A Richard M. Fairbanks Foundation
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The Obesity Epidemic

in Marion County and Indiana

Causes, consequences, and a critical review of solutions to address it

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Executive Summary

Obesity has increased dramatically over the past several decades, becoming one of the most significant preventable causes of morbidity and mortality in the U.S. In Indiana, one in three adults is obese. Obesity rates are even higher in Marion County, where 38.6% of adults are obese. Indiana has the 12th highest rate of obesity among adults and the 11th highest rate of obesity among children and teenagers in the U.S. More than 13% of Indiana's young children from low-income families are obese before they reach kindergarten. In 2018, the Richard M. Fairbanks Foundation commissioned this report to better understand the prevalence, causes, and consequences of obesity and effective solutions to address it.

Causes

Obesity results from an excess of calories consumed compared with those expended, which leads to excess fat. It is a complex condition caused by a multitude of factors. Some genes may make certain individuals more susceptible to obesity; however, the rapid rise in obesity over a relatively short period of time indicates that genetics alone are not the cause of the obesity epidemic. Rather, changes to the environment combined with genetic susceptibility and social determinants have affected health behaviors, leading to a rise in obesity among various populations.

Urban sprawl and land use policies have affected how communities are designed and how easy or difficult it is for people to use active transportation to get to work, school, or other destinations. There is abundant access to cheap, energy-dense, highly palatable foods. People are inundated with marketing for these unhealthy foods and beverages. Families are eating at home less and eating out at restaurants more, where food often comes in larger portion sizes, has more calories, and is less healthful. Most people do not get enough physical activity and consume too much media through television, computers, cell phones, and video games. At worksites, technology advancements have changed the ways people work, and many people are sedentary for hours throughout the day. In schools, not all children have access to daily recess and physical education (PE) class, and unhealthy foods and beverages, such as soda, cookies, and other snack foods, are allowed to compete with more healthful options served through school meal programs.

Consequences

Obesity is associated with serious health consequences, including increased risk of type 2 diabetes, cardiovascular disease, some cancers, arthritis, sleep apnea, liver diseases, kidney diseases, and gallbladder diseases. Obesity also affects socioemotional factors, increasing the risks of depression, low self-esteem, and bullying. Obese individuals may face stigmatization and discrimination in the workplace and in their communities. Obesity is also associated with significant costs to government, healthcare, and individuals. Obesity costs Indiana more than $8 billion per year and Marion County $1.3 billion per year in increased healthcare costs, lost productivity, and premature death.

Assessment of Effective Strategies to Address Obesity

In 2018, we conducted a review and critical analysis of the literature on obesity solutions in five key areas: healthcare, worksites, schools, communities, and policy. We concurrently conducted key informant interviews with local and state leaders from Indiana, as well as national obesity experts, to inform the literature review and recommendations. We identified and reviewed the findings from more than 1,300 studies primarily focused on interventions to prevent or

treat obesity. Our review focused in particular on studies conducted within the last five to 10 years and features some of the most common types of interventions, especially those that are the focus of one or more systematic reviews, meta-analyses, or expert recommendation guidelines reports. This review is comprehensive; however, it does not exhaustively cover all interventions that could be conducted to prevent or treat obesity.

Below are the strategies identified as recommended, promising, or mixed/inconclusive

Healthcare Strategies	Worksite Strategies
RECOMMENDED • Screening for obesity in adults • Multicomponent* weight loss programs for adults • Diet programs for adults • Multicomponent interventions to prevent excessive weight gain in pregnancy • Pharmacotherapy for adults • Bariatric surgery for adults • Screening for obesity in children and adolescents • Multicomponent weight loss programs for children and adolescents	**RECOMMENDED** • Multicomponent interventions to improve diet and physical activity
PROMISING • Baby-Friendly Hospital Initiative	**PROMISING** • Active workstations • Multicomponent interventions to improve diet • Multicomponent interventions to reduce workplace sitting
MIXED/INCONCLUSIVE • Motivational interviewing in primary care for adults • "Prescription" programs for adults • Lifestyle-based interventions for the first 1,000 days • Parent-focused interventions for children five to 11 years old • Technology-based interventions for adolescents • Pharmacotherapy for children and adolescents • Bariatric surgery for adolescents	**MIXED/INCONCLUSIVE** • Information/counseling to reduce sedentary time • Counseling to increase physical activity • Informational strategies to increase physical activity • Exercise or walking programs • Pedometer interventions • Financial incentives for weight loss • Stair use interventions • Modifying the food environment • Breastfeeding supports

*Multicomponent interventions are those that include at least two types of strategies, such as an informational/behavioral intervention and an environmental/policy intervention, or that address multiple behaviors, such as physical activity and fruit and vegetable consumption.

for each key area. Recommended strategies have good and consistent evidence that they reduce body weight, BMI, or other weight-related measures. Promising strategies have some evidence that they positively affect weight-related measures and/or good and consistent evidence that they affect diet, physical activity, or other behaviors associated with obesity. Strategies identified as mixed/inconclusive have either inconsistent evidence of an impact on obesity or its risk factors or too little information to determine effectiveness.

School Strategies	Community Strategies
PROMISING • Physical education programs • Active recess interventions • Cafeteria interventions • Multicomponent interventions to improve diet and physical activity **MIXED/INCONCLUSIVE** • Interventions to increase active travel to school • Classroom-based physical activity breaks • Fresh Fruit and Vegetable Program • Nutrition education programs • Promoting drinking water • School gardening programs • Farm-to-school programs	**PROMISING** • Multicomponent interventions in faith-based institutions • In-store grocery store interventions **MIXED/INCONCLUSIVE** • Nutrition and physical activity policies and practices in child care • Implementing healthy eating standards in afterschool programs • Increasing water intake in afterschool programs • Afterschool physical activity programs • Nutrition environment interventions in colleges • Nutrition education and behavioral interventions in colleges • Physical activity educational interventions in colleges • Weight loss programs in colleges • Community-wide interventions to increase physical activity • Physical activity enhancements to the built environment • Implementing smart growth principles • Locating grocery stores in low-access areas • Community-supported agriculture

Policy Strategies

PROMISING

- Subsidies and grants to improve the physical activity environment
- Nutrition and physical activity regulations in schools
- Land use and zoning requirements (e.g., zoning for fast food establishments)

MIXED/INCONCLUSIVE

- Sugar-sweetened beverage tax
- "Junk food tax" or "fat tax"
- Vouchers to subsidize the purchase of healthy foods
- Subsidies and grants to improve food access
- Professional licensing and credentialing regulations
- Labeling requirements
- Nutrition and physical activity regulations in child care settings
- Provision of training and technical assistance for policy implementation
- Government standards, ratings, or guidelines
- Dissemination of information on new or existing policies and services

Conclusion

Indiana and Marion County have high rates of obesity among both children and adults. This is concerning, because obesity increases risks for chronic diseases, lowers quality of life, and contributes substantially to rising healthcare costs. The dramatic increase in obesity over the past several decades is not the result of changes to the gene pool or the failure of individuals but rather the result of changes to policies and environments, which, along with social determinants, influence health behaviors.

In this comprehensive review and critical analysis of the literature, we identified recommended and promising strategies to address obesity in five key settings. These interventions are most likely to result in changes to weight or behaviors that affect weight, such as dietary intake and physical activity. The most effective solutions are high in intensity, are longer in duration, and address both diet and physical activity. There are many interventions that we are still learning about. These interventions have a rating of mixed/inconclusive, either because the effectiveness of these interventions or policies is inconsistent across studies or because we simply do not have a sufficient number of quality studies to accurately assess the evidence base. This rating does not mean these strategies are ineffective or without merit. Rather, it is reflective of where the field of obesity is more broadly, still searching for the most effective solutions for a condition for which we have seen very little in the way of population-level declines.

Importantly, organizations must not wait until they have the best evidence possible to address obesity. Individuals and organizations must act on the best evidence available today. Since obesity does not have a single cause, no single intervention is likely to reduce obesity in populations. Furthermore, the influence of a single setting alone did not cause the obesity epidemic. To effectively address obesity, groups need to address the changes to policies and environments that have influenced behaviors that led to the obesity epidemic. Strategies must be applied for longer periods of time before results can be expected; the obesity epidemic grew over multiple decades and may take many years to reverse. Population-based solutions should encompass all of the places where individuals live, work, learn, and play and address both prevention and treatment. This means that all types of organizations must be involved as part of the solution; no one organization can reduce obesity on its own. Multisectoral coalitions of partners that work together to design, implement, and evaluate solutions for all of the settings addressed in this report are most likely to be effective in addressing obesity.

Introduction

Obesity is one of the most significant threats to the health and well-being of the residents of Marion County, the State of Indiana, and the United States. In 2017, Indiana had the 12th highest rate of obesity in the country among adults and the 11th highest rate of obesity in the country among children and adolescents. One in seven low-income children ages two to five in Indiana is obese before reaching kindergarten. Obesity increases risk of chronic diseases such as heart disease, type 2 diabetes and some cancers. It also costs the State of Indiana billions of dollars each year in premature death, healthcare costs, absenteeism, and reduced productivity. The purpose of this report is to describe the obesity problem in Indiana and Marion County and identify effective solutions to address obesity in five key areas: healthcare, worksites, schools, communities, and policy.

Defining Obesity

Obesity is a condition in which there is excess body fat. Since body fatness can be difficult and expensive to measure accurately, body mass index (BMI) is frequently used to estimate body fatness.

BMI is associated with body fat and correlated with health risks (Jensen, et al., 2014). BMI is calculated by using height and weight:

$$BMI = \frac{\text{weight in kilograms}}{\text{height in meters squared}} \text{ or } \left(\frac{\text{weight in pounds}}{(\text{height in inches}) \times (\text{height in inches})} \right) \times 703$$

BMI is used to classify adults as underweight, healthy weight, overweight, or obese according to the classifications below in Table 1. Adults with a BMI of 30 or greater are obese. Obesity is subdivided into three classes: Class 1 obesity, Class 2 obesity, and Class 3 obesity, which is sometimes referred to as extreme obesity or severe obesity.

Losing 5% to 10% of initial body weight is considered to be clinically significant weight loss for adults (Jensen, et al., 2014).

In children and adolescents, obesity is defined as having a BMI in the 95th percentile or greater for children and adolescents of the same age and sex (Table 2). BMI is calculated by using the equation above and then plotted on a sex-specific growth chart with the child's age. Sex and age are used to determine children's BMI classification,

Table 1. BMI Classifications for Adults Age 20 and Older

BMI	Weight Classification
Below 18.5	Underweight
18.5 to <25	Healthy weight
25 to <30	Overweight
30 to <35	Obese (Class 1)
35 to <40	Obese (Class 2)
40 and above	Obese (Class 3)

Table 2. BMI Classifications for Children and Adolescents Ages Two to 19

BMI	Weight Classification
Less than 5th percentile	Underweight
5th percentile to <85th percentile	Healthy weight
85th percentile to <95th percentile	Overweight
95th percentile or greater	Obese
120 percent of the 95th percentile	Severe obesity

because body composition varies by age and between boys and girls.

In research studies, BMI z-score is sometimes used for children and adolescents. BMI z-score is "a measure of relative weight adjusted for child age and sex" (Must & Anderson, 2006). Using BMI z-score allows comparisons in results across children of different ages and over time as they grow. The U.S. Preventive Services Task Force has suggested that a reduction in BMI z-score of 0.20 to 0.25 is clinically significant (U.S. Preventive Services Task Force, 2017). However, recently, some researchers and clinicians have suggested BMI z-score may be unreliable and misleading among severely obese children in particular (Kelly & Daniels, 2017).

It is important to note that BMI is an indirect measure of body fatness and a clinical screening tool; it is not used alone to diagnose obesity in individuals and must be considered along with other health assessments. However, when used for populations, BMI is strongly correlated with adverse health outcomes and is the most widely used tool to track and monitor obesity. Other proxy measures for obesity include waist-to-hip ratio (obesity in women: >0.85; obesity in men: >0.9), waist circumference (obesity in women: 35 inches or greater; obesity in men: 40 inches or greater), and measures of skinfold thickness using calipers. Direct measures of body fatness include dual-energy X-ray absorptiometry (DXA), bioelectric impedance (BIA), underwater weighing, air-displacement plethysmography, the dilution method (hydrometry), and computerized tomography and magnetic resonance imaging. Direct measures are less commonly used and tend to be more expensive (Kim, 2016).

Prevalence and Trends in Obesity

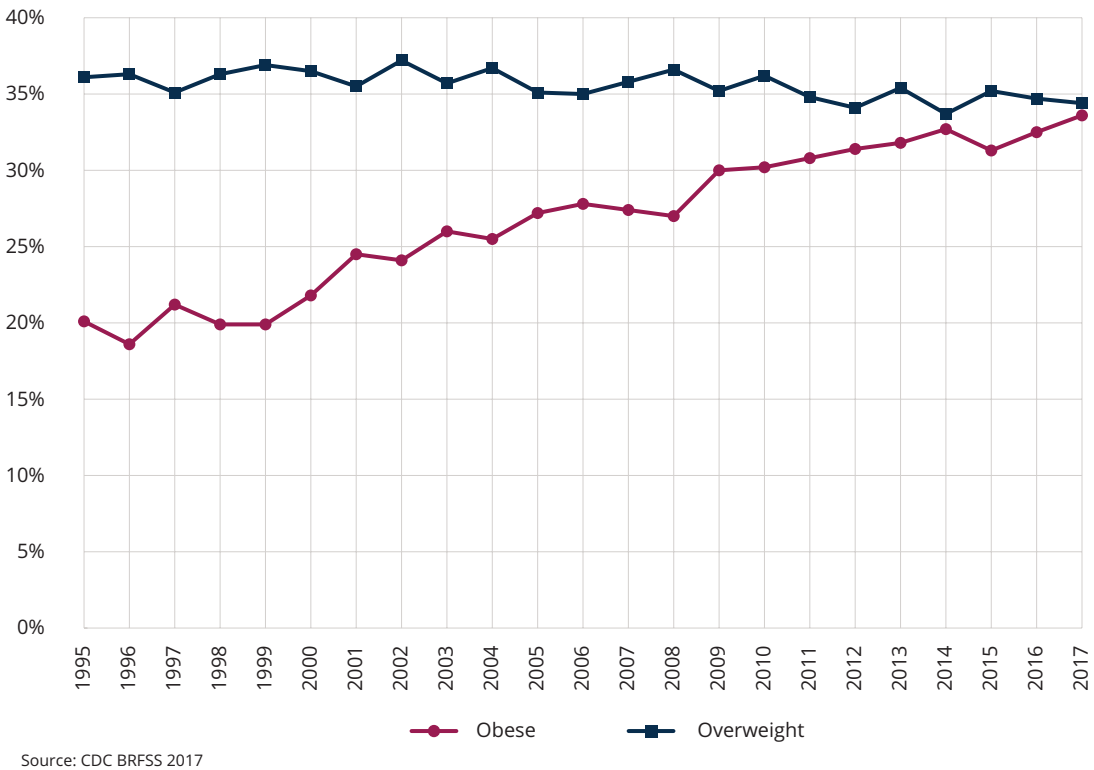
The prevalence of obesity has risen dramatically among adults and children over the past several decades. There have been reports that obesity rates have stabilized in some groups; however, overall obesity rates remain high. In the U.S., 18.5% of youth and 39.8% of adults are obese (Hales, Carroll, Fryar, & Ogden, 2017).

Indiana

Indiana was ranked the 12th most obese state in the U.S. based on 2017 data from the Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System (BRFSS) (Trust for American's Health, 2018). One in three Indiana adults (33.6%) is obese. Obesity and overweight combined affect more than two-thirds of Indiana adults (68.0%) (Centers for Disease Control and Prevention, 2017a). Over the past 20 years, obesity rates have steadily risen, and rates of overweight have remained high (Figure 1).

Obesity affects people of all ages, sometimes starting very early in life. Among Indiana children two to five years old who participated in the Women, Infants, and Children (WIC) program in 2016 and 2017, 13.5% were obese (Indiana State Department of Health, WIC Program, 2017). The prevalence of obesity among Indiana children and teenagers in 2016–2017 was 17.5%, the 11th

Figure 1. Overweight and Obesity in Indiana, 1995–2017



Source: CDC BRFSS 2017

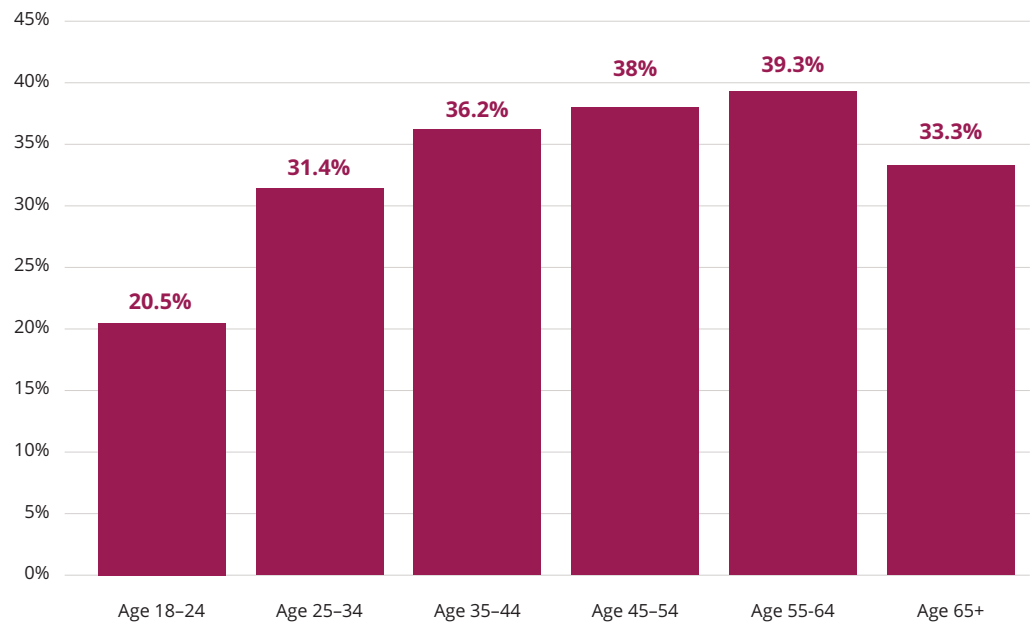
highest rate of obesity in the U.S. for this age group (Child and Adolescent Health Measurement Initiative, 2018). Obesity rates continue to climb through adulthood before declining among older adults (Figure 2).

Obesity affects people of all races and ethnicities; however, some groups are disproportionately affected by obesity. For example, in Indiana, black adults have a 31% higher prevalence of obesity compared with white adults (Figure 3).

Obesity is a risk factor for type 2 diabetes, and it is estimated that 87.5% of people with type 2 diabetes are overweight or obese (Centers for Disease Control and Prevention, 2017b). In Indiana, 11.8% of adults have type 2 diabetes, and the prevalence steadily increases with age (Centers for Disease Control and Prevention, 2017a) (Figure 4). American Indian or Alaskan Native non-Hispanic individuals in Indiana have the highest rate of type 2 diabetes: 19.6% (Figure 5).

