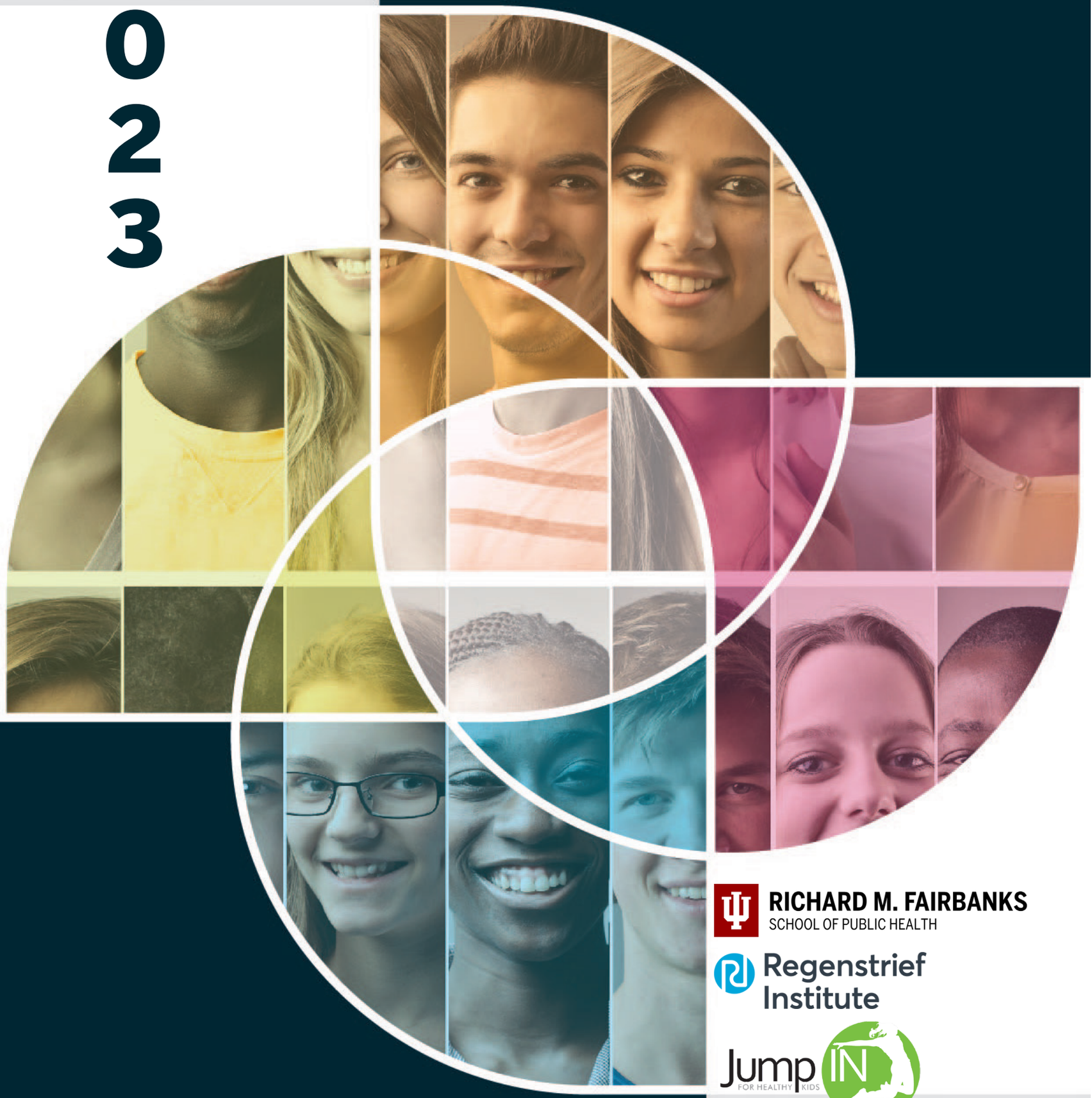
2023

Weight Trends Among Children and Adolescents within Central Indiana



RICHARD M. FAIRBANKS
SCHOOL OF PUBLIC HEALTH

Regenstrief Institute

Jump IN
FOR HEALTHY KIDS

Project Team

Jennifer Crago
Thomas Duszynski
Amy Hancock
Nimish Valvi
Ava Luo

Acknowledgements

The Project Team gratefully acknowledges feedback from members of the Jump IN for Healthy Kids Data Advisory Work Group.

This publication was made possible in part by a grant from Jump IN for Healthy Kids.

This publication was supported by Coronavirus Relief Fund Grants from Department of the Treasury. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Department of the Treasury.

Table of Contents

Executive Summary

Childhood and adolescent obesity represent a serious health problem in the U.S. and globally and is the biggest risk factor for adult obesity. Sequalae from obesity has been emerging earlier in life, resulting in long-term complications and lower quality of life and life expectancy.

Most research points to simple factors of excessive caloric intake combined with a lack of physical activity. Caloric intake is more than just consuming "too much", rather it is the number of calories in the foods being eaten, with increased portion sizes, fast foods, and accessibility or lack thereof to nutritious, healthy options. This, coupled with the lack of physical activity, such as drive-thru dining, and modern conveniences that reduce societies' need to move, including our sedentary work environments are contributing factors.

Baseline measurements were needed to assess the prevalence by age, race/ethnicity, and county of residence. The Body Mass Index (BMI) is the current standard measurement and is calculated by dividing a person's weight in kilograms by their height in meters squared (weight (kg)/[height (m)]^2) and the higher the value, is an indication of higher body fatness. A BMI <18.5 would be classified as underweight, 18.5-24.9 is classified as normal weight, 25.0-29.9 is classified as overweight, and 30+ is classified as obese in adults. The BMI, while calculated the same in children, is interpreted differently for children and adolescents. Children and adolescents BMI's need to be age and sex specific due to the amount of fat changes with age, as well as differences in fat between females and males. Generally, for children and adolescents, the BMI is converted into a percentile ranking that is plotted on a curve by age.

In 2011, a group of business and civic leaders in Indianapolis began a conversation on what could be done collectively to improve the health of our community. Alarmed by the region's poor health ranking on surveys such as the American Fitness Index and informed by the community health needs assessments completed by our major health care systems, this group decided to focus its efforts on improving the health of children and their families. Throughout 2014 and into early 2015, Jump IN engaged more than 100 representatives from 85 businesses and civic organizations in several task forces.

Jump IN has convened dozens of stakeholders to develop a set of multi-sector strategies that address the many causes of obesity. Through creating healthy places such as embedding healthy nutrition and physical activity policies into those settings that directly influence children's behavior (such as school and childcare).

The data for this report is from the state's Health Information Exchange (HIE) and was obtained via the Indiana Network for Patient Care (INPC) database, from a separate file for Ascension St. Vincent visits, electronic medical records (EMR) data warehouses for Indiana University Health (IU Health), a statewide system

with 18 hospitals, as well as outpatient clinics, and Eskenazi Health, the county hospital in Marion County.

Available data comes from physician data entry during routine patient care. Demographics, encounters, and height, weight and BMI data were pulled for patients aged 0-19 and living in the Indianapolis metropolitan area from January 1, 2014, to December 31, 2022, from each system.

- The overall prevalence of obesity among 2-19 year-olds in central Indiana in 2022 was 21.24%. Among only females, it was 19.75% and 22.74% for males. The overall prevalence represents nearly a 36% increase from 2014.
- Among the weight categories, normal weights (BMI = 18.5-24.9) dropped by just over 10% with increases in over and obese weights of 9.6% and 32.4% respectively among females. While males in the normal weight range dropped by just over 11%, with increases among over and obese individuals of 5.8 and 39.3% respectively.
- When assessing obesity by race/ethnicity, Asian, Hispanic, and Other experienced the largest increases between 2014-2022. Hispanics between those years experienced the largest gain of 69.4%, followed by Asians (66.1%) and then Other (67.1%).
- The age category of 2-5 years experienced the largest increase in obesity (>96%) with a nearly 40% gain among 6-11 year-olds and a more than 26% increase among 12-19 year-olds.
- Among females, Marion County has the highest obesity rates compared to surrounding counties and experienced a greater than 31% increase in rates between 2014-2022. When assessing male populations by county of residence on average Marion County residents have the highest rates of obesity between 2014-2022. Marion County obesity increased by more than 44% between 2014-2022. Shelby County males experienced the greatest increase during the data period with an increase of greater than 53%. Unlike the female population, males experienced an increase of more than 10% during the pandemic years (2020-2022).

Childhood and adolescent obesity represents a serious health problem in the U.S. and globally and is the biggest risk factor for adult obesity. Sequalae from childhood and adolescent obesity has been emerging earlier in life, resulting in long-term complications and lower quality of life and life expectancy. Focusing on primordial, primary, and secondary prevention among younger population translates into primary prevention in the adult populations as prevention is less expensive than treatment.

Introduction

Obesity affecting a large percentage of the population in the United States is a relatively recent phenomenon that not only changed our culture, but health outcomes for millions in the past four decades (1). A longitudinal look at adult data shows that prevalence of body mass index (BMI) of > 30 (obese) crept up to an epidemic threshold likely in the mid to late 1970s and has continued to increase rapidly through the 1990s (1,2). The increasing percentage of the population that is either overweight or obese represents a significant public health challenge for the U.S., which focuses more on treatment than prevention (3). This isn't affecting only the adult population; children and adolescents are also experiencing the same effect.

History of Obesity and the Body Mass Index Metric

The term obesity doesn't appear in the English language literature until the 17th century and the origins can be traced to pre-historic humans who could store energy and would have a better chance of survival during the reoccurring famine events throughout history (4, 5). The recognition of obesity affecting a greater percentage of the U.S. population first emerged after World War II when physicians noted increasing waistlines in their patient population (6). A group of physicians at the time formed a professional clinical society that eventually became the American Society of Bariatric Physicians in 1972 and led to the present-day Obesity Medicine Association (6). However, this phenomenon wasn't confined to the U.S. population, and emerged as the same public health threat in other developed societies around the globe (7). During the 28 years from 1980 through 2008, the global overweight/obesity prevalence nearly doubled to 1.5 billion adults with a BMI of 25 or greater (8).

For the past four decades, the definition of obesity has been quantified using the Body Mass Index (BMI) metric that was developed in the 1830's by statistician Adolphe Quetelet, who was interested in defining the "*l'homme moyen*" or the "*average man*" (9). Quetelet developed the metric at a time when actuaries were interested in determining the relationship between a person's height, weight, and premature death (10). The question was, could a single value be calculated and used to assess a person's overall health (10)? By 1972, the Quetelet Index had become the now-known BMI when a physiologist, Ancel Keys, insisted on a single measure to quantify health, leading family doctors, insurance companies, and public health agencies to start using the BMI as a first measure to assess health (10). The common perception of the BMI metric is that it is a measure of an individual's "*fatness*" which is correlated with health and important psychosocial issues (11).

Beyond the societal implications, excess adipose tissue can have serious medical consequences for the individual and result in a lower of quality of life and overall life expectancy (11). In 1959, the Metropolitan Life Insurance Company published tables of average body height and weight by gender and age groups and

created the "*desirable*" category of weight (11). It was recognized early in the data collection that taller people lived longer than shorter people with the same height to weight ratio (11).

BMI Calculations and Challenges

The BMI is calculated by dividing a person's weight in kilograms by height in meters squared (weight (kg)/[height (m)]^2) and higher values indicate higher body fatness (12). An adult with a BMI <18.5 would be classified as underweight, 18.5-24.9 classified as healthy weight, 25.0-29.9 classified as overweight, and those at or above 30 classified as obese.

There are many challenges with attempting to use a single value as a measure of health in modern society with advanced medical knowledge. One of the biggest issues with the BMI is that it doesn't account for body composition, such as muscle mass, since muscle weighs more than fat (13). Second, there is a danger of dismissing potential health problems because of a "normal" BMI score since body fatness has become a driver for certain diseases (13). Third, the BMI was based on white males in the 1800's, not accounting for differences in race, ethnicity, body type, lifestyle, and sex differences (13). In June 2023, the American Medical Association (AMA) cited that the BMI is an "imperfect measure" and doesn't account for variation across races and ethnicities (14).

Major Contributors of Obesity in the U.S.

Since the mid-20th century, the U.S. has seen overweight and obesity rates climbing in the population. While there is ongoing research into the extent of the determinants, it is likely due to a web of causation. Most research points to excessive caloric intake combined with a lack of physical activity (15). Caloric intake is more than just consuming "too much". Increased portion sizes, fast foods, and poor accessibility to nutritious, healthy options can encourage excessive caloric intake (16). Meanwhile, drive-thru dining and modern conveniences that reduce individuals' need to move—including our sedentary work environments—encourage reduced physical activity (16). Caloric intake is necessary to sustain life and maintain overall health; however other social determinants drive our choice of calories. The built environment influences both caloric intake and the amount of physical activity that an individual experiences over the course of a lifetime (17). While it is easy to think about not having parks, safe neighborhoods and sidewalks, and affordable access to gyms as a reason for inactivity, our zip code plays a bigger role. The built environment contributes beyond those easily identifiable reasons. For example, urban sprawl has moved persons farther from their work, meaning more time in the car and less time with family or preparing healthy meals (17).

Beyond the urban sprawl associations, those that continue to live in urban environments may also find they live in a food desert, lacking access to fresh foods, resulting in the purchase of high-calorie, low-nutrition foods. Food deserts and the inability to afford fresh, healthy foods, are highly correlated to obesity

in the U.S. (18). Having physical access to fresh, healthier food options does not ensure uptake of those products. Individual choice of food is also driven by cost of those options. This is especially true in neighborhoods with low socioeconomic status, which is again correlated with higher overall BMI (18). This leaves many choosing to purchase higher-calorie, less nutritious foods that are lower in cost and have a longer shelf life (19).

U.S. Childhood and Adolescents Trends

The overall prevalence of childhood obesity in the United States has been increasing over the past several decades, representing a major public health concern. According to the most recent national estimates using 2017-2020, pre-pandemic data:

- The prevalence of obesity was 19.7% and affected about 14.7 million children and adolescents.
- Obesity prevalence was 12.7% among 2-5 year-olds, 20.7% among 6-11 year-olds, and 22.2% among 12-19 year-olds.
- Childhood obesity is also more common among certain populations.
- Obesity prevalence was 26.2% among Hispanic children, 24.8% among non-Hispanic Black children, 16.6% among non-Hispanic White children, and 9.0% among non-Hispanic Asian children.
- Obesity-related conditions include high blood pressure, high cholesterol, type 2 diabetes, breathing problems such as asthma, sleep apnea, and joint problems. (20)

As is the case among adults, obesity among children and adolescents is associated with the socioeconomic status of the family.

- In 2011-2014, among children and adolescents aged 2-19 years, the prevalence of obesity decreased as the head of household's level of education increased.
- Obesity prevalence was 18.9% among children and adolescents aged 2-19 years in the lowest income group, 19.9% among those in the middle-income group, and 10.9% among those in the highest income group.
- Obesity prevalence was lower in the highest income group among non-Hispanic Asian boys and Hispanic boys.
- Obesity prevalence was lower in the highest income group among non-Hispanic White girls, non-Hispanic Asian girls, and Hispanic girls. Obesity prevalence did not differ by income among non-Hispanic Black girls (21).

Also as among adults, the decreasing amount of physical activity plays a significant role in child and adolescent obesity rates (22). While many school programs are reducing or eliminating physical education programs, the amount of physical activity needed generally would exceed what was offered in these programs (23). A recent 5-year study determined that as much as three times the amount of physical education would be needed to reduce the risk of childhood overweight and obesity (24). Another

challenge with increasing physical activity is that it may produce an inverse effect in which the person may consume more calories due to exercising more (25). This effect may continue into adulthood, causing more weight gain, especially if physical activity declines (25).

Behavior and environmental factors are also significant contributors to childhood obesity through technological advances that allow for a more sedentary lifestyle, as well as the consumption of less expensive, high-calorie, energy-rich foods (26). Genetic variations and mutations account for a small percentage of the overall burden of childhood obesity. Most phenotypic expressions are modest in terms of weight gain. The more pronounced weight gain due to genetic variations is seen in the first years of life and is likely due to hypothalamic regulation (26).

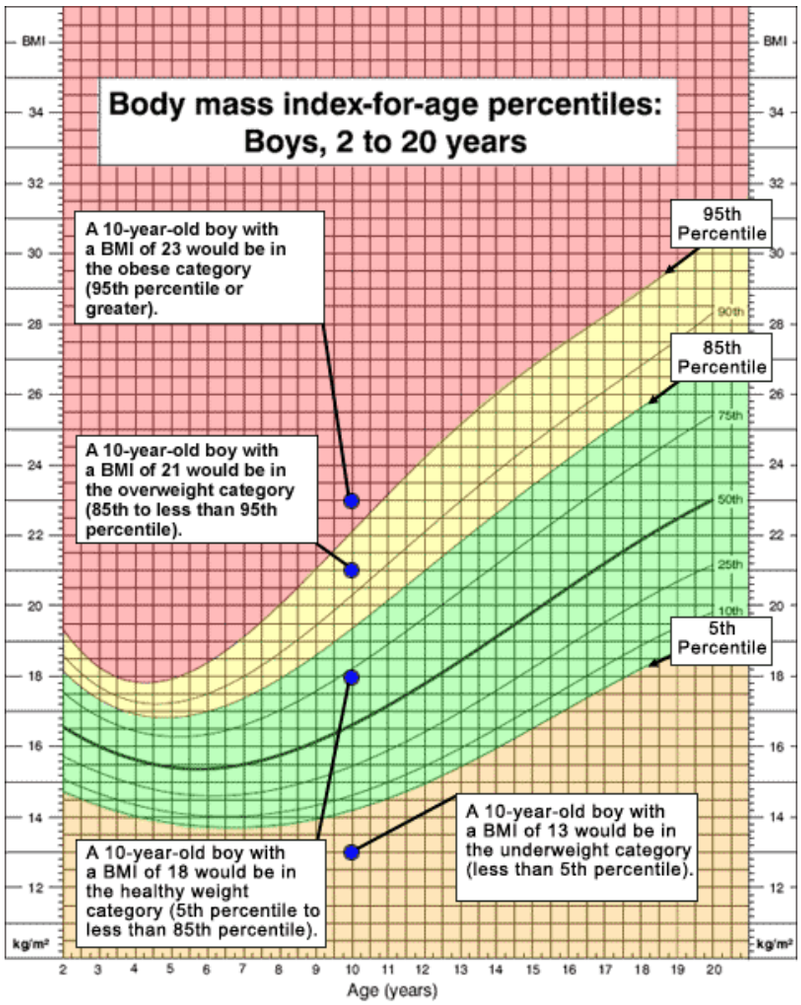
Along with socioeconomic factors, networks of social support and social acceptance are considered one of the most important factors in overall health (27). There is an association between low social support and decreased fresh fruits and vegetables consumption, as well as lower overall physical activity (27).

