# Trends and Subgroup Comparisons of Obesity and Severe Obesity Prevalence among Mississippi Adults, 2011-2021

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*Article*

# Trends and Subgroup Comparisons of Obesity and Severe Obesity Prevalence among Mississippi Adults, 2011–2021

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**Abstract:** Mississippi has long been one of the most obese states in the U.S., with its obesity rates consistently exceeding the national average. The state's severe obesity rate is also among the highest in the nation. This study utilized the 2011 to 2021 data from the Mississippi Behavioral Risk Factor Surveillance System (BRFSS) to conduct a comprehensive analysis of obesity and severe obesity trends in Mississippi by sex, age, and race and ethnicity. The data set included a BMI variable calculated by using self-reported height and weight, which the authors categorized into two obesity classification groups: obesity (BMI: 30.00 to 39.99) and severe obesity (BMI: 40.00 or greater), and demographic characteristics such as sex, age, race and ethnicity. The data were analyzed using SAS 9.4 software to account for the complex design. Weighted prevalence estimates and associated standard errors (SEs) for obesity and severe obesity were calculated. Changes in the prevalence over time were assessed using logistic regression models. The prevalence estimates and SEs were exported to Joinpoint software to calculate the annual percentage change (APC) and associated 95% confidence intervals (CIs) and p-values for the trends. Our analysis of the data revealed a consistent increase in severe obesity, regardless of age, race, or race. A concerning trend exists where individuals are moving from the obese category to the severely obese category, indicating a worsening trend in overall weight status. This is likely to accelerate the development of chronic disease and, hence, place additional strain on an economically disadvantaged state. Future research should explore the underlying drivers of this shift, including biological, behavioral, and socioeconomic factors, while also evaluating the effectiveness of existing obesity prevention and treatment programs.

**Keywords:** BRFSS; prevalence; obesity; severe obesity; trend

## 1. Introduction

The prevalence of obesity, as estimated by a body mass index (BMI) greater than or equal to 30.0, has been escalating worldwide since the 1970s [1], and more than 650 million adults aged 18 years and older were obese in 2022 [2]. According to 2017-2018 data from the National Health and Nutrition Examination Survey (NHANES) [3], more than two in five adults aged 20 years or older (42.4%) in the United States (U.S.) were obese. Mississippi has been considered one of the most obese states in the U.S., and its obesity rates have consistently exceeded the national average since 1990, with the gap widening each year [4]. Based on the 2021 annual report by Trust for America's Health, 72.8% of Mississippians aged 20 years or older were either overweight or obese, which was the highest state-

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level prevalence in the nation. Additionally, Mississippi had the highest self-reported rate of severe obesity (BMI ≥ 40) in the nation, at 7.8% [5].

Research has established that race, sex, and age are risk factors for obesity [6–9]. NHANES 2017-March 2020 data suggested that non-Hispanic Black adults endured the highest prevalence of obesity at 49.9%, followed by Hispanic adults at 45.6%, non-Hispanic white adults at 41.4%, and non-Hispanic Asian adults at 16.1% [10]. Though the obesity rates for both men and women were 41.8%, more women (11.7%) than men (6.6%) had severe obesity [10]. Furthermore, non-Hispanic Black women had the highest obesity rate (57.9%), followed by Hispanic women (45.7%), non-Hispanic white women (39.6%), and non-Hispanic Asian women (14.5%). Hispanic men had the highest obesity rate (45.2%), followed by non-Hispanic white men (43.1%), non-Hispanic Black men (40.4%), and non-Hispanic Asian men (17.6%) [10]. The same data also showed that the prevalence of obesity increased with age among adults aged 20 to 59 years; the prevalence was 39.8% for those aged 20 to 39 years and 44.3% for those aged 40 to 59 years. However, the prevalence decreased among adults aged 60 years or older (41.5%) [10]. In Mississippi, the disparities among different racial, sex, and age groups were notably amplified. In 2020, the obesity rate among non-Hispanic Black adults was 48.0% compared to 34.5% among non-Hispanic white adults. Nearly 43% of women were obese compared to 36.4% of men. Adults aged 45-64 years had the highest percentage of obesity (46.4%), followed by adults aged 18 to 44 years (38.0%), and adults aged 65 years and older (33.6%) [4].