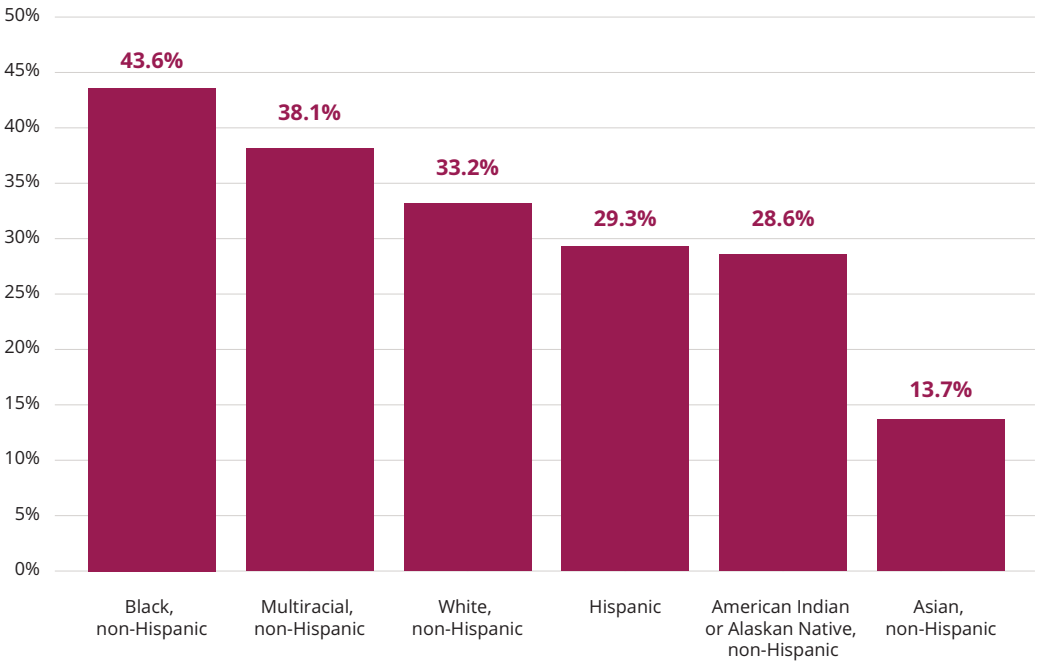
Obesity, particularly abdominal obesity (excessive fat around the stomach and abdomen), is also a risk factor for cardiovascular diseases such as hypertension, stroke, and coronary artery disease, including heart attack. Adults who are overweight or obese have a significantly increased risk of developing cardiovascular disease. Compared with healthy weight adults, adults who are overweight have a 21% to 32% greater risk of having cardiovascular disease in their lifetime, and adults who are obese have a 67% to 85% greater risk of having cardiovascular disease in their lifetime (Khan, Ning, & Wilkins, 2018). In Indiana,

Figure 2. Indiana Obesity Prevalence by Age, 2017



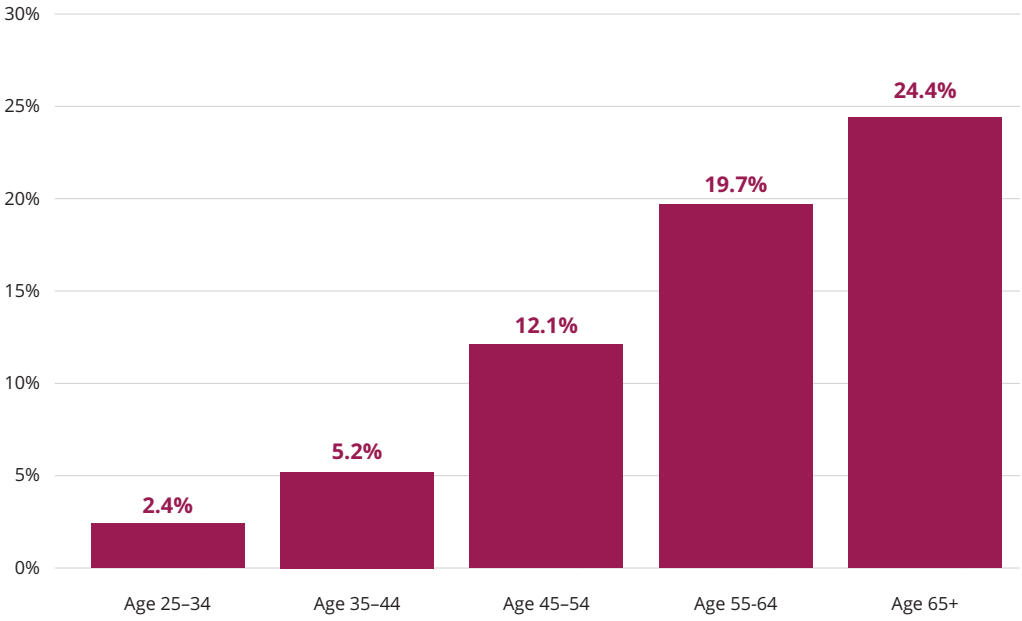
Source: CDC BRFSS 2017

Figure 3. Indiana Obesity Prevalence, by Race/Ethnicity, 2017



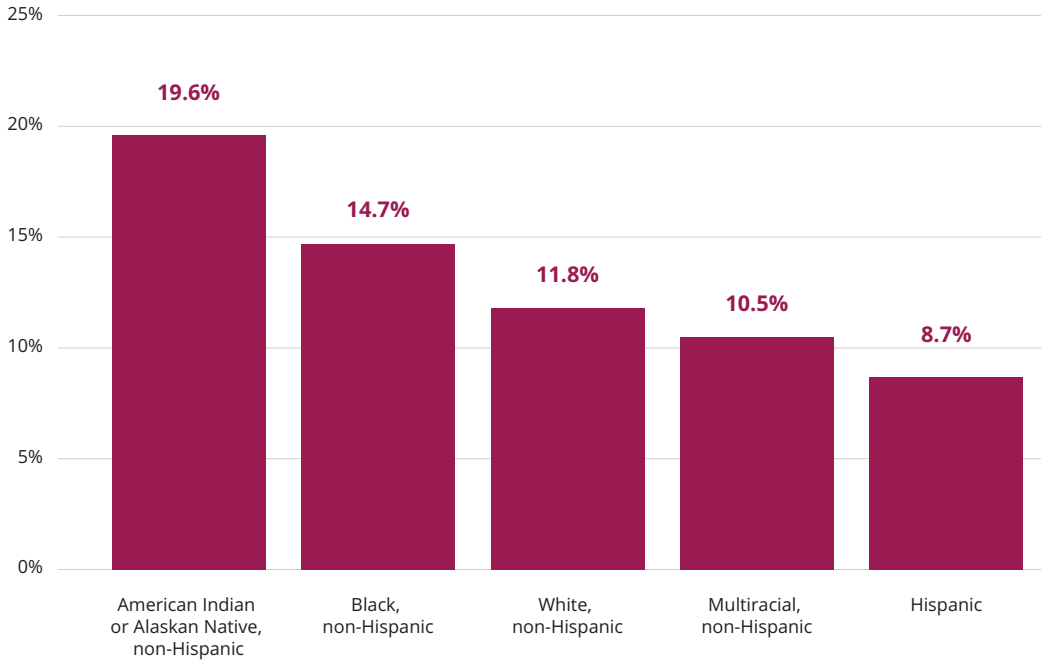
Source: CDC BRFSS 2017

Figure 4. Indiana Type 2 Diabetes Prevalence, by Age, 2017



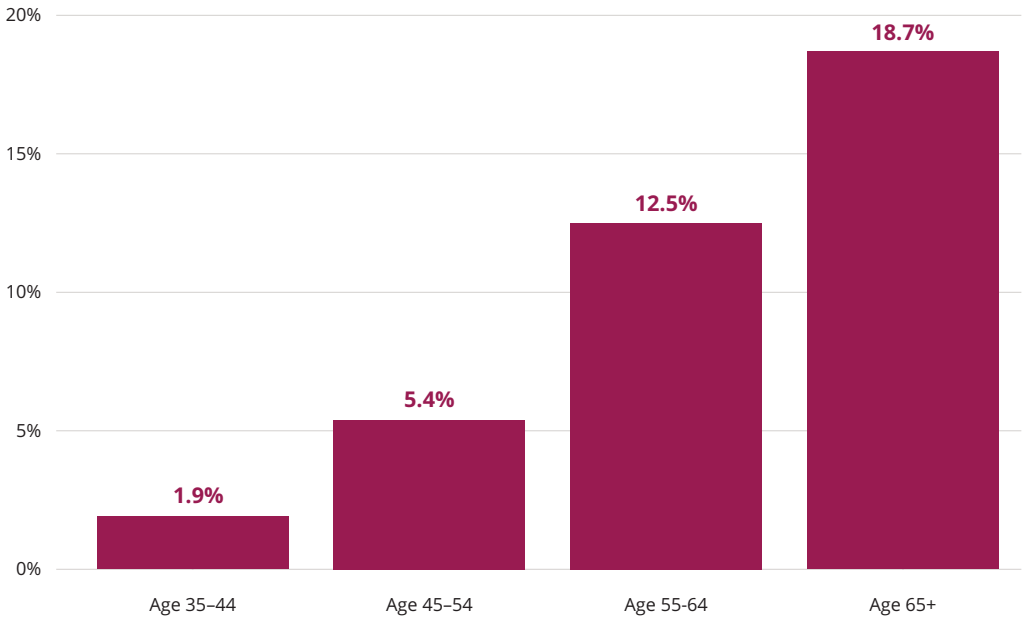
Source: CDC BRFSS 2017

Figure 5. Indiana Type 2 Diabetes Prevalence, by Race/Ethnicity, 2017



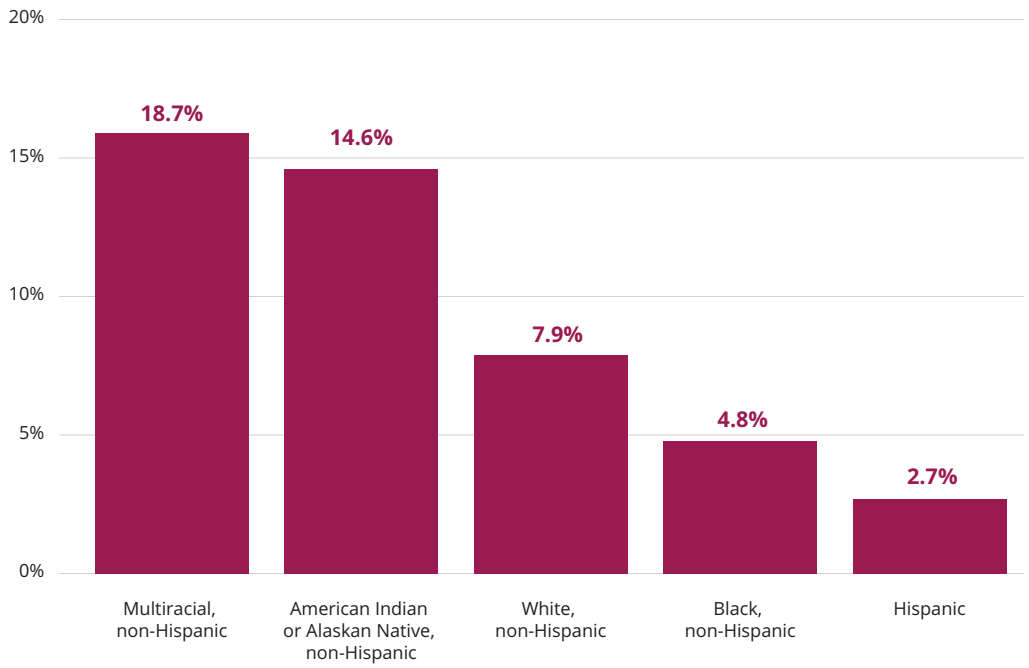
Source: CDC BRFSS 2017

Figure 6. Indiana Prevalence of Having Coronary Heart Disease or Heart Attack, by Age, 2017



Source: CDC BRFSS 2017

Figure 7. Indiana Prevalence of Having Coronary Heart Disease or Heart Attack, by Race/Ethnicity, 2017



Source: CDC BRFSS 2017

7.4% of adults have coronary heart disease or have had a heart attack (Centers for Disease Control and Prevention, 2017a). The percentage of adults experiencing cardiovascular disease increases with age (Figure 6). Multiracial non-Hispanic adults and American Indian or Alaska Native non-Hispanic adults have the highest rates of cardiovascular disease in Indiana (Figure 7).

Marion County

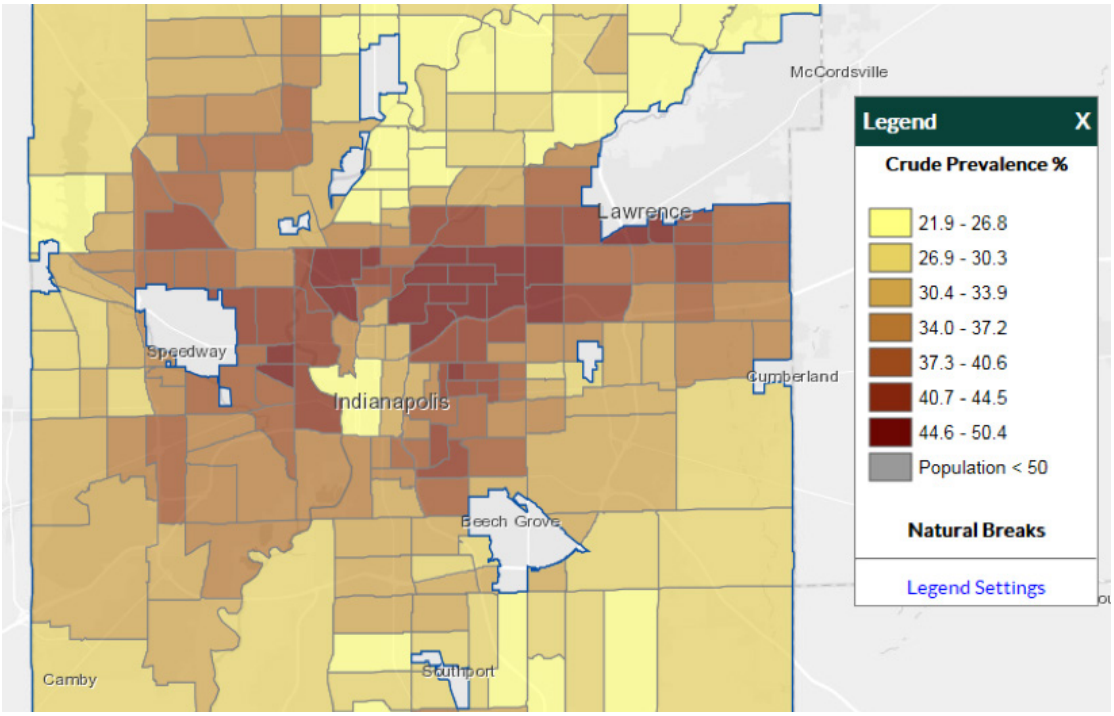
In Marion County, 38.6% of adults are obese and an additional 30.1% are overweight, according to a 2018 survey (Marion County Public Health Department, 2018). This represents a steady increase in obesity from 26% in 2005 and 33% in 2012 (Marion County Public Health Department, 2014). Obesity rates vary across the county by U.S. Census tract (see Figure 8).

Among the 30 largest cities in the U.S., Indianapolis has the 11th highest rate of obesity (Centers for Disease Control and Prevention, 2018a) (Figure 9). In 2016, the prevalence of diabetes in Marion County was 11.9% (Centers for Disease Control and Prevention, 2018b), and the prevalence of coronary heart disease was 6.4% (Centers for Disease Control and Prevention, 2018c).

Youth in Marion County also have high rates of obesity. Among low-income children ages two to five in the WIC program, 12.3% are obese and 16.1% are overweight (Indiana State Department of Health, WIC Program, 2017). A Child Health and Wellness Initiative report published in 2005 found that 22% of school-age youth in Marion County were obese. The data for the report came from the Marion County Public Health Department's efforts to measure the heights and weights of students

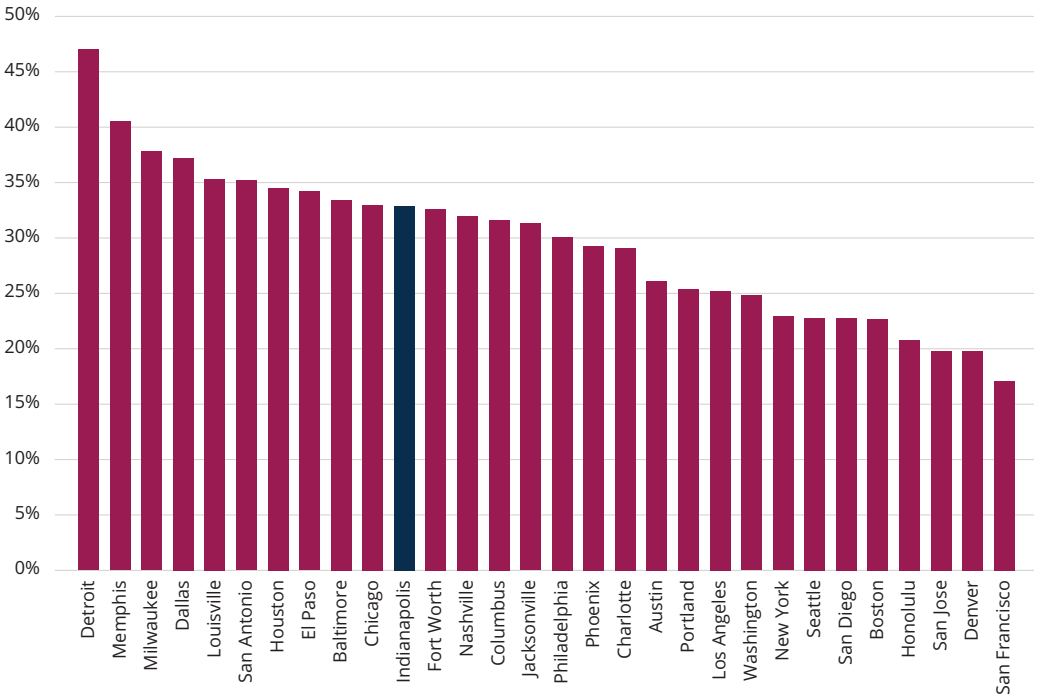
in 10 public school districts (Holly & Gibson, 2005). More recently, Jump IN for Healthy Kids, a community-wide effort to empower kids in Central Indiana to lead healthier lives, conducted a three-year project (2015–2018) to measure height and weight among students in Central Indiana schools. Among eight- to 19-year-olds, the prevalence of obesity was 25% and the prevalence of overweight was 18%. Hispanic students had the highest rates of obesity (34% for Hispanic boys and girls combined, 39% for Hispanic boys only), African American students had an obesity rate of 25%, and white students had an obesity rate of 19% (Barclay, 2018). In 2018, researchers at Indiana University estimated the prevalence of obesity among Marion County children by using 2014, 2015, and 2016 data from the Indiana Network for Patient Care (Blackburn, Jacinto, Vest, & Menachemi, 2018). The combined prevalence of overweight and obesity was 28.3% among children ages two to five, 37.9% among children ages six to 11, 46.6% among adolescents ages 12 to 17, and 46.0% among young adults ages 18 to 20 (Figure 10).

Figure 8. Model-Based Estimates for Obesity Among Adults Age 18 or Older, 2016



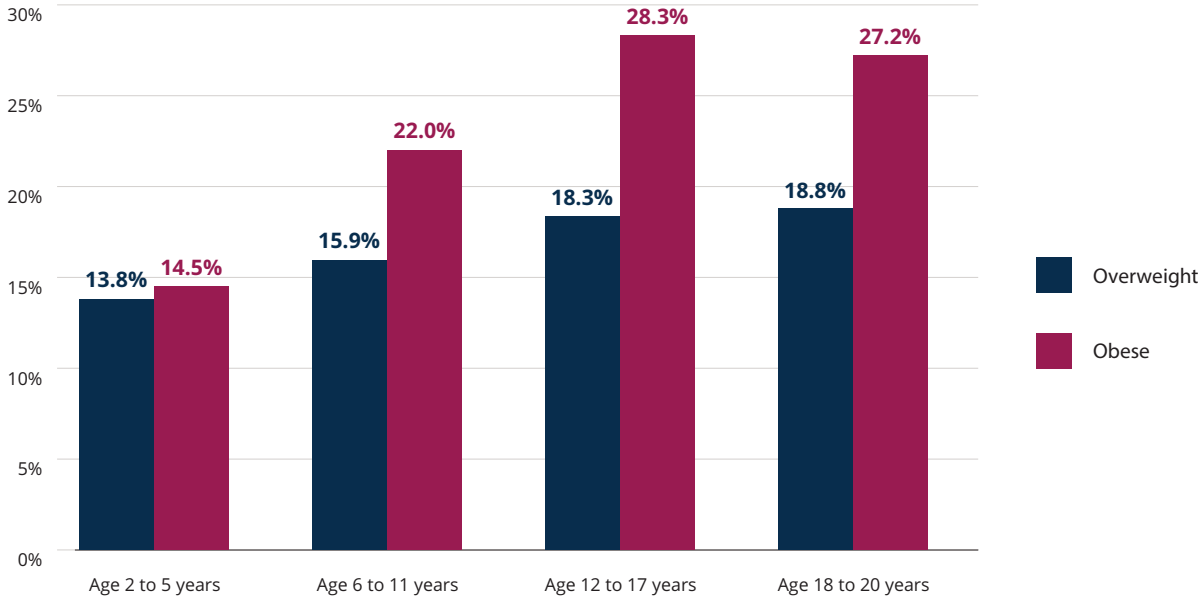
Source: CDC, 500 Cities

Figure 9. Obesity Prevalence (Age 18+) for 30 Largest U.S. Cities, 2016



Source: CDC 500 Cities Program

Figure 10. Prevalence of Overweight and Obesity in Marion County, by Age, 2014-2016



Source: Blackburn et al.

Causes of Obesity

Obesity results from an excess of calories consumed compared with those expended, which leads to excess fat. The rapid rise in obesity prevalence over the past several decades cannot be explained by genetic factors alone, nor can it be explained as the personal failure of individuals to eat healthy and be physically active. The dramatic rise in obesity across Marion County, the State of Indiana, and the U.S. is the result of a complex interplay of genetic, behavioral, and social factors that are influenced by the environments in which people live, work, learn, and play. Social determinants such as income, employment, education, early childhood experiences and development, housing, transportation, food insecurity, stress, social networks, health services, gender, and race/ethnicity can profoundly affect individuals' experiences, perceptions, behaviors, and health outcomes.

Genetic Contributors

Genetic factors may predispose some individuals to obesity, but genes alone are not thought to cause most cases of obesity. Single-gene causes of obesity are rare and affect only a very small percentage of the population. However, studies of twins and children who are adopted into other families show that weight is associated with biological relatives and that genetic makeup has an influence on an individual's propensity for obesity (Herrera & Lindgren, 2010). Dozens of genes that have been studied potentially affect susceptibility for obesity, including genes that regulate hunger, feelings of fullness, energy expenditure, and behaviors. Although genes may play a role in individuals' susceptibility to obesity, they do not define the individual's destiny. It is how these genes interact with the environment that is thought to explain the dramatic rise in obesity over the past several decades at a pace much faster than the gene pool could have evolved.

Environmental Contributors

Our environment has been referred to as "obesogenic." There are numerous policy and environmental factors that have been suggested as potential contributors to the obesity epidemic. Access to healthy and affordable foods may be limited in some communities, whereas energy-dense, highly palatable foods are available in abundance and inexpensive (Gordon-Larsen, 2014). Restaurants and fast food establishments with extra large portions have distorted what many people see as a normal portion size (Vermeer, Steenhuis, & Poelman, 2014). Individuals are flooded with advertisements for foods and beverages that are cheap and unhealthy. The U.S. food and beverage industry spends around $10 billion annually in advertising and marketing, $1.8 billion of which is directed at children and teens (Federal Trade Commission, 2012). Many advertisements are for less healthful options, such as fast food, snack food, sugar-sweetened beverages (SSBs), candy, and frozen desserts.

Urban sprawl has led to larger percentages of the population living in lower-density residential areas, resulting in a larger reliance on automobile transportation and a decreased ability to walk to destinations (Lopez, 2004). Land use policies have affected where business and schools are located in relation to residential areas. Some neighborhoods lack access to sidewalks, bicycle paths, greenspaces, and safe places for children to play (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011).

Many adults spend their time in workplace settings where advancements in technology have changed the ways people work, such that workers now spend hours engaged in sedentary behavior (Anderson, et al., 2009). Worksite cafeterias and vending machines are often filled with unhealthy

options, and with more employees skipping lunch or eating at their desks, many adults look for quick and easy options (Nobrega, et al., 2016). Women may not have access to supports to continue breastfeeding children after returning to work (Shealy, Li, Benton-Davis, & Grummer-Strawn, 2005).

In schools, some children do not have access to regular recess periods or daily PE classes to be physically active. Competing foods outside of the National School Lunch Program (NSLP) may be sold in vending machines and school stores. Fundraisers encourage families to purchase baked goods, pizza, candy, and other less healthful options. Bringing in cupcakes for every birthday has become the norm in some schools, and between parties and holiday celebrations, treats are often abundant.