Culture, a social construct, can contribute to the burden of childhood obesity and drives acceptance as to what individuals in a culture identify as normal. Cultural variation can change as patterns of migration, acculturation, and globalization cause shifts in cultural beliefs which may have kept an individual from becoming overweight and cause an adoption of more sedentary lifestyle (28). Cultural adaptation can influence other aspects including increases in screentime, changes in dietary habits, and social networks.

BMI for Children and Adolescents

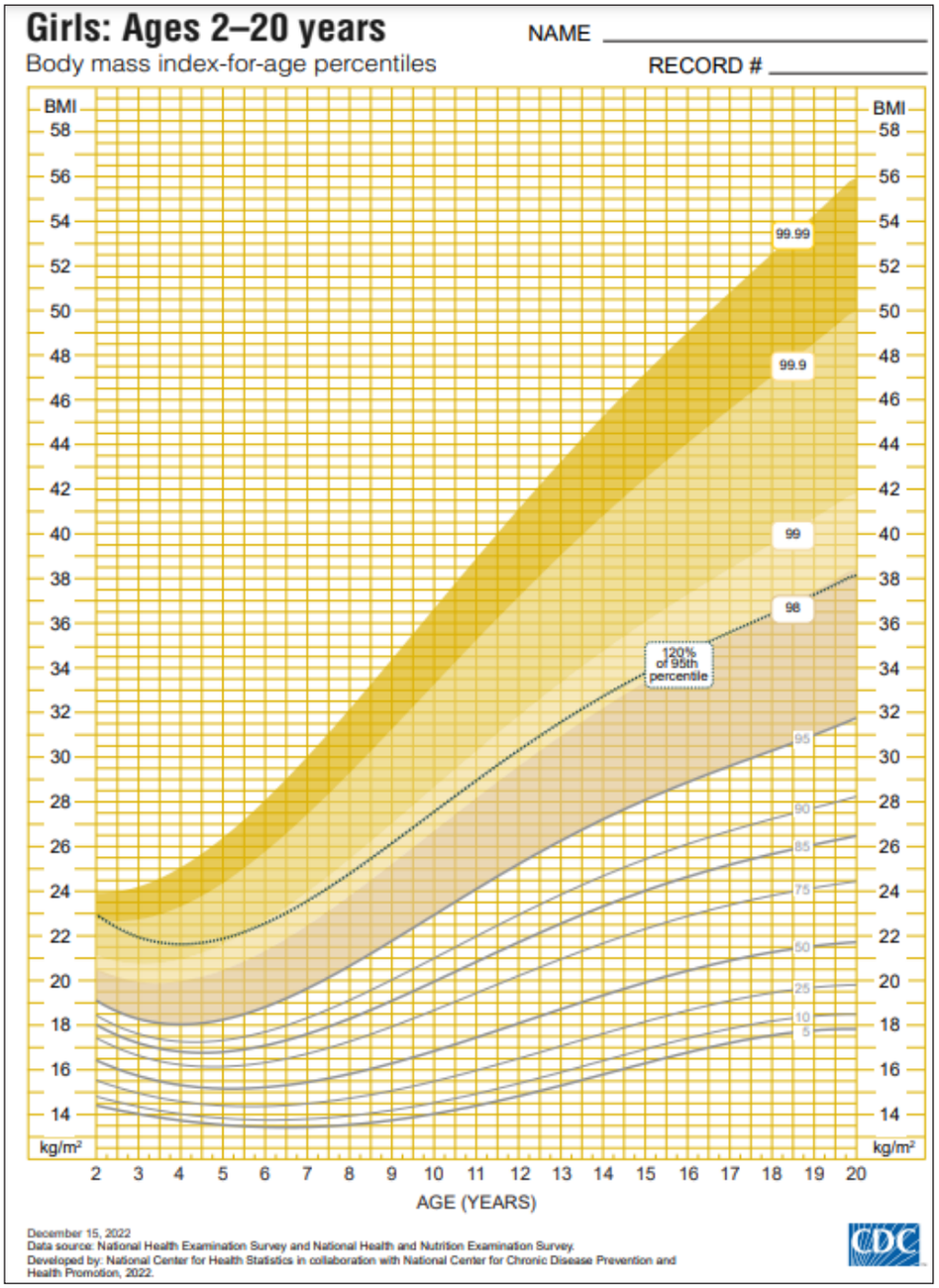
The BMI, while calculated the same in children, is interpreted differently for children and adolescents. Children and adolescent BMI needs to be age-and sex-specific due to fat changes with age as well as differences in fat between females and males (12). Generally, for children and adolescents the BMI is converted into a percentile ranking that is plotted on a curve by age as seen in **figure 1**. There are separate charts for males and females with age (2-20) on the X-axis and BMI on the Y-axis.

Figure 1. An example of how a BMI would be interpreted for a 10-year-old male, 1977 (29)



The growth chart percentiles were adopted in 1977 in an attempt to reflect the changing bodies of children and adolescents (30). In 2022, the growth charts were revised and extended to address higher BMI values in the population as seen in **figure 2**. (30). While the revised growth charts can now assess higher BMI values for children and adolescents, they still fail to account for changes in early development among different races and ethnicities (31).

Figure 2. CDC Extended BMI-for-age Growth Chart for Girls aged 2-20 years (30)



Consequences of Childhood Obesity

The continuing trends in childhood overweight and obesity contribute to a growing list of comorbidities and threaten to diminish the ability for a significant percentage of the population to achieve their full potential and life expectancy (32). This includes being a contributing member of society as well as creating increasing burdens on public health and medical communities (32). The impact on the maturing individual can include the physiological systems as seen in **table 1**.

Table 1. Comorbidities of Childhood Overweight and Obesity (32)

Comorbidity Category	Individual Comorbidities Associated with Categories
Cardiovascular:	Hyperlipidemia (high cholesterol)
	Hypertension (high blood pressure)
	Vascular dysfunction (not functioning properly)
	Early coronary atherosclerosis (plaque buildup inside arteries)
Endocrinologic:	Metabolic syndrome (cluster of factors for cardiovascular disease)
	Hyperinsulinemia (higher amounts of insulin released in blood)
	Insulin resistance (cells not responding to insulin used to control glucose levels in blood)
	Prediabetes (increasing sugar levels in blood)
	Type 2 diabetes (blood sugar levels too high)
Respiratory:	Obstructive sleep apnea (complete or partial collapse of the upper airway)
Gastrointestinal:	NASH (Inflammation of the liver)
	Cirrhosis (scarring of the liver)
	Liver failure (requiring transplant)
Musculoskeletal:	Lower extremity arthralgias (joint stiffness)
	Impaired mobility (lack of the ability to move as well)
	Tibial bowing (curvature of the lower legs, bow in or out)
	Slipped capital femoral epiphysis (growth plate damage causing the slipping of the head of the femur)
Psychosocial:	Body image disturbances, low self-esteem, impaired socialization, victimization, depressive symptoms, disordered eating, anxiety
Adult Obesity:	Comorbidities, diminished potential, and lower life expectancy

Financial Cost in Care for the Population

The impact of childhood and adolescent overweight and obesity represent a significant health emergency in our population, that has slowly and steadily risen over the past four decades (33). Declining human health resulting in a lower quality of life now occurring in younger populations is part of the equation when assessing the impact. Coupled with the human health consequences are the annual medical costs to individuals and society. In 2022, it is estimated that annual total medical costs increased by $237.55 per capita directly attributable to childhood overweight and obesity (33). Increases in cost for nonhospital healthcare, outpatient visits, medications, and hospitalizations have been observed that are directly related to overweight and obesity in individuals (33).

Impact of the SARS-CoV-2 Pandemic

The emergence of the SARS-CoV-2 pandemic has impacted every aspect of human life over the past 3 years and childhood overweight and obesity trends are no exception. The known risk factors for severe outcomes of infection of SARS-CoV-2 include hospitalization, intensive care, and any immunocompromising conditions including obesity (BMI > 30 kg/m^2 or > 95^{th} percentile in children) (34). Other sequalae associated with having overweight or obesity such as diabetes (type I and II), physical inactivity, and heart conditions, are also known risk factors for severe outcomes from SARS-CoV-2 infection (34, 35). The correlation between severe outcomes and obesity (childhood and adult) can be traced through biological response of the immune system and the cells produced (36).

The creation and use of several vaccines to protect against severe outcomes of COVID-19 saved countless lives by swift implementation and uptake of those at greatest risk. The high effectiveness of vaccines across the population was slightly lower for elderly and those suffering from diabetes, hypertension, and obesity (36).

While those suffering from overweight or obesity were at greater risk for severe outcomes, the pandemic was also a risk factor for increases in weight for many Americans. Among more than 3,400 adults surveyed, 48% gained weight, 34% maintained their weight, and 18% lost weight (37). Among those who reported already being overweight, 65% were the most likely to gain weight as compared to slightly overweight or normal weight (37). Children and adolescents also experienced weight gain during the pandemic primarily due to lack of physical activity due to lockdowns, home isolation, and online learning (38). During the initial 3-4 weeks of lockdown, overall exercise time decreased and consumption of high-calorie, low-nutritional-value foods increased (38). In a study of 200,000 children, the resulting weight gain was disproportionally distributed among age groups with those 5-11 years of age, on average gaining 5 pounds, while 16-17 year olds gained on average 2 pounds (39). These gains, while appearing small, resulted in approximately 9% more children and

adolescents developing overweight or obesity (39).

Prevention Strategies

As with many chronic diseases, a multifactorial approach to prevention is needed including addressing eating patterns, physical movement, good sleeping habits, and reducing screen times (40). While children and adolescents spend the greatest percentage of time at home, schools and community leaders also have a role in maintaining a healthy weight (41). Promoting physical activity, outdoor family activities, and lesson plans that have health-oriented messages (41).

Diet and eating patterns contribute to overweight and obesity as well. Nutrition beginning during the prenatal period and continuing through infancy, preschool, childhood, and adolescence includes incorporating plant-based foods (vegetables and fresh fruits) (42). Early development of healthy eating patterns and diet can help continuation of these practices into adulthood (42).

Sleep, physical movement, and reducing screen time are interconnected activities that can have impact on childhood overweight and obesity. Declining physical activity and increasing sedentary screen time can adversely affect a child's sleep (43). Research indicates that more screen time is strongly associated with lower sleep quality and duration while more physical activity (moderate to vigorous) was associated with better sleep quality and duration (43).

Reducing overweight and obesity is associated with lower medical costs for the individual and can have positive impacts at the population level (44). Interventions that are intended to reduce overweight and obesity can save intervention dollars that can be utilized to increase services to more of the population (44).

History of Jump IN for Healthy Kids

In 2011, a group of business and civic leaders in Indianapolis began a conversation on what could be done collectively to improve the health of our community. Alarmed by the region's poor health ranking on surveys such as the American Fitness Index and informed by the community health needs assessments completed by our major health care systems, this group decided to focus its efforts on improving the health of children and their families. Based on research from the Centers for Disease Control and Prevention and the Robert Wood Johnson Foundation, the founding CEOs agreed to create and fund a multi-year collective impact initiative targeting childhood obesity. Jump IN for Healthy Kids formally launched in January 2014 as the backbone organization of that initiative. Throughout 2014 and into early 2015, Jump IN engaged more than 100 representatives from 85 businesses and civic organizations in several task forces.

Jump IN has convened dozens of stakeholders to develop a set of multi-sector strategies that address the many causes of obesity. Strategies include creating healthy places by embedding healthy nutrition and physical activity

practices into those settings that directly influence children's behavior (such as school and childcare). Jump IN also seeks to create healthy neighborhoods and solve systemic issues such as lack of access to affordable, nutritious food and a scarcity of environments that promote physical activity. In addition, Jump IN creates healthy communities by increasing public awareness and education, influencing public policy, and connecting clinical care with community resources.

Purpose of this report

This report was determined necessary to assess prevalence and annual trends in childhood overweight and obesity in central Indiana children. The data for this report was gathered over the 9-year period between 2014-2022. This report will analyze and calculate prevalence rates by demographic characteristics and provide annual trends among eight counties in central Indiana group. These measurements will stratify by age group, sex, race/ethnicity, and weight categories to determine trends in these stratums to develop a comprehensive picture of the population being studied. These measurements can then be utilized to develop prevention strategies that can target specific sub-populations to increase effectiveness of limited resources.

Funding

Funding for this project originated from a Health Issues and Challenges Grant from the Division of Health Innovation Partnerships Program at the Indiana Department of Health (IDOH). This grant was supported through the American Rescue Plan Act (ARPA) allocated through the Indiana General Assembly.

Methods

For the "Multi-Sector Systems Improvements to Decrease Childhood Obesity in Central Indiana" study, Jennifer Crago was the assigned Project Manager. In this role, she coordinated all tasks and communications between Principle Investigator (PI), the post-doc student researcher, assigned data analyst and lead partner (Jump IN). As the project manager, she coordinated all meetings and provided actions items and meeting summaries for the team.

The project manager ensures distribution of any necessary documentation and research pertaining to the project aims. She is responsible for submitting data requests to the Regenstrief Data Core Services department at Regenstrief and facilitating any discussions regarding the project cohort and informatics needs.

She also submits any IRB protocols to ensure regulatory compliance and conducts necessary follow-up (IRB approval 17446). Furthermore, the project manager creates and manages a secure Microsoft Teams folder that is compliant with storing unidentified patient data. The project manager assists the PI in preparing project presentations, published manuscript articles and reports. She tracks all invoices and budgets for the project to ensure deliverables are met.

Data

The data for this report are from Indiana Network for Patient Care (INPC) database, managed by the Indiana Health Information Exchange (IHIE), from a separate file for Ascension St. Vincent visits, the electronic medical records (EMR) data warehouses for Indiana University Health (IU Health), a statewide system with 18 hospitals as well as outpatient clinics, and Eskenazi Health, the county hospital in Marion County where Indianapolis, Indiana, is located.

Available data come from physician data entry during routine patient care. The data warehouses capture all structured data from patient encounters within these health systems, while the INPC received specific pieces of clinical data but is not as comprehensive in terms of data elements. The Regenstreif Data Core serves as the honest data broker for access to these data sources for research re-use.

Encounters, demographics, height, weight, and selected other data items were pulled from each system for patients aged 0-19 and living in the eight-county Indianapolis metropolitan area from January 1, 2014, to December 31, 2022. Years 2012 and 2013 lacked sufficient data to be comparable to the subsequent years and were removed from the analysis. Patients that were not previously linked in the INPC were linked using medical record number (MRN). If the MRN was not available, then the data was matched using Regenstrief Institute's Global Match program which matched on first and last name, date of birth and ZIP code.

The most recent patient encounter with measured height and weight was utilized to calculate body mass index (BMI). Valid BMI entries were screened by examining records between the 0-5th and 95-100th percentiles. The following steps were undertaken to validate the BMI results:

- exclude records with one encounter
- extreme values (BMI was less than 5 or greater than 100)

BMI was calculated using the remaining encounters; calculating the percent difference from the mean BMI for each encounter; and excluding BMI encounters greater or less than 10% from the mean BMI. The Centers for Disease Control and Prevention (CDC) age- and sex-specific growth charts were used, and BMI was classified as underweight (0-5th percentiles), healthy weight (5-85th percentiles), overweight (85-95th percentiles), and obese (>95th percentile) using SAS.

Rate differences were calculated between 2014-2022 to assess the amount of change during this time period. Rate differences were then calculated between 2020-2022 to capture variations and trends during the SARS-CoV-2 pandemic.

Results

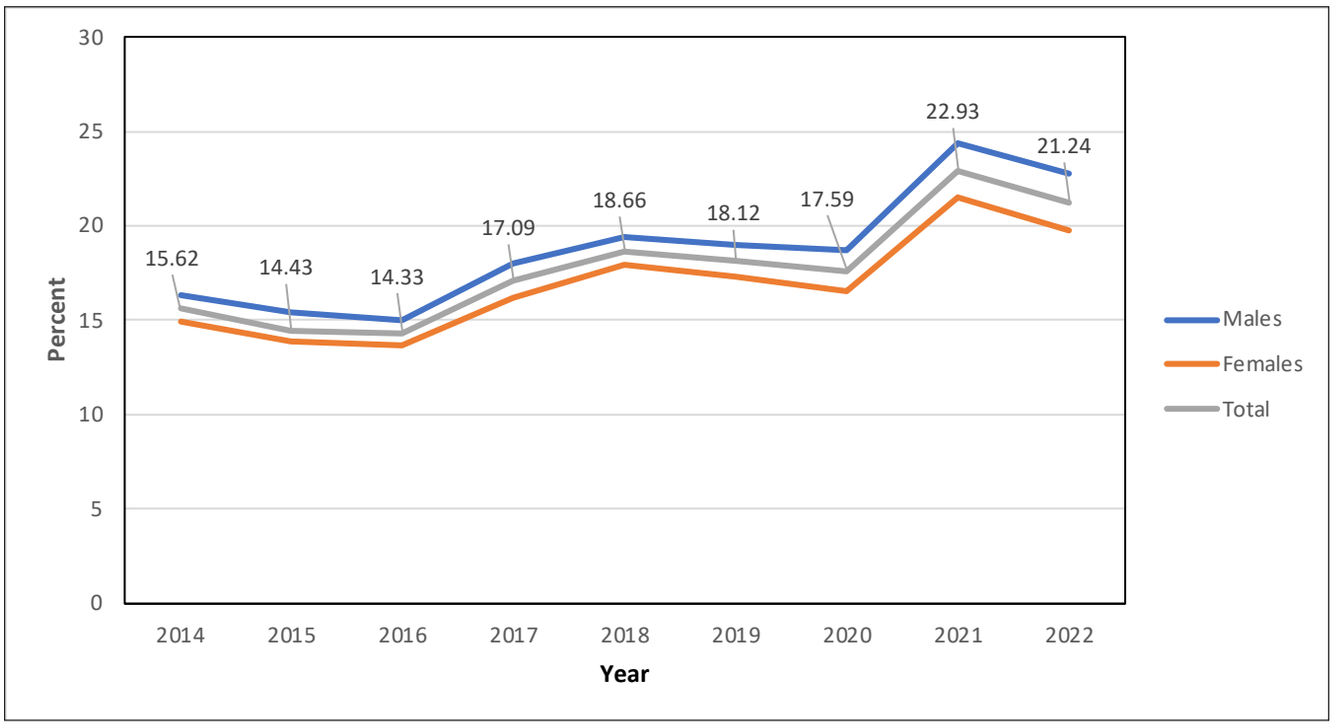
The descriptive characteristics of the data that were analyzed, in **table 2** below, giving frequencies and percentages by characteristics which included county of residence, age categories, and race/ethnicity stratifying by sex. The total percent reflects the characteristic divided by the N and multiplied by 100.

