.
[5] Rich-Edwards JW, et al. (2002) Physical activity, body mass index, and ovulatory disorder infertility. *Epidemiology* 13.2:184-90.
[6] Bajos, N. et al (2010) Sexuality and obesity, a gender perspective: results from French national random probability survey of sexual behaviours. *BMJ (Online)*, 340.

be $147 billion in 2008.[7] The annual medical costs due to obesity are projected to increase to $22 billion per year by 2020, and $48 billion per year by 2030.[8] Beyond direct medical costs, there are also several indirect costs of obesity, especially in terms of lost productivity. Based on 2008 NHANES, Wang et al. estimated a loss of 1.7 million to 3 million productive person-years for working US adults, which amounts to economic costs of $390 billion to $580 billion.[9]

Obesity is a complex, multifactorial phenomenon, caused by a combination of genetics, family history, physical and social environment, behavior, education, medication, diseases, and other factors. While researchers have not found a single genetic locus for obesity, they have found evidence that genetic variation is related to individuals' predisposition to gain weight and their risk of becoming obese. This is particularly true for the risk of severe obesity.[10] Family history, behavioral patterns such as diet and physical activity, and community environment also contribute to increased rates of obesity. Scholars have theorized that, since WWII, broader societal factors have resulted in increases in BMI. These include the sedentary nature of most US jobs[11], an increase in the number of restaurants and a decrease in food prices[12], and technical advancements that made prepared food readily available, and contributed to overeating by individuals who prioritized immediate and short-term gratification from food over the long-term costs of obesity.[13]

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[7] Finklestein, Eric A. et al (2009) Annual Medical Spending attributable to obesity: payer and service specific estimates. *Health Affairs* 28(5): w822-w831.
[8] Wang, Claire Y. et al (2011) Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 378:815-25.
[9] Wang, Claire Y. et al (2011) Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 378:815-25.
[10] Choquet, H, Meyer, D. (2011) Genetics of Obesity: what have we learned? *Current Genomics* 12(3):169-179.
[11] Lakdawalla, Darius, and Tomas Philipson (2009) Growth of obesity and technological change. *Economics and human biology* 7(3): 283-293
[12] Chou, Shin-Yi, Grossman, Michael, and Saffer, Henry (2004) An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System. *Journal of Health Economics* 23(3): 565-587.
[13] Cutler, David, Graeser, Edward, and Shapiro, Jesse (2003) Why have Americans become more obese? *Journal of Economic Perspectives* 17(3): 93-118.

There is a strong correlation between poverty and obesity in developed countries like the US.[14] This seems paradoxical, because poverty is traditionally associated with a lack of food, while obesity is characterized as a disease of excess. A possible explanation is that poor, food-insecure households are more likely to consume calorie-dense but nutritionally poor foods. Lack of adequate nutrition can lead to faster weight gain, stress, and depression.[15] Food environment—the availability of food venues like grocery stores, supermarkets, etc. surrounding a home—also plays a role in dietary intake and obesity rates. Neighborhoods without healthy food options report higher BMI.[16] Given this, demographic sub-groups with higher incidences of poverty also have higher incidences of obesity. Native Americans and African Americans have higher rates of obesity compared to Whites and Asians. Research indicates that gender plays a key role in the relationship between poverty and obesity. Participation in the food stamps program is significantly associated with increased obesity for low-income women, but not for low-income men.[17]

Methods:

This paper uses the National Health Interview Survey (NHIS) data from 1997 to 2016. The NHIS is a cross-sectional household survey that represents the civilian, non-institutionalized population of the United States. The survey uses a multi-stage area probability sampling design. The questionnaire solicits information about demographics, health status, healthcare access, and health-related behaviors. The interviews are conducted by trained interviewers using Computer

[14] Levine, James A. (2011) Poverty and Obesity in the US. *Diabetes* 60(11):6667-68.
[15] Sarlio-Lähteenkorva S. & Lahelma, E. (2001). Food insecurity is associated with past and present economic disadvantage and body mass index. *Journal of Nutrition* 141: 2880-2884.
[16] Black J.L, Macinko J. (2008) Neighborhoods and obesity. *Nutrition Review* 66(1): 2-20., Larson N.I. et al. (2009) Neighborhood environments: disparities in access to healthy foods in the U.S. *American Journal of Preventative Medicine* 36(1): 74-81.
[17] Martin, M. A. & Lippert, A. (2011). "Feeding her children, but risking her health": The intersection of gender, household food insecurity, and poverty. *Social Science and Medicine* 74: 1754-1764.

Assisted Personal Interviewing (CAPI). The annual response rate for NHIS is around 80% for eligible households.[18]

The dataset for this analysis is limited to adults over 18 years of age, and includes 619,537 observations. Version 15 of Stata was used to recode relevant variables, and to calculate bivariate tables and chi square tests for these variables. These calculations helped determine the variables to include in further logistic regression analyses. Stata's "SVY:" procedure was used throughout this paper to provide population estimates and standard errors that take NHIS's complex sample design into account.

To study the prevalence of overweight and obesity over the years, BMI was recoded into four categories based on the CDC classification ("*BMI in CDC Categories*"). Adults were classified as "underweight" if their BMI was less than 18.5, "normal" if their BMI was between 18.5 and 25, "overweight" if BMI was between 25 to 30, and "obese" if their BMI was greater than 30.[19] For logistic regression analysis, BMI was recoded to create a dummy variable, "*Obesity*," where BMI of less than 30 was defined as "not obese," and BMI of 30 or higher was defined as "obese."

Demographic variables that were recoded into categorical variables and used in this analysis include sex, age, race, Hispanic ethnicity, and citizenship. Social and economic variables recoded and used in the paper include education, income, and participation in the food stamps program.