Obesity is associated with increased risk for mortality and many health conditions, such as cardiovascular disease, type 2 diabetes mellitus, hypertension, stroke, certain cancers, kidney disease, liver disease, gall bladder disease, gynecological disease, among others [1,11]. Being obese may also catalyze the development of psychological and behavioral comorbidities such as depression, sleep apnea, and disordered eating [12–15]. In addition to the comorbid health conditions, obesity is linked to socioeconomic factors such as income, education, food security, and access to health care [16–18]. The U.S. Census Bureau 2020 data showed that Mississippi's population was comprised as follows: 58.8% white, 38% Black, 3.5% Hispanic, 1.8% Asian, American Indian and Alaska Native, Native Hawaiian and other Pacific Islander, and 1.4% “two or more races” [19]. The state is predominantly rural, as 65 (79.3%) of 82 counties are considered rural [20]. The poverty rate was higher than the national average (19.4% vs. 11.6%, respectively), and the median income was $25,444 compared to the national median of $71,186 [19,21,22]. Mississippi also had lower educational completion rates compared to the nation, with a high school completion rate of 85.3% compared to 91.1% for the nation and a Bachelor’s degree or higher completion rate of 22.8% compared to 37.9% for the nation [19,23]. More than 15% of households in Mississippi faced food insecurity compared to the national average of 10.7% in 2020 [24]. Meanwhile, 13% of Mississippians were not covered by private or public health insurance, which was higher than the 9.2% national average [25]. The combination of low socio-economic status and high prevalence of comorbid conditions undoubtedly exacerbates the overall health challenges faced by Mississippians.

This study utilized data from the Mississippi Behavioral Risk Factor Surveillance System (BRFSS), which is a telephone survey that collects health-related data from non-institutionalized adults aged 18 years and older in each of the 50 states, as well as the District of Columbia and three territories [26]. The BRFSS is conducted through a cooperative agreement between the Centers for Disease Control and Prevention (CDC) and the Mississippi State Department of Health (MSDH) (MSDH, n.d.). It collects data related to health-related risk behaviors, chronic health conditions, and the use of preventive services from eligible respondents [26]. Since 2011, CDC has used a weighting methodology called iterative proportional fitting, or “raking” to weight BRFSS data [27]. Raking incorporates cellular telephone survey data and allows for the inclusion of additional demographic characteristics in the weighting process to ensure that sample estimates are representative of the sociodemographic distribution of individual states [27]. Because of the change in methodology, the CDC recommends against direct comparison of 2011 or later BRFSS data to 2010 or older BRFSS data [28]. This research aims to conduct a comprehensive analysis of obesity and severe obesity trends in Mississippi by sex, age, and race and ethnicity, utilizing 2011 to 2021 MS BRFSS data. The ultimate

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goal is to provide insights that can inform policy recommendations and contribute to the state's ongoing initiatives for sustainable obesity prevention.

## 2. Materials and Methods

The current study drew inspiration from a 2017 article published by Mendy et al. [29], which analyzed overweight, obesity, and extreme obesity among Mississippi adults from 2001 to 2010 and 2011 to 2015. The Mendy study utilized Joinpoint software to calculate the annual percentage change (APC) in the prevalence of each level of overweight and obesity, both overall and by demographic subgroups. The current study applies the general analytical approach to obesity data collected from Mississippi adults from 2011 to 2021.