Behaviors Associated with Obesity

Poor diet and physical inactivity lead to obesity. A variety of behaviors affect the healthfulness of people's diets and how physically active people are, in turn affecting weight (Olson, 2016) (Affenito, Franko, Striegel-Moore, & Thompson, 2012). The majority of the population does not consume the recommended amounts of fruits and vegetables or get the nationally recommended amount of physical activity; these shortfalls are associated with obesity. Over the past three decades, Americans have increased their consumption of food prepared away from home, which is associated with obesity (Saskena, et al., 2018). Foods prepared away from home typically contain fewer fruits and vegetables and more calories, fat, and sodium compared with foods prepared at home. People are increasingly sedentary and consuming more media than ever. Children spend up to 44.5 hours per week in front of cell phone, computer, television, and video game console screens instead of being physically active (American Psychological Association, n.d.). Table 3 outlines behaviors from pregnancy through adulthood that have been associated with protecting against obesity and increasing risk of obesity.

Indiana

In Indiana, there are similar trends. Only 11.5% of Indiana adults consumed the recommended number of fruits, and just 8.6% consumed the recommended number of vegetables (Lee-Kwan, 2017). Eighty-three percent of Indiana adults did not get enough physical activity to meet national guidelines (Centers for Disease Control and Prevention, 2017a). In 2017, 4.5% of Indiana residents age 16 and older took public transportation, a taxicab, a motorcycle, or a bicycle or walked to work (United States Census Bureau, 2017). Among Indiana high schoolers, 20% drank regular (non-diet) soda at least once per day, 39.5% ate fruit or drank 100% fruit juice less than once per day, and 42.5% consumed vegetables less than once per day (Kann, et al., 2016). More than 22% of Indiana adolescents watched three or more hours of television per day, 38.4% used computers for three or more hours per day for purposes other than schoolwork, and only 25.3% were physically active for 60 minutes every day (Kann, et al., 2016). Among Indiana schools, 64.1% of secondary schools allowed students to purchase snack foods or beverages. Of these schools, 14.1% allowed students to purchase chocolate candy; 20.1% allowed students to purchase other kinds of candy; 19.6% allowed students to purchase salty snacks; 20.4% allowed students to purchase cookies, crackers, cakes, pastries, or other baked goods; 29.4% allowed students to purchase soda pop or fruit drinks; and 43.7% allowed students to purchase sports drinks (Brener, et al., 2017).

Marion County

In the 2018 American Fitness Index rankings, Indianapolis was ranked 99th best out of 100 cities for community fitness (American College

Table 3. Obesity Risk and Protective Factors

Protective Factors	Risk Factors
Fruit and vegetable consumption	Low intake of fruits and vegetables
Fiber consumption	Fast food consumption
Regular family meals	Eating food prepared outside the home
Eating breakfast	Eating large portion sizes
Adequate physical activity	Sugar-sweetened beverage consumption
Adequate sleep	Inadequate physical activity
Healthy weight prior to pregnancy	Sedentary behavior
Appropriate maternal weight gain	Screen time
Breastfeeding	Smoking during pregnancy
Responsive parent feeding	Excess pregnancy weight gain
	Lack of breastfeeding
	Early introduction of solids
	Lack of responsive feeding by caregivers
	Lack of family meals
	Insufficient sleep

of Sports Medicine, 2018). Twenty-seven percent of county residents were physically inactive (having had no leisure-time physical activity in the past month) (University of Wisconsin Population Health Institute, n.d.). Between 2013 and 2017, 1.9% of Marion County workers age 16 and older took public transportation to work, 1.8% walked to work, and 0.5% bicycled to work (United States Census Bureau, n.d.). Nine percent of residents faced limited access to healthy foods, and approximately one in five county residents was food insecure (University of Wisconsin Population Health Institute, n.d.).

Social Determinants

Social determinants or so-called "root causes" of obesity include income level, educational attainment, race/ethnicity, gender, housing, social class, and social networks. These factors may contribute to obesity and inequalities related to obesity prevalence. Low-income households from all racial/ethnic backgrounds and gender groups have higher rates of obesity. Lower levels of education are associated with higher obesity rates. Some racial/ethnic minority groups face higher rates of obesity. Living in unsafe neighborhoods may reduce physical activity (An, Yang, Hoschke, Xue, & Wang, 2017). We are still learning how social determinants affect obesity and inequalities in obesity rates to develop upstream approaches that can address the underlying reasons for certain groups being more likely than others to be obese. It is likely these issues are interwoven, creating complex relationships that influence health behaviors and health status.

Consequences of Obesity

A number of consequences result from obesity. On a personal level, obesity can affect health and have socioemotional consequences. On a societal level, obesity has serious implications for healthcare costs, military readiness, and the workforce.

Health Consequences

Obesity is associated with serious health consequences. Obesity increases the risks of a variety of health conditions, including type 2 diabetes, high blood pressure, heart disease, stroke, arthritis, asthma, sleep apnea, liver disease, kidney disease, gall bladder disease, and certain types of cancer (Meldrum, 2017). These conditions can begin to develop even during childhood. Obese children are more likely to have risk factors for heart disease, such as high blood pressure and high cholesterol, type 2 diabetes, asthma, sleep apnea, joint problems, fatty liver disease, gallstones, and gastroesophageal reflux (Centers for Disease Control and Prevention, 2016) (Mead, et al., 2017). Furthermore, children who are obese are more likely to become obese adults (Herman, 2009).

Socioemotional Consequences

Obesity affects mental and psychological health. Obese individuals are more likely to face stigmatization, anxiety, depression, and low-self-esteem. These problems are also seen in obese youth, who are more likely than healthy weight youth to experience victimization, teasing, and bullying (Pont, Puhl, Cook, & Slusser, 2017).

National Security Consequences

Obesity affects our national security. Overweight or obesity is one of the most common reasons for young people being ineligible to serve in the military. Obesity among active duty service members rose 61% between 2002 and 2011, and nearly one in four young adults is too heavy to serve in the military (Centers for Disease Control and Prevention, n.d.).

Economic Impact of Obesity

The long-term impacts of excess weight and obesity affect the outcomes for obese individuals through a variety of pathways. Previous research has identified significant downstream impacts of obesity on health, average healthcare spending, employment, life expectancy, and lifetime earnings. We combined the economic costs of these impacts in order to estimate the economic burden of obesity for Indiana and Marion County. We quantify both the individual economic impacts and the downstream impacts on other stakeholders, such as federal and state governments (who fund a proportion of healthcare expenditures), employers, and communities, through impacts of the labor market outcomes. The most direct benefits of reducing obesity prevalence are improved health and quality of life for the population, but helping individuals reach a healthy weight is also likely to improve economic outcomes. This provides further data and incentive for public and private investment in solutions to the obesity epidemic.

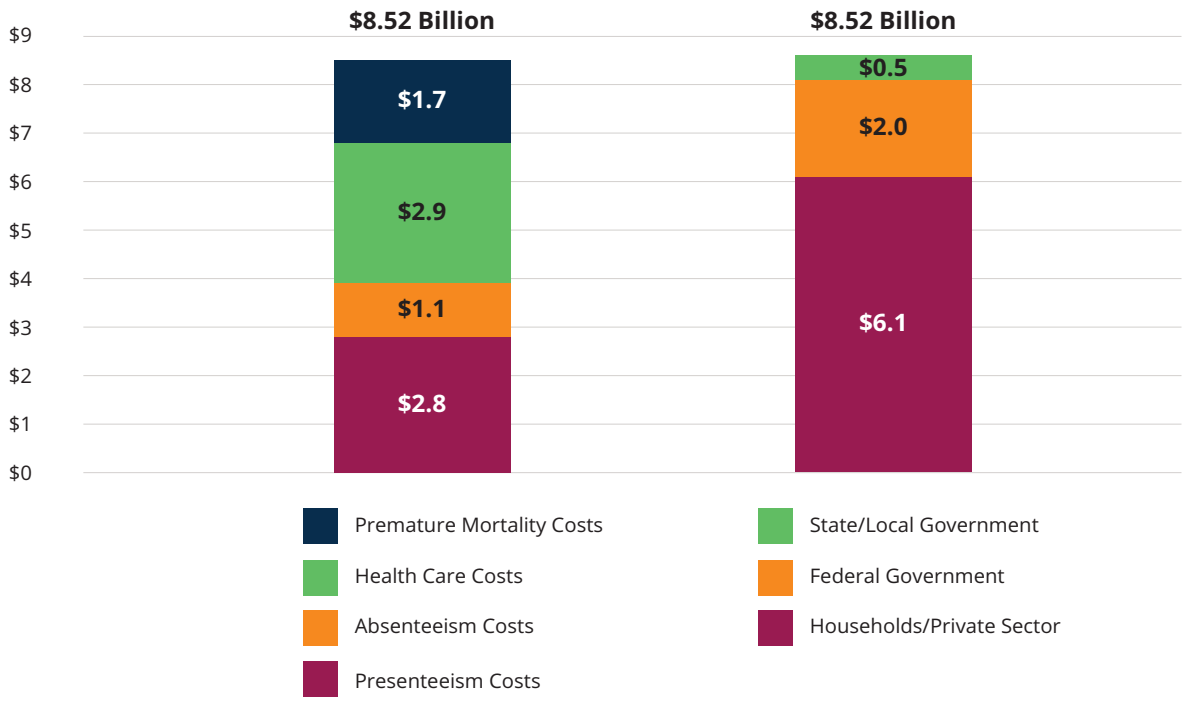
In 2017, the estimated economic cost of obesity for the State of Indiana was $8.5 billion. This includes $3.9 billion in labor market costs (increased absenteeism and presenteeism* for obese employees), $2.9 billion in excess healthcare costs, and $1.7 billion in lost economic output resulting from premature mortality (net of government expenditures) (Figure 11; see Appendix A for the economic analysis methodology).

*Presenteeism costs are those resulting from working while sick, feeling ill, or unwell, leading to lower workplace output and productivity.

The labor market impacts are the largest component of the burden. Even the moderate impacts of obesity on expected wages and earnings have a significant impact on the total economic output when aggregated across the population. The increased healthcare costs are the second largest component, resulting from expected increases in spending on obesity-related health conditions. Estimates of increased healthcare costs are based on studies that compare aggregate average annual healthcare spending of obese individuals to healthy weight individuals. Increased spending on diseases such as coronary heart disease, hypertension, type 2 diabetes, stroke, and some cancers is likely a key driver. The American Diabetes Association estimated that type 2 diabetes costs Indiana $6.6 billion in direct medical expenses and indirect costs from lost productivity (American Diabetes Association, n.d.). The American Heart Association and the American Stroke Association estimated that cardiovascular disease costs Indiana $11.1 billion per year in direct medical expenses and indirect costs from lost productivity (American Heart Association and American Stroke Association, 2017).

When expected burden costs are apportioned to the relevant stakeholders/payers, the majority of $8.5 billion of costs of obesity are applied to households and the private sector, showing $6.1 billion of the 2017 economic burden. These costs include the lost potential earnings, net of taxes; the increased healthcare costs paid by private insurance, employers, and individuals; and the lost future earnings resulting from premature mortality. The second largest payer is the federal

Figure 11. Annual Economic Burden of Obesity in Indiana, in Billions ($2017)



government, seeing costs from increased healthcare spending for obesity and decreased tax revenues from reduced earnings. State government costs, driven by increased spending by Medicaid and lower state and local income tax revenues, account for $500 million of the total cost.

Economic Burden by Age Group Categories

Measuring the economic burden of obesity by the population age distribution and type of burden (Figure 12) demonstrates where in individuals' lifetimes these costs accrue. The lost productivity costs (the combination of the absenteeism and presenteeism costs) peak at the same time population total earnings reach their maximum, for people ages 45 to 54. The increased healthcare costs are largest for people with obesity age 65 and older, as that age range is when healthcare spending peaks. Premature mortality burdens are mostly constant across the adult age groups, peaking for people ages 45 to 54. Among individuals who are over age 64 or under age 18, there are no differences in mortality rates between obese and non-obese individuals. As a result, premature mortality costs for those age groups are zero.

Economic Burden of Obesity in Marion County

The total economic burden of obesity for Marion County is a proportion of the burden for the entire State of Indiana, based on the subset of the population living in Marion County. The total burden for Marion County in 2017 was $1.3 billion, including $422 million in presenteeism costs, $165 million in absenteeism costs, $395 million in increased healthcare costs, and $315 million in costs from premature mortality. When costs are apportioned by payer, a story similar to that of the entire State of Indiana is seen, with a majority ($947 million) of the economic burden paid by the private sector and households. A total of $279 million in lost potential taxes and increased healthcare costs was borne by the federal government, and $71 million was borne by state and local governments (Figure 13).

When comparing the economic burden of Marion County to that of the entire State of Indiana, Marion County has slightly higher costs per capita, as a result of a larger estimated obesity prevalence and a different age distribution of the population. Marion County's economic burden of $1.3 billion equates to $1,365 per capita per year for the county, compared with the State of Indiana's economic burden of $1,276 per capita per year. The distribution of the $1.3 billion in economic costs across the age groups for Marion County also looks similar to that of the State of Indiana as a whole, with labor market costs peaking for people ages 45 to 54 and healthcare costs peaking for people age 65 and older (Figure 14). The proportion of Marion County's total population age 65 and older is smaller relative to the entire State of Indiana, leading to somewhat lower total healthcare costs for the oldest age group.

Comparison to Previous Literature

Given the growing prevalence of obesity for Indiana and across the United States and the varying populations of focus of other researchers, it is challenging to directly compare previous estimates of the economic cost of obesity to these findings. However, on a per capita basis, we would expect its findings to be comparable to previous work for the entire U.S., given that Indiana's obesity prevalence is similar to that of the entire country. In a very brief literature review, we found estimates for the total economic cost of obesity to the United States to be between $147 billion (Centers for Disease Control and Prevention, 2018d) and $663 billion (Dobbs & Manyika, 2015). While both of these analyses are for years with lower obesity

Figure 12. Annual Economic Burden of Obesity in Indiana, in Billions ($2017), by Age and Type of Cost

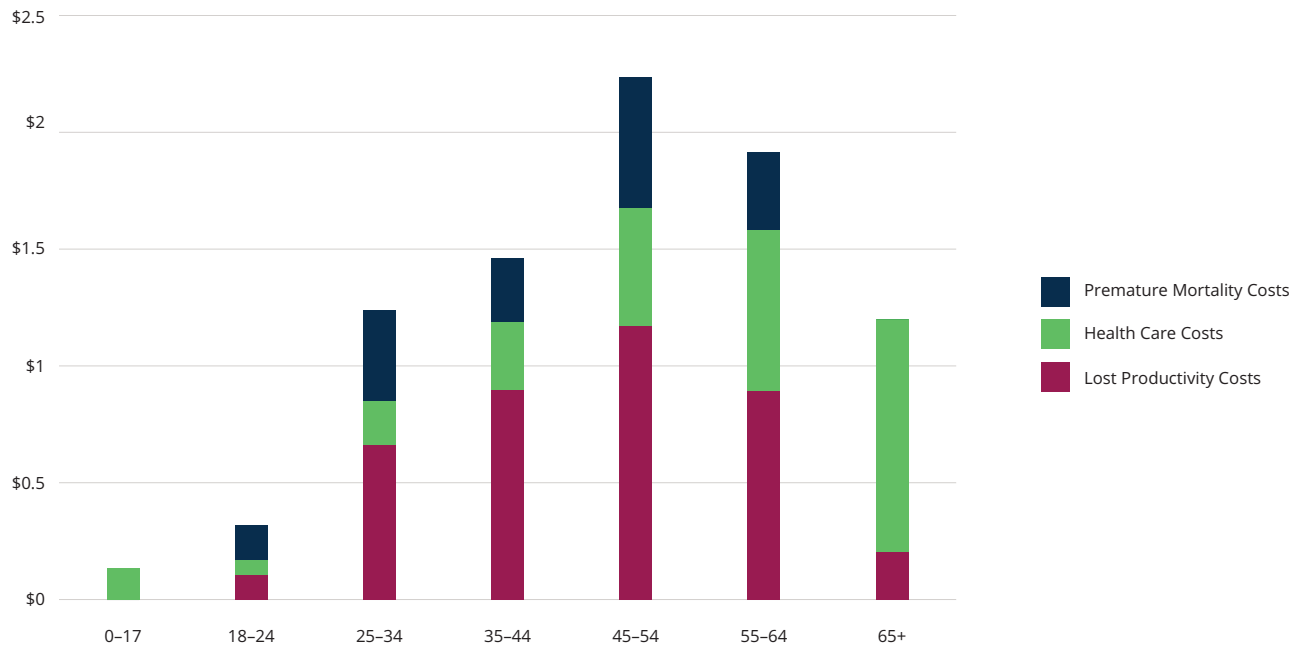
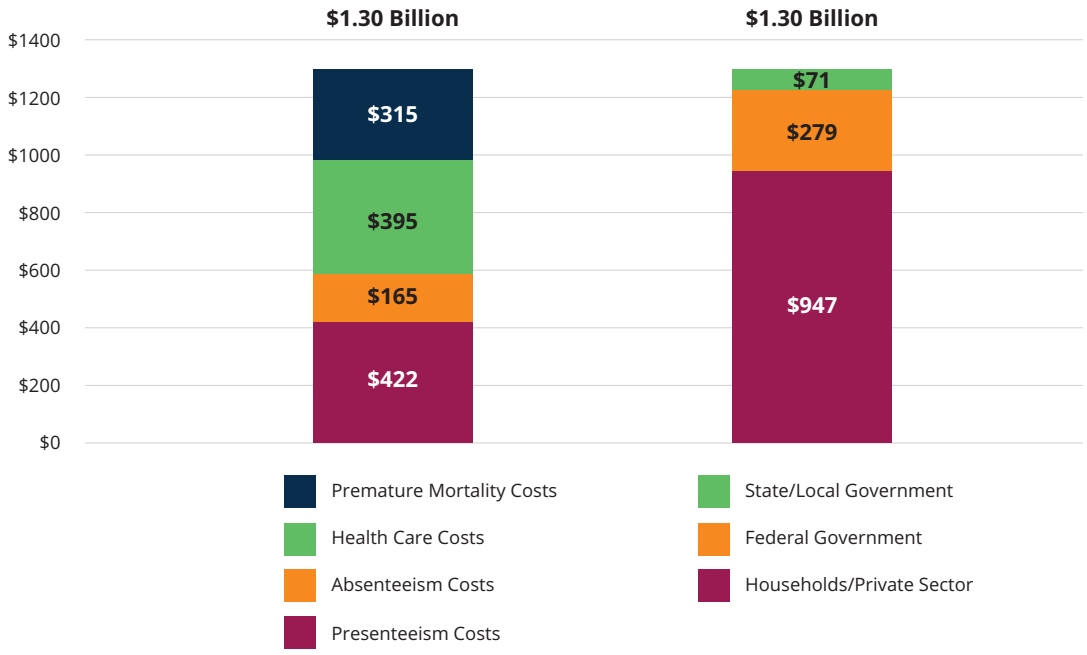


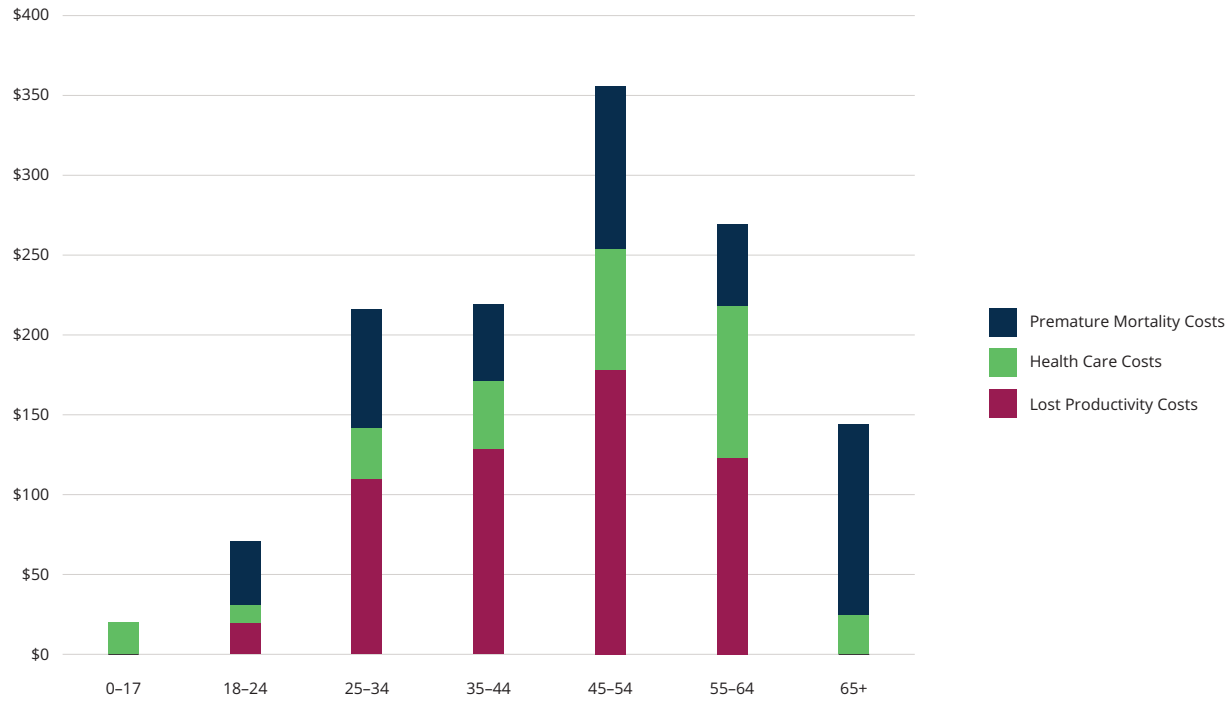
Figure 13. Annual Economic Burden of Obesity in Marion County, in Millions ($2017)



prevalence rates (2010 and 2012) and for the nation as a whole, given that the State of Indiana has 2.0% of the total U.S. population, our estimate of $8.5 billion would fall between an implied estimate from the Centers for Disease Control and Prevention (CDC) of $2.9 billion and an implied estimate from Dobbs and Manyika of $13.3 billion.