Results:

NHIS data shows that the percentage of underweight and overweight adults in the U.S. population stayed relatively stable from 1997 to 2016, at 1.9% and 35.0% respectively. (see

[18] https://www.cdc.gov/nchs/nhis/about_nhis.htm
[19] https://www.cdc.gov/obesity/adult/defining.html

Appendix I for a full table of 4 BMI categories by year). However, there was a significant change in the proportion of normal-weight and obese populations during the same 20-year period (see Figure 1). In 1997, obese individuals were 19.6% of U.S. adult population, while normal-weight individuals were 42.9% of the population. By 2016, the prevalence of obesity had increased to 30.3%, and that of normal-weight had decreased to 33.3%.

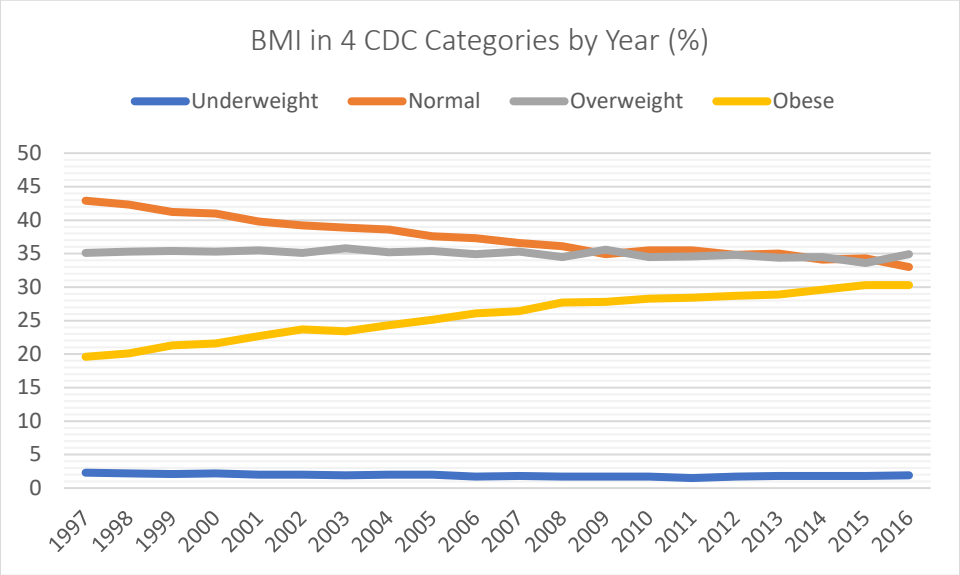


Figure 1. Percentage of US adults in 4 BMI categories by year.

Logistic regression analysis, with obesity prevalence as the dependent variable and survey year and sociodemographic factors as the predictor variables, generates an odds ratio of 1.04. In other words, between 1997 and 2016, the odds of obesity increased by a factor of 1.04 with each subsequent year.[20] This increased prevalence of obesity was distributed unevenly across various sociodemographic groups.

*Gender and Age*

[20] See Appendix VI for this logistic regression model

During 1997-2016, the average prevalence of obesity was slightly higher among men (26.3%) than among women (25.6%). The prevalence of obesity increased by more than 50% for both men and women. The proportion of women who were obese increased from 19.8% in 1997 to 30.3% in 2016, which represents a percentage increase of 53%. The proportion of men who were obese increased from 19.4% in 1997 to 30.3% in 2016, which represents a percentage increase of 56.2%. Interestingly, the prevalence of "severe obesity"— defined as a BMI of greater than 40—was higher in women (4.6%) than in men (2.7%). The higher rate of severe obesity among women holds true for every year between 1997 and 2016 (see Appendix II for a full table of BMI categories by gender and year). Figure 2 shows the annual trends in prevalence of obesity and severe obesity for men and women.

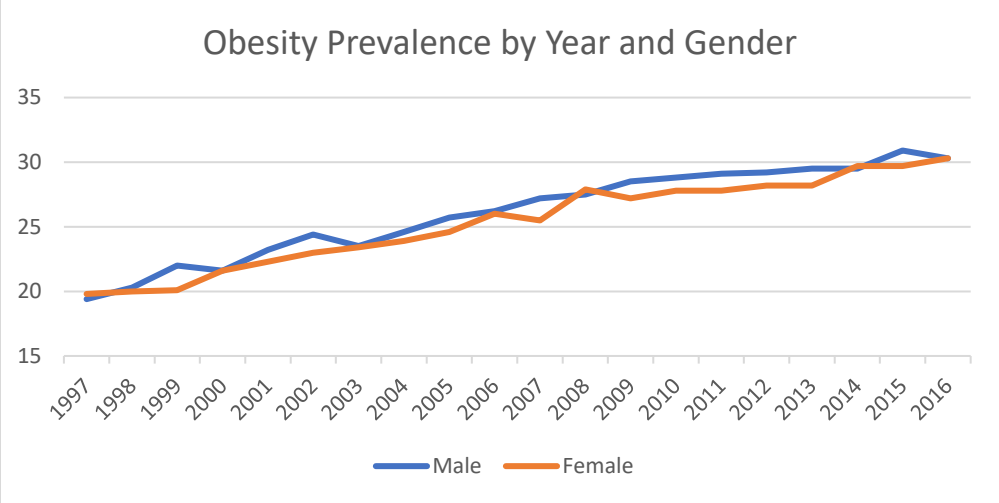


Figure 2.1. Obesity prevalence by gender from 1997 to 2016 (%).