Table 2. Descriptive Statistics N= 849,073 Encounters among 423,679 Unique Individuals

Characteristic	Female Encounters n = 429,499 (50.6%)	Male Encounters n = 419,574 (49.4%)	Total Encounters n = 849,073 (100%)
Counties			
Boone	15,947 (50.7)	15,518 (49.3)	31,465 (3.7)
Hamilton	76,994 (51.1)	73,654 (48.9)	150,648 (17.7)
Hancock	14,221 (50.3)	14,037 (49.7)	28,258 (3.3)
Hendricks	30,774 (50.1)	30,666 (49.9)	61,440 (7.2)
Johnson	25,423 (50.2)	25,255 (49.8)	50,678 (6.0)
Marion	243,437 (50.6)	237,813 (49.4)	481,250 (56.7)
Morgan	19,296 (50.1)	19,197 (49.9)	38,493 (4.5)
Shelby	3,407 (49.8)	3,434 (50.2)	6,841 (0.8)
Age Groups			
2-5	92,900 (46.8)	105,602 (53.2)	198,502 (23.4)
6-11	134,825 (48.0)	145,910 (52.0)	280,735 (33.1)
12-19	201,774 (54.6)	168,062 (45.4)	369,836 (43.6)
Race/Ethnicity			
African American	85,439 (50.6)	83,575 (49.5)	169,014 (19.9)
Asian	12,693 (50.5)	12,453 (49.5)	25,146 (3.0)
Hispanic	64,829 (50.7)	63,109 (49.3)	127,938 (15.1)
Other	1,302 (49.2)	1,345 (50.8)	2,647 (0.3)
Unknown	77,680 (50.9)	74,882 (49.1)	152,562 (18.0)
Caucasian	187,556 (50.5)	184,210 (49.5)	371,766 (43.8)

Obesity among children and adolescents in central Indiana continues to climb and was accelerated during the SARS-CoV-2 pandemic, which began in 2020. These trends can be observed in **figure 3**. which shows a comparison between the overall obesity prevalence for all data with a stratification by sex.

Figure 3. Overall Prevalence of Obesity among Children and Adolescents in Central Indiana, 2014-2022 (Percentages for total are shown)



Figures 4 and 5 stratify overall prevalence by sex and year for all data and provide specific data labels for each year. For both male and females, the overall trends between 2014 and 2022 increased, with some fluctuations by year. The largest increases occurred between 2020 and 2022 for both female and male populations.

Figure 4. Prevalence of Obesity among Females 2-19 years of age by Year in Central Indiana 2014-2022

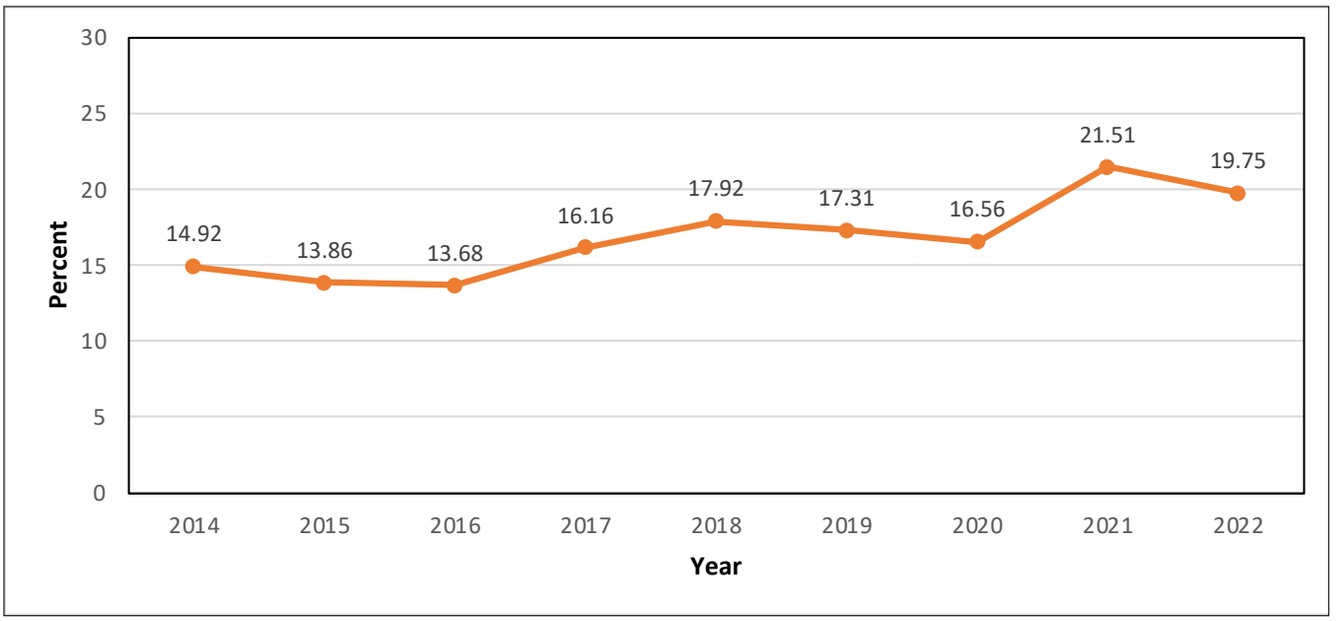
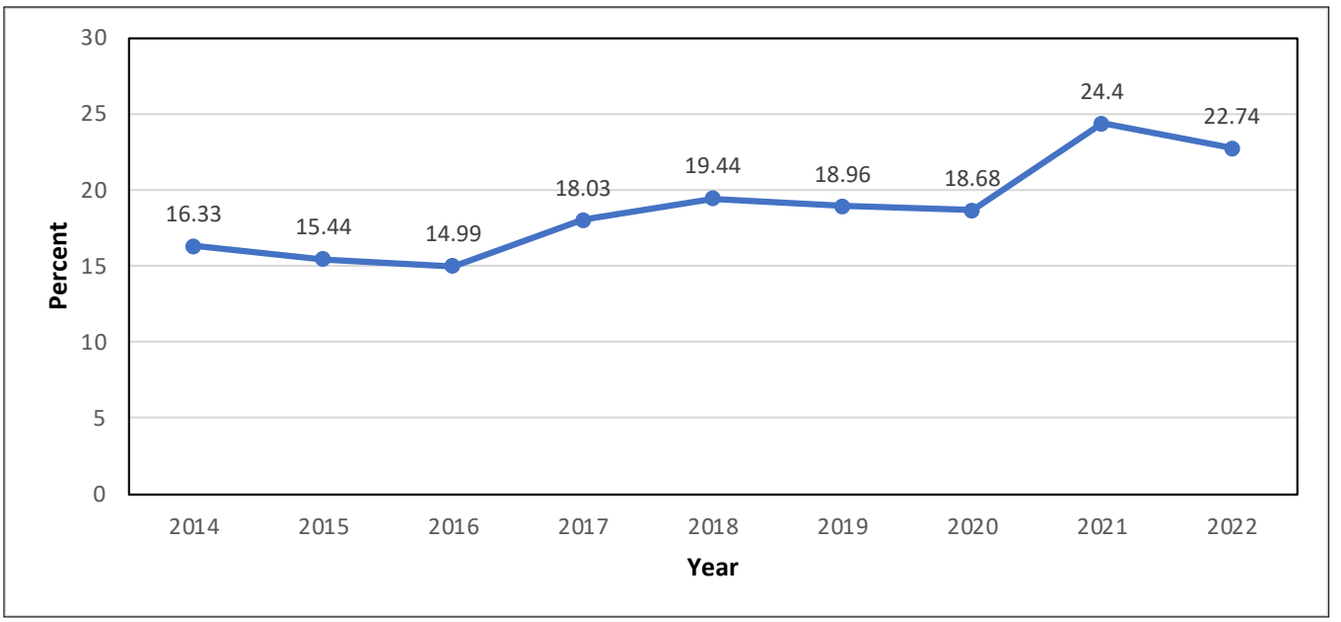
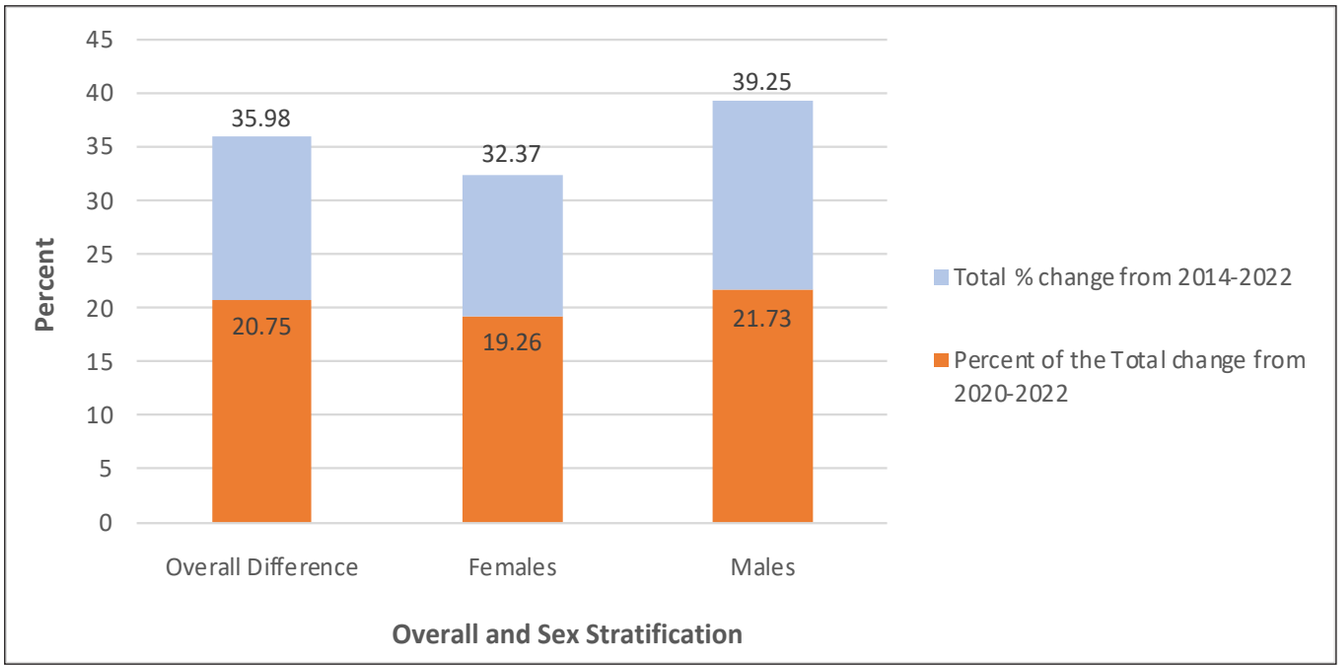


Figure 5. Prevalence of Obesity among Males 2-19 years of age by Year in Central Indiana 2014-2022



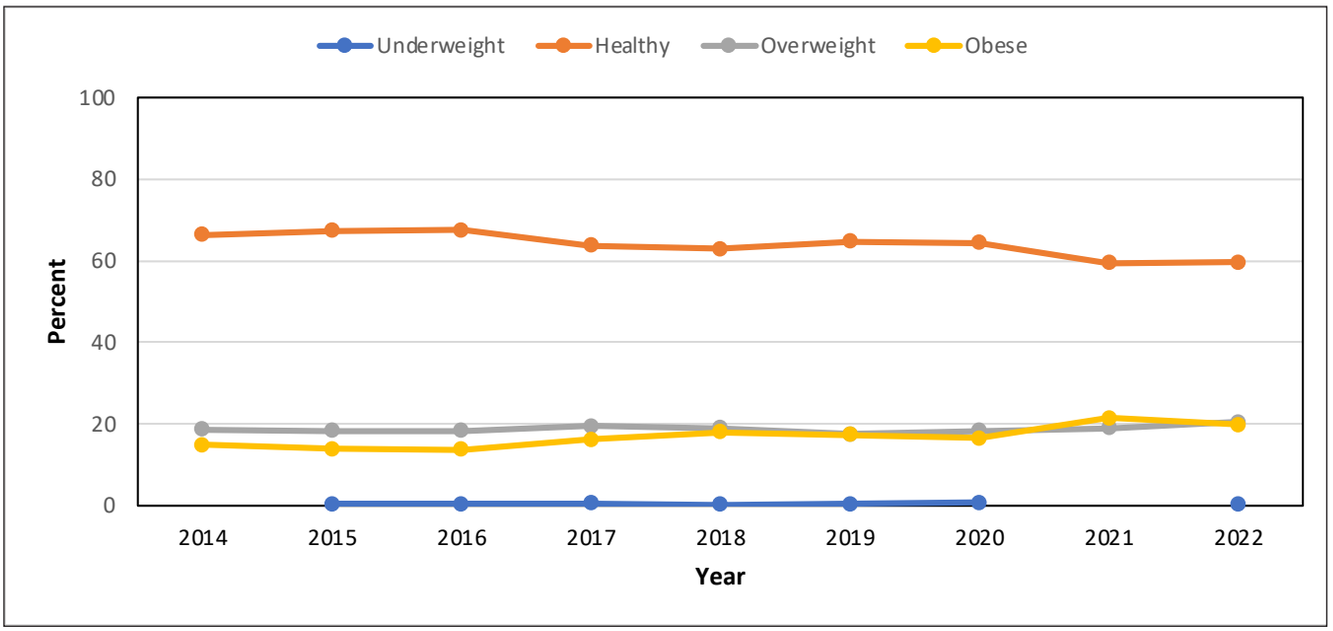
Obesity increased between 2014-2022 by nearly 36% with 21% of that increase occurring between 2020-2022, which covers the 3 years of the SARS-CoV-2 pandemic and subsequent shutdowns, school closures, fewer medical follow-ups, and potential decreases in physical activity. These trends are similar when stratifying by sex and can be observed in **figure 6**. Between 2014-2022, obesity in males increased by nearly 40% and among females there was nearly a 33% increase.

Figure 6. Increases of Obesity prevalence by Sex among 2–19 year-old's Between years 2014-2022 and 2020-2022



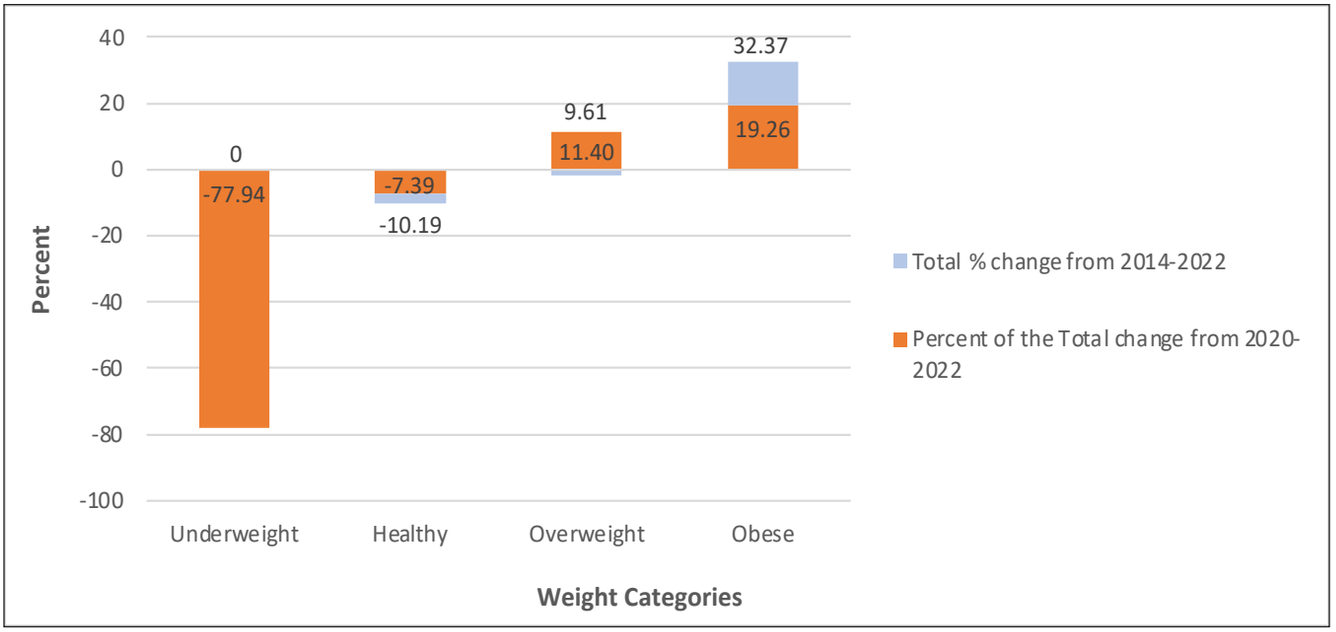
When assessing the four different weight status categories (underweight, healthy weight, overweight, and obese), stratifying by sex and year, there are differences across the categories that can be explained by increases in weight among the population over time. As seen in **figure 7**, there is a decline in the healthy weight category, among females, beginning in 2020 with a corresponding increase in over and obese weight categories. Changes in the prevalence in the underweight categories are negligible.