Our estimates differ from the previous work because of the types of costs considered and methodologies used to estimate those costs. The CDC estimates are limited to the additional healthcare costs of obesity, leading to a much lower estimate. The Dobbs and Manyika estimates are more similar to those of our work; however, Dobbs and Manyika include an additional component: the cost of direct investments being made to mitigate the obesity epidemic. Our work does not include investments in prevention and treatment in the estimates of the burden, instead focusing only on the negative impacts of obesity on health, longevity, and productivity. This leads to a slightly smaller estimate. Finally, our estimates differ from the Dobbs and Manyika estimates in how productivity losses are calculated. We used previous literature on the direct changes on earnings and employment for those with obesity, while Dobbs and Manyika applied estimates to a dataset on the number of disability-adjusted life years lost because of obesity and obesity-related diseases. This approach generated a larger estimate, possibly from including a larger number of workdays lost because of obesity-related conditions or perhaps from including a larger estimate of the total lost productivity.

Figure 14. Annual Economic Burden of Obesity in Marion County, in Millions ($2017), by Age and Type of Cost



Strategies to Address Obesity

Given the significant rise in obesity over the past four decades and the many consequences and economic burden of obesity, identifying effective solutions to address obesity is critical. To identify potential effective solutions, we conducted a comprehensive literature search of interventions and solutions to prevent and treat obesity in five key areas: healthcare, worksites, schools, community, and policy. To inform our literature review and recommendations, we concurrently conducted key informant interviews with local and state leaders from Indiana selected by the Richard M. Fairbanks Foundation, as well as national experts in obesity (Appendix B).

The literature search focused on studies conducted in the past five to 10 years (see methods in Appendix C). Since genetic risk factors and some social determinants, such as race and ethnicity, cannot be changed, most interventions to prevent or reduce obesity are focused on the primary modifiable risk factors for obesity: diet and physical activity. Although there is increasing interest in addressing obesity and health more broadly by working to influence social determinants that have the potential to be modified (e.g., housing, adverse childhood experiences), for the purposes of this report, our literature review focused on interventions primarily aimed at preventing or treating obesity or its primary modifiable risk factors. In total, our staff reviewed findings from more than 1,300 studies. Because of the sheer volume of research, we prioritized the presentation of information obtained from systematic reviews and meta-analyses for several reasons: (1) They provide an indication of which interventions are most studied and thus may be of interest to stakeholders reviewing this report; (2) they provide a comprehensive look at the breadth of literature on a given intervention topic, often with a study quality assessment, which helps to facilitate a critical review of each intervention approach; and (3) meta-analyses combine results from multiple studies to improve estimates of effect size.

For each identified intervention, we critically assessed the evidence and assigned a rating of "recommended," "promising," "mixed/inconclusive," or "not recommended" based on the scoring rubric in Table 4. Our primary outcomes for rating study evidence were adiposity (obesity) and body mass, which includes weight, BMI, waist circumference, and waist-to-hip ratio (i.e., weight-related measures). Our secondary outcomes for rating evidence were dietary behaviors (e.g., total dietary intake, consumption of fruits and vegetables, SSBs*, water, or snacks), physical activity behaviors (e.g., time spent in total physical activity, time spent in moderate to vigorous physical activity, time spent walking or cycling to or from work or school), and sedentary behaviors (e.g., time spent sitting, screen time). Interventions that had consistent evidence of a significant, positive impact on weight status or for which there were recommended clinical guidelines in the healthcare setting were rated as recommended. Interventions that often produced a change in weight status or usually produced a change in behaviors were rated as promising. Interventions that had an inconsistent impact on weight or behaviors or for which there were few studies were rated as mixed/inconclusive. Interventions that usually produced no impact on weight or obesity behaviors would have been rated as not recommended, but we identified no interventions that met this criteria. In the following chapters, we describe strategies and levels of effectiveness for each of the five key areas.

*Sugar-Sweetened Beverages (SSBs)

Table 4. Evidence Classification Criteria

Key Findings	Effectiveness Classification	Criteria for Effectiveness Classification
• Studies usually find significant change in weight, and/or • Clinical guidelines recommend practice	Recommended	• 67% or more of studies in systematic review(s) reported a significant positive change in weight related-measures and/or meta-analysis(es) reported a significant positive change in weight-related measures. In healthcare area only, change must be clinically significant (e.g., BMI z-score 0.20-0.25, 5%+ loss of body weight from baseline). • If no systematic reviews or meta-analyses were identified, there are at least five high-quality (e.g., randomized controlled trials) studies on the intervention and 67% or more reported significant positive change in weight-related measures. • In healthcare only, expert recommendations and clinical guidelines recommend the intervention or practice as part of clinical care for obesity prevention or treatment.
• Studies often find significant change in weight, and/or • Studies usually find significant change in diet or physical activity	Promising	• 51%-66% of studies in systematic review(s) reported a significant positive change in weight related-measures. • 67% or more of studies in systematic review(s) reported a significant positive change in diet, physical activity, or sedentary behaviors, and/or a meta-analysis reported a significant positive change in these measures. • If no systematic review or meta-analyses were identified, there are at least five high-quality (e.g., randomized controlled trials) studies and 51-66% reported a positive change in weight-related measures, or 67% or more reported a significant positive change in diet, physical activity, or sedentary behaviors.

Table 4. Evidence Classification Criteria (cont.)

Key Findings	Effectiveness Classification	Criteria for Effectiveness Classification
• Studies sometimes find a significant change in weight, and/or • Studies sometimes find a significant change in diet or physical activity, and/or • There may be inconsistencies among review studies in results or there is a change in behavior, but not in weight status	Mixed/ Inconclusive	• 50% or less of studies in systematic review(s) reported a significant positive change in weight-related measures, and/or meta-analysis(es) finds no statistically significant impact on weight-related measures despite some studies reporting significant positive findings, and/or multiple reviews reported mixed findings. • 66% or less of studies in systematic review(s) reported a significant positive change in diet, physical activity, or sedentary behaviors, and/or a meta-analysis reported no statistically significant impact on these behaviors despite some studies reporting significant positive findings, and/or multiple reviews reported mixed findings. • If no systematic reviews or meta-analyses were identified, studies were limited in number (less than five identified), quality (e.g., lacking control group, small sample size), and/or 50% or less found significant positive change in weight-related measures or 66% or less reported a significant positive change in diet, physical activity, or sedentary behaviors. • In healthcare only, effect on weight-related measures may not be clinically significant.
• Studies usually find no significant change in weight, diet or physical activity	Not Recommended	• 67% or more of studies in systematic review(s) reported significant null or negative findings for weight-related measures or diet, physical activity, and sedentary behaviors.

Healthcare Strategies to Address Obesity

Healthcare providers play an instrumental role in addressing the obesity epidemic. Healthcare is the natural setting to identify obesity in children and adults. Height and weight, which are used to calculate BMI, are routinely measured during clinical visits. Physicians, especially pediatricians, have regular contact with patients. They are trusted authorities on health in their communities; can provide anticipatory guidance on healthy behaviors to prevent and reduce obesity, such as eating more fruits and vegetables, getting adequate physical activity, reducing screen time, and reducing SSBs*; and can work with patients who are already overweight or obese to select the appropriate treatment options based on BMI and other health risk factors. Furthermore, seeking adjunct therapies or pursuing aggressive treatment options requires patients to see their healthcare provider for prescription medications and surgical options.

Multidisciplinary teams including physicians, nurses, medical assistants, dietitians, exercise physiologists, and counselors can work together to support healthy weight in patients by offering effective treatment solutions. Expert guidelines have been published on effective treatment strategies to help clinicians navigate the management of obesity in both children and adults (LeBlanc, et al., 2018) (Jensen, et al., 2014) (Barlow & The Expert Committee, 2007). Achieving weight loss of just 5% to 10% of body weight can lower the risk of cardiovascular disease, prevent or delay the onset of type 2 diabetes, and improve other health consequences of obesity (Yanovski & Yanovski, 2014). This can lead to reductions in medical costs associated with obesity.

In this chapter, we describe healthcare strategies that have been studied to address obesity. Strategies are organized into two categories defined below:

- **Addressing obesity in adults:** Strategies, interventions, or treatments involving adults age 18 and above in a healthcare setting.
- **Addressing obesity in children and adolescents:** Strategies, interventions, or treatments involving youth ages 0 to 18 in a healthcare setting.

Each strategy includes a brief summary of the approach and the evidence of effectiveness, along with effectiveness classification (according to Table 4). Under each category, strategies are organized by their evidence classification, from the highest evidence of a positive effect (i.e., recommended) to the lowest evidence of a positive effect (i.e., mixed/inconclusive).

Evidence Summary

There are several effective solutions that healthcare providers can offer to overweight and obese patients. To determine the appropriate approach, screening is necessary to identify patients who are overweight or obese. The first approach for many patients is to try to reduce body weight through lifestyle-behavior change interventions. Multicomponent programs have been found to be effective in producing weight loss in young children through adults. High-intensity programs that focus on diet and physical activity are most effective. When lifestyle-based interventions are unsuccessful, adjunct therapies may be indicated. Pharmacologic intervention has led to successful weight reduction among adults; however, use of medication to reduce weight among adolescents has been mixed. In severely obese patients with or without comorbidities, bariatric surgery is successful in significantly reducing body weight and has promising but limited results for adolescents. Since bariatric surgery is invasive and involves

*Sugar-Sweetened Beverages (SSBs)

significant risks, it is not suitable for all. For preventing obesity, the Baby-Friendly Hospital Initiative has been found to increase initiation, exclusivity, and duration of breastfeeding.

Addressing Obesity in Adults

Screening for Obesity in Adults

The U.S. Preventive Services Task Force (U.S. Preventive Services Task Force, 2017) and Jensen and colleagues (Jensen, et al., 2014) recommend that healthcare providers screen all adults for obesity. The Centers for Medicare & Medicaid Services also mandates that electronic medical records calculate BMI as one of the core measures of vital signs. Screening enables clinicians to refer patients who are overweight or obese to appropriate therapies based on their weight status and any related comorbidities they may have. It is currently part of standard clinical practice in most medical settings; however, consistent documentation and tracking of weight over time has been low (LeBlanc, et al., 2018).

EVIDENCE OF EFFECTIVENESS: ***Recommended***

There is no evidence to support the idea that screening alone is effective in reducing body weight in adults (Yao, 2013). However, screening is a tool that, if used consistently, can assist providers in identifying overweight and obesity earlier so they can provide counseling and referrals for treatment. On the bases that experts and clinical guidelines recommend screening for obesity in adults and that screening is necessary to determine the most appropriate prevention or treatment approach, screening is recommended.

Multicomponent Weight Loss Programs for Adults

Multicomponent weight loss programs for adults in the healthcare setting are focused on changing lifestyle behaviors. There are typically three components: a reduced-calorie diet, increased physical activity, and behavioral therapy. A reduction in caloric intake may be achieved by using commercial and non-commercial dieting approaches and/or by following evidence-based recommendations for weight loss, such as reducing intake of SSBs and increasing consumption of fruits and vegetables. Physical activity may include individual and/or group physical activity sessions that aim to increase calorie expenditure. National recommendations for physical activity for adults are 150 to 300 minutes per week of moderate-intensity aerobic activity or 75 to 150 minutes per week of vigorous-intensity aerobic activity. In addition, adults should do muscle-strengthening activities of at least moderate intensity and involve all major muscle groups on two or more days per week (U.S. Department of Health and Human Services, 2018). Behavioral therapy may be based on theoretical frameworks, such as the transtheoretical model or cognitive behavioral therapy, and include strategies such as self-monitoring, goal setting, and positive reinforcement. Multicomponent lifestyle-based programs are delivered in person to individuals, groups, and mixed individual and group sessions and sometimes incorporate technology and print-based materials. Programs can also be delivered primarily through technology, such as computers, online social networks, apps, and mobile text messaging. Technology interventions sometimes incorporate telephone or individual coaching or consultation. Computer-based intervention can be delivered over the Internet or by installing computer software. Online social networks are web-based platforms (e.g., Facebook, Twitter) that allow users to develop a profile, interact with other users with whom they share a connection, and share experiences with, ask questions of, and provide support to other users. Mobile text messaging is sending information, recommendations, and encouragement for diet and exercise to cell phones via a text message. An app is an application that is accessed on a mobile

device, such as a smart phone or tablet, and can be used to deliver content and provide behavioral tracking.

EVIDENCE OF EFFECTIVENESS: *Recommended*

Behaviorally based multicomponent weight loss programs are effective in producing weight loss in obese individuals. In a systematic review of primary-care-relevant behavioral approaches to weight loss that included 89 randomized controlled trials (LeBlanc, et al., 2018), participants in behavior-based interventions had an average greater weight loss of 5.3 pounds at 12 to 18 months compared to controls. Those who participated in behavioral programs were also more likely to achieve 5% weight loss from baseline measurement and were less likely to

Example: Practice-based Opportunities for Weight Reduction (POWER) (Appel, et al., 2011)

Setting: Six primary care clinics in the Baltimore metropolitan area.

Participants: 415 individuals, 63.6% women, 41.0% African American, with an average age of 54 and an average BMI of 36.6.

Intervention: POWER was a 24-month study based on social cognitive theory where obese participants were encouraged to lose 5% of their body weight in six months and maintain their reduced weight until the end of the study. There were two intervention groups: an in-person group and a remote group. Both groups had access to a study website, which contained learning modules and opportunities to self-monitor and receive feedback on weight, calorie intake, and exercise. Participants were reminded to log into the website if they had not done so in seven days. Weight loss coaches encouraged participants (either in person or by phone) to complete the learning modules and provided positive reinforcement for healthy behaviors, with an emphasis on tracking weight, calorie intake, and physical activity by using motivational interviewing techniques (e.g., asking open-ended questions, exploring feelings of ambivalence). For the in-person group, there were three individual sessions and nine group sessions during the first three months. For the remote group, there were 12 weekly calls during the first three months. During the next three months, the remote group had one call per month, and the in-person group had one group session and two individual sessions. For the remainder of the study, in-person group participants were offered two monthly contacts (one group session and one individual session), and remote group participants continued to be offered monthly calls. Individual sessions lasted approximately 20 minutes, and group sessions lasted 90 minutes.

Results: At 24 months, the average change in weight from baseline was -0.8 kg for control participants, -4.6 kg for remote support only participants, and -5.1 kg for the in-person support participants. The percentage of participants that lost 5% or more of their baseline weight was 18.8% of the control group, 38.2% of the remote support only group, and 41.4% of the in-person support group.

regain weight at 12 to 18 months. Weight loss among intervention groups remained statistically significant at 36 months. Among good-quality studies, participants were also less likely to develop type 2 diabetes compared with those who did not receive the behavioral intervention. Higher-intensity programs (14 or more sessions in six months or 12 to 26 sessions per year) were more likely to achieve weight loss (Jensen, et al., 2014) (Yao, 2013). Higher levels of activity (200 to 300 minutes per week) are recommended to sustain weight loss for the long term (Jensen, et al., 2014). The evidence rating for multicomponent interventions is based on interventions delivered primarily in person. Evidence for multicomponent interventions that use technology as the primary mode of delivery are summarized below. These interventions sometimes include an in-person component, but the intervention is primarily delivered through the use of technology.

In a review of computer-based interventions only, computer-based behavioral interventions were more effective in achieving weight loss among participants at six months compared to minimal intervention (average difference -3.3 pounds), but were less effective than in-person treatment (Weiland, et al., 2012). Across multiple systematic reviews of web-based interventions (Sorgente, et al., 2017), web-based interventions were consistently found to be more effective than minimal or no treatment in reducing weight and BMI; however, they were less effective than in-person interventions. The effectiveness of web-based interventions compared with similar non-web-based interventions (e.g., intervention from a manual, paper diary tracking of behaviors) or hybrid interventions (a web-based component plus non-web-based components) was inconsistent. An interactive or tailored website appeared to be more effective than an information-only website.

In a systematic review of studies where the primary delivery mode for the intervention was an online social network (Willis, et al., 2017), a small number of lower-quality trials found a consistent, modest reduction in body weight (1.4 to 11.0 pounds) for intervention groups, but only one of five studies resulted in a reduction in body weight greater or equal to 5%. Although evidence was limited, completion of all activities and interaction with a health educator appeared to be associated with greater weight loss, compared with self-guided interventions.

Limited evidence from randomized controlled trials suggests that mobile text messaging interventions are a promising strategy for delivering multicomponent interventions (Wang, Xue, Huang, Huang, & Zhang, 2017). Most studies yielded positive results. Data on weight loss were very limited. The data that were available showed a 4.3- to 4.8-pound greater reduction in body weight for participants in a mobile text messaging intervention compared with controls; however, text messaging was coupled with other strategies, such as calls from a counselor or coach, making it impossible to determine the effect of text messaging alone (Patrick, et al., 2009) (Partridge, et al., 2015). Additional research is needed to further assess the effectiveness of using text messaging as the primary delivery mode for multicomponent interventions.

Noncommercial health apps as the primary delivery mode for multicomponent interventions have been shown to produce weight loss of up to 11 pounds at one year when used in conjunction with contact from a health coach. Most studies of health apps have been of short duration and are lower-quality studies (Bennett, et al., 2018). In a review of mobile health interventions (Wang, Xue, Huang, Huang, & Zhang, 2017), half of studies using an app as the primary delivery mode of information were effective in achieving weight loss or improvement in health behaviors related to obesity, such as increased fruit and vegetable consumption or reduced sedentary time. Many of these studies had small sample sizes and were shorter in duration.

Diet Programs for Adults

There are numerous diet plans, books, apps, and websites that comprise the multibillion-dollar dieting industry in the U.S. All diets for weight loss essentially aim to create an energy deficit, thus producing weight loss; however, diets go about achieving this energy deficit in different ways, such as:

- Restriction of certain foods or food groups (e.g., restriction of SSBs or grains).
- Restriction of energy intake (e.g., a very low-calorie diet).
- Restriction of portion sizes (e.g., portion-controlled meals and snacks).
- Modification of the percentage of calories from macronutrients fat, carbohydrates, and protein (e.g., a high-protein/low-carb diet, a low-fat diet).
- Frequency of eating (e.g., prescription of the number and/or timing of meals, restriction of meals to certain times of the day).
- Meal replacement (e.g., replacement of one meal per day with a shake or a bar).

Some diets combine multiple approaches, and many diets have different phases that are more restrictive or more relaxed. For example, diets may start out with a highly restrictive introductory phase to produce immediate results and transition to progressively more relaxed phases to maintain weight loss. Most diets are self-guided; however, there are medically supervised diets, such as very low-calorie diets, as well as diets with group-based components, such as Weight Watchers.

EVIDENCE OF EFFECTIVENESS: ***Recommended***

There is strong evidence that a wide variety of dietary approaches can produce weight loss in overweight and obese adults, provided that reduction in calories consumed is achieved. Energy targets must be customized to individuals based on weight, height, age, and activity level; however, a total of 1,200 to 1,500 calories per day for a woman or 1,500 to 1,800 calories per day for a man typically produces an energy deficit. If individual calorie requirements are known, prescribing 500 to 700 calories less per day or a 30% energy deficit is associated with weight loss. Weight loss on diets is generally highest at six months (8.8 pounds to 26.4 pounds), and smaller losses or regain are likely to occur. Weight loss on diets ranges from 8.8 pounds to 22.0 pounds at one year and 6.6 pounds to 8.8 pounds at two years (Jensen, et al., 2014). In a systematic review of commercial weight loss programs (e.g., Atkins, Jenny Craig, Curves, Nutrisystem, Slim Fast), there was limited evidence that any particular program was more effective than another (Vakil, et al., 2016).

Multicomponent Interventions to Prevent Excessive Weight Gain in Pregnancy

Pregnancy has been identified as a critical period for the prevention of obesity. Excess weight gain can negatively affect the health of both the mother and the fetus. Risk for the mother includes higher postpartum body weight. Women who are already overweight or obese at pregnancy face higher risks of having gestational diabetes, having hypertensive disorders, and giving birth to larger babies (Gunderson, 2009). Children of women who gain excessive weight during pregnancy are more likely to be overweight by age three (Oken, Taveras, Kleinman, Rich-Edwards, & Gillman, 2007). The fetus may also be exposed to levels of high blood sugar and insulin, which can lead to increased body fat and may result in larger birth size. Higher birth weight has been associated with higher BMI later in life (Rogers, 2003). In clinical studies, lifestyle-based interventions to prevent excessive weight gain

during pregnancy have focused on modifications to diet, physical activity, or both. Diets have included low-sugar/diabetic, low-calorie, and low-fat diets. Some interventions have included food diaries and regular weigh-ins. Exercise interventions have included walking, dance, and aerobic classes, as well as provision of pedometers and treadmills. Most interventions also included counseling for these behaviors in person at clinical visits, by phone, in home, or in a combination of these ways.

EVIDENCE OF EFFECTIVENESS: ***Recommended***

There is high-quality evidence to support the idea that diet, exercise, or both can reduce the risk of excessive weight gain in pregnant women. In a review study, these interventions reduced the number of pregnant women gaining excessive weight by 20% (Muktabhant, Lawrie, Lumbiganon, & Laopaiboon, 2015). In a meta-analysis of 30 randomized controlled trials, the reduction in weight gain was 2.1 pounds for intervention participants compared with controls (Thangaratinam, et al., 2012).

Pharmacotherapy for Adults

Pharmacotherapy for obesity is the use of medication to promote weight loss. The American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society (Jensen, et al., 2014) recommend considering pharmacotherapy for adults with a BMI at or above 30 or a BMI at or above 27 with a comorbidity, in addition to comprehensive lifestyle-based intervention or after the failure of lifestyle-based treatment to achieve at least a 5% reduction in body weight. Current Food and Drug Administration (FDA)-approved weight loss drugs and how they produce weight loss are listed below (National Institute of Diabetes and Digestive Kidney Diseases, 2016):

- **Liraglutide:** Reduces appetite and makes individuals feel full sooner.
- **Lorcaserin**: Acts on receptors in the brain to make individuals feel full after eating smaller amounts.
- **Naltrexone-bupropion:** A combination of two medications that make individuals feel less hungry or feel full sooner.
- **Orlistat:** Reduces the amount of fat the body absorbs from the food that individuals eat.
- **Phentermine-topiramate:** A combination of two medications that reduce appetite and make individuals feel full sooner.

EVIDENCE OF EFFECTIVENESS: ***Recommended***

In a review that included 33 randomized controlled trials and two observational studies of all types of medications that are FDA-approved for weight loss (LeBlanc, et al., 2018), individuals who received weight loss medications were more likely to lose 5% of their body weight and have a greater decrease in waist circumference compared with those who did not receive medication. There was also a lower risk of developing type 2 diabetes over the course of one to four years. Adverse effects were reported in most studies; however, serious side effects were generally low.