*Data Source*

The Mississippi BRFSS data from the 2011 to 2021 surveys were analyzed. The analyses were limited to respondents who reported their race/ethnicity as non-Hispanic (NH) Black or NH White due to low sample sizes for respondents of other racial/ethnic groups. In Mississippi, these two groups account for approximately 94% of the state's population (U.S. Census Bureau, n.d.). In addition to respondents of other races, women who reported being pregnant at the time of interview and respondents who did not provide their height or weight, sex, race or ethnicity, age, highest level of education, or annual household income were also excluded from the analysis. The total combined number of records in the 2011 to 2021 data sets that were utilized for original weighting and variance calculation in this study was 66,468. However, after applying the exclusion criteria, 59,780 records were remaining for inclusion in the trend analysis. Exclusions were based on pregnancy status (excluding pregnant women), race/ethnicity (excluding individuals who were not non-Hispanic White or non-Hispanic Black), and missing data on BMI, sex, race/ethnicity, age, education, or household income.

*Variables of Interest*

Obesity classification was the dependent variable. The BRFSS data set included a BMI variable calculated by the CDC using the respondents' self-reported height and weight, which the authors categorized into two obesity classification groups: obesity (BMI: 30.00 to 39.99) and severe obesity (BMI: 40.00 or greater) [30].

The demographic characteristics sex, age, race and ethnicity, and race by sex were the independent variables in this study. Two self-reported sexes were included in the current study: male and female. Self-reported age was categorized into four groups: 18 to 34 years, 35 to 49 years, 50 to 64 years, and 65 years or older. Only two race/ethnicity groups were included in the current study: NH White and NH Black. Self-reported race/ethnicity and sex groups were combined to create four race-by-sex groups: NH White male, NH White female, NH Black male, and NH Black female.

*Statistical Analysis*

The data were analyzed using SAS 9.4 software (SAS Institute, Inc.). Mississippi BRFSS data sets for the 2011 to 2021 survey years were weighted to represent the state population aged 18 years and older based on the current methodology recommended by the CDC [28]. Changes in the prevalence of overweight and obesity over time were assessed using logistic regression models that controlled for age, race and ethnicity, sex, education, and household income.

Weighted prevalence estimates and associated standard errors (SEs) for obesity and severe obesity were calculated for each survey year and for each of the selected demographic characteristics. If the number of cases (numerator) for a particular group was less than 50, the relative standard error (RSE) was calculated. RSE is calculated by dividing the SE by the mean [31]. Per CDC recommendation, percentage estimates were not reported if the RSE was greater than 30% or if the denominator represented fewer than 50 unweighted responses [31]. To determine whether there were

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changes in trend, the prevalence estimates and SEs were exported to Joinpoint software (Version 4.9.1.0, US Surveillance, Epidemiology, and End Results Program) to calculate the APC and associated 95% confidence intervals (CIs) and P values. An APC was determined to be significantly different from 0 if the associated P-value was less than 0.05.

## 3. Results

*Overall Findings*

The entire combined sample of 2011 to 2021 data, including respondents who were not included in the analysis due to exclusion criteria, consisted of 66,468 respondents (Table 1). Of these, 31.1% were aged 18-34 years, 59.0% were NH White, and 52.2% were female.

**Table 1.** Sociodemographic Characteristics of Mississippi Adults, Behavioral Risk Factor Surveillance System, 2011–2021 (*n* = 66,468).