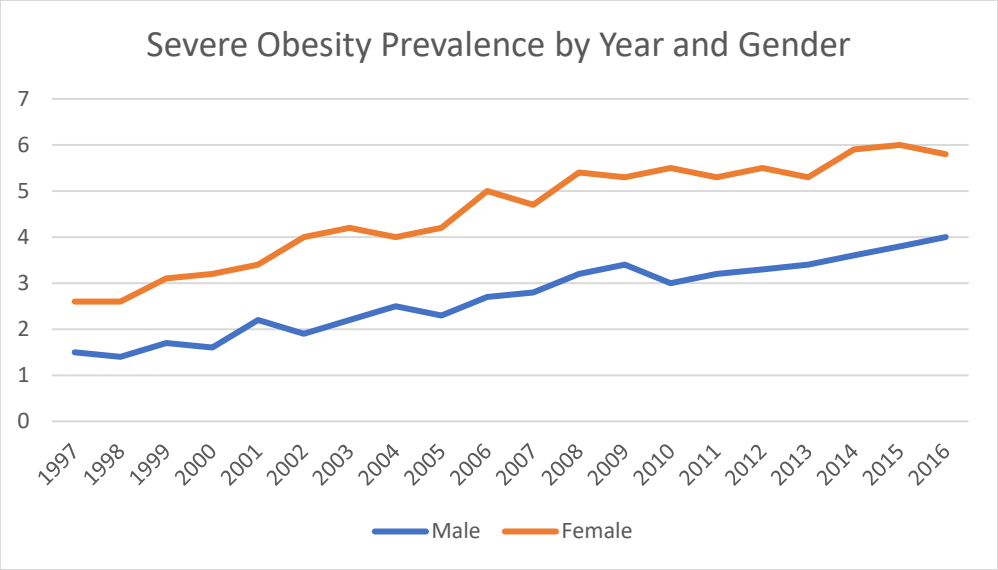


Figure 2.2. Severe obesity prevalence by gender from 1997-2016 (%).

The relationship between obesity and age is curvilinear, with increases in age corresponding to increases in BMI, but only up to a certain point (here 61+ years). After 61 years, BMI and prevalence of obesity start decreasing with each additional year of age. Accordingly, the lowest prevalence of obesity was found in the youngest age group of 18-29 years (18.9%), while the highest prevalence of obesity was found in adults aged 45-60 years (30.8%). The oldest age group, 61-85 years, had the second lowest rate of obesity (25.5%). The curvilinear relationship between age and obesity was true for both men and women, as well as across race and ethnicity, as can be seen in Table 1. For all these subgroups, the prevalence of obesity was lowest among 18-29-year-olds, and highest among 45-60-year-olds.

**Table 1. Obesity Prevalence Across Age Groups by Gender, Race, and Ethnicity (%)**

| | Age Groups | | | |
|---|---|---|---|---|
| | **18-29 Years** | **30-44 Years** | **45-60 Years** | **61-85 Years** |
| **ALL** | 18.9 | 27.1 | 30.8 | 25.5 |
| **Gender** | | | | |
| **Male** | 18.8 | 28.1 | 31.4 | 25.2 |
| **Female** | 19.0 | 26.2 | 30.2 | 25.7 |
| **Race** | | | | |

| | | | | |
|---|---|---|---|---|
| **White** | 18.3 | 27.0 | 30.8 | 25.6 |
| **Black** | 26.8 | 39.4 | 41.5 | 36.1 |
| **American Indian** | 30.0 | 42.1 | 44.5 | 36.6 |
| **Asian** | 7.9 | 9.1 | 10.7 | 9.1 |
| **Other** | 22.8 | 32.0 | 34.3 | 29.8 |
| **Ethnicity** | | | | |
| **Non-Hispanic** | 18.2 | 26.4 | 30.4 | 25.2 |
| **Hispanic** | 22.0 | 30.8 | 34.5 | 29.2 |

*Race, Ethnicity, and Citizenship*

Obesity prevalence trends for U.S. adults also varied by race, ethnicity, and citizenship. The average obesity prevalence for the years 1997 to 2016 was 26.5%. American Indians had the highest rates of obesity (38.7%), followed by African Americans (36.2%), and those who belonged to the 'Other' category (29.1%). The obesity prevalence among Whites was 26.0%, or slightly lower than the average. Asians had dramatically lower rates of obesity at 9.2%. In terms of ethnicity, obesity prevalence among people of Hispanic descent was higher compared to non-Hispanic individuals—28.7% vs. 25.5%.

Figure 3, which shows the prevalence of obesity among four major race groups by year, reveals some interesting variations.[21] All groups experienced a marked increase in obesity during this period. African Americans and American Indians had the highest rates of obesity every year, while Asians had the lowest rates of obesity every year. The obesity rates for these groups also show yearly fluctuations.[22] In contrast, the obesity rates for Whites show mostly steady growth per year. (See Appendix III for a full table of obesity prevalence by race and year)

[21] Note: The 'Other' race category, which combines Multiple and Other races, has been omitted from this graph for the sake of clarity. This category has been subject to redefinitions over the survey period, and the population estimates are uneven, with 0 'Other' race individuals in certain years.
[22] The sharp spikes for American Indians may reflect smaller sample sizes and lack of adequate data by survey year.