There is strong evidence that adding orlistat to lifestyle-based behavioral programs for overweight and obese adults with type 2 diabetes results in a 4.4- to 6.6-pound greater weight loss at one and two years compared with a placebo with lifestyle intervention and that the addition of orlistat results in greater reductions in fasting blood sugar and hemoglobin A1c (Jensen, et al., 2014).

In a systematic review of long-term pharmacologic treatment for obesity in adults (Yanovski & Yanovski, 2014), use of medication for obesity in addition to lifestyle intervention led to greater weight loss and increased the likelihood of meaningful weight loss at one year. For specific medications plus lifestyle intervention, authors

found that orlistat produced a loss of 3% of body weight on average and at least 5% in 35% to 73% of patients, lorcaserin produced a loss of 3% of body weight on average and at least 5% in 37% to 47% of patients, and phentermine-topiramate produced a loss of 9% of body weight on average and at least 5% in 67% to 70% of patients.

Bariatric Surgery for Adults

Bariatric surgery is an invasive approach to treatment of obesity. It may be recommended for severely obese patients as well as patients with lesser degrees of obesity who have comorbid diseases such as type 2 diabetes. Bariatric surgery can be done through open or laparoscopic surgery. Open surgery is done through a single large cut in the abdomen. Laparoscopic surgery includes several small cuts where surgical tools are then inserted. The most common types of bariatric surgery are as follows (National Institute of Diabetes and Digestive and Kidney Diseases, 2016):

- **Laparoscopic adjustable gastric band:** An adjustable band is placed around the top part of the stomach, creating a small pouch with an adjustable opening.
- **Gastric sleeve or sleeve gastrectomy:** Approximately 80% of the stomach is removed, creating a smaller pouch.
- **Gastric bypass (Roux-en-Y):** The top part of the stomach is stapled, creating a smaller pouch and attaching it to the middle part of the small intestine.

EVIDENCE OF EFFECTIVENESS: *Recommended*

There is strong evidence that bariatric surgery for obese adults, regardless of type, results in greater weight loss and weight loss maintenance than usual medical care, lifestyle-based weight loss programs, or other medically supervised weight loss. Weight loss two to three years after bariatric surgery for patients with a BMI of 30 or greater averages 20% to 35% of baseline weight, and there is a greater likelihood of remission of type 2 diabetes for patients who have type 2 diabetes at baseline. There is moderate evidence that most health-related quality of life measures are improved two to 10 years after bariatric surgery. There is lower-quality evidence that 10 years after bariatric surgery, mean weight loss is 16% of baseline weight (with an average weight regain of 7%) (Jensen, et al., 2014). There is some evidence that laparoscopic gastric bypass and gastrectomy produce similar outcomes, which are better than those of adjustable gastric banding; however, evidence of which approaches achieved the best results in open surgery was mixed (Colquitt, Pickett, Loveman, & Frampton, 2014). Bariatric surgery does have significant risks. A meta-analysis concluded that the mortality rate was 0.31% after 30 days, complication rate was 17%, and reoperation rate was 7% (Chang, et al., 2014).

Baby-Friendly Hospital Initiative

Breastfeeding is associated with reduced risk of obesity for children and earlier return to pre-pregnancy weight for women. The Baby-Friendly Hospital Initiative was launched by the World Health Organization and the United Nations Children's Fund in 1991. The goals of this global program are to encourage the broad-scale implementation of Ten Steps to Successful Breastfeeding and the International Code of Marketing of Breast-milk Substitutes (Baby-Friendly USA, 2018a). The initiative assists hospitals in providing mothers with the information and skills needed to initiate and continue breastfeeding or safely feed with formula. There are three basic tenets of the Baby-Friendly philosophy (Baby-Friendly USA, 2018b):

- Human milk fed through direct breastfeeding is the optimal way for human infants to be nurtured and nourished.
- The first days in the birth facility should be

protected as a time of bonding and support not influenced by commercial interests.

- Every mother should be informed about the importance of breastfeeding and respected to make her own decision.

Hospitals that implement the practices receive recognition and are designated as "Baby-Friendly" facilities. In the United States, Baby-Friendly USA, Inc. is the accrediting body and national authority for the Baby-Friendly Hospital Initiative. Baby-Friendly USA coordinates and conducts all activities associated with conferring the Baby-Friendly designation to hospitals. In 2018, 31.0% of live births in Indiana occurred in Baby-Friendly facilities, compared with 26.1% of live births throughout the U.S. (Centers for Disease Control and Prevention, 2018e). Of infants born in 2015 in Indiana, 78.8% were ever breastfed and 53.5% were breastfeeding at six months, compared with 83.2% and 57.6% of infants born in 2015 anywhere in the U.S., respectively (Centers for Disease Control and Prevention, 2015a). While organizations seeking Baby-Friendly certification do so voluntarily, 18 states have passed laws requiring hospitals to implement one or more of the 10 steps to support breastfeeding among maternity patients (Changelab Solutions, 2018) (Munn, Newman, Mueller, Phillips, & Taylor, 2016).

EVIDENCE OF EFFECTIVENESS: *Promising*

There is clear evidence that Baby-Friendly policies contribute to increased rates of breastfeeding initiation, exclusive breastfeeding, and duration of breastfeeding (Munn, Newman, Mueller, Phillips, & Taylor, 2016) (Perez-Escamilla, Martinez, & Segura-Perez, 2016). This is particularly true among racial/ethnic minorities, mothers with low education, and low-income mothers (Munn, Newman, Mueller, Phillips, & Taylor, 2016) (Perez-Escamilla, Martinez, & Segura-Perez, 2016). Researchers also found that implementing some of the 10 steps (versus an all-or-none approach) improves breastfeeding outcomes, supporting state policies that focus on one or more of the steps (Perez-Escamilla, Martinez, & Segura-Perez, 2016). In a 2018 Agency for Healthcare Research and Quality comparative effectiveness review, evidence from nine cohort studies found consistently higher rates of breastfeeding initiation among women giving birth at Baby-Friendly Hospital Initiative–certified or accredited hospitals compared with noncertified hospitals (Feltner, et al., 2018). One randomized controlled trial and five cohort studies found that the Baby-Friendly Hospital Initiative increased duration of breastfeeding through 12 months postpartum.

Motivational Interviewing in Primary Care for Adults

Motivational interviewing is a specific type of behavioral counseling that uses a client-centered approach to resolve patient ambivalence toward changing unhealthy behaviors and enhancing motivation for behavior change. Trained providers use reflection, open-ended questioning, and empathy to help patients discuss reasons for change, optimism, and intent for change. Motivational interviewing is a time-limited approach and thus can be used in medical settings, where time is often lacking. In studies, various people in primary care settings have delivered motivational interviewing, including nurses, physicians, dietitians, counselors, and medical assistants. Accredited or certified trainers can train clinical staff. Training length has varied substantially in studies, from three to 170 hours. Motivational interviewing is usually delivered one on one, but mixed one-on-one/group and group therapy have also been used. In-person visits, telephones, and other technology have been used to deliver motivational interviewing. Interventions have lasted three to 12 months, where patients are exposed to motivational interviewing for 60 to 75 minutes over the course of three months and up to 720 minutes over the course of 12 months. Motivational interviewing may be combined with other behavioral approaches, such as cognitive

behavioral therapy, as well as supplemental materials, such as a pedometer and print information about weight loss.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

In a meta-analysis of motivational interviewing interventions in primary care settings (Barnes & Ivezaj, 2015), less than half of studies (nine out of 24) reported significant weight loss in groups receiving motivational interviewing compared with patients in usual care or controls. Approximately half of studies reported that 6% to 35.7% of participants lost 5% of their body weight. Overall, the effectiveness of motivational interviewing in primary care settings for weight loss is inconclusive. Some studies have reported positive results, but more studies have reported negative results.

"Prescription" Programs for Adults

Prescription programs operate on a "health as medicine" approach that equates healthy lifestyle behaviors, such as engaging in physical activity, with medications by having the healthcare provider "prescribe" healthy behaviors. This has included prescribing physical activity (e.g., walking), eating more fruits and vegetables, cooking at home, and more. Some prescription programs link the clinical setting to the community setting. For example, the Fruit and Vegetable Prescription Program enrolls patients in the healthcare setting; the patients attend a clinical visit to set goals, followed by regular check-ins; and then the patients receive a prescription for fresh fruits and vegetables. The participants can redeem their "prescription" at retailers such as farmers' markets to obtain fresh fruits and vegetables. Physical activity prescriptions may recommend walking in area parks or trails. The Prescription for Health program was developed by the Robert Wood Johnson Foundation in collaboration with the Agency for Healthcare Research and Quality and relied on primary care practice-based research networks to develop and test ideas about how to help people modify unhealthy behaviors and make better choices (Cifuentes, et al., 2006).

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

Evidence regarding prescription programs is extremely limited. Studies have examined prescription programs aimed at both prevention and treatment of obesity and its risk factors. Evidence from lower-quality studies had mixed findings for increasing physical activity (Schutz, Nguyen, Byrne, & Hills, 2014). Studies rarely reported weight; however, studies that did report weight did not find that these programs led to weight reduction (Bryce, et al., 2017).

Addressing Obesity in Children and Adolescents

Screening for Obesity in Children and Adolescents

Screening for obesity is recommended as part of routine care for children and adolescents. Screening is used primarily as a tool, along with additional health assessment, to identify individuals who are obese or at greater risk for obesity. Some expert guidance recommends screening for obesity by age (Barlow & The Expert Committee, 2007), while others recommend screening by age six (U.S. Preventive Services Task Force, 2017). Studies have found that pediatricians are more likely to recognize obesity when they use BMI growth charts to screen for it (Perrin, Flower, & Ammerman, 2004).

EVIDENCE OF EFFECTIVENESS:
Recommended

There are no studies that address the benefits or harms of screening for obesity (O'Connor, et al., 2017). Wein and colleagues used mathematical modeling to estimate optimal screening and suggested that the focus should be on screening

and treatment for adolescents; however, this theory has not been confirmed in practice to our knowledge (Wein, Yang, & Goldhaber-Fiebert, 2012). On the bases that experts and clinical guidelines recommend screening for obesity in children and adolescents and that screening is necessary to determine the most appropriate prevention or treatment approach, screening is recommended.

Multicomponent Weight Loss Programs for Children and Adolescents

Multicomponent lifestyle-based weight management programs for children and adolescents are usually conducted in primary care or other healthcare settings. Some programs are conducted outside of the healthcare setting but rely on healthcare referrals. These programs usually target elementary school-age children and adolescents who have a BMI well above the 95th percentile for age and sex; however, interventions have included children as young as age two. Almost all programs engage parents and involve behavioral counseling, goal setting, and motivational interviewing on nutrition and physical activity. In research studies, low-intensity programs (six contact hours or less) were usually conducted in a primary care setting with a physician and/or another healthcare professional. Higher-intensity interventions (26 contact hours or more) were usually conducted in a group setting. Group-based programs often have separate activities for youth and parents and include physical activity.

EVIDENCE OF EFFECTIVENESS: ***Recommended***

An evidence report and systematic review for the U.S. Preventive Services Task Force (O'Connor, et al., 2017) concluded high-intensity (26 hours of contact or more) lifestyle-based weight management programs are effective in reducing weight among obese children after six to 12 months. Most interventions had a reduction in BMI z-score by 0.20 or more, which is clinically significant. Hours of contact was the only component of programs that was clearly associated with weight outcomes. There is a dose–response relationship between the number of program hours with the child or family and change in BMI z-score. The interventions with the greatest number of contact hours (52 contact hours or more) consistently showed treatment effects and had the greatest impact on weight, ranging from a 2.6-pound weight gain to a 7.0-pound weight loss, while control groups gained eight to 17 pounds. These groups also had improvements in blood pressure but not in lipids or fasting glucose. Interventions with 26 to 51 contact hours were also usually effective, but impact on BMI z-score was smaller. Few of the interventions with less than 26 contact hours resulted in significant weight reduction. Studies have reported no significant adverse effects (e.g., disordered eating) from youth participating in lifestyle-based weight loss programs.

Systematic reviews that looked at the effectiveness of lifestyle-based interventions by age found that in interventions for obese children from preschool age to age six, the average change in BMI z-score was 0.4 units lower than for control groups (Colquitt, et al., 2016). For youth six to 11 years old, settings included healthcare settings as well as schools, communities, homes, and university research clinics; however, no differences were found for change in BMI by setting. For all interventions, the mean difference in BMI was −0.53 kg/m^2 and the average difference in BMI z-score was −0.06 units for participants compared to controls (Mead, et al., 2017). For adolescents, ages 12 to 17, BMI reduction at 18 to 24 months was an average of 1.49 kg/m^2 lower for intervention participants than for controls (Al-Khudairy, et al., 2017).

Lifestyle-Based Interventions for the First 1,000 Days*

The early childhood years are considered to be an important period for the development and prevention of childhood obesity. Inappropriate bottle use (e.g., prolonged bottle use), early introduction of solid foods, and non-responsive feeding styles (e.g., over- or underregulating intake) have been identified as potential risk factors for obesity (Engle & Pelto, 2011), whereas breastfeeding has been found to be protective (Yan, Liu, Zhu, Huang, & Wang, 2014). Interventions for the first 1,000 days of life are limited and varied. They include group sessions for the mother and child; educational home visiting programs, where community nurses visit the home and provide information on infant diet and activity; community health workers providing information and education on infant diet and feeding practices in home visiting and group visits; use of dietary supplements (e.g., lactobacillus, fish oil); use of different types of infant formula; clinical programs targeting mother's diet and activity behaviors; and family-based behavioral counseling.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

Overall, the evidence base for interventions during the first 1,000 days of life is limited. In a review study of interventions for this period, only seven out of 26 studies reported positive effects on a child's growth status (Blake-Lamb, et al., 2016). Some interventions that appear promising include those focused on home visiting, individual or group counseling in healthcare settings, a combination of home and group visiting in community settings, and use of hydrolyzed-protein formula; however, there is currently insufficient evidence to establish the effectiveness of these approaches for reducing childhood obesity. In a systematic review of interventions for children 0 to three years old, lower protein in infant formula was considered promising, but evidence was mixed for other strategies (e.g., timing and type of complementary feeding) (Patro-Golab, et al., 2016).

*Excludes the Baby-Friendly Hospital Initiative, which occurs during the first 1,000 days but is described earlier.

Parent-Focused Interventions for Children Five to 11 Years Old

Parents have considerable control and influence over children's dietary and physical activity habits during the children's early years. Parenting styles and behaviors have been shown to both promote and inhibit healthy habits, and parents have been called "agents of change" for obese children under age 12 (Golan & Crow, 2004). The goal of parent-focused interventions is to treat overweight or obesity in children through behavioral approaches with the parent as the target for change. Settings for interventions may include outpatient care, primary care, universities, and communities and can be delivered by primary care providers, registered dietitians, and psychologists. The theoretical bases of interventions may include social cognitive theory, the health belief model, and the transtheoretical model. Motivational interviewing and cognitive behavioral therapy have also been used. Interventions may focus on provision of information and behavioral counseling and typically emphasize one or more of the following: parent role modeling, enhancement of parental self-efficacy to make positive change, self-monitoring, stimulus control, problem solving, goal setting, positive reinforcement, and creation of realistic expectations. Education on healthy behaviors and a healthy home environment can be delivered via one-on-one or group sessions, and some interventions include check-in phone calls. Educational topics usually include several of the following areas: selection of healthy food choices, reading of food labels, food preparation and cooking techniques, creation of a positive eating environment, healthy snacks, reduction of SSB intake, reduction of sweet and salty snack

intake, increase in fruit and vegetable intake, age-appropriate serving sizes, physical activity guidelines, and recommendations for reducing screen time and sedentary behaviors. Sessions sometimes include activity diaries, family action planning, and workbooks.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

A systematic review of parent interventions for children ages five to 11 years found small reductions in BMI z-score. In studies that compared parent-only interventions to parent-child interventions, the mean difference in BMI z-score was -0.04. In studies comparing parent-only interventions to controls the mean difference in BMI z-score was -0.01 (Loveman, et al., 2015). Studies were mostly of low quality. Intervention effects were similar for parent-only interventions and parent interventions with a child component. Given the small reduction in BMI z-score and the lower quality of studies, evidence overall is inconclusive.

Technology-Based Interventions for Adolescents

A large proportion of U.S. adolescents have access to cell phones, home computers, or tablets. Use of technology has been suggested as a practical way to manage youth obesity in busy primary care settings. Interventions through Internet-based and video game-based approaches have been tested. Examples of interventions studied in clinical trials include use of *Wii Fit* in the home, "exer-gaming" alone or in a group setting (exer-games are video games that require physical activity, such as Dance Dance Revolution or games that work when pedaling a stationary bicycle), weekly educational fitness classes plus an Internet-based study program, and group sessions on diet and physical activity combined with telephone or email counseling.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

In a systematic review of technology-based interventions for adolescents (Chen & Wilkosz, 2014), six of 14 studies reported reductions in BMI or body weight, six of 11 studies found improved physical activity, and five of seven studies reported improvements in dietary behaviors (e.g., increased fruit and vegetable intake). All studies that reported improvements in BMI or body weight focused on diet and physical activity together. Overall, there is limited information about the effectiveness of technology-based interventions for reducing obesity in adolescents, and available evidence is mixed.

Pharmacotherapy for Children and Adolescents

Orlistat is a drug used to treat obesity by preventing the absorption of fat. Orlistat has been approved by the FDA for adolescents age 12 and older (U.S. Preventive Services Task Force, 2017). Metformin is a drug used to treat type 2 diabetes that reduces glucose production and absorption in the intestines. Although metformin is not approved to treat obesity, it has been used for this purpose.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

In studies of orlistat, youth were 12 to 18 years old and more obese than those who participated in lifestyle-based weight loss programs (mean BMI: 37.4 kg/m^2), and most studies did not require patients to have an additional risk factor. Counseling was usually offered in addition to orlistat. An evidence report and systematic review for the U.S. Preventive Services Task Force (O'Connor, et al., 2017) from a small number of fair-quality studies found that orlistat use resulted in small but significant reductions in BMI by 0.50 kg/m^2 to 0.94 kg/m^2 compared with placebo use; however, the reduction is not considered clinically

significant. Adverse effects were very common and reported by up to 65% of participants for the most common complaint, abdominal cramps. Flatus and fecal incontinence were also reported more frequently than in the placebo group; however, less than 5% of study participants stopped participating because of adverse effects.

In clinical studies, metformin has been tested in children and adolescents six to 19 years of age in pediatric obesity clinics, endocrine clinics, and clinical research settings (U.S. Preventive Services Task Force, 2017). These youth were more obese than those who participated in lifestyle-based weight loss programs (mean BMI: 36 kg/m^2), and many interventions required participants to have other health risks in addition to obesity, such as insulin resistance or impaired glucose tolerance, or to have had previous unsuccessful attempts at lifestyle intervention. An evidence report and systematic review for the U.S. Preventive Services Task Force (O'Connor, et al., 2017) from mostly low-quality studies indicated that use of metformin in obese children and adolescents is associated with a small reduction in weight after six to 12 months; however, the reduction in BMI z-score may be below a level that is considered clinically significant (U.S. Preventive Services Task Force, 2017). Mean weight changes ranged from a five-pound weight gain to a five-pound weight loss, compared with an 11-pound weight gain to a two-pound weight loss with a placebo—a reduction in BMI by 0.86 kg/m^2 compared with the placebo. Adverse effects were not markedly different between metformin and the placebo, and less than 5% of study participants stopped participating because of adverse effects.

Bariatric Surgery for Adolescents

For some groups of obese adolescents, lifestyle modification alone may not be effective and sustainable in achieving significant weight loss. Severely obese adolescents (having a BMI equal to or greater than 40 kg/m^2) with obesity-related comorbidities, such as type 2 diabetes and obstructive sleep apnea, who have failed previous attempts at weight management may be candidates for bariatric surgery. The most common types of bariatric surgery performed in adolescents are Roux-en-Y gastric bypass and laparoscopic adjustable gastric band (Ells, et al., 2015).

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Few reports of randomized controlled trials of bariatric surgery in adolescents are available, and long-term effectiveness is largely unknown (Ells, et al., 2015). In other types of studies, bariatric surgery for severely obese adolescents resulted in considerable weight loss (29.8 to 50.3 pounds) and significant resolution of obesity-related comorbidities (Durkin & Desai, 2017). Bariatric surgery presents many safety risks, including death. Although evidence seems promising, review conclusions were mixed, with some researchers calling for more studies on the long-term effectiveness of bariatric surgery in this age group.

Worksite Strategies to Address Obesity

There is a strong incentive for employers to support healthy lifestyles in the workplace. Employees who are obese are more likely to miss work and have more frequent injuries and healthcare claims than non-obese employees (Van Nuys, et al., 2014). Promoting health can increase employee productivity and reduce employer healthcare costs. Workplace interventions to reduce obesity are recommended by the CDC and the World Health Organization and are among the strategies determined to have enough evidence for the Task Force on Community Preventive Services to recommend them (Anderson, et al., 2009).

From a public health standpoint, worksites offer a unique opportunity to address obesity among adults. In Marion County, 68% of the population age 16 and older is employed (United States Census Bureau, 2018), so worksites provide access to a large percentage of the adult population. Full-time employees spend up to 60% of their day in the workplace (U.S. Department of Labor, 2018). Many employees return to the same workplace setting each day, providing access over time to a fixed population that can be exposed to interventions, environments, and cultural norms that influence health behaviors. However, there are factors in worksites that may work against obesity prevention. Advancements in technology and the computerization of worksite tasks, automation, and labor-saving devices have resulted in more jobs that are sedentary in nature, with workers sitting for many hours of the day. Workers typically consume one meal at work but may lack access to convenient and healthful options, facilities for preparing food, or time to consume meals, opting to skip them or eat them at their desks. Furthermore, stressors such as night shift work, long hours, and job strain have been shown to be associated with higher BMI among employees (Tam & Yeung, 2018).