Figure 7. Weight Status Prevalence of 2–19 year-old Females 2014-2022



Percent changes in weight status prevalence among females by weight categories can be observed by percentages in **figure 8**, in which decreases among under and healthy weight categories can be explained by increases in overweight and obese weight categories. These changes in percentages are also categorized by the year range of 2014-2022 as well as the pandemic years of 2020-2022. Among females, from 2014 to 2022, there was a decrease of just over 10% of healthy weight females and an increase in both overweight (9.6%) and obesity (32.4%).

Figure 8. Percent Weight Change by Year Ranges and Weight Categories for 2–19 year-old Females



Similarly, among males, declines in prevalence of underweight and healthy weight corresponds to increases in prevalence of overweight and obesity. These can be observed in **figure 9**. Among males, there was just over an 11% decrease in healthy weight males and a corresponding increase in overweight (5.8%) and obese (39.3%) males between 2014-2022. Approximately 22% of the 39.3% increase in obesity among males occurred between 2020-2022 as seen in **figure 10**.

Figure 9. Weight Status Prevalence Among of 2-19 year-old Males

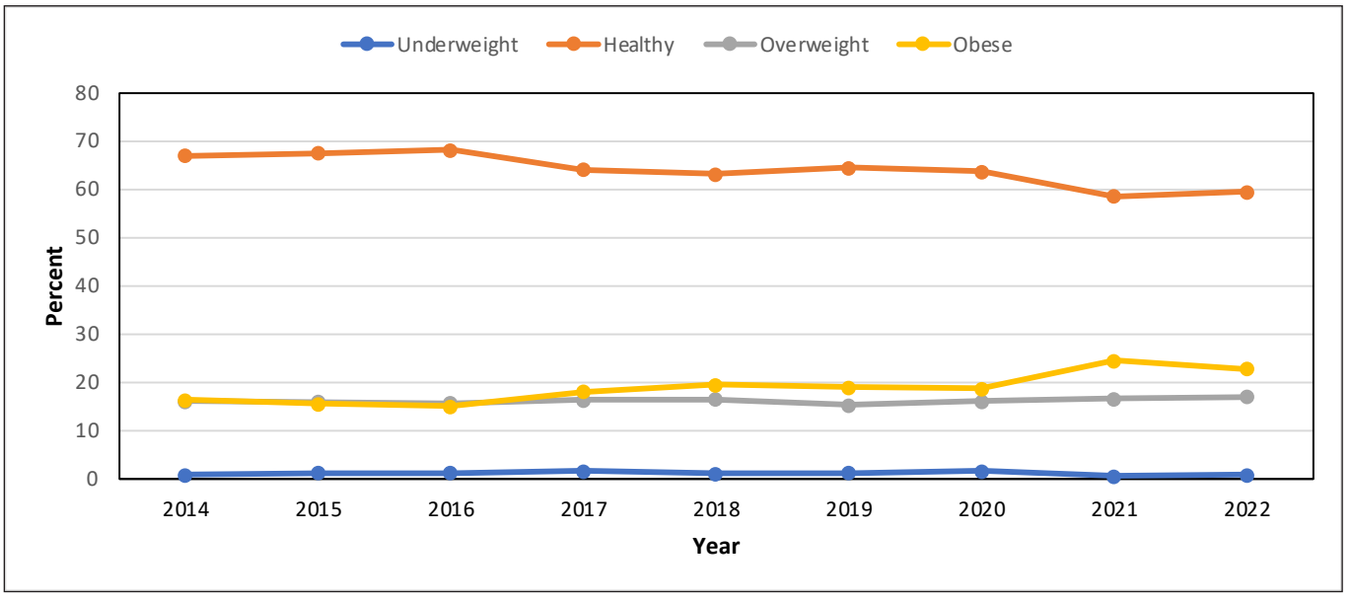
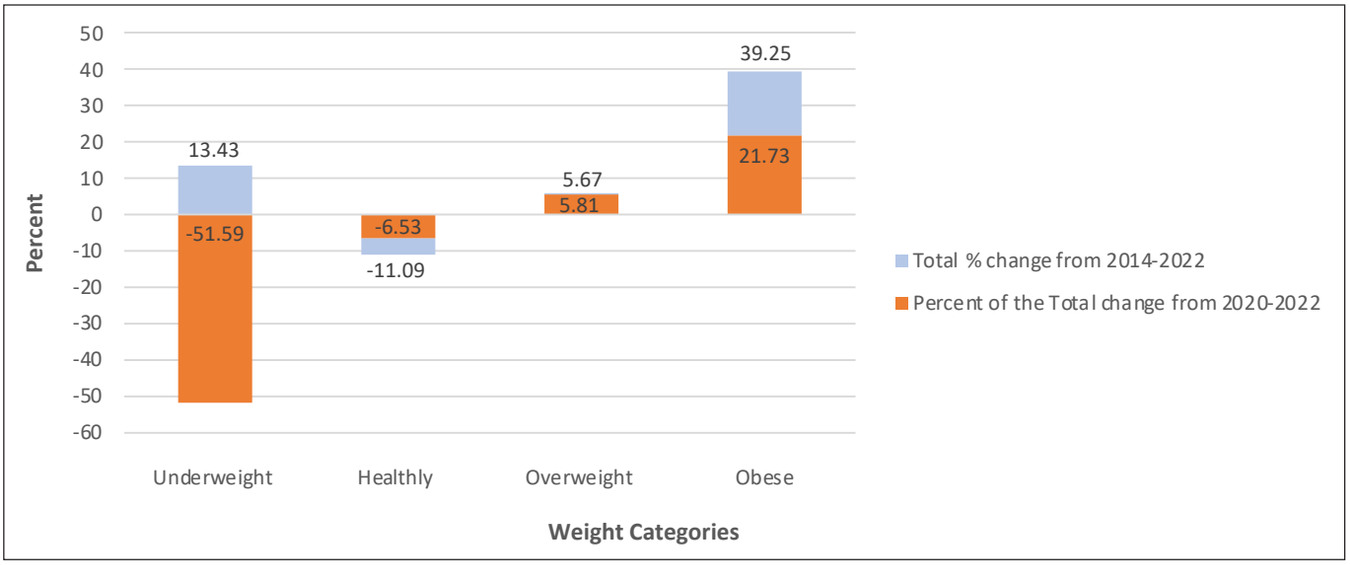


Figure 10. Percent Weight Change by Year Range and Weight Categories for 2-19 year-old Males



Obesity prevalence increases over time between 2014-2022 among all age groups. The largest increases occurred among those between the ages of 2-5 years. Some of these increases can be explained by normal growth patterns, however the figures below focus on those individuals classified as obese. Increases as seen in **figure 11** focus on those individuals by the differing age categories. Among those 2-5 years of age, there was more than a 96% increase in obesity from 2014-2022, of which nearly 70% occurred between 2020-2022. Smaller increases were seen among the other age categories as seen in **figure 12**.

Figure 11. Obesity Prevalence by Age Group and Year for Central Indiana 2014-2022

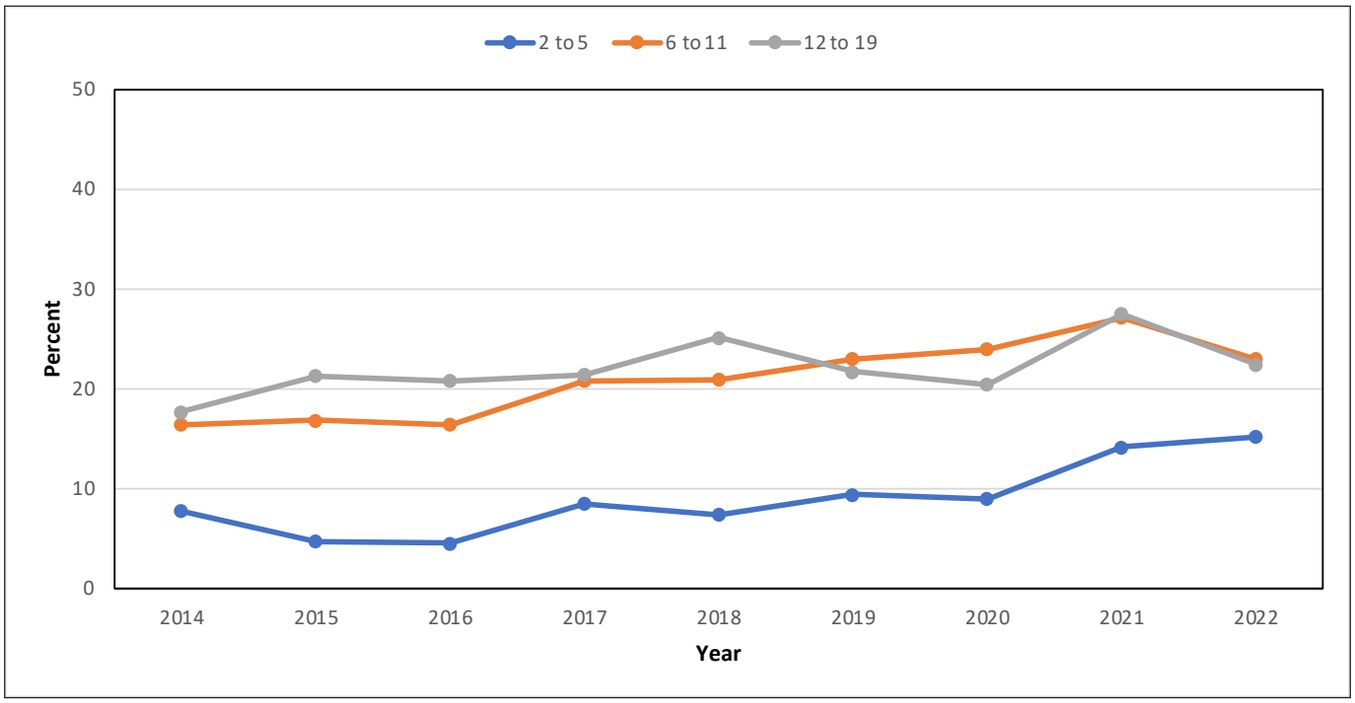
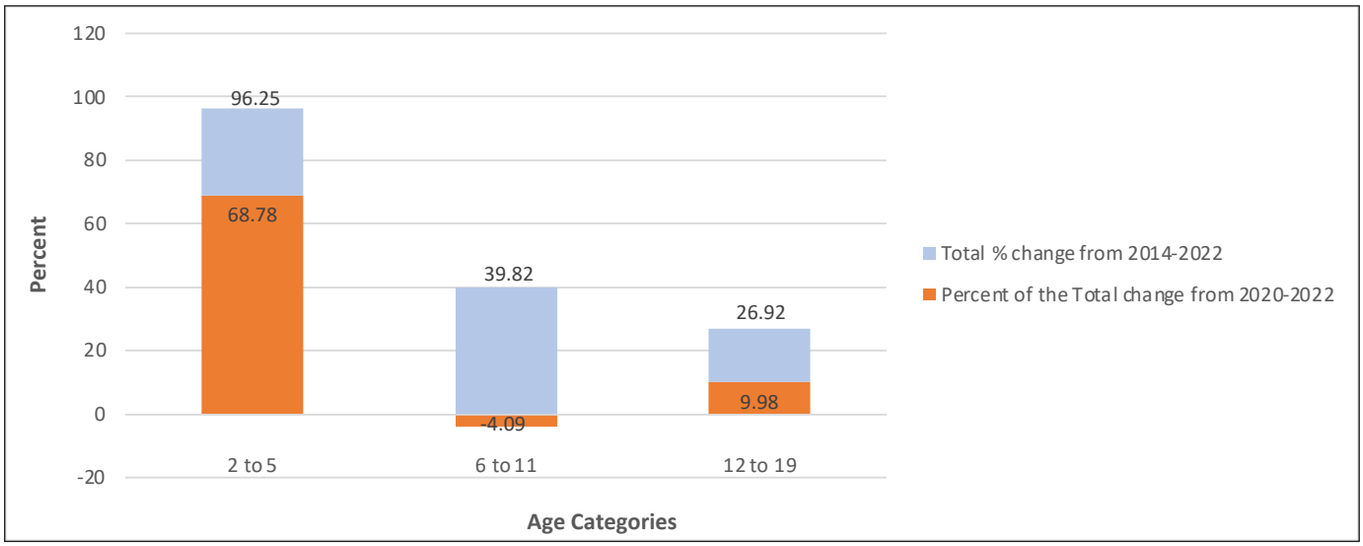
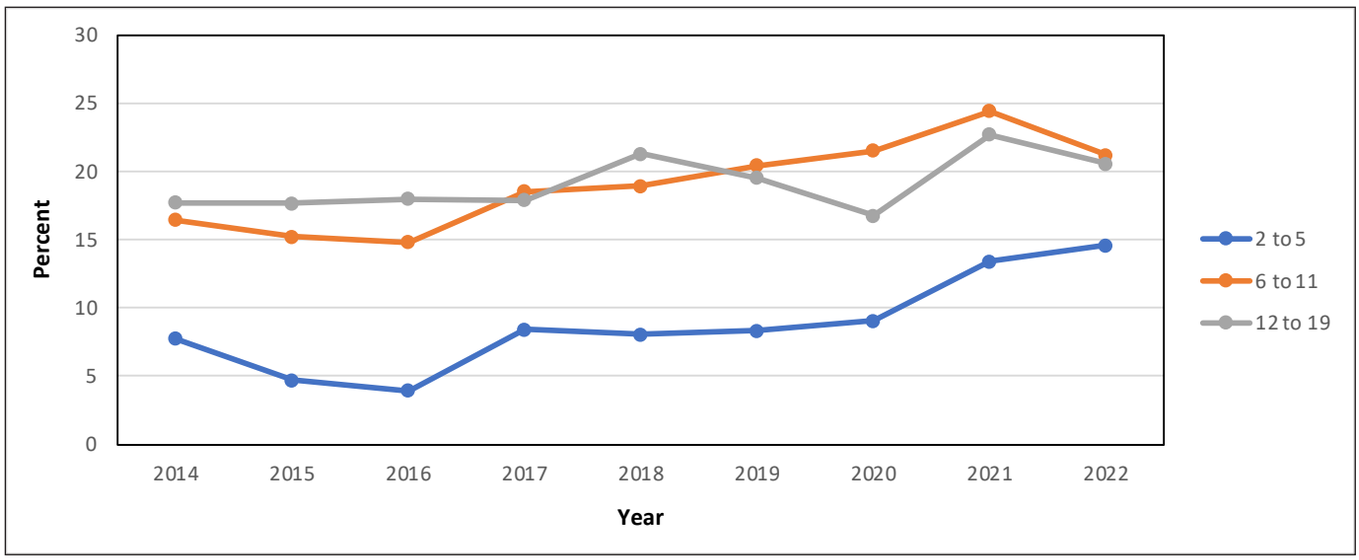


Figure 12. Percent Change in Obesity Prevalence by Age Group and Year Range



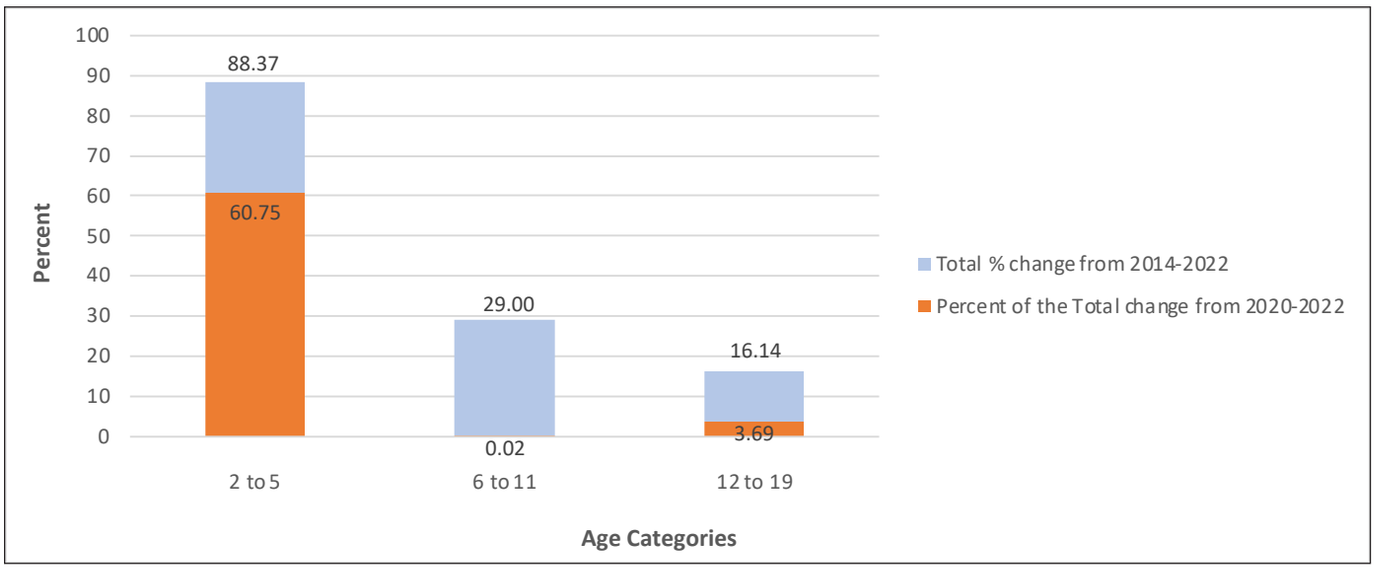
Similar increases among the different age groups were observed when stratifying by sex as seen in **figure 13**. Among the 2-5 year old female population, there was an 88% increase in obesity from 2014-2022 with approximately 61% occurring between 2020-2022. Smaller increases were seen in the 6-11 age group which increased 29% and among 12-19 year old's, there was a more than a 16% increase between 2014-2022.