| Characteristics | Weighted % (95% CI ) |
|---|---|
| **Age group, y**ears | |
| 18-34 | 31.1 (30.5 - 31.7) |
| 35-49 | 23.8 (23.3 - 24.2) |
| 50 -64 | 25.2 (24.8 - 25.6) |
| ≥65 | 20.0 (19.7 - 20.3) |
| **Race** | |
| White | 59.0 (58.4 - 59.5) |
| Black | 35.5 (35.0 - 36.1) |
| **Sex** | |
| Male | 47.8 (47.3 - 48.3) |
| Female | 52.2 (51.7 - 52.7) |
| **Annual household income, $** | |
| <15,000 | 14.0 (13.6 - 14.4) |
| 15,000-24,999 | 19.3 (18.9 - 19.7) |
| 25,000-34,999 | 10.8 (10.4 - 11.1) |
| 35,000-49,999 | 11.4 (11.1 - 11.7) |
| 50,000-74,999 | 11.2 (10.9 - 11.5) |
| ≥75,000 | 16.5 (16.1 - 16.9) |
| Refused/Don't know/Missing | 16.8 (16.4 - 17.2) |
| **Education level** | |
| <High school graduate | 18.0 (17.6 - 18.5) |
| High school graduate or equivalent | 30.4 (29.9 - 30.8) |
| Attended college or technical school | 33.0 (32.5 - 33.5) |
| Graduated from college or technical school | 18.6 (18.2 - 18.9) |

From 2011 to 2021, there were significant increases in the prevalence of obesity (APC, 1.3%, p = 0.0013) and severe obesity (APC, 4.8%, p < 0.0001) (Table 2). There were no directional changes in overall prevalence trends for either of the obese groups.

*Sex*

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Among men (Table 2), there was a non-significant increase in obesity (APC, 0.8%, p = 0.0710) and a significant increase in severe obesity (APC, 3.6%, p = 0.0011). Among women, there were significant increases in both obesity (APC, 1.4%, p = 0.0154) and severe obesity (APC, 5.4%, p < 0.0001).

*Race/Ethnicity*

From 2011 to 2021, both the NH Black and NH White groups (Table 2) experienced significant increases in severe obesity prevalence (NH Black APC: 4.1%, p = 0.0009; NH White APC: 5.5%, p < 0.0001). However, the NH Black group had a non-significant increase in obesity prevalence (APC 0.6%, p = 0.1030), while the NH White group had a significant increase in obesity prevalence (APC, 1.8%, p = 0.0012).

*Age*

Among both the 18–34 years and 35-49 years age groups (Table 3), there were non-significant increases in obesity (18-34 years APC: 0.6%, p = 0.3172; 35-49 years APC: 0.9%, p = 0.1576) and significant increases in severe obesity (18-34 years APC: 5.5%, p = 0.0051; 35-49 years APC: 4.3%, p = 0.0011).

Among respondents aged 50–64 years, there was a significant increase in severe obesity (APC, 4.9%, p = 0.001). For obesity, there was a non-significant decrease from 2011 to 2015 (APC, -1.8%, p = 0.2568) but a significant increase from 2016 to 2021 (APC, 4.7%, p = 0.0011).

Among respondents aged 65 years and older, there were significant increases in both obesity (APC, 1.8%, p = 0.0018) and severe obesity (APC, 3.4%, p = 0.0193).

*Race/Ethnicity and Sex*

Among both White men and Black men (Table 4), there were significant increases in obesity (White APC: 1.4%, p = 0.0120; Black APC: 1.9%, p = 0.0050) and severe obesity (White APC: 4.6%, p = 0.0032; Black APC: 5.5%, p = 0.0017).

Both White women and Black women (Table 4) experienced non-significant increases in obesity prevalence (White women APC: 0.3%, p =0.6601; Black women APC: 0.8%, P = 0.1600). However, although both White- and Black women had increases in severe obesity, the increase was non-significant among White women (APC: 1.4%, p = 0.4314) and significant among Black women (4.5%, p = 0.0008).

**Table 2.** Adjusted Prevalence of Obesity and Severe Obesity Among Mississippi Adults Overall, by Sex, and by Race, 2011–2021[a.]