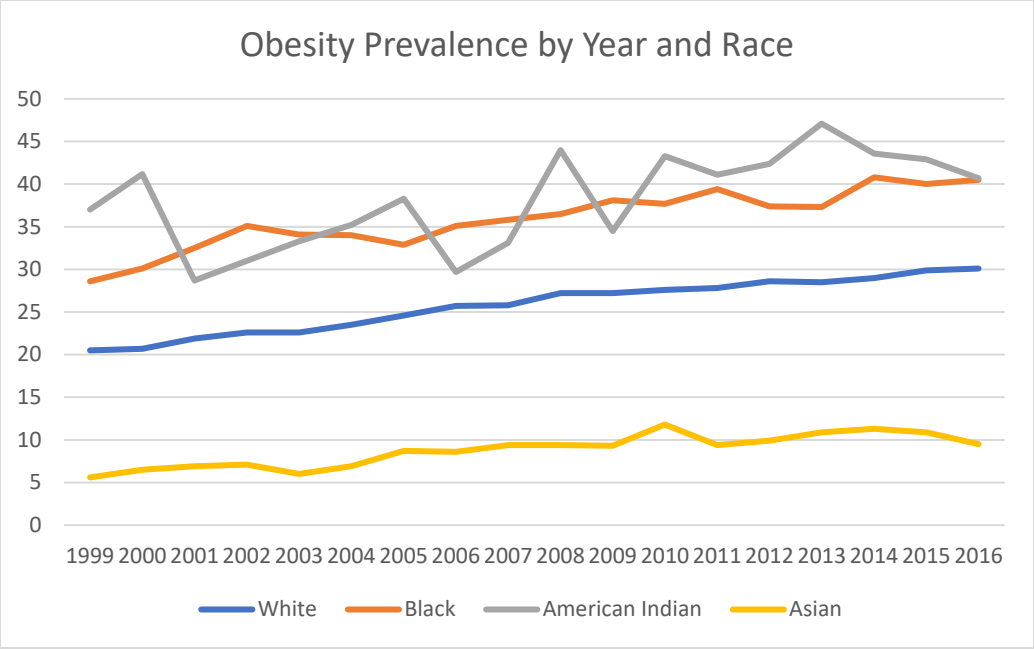


Figure 3. Obesity prevalence percentage by race and year (%).

Citizenship, birthplace, and duration of residence in the U.S were also associated with obesity. On average, U.S. citizens were more likely to be obese (26.8%) than non-U.S. citizens (19.4%). Table 2 illustrates that this holds true for both genders, and across ethnicity and race. The most dramatic differences were seen for African Americans and American Indians. Obesity prevalence among non-citizen African Americans was 21.0%, compared to 37.1% among African Americans who were U.S citizens. Similarly, American Indians who were U.S. citizens were much more likely to be obese than non-citizen American Indians (40.7% vs. 25.0%).

**Table 2. Obesity Prevalence by Citizenship, Gender, Race, & Ethnicity (%)**

| | Not U.S. Citizen | U.S. Citizen |
|---|---|---|
| **ALL** | 19.4 | 26.8 |
| **Gender** | | |
| **Male** | 18.4 | 27.4 |
| **Female** | 20.5 | 26.3 |
| **Race** | | |
| **White** | 23.0 | 26.2 |
| **Black** | 21.0 | 37.1 |
| **American Indian** | 25.0 | 40.7 |

| | | |
|---|---|---|
| **Asian** | 6.3 | 10.7 |
| **Other** | 20.7 | 30.4 |
| **Ethnicity** | | |
| **Non-Hispanic** | 11.6 | 26.4 |
| **Hispanic** | 24.5 | 31.6 |

The prevalence of obesity was also higher among individuals who were born in the U.S. and its territories (27.2%), compared to those were born in foreign countries (19.2%). This also holds true across gender, race, and ethnicity (see Appendix IV). Though there is overlap between birthplace and citizenship—those born in the U.S. and its territories are citizens by default—the birthplace variable includes foreign-born, naturalized U.S. citizens, and provides insight into how nativity and national origin affect obesity prevalence. For instance, while Asians had the lowest rates of obesity overall, there was a pronounced difference in obesity prevalence between Asian individuals born in the U.S (15.7%) and Asian individuals born outside the U.S. (7.4%). For those born outside the U.S., the risk of obesity increased with more years in the U.S, as can be seen in Figure 4. In general, longer duration of residence in the U.S. was correlated with higher risk of obesity, across gender, ethnicity, and race (see Appendix V). This indicates that societal and environmental factors likely play a significant role in the prevalence of obesity in the U.S.

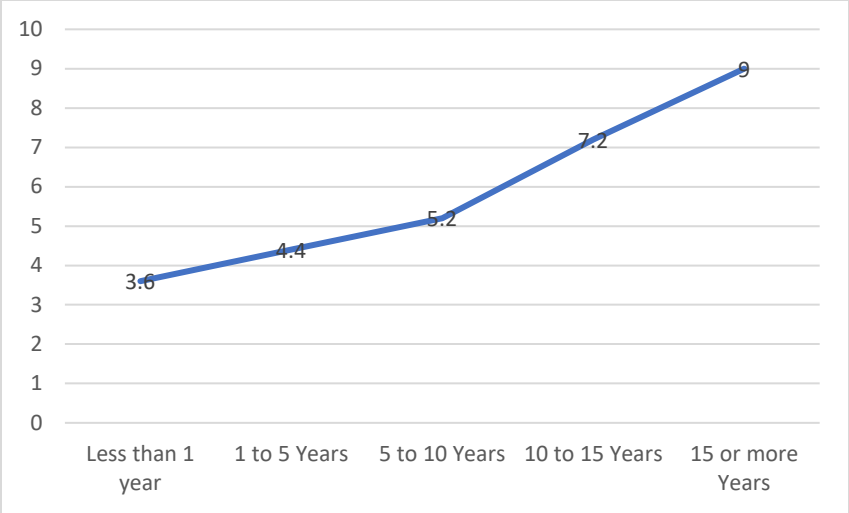


Figure 4. Obesity Prevalence among Foreign-born Asians by Years in U.S. (%).