In this chapter, we describe worksite strategies that have been studied to address obesity. Strategies are organized into three categories defined below:

- **Informational/behavioral interventions:** Informational/behavioral interventions are designed to increase knowledge and awareness and change behaviors related to eating and physical activity. Behavioral strategies are aimed at changing behavior through approaches such as coaching, counseling, skill building, motivational interviewing, and goal setting, as well as the provision of rewards, reinforcements, or incentives designed to influence behavior.
- **Environmental/policy interventions:** Environmental interventions are principally designed to modify the physical properties or placement of objects or stimuli in the worksite environment. Policy interventions are those that modify organizational rules or procedures.
- **Multicomponent interventions:** Multicomponent interventions include at least two types of strategies, such as an informational/behavioral intervention and an environmental/policy intervention or an informational/behavioral intervention focused on physical activity and nutrition.

Each strategy includes a brief summary of the approach and the evidence of effectiveness, along with effectiveness classification (according to Table 4). Under each category, strategies are organized by their evidence classification, from the best evidence of a positive effect (i.e., recommended) to lowest evidence of a positive effect (i.e., mixed/inconclusive).

Evidence Summary

There are effective worksite solutions for obesity. Multicomponent workplace interventions consistently produce a modest effect on employee weight status. Most of the studies with a positive effect used a combination of behavioral and informational strategies and addressed both physical activity and healthy eating. Unfortunately, there is a lack of evidence and clarity around which intervention components or combination of components is most effective in producing positive outcomes in employee weight. What is apparent is that more intensive interventions tend to be more effective, that having a structured program is more effective than having an unstructured program, that offering informational activities along with behavioral counseling is more effective than informational activities alone, and that there is no difference between interventions offered by professionals and interventions offered by laypeople. Although workplace environmental approaches alone may not be effective in reducing weight and BMI, they have a modest positive effect on eating and physical activity behaviors in studies, and they have advantages over other strategies, because they are low intensity and do not require employees to opt in to experience benefits.

There are many limitations to the research on workplace-based programs designed to address obesity, physical activity, and healthy eating. There is often a wide range of strategies used (one study reported three to 15 strategies across one group of interventions), making it difficult to ascertain which strategies are most effective. Program characteristics are sometimes poorly described. There is a heavy reliance on self-reported data, which is subject to recall bias, measurement error, and over- and underreporting. Studies of the same intervention type often used different instruments to collect data and sampling strategies, and study designs varied. Furthermore, few studies look at what compensatory behaviors employees may engage in outside of the worksite setting. For example, if a worksite changes its cafeteria menu to no longer offer some less healthful products, employees may compensate by bringing that type of food in from outside sources, or they may compensate for smaller portion sizes in a cafeteria by purchasing more food or eating additional food at other times (Vermeer, Steenhuis, Leeuwis, Heymans, & Seidell, 2011).

Information/Behavioral Interventions

Informational interventions are designed to increase knowledge of healthy eating or physical activity. This information may be delivered through presentations at worksites, emails, newsletters, leaflets, books, or other strategies. Informational strategies are rarely examined alone and are frequently coupled with behavioral interventions.

Behavioral interventions are designed to support positive behaviors and societal factors. Behavioral strategies used in workplace weight loss interventions have included general or customized counseling based on health risk assessments or other assessments, goal setting, and motivational interviewing. Motivational interviewing is a counseling approach designed to elicit behavior change by helping people to explore and resolve ambivalence and find internal motivation for the behavior.

Informational and behavioral interventions have been delivered by trained staff (e.g., registered dietitians, exercise physiologists) as well as lay health educators (i.e., worksite staff trained to deliver the approach). Behavioral interventions are often based on theoretical frameworks of behavior change. In the worksite setting, the most commonly used theoretical frameworks are the transtheoretical model (or stages of change), the socioecological model, and social cognitive theory. These theories provide the basis for what information is conveyed to participants and how.

For example, an employee's stage of change may be assessed, and informational and behavioral strategies may be tailored to the specific stage of change. A thorough review of all of the theoretical frameworks used in interventions is outside of the scope of this report. More information about these frameworks can readily be found online (Glanz, Rimer, & Viswanath, 2008).

Information/Counseling to Reduce Sedentary Time

Information and counseling interventions to reduce sedentary time at work have been numerous and diverse. Studies that have measured reductions in workplace sedentary time have tested various combinations involving one or more of the following strategies: face-to-face interactions with a health or physical activity coach, meeting with an exercise physiologist, weight management program with a health coach, counseling and goal setting, self-monitoring of physical activity, print information based on stage of change or with personalized information, web-based activities with interactive features, automatic deactivation of employee computer screens to signal short bursts of physical activity, and computer screen prompts to stand up or be physically active.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

Providing information or counseling to reduce sitting time at work results in a decrease in sitting time of five to 51 minutes per eight-hour workday after three to 12 months of intervention. Short-term effects were not significant. A similar pattern was found with information or counseling interventions combined with computer prompts; sitting time was reduced by 14 to 96 minutes per eight-hour day after three to 12 months but not in the short term (Shrestha, et al., 2018). In a review of studies conducted among white-collar workers, information and counseling interventions led to reductions in sitting time but were less effective than other approaches, with a pooled effect of −15.5 minutes per eight-hour workday (Chu, et al., 2016). Few of the included studies (three of 15) resulted in statistically significant changes in sitting time. Overall, there is inconsistent evidence regarding whether interventions that focused primarily on an informational or counseling strategy led to changes in sedentary time.

Counseling to Increase Physical Activity

The primary focus of this group of interventions is providing behavioral counseling, and physical activity was one of the outcomes measured. Interventions used counseling, behavioral skills training, a peer support program, and motivational interviewing. Interventions were conducted one on one and in group settings and delivered in person, via telephone, or via the web. Both professional and lay health educators have been used to deliver counseling interventions. Most interventions used a theoretical framework, with transtheoretical model and social cognitive theory being among the most commonly used.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

In a systematic review of workplace physical activity strategies, eight out of 13 studies examining the impact of counseling strategies on physical activity resulted in a statistically significant increase in physical activity among the intervention group compared to control group (Malik, Black, & Suggs, 2014). Evidence was inconclusive as to what types of counseling strategies were most effective. Overall, evidence is mixed, bordering on promising, for counseling alone as a strategy to increase physical activity among employees.

Informational Strategies to Increase Physical Activity

Informational strategies to increase physical activity aim to increase knowledge about the health benefits of physical activity and health risks of

inactivity. Activities in this category include health presentations and written and electronic health promotion materials, such as emails, posters, and flyers. Information is sometimes given in addition to a health screening or health risk assessment. Most informational intervention studies have been informed by a theoretical framework, such as the transtheoretical model, social cognitive theory, the theory of planned behavior, and protection motivation theory.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

In a systematic review of informational interventions designed to increase physical activity, a little more than half of the studies (22 out of 39) found a significant increase in physical activity among an intervention group compared to a control group (Malik, Black, & Suggs, 2014). Information that was tailored to the employee's stage of change was usually more effective than general information or information targeted to a different stage, although this finding was not consistent. Overall, informational strategies alone produce inconsistent outcomes in physical activity levels among employees, and it is difficult to ascertain which strategies are most impactful because of difficulties in comparing studies across different time points, intervention characteristics, and data collection strategies.

Exercise or Walking Programs

Worksite physical activity programs are designed to get employees physically active during and outside of the workday, increase physical activity levels, and improve health outcomes. Walking, aerobic exercise, a choice of medium- to high-intensity exercises, and strength training are examples of exercise programs offered to employees. Types of interventions that have been studied include 16 weeks of 30-minute walks six times per week, 10-week workplace walking for 10 minutes per day during work breaks, 12-week low-impact aerobic exercise classes, 20 weeks with 30 minutes of activity three to four times per week in addition to 15 to 20 minutes of strength training three times per week, mandatory physical exercise during 2.5 hours of the workweek, reduction from 40 to 37.5 hours of work per week, and 10-minute exercise breaks of aerobic dance movements incorporated into meetings and events during work time.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Evidence for exercise programs is mixed. Workplace walking groups produced significant changes in physical activity levels compared with interventions that assigned exercise classes or a choice of aerobic exercise; however, the number of studies was limited and of lower quality, and results overall were mixed (two out of six studies saw statistically significant increases in physical activity compared with the control groups) (Malik, Black, & Suggs, 2014). In a review of studies conducted only in Europe, findings were consistent, with a greater percentage of walking programs achieving statistically significant increases in physical activity compared with exercise classes. Few studies measured changes in BMI; however, those that did had mixed effects on BMI status (Vuillemin, et al., 2011). Overall, evidence is mixed, with inconsistent findings on physical activity levels and BMI.

Pedometer Interventions

A pedometer is a small, portable device designed to track steps taken by an individual. In health promotion programs, pedometers are used by participants to track steps and monitor changes in steps taken over time. Pedometers provide continuous feedback on physical activity levels and can act as a motivator to increase physical activity. Participants may work toward achieving a target number of steps per day, increasing steps per day over a baseline amount, or logging steps for multiple days to achieve an end goal. Pedometers

are typically used as one component of a multicomponent health promotion program and are frequently coupled with distribution of health information, motivational reminders, individual or group counseling or coaching sessions or meetings, rewards or incentives (e.g., T-shirts, plaques, gift cards), and a diary or website to record and report steps. Pedometer interventions sometimes focus on achieving individual goals and sometimes focus on achieving team goals, in which multiple people work together to take the most steps and track progress against other teams. In studies, pedometer interventions lasted between three and 104 weeks, with an average duration of 18 weeks.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Pedometer interventions conducted in a variety of settings (not only worksites) have been associated with increases in physical activity (a 26.9% increase over the baseline, or about one mile per day) and decreases in BMI (0.38 kg/m^2) and blood pressure (3.8 mm Hg) (Bravata, et al., 2007). Setting step goals (e.g., 10,000 steps per day or personalized goal) and tracking daily steps (e.g., with diary) were key predictors of increases in physical activity. Interventions that were longer in duration produced a greater reduction in BMI. In worksite settings specifically, increases in physical activity were smaller. Bravata and colleagues found that their systematic review of pedometer interventions corroborated earlier findings that worksite pedometer interventions tend to attract staff who are already physically active, so there is less room for improvement, and those interventions may be best suited for sedentary populations.

Another systematic review of pedometer interventions conducted only in worksite settings found mixed results for increasing physical activity and some evidence of improvement in BMI (0.92 kg/m^2 lower in intervention participants compared to controls), fasting plasma glucose, mental component of quality of life, and worksite injury, although evidence was from few studies which were of lower quality (Freak-Poli, Cumpston, Peeters, & Clemes, 2013). Overall, pedometer interventions appear to hold promise for improving physical activity and BMI; however, worksites may not be the most effective locations for these interventions, unless employees are sedentary at baseline.

Financial Incentives for Weight Loss

Employers have experimented with a variety of financial incentives to promote healthy weight among employees, including reduction in health insurance premiums, payments for weight loss, lotteries, and deposits or bonds. Health insurance premiums reward employees for being at a healthy weight or weight loss by covering a greater percentage of health insurance costs. Payments for weight loss may be time based (e.g., quarterly) or according to the amount or percentage of body weight lost. Lotteries offer opportunities for employees who lost weight during a given time frame to enter a drawing to win cash or other prizes. Deposits or bonds have employees pay an amount once or on a schedule (e.g., monthly) that is then refunded to the employee after a certain period if weight is lost.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Several studies have examined the impact of financial incentives to promote weight loss among employees, with mixed results. One study that assessed front-loaded incentives (larger at the beginning of the program), back-loaded incentives (larger later in the program), and incentives that were steady throughout the program reported modest weight loss in the short term but not in the long term and high attrition rates (Finkelstein, Linnan, Tate, & Birken, 2007). A study where employees were offered adjusted health premiums

(immediate or delayed) and lottery incentives found no effect of financial incentives on weight loss (Patel, et al., 2016). A third study reported very high attrition rates and no impact with quarterly payments for weight lost but a modest reduction in weight in the long term with a deposit contract plus a bonus (Cawley & Price, 2013). Overall, financial incentives have produced modest weight loss results in some studies; however, evidence is limited and mixed, and there are concerns regarding high attrition with these types of programs, as well as the long-term effectiveness of financial rewards for weight loss.

Policy and Environmental Change Interventions

Workplace environmental interventions aim to change health behavior by altering the placement or properties of objects or stimuli in the physical environment. Examples of workplace environmental strategies include prompting to encourage stair usage, labeling cafeteria items to provide health information or denote healthful choices, increasing the amount of healthful options available, reducing portion sizes, and changing the placement of items, such as moving less healthful foods away from checkout stations. The rationale for changing the environment is that human behavior is influenced by cues from our environment that we are not always conscious of. Altering the cues may encourage healthful behaviors. Furthermore, environmental changes are passive interventions, which do not require individuals to opt in to a specific program or make conscious choices to pursue healthier behaviors; rather, they influence individuals through their presence. In this section, we describe policy and environmental interventions that have been studied to affect obesity and its risk factors, along with a classification of the evidence of effectiveness for each strategy.

Active Workstations

Excessive sedentary time has been associated with obesity, type 2 diabetes, cardiovascular disease, and premature death. Interest in active workstations has grown over the years as studies have shown that activity-permissive workstations may reduce workplace sedentary time, lower BMI, and lower musculoskeletal discomfort (Neuhaus, et al., 2014). Active workstations or activity-permissive workstations incorporate equipment into the workstation area that enables employees to be physically active while doing their work, particularly work that is usually sedentary in nature (e.g., working at a computer). There are various types of active workstations. The most common are height adjustable and sit-stand desks, which allow the employee to raise and lower the desk height to accommodate work while standing or sitting. There are also treadmill desks which contain a desktop attached to a treadmill to allow walking or running while working as well as cycling desks, including traditional stationary bicycles with a desktop or under-desk pedals and cycle ergometers.

EVIDENCE OF EFFECTIVENESS: ***Promising***

Systematic reviews have found that sit-stand desks reduce sitting time from 84 to 116 minutes per eight-hour day in the short term compared with regular sitting desks and an average of 57 minutes per eight-hour workday in studies lasting three to 12 months (Shrestha, et al., 2018). Sit-stand desks also reduced sitting bouts of 30 minutes or greater (Neuhaus, et al., 2014) (Shrestha, et al., 2018). There were no major differences found between standing desks and sit-stand desks or between sit-stand desks with counseling and information and without them. Evidence for other active workstation components, such as treadmill desks and cycling desks, was inconsistent. Several studies found improvements in waist circumference, but health outcomes were not reported for the majority of studies. In white-collar workers only,

a systematic review found a pooled effect of a 72.8-minute reduction in sitting time per eight-hour workday for any type of active workstation (one study with treadmill desks, five with sit-stand desks) (Chu, et al., 2016). Overall, there is consistent evidence from lower-quality studies that active workstations, particularly sit-stand desks, may reduce sedentary time, and there is limited evidence from lower-quality studies that they may produce positive changes in waist circumference.

Stair Use Interventions

Interventions to increase stair use are based on recommendations that accumulating small bouts of physical activity, such as when individuals take the stairs, can contribute meaningfully to reaching recommended physical activity levels. Stair use is easy to incorporate into most daily routines, and climbing stairs has been associated with health benefits. Stair use interventions aim to increase stair use by strategies such as point-of-decision prompts, modification of the aesthetics of stairwells, and promotional activities. Point-of-decision prompts include both motivational signs and directional signs. Examples of motivational signs include encouragement to take the stairs (e.g., "Take the stairs for your health") and posters about the health benefits of taking the stairs placed near stairwells, elevators, and escalators. Directional sign examples include arrows or signs directing individuals to the stairwell and footprints on the ground directing the route to the stairs. Aesthetic enhancements include painting stairwell walls, and placing artwork and playing music in stairwells. In one study, throughout the stairwell, artwork was hung and changed weekly and a CD player played music that was changed daily. In another study, the stairwell was decorated with interactive paintings such as maps, storyboards, and wish lists to encourage employees to take the stairs. Promotional activities included stair use promotion days and emails sent to employees to encourage stair use. Interventions have lasted anywhere from one day to 16 weeks.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

A systematic review of stair use interventions (Belicha, 2015) in worksites and public settings included 25 studies conducted in worksites and found increased stair use in 64% of studies, bordering on promising. Studies that found a positive effect were of weak quality. A combination of motivational and directional signs was more effective at increasing stair climbing than use of motivational signs only. Interventions that modified the aesthetics of the stairwell with artwork and other enhancements, in addition to prompts, all reported increases in stairwell use (Boutelle, Jeffery, Murray, & Schmitz, 2001) (Swenson & Siegel, 2013) (Van Nieuw-Amerongen, Kremers, De, & Kok, 2001). For studies that included a follow-up period, stair climbing remained elevated in two-thirds of worksites after the intervention was completed. Overall, stair use interventions may increase physical activity; however, current information suggests that slightly less than two-thirds of interventions produce positive changes.

Modifying the Food Environment

Most full-time employees consume at least one meal per day at work and may also consume snacks and beverages in the workplace. As of 2016, approximately 18% of worksites had on-site cafeterias for staff. Worksites may also have on-site vending facilities or food deliveries. A variety of strategies have been undertaken to modify the food environment at worksites. They typically fall into one of the following categories:

- **Promotional:** Marketing materials promote healthy eating in worksites, including table tents, signs, posters, and displays.
- **Labeling:** Nutrition labeling is designed to provide information about the healthfulness of products at the point of purchase or service to influence consumer choice. Nutrition labels are typically placed near the products in cafeterias

or vending machines. Labels may include nutrition information (e.g., calories, grams of fat, grams of carbohydrates, grams of protein, energy density) or be in the form of an icon or another marker (e.g., a heart symbol) that denotes the healthfulness of the product.

- **Price:** Price subsidies are sometimes used to make healthier foods more affordable, relative to their normal price or to less desirable options. A variety of discounts have been offered to encourage individuals to purchase more healthful items, such as fruits and vegetables, lower-fat items, or low energy dense foods. Examples of interventions have included reducing the price of the salad bar by 50%, offering 15% discounts on low-energy dense foods and 25% discounts on very low-energy dense foods, reducing the price of low-fat vending items by 10% to 50%, and proportionally reducing prices on smaller portion size items. Most interventions offering price subsidies also increased the availability of healthy foods and/or labeled healthier items with an icon or nutrition information.
- **Product:** Increasing the availability of healthy foods changes the mix of products available for people to choose. These changes may occur in worksite cafeterias, vending machines, and other locations. New items may be introduced, variety may be increased, or existing products may be modified (e.g., changing a recipe to modify the nutrient profile or increase the amount of fruits and vegetables). Examples of product changes include offering employees one piece of fruit per day, creating healthy "grab-and-go" items, creating healthier versions of well-liked items, and adding more fruit and vegetable choices to the salad bar.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

In a systematic review of workplace environmental interventions designed to affect eating behaviors, 13 of 22 identified research studies had a small to medium-sized effect on outcomes such as eating behaviors and sales of healthful foods (Allan, Querstret, Banas, & de Bruin, 2017). There was little to no evidence that environmental interventions that were targeted at changing eating behaviors resulted in significant changes in weight or BMI. The interventions contained three to 15 different strategies, many of which were not described in sufficient detail, making it challenging to identify which elements were most effective or least effective. One review of worksite cafeteria interventions suggested a combination of price subsidies, marketing materials, and menu changes held the most promise (Hendren & Logomarsino, 2017), but findings overall are inconclusive.

Breastfeeding Supports

Breastfeeding is associated with reduced risk of obesity for children and earlier return to pre-pregnancy weight for women, among many other health benefits. Furthermore, parents of breastfed babies have fewer work absences than parents of formula-fed babies, so there is a financial incentive for employers to encourage working mothers to breastfeed (Health Resources and Services Administration, 2008). One-day absences for sick children occur more than twice as often for mothers of formula-fed babies compared with mothers of breastfed babies, and formula-fed babies have higher healthcare costs, visit the physician more often, spend more days in the hospital, and require more prescriptions. Returning to work is one factor that has been associated with failure to initiate or continue breastfeeding. Types of breastfeeding supports in worksites have included lactation space (e.g., a private room with a chair and an electrical outlet for pumping), lactation breaks policies to allow for breastfeeding or pumping at certain intervals during the day,

education, support, refrigeration for storing breastmilk, and on-site child care facilities where employees can visit their children and breastfeed on site during work hours. The Patient Protection and Affordable Care Act includes the "Break Time for Nursing Mothers" law of 2010, which requires companies with 50 or more employees to provide time and private space other than a restroom to express milk.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

A 2017 review of breastfeeding accommodations in worksites (Hilliard, 2017) found that no clinical trials had been conducted. In non-experimental studies, corporate lactation programs, on-site child care, support from a lactation consultant via telephone, and coworker and supervisor support were all associated with longer breastfeeding duration. Private spaces for lactation and lactation breaks were not consistently associated with breastfeeding duration. Overall, evidence suggests that worksite programs may improve breastfeeding duration; however, studies are limited, and findings are mixed.

Multicomponent Interventions

Multicomponent interventions typically include a combination of an information or behavioral strategy and an environmental strategy but may also include multiple behavioral strategies that focus on nutrition and physical activity. Behavioral components addressing nutrition include counseling, group education, and motivational interviewing. Behavioral components addressing physical activity include walking groups, fitness challenges, and exercise classes. Environmental changes addressing nutrition include changes to worksite food offerings in cafeterias and vending machines, including changes to products, placement, pricing, and promotion. Environmental changes addressing physical activity include mapped walking routes and on-site exercise facilities.

Multicomponent Interventions to Improve Diet and Physical Activity

Multicomponent interventions to improve diet and physical activity in worksites are similar to multicomponent interventions in healthcare and other settings. Interventions typically include in-person counseling support on nutrition and physical activity delivered through one-on-one or group meetings as well as provision of information on diet and physical activity, such as through newsletters, brochures, emails, or informational presentations. Other activities are added to these individual or group classes, such as cooking demonstrations, grocery shopping tours, tracking behaviors, exercise programs, and pedometers. Some worksite multicomponent interventions also include forming advisory boards of employees who work together to assess the worksite environment, make a plan for change, implement activities from the plan, and measure progress.