| **Weight Status** | **Adjusted Prevalence, %** | | | | | | | | | | | **Trends Determined by Joinpoint Analysis** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **APC[e] (95% CI)** | **P-value** |
| **Sample size, *n*** | 8,148 | 7,112 | 6,741 | 3,823 | 5,506 | 4,602 | 4,402 | 5,227 | 4,517 | 5,809 | 3,893 | | |
| **Overall[b]** | | | | | | | | | | | | | |
| Obesity | 28.8 | 29.1 | 29.1 | 29.8 | 28.4 | 30.7 | 30.1 | 32.0 | 33.4 | 32.0 | 31.2 | 1.3 (0.7 to 2.0) | 0.0013 |
| Severe Obesity | 6.1 | 5.6 | 6.0 | 6.3 | 7.3 | 6.9 | 7.6 | 8.1 | 8.3 | 8.3 | 9.3 | 4.8 (3.8 to 5.9) | <0.0001 |
| **Sex[c]** | | | | | | | | | | | | | |
| **Male** | | | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Obesity | 28.2 | 28.3 | 29.5 | 29.5 | 29.6 | 31.3 | 30.5 | 31.0 | 31.9 | 30.9 | 31.0 | 0.8 (-0.1 to 1.8) | 0.0710 |
| Severe Obesity | 4.2 | 4.0 | 4.8 | 4.4 | 4.6 | 4.4 | 5.9 | 5.6 | 5.5 | 5.2 | 6.2 | 3.6 (1.9 to 5.4) | 0.0011 |
| **Female** | | | | | | | | | | | | | |
| Obesity | 29.5 | 30.0 | 29.0 | 29.8 | 27.1 | 30.0 | 29.5 | 32.9 | 34.7 | 33.2 | 31.5 | 1.4 (0.35 to 2.55) | 0.0154 |
| Severe Obesity | 7.9 | 7.0 | 7.2 | 8.1 | 9.9 | 9.2 | 9.4 | 10.5 | 10.8 | 11.3 | 12.4 | 5.4 (3.9 to 6.9) | <0.0001 |
| | | | | | | **Race[d]** | | | | | | | |
| **Black** | | | | | | | | | | | | | |
| Obesity | 34.0 | 35.4 | 33.8 | 33.5 | 31.9 | 35.9 | 34.5 | 35.7 | 35.3 | 36.3 | 35.2 | 0.6 (-0.1 to 1.2) | 0.1030 |
| Severe Obesity | 9.4 | 7.7 | 8.9 | 9.3 | 11.9 | 10.5 | 11.1 | 10.5 | 11.3 | 12.6 | 13.1 | 4.1 (2.2 to 6.1) | 0.0009 |
| **White** | | | | | | | | | | | | | |
| Obesity | 25.8 | 25.5 | 26.4 | 27.7 | 26.4 | 27.5 | 27.4 | 29.8 | 32.1 | 29.6 | 28.7 | 1.8 (0.9 to 2.7) | 0.0012 |
| Severe Obesity | 4.1 | 4.3 | 4.3 | 4.6 | 4.6 | 4.8 | 5.6 | 6.7 | 6.4 | 5.8 | 7.1 | 5.5 (3.8 to 7.3) | <0.0001 |

Abbreviations: APC, annual percentage change; CI, confidence interval. [a] Body mass index (BMI) is defined as a person's weight in kilograms divided by the square of their height in meters. Obesity is BMI ≥30.0. Extreme obesity is BMI ≥40.0. Pregnant women were excluded from the analysis. [b] Adjusted for age, race, sex, annual household income, and education. [c] Adjusted for age, race, annual household income, and education. [d] Adjusted for age, sex, annual household income, and education. [e] APC is significantly different from 0 if the p-value ≤ 0.05.