*Educational Attainment, Poverty, and Food Insecurity*

The relationship between obesity and socio-economic variables, including education, income, and participation in the food stamps program (SNAP), is shown in Table 3. Educational attainment is inversely related to obesity prevalence. Individuals with less than a high school education have the highest prevalence of obesity (29.1%), followed by those with only a high school diploma or a GED (28.7%). Those with Bachelor's and Advanced degrees are much less likely to be obese (20.2% and 18.2%). Compared to people with less than high school education, Bachelor's degree recipients have 0.7 lower odds of being obese, and Advanced degree recipients have 0.6 lower odds of being obese.

Table 3 also shows an inverse relationship between obesity prevalence and total family income. For this analysis, total family income is defined using the national poverty threshold.[23] If the ratio of family income to poverty threshold is less than 1, the category is defined as "Below Poverty Level." The categories "Low Income," "Middle Income," and "High Income,"

[23] This is because the variable for income combines income categories from 1997 and 2007, and there is overlap between the categories; it also does not take inflation into account.

refer to ratios of 1.00 – 1.99, 2.00 – 3.99, and 4.00+ respectively. Obesity prevalence is highest among those living below the poverty threshold, and among those with low incomes (29.4% for both). Individuals in the highest income category have the lowest prevalence of obesity (23.30%).

The Supplemental Nutrition Assistance Program (SNAP), formerly called food stamps, is a program administered by the USDA to help low or no-income families purchase food, and is often used as a proxy for poverty and food insecurity. Participation in this program is highly correlated to increased obesity prevalence: the prevalence of obesity among those receiving food stamps is 36.7%, compared to 23.8% for those not in the program.

**Table 3. Obesity Prevalence by Education, Income, and Food Stamp Receipt (%)**

| | Obesity Prevalence % | Odds Ratio | P-value |
|---|---|---|---|
| **Education** | | | |
| Less than High School | 29.1 | Ref | NA |
| High School Diploma or GED | 28.7 | 0.97 | 0.117 |
| Some College | 27.6 | 0.94 | 0.001 |
| Bachelor's Degree | 20.2 | 0.67 | <0.001 |
| Advanced Degree | 18.2 | 0.56 | <0.001 |
| **Total Family Income** | | | |
| Below Poverty Level<br>Ratio of income to poverty threshold less than 1 | 29.4 | Ref | NA |
| Low Income<br>Ratio of income to poverty threshold 1.00 – 1.99 | 29.4 | 1.12 | <0.001 |
| Middle Income<br>Ratio of income to poverty threshold 2.00 – 3.99 | 28.0 | 1.09 | <0.001 |
| High Income<br>Ratio of income to poverty threshold 4.00 and above | 23.4 | 0.93 | 0.001 |
| **Food Stamps (SNAP)** | | | |
| Received food stamps | 36.7 | 1.50 | <0.001 |
| Did not receive food stamps | 23.8 | Ref | NA |

*Gendered Differences in Obesity Prevalence*

Table 4 shows the results of logistic regression analysis using a pruned set of gender interactions. The first logistic regression model (Appendix VI) assessed the net impact of demographic and socioeconomic variables on the odds of obesity. Further regression analyses included main and interaction effects to test the assumption that the impact of predictor variables on obesity prevalence differed for men and women. The final logistic regression model used here was then modified to exclude variables with insignificant effect.

Controlling for all other variables, the odds of obesity increased by a factor of 1.04 with each passing year. With gender interactions taken into account, the pruned regression model showed that women had 1.3 higher odds than men of being obese; this differs from results in the previous model, which showed that women had 0.9 lower odds. The odds ratios for different age groups reflect the curvilinear relationship between obesity and age. In comparison to 18-29-year-olds, those who were 45 to 60 years old were most likely to be obese (2.2 OR), followed by those who were 30 to 44 years old (1.8 OR).

With Whites as the reference group, all races had statistically significant differences in the odds of obesity. Compared to Whites, African Americans had 1.2 higher odds of being obese, and American Indians had 1.6 higher odds of being obese. Asians had 0.4 lower odds of being obese than Whites. A significant interaction effect was observed for African American women, who had 1.5 higher odds of being obese ($P<0.001$). In terms of ethnicity and citizenship, Hispanic individuals had 1.3 higher odds of being obese than non-Hispanic individuals, while U.S. citizens had 1.7 higher odds of being obese than non-U.S. citizens.

This model supports the notion that educational attainment is inversely related to obesity prevalence. Individuals with Bachelor's or Advanced degrees were much less likely to be obese

than those who had less than high-school-level education (0.7 and 0.6 lower odds, respectively). The association between higher levels of education and lower odds of obesity was slightly less for women. Compared to women without a high school education, women who had a high school diploma or equivalent, women who had some college education, and women who had Bachelor's degrees, all had 0.9 lower odds of being obese ($P<0.05$).

Individuals who belonged to the low-income, middle-income, and high-income categories had higher odds of being obese than individuals living below the poverty threshold (1.2 for low income, 1.3 for middle income, and 1.2 for high income). However, middle- and high-income women were much less likely to be obese. Compared to women living below poverty, women in the middle-income category had 0.8 lower odds of being obese, and women in the high-income category had 0.6 lower odds of being obese. Receipt of food stamps was associated with higher risk of obesity. Those who were received food stamps had 1.2 higher odds of being obese than those who did not receive food stamp. There was a significant interaction effect for gender and food stamps, so that women who received food stamps had 1.3 higher odds of obesity ($P<0.001$). These findings indicate that poverty is strongly correlated with obesity for women.