EVIDENCE OF EFFECTIVENESS: ***Recommended***

There is moderate-quality evidence that behaviorally focused interventions that address nutrition and physical activity are effective in producing modest changes in body weight and BMI. Meta-analyses have estimated the effects of these interventions to be a weight loss of 2.6 to 2.8 pounds and a reduction in BMI by 0.34 to 0.47 kg/m^2 (Anderson, et al., 2009) (Verweij, Coffeng, van Mechelen, & Proper, 2010). Interventions that address both nutrition and physical activity are more effective than interventions that address either of those areas alone. Most interventions were of moderate (two to five contacts) to high (more than five contacts per week) intensity. A systematic review published in 2018 (Tam & Yeung, 2018) reviewed 11 randomized controlled trials that assessed the impact of multicomponent interventions in the workplace setting on overweight populations (with a mean baseline BMI greater than or equal to 25 kg/m^2). The studies that produced a significant reduction

in BMI were of high-intensity (12 to 26 sessions per year) and included a behavioral component such as motivational interviewing (e.g., four to 12 motivational interviewing sessions, use of rewards or enhancements). Four out of the five (80%) interventions producing weight loss also included exercise classes in addition to group education classes. A fourth systematic review that assessed worksite interventions for healthcare professionals found that interventions that targeted both physical activity and healthy eating were more effective at reducing weight than targeting either physical activity or healthy eating alone (Power, Kiezebrink, Allan, & Campbell, 2014). Across studies, activities varied in type, number, and duration, which makes it difficult to determine which activity or mix of activities is most effective at producing changes in weight or BMI; however, a

Example: Images of a Healthy Worksite Study
(Fernandez, et al., 2015)

Setting: 10 worksites in the northeastern U.S. that are part of a nonunionized manufacturing research development company.

Participants: 3,799 individuals, mostly middle aged, male, highly educated, earning $60,000 or more per year, with an average BMI in the overweight category.

Intervention: Each worksite formed an employee advisory board with five to 10 employees from different levels of the company, food service representatives, researchers, and a facilitator. Boards surveyed coworkers on feasible strategies and selected those that were most important and rated highest in probable acceptance, participation, costs, and more. Worksites then implemented action plans. Awareness- and capacity-building strategy examples included workshops on health topics (e.g., packing a healthy lunch), orientations at worksite gyms, wellness books for worksite libraries, brochures on health topics (e.g., stretching in the workplace), newsletters with recipes and topical information, stickers and signage on vending and beverages, monthly cafeteria promotions (e.g., taste testing, saving of 100 calories per day), educational posters and table tents in common areas, a website with wellness information (e.g., walking routes), and health and wellness fairs. Examples of strategies to reduce energy intake and increase energy expenditures included mapping indoor and outdoor walking routes, placing signs to promote stair use, providing a chef training workshop, offering price incentives (e.g., "Buy 3, Get 1 Free" punch cards for healthy entrees), offering outdoor power walks, improving fitness facilities and adding fitness equipment, offering team competitions and tournaments, offering a veggie bar, providing fruit basket deliveries, and adding healthy items to vending machines.

Results: At the conclusion of the study, average BMI decreased 0.54 kg/m^2 in intervention worksites and 0.12 kg/m^2 in control worksites. The percentage of overweight or obese employees decreased by 3.7% in intervention worksites and increased by 4.9% at control worksites.

combination of information and counseling and a structured program with scheduled sessions was associated with success.

Multicomponent Interventions to Improve Diet Only

Multicomponent interventions to affect dietary habits have included modification of the food environment combined with behavioral strategies, both of these components being described in detail above. An example of this type of multicomponent intervention is changing food offerings and placing point-of-decision prompts for healthy foods in the worksite cafeteria, combined with direct education offered through group education classes.

EVIDENCE OF EFFECTIVENESS: *Promising*

Environmental changes plus behavioral strategies consistently show modest improvements in eating behavior, particularly fruit and vegetable consumption. In a systematic review, four of six studies that assessed the impact of multicomponent interventions to improve diet reported positive change in fruit and vegetable intake (Ni Mhurchu, Aston, & Jebb, 2010). A second review study reported similar findings for fruit and vegetable consumption (Geaney, et al., 2013).

Multicomponent Interventions to Reduce Workplace Sitting

Multicomponent interventions to reduce sitting in the workplace utilize a combination of environmental interventions with behavioral/counseling interventions. Environmental changes include installment of sit-stand workstations, pedal machines, treadmill desks, cycle ergometers, standing tables in conference rooms, exercise balls, table tennis, and footsteps on the floor to promote stair use. Behavioral/counseling strategies included goal setting, self-monitoring with pedometers, lunchtime walks, incentives for bicycle commuting or engaging in sports activities, lectures, promotional and motivational emails and text messages, computer prompts and computer-based programs, and coaching.

EVIDENCE OF EFFECTIVENESS: *Promising*

A systematic review that assessed various types of multicomponent interventions (sit-stand desk plus behavioral/counseling intervention or other environmental support plus behavioral/counseling intervention) found a significant reduction in sitting of 101 minutes per eight-hour work day (Shrestha, et al., 2018). A second review (Chu, et al., 2016) that focused on white-collar workers had similar findings: Multicomponent interventions resulted in a nearly 1.5-hour reduction in workplace sitting over an eight-hour workday, a reduction 16 minutes greater than with environmental interventions alone and approximately nine times greater than with behavioral approaches alone. Overall, combining multiple interventions seems to be effective at reducing sitting time and time spent in prolonged sitting bouts in the short and medium terms. However, this evidence comes from only a small number of studies, and the effects were very different across the studies.

School Strategies to Address Obesity

Schools are, in many ways, ideal settings for population-based strategies aimed at obesity prevention for children and adolescents. Children spend a large portion of waking hours in the school setting and consume half their daily calories in school, providing opportunities to influence consumption habits. There are also ample opportunities to influence physical activity behaviors in the classroom, at recess, and in PE*.

Being physically active and eating a healthy diet are associated with improved school outcomes, an incentive for schools to promote healthy lifestyles. Physical activity at school has been associated with improved academic performance, including better grades and standardized test scores, enhanced concentration and attention, and improved classroom behavior (Centers for Disease Control and Prevention, 2010). Lack of healthy foods such as fruits and vegetables is associated with lower grades and higher rates of absenteeism and tardiness (MacLellan, Taylor, & Wood, 2008) (Neumark-Sztainer, Story, Dixon, Resnick, & Blum, 1997) (Neumark-Sztainer, Story, Resnick, & Blum, 1996).

In this chapter, we describe school strategies that have been studied to address obesity. Strategies are organized into three categories below:

- **Physical activity interventions:** Interventions that address physical activity only or predominantly.
- **Nutrition interventions:** Interventions that address nutrition only or predominantly.
- **Combined nutrition and physical activity interventions:** Interventions that address both nutrition and physical activity, with neither being the predominant focus.

*Physical Education (PE)

Each strategy includes a brief summary of the approach and the evidence of effectiveness, along with the effectiveness classification (see Table 4). Under each category, strategies are organized by their evidence classification, from the highest evidence of a positive effect (i.e., recommended) to the lowest evidence of a positive effect (i.e., mixed/inconclusive).

Evidence Summary

The interventions with the most promising findings in schools are physical education programs, active recess interventions, interventions to improve the cafeteria environment, and multicomponent interventions. These interventions most consistently produced changes in student diet and physical activity behaviors. Other interventions may be effective in promoting healthy behaviors in the school setting, but either results from those interventions were inconsistent, or there were not enough studies to ascertain their effectiveness. Most school interventions focus on the entire school population, versus specifically addressing obese or overweight children. As such, measures of weight are less common study outcomes than dietary and physical activity behaviors.

Physical Activity Interventions

Physical Education Programs

School-based physical education programs aim to increase the amount of time students spend during the school day being physically active and the percentage of physical activity time students are engaged in moderate-to-vigorous activity. These strategies target all students, so everyone is exposed to the intervention. Programs typically include the following components:

- Changes to the school curriculum (e.g., a PE curriculum change; a whole curriculum change,

such as incorporation of physical activity and healthy eating into another subject, such as science).

- Changes to school schedules to increase the time students are engaged in physical activity.
- Increases in the percentage of physical activity time students are engaged in moderate-to-vigorous physical activity (e.g., with three weekly 30-minutes sessions with a PE curriculum, 10 minutes of jumping activity in PE class twice per week).
- Provision of PE equipment.
- Training for teachers on school curricula and how to incorporate more physical activity, including training materials, resources, and kits for teachers.
- Educational materials for teachers (e.g., health information), students (e.g., benefits of healthy lifestyle, body image, self-esteem, physical fitness), and parents (e.g., easy activities requiring few resources, recipes for healthy snacks).
- Educational sessions for students.

In addition to physical activity, curricula sometimes included information on self-efficacy, development of self-regulatory behaviors, education about the benefits of healthy behaviors (e.g., increasing fruit and vegetable consumption, reducing SSB* intake), and behavioral tracking (e.g., monitoring physical activity with pedometers).

EVIDENCE OF EFFECTIVENESS: ***Promising***

A systematic review (Dobbins, Husson, DeCorby, & LaRocca, 2013) of randomized controlled trials conducted during the school day found lower-quality evidence that school-based physical activity interventions are effective at increasing the amount of physical activity students get per day from five to 45 minutes per day and that children who are exposed to these interventions are three times more likely to engage in moderate-to-vigorous physical activity than those who are not exposed. There is also some evidence that these programs reduce television viewing time by five to 60 minutes per day. Studies typically found a limited effect on BMI; students in interventions groups experienced 0.1 to 1.0 kg/m^2 less increase in BMI compared with controls. The most effective programs were those that included a combination of school curricula and educational materials. Educational sessions and physical activity-specific sessions may increase effectiveness. Most studies involved children age 12 and younger; evidence is less convincing for adolescents. Studies reporting positive effects on physical activity ranged from three months to four school years.

Active Recess Interventions

Most U.S. elementary schools provide regular recess periods; however, not all students engage in physical activity. Active recess interventions aim to improve health by increasing the number of youths who are physically active at recess time and the amount of recess time they spend engaged in moderate-to-vigorous activity. Interventions are usually structured or semi-structured and involve one or more of the following components:

- Provision of playground equipment (e.g., balls, hula hoops, jump ropes)
- Provision of activity cards (e.g., cards with active games)
- Playground markings (e.g., colored zones for sports/fitness/chill-out areas or castles/dragons/clock faces/mazes)
- Teacher-led games and activities, with training for teachers to learn how to use equipment and engage students in games and activity
- Teacher encouragement to be physically active

Some studies have also used video games such as *Wii Fit* in interventions during recess time.

*Sugar-Sweetened Beverage (SSB)

EVIDENCE OF EFFECTIVENESS:
Promising

Several review studies on the effectiveness of active recess interventions in the U.S. and other countries found mostly positive results from lower-quality studies that these interventions increase physical activity (12 out of 13 studies, with a meta-analysis with a significant positive effect) (Erwin, Ickes, Ahn, & Fedewa, 2014) (Ickes, Erwin, & Beighle, 2013). A very small study estimated that the average increase in calories expended for active recess versus traditional recess was 56 calories (Howe, Freedson, Alhassan, Feldman, & Osganian, 2012). Another review of active recess found that only four of nine studies reported a statistically significant increase in physical activity (Parrish, Okely, Stanley, & Ridgers, 2013). Interventions varied substantially across studies, making it difficult to assess which strategies were most effective; however, larger effects were seen for younger children and for active recess interventions that included playground equipment, playground markings, and structured (teacher-led or organized) activity. In studies, most interventions lasted two to six weeks, with the longest intervention lasting seven months. Overall, most studies report that active recess interventions increase physical activity.

Interventions to Increase Active Travel to School

Interventions to increase active travel to school are designed to increase physical activity by encouraging children to walk or bicycle to school. Using active transport to get to school is inexpensive and may be easy to incorporate into everyday routines. Evidence has shown that youth who use active transportation methods to get to school are more physically active than those who travel by motorized vehicle (Larouche, Saunders, Faulkner, Colley, & Tremblay, 2014). Being more physically active has potential health benefits for youth, such as reduced risk for obesity and increased cardiovascular fitness. There are also potential environmental benefits to replacing motorized travel with walking and biking to school, by way of reducing exhaust and greenhouse gas emissions (Larouche, Mammen, Rowe, & Faulkner, 2018). The most common interventions to increase active travel in the U.S. are as follows:

- **A designated day to walk to school:** This promotional activity is designed to encourage students to walk or bicycle to school. There is an annual Walk and Bike to School Day event, and there are materials for planning and promoting events (UNC Highway Safety Research Center, 2018).
- **Drop-off:** Students are bussed to a location and then walk the rest of the way to school.
- **Safe Routes to School (SRTS):** This program is designed to make it safe, convenient, and fun for children to walk and bicycle to school. Components of the program include plans to address the built environment to ensure safe conditions, resources for active transportation, activities for school and community members, enforcement approaches, and evaluation (Safe Routes to School National Partnership, n.d.).
- **A walking school bus:** A group of children walk to school with one or more adults (National Center for Safe Routes to School, n.d.).

In other countries, there are similar approaches implemented, such as School Travel Planning, a collaborative stakeholder-based approach that addresses engineering, education, enforcement, and encouragement for active transport; and Bikability, a national cycling training program. Some studies used a theoretical framework, including social ecological theory, social cognitive theory, and the theory of planned behavior. Studies have mostly focused on elementary school-age students.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

Multiple recent review studies have found mixed evidence of effectiveness of active transport on improving physical activity levels among youth from mostly low-quality studies. Studies that found a positive effect of active transportation to school (13 out of 30 interventions) reported that positive findings were mostly "trivial to small," although they could be significant at the population level (Larouche, Mammen, Rowe, & Faulkner, 2018). Few studies reported on BMI, and for those that did, evidence was mixed (Pang, 2017). There were no specific strategies that appeared to be more effective than others. The Community Preventive Services Task Force has recommended interventions to increase active travel to school on the basis that it increases walking among students and reduces pedestrian and bicycling injuries; however, the task force's review of study findings indicated that there was not enough evidence to show that active school travel increased students' daily physical activity (Community Preventive Services Task Force, 2018).

Classroom-Based Physical Activity Breaks

Classroom physical activity interventions aim to increase physical activity by providing brief, structured classroom physical activity sessions. These sessions can be "brain breaks"—short bursts of physical activity without a lesson, used as a break or transition from lessons—or be integrated with lessons or other academic content to reinforce learning. There are various software and other programs that can be used to customize sessions based on grade level and academic topic, such as science, reading, math, or spelling. Classroom-based physical activity sessions typically last five to 20 minutes. In addition to improving physical activity, these interventions are adopted to help improve classroom behavior and performance by giving students an outlet to be physically active during the day at times when they are normally seated. An added benefit of breaks with academic content is that they do not take away from academic time.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

In a systematic review and meta-analysis of classroom-based physical activity interventions (Watson, Timperio, Brown, Best, & Hesketh, 2017), most studies that examined physical activity outcomes found small increases in physical activity and 2% to 16% increases in moderate-to-vigorous physical activity; however, there was no significant effect on physical activity based on the pooled analysis. There were significant improvements in classroom behavior and academic achievement. Overall, classroom-based breaks may improve classroom behavior and performance, but there is insufficient evidence that they significantly affect physical activity.

Nutrition Interventions

Cafeteria Interventions

Cafeteria interventions are designed to encourage students and staff to make healthy food choices, such as selecting more fruits and vegetables. Schools have used a variety of strategies:

- Increasing the variety of healthy foods, such as fruits and vegetables (e.g., through a salad bar, through adding a "healthy express lane" with only healthier items, by offering a choice of one to three varieties of fruit or vegetable instead of no choice).
- Allowing preordering (e.g., preordering lunch selections).
- Mandating selection of a fruit or vegetable (e.g., removing the option to decline a fruit or vegetable).

- Decreasing costs of healthier food items relative to their usual price (e.g., 50% off fruit).
- Modifying recipes to make them healthier.
- Marketing and promotional strategies (e.g., creatively naming fruits and vegetables, branding items with stickers, placing fruit in attractive bowls and displays, having staff provide verbal prompts).
- Slicing fruit.
- Offering positive reinforcements (e.g., a token for eating 1/8 cup of fruits or vegetables that can be redeemed for prizes).
- Providing weekly reports to parents on their child's intake.
- Providing training to cafeteria staff.

EVIDENCE OF EFFECTIVENESS: *Promising*

In a review study (Kessler, 2016) of a variety of cafeteria interventions, all interventions yielded some positive results for fruit and vegetable selection and/or intake, at least in the short term. The differences in types of interventions tested and the small number of studies per intervention type make it difficult to ascertain which specific strategies are most effective in changing dietary habits. Increasing the variety of healthy foods was associated with greater fruit and vegetable intake, as was slicing fruit, although fruit type mattered. Positive reinforcements such as tokens, prizes, and price subsidies were effective at increasing fruit and vegetable intake in the short term, but effects did not persist when the reinforcements were removed. Promoting fruits and vegetables with creative names and labeling them with stickers of well-known characters were associated with greater selection of fruits and vegetables. A subsequent study similarly found positive results of promoting fruits and vegetables with characters on a banner, with or without a short television segment with the character (Hanks, Just, & Brumberg, 2016). There is some evidence that training cafeteria workers increased their knowledge of cafeteria intervention strategies and resulted in increased use of these strategies (Rajbhandari-Thapa, et al., 2017). Overall, this evidence is of lower quality, but the evidence for a positive effect on fruit and vegetable consumption is mostly consistent.

Fresh Fruit and Vegetable Program

The Fresh Fruit and Vegetable Program (FFVP) was created by the U.S. Department of Agriculture to improve the overall diet quality of school children by providing healthy food. The program reimburses elementary schools with high rates of free and reduced-price (FRP) meal enrollment to provide a free fresh fruit or vegetable snack at least twice per week outside of school meal programs (United States Department of Agriculture, 2018).

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

A small number of studies (Ohri-Vachaspati, et al., 2018) (Olsho, et al., 2015) (Davis, Cullen, Watson, Konarik, & Radcliffe, 2009) (Jamelske, Bica, McCarty, & Meinen, 2008) have consistently found small positive increases in fruit intake among students at schools that participated in the Fresh Fruit and Vegetable Program compared with students at schools that did not participate in the program, although findings for vegetables have been mixed. In one study (Olsho, et al., 2015), students at schools that had the program consumed approximately 1/3 cup more fruits and vegetables on fresh fruit and vegetable days compared with students at schools not participating in the program. Energy intake between participating and non-participating schools was not different. Overall, evidence for a positive effect from lower-quality studies seems fairly consistent; however, more studies are needed to confirm effects.

Nutrition Education Programs

Nutrition education is provided to most students in U.S. schools. In Indiana, more than 90% of schools provide students with nutrition education (Brener, et al., 2017). However, schools may lack staff with formal training in nutrition, and training for staff has time and cost burdens. Furthermore, nutrition is not on standardized tests, so it can be viewed as less important than other subjects. Schools typically use a curriculum to deliver nutrition education. The U.S. government and professional organizations are both sources of curricula. Teachers deliver lessons and follow-up activities. Usually, the teachers are regular classroom teachers who have participated in supplemental training on the curriculum. Nutrition education may be taught as part of health class or may be integrated into other topics, such as math, science, and language arts.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

A systematic review of nutrition education interventions (Price, Cohen, Pribis, & Cerami, 2017) reported mixed results on the impact of nutrition education on BMI. More than half of studies on students in kindergarten through fifth grade (four out of seven) reported positive results on BMI or weight status. There were only two studies on students in grades six through 12, and neither reported a positive impact on weight. Generally, longer studies were more effective than shorter studies at producing a change in BMI, and nutrition education seemed to be more effective at younger ages. The programs that were most effective used an integrated curriculum approach.

Promoting Drinking Water

Drinking water is essential for life and has been associated with other health benefits. Water also has the potential to replace SSB consumption, making water a target for obesity prevention initiatives. However, water consumption among children and adolescents is low. School-based interventions to increase water consumption aim to make water accessible, normal, and appealing to youth. Schools participating in the National School Lunch Program are required to make free drinking water available at lunch during meal service. A single water fountain can meet this requirement, but more accessible forms of water may be needed to encourage consumption. Examples of interventions to promote water consumption in schools include providing cold, filtered tap water in cafeterias; distributing reusable water bottles to students and staff; conducting promotional and educational activities throughout the school; using signage promoting water; offering disposable cups near water sources; and offering a water cooler with reusable cups plus signage declaring that water is safe, healthy, cheap, easy, and green.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Several studies (Kenney, et al., 2015) (Patel, et al., 2016) (Patel, et al., 2011) that have assessed drinking water interventions in schools have found consistently positive results in increasing student intake of water. One study found that water consumed per student more than tripled and that the percentage of students choosing water during lunch doubled. A small number of studies have assessed SSB intake, and results have been mixed. Overall, evidence seems positive that these interventions lead to increased water drinking in schools; however, there is insufficient and mixed evidence that water interventions lead to reductions in other behaviors known to affect obesity rates, such as SSB consumption.

School Gardening Programs

Gardens have been introduced in schools as a way to increase fruit and vegetable knowledge and consumption. These programs use gardening to teach about nutrition, food production, the science of growing, agriculture, and cooking. The gardens

may also be used to enhance learning in other academic areas, such as language arts and science. Gardens expose students to the growing process, enabling them to participate in cultivating and harvesting produce; offer opportunities to taste the food that is grown; and potentially introduce children to produce they have not previously been exposed to. A typical school gardening program might include weekly gardening education classes, hands-on gardening activities, and food preparation education combined with hands-on food preparation/cooking activity. In 2016, 20% of Indiana secondary schools reported having a school garden (Brener, et al., 2017).

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

In a review of studies of school gardening programs (Savoie-Roskos, Wengreen, & Durward, 2017) (Davis, Spaniol, & Somerset, 2015), there was evidence from lower-quality studies that gardening programs improved preference for, attitudes toward, willingness to taste, identification of, and self-efficacy to prepare or cook fruits and vegetables. Many studies did not assess fruit and vegetable consumption. Those that did reported mostly positive results, bordering on promising evidence (10 out of 14 studies in Savoie-Roskos and colleagues and six out of 11 studies in a review by Davis and colleagues reported a positive effect on vegetable intake). School garden interventions lasted from 10 weeks to 12 months and included students in kindergarten through eighth grade, although most focused on elementary schools. Overall, there is some evidence to suggest that school gardening programs may improve antecedents of fruit and vegetable intake and evidence is bordering on promising for improving fruit and vegetable intake.