Figure 13 Obesity Prevalence by Age Group by Year for Females



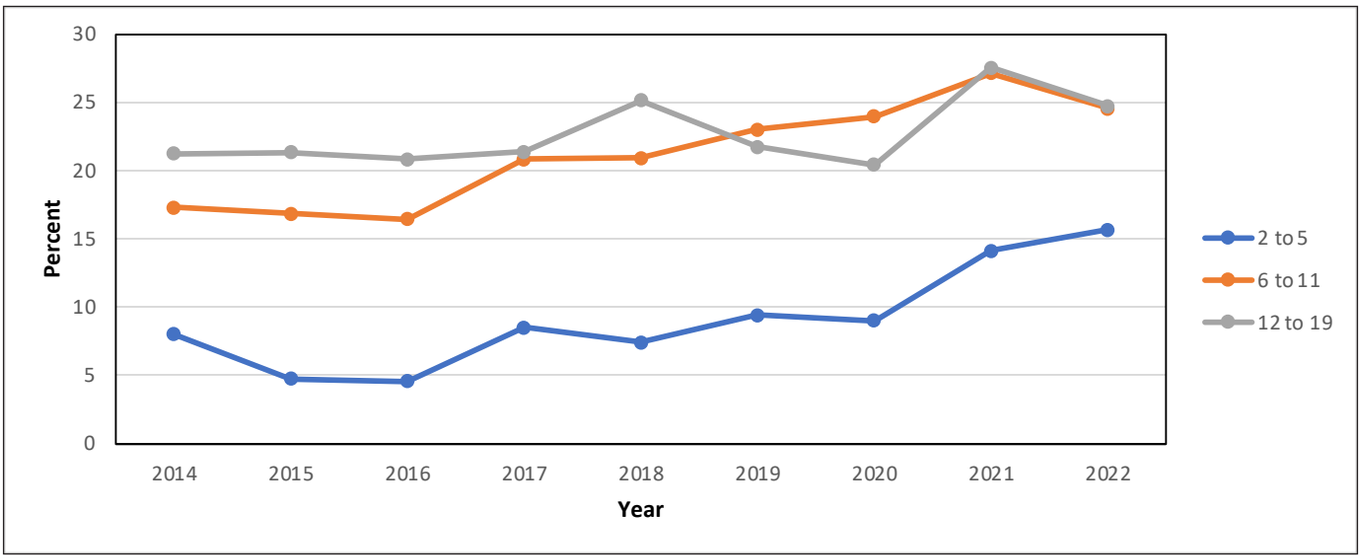
Of the nearly 90% increase in obesity prevalence among 2-5 year-old females from 2014-2022, with 60% of that increase occurred between 2020-2022 as seen in **figure 14**. There were smaller increases during the same periods among the other age groups; while 6-11 year-olds experienced a 29% increase, 12-19- year old's experienced a 16% increase with almost 23% of that occurring during the pandemic.

Figure 14. Percent Change in Obesity Prevalence by Age Group and Year Range for Females



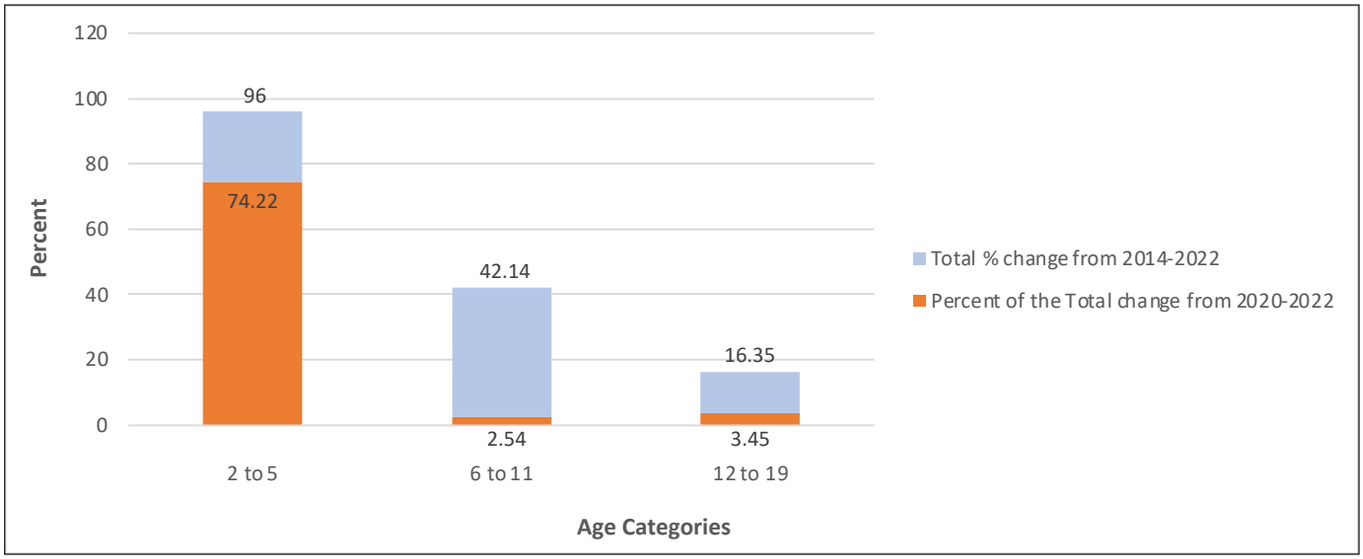
Among males, from 2014-2022, there was 96% increase in obesity prevalence among the 2-5 years, of which approximately 74% occurred between 2020-2022. Among the 6–11-year old's there was a 42% increase and among 12-19 year old's a 16% increase as seen in **figure 15**.

Figure 15. Obesity Prevalence by Age Group by Year for Males



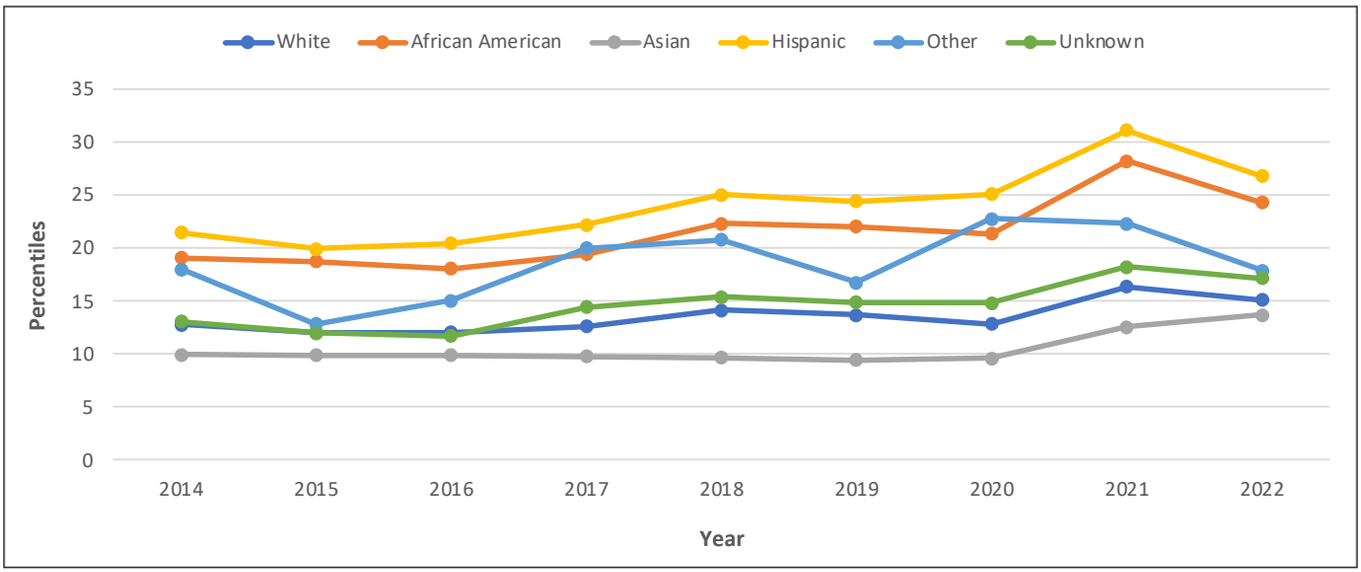
As seen in **figure 16** among 2-5 year-old males, there was a 96% increase in obesity prevalence between 2014-2022, with 74% of that increase occurring during the pandemic. Among 6-11 year-olds there was a 42% increase and among 12-19 year-olds there was a 16% increase with 3.5% of that occurring during the pandemic.

Figure 16. Percent Change in Obesity by Age Categories and Year Range for Males



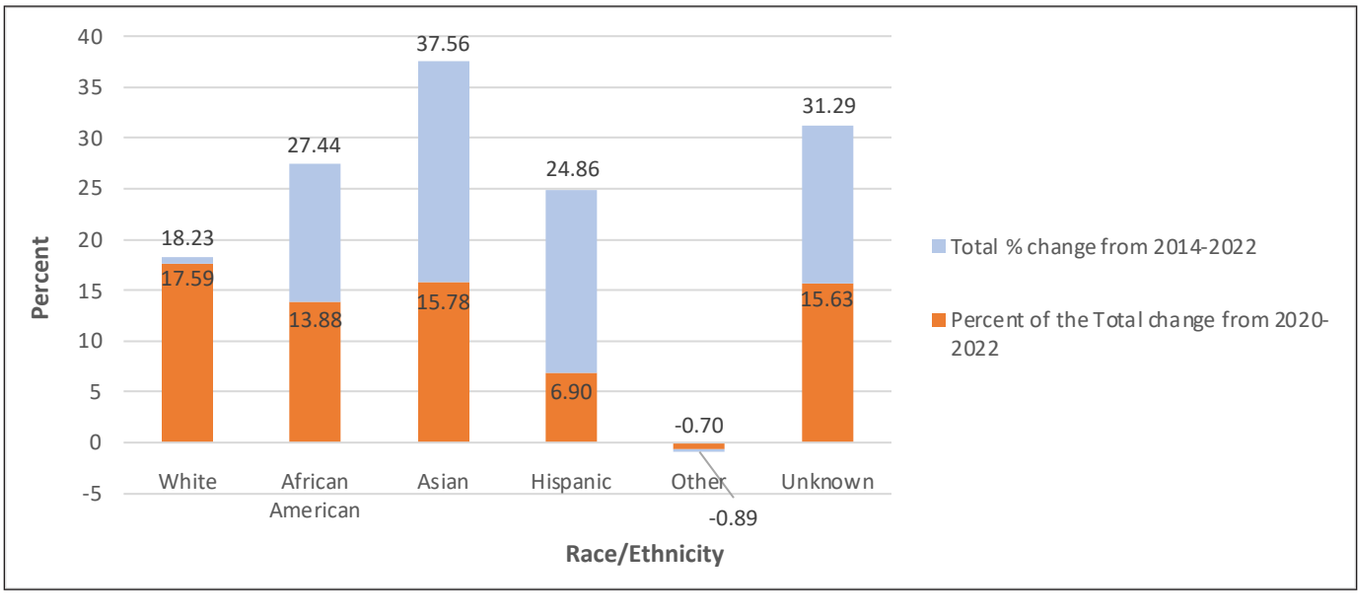
Race and ethnicity are predictors for weight status trends among the population and our results are parallel to U.S. trends in the population. In **figure 17**, among females, we observed that those that identify as Hispanic have the highest rates of obesity between 2014-2022 with a 24% increase in that time period. This is followed by African American females with more than a 27% increase in the same time period. Females that identify as Asian had the highest increase in obesity rates with a more than 37% increase between 2014-2022 and a 42% increase between 2020-2022.

Figure 17. Obesity Prevalence by Race/Ethnicity and Year for 2–19 year-old Females



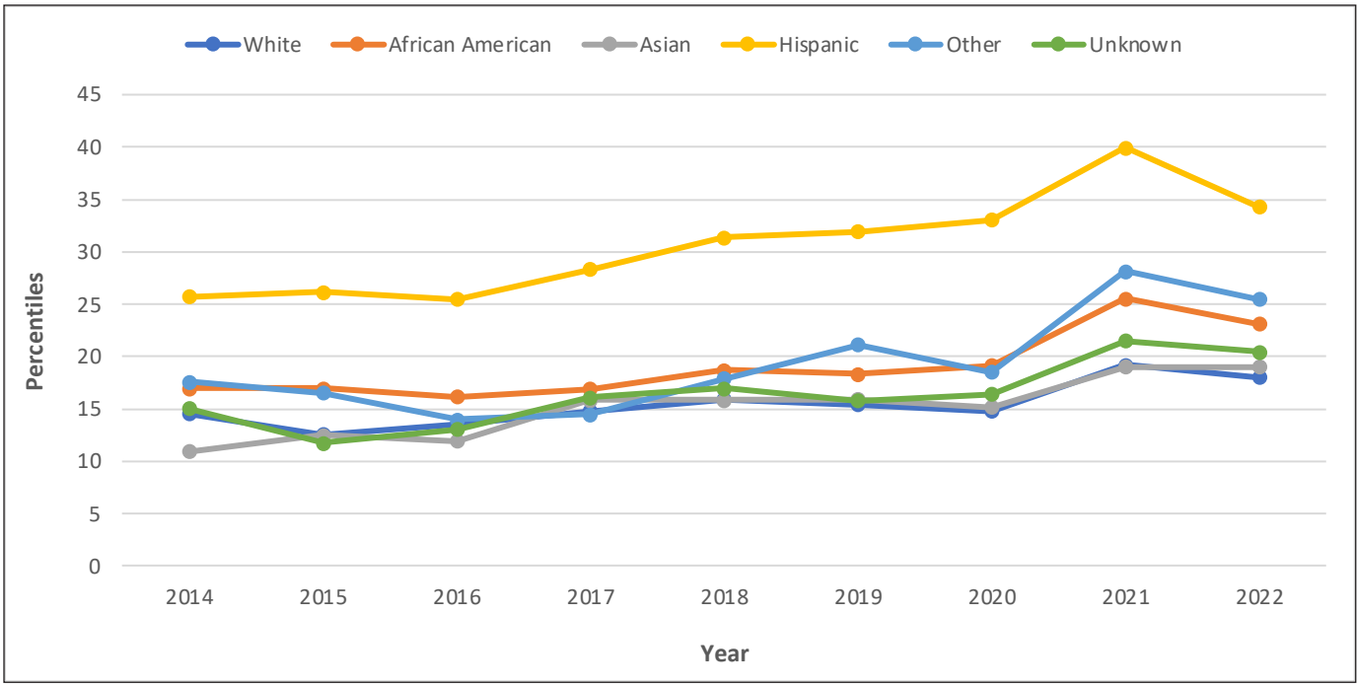
Asian females experienced the largest increase of obesity among all race/ethnicity categories as seen in **figure 18** with a nearly 38% increase between 2014-2022, 42% of which occurred during the pandemic. The "other" category did experience decreasing obesity overall, even during the pandemic.

Figure 18. Percent Change in Obesity Prevalence by Race/Ethnicity and Year Range for 2–19 year-old Females



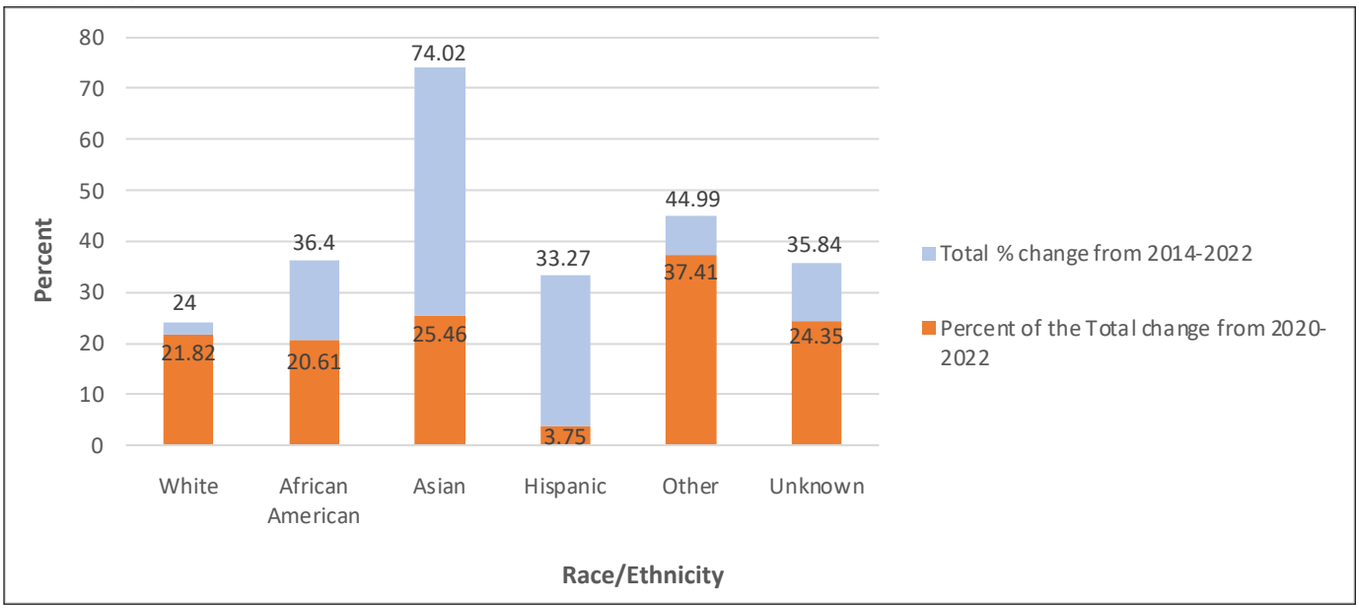
Among the male population, again obesity prevalence is highest among those that identify as Hispanic as seen in **figure 19**. Hispanic males experienced a 33% increase in obesity prevalence between 2014-2022. However, like females, those that identify as Asian had the greatest increase in obesity between 2014-2022 of approximately 74%. With the exception of those that identify as Hispanic, most races and ethnicities experienced more than a 20% increase during the period between 2020-2022.