**Table 4. Logistic regression analysis predicting odds of obesity as function of sociodemographic variables and pruned set of gender interactions**

```
. svy: logistic obesity year female##i.racenew female##educ1 female##povertylevel female##gotstamp i.age_groups
> hispanic citizenship
(running logistic on estimation sample)

Survey: Logistic regression

Number of strata   =     3,176              Number of obs     =       264,358
Number of PSUs     =     6,351              Population size   =  1,986,283,379
                                            Design df         =         3,175
                                            F(  31,    3145)  =        241.27
                                            Prob > F          =        0.0000

------------------------------------------------------------------------------
             |             Linearized
     obesity | Odds Ratio   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |   1.039128   .0017443    22.86   0.000     1.035713    1.042554
      1.female |   1.246082   .0509318     5.38   0.000     1.150116    1.350055
             |
    racenew |
Black/African American |   1.236985   .0308953     8.52   0.000     1.177868     1.29907
American Indian/Alaskan Native |   1.632282   .1566803     5.10   0.000     1.352255    1.970298
Asian |   .3653835   .0224515   -16.39   0.000      .323911     .412166
Other Race |   1.178694   .0647144     2.99   0.003     1.058398    1.312661
             |
female#racenew |
1#Black/African American |   1.480939   .0464228    12.53   0.000     1.392658    1.574816
1#American Indian/Alaskan Native |   .9152218   .1124076    -0.72   0.471     .7193527    1.164423
1#Asian |   .9408783   .0846934    -0.68   0.498     .7886478    1.122493
1#Other Race |   1.029238   .0743635     0.40   0.690     .8932891    1.185876
             |
      educ1 |
HS Dipl or GED |   1.024592   .0263811     0.94   0.345     .9741502    1.077646
Some College |   .9840682    .026277    -0.60   0.548     .9338721    1.036962
Bachelor's Degree |   .7045143   .0218165   -11.31   0.000     .6630112    .7486154
Advanced Degree |   .5681788   .0219813   -14.61   0.000      .526674    .6129545
female#educ1 |
1#HS Dipl or GED |   .8919391    .030757    -3.32   0.001     .8336269    .9543302
1#Some College |   .8983164   .0317546    -3.03   0.002     .8381634    .9627864
1#Bachelor's Degree |   .8674309    .035566    -3.47   0.001     .8004257    .9400453
1#Advanced Degree |   .9433894   .0505139    -1.09   0.277      .849368    1.047819
             |
povertylevel |
Low Income |   1.174466   .0396556     4.76   0.000      1.09923     1.25485
Middle Income |   1.255085   .0405343     7.04   0.000     1.178073    1.337132
High Income |   1.208377   .0398346     5.74   0.000     1.132744    1.289061
             |
female#povertylevel |
1#Low Income |   .9433751   .0397765    -1.38   0.167     .8685216     1.02468
1#Middle Income |   .7987816    .032578    -5.51   0.000     .7373928     .865281
1#High Income |   .6002941    .025019   -12.24   0.000       .55319    .6514093
             |
    gotstamp |
Yes |   1.167912   .0548335     3.31   0.001     1.065199    1.280528
             |
female#gotstamp |
1#Yes |   1.294898   .0695874     4.81   0.000     1.165399    1.438786
             |
  age_groups |
30 to 44 years |   1.812913   .0311121    34.67   0.000     1.752926    1.874953
45 to 60 years |   2.169057   .0395783    42.43   0.000     2.092827    2.248064
61 to 85 years |   1.538251   .0291479    22.73   0.000     1.482149    1.596476
             |
    hispanic |   1.270749    .023551    12.93   0.000     1.225402    1.317775
citizenship |   1.704172   .0441461    20.58   0.000     1.619776    1.792966
       _cons |   4.40e-35   1.48e-34   -23.50   0.000     6.00e-38    3.23e-32
------------------------------------------------------------------------------
Note: _cons estimates baseline odds.
Note: Variance scaled to handle strata with a single sampling unit.
```

Discussion:

This paper corroborates previous studies that have shown a significant association between increased obesity and gender, race, and poverty. While the overall prevalence of obesity has increased since 1997, these increases are not distributed evenly across the population. Certain sub-groups are more likely to suffer from obesity than others. American Indians and African Americans, and Hispanics have higher rates of obesity than Whites and Asians. In fact, Asians have dramatically lower rates of obesity than other racial groups. It would be interesting to further investigate the relationship between obesity and various Asian ethnicities and nationalities.

Low income and lack of education are also correlated with higher obesity. In this paper, food stamps are used as a proxy for poverty and food insecurity. As such, analyses of other governmental aid programs are likely to yield similar results: recipients of these programs will have higher rates of obesity. Gender is a significant moderating factor in the relationship between obesity, race, income, and education. Poverty and lack of resources disproportionately affect women, as can be seen in the high obesity risks for women who receive food stamps, and women with low incomes and educations.

This analysis of obesity prevalence would be strengthened by including factors such as employment status, hours worked, level of stress, health status, occupation, and urban vs. rural residence.