Farm to School Programs

Farm to School is designed to provide students with access to fresh, local produce to improve nutrition. These programs can also benefit farmers by providing a source of income. It is estimated that each dollar invested in farm to school stimulates $0.60 to $2.16 of local economic activity (National Farm to School Network, 2017). Farm to School programs typically include three components (National Farm to School Network, About Farm to School, 2018):

- **Procurement:** Locally grown foods are purchased. Foods are then served in the cafeteria, as a snack, or as a taste test.
- **Education:** Students participate in educational activities about agriculture and nutrition.
- **School gardens:** Students engage in hands-on gardening activities.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

Overall, very few studies assess the impact of Farm to School programs. There is some low-quality evidence that Farm to School programs may increase children's perceptions of (Evers, 2015), knowledge of (Moss, Smith, Null, Roth, & Tragoudas, 2013), willingness to taste, and requests for more fruits and vegetables at home (Jones, 2015). Findings regarding consumption of fruits and vegetables have been mixed. In one non-randomized study, authors reported that fruit and vegetable consumption increased among the third- to fifth-grade students who had the lowest consumption of fruits and vegetables at baseline (Yoder, et al., 2014). In another study (Jones, 2015), vegetable intake increased but fruit intake decreased among students at schools with a Farm to School program versus students at schools

without the program. In an older review (Joshi, Azuma, & Feenstra, 2008), most studies found that the percentage of fruits and vegetables consumed by students increased in most programs that had a Farm to School salad bar. In schools that used classroom activities, effects on consumption were mixed. There is a lack of studies with consistent evidence to support the idea that Farm to School programs increase fruit and vegetable consumption.

Combined Nutrition and Physical Activity Interventions

Multicomponent Interventions to Improve Diet and Physical Activity

Multicomponent interventions in schools focus on reducing and preventing obesity by implementing several of the strategies that are discussed above, including health education curricula, supportive school polices, PE programs, serving healthy food

Example: School Nutrition Policy Initiative
(Foster, et al., 2008)

Setting: 10 schools in the mid-Atlantic region of U.S. with 50% or more of students eligible for free or reduced-priced meals.

Participants: 1,349 students in grades four through six.

Intervention: The study consisted of five intervention components:

(1) School self-assessment: Schools formed a Nutrition Advisory Group (a team including administrators, teachers, nurses, coaches, food service providers, and more) and used the CDC School Health Index to assess their environments.

(2) Nutrition education: Each staff member was offered 10 hours per year of training on nutrition education. Staff received Planet Health and Know Your Body curricula, along with nutrition and physical activity theme packets to incorporate into classrooms, parent outreach, and more. Teachers provided 50 hours of nutrition education per student per year.

(3) Nutrition policy: All foods sold and served were changed to meet specific standards that aligned with Dietary Guidelines for Americans.

(4) Social marketing: Students who purchased healthy items or brought items from home meeting standards received raffle tickets that could be redeemed for prizes. Messages combined with recognizable characters were also used.

(5) Parent outreach: School association meetings, report card nights, parent education meetings, and weekly nutrition workshops were used to encourage parents to purchase healthy snacks. Fundraisers of unhealthy foods were also reduced.

Results: After the two-year intervention, there was a 50% reduction in the incidence of overweight. Significantly fewer youth in intervention schools (7.5%) became overweight compared to youth at control schools (14.9%). There were no significant differences in the incidence or prevalence of obesity after two years.

and beverage options in school cafeterias and vending machines, and engaging parents and families, as well as the community, by forming partnerships with other agencies or groups, for example.

EVIDENCE OF EFFECTIVENESS: ***Promising***

Multicomponent school-based interventions may be effective at improving knowledge and attitudes about nutrition and physical activity and increasing physical activity and healthy eating. The vast majority (more than 90%) of multicomponent intervention studies included in reviews have found positive effects on dietary intake, physical activity, or both (Mozaffarian, et al., 2012). Findings on BMI are less consistent. In a scientific statement article that included multiple review studies, in one review, nine out of 14 studies that assessed weight-related measures found significant positive outcomes; and in another review, nine out of 20 randomized controlled trials reported significant improvements in BMI z-score for school interventions that address both diet and physical activity (Mozaffarian, et al., 2012). A subsequent review study reported more consistently positive results: four out of five multicomponent interventions reported improvements in BMI (Shirley, et al., 2015). High-intensity programs that focus on diet and physical activity, are longer in duration (one year or more), and involve parents and/or community are among the most promising interventions. Multicomponent interventions are usually effective at changing diet and physical activity behaviors and may be effective at reducing obesity; however, findings related to weight-based measures are less consistent.

Community Strategies to Address Obesity

Communities are the places where people live, work, and play. Since communities have been shown to have a strong influence on behaviors and are associated with factors such as BMI, they are an important setting to address obesity. For the purposes of this report, we defined the community setting as the organizations, institutions, and environments that exist outside of healthcare, worksites, and schools, which we addressed in other chapters.

In this chapter, we describe community strategies that have been studied to address obesity. Strategies are organized into five categories:

- **Early childhood setting.**
- **Out-of-school time setting.**
- **Colleges and universities.**
- **Built environment** (human-made surroundings that provide the setting for human activity, including buildings and parks).
- **Other community-level strategies** (including faith-based interventions, and community-wide interventions).

Each strategy includes a brief summary of the approach and the evidence of effectiveness, along with effectiveness classification (see Table 4). Under each category, strategies are organized by their evidence classification, from the highest evidence of a positive effect (i.e., recommended) to the lowest evidence of a positive effect (i.e., mixed/inconclusive).

Evidence Summary

In reviewing the evidence on community-based interventions, obesity interventions in faith-based settings and in-store campaigns to increase sales of healthy foods were among the most promising at achieving consistent change in diet and physical activity behaviors. Interventions in other settings may be effective, but there was inconsistent evidence that they had a positive effect on either behaviors or weight-related measures.

There are many limitations to the literature for interventions in the community setting. In the built environment in particular, the environment is uncontrolled, and randomization might not be feasible. Direct measures of behavior can be time consuming and expensive to gather, so there is more reliance on self-reported data. Even in community settings that are more controlled, such as early childhood and afterschool programs, strategies are often aimed at preventing obesity before it occurs. It is difficult to determine how effective these studies are at changing long-term outcomes related to weight, because most study follow-up periods do not last very long. Given the many challenges in measuring the impact of community-based interventions, it is not surprising that the literature is mostly inconclusive; however, inconclusiveness does not mean that these strategies are ineffective. Rather, we are still learning how these interventions may affect obesity, and mixed evidence may be reflecting some of the challenges in conducting research studies in these settings.

Early Childhood Setting

Early childhood is a critical period in the epidemiology of obesity. Nutrition and physical activity patterns of behavior are formulated during the early years, and the earlier the age at which a child becomes overweight or obese, the higher the likelihood that overweight or obesity will persist into adolescence and adulthood (Nader, et al., 2006) (Guo & Chumela, 1999). An Institute of Medicine report on early childhood obesity called for obesity prevention efforts targeting the system

of environments in which young children spend their days (Institute of Medicine, 2011). Outside of the home, child care settings are the most common environment where preschool-age children spend their time. In the U.S., 12.5 million of the 20.4 million children under age five are in some type of regular child care arrangement (Laughlin, 2013). On average, preschool-age children spend 33 hours per week in child care. These child care settings present a tremendous opportunity to prevent obesity by improving the meals and snacks they serve and increasing the opportunities they provide for children to be physically active. Child care providers are also a trusted source of information for many parents on child-rearing practices, and thus they can play an important role in educating parents on how they can promote healthy eating and physical activity habits for their children at home and in the community. Early childhood care and education programs include center-based care, preschools, Head Start, prekindergarten, and family home day care settings.

Nutrition and Physical Activity Policies and Practices in Child Care

Nutrition and physical activity policies and practices in child care settings are aimed at promoting healthy weight in children by increasing healthy eating, increasing physical activity, and reducing screen time. They are usually not targeted specifically at obese children; rather, they aim to improve behaviors to promote healthy weight in all children. Interventions may specifically target children, parents, and/or teachers as the agents for change, and some address the facility environment. They may include provision of training and technical assistance to center directors, teachers, and/or cooks on healthy eating and/or physical activity; changing center practices, policies, menus, and schedules around healthy eating and physical activity; providing structured physical activity and nutrition education lessons and supportive games or activities (e.g., books, music, taste testing) for young children to promote healthy lifestyle behaviors; and engaging parents in nutrition and physical activity behaviors of their child.

Best-practice guidelines for child care include serving fruits and vegetables with all meals and snacks, serving water at all meals and snacks, reducing SSB and juice consumption, offering more whole grains, limiting desserts and fried foods, offering 60 minutes of physical activity, and reducing screen time and sedentary time. An example of a single intervention is a set of five one-hour educational workshops for child care center directors, staff, and cooks providing information on childhood obesity, healthy eating and physical activity for young children, and personal health and wellness and working with families to promote healthy behaviors, in addition to monthly on-site technical assistance and additional phone or email consultations. Educational and promotional materials (e.g., posters, information sheets on nutrition and physical activity) were also provided. In addition, researchers provided technical assistance in working with child care centers to modify policies regarding center nutrition and physical activity guidelines and offered workshops to parents on how to raise healthy kids.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

There were mixed conclusions from review studies regarding the effectiveness of early childhood interventions on weight and related behaviors. In a systematic review of interventions, with 97 studies in the child care setting representing 71 distinct projects (Sisson, Krampe, Anundson, & Castle, 2016), almost half the studies that had obesity as an outcome measure (e.g., BMI, waist circumference, skin folds, percent body fat, weight status, waist-to-hip ratio) had positive results. More than two-thirds of interventions that were effective in reducing obesity were based on a behavioral theory and mostly of moderate to high quality. Children who were at greater risks

of obesity and lower socioeconomic status were more likely than children from higher economic groups to achieve positive results. Seventy-three percent of studies that included physical activity as an outcome measure had positive results. The majority of studies with positive findings on physical activity focused on the center environment and included structured physical activity, parent engagement, staff training, and technical assistance and training. Eighty-seven percent of studies that measured a nutrition outcome reported favorable results; however, there was mixed evidence that these results translated to changes in children's eating habits. Lastly, the majority of studies that included screen time as an outcome reported positive results, mostly from preventing an increase in screen time, because children at this age may already have low screen time usage, and most child care centers already limit screen time. Interventions lasted three weeks to two school years.

Other reviews have reported less consistently positive results. A review that looked only at preschool-based studies with a control group found weak and inconsistent evidence of effectiveness of interventions on child diet, physical activity, and weight status (Wolfenden, et al., 2016). In the review, one out of three studies assessing individual behaviors reported positive outcomes, one out of two studies assessing weight status reported a significant positive outcome, and of 10 studies assessing policies and practices around nutrition and physical activity, four reported positive findings and four reported mixed findings. Another review found that most multicomponent interventions led to increases in fruit and vegetable intake, but changes in BMI were inconclusive (Mikkelsen, Husby, Skov, & Perez-Cueto, 2014). A review that assessed environmental approaches and combined environmental and behavioral approaches to increase physical activity reported that less than half the approaches increased physical activity, with a greater percentage of environmental interventions leading to increases in physical activity (Temple & Robinson, 2014). Overall, there is some encouraging evidence that these programs affect child behaviors; however, there is inconsistent evidence from higher-quality studies.

Out-of-School Time Programs

Out-of-school time programs are supervised programs for school-age children and adolescents that are offered either before or after school. Most programs offer a snack and provide time for homework assistance or academics, enrichment (e.g., art, music), and physical activity. Programs may be offered at the school or in a community setting, such as a YMCA or a Boys & Girls Club. More than 10 million children in the U.S. (18%) attend an afterschool program, and nearly one in four families has a child enrolled in an afterschool program (Afterschool Alliance, 2014). Kids spend a significant proportion of their time in afterschool care. According to the Afterschool Alliance, children can be in afterschool programs for 15 or more hours per week during the school year. Afterschool programs reach children who are less likely to have adequate opportunities for healthy eating and safe places to be physically active. Asian American, African American, Hispanic, and Native American children are more likely to be in afterschool programs than Caucasian children, and 41% of afterschool program participants are from low-income families (Afterschool Alliance, 2014). Numerous national stakeholders, including the Food Research & Action Center, the Secretary of Health and Human Services, the Secretary of Education, and the American Academy of Pediatrics, have recognized the potential of using afterschool programs to help combat childhood obesity and inactivity.

Recent research has suggested that there are many changes that can be made to improve the healthfulness of foods in afterschool programs. In one study, SSBs were served 1.8 days per week, and desserts were served 2.7 times per week, compared with fruits and vegetables, which were

served 0.6 and 0.1 days per week, respectively (Beets, et al., 2015). In response, a number of organizations have introduced standards for nutrition, physical activity, and screen time for afterschool programs and have developed physical activity and healthy eating programs designed to prevent obesity.

Implementing Healthy Eating Standards in Afterschool Programs

Healthy eating standards have been developed by a number of groups (e.g., the National AfterSchool Association, the YMCA of the USA) in an effort to improve nutrition among students attending afterschool programs. Specific standards include serving a fruit or vegetable at every snack, serving whole-grain–rich options, eliminating SSBs*, reducing service and portion sizes of juice, serving water at all mealtimes and snack times, serving meals or snacks family style, and engaging family and caregivers. These standards typically go above and beyond requirements for government-funded programs, such as the Child and Adult Care Food Program (CACFP). Intervention components include adopting the standards through commitment to implement and inclusion of the standards in normal operating policy, such as integration of them into program handbooks; providing technical support to program leaders to develop or modify a menu of snack offerings; assisting in budgeting for snacks and identifying where they can be purchased; and addressing challenges and barriers. Training may be provided to afterschool staff to improve their knowledge of healthy food options and develop their self-efficacy to improve the nutrition environment in afterschool programs. For example, one three-hour training and four 30-minute additional follow-up sessions would reinforce the goals of the standards, teach strategies for implementation, and help overcome barriers. Some interventions engaged a community of advisors, including afterschool leaders, food service personnel, and other community partners, to assist in the development of the changes.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

A small number of studies have assessed implementation of nutrition standards in afterschool programs, with mostly positive outcomes. One randomized controlled trial found that participating in a collaborative process to improve nutrition standards was associated with a significant increase in having standards-based policy statements that addressed snacks, beverages, screen time, and family engagement (Kenney, et al., 2014). Researchers have suggested that adoption of standards alone through organizational policy change is insufficient to achieve full compliance with standards and that additional training, technical assistance, and support may be needed for effective implementation (Beets M. W., et al., 2016a) (Hohman & Mantinan, 2014). When technical support and training are provided, there is evidence that adopting healthy eating and physical activity centers in afterschool programs leads to changes in food and beverages served during snack time. One randomized controlled trial involving 20 afterschool programs that served 1,700 youths found that at one-year follow-up, afterschool programs had increased the number of days per week serving fruits and vegetable and water, had nearly eliminated serving SSBs and served fewer desserts and sugar-sweetened cereals. The majority of children in both intervention and control programs were observed consuming fruits and vegetables served (Beets M. W., et al., 2016b). Intervention programs reduced the calories per snack by 66 compared with controls (Beets, et al., 2016c). At two-year follow-up, improvements had been maintained, and the number of days serving water had increased (Beets M. W., et al., 2017a). In another randomized controlled trial, with 20 afterschool sites serving 400 youths that included training, menu change,

*Sugar-Sweetened Beverages (SSBs)

and a learning collaborative, there was a significant decrease in calories consumed (−47.8 calories, mostly from beverages) in snacks but no significant change in fruit and vegetable consumption compared with controls (Lee, et al., 2018). In another randomized controlled trial of afterschool programs, programs that implemented healthy eating standards served fruits and vegetables more often and served sugar-sweetened foods and beverages less often (Weaver, et al., 2015). Limited evidence suggests that this strategy improves food served in afterschool programs and may lead to a reduction in calories consumed during afterschool time. It is unknown whether this translates to lower calorie intake overall. More evidence is needed to confirm that implementing healthy eating standards in afterschool programs changes behaviors or weight status.

Increasing Water Intake in Afterschool Programs

Programs to increase water intake in the afterschool setting aim to make water the beverage of choice by increasing the availability and promotion of water, sometimes to replace more caloric options such as SSBs and juices. Interventions have included learning collaboratives focused on making policy and environmental changes to the afterschool environment and establishing water delivery systems to ensure that children are served water at snack time, providing education and training on the importance and health benefits of drinking water and reducing SSBs and filling insulated jugs with tap water or pitchers with bottled water from coolers.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

The small number of studies that have focused on increasing water consumption have all reported positive results, with increases of 1.49 to 3.6 ounces of water consumed per snack period (Lee, Okechukwu, Emmons, & Gortmaker, 2014) (Giles, et al., 2012). Increased water consumption has led to a decrease in calories (by 29.1 to 60.9) from beverages during snack time, with a focus on offering water only or on improving the nutrition environment overall, including the water (Lee, et al., 2018) (Giles, et al., 2012). Overall, evidence is positive, but more studies are needed to determine the effectiveness of this strategy.

Afterschool Physical Activity Programs

Afterschool physical activity programs aim to increase the amount of time children and adolescents are physically active. Programs have included training for afterschool site leaders on physical activity recommendations and how to increase children's moderate to vigorous activity, creation of schedules that define roles and responsibilities of staff during physical activity, enhancement of games played at the afterschool program (e.g., removal of lines, discontinuation of elimination games), and provision of structured exercise. Some studies formed advisory boards consisting of program leaders and community representatives who provided input on the design of programs. One study offered 30 minutes of weekly group nutrition education (15 minutes of education and 15 minutes of interactive games) with printed materials and motivational advice, the GoKids PA program, and 60 minutes of supervised physical activity (e.g., treadmill, stationary bike, free weights, exer-gaming) sessions three times per week for 10 weeks. Another study offered FitKid, which included 80 minutes of physical activity time (20 minutes of skill-based physical activity, 40 minutes of vigorous physical activity, and 20 minutes of stretching/resistance training and cooldown) daily and encouraged youth to attend at least three sessions per week. Lookin' Good! Feelin' Good! was a school nurse-led counseling intervention and afterschool exercise program

that included six 30-minute individual counseling sessions per week (i.e., weighing in, reviewing the diet and activity log, assessing behavioral goals, discussing education topics, assessing current behavior related to the topic, and setting a goal for the next week) and six monthly sessions. Exercise included three sessions per week for eight months of group sports, games, and non-competitive fitness.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

There is limited information about physical activity programs in peer-reviewed studies. In a quasi-experimental study of offering training and support to increase moderate to vigorous physical activity, there was no statistically significant change in the percentage of youth who were moderately to vigorously active for 30 minutes; however, students reduced sedentary time by 3.3 to 4.3 minutes (Beets M. W., et al., 2017b). In a randomized controlled pilot study, nutrition education plus physical activity sessions resulted in positive changes in sedentary time and light, moderate, and vigorous physical activity, but there were no changes in body composition or fitness (Crouter, et al., 2015). In a second randomized controlled trial, a physical activity program reduced body fat and improved cardiorespiratory fitness, especially for youth who attended at least three sessions per week. There were no significant changes in weight or BMI, and follow-up indicated that results were not maintained over the summer after the program had ended (Yin, Moore, Johnson, Vernon, & Gutin, 2012). Participants in a nurse-led counseling and afterschool exercise program had no significant differences in BMI, body fat, or waist circumference at the end of the study compared with baseline (Pbert, et al., 2016). Overall, studies are limited in number, and most sample sizes were small, so evidence is inconclusive for effectiveness.

Colleges and Universities

The transition to college is a period of immense change for many young adults. Students may be responsible for purchasing and preparing their meals for the first time and be concerned about the cost of food. Inconsistent schedules and the stressors of academic study coupled with social factors could lead to changes in dietary habits, such as increased intake of alcohol and calorically dense foods. College students no longer have the same structure as grade school, with PE classes and sports activities, which may lead to changes in physical activity behaviors. Indeed, many young adults gain weight during their first year of college (Morrow, Heesch, Dinger, Hull, & Kneehans, 2012). There is evidence that college students are concerned about weight gain in college and are interested in receiving information about eating healthy and being physically active (Monroe, 2017). Interventions in colleges have sought to influence nutrition, physical activity, or both, with some focused specifically on weight loss.

Nutrition Environment Interventions in Colleges

Nutrition environmental interventions aim to change health behavior by altering the placement or properties of objects or stimuli in the physical environment. The rationale for changing the environment is that human behavior is influenced by cues from our environment that we are not always aware of. Altering the cues may encourage healthful behaviors. Furthermore, environmental changes are passive interventions that do not require individuals to opt into a specific program or make conscious choices to pursue healthier behaviors; rather, they influence individuals through their presence. Below, we describe environmental interventions that have been studied to affect obesity and its risk factors in college settings:

- **Labeling:** Nutrition labeling is designed to provide information about the healthfulness

of products at point of purchase or service to influence consumer choice. Nutrition labels are typically placed near the products in cafeterias or vending machines. Labels may include nutrition information (e.g., calories, grams of fat, grams of carbohydrates, grams of protein, energy density), or they may be in the form of an icon or other marker (e.g., heart symbol) that denotes healthfulness of the product.

- **Product:** Increasing the availability of healthy foods changes the mix of products available for people to choose from. These changes may occur in cafeterias, vending machines, or other locations. New items may be introduced, variety may be increased, or existing products may be modified (e.g., changing a recipe to modify the nutrient profile or increase the amount of fruits and vegetables). Examples of product changes include offering free fruits and vegetables and portion-controlled items (e.g., 100-calorie snack packs, offering French fries in a bag instead of "all you can eat").
- **Price:** Price subsidies are sometimes used to make healthier foods more affordable, relative to their normal price or to less desirable options. An example is offering a 20% discount on fruits and vegetables.
- **Trayless dining:** Trayless dining, the removal of trays from cafeterias, has recently emerged as a strategy for colleges and universities. One of the primary reasons for this has been a desire to reduce plate waste. From an obesity standpoint, trayless dining has potential to reduce consumption, because it limits the amount of items an individual can carry at one time.

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

In a systematic review of mostly lower-quality nutrition environment interventions (Roy, Kelly, Rangan, & Allman-Farinelli, 2015), point-of-decision interventions yielded mixed results. Some studies found that labeling resulted in selection of fewer calories or higher-fat entrees (e.g., French fries, desserts) and increased sales of promoted items, and one study found that calorie labeling was associated with less weight gain. Reducing portion sizes decreased consumption and offering free fruits and vegetables increased their consumption.

There is limited information available about trayless dining. One study (Rajbhandari-Thapa, Ingerson, & Lewis, 2018) found that students in facilities without trays served themselves fewer servings of lunch entrees and drinks and more salad compared with students in facilities with