Figure 19 Obesity Prevalence by Race and Year for 2-19 year-old Males



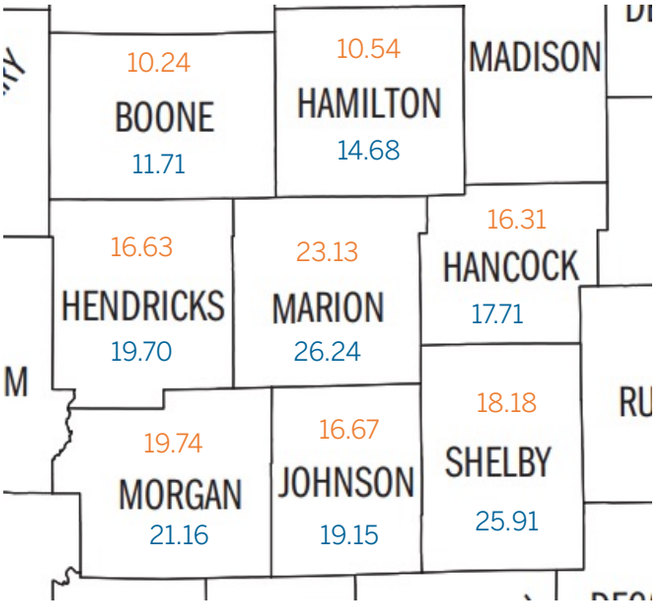
Asian males experienced the largest increase in obesity between 2014-2022 with nearly a third of the increase occurring during the pandemic as seen in **figure 20**. While Hispanic males have higher overall obesity prevalence, the increase during the pandemic was more modest compared to other races/ethnicities.

Figure 20. Percent Change in Obesity Prevalence by Race/Ethnicity and Year Range for 2–19 year-old Males



Prevalence rates by central Indiana counties were calculated and stratified by sex to assess geographic differences. As seen in **figure 21**, there were differences in rates by county, but on average there weren't vast differences between male and female rates within the counties, except for Shelby County in which females were nearly eight percentage points lower than males. The mean difference between males and females outside of Shelby County was 2.46% with the overall difference between male and female obesity rates for all counties assessed was just less than 3%.

Figure 21. Map of Central Indiana and Obesity Prevalence by County by Sex for 2022 among 2–19 year-olds



2022 Obesity Prevalence for Central Indiana

Overall 21.24%

Female 19.75%

Male 22.74%

When assessing obesity prevalence by sex and county of residence, the anticipated increases are evident and can be observed in **figures 22 and 23**. Among females, Marion County has the highest obesity prevalence and experienced a greater than 31% increase in rates between 2014-2022, of which more than 11% occurred between 2020-2022. In Shelby County, however, obesity prevalence among females rose between 2017-2020, but then during the pandemic years (2020-2022), declined nearly 16% increasing on average more than 15% in other counties.

Figure 22. Obesity Prevalence by Year and County 2–19 year-old Females

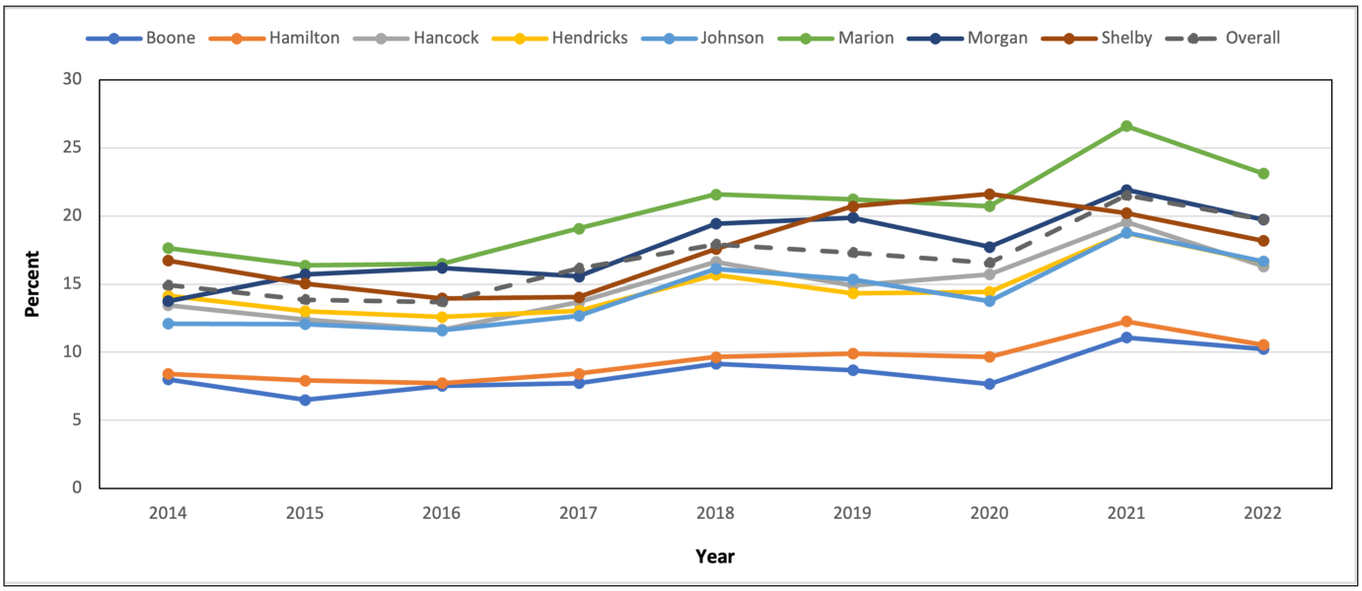
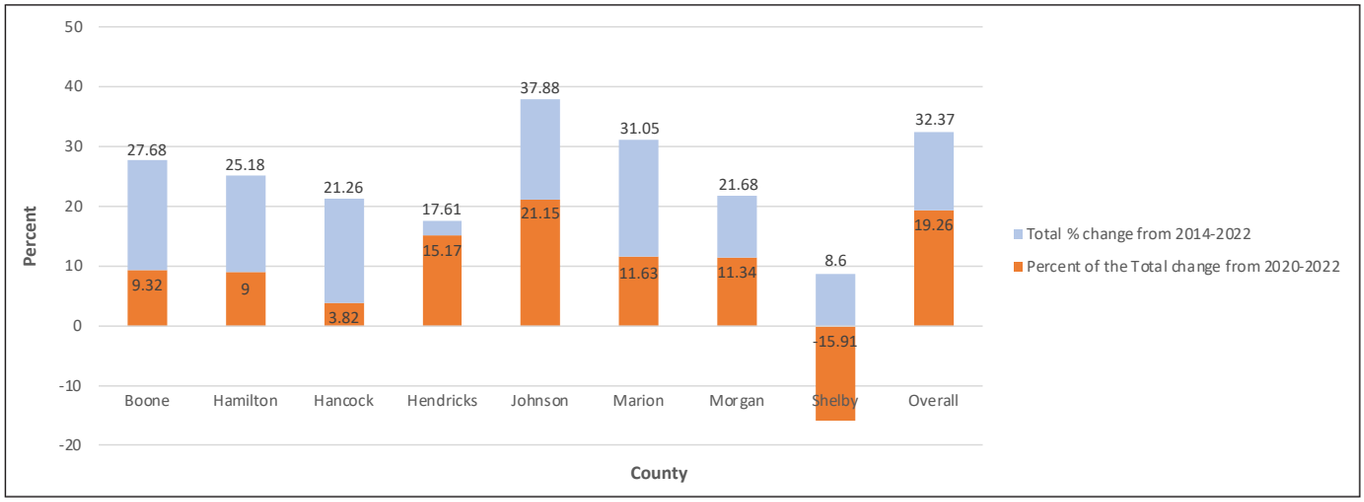


Figure 23. Percent Change in Prevalence by Year and County of Residence for 2–19 year-old Females



When assessing the male population by county of residence, Marion County males typically have the highest rates of obesity between 2014-2022 as seen in **figure 24**. Marion County male obesity prevalence increased by more than 44% between 2014-2022, with more than 15% occurring between 2020-2022, which can be seen in **figure 25**. Shelby County males experienced the greatest increase during the data period (54%). Unlike Shelby County females, males experienced an increase of more than 10% during the pandemic years (2020-2022).

Figure 24. Obesity Prevalence by Year and County for 2–19 year-old Males

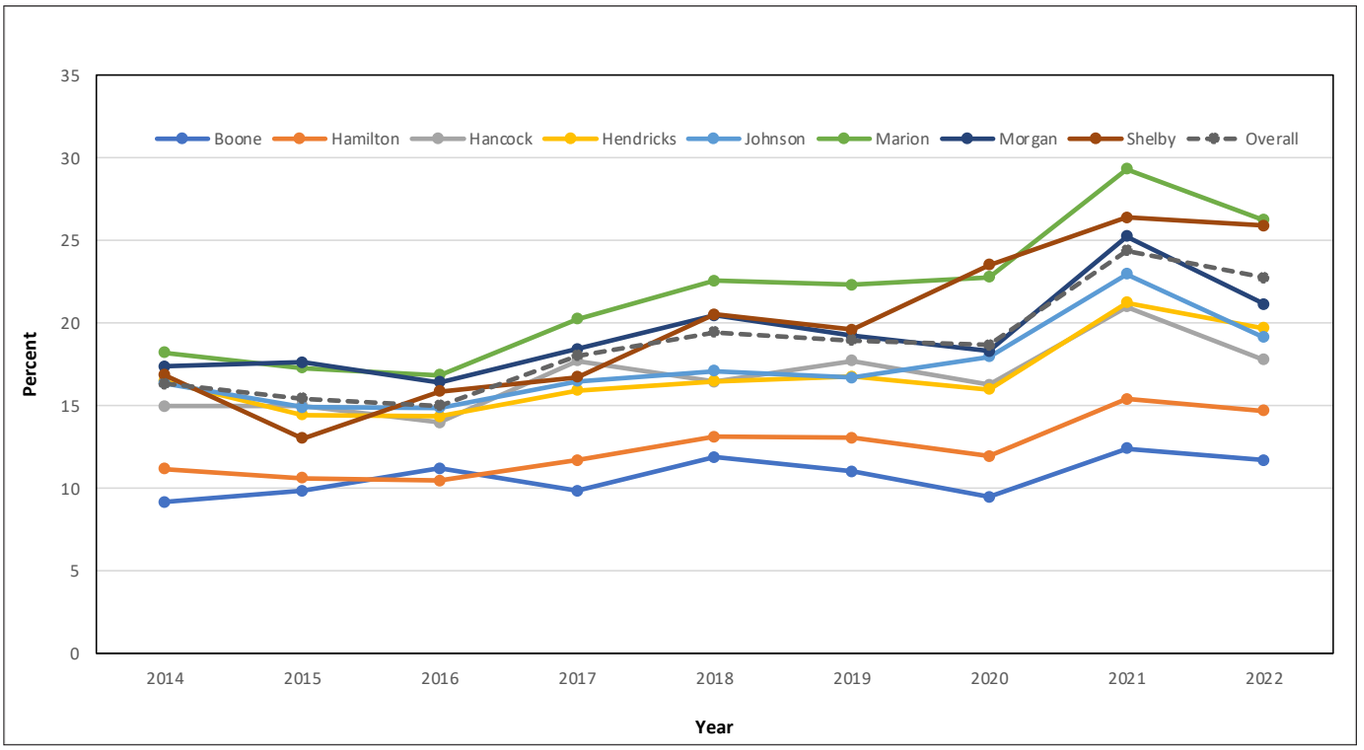
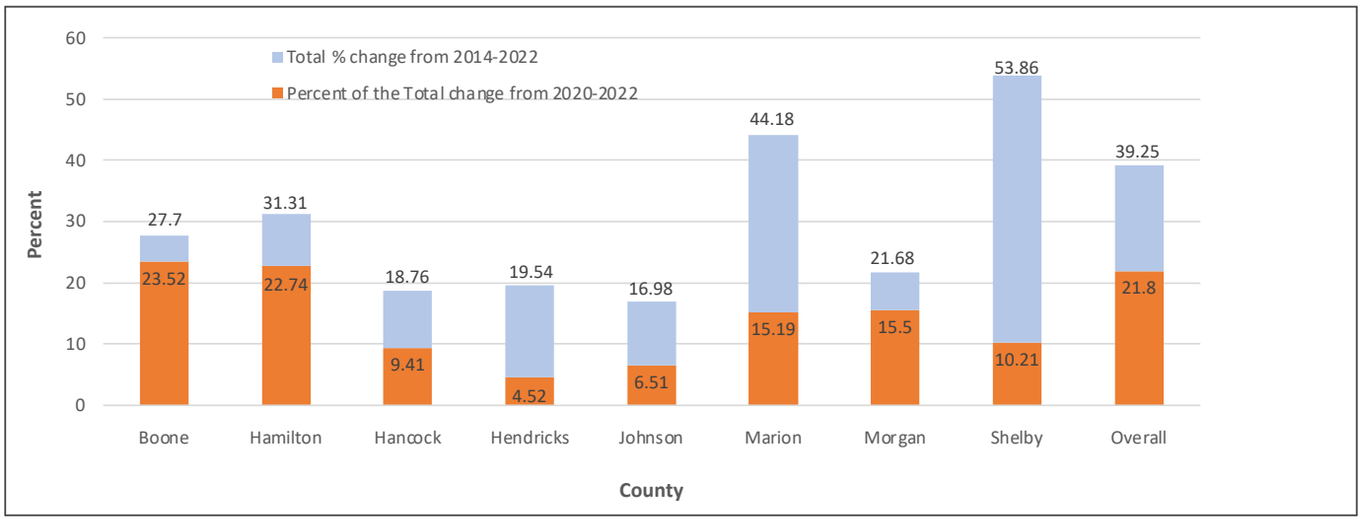
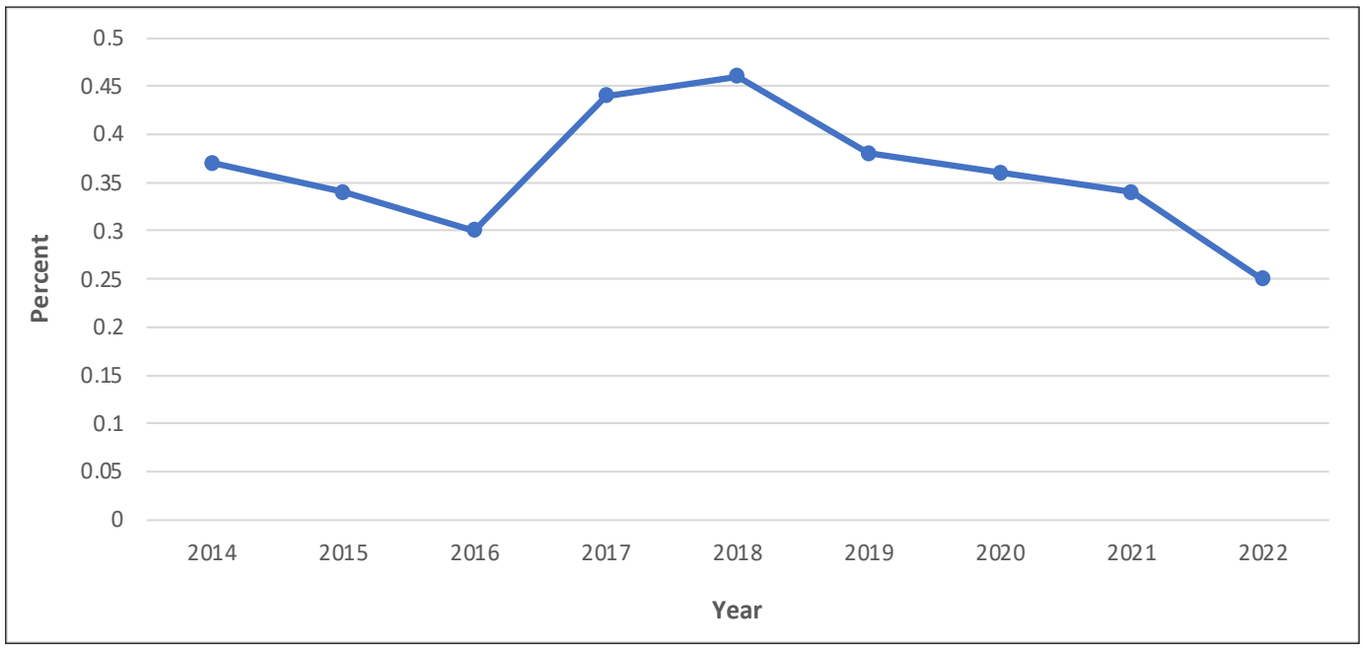


Figure 25. Percent Change in Prevalence by Year and County of Residence for 2-19 year-old Males



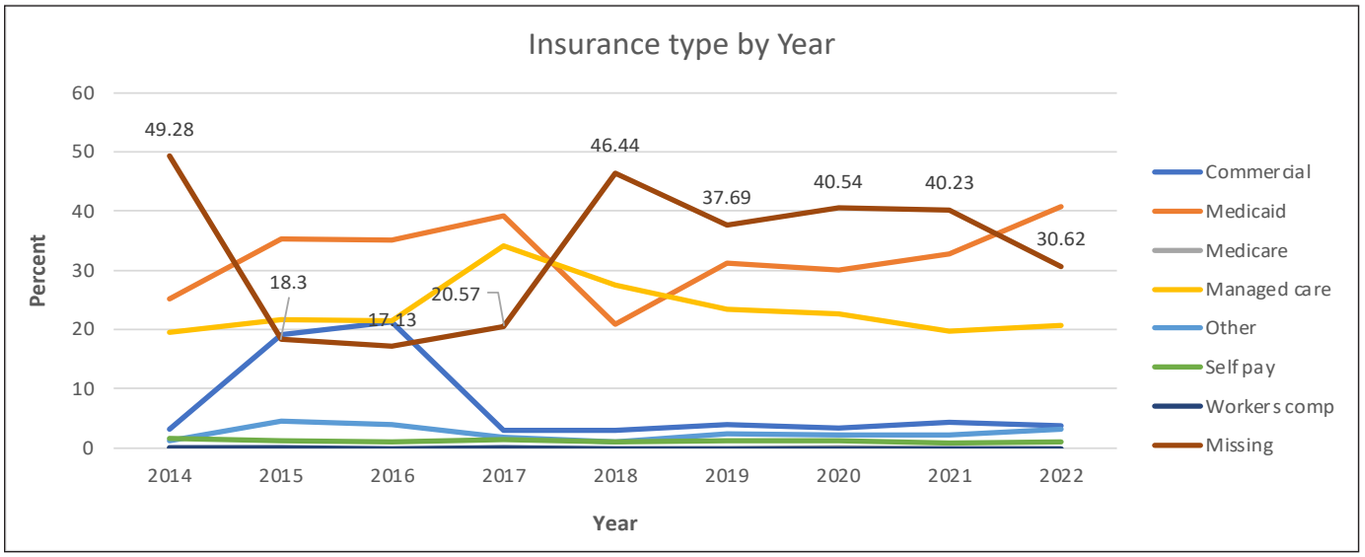
Assessing the prevalence of diabetes among the sample population is an important trend to measure since it is a known sequela of obesity. Among the sample, the overall prevalence is less than 1% as seen in **figure 26** which translates to just over three thousand diagnosed in the sample. There is an increase in the overall trend beginning in 2016 that continues through 2018 and then has a gradual decline.