## APPENDIX:

## I. BMI in 4 CDC Categories by Year (%)

| Survey Year | Underweight | Normal | Overweight | Obese |
|---|---|---|---|---|
| **1997** | 2.3 | 42.9 | 35.1 | 19.6 |
| **1998** | 2.2 | 42.3 | 35.3 | 20.1 |
| **1999** | 2.1 | 41.2 | 35.4 | 21.3 |
| **2000** | 2.2 | 41.0 | 35.3 | 21.6 |
| **2001** | 2.0 | 39.8 | 35.5 | 22.7 |
| **2002** | 2.0 | 39.2 | 35.1 | 23.7 |
| **2003** | 1.9 | 38.9 | 35.8 | 23.4 |
| **2004** | 2.0 | 38.6 | 35.2 | 24.3 |
| **2005** | 2.0 | 37.6 | 35.4 | 25.1 |
| **2006** | 1.7 | 37.3 | 34.9 | 26.1 |
| **2007** | 1.8 | 36.6 | 35.3 | 26.4 |
| **2008** | 1.7 | 36.1 | 34.5 | 27.7 |
| **2009** | 1.7 | 34.9 | 35.6 | 27.8 |
| **2010** | 1.7 | 35.5 | 34.5 | 28.3 |
| **2011** | 1.5 | 35.5 | 34.6 | 28.4 |
| **2012** | 1.7 | 34.8 | 34.8 | 28.7 |
| **2013** | 1.8 | 35.0 | 34.4 | 28.9 |
| **2014** | 1.8 | 34.1 | 34.5 | 29.6 |
| **2015** | 1.8 | 34.3 | 33.6 | 30.3 |
| **2016** | 1.9 | 33.0 | 34.9 | 30.3 |
| **Total (mean)** | **1.9** | **37.2** | **35.0** | **26.0** |

## II. BMI Categories by Year and Gender

| | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Under-weight** | **Normal** | **Over-weight** | **Obese** | **Severely Obese** | **Under-weight** | **Normal** | **Over-weight** | **Obese** | **Severely Obese** |
| **1997** | 0.8 | 36.5 | 43.2 | 18.0 | 1.5 | 3.7 | 49.0 | 27.5 | 17.2 | 2.6 |
| **1998** | 0.9 | 35.1 | 43.7 | 19.0 | 1.4 | 3.5 | 49.2 | 27.4 | 17.4 | 2.6 |
| **1999** | 0.8 | 33.8 | 43.4 | 20.3 | 1.7 | 3.4 | 48.2 | 27.9 | 17.5 | 3.1 |
| **2000** | 1.0 | 34.4 | 43.1 | 20.0 | 1.6 | 3.4 | 47.2 | 27.8 | 18.5 | 3.2 |
| **2001** | 0.8 | 32.5 | 43.6 | 21.0 | 2.2 | 3.1 | 46.8 | 27.8 | 19.0 | 3.4 |
| **2002** | 1.0 | 31.4 | 43.1 | 22.5 | 1.9 | 3.0 | 46.7 | 27.4 | 19.0 | 4.0 |
| **2003** | 0.9 | 31.6 | 44.0 | 21.2 | 2.2 | 3.0 | 45.8 | 27.9 | 19.2 | 4.2 |
| **2004** | 1.0 | 31.1 | 43.2 | 22.5 | 2.5 | 2.9 | 45.8 | 27.5 | 19.8 | 4.0 |
| **2005** | 1.1 | 30.1 | 42.7 | 23.4 | 2.3 | 2.8 | 44.3 | 28.4 | 20.4 | 4.2 |
| **2006** | 0.9 | 31.0 | 41.9 | 23.5 | 2.7 | 2.5 | 43.5 | 28.1 | 21.0 | 5.0 |
| **2007** | 0.9 | 29.6 | 42.3 | 24.4 | 2.8 | 2.7 | 43.3 | 28.4 | 20.8 | 4.7 |
| **2008** | 0.9 | 30.1 | 41.5 | 24.3 | 3.2 | 2.4 | 42.0 | 27.7 | 22.5 | 5.4 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **2009** | 0.7 | 28.5 | 42.2 | 25.1 | 3.4 | 2.6 | 41.1 | 29.2 | 21.8 | 5.3 |
| **2010** | 0.9 | 29.3 | 41.0 | 25.8 | 3.0 | 2.5 | 41.4 | 28.3 | 22.3 | 5.5 |
| **2011** | 0.6 | 29.3 | 41.0 | 25.9 | 3.2 | 2.4 | 41.5 | 28.4 | 22.6 | 5.3 |
| **2012** | 1.0 | 27.9 | 42.0 | 26.0 | 3.3 | 2.4 | 41.6 | 27.8 | 22.7 | 5.5 |
| **2013** | 0.9 | 28.7 | 41.0 | 26.2 | 3.4 | 2.7 | 41.1 | 28.1 | 23.0 | 5.3 |
| **2014** | 1.0 | 28.3 | 41.2 | 26.0 | 3.6 | 2.6 | 39.6 | 28.1 | 23.8 | 5.9 |
| **2015** | 1.1 | 28.8 | 39.2 | 27.1 | 3.8 | 2.5 | 39.6 | 28.2 | 23.7 | 6.0 |
| **2016** | 1.2 | 27.5 | 41.1 | 26.4 | 4.0 | 2.5 | 38.3 | 29.0 | 24.5 | 5.8 |

## III. Obesity Prevalence by Year and Race.

| Year | White | Black | American Indian | Asian | Other |
|---|---|---|---|---|---|
| **1999** | 20.5 | 28.6 | 37.0 | 5.6 | 24.4 |
| **2000** | 20.7 | 30.1 | 41.2 | 6.5 | 25.9 |
| **2001** | 21.9 | 32.5 | 28.7 | 6.9 | 25.0 |
| **2002** | 22.6 | 35.1 | 31.0 | 7.1 | 26.5 |
| **2003** | 22.6 | 34.1 | 33.3 | 6.0 | 26.9 |
| **2004** | 23.5 | 34.0 | 35.2 | 6.9 | 27.2 |
| **2005** | 24.6 | 32.9 | 38.3 | 8.7 | 35.6 |
| **2006** | 25.7 | 35.1 | 29.7 | 8.6 | 25.3 |
| **2007** | 25.8 | 35.8 | 33.1 | 9.4 | 30.2 |
| **2008** | 27.2 | 36.5 | 44.0 | 9.4 | 33.0 |
| **2009** | 27.2 | 38.1 | 34.5 | 9.3 | 30.4 |
| **2010** | 27.6 | 37.7 | 43.3 | 11.8 | 37.6 |
| **2011** | 27.8 | 39.4 | 41.1 | 9.4 | 33.0 |
| **2012** | 28.6 | 37.4 | 42.4 | 9.9 | 26.9 |
| **2013** | 28.5 | 37.3 | 47.1 | 10.9 | 32.5 |
| **2014** | 29.0 | 40.8 | 43.6 | 11.3 | 30.1 |
| **2015** | 29.9 | 40.0 | 42.9 | 10.9 | 35.7 |
| **2016** | 30.1 | 40.5 | 40.7 | 9.5 | 31.8 |