**Table 3.** Adjusted Prevalence of Obesity and Severe Obesity Among Mississippi Adults by Age Group, 2011–2021[a].

| **Weight Status** | **Adjusted Prevalence, %[b]** | | | | | | | | | | | **Trends Determined by Joinpoint Analysis** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **APC[c] (95% CI)** | **P-value** |
| **Sample size, *n*** | 8,148 | 7,112 | 6,741 | 3,823 | 5,506 | 4,602 | 4,402 | 5,227 | 4,517 | 5,809 | 3,893 | | |
| | | | | | | **Age Group** | | | | | | | |
| **18 - 34** | | | | | | | | | | | | | |
| **Obesity** | 25.0 | 26.0 | 23.1 | 28.5 | 24.7 | 27.0 | 25.0 | 27.8 | 25.9 | 26.8 | 25.4 | 0.6 (-0.6 to 1.7) | 0.3172 |
| **Severe Obesity** | 5.9 | 4.6 | 6.4 | 5.3 | 7.2 | 4.5 | 8.5 | 7.7 | 7.5 | 8.6 | 9.4 | 5.5 (2.1 to 9.0) | 0.0051 |
| **35 - 49** | | | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Obesity** | 31.9 | 32.1 | 34.8 | 34.4 | 33.6 | 36.6 | 32.7 | 35.6 | 39.1 | 33.4 | 33.1 | 0.9 (-0.4 to 2.1) | 0.1576 |
| **Severe Obesity** | 8.5 | 8.3 | 7.4 | 9.7 | 9.9 | 11.5 | 9.4 | 10.1 | 10.2 | 11.9 | 13.4 | 4.3 (2.2 to 6.4) | 0.0011 |
| **50 - 64** | | | | | | | | | | | | | |
| **Obesity** | 33.0 | 32.2 | 33.3 | 30.4 | 29.3 | | | | | | | -1.8 (-5.2 to 1.7) | 0.2568 |
| **Obesity** | | | | | | 32.8 | 34.4 | 36.7 | 37.4 | 39.7 | 38.3 | 4.7 (2.7 to 6.8) | 0.0011 |
| **Severe Obesity** | 6.7 | 6.0 | 6.9 | 7.0 | 7.5 | 7.7 | 8.1 | 9.7 | 10.8 | 7.8 | 10.5 | 4.9 (2.5 to 7.4) | 0.0011 |
| **65 and older** | | | | | | | | | | | | | |
| **Obesity** | 25.3 | 26.0 | 25.9 | 25.9 | 26.7 | 27.0 | 29.2 | 28.3 | 32.1 | 29.1 | 28.3 | 1.8 (0.9 to 2.8) | 0.0018 |
| **Severe Obesity** | 2.9 | 3.5 | 2.7 | 3.2 | 4.2 | 3.8 | 3.9 | 4.3 | 4.1 | 4.3 | 3.6 | 3.4 (0.7 to 6.2) | 0.0193 |

Abbreviations: APC, annual percentage change; CI, confidence interval. [a] Body mass index (BMI) is defined as a person's weight in kilograms divided by the square of their height in meters. Obesity is BMI ≥30.0. Extreme obesity is BMI ≥40.0. Pregnant women were excluded from the analysis. [b] Adjusted for race, sex, annual household income, and education. [c] APC is significantly different from 0 if the p-value ≤ 0.05. .