Figure 26. Percent of Those with Diabetes Diagnosis by Year for 2-19 year-olds, Central Indiana (N=3,031)



The data utilized in this report were extracted from clinical encounters with the healthcare system in central Indiana. Data collection for this study included the type of insurance that was presented at the healthcare encounter. Approximately 34% of the sample was missing the type of insurance. Among those with known insurance type, the highest percentage utilized Medicaid, followed by a managed care insurance as seen in **figure 27**.

Figure 27. Insurance Type Utilization by Year among 2-19 year-olds (missing insurance type percentages shown)



Discussion

Over the past decade there were fluctuations in prevalence trends for childhood underweight, healthy weight, overweight, and obesity, but the overall prevalences of overweight and obesity weights have increased, while healthy weight prevalence decreased. Increases in obesity prevalence are evident across age groups, county of residence, race/ethnicity, and gender, and have been influenced by unidentified factors as well as the SARS-CoV-2 pandemic. While a majority of the study population experienced increases in obesity prevalence, the data indicate that there may be a decline starting in 2022 as the U.S. transitioned from the pandemic to the endemic phase of SARS-CoV-2. Reopening of schools, businesses, and agencies may allow for increases in physical activity and the reactivation of programs that were intended to strengthen nutrition. In addition, increases in healthcare visits may be an influence in what appears to be recent decreases in obesity prevalence by age group, sex, and race. Whether these declines are actual and will be sustained will have to be assessed in the coming years.

As with any research, baseline prevalence measurements were essential to assess the need for interventions. Some of the trends in this study demonstrate differences by characteristics such as age group, race/ethnicity, and geography. For example, differences between male and female obesity prevalence only varied by less than 3%, while obesity prevalence by race/ethnicity indicated starker differences. Obesity is more prevalent among non-white populations in this study. While race and ethnicity are social constructs, there is 3-7% genetic variation among race and ethnic groups, which may not account for the differences in obesity trends (45). Rather, differences in obesity prevalence may reflect in socio-economic status, culture, environment, and the potential for an interaction among all the variables, including genetics (45).

When assessing the age categories of 2-5, 6-11, and 12-19 years of age, there were differences between the groups. The 2-5 year age group experienced a near 100% increase in obesity prevalence between 2014 and 2022, with nearly 70% occurring between 2020-2022. The other age groups of 6-11 and 12-19 experienced more modest increase in obesity prevalence, averaging 33% and almost 3% respectively. The 2-5 year age group is an important time of childhood, since, as reflected in the data, trends tend to level out in the adolescent years. If more children are entering adolescence heavier, then they will level off at a higher rate than previous generations, which puts them at greater risk for adult obesity.

When stratifying the data by county of residence, there are some distinctions that need to be highlighted. Two of the region's more affluent counties have lower increases in obesity rates as compared to other counties, and in one instance, less than half the increase in the larger urban centers. This is contrary to U.S. trends in which children who live in rural areas have between 20-25% increased odds for being overweight or obese as compared to those in urban settings (46). These two counties may not be considered rural, but rather suburban in nature, which may have an impact on the trends in those jurisdictions. This trend may be due to higher levels of socio-economic status or an interaction between socio-economic status, environment, and culture.

Unfortunately, obesity rates in central Indiana tend to be, on average, 1.67 percentage points higher than U.S. rates in the same age groups. In addition, obesity prevalence among Hispanic children in central Indiana is more than 4 percentage points higher and among Asian children is more than 7 percentage points higher than the U.S. rates (20). Prevalence in these age groups and race/ethnic categories are likely influenced by multiple factors, including geographic variations.

Strengths and Limitations

Data utilized in this report are actual anthropometric measurements from provider encounters and physical examinations, thus providing increased accuracy of the data. Not relying on self-reported data is essential as some

research has found that prevalence of underweight was overestimated and overweight and obesity were underestimated when based on self-reported data (47). Additionally, the large sample size allows for a more comprehensive understanding of the populations at risk as we were able to stratify by gender, age group, race/ethnicity, weight categories, and county of residence. These stratifications allow for precision in determining target groups for interventions to conserve and use resources strategically. These data obtained from a health information exchange (HIE) demonstrate the accuracy and the benefits of HIE utilization for a more comprehensive view of the population.

One of the limitations of this study is that the data represent only those that engaged in the healthcare system and do not include those that didn't utilize the healthcare system during the same time period. Healthcare visits dropped substantially during the first year of the pandemic, likely due to fear of nosocomial transmission during the visit (48). Households with special needs children likely experienced a more extensive burden due to the pandemic and may have experienced more missed healthcare visits during this time (49). While engagement with the healthcare community may be returning to pre-pandemic levels, there were missed opportunities during the pandemic to assess health.

Another limitation is the high rate of missing data on the type of insurance that was presented during the healthcare encounter. Most studies agree that there is a positive association between having health insurance and regularly accessing the healthcare system (50). While the data for this report are from healthcare encounters, the "missingness" in insurance data needs to be assessed as to why the data is missing and whether this can be improved. Insurance data is important and could be utilized to improve prevention programs.

Conclusions and Recommendations

Childhood and adolescent obesity represents a serious health problem globally, in the U.S., and in central Indiana. It is the biggest risk factor for adult obesity. Sequalae from childhood and adolescent obesity have been emerging earlier in life, resulting in long-term complications and lower quality of life and life expectancy. Focusing on primordial, primary, and secondary prevention among younger populations translates into primary prevention in the adult populations, as prevention is less expensive than treatment. Primordially speaking, what risk factors can be eliminated to prevent disease from occurring? Primary prevention aims at preventing change transitions among children from healthy weight to overweight and from overweight to obese. Secondary prevention is focused on reversing trends by transitioning children from obese to overweight and from overweight to healthy weight. Unfortunately, there isn't just one simple solution. Rather the problem is multifactorial, which means the solutions must also be multifactorial.

CONCLUSIONS AND RECOMMENDATIONS

While Indiana has some programs focused on improving nutrition and increasing physical activity among children and adolescents, there remains a substantial need for funding opportunities that would enable organizations to implement and sustain new and existing evidence-based programs. The data in this report should be utilized to leverage advocacy efforts at the local and state level with the goal of supporting childhood obesity programs through increased funding. More specifically, children at highest risk could benefit from policy changes within schools and child care settings that support feeding children with healthier options and reducing costs of meals. Another policy change that could help ensure healthy options for school-aged children is to continue offering free breakfasts and lunches year-round. Implementation of healthy best practices food pantries and farmer's markets and nutrition incentive programs and partnerships with community retailers in areas that have been classified as a food desert could help provide healthful and quality food. These opportunities would allow high-risk populations to reduce food and nutrition insecurity and ultimately improve health outcomes for children. Lastly, increased education and outreach to community leaders and stakeholders could create additional funding and partnerships with a goal of reducing childhood obesity. Ultimately, collaboration among community members, organizations and policy leaders is needed to shift the dial in the right direction of reducing risk factors that negatively impact childhood obesity.

References

1. Temple NJ. The Origins of the Obesity Epidemic in the USA-Lessons for Today. Nutrients. 2022 Oct 12;14(20):4253. doi: 10.3390/nu14204253. PMID: 36296935; PMCID: PMC9611578
2. Centers for Disease Control and Prevention, Obesity epidemic increases dramatically in the United States: CDC director calls for national prevention effort. Press Release October 26, 1999, retrieved from: https://www.cdc.gov/media/pressrel/r991026.htm
3. Levine S, Malone E, Lekiachvili A, Briss P. Health Care Industry Insights: Why the Use of Preventive Services Is Still Low. Prev Chronic Dis 2019;16:180625. DOI: http://dx.doi.org/10.5888/pcd16.180625
4. Eknoyan G. A history of obesity, or how what was good became ugly and then bad. Adv Chronic Kidney Dis. 2006 Oct;13(4):421-7. doi: 10.1053/j.ackd.2006.07.002. PMID: 17045228.
5. Haslam D. Obesity: a medical history. Obes Rev. 2007 Mar;8 Suppl 1:31-6. doi: 10.1111/j.1467-789X.2007.00314.x. PMID: 17316298.
6. Bray GA, Greenwood MRC, Hansen BC. The Obesity Society is turning 40: A history of the early years. Obesity (Silver Spring). 2021 Dec;29(12):1978-1981. doi: 10.1002/oby.23319. PMID: 34813174.
7. Blüher M. Obesity: global epidemiology and pathogenesis. Nat Rev Endocrinol. 2019 May;15(5):288-298. doi: 10.1038/s41574-019-0176-8. PMID: 30814686.
8. Seidell JC, Halberstadt J. The global burden of obesity and the challenges of prevention. Ann Nutr Metab. 2015;66 Suppl 2:7-12. doi: 10.1159/000375143. Epub 2015 Jun 2. PMID: 26045323.
9. Henry Blackburn, David Jacobs, Jr, Commentary: Origins and evolution of body mass index (BMI): continuing saga, International Journal of Epidemiology, Volume 43, Issue 3, June 2014, Pages 665–669, https://doi.org/10.1093/ije/dyu061
10. Basile, LM, Rodriguez, J, and Cunneen, SA. The Problem with the BMI published May 7, 2021 and retrieved from https://www.endocrineweb.com/news/problems-with-BMI
11. Nuttall FQ. Body Mass Index: Obesity, BMI, and Health: A Critical Review. Nutr Today. 2015 May;50(3):117-128. doi: 10.1097/NT.0000000000000092. Epub 2015 Apr 7. PMID: 27340299; PMCID: PMC4890841.
12. Centers for Disease Control and Prevention, Healthy Weight, Nutrition, and Physical Activity, Assessing Your Weight, About Adult BMI retrieved on March 23, 2023 from https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html
13. Basile, LM. The Problem with BMI, (2021). Endocrineweb News and Research, Retrieved March 23, 2023, from https://www.endocrineweb.com/news/problems-with-BMI
14. American Medical Association: AMA adopts new policy clarifying role of BMI as a measure in medicine. Retrieved on June 21, 2023 from : https://www.ama-assn.org/press-center/press-releases/ama-adopts-new-policy-clarifying-role-bmi-measure-medicine
15. Public Health: Obesity in America retrieved on March 31, 2023 from https://www.publichealth.org/public-awareness/obesity/#:~:text=Scientific%20studies%20often%20reach%20conflicting,food%20and%20too%20little%20exercise.
16. McAllister EJ, Dhurandhar NV, Keith SW, Aronne LJ, Barger J, Baskin M, Benca RM, Biggio J, Boggiano MM, Eisenmann JC, Elobeid M, Fontaine KR, Gluckman P, Hanlon EC, Katzmarzyk P, Pietrobelli A, Redden DT, Ruden DM, Wang C, Waterland RA, Wright SM, Allison DB. Ten putative contributors to the obesity epidemic. Crit Rev Food Sci Nutr.

REFERENCES

2009 Nov;49(10):868-913. doi: 10.1080/10408390903372599. PMID: 19960394; PMCID: PMC2932668.

17. Lopez R. Urban sprawl and risk for being overweight or obese. Am J Public Health. 2004 Sep;94(9):1574-9. doi: 10.2105/ajph.94.9.1574. PMID: 15333317; PMCID: PMC1448496.
18. Ghosh-Dastidar B, Cohen D, Hunter G, Zenk SN, Huang C, Beckman R, Dubowitz T. Distance to store, food prices, and obesity in urban food deserts. Am J Prev Med. 2014 Nov;47(5):587-95. doi: 10.1016/j.amepre.2014.07.005. Epub 2014 Sep 10. PMID: 25217097; PMCID: PMC4205193.
19. Chrisinger BW, DiSantis KI, Hillier AE, Kumanyika SK. Family food purchases of high- and low-calorie foods in full-service supermarkets and other food retailers by Black women in an urban US setting. Prev Med Rep. 2018 Mar 1;10:136-143. doi: 10.1016/j.pmedr.2018.02.018. Erratum in: Prev Med Rep. 2020 Dec 10;20:101282. PMID: 29755932; PMCID: PMC5945917.
20. Centers for Disease Control and Prevention, Overweight and Obesity, Childhood Obesity Facts, retrieved on March 23, 2023, from https://www.cdc.gov/obesity/data/childhood.html
21. Ogden CL, Carroll MD, Fakhouri TH, et al. Prevalence of Obesity Among Youths by Household Income and Education Level of Head of Household – United States 2011-2014. MMWR Morb Mortal Wkly Rep 2018;67:186-189 DOI: http://dx.doi.org/10.15585/mmwr.mm6706a3
22. Hong I, Coker-Bolt P, Anderson KR, Lee D, Velozo CA. Relationship Between Physical Activity and Overweight and Obesity in Children: Findings From the 2012 National Health and Nutrition Examination Survey National Youth Fitness Survey. Am J Occup Ther. 2016 Sep-Oct;70(5):7005180060p1-8. doi: 10.5014/ajot.2016.021212. PMID: 27548862; PMCID: PMC4993132.
23. National Bureau of Economic Research, Bulletin on Aging and Health, Would More Physical Education Reduce Youth Overweight? No. 3, September 2005. Retrieved on March 31, 2023 from https://www.nber.org/bah/2005number2/would-more-physical-education-reduce-youth-overweight
24. Kühr P, Lima RA, Grøntved A, Wedderkopp N, Klakk H. Three times as much physical education reduced the risk of children being overweight or obese after 5 years. Acta Paediatr. 2020 Mar;109(3):595-601. doi: 10.1111/apa.15005. Epub 2019 Oct 16. PMID: 31509297; PMCID: PMC7028115.
25. Pradinuk M, Chanoine JP, Goldman RD. Obesity and physical activity in children. Can Fam Physician. 2011 Jul;57(7):779-82. PMID: 21753100; PMCID: PMC3135442.
26. Haqq AM, Kebbe M, Tan Q, Manco M, Salas XR. Complexity and Stigma of Pediatric Obesity. Child Obes. 2021 Jun;17(4):229-240. doi: 10.1089/chi.2021.0003. Epub 2021 Mar 29. PMID: 33780639; PMCID: PMC8147499.
27. Iguacel I, Gasch-Gallén Á, Ayala-Marín AM, De Miguel-Etayo P, Moreno LA. Social vulnerabilities as risk factor of childhood obesity development and their role in prevention programs. Int J Obes (Lond). 2021 Jan;45(1):1-11. doi: 10.1038/s41366-020-00697-y. Epub 2020 Oct 8. PMID: 33033393.
28. Caprio S, Daniels SR, Drewnowski A, Kaufman FR, Palinkas LA, Rosenbloom AL, Schwimmer JB. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment: a consensus statement of Shaping America's Health and the Obesity Society. Diabetes Care. 2008 Nov;31(11):2211-21. doi: 10.2337/dc08-9024. PMID: 18955718; PMCID: PMC2571048.