## IV. Obesity Prevalence by Birthplace, Gender, Race, and Ethnicity (%)

| | Not born in U.S. or U.S. Territories | Born in U.S. or U.S. Territories |
|---|---|---|
| **ALL** | 19.2 | 27.2 |
| **Gender** | | |
| **Male** | 18.7 | 27.7 |
| **Female** | 19.7 | 26.6 |
| **Race** | | |
| **White** | 23.1 | 26.3 |
| **Black** | 23.2 | 38.0 |
| **American Indian** | 27.6 | 41.5 |
| **Asian** | 7.4 | 15.7 |
| **Other** | 23.0 | 31.2 |
| **Ethnicity** | | |
| **Non-Hispanic** | 14.0 | 26.7 |
| **Hispanic** | 25.0 | 33.4 |

## V. Obesity Prevalence by Years in U.S., Gender, Race, and Ethnicity (%)

| | Less than 1 year | 1 to 5 Years | 5 to 10 Years | 10 to 15 Years | 15 or more Years |
|---|---|---|---|---|---|
| **ALL** | 7.4 | 11.2 | 14.6 | 18.4 | 23.0 |
| **Gender** | | | | | |
| **Male** | 6.3 | 10.0 | 14.1 | 18.1 | 22.7 |
| **Female** | 8.7 | 12.5 | 15.0 | 18.7 | 23.3 |
| **Race** | | | | | |
| **White** | 8.4 | 13.8 | 18.2 | 21.8 | 27.0 |
| **Black** | 15.4 | 14.8 | 16.7 | 22.4 | 27.7 |
| **American Indian** | 0 (no obs) | 15.3 | 11.7 | 26.6 | 34 |
| **Asian** | 3.6 | 4.4 | 5.2 | 7.2 | 9.0 |
| **Other** | 12.4 | 16.4 | 15.4 | 22.3 | 27.4 |
| **Ethnicity** | | | | | |
| **Non-Hispanic** | 6.1 | 8.3 | 9.7 | 12.4 | 16.8 |
| **Hispanic** | 9.2 | 15.0 | 19.1 | 23.5 | 30.0 |

## VI. Logistic regression analysis predicting odds of obesity, as a function of time, gender, age, race, ethnicity, citizenship, education, poverty level, and food stamp receipt

| obesity | Odds Ratio | Linearized Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| year | 1.038428 | .0017348 | 22.57 | 0.000 | 1.035033 | 1.041836 |
| female | .9189625 | .0104678 | -7.42 | 0.000 | .8986656 | .9397177 |
| age_groups | | | | | | |
| 30 to 44 years | 1.808432 | .030974 | 34.59 | 0.000 | 1.748709 | 1.870195 |
| 45 to 60 years | 2.159788 | .0392787 | 42.34 | 0.000 | 2.084131 | 2.238192 |
| 61 to 85 years | 1.549542 | .0292001 | 23.24 | 0.000 | 1.493333 | 1.607865 |
| racenew | | | | | | |
| Black/African American | 1.541301 | .0248948 | 26.79 | 0.000 | 1.493254 | 1.590894 |
| American Indian/Alaskan Native | 1.549297 | .1015431 | 6.68 | 0.000 | 1.362463 | 1.761753 |
| Asian | .3553153 | .0162098 | -22.68 | 0.000 | .3249126 | .3885628 |
| Other Race | 1.191442 | .0451035 | 4.63 | 0.000 | 1.10621 | 1.283242 |
| hispanic | 1.272157 | .0235102 | 13.03 | 0.000 | 1.226885 | 1.319099 |
| citizenship | 1.7183 | .0444915 | 20.91 | 0.000 | 1.633242 | 1.807787 |
| educ1 | | | | | | |
| HS Dipl or GED | .9732182 | .0168723 | -1.57 | 0.117 | .9406923 | 1.006869 |
| Some College | .9415273 | .0168898 | -3.36 | 0.001 | .9089868 | .9752326 |
| Bachelor's Degree | .6646811 | .0147328 | -18.43 | 0.000 | .636413 | .6942049 |
| Advanced Degree | .5583661 | .0150947 | -21.56 | 0.000 | .5295405 | .5887609 |
| povertylevel | | | | | | |
| Low Income | 1.123924 | .0230464 | 5.70 | 0.000 | 1.079633 | 1.170032 |
| Middle Income | 1.096987 | .022809 | 4.45 | 0.000 | 1.053165 | 1.142634 |
| High Income | .9310218 | .0203917 | -3.26 | 0.001 | .8918858 | .971875 |
| gotstamp | 1.49998 | .0363516 | 16.73 | 0.000 | 1.430372 | 1.572976 |
| _cons | 1.32e-34 | 4.43e-34 | -23.29 | 0.000 | 1.86e-37 | 9.40e-32 |

Note: _cons estimates baseline odds.
Note: Variance scaled to handle strata with a single sampling unit.