**Table 4.** Adjusted Prevalence of Obesity and Severe Obesity Among Mississippi Adults by Sex and Race, 2011–2021[a].

| **Weight Status** | **Adjusted Prevalence, %[b]** | | | | | | | | | | | **Trends Determined by Joinpoint Analysis** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **APC[c] (95% CI)** | **P-value** |
| **Sample size, *n*** | 8,148 | 7,112 | 6,741 | 3,823 | 5,506 | 4,602 | 4,402 | 5,227 | 4,517 | 5,809 | 3,893 | | |
| **Sex and Race** | | | | | | | | | | | | | |
| **White male** | | | | | | | | | | | | | |
| Obesity | 28.5 | 26.1 | 28.5 | 30.4 | 29.5 | 29.6 | 28.6 | 31.5 | 33.5 | 31.4 | 29.8 | 1.4 (0.4 to 2.5) | 0.0120 |
| Severe Obesity | 3.0 | 4.1 | 4.6 | 4.2 | 3.7 | 4.3 | 5.1 | 5.3 | 5.3 | 4.7 | 5.6 | 4.6 (2.0 to 7.3) | 0.0032 |
| **White female** | | | | | | | | | | | | | |
| Obesity | 27.6 | 32.7 | 31.2 | 28.5 | 29.5 | 34.2 | 33.6 | 30.6 | 28.6 | 30.0 | 32.7 | 0.3 (-1.3 to 1.9) | 0.6601 |
| Severe Obesity | 6.7 | 4.2 | 5.3 | 4.9 | 6.3 | 4.5 | 7.1 | 5.9 | 5.4 | 5.8 | 6.9 | 1.4 (-2.3 to 5.2) | 0.4314 |
| **Black male** | | | | | | | | | | | | | |
| Obesity | 23.6 | 25.2 | 24.7 | 24.8 | 23.0 | 25.7 | 25.7 | 28.2 | 30.3 | 27.3 | 27.4 | 1.9 (0.7 to 3.1) | 0.0050 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Severe Obesity | 5.4 | 4.7 | 4.2 | 4.9 | 5.4 | 5.3 | 6.0 | 8.0 | 7.1 | 6.5 | 8.3 | 5.5 (2.6 to 8.4) | 0.0017 |
| **Black female** | | | | | | | | | | | | | |
| Obesity | 39.0 | 37.7 | 36.0 | 37.9 | 33.7 | 37.5 | 35.3 | 39.9 | 41.0 | 41.8 | 37.7 | 0.8 (-0.4 to 2.0) | 0.1600 |
| Severe Obesity | 12.1 | 10.9 | 12.1 | 13.4 | 16.8 | 15.6 | 14.1 | 14.3 | 16.2 | 18.2 | 17.7 | 4.5 (2.4 to 6.6) | 0.0008 |

Abbreviations: APC, annual percentage change; CI, confidence interval. [a] Body mass index (BMI) is defined as a person's weight in kilograms divided by the square of their height in meters. Overweight is BMI ≥25.0 and <30.0. Obesity is BMI ≥ 30.0. Extreme obesity is BMI ≥ 40.0. Pregnant women were excluded from the analysis. [b] Adjusted for age, annual household income, and education. [c] APC is significantly different from 0 if the p-value ≤ 0.05.

## 4. Discussion

Our analysis of the data revealed a consistent increase in severe obesity, regardless of age, race, or race with sex with one notable exception: white women. Some increases were as high as two- to three-fold differences over the obesity categories. Significant increases were observed in seven demographic areas (the entire population, female only, ages 50-34 years [2016–2021], 65+ years, non-Hispanic white, white male, and Black male). However, no significant changes were revealed in six demographic subdivisions, including overall male, younger Mississippians, non-Hispanic Black adults, and white and Black women. All categories of obesity showed modest increases of less than 2% annually, while the severe obesity BMI increases were all 3.4% or higher. This suggests that while some groups may show slight improvements in obesity rates, a concerning trend exists where individuals are moving from the obese category to the severely obese category, indicating a worsening trend in overall weight status. Meanwhile, the consistent upward trend in BMI across all sexes, ages, and races/ethnicities should be a major concern.

The data highlighted a disparity between severely obese Black and white adults. Black women in the obese category showed no significant increases, but there was a notable 4.5% rise in the severely obese category. In contrast, white women's rates in both obese and severely obese remained stable. Such findings suggest further investigation is needed to understand why severely obese Black women are progressing to higher BMI categories and contributing to a widening gap in the female population of Mississippi.

Interestingly, when analyzing males as a collective group, there is no significant change in the obesity category. However, when race and sex were considered jointly, both white and Black males showed significant increases in obesity, with annual rises of 1.4% and 1.9%, respectively.