29. Centers for Disease Control and Prevention, Healthy Weight, Nutrition, and Physical Activity, Assessing Your Weight, About Child and Teen BMI. Retrieved on March 27, 2023, from https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html
30. Centers for Disease Control and Prevention, National Center for Health Statistics. CDC Growth Charts: United States. Retrieved on April 20, 2023 from https://www.cdc.gov/growthcharts/background.htm#:~:text=The%201977%20growth%20charts%20were,of%20a%20child%20is%20adequate.
31. Akhabue E, Perak AM, Chan C, Greenland P, Allen NB. Racial Differences in Rates of Change of Childhood Body Mass Index and Blood Pressure Percentiles. J Pediatr. 2018 Nov;202:98-105.e6. doi: 10.1016/j.jpeds.2018.07.023. Epub 2018 Aug 31. PMID: 30177351; PMCID: PMC6203603.
32. Grant-Guimaraes J, Feinstein R, Laber E, Kosoy J. Childhood Overweight and Obesity. Gastroenterol Clin North Am. 2016 Dec;45(4):715-728. doi: 10.1016/j.gtc.2016.07.007. PMID: 27837784.
33. Ling J, Chen S, Zahry NR, Kao TA. Economic burden of childhood overweight and obesity: A systematic review and meta-analysis. Obes Rev. 2023 Feb;24(2):e13535. doi: 10.1111/obr.13535. Epub 2022 Nov 27. PMID: 36437105; PMCID: PMC10078467.
34. Centers for Disease Control and Prevention, COVID-19, Underlying Medical Conditions Associated with Higher Risk for Severe COVID-19: Information for Healthcare Professionals. Retrieved April 14, 2023, from https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-care/underlyingconditions.html#print
35. Gao YD, Ding M, Dong X, Zhang JJ, Kursat Azkur A, Azkur D, Gan H, Sun YL, Fu W, Li W, Liang HL, Cao YY, Yan Q, Cao C, Gao HY, Brüggen MC, van de Veen W, Sokolowska M, Akdis M, Akdis CA. Risk factors for severe and critically ill COVID-19 patients: A review. Allergy. 2021 Feb;76(2):428-455. doi: 10.1111/all.14657. Epub 2020 Dec 4. PMID: 33185910.
36. Belchior-Bezerra M, Lima RS, Medeiros NI, Gomes JAS. COVID-19, obesity, and immune response 2 years after the pandemic: A timeline of scientific advances. Obes Rev. 2022 Oct;23(10):e13496. doi: 10.1111/obr.13496. Epub 2022 Jul 15. PMID: 35837843; PMCID: PMC9349458.
37. Khubchandani J, Price JH, Sharma S, Wiblishauser MJ, Webb FJ. COVID-19 pandemic and weight gain in American adults: A nationwide population-based study. Diabetes Metab Syndr. 2022 Jan;16(1):102392. doi: 10.1016/j.dsx.2022.102392. Epub 2022 Jan 10. PMID: 35030452; PMCID: PMC8743853.
38. Jha S, Mehendale AM. Increased Incidence of Obesity in Children and Adolescents Post-COVID-19 Pandemic: A Review Article. Cureus. 2022 Sep 20;14(9):e29348. doi: 10.7759/cureus.29348. PMID: 36284800; PMCID: PMC9582903.
39. Kaiser Permanente: Health and Wellness: Research and Innovation. "Young Children Gained Weight During the Pandemic". Retrieved April 14, 2023, from https://about.kaiserpermanente.org/health-and-wellness/health-research/news/young-children-gained-weight-during-the-pandemic
40. Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, and Obesity: Preventing Childhood Obesity: 4 Things Families Can Do. Retrieved on April 14, 2023, from https://www.cdc.gov/nccdphp/dnpao/features/childhood-obesity/index.html
41. Galson SK. Childhood overweight and obesity prevention. Public Health Rep. 2008 May-Jun;123(3):258-9. doi: 10.1177/003335490812300302. PMID: 19006963; PMCID:

PMC2289973.
42. Pandita A, Sharma D, Pandita D, Pawar S, Tariq M, Kaul A. Childhood obesity: prevention is better than cure. Diabetes Metab Syndr Obes. 2016 Mar 15;9:83-9. doi: 10.2147/DMSO.S90783. PMID: 27042133; PMCID: PMC4801195.
43. Janssen X, Martin A, Hughes AR, Hill CM, Kotronoulas G, Hesketh KR. Associations of screen time, sedentary time and physical activity with sleep in under 5s: A systematic review and meta-analysis. Sleep Med Rev. 2020 Feb;49:101226. doi: 10.1016/j.smrv.2019.101226. Epub 2019 Nov 1. PMID: 31778942; PMCID: PMC7034412.
44. Hammond RA, Levine R. The economic impact of obesity in the United States. Diabetes Metab Syndr Obes. 2010 Aug 30;3:285-95. doi: 10.2147/DMSOTT.S7384. PMID: 21437097; PMCID: PMC3047996.
45. Caprio S, Daniels SR, Drewnowski A, Kaufman FR, Palinkas LA, Rosenbloom AL, Schwimmer JB. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment: a consensus statement of Shaping America's Health and the Obesity Society. Diabetes Care. 2008 Nov;31(11):2211-21. doi: 10.2337/dc08-9024. PMID: 18955718; PMCID: PMC2571048.
46. Flattum, C., Friend, S., Horning, M. et al. Family-focused obesity prevention program implementation in urban versus rural communities: a case study. BMC Public Health 21, 1915 (2021). https://doi.org/10.1186/s12889-021-11967-3
47. Rios-Leyvraz M, Ortega N, Chiolero A. Reliability of Self-Reported Height and Weight in Children: A School-Based Cross-Sectional Study and a Review. Nutrients. 2022 Dec 23;15(1):75. doi: 10.3390/nu15010075. PMID: 36615731; PMCID: PMC9824624.
48. Schroeder AR, Dahlen A, Purington N, Alvarez F, Brooks R, Destino L, Madduri G, Wang M, Coon ER. Healthcare utilization in children across the care continuum during the COVID-19 pandemic. PLoS One. 2022 Oct 27;17(10):e0276461. doi: 10.1371/journal.pone.0276461. PMID: 36301947; PMCID: PMC9612476.
49. Liu S, Lombardi J, Fisher PA. The COVID-19 Pandemic Impact on Households of Young Children With Special Healthcare Needs. J Pediatr Psychol. 2022 Feb 14;47(2):158-170. doi: 10.1093/jpepsy/jsab135. PMID: 34957525; PMCID: PMC8755305.
50. Institute of Medicine (US) Committee on the Consequences of Uninsurance. Care Without Coverage: Too Little, Too Late. Washington (DC): National Academies Press (US); 2002. 3, Effects of Health Insurance on Health. Available from: https://www.ncbi.nlm.nih.gov/books/NBK220636/

Appendices

Appendix A, Data Tables

All data combined frequencies and prevalence by year (%)

	Total	Obese	Overall Percent
2014	103207	16119	15.62
2015	108367	15873	14.43
2016	117605	16859	14.33
2017	72388	12372	17.09
2018	85352	15926	18.66
2019	92949	16843	18.12
2020	83800	14742	17.59
2021	98718	22636	22.93
2022	86687	18418	21.24

All data combined frequencies and prevalence by year for females (g=]irls) (%)

	Total	Obese	Girls Percent
2014	52091	7770	14.92
2015	54533	7559	13.86
2016	58929	8062	13.68
2017	36308	5866	16.16
2018	43703	7830	17.92
2019	47453	8215	17.31
2020	42847	7094	16.56
2021	50356	10834	21.51
2022	43279	8548	19.75

All data combined frequencies and prevalence by year for males (boys) (%)

	Total	Obese	Boys Percent
2014	51116	8349	16.33
2015	53834	8314	15.44
2016	58676	8797	14.99
2017	36080	6506	18.03
2018	41649	8096	19.44
2019	45496	8628	18.96
2020	40953	7648	18.68
2021	48362	11802	24.4
2022	43408	9870	22.74

Combined prevalence by sex and total by year (%)

	Boys	Girls	Total
2014	16.33	14.92	15.62
2015	15.44	13.86	14.43
2016	14.99	13.68	14.33
2017	18.03	16.16	17.09
2018	19.44	17.92	18.66
2019	18.96	17.31	18.12
2020	18.68	16.56	17.59
2021	24.40	21.51	22.93
2022	22.74	19.75	21.24

Prevalence by weight category by year for females (girls) (%)

Girls	Underweight	Healthy Weight	Overweight	Obese
2014		66.45	18.63	14.92
2015	0.31	67.49	18.34	13.86
2016	0.31	67.63	18.37	13.68
2017	0.5	63.85	19.50	16.16
2018	0.12	62.92	19.05	17.92
2019	0.29	64.82	17.58	17.31
2020	0.68	64.44	18.33	16.56
2021		59.48	19.01	21.51
2022	0.15	59.68	20.42	19.75

Prevalence by weight category by year for males (boys) (%)

Boys	Underweight	Healthy Weight	Overweight	Obese
2014	0.67	66.98	16.02	16.33
2015	1.16	67.56	15.84	15.44
2016	1.16	68.20	15.65	14.99
2017	1.47	64.16	16.34	18.03
2018	0.93	63.16	16.47	19.44
2019	1.19	64.55	15.29	18.96
2020	1.57	63.71	16.04	18.68
2021	0.49	58.54	16.57	24.40
2022	0.76	59.55	16.95	22.74

Prevalence by race/ethnicity by year (%)

	White	African American	Asian	Hispanic	Other
2014	12.78	19.06	9.93	18.02	13.07
2015	12.58	16.99	12.49	26.16	16.57
2016	13.55	16.14	11.96	25.47	13.97
2017	14.82	16.89	15.84	28.35	14.49
2018	15.92	18.74	15.86	31.39	17.93
2019	15.45	18.36	15.91	31.97	21.15
2020	14.80	19.17	15.16	33.05	18.55
2021	19.23	25.54	19.00	39.92	28.13
2022	16.57	23.70	16.49	30.53	21.84

Prevalence of obesity by year for females (girls) by age group (%)

	2 to 5	6 to 11	12 to 19
2014	7.74	16.45	17.72
2015	4.71	15.22	17.69
2016	3.94	14.82	18.00
2017	8.41	18.56	17.92
2018	8.04	18.93	21.30
2019	8.34	20.44	19.53
2020	9.07	21.55	16.75
2021	13.40	24.44	22.71
2022	14.58	21.22	20.58

Prevalence of obesity by year for males (boys) by age group (%)

	2 to 5	6 to 11	12 to 19
2014	8.00	17.30	21.28
2015	4.74	16.87	21.34
2016	4.56	16.46	20.85
2017	8.51	20.85	21.41
2018	7.42	20.93	25.15
2019	9.43	23.03	21.75
2020	9.00	23.98	20.45
2021	14.15	27.16	27.55
2022	15.68	24.59	24.76

Obesity rates by county by year for females (girls) (%)

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Boone	8.02	6.51	7.53	7.75	9.15	8.69	7.66	11.09	10.24
Hamilton	8.42	7.92	7.74	8.43	9.65	9.91	9.67	12.27	10.54
Hancock	13.45	12.39	11.66	13.67	16.62	14.91	15.71	19.55	16.31
Hendricks	14.14	13.01	12.59	13.04	15.69	14.33	14.44	18.75	16.63
Johnson	12.09	12.07	11.61	12.67	16.12	15.35	13.76	18.78	16.67
Marion	17.65	16.38	16.50	19.08	21.58	21.23	20.72	26.59	23.13
Morgan	13.75	15.72	16.18	15.56	19.44	19.88	17.73	21.92	19.74
Shelby	16.74	15.04	13.96	14.04	17.58	20.70	21.62	20.21	18.18
Overall	14.92	13.86	13.68	16.16	17.92	17.31	16.56	21.51	19.75

APPENDIX

Obesity Prevalence by county by year for males (boys) (%)

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Boone	9.17	9.86	11.19	9.86	11.87	11.02	9.48	12.41	11.71
Hamilton	11.18	10.62	10.45	11.70	13.13	13.06	11.96	15.41	14.68
Hancock	14.98	15.00	13.97	17.72	16.44	17.72	16.26	20.99	17.79
Hendricks	16.48	14.44	14.36	15.94	16.48	16.77	16.00	21.23	19.70
Johnson	16.37	14.90	14.87	16.48	17.09	16.70	17.98	22.98	19.15
Marion	18.20	17.29	16.86	20.25	22.56	22.32	22.78	29.34	26.24
Morgan	17.39	17.64	16.41	18.42	20.48	19.22	18.32	25.26	21.16
Shelby	16.84	13.03	15.86	16.73	20.53	19.59	23.51	26.39	25.91
Overall	16.33	15.44	14.99	18.03	19.44	18.96	18.67	24.40	22.74

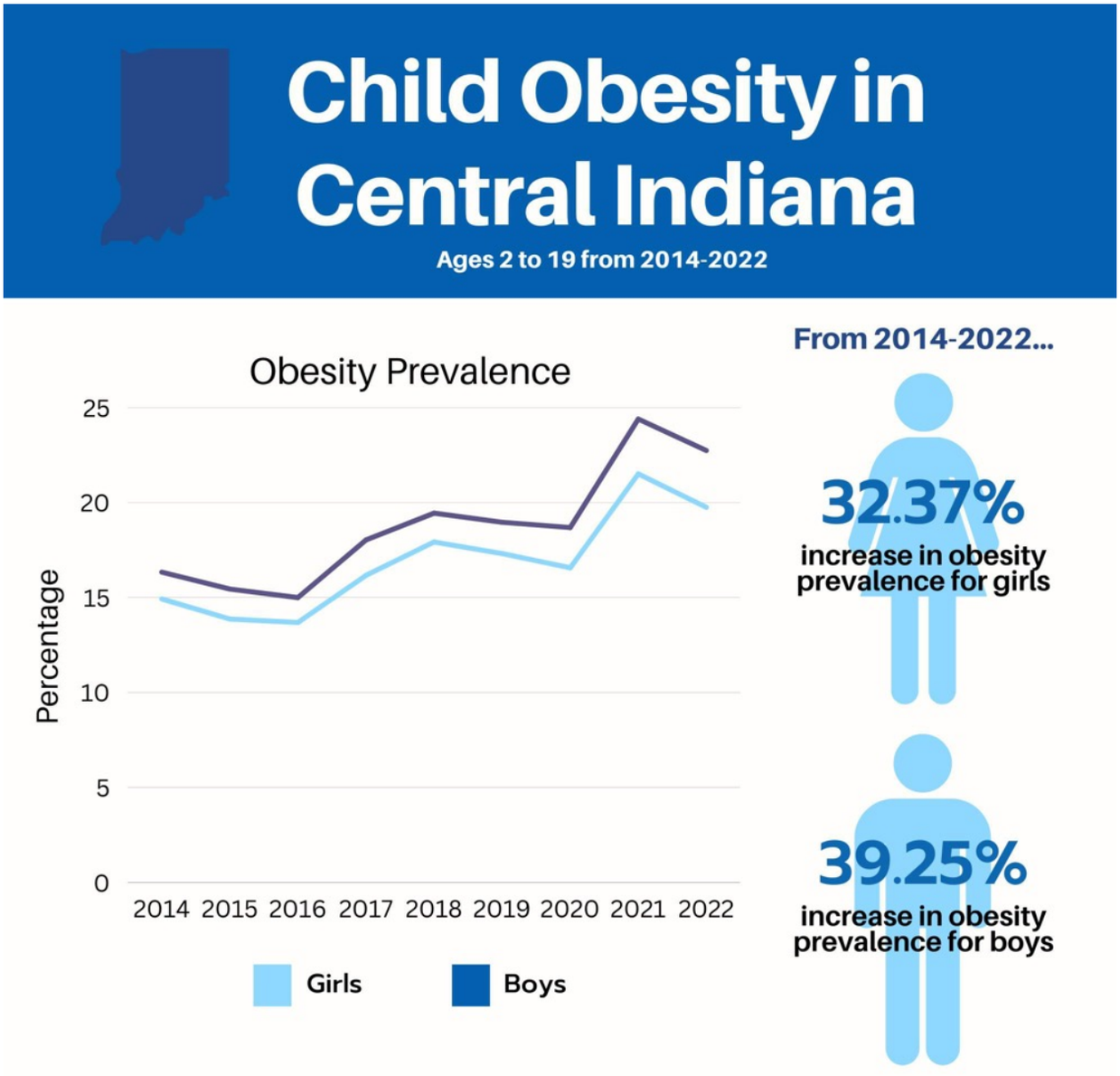
Insurance type percentages by year

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Commercial	3.11	19.04	21.31	2.93	2.95	3.90	3.37	4.25	3.81
Medicaid	25.25	35.2	35.08	39.27	20.97	31.27	30.08	32.8	40.75
Medicare	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Managed Care	19.45	21.58	21.55	34.09	27.56	23.37	22.64	19.65	20.76
Other	1.24	4.51	3.90	1.76	0.98	2.47	2.17	2.15	3.08
Self Pay	1.64	1.29	1.02	1.35	1.08	1.28	1.18	0.89	0.95
Workers Comp	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Missing	49.28	18.3	17.13	20.57	46.44	37.69	40.54	40.23	30.62

Diabetes prevalence by year

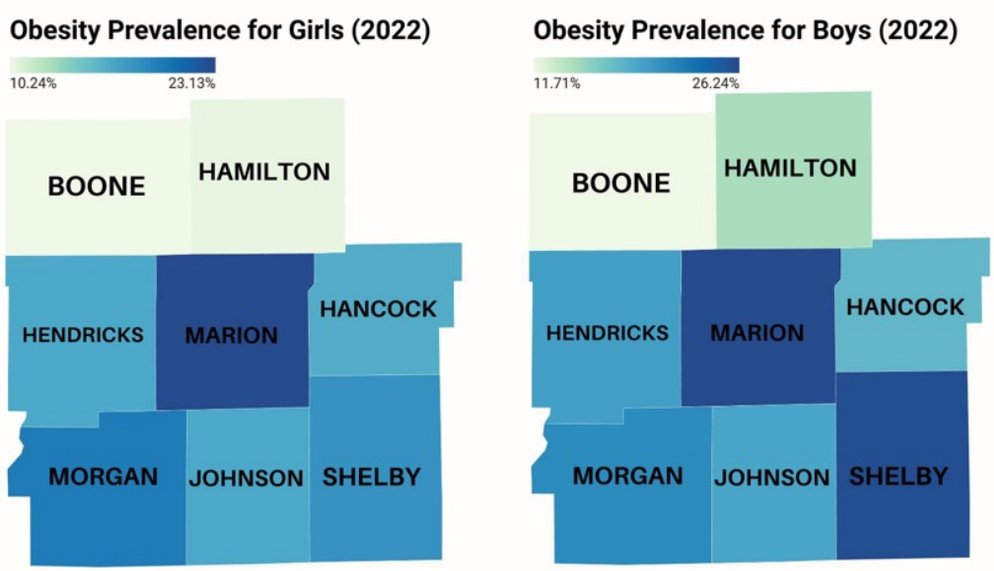
	2014	2015	2016	2017	2018	2019	2020	2021	2022
Diabetes	0.37	0.34	0.30	0.44	0.46	0.38	0.36	0.34	0.25

Appendix B, Infographics



Child Obesity in Central Indiana

Ages 2 to 19 from 2014-2022



Two of the more affluent counties in central Indiana had lower increases and overall prevalence in obesity rates

Child Obesity in Central Indiana

Ages 2 to 19 from 2014-2022

The obesity rate in 2 to 5 year-olds

NEARLY DOUBLED

from 2014-2022 and other age groups saw an average of 33% increase.