We propose that the reasons for the increase in severe obesity are multi-factorial. Once a person reaches a certain level of BMI, physical activity tends to decrease, and social stigma may discourage them from seeking help [32–34]. Furthermore, individuals in the severe obesity category often face higher comorbidities such as depression, sleep apnea, and disordered eating behaviors [35–37]. These comorbidities complicate efforts to reduce BMI and further elevate health risks. At first glance, one could perceive that the obesity group is improving in Mississippi; however, rather than moving toward healthier weight status, many individuals appear to be progressing toward more extreme levels of obesity. From this data, a clear target group can be identified that needs enhanced emphasis in Mississippi; the severely obese population is the most profound concern. Addressing this group is essential for achieving meaningful improvements in public health across the state.

Future scientific studies should explore whether increased body fat triggers chemical behaviors in the body that contribute to an increase in BMI [38,39]. While obesity is often framed as a behavioral issue, biological factors combined with socioeconomic influences may play a significant role in perpetuating poor health outcomes [40,41]. Understanding these interactions could inform more effective interventions.

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Mississippi faces unique challenges that exacerbate obesity rates, including a higher poverty rate, lower educational attainment, food insecurity, and lower rates of health insurance coverage compared to the national average [42–46]. These socioeconomic disparities have a profound impact on the overall health of the state. This analysis indicates that the trend is moving more negatively for those Mississippians already in the unhealthiest groups and that the most vulnerable subpopulations are experiencing the most negative trends. Without a focused and strategic effort, the prevalence of obesity-related diseases and complications will continue to rise, placing an increasing burden on the healthcare system. With the ever-rising cost of healthcare associated with obesity-related conditions, such as cardiovascular and renal complications, the promotion of healthy lifestyles through targeted interventions for high-risk populations is vital to improving overall health in Mississippi. However, implementing such strategies is particularly challenging given the state's rural landscape, educational barriers, and widespread food insecurity. To create meaningful change, Mississippi must prioritize policies that encourage healthier living and provide education on proper nutrition. Efforts should be concentrated on reaching the most vulnerable individuals and implementing evidence-based programs specifically designed to address severe obesity.

Limitations of this study must be acknowledged. BRFSS is not a longitudinal study, meaning it does not track the same individuals over a period of time. While this study includes data from a full-year survey, there is variability in participant composition across years, which may influence trend interpretation. As stated earlier, due to methodological changes, the data trends can only be analyzed from 2011 to later years, which prevents direct comparisons to data collected before 2011, thereby limiting the ability to assess long-term patterns. Additionally, because the BRFSS is a self-reported study, limitations may exist due to social desirability bias. BMI is derived from the height and weight of the individual. These parameters are sensitive areas for many individuals, and a participant may have reported a more socially desirable measurement when self-reporting. By recognizing these limitations and addressing the severe obesity crisis through targeted interventions, Mississippi can work toward reversing these concerning trends and improving public health outcomes.

## 5. Conclusions

This study used MS BRFSS data to examine obesity and severe obesity trends in Mississippi from 2011 to 2021 by sex, age, and race. The findings revealed a significant increase in the prevalence of severe obesity across all demographic groups, irrespective of age, race, or sex, with the exception of white women. While specific subgroups within the obesity category showed a downward trend, this may not signify an improvement in BMI but rather a shift of individuals from the obesity category to the severe obesity category. These trends carry significant implications for public health, particularly given the well-documented associations between severe obesity and a higher risk of comorbidities, including cardiovascular disease, diabetes, and certain cancers. The rising prevalence of severe obesity is also likely to exacerbate healthcare costs in Mississippi, placing additional strain on an economically disadvantaged state. Addressing this growing crisis requires targeted public health interventions and policies aimed at prevention and early interventions. Future research should explore the underlying drivers of this shift, including biological, behavioral, and socioeconomic factors, while also evaluating the effectiveness of existing obesity prevention and treatment programs. By identifying challenges and implementing evidence-based interventions, policymakers and healthcare providers can work toward improving health outcomes, reducing disparities, and alleviating the long-term economic and medical consequences of severe obesity in Mississippi.

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**Data Availability Statement:** The data used and analyzed during the current study are available from the corresponding author upon reasonable request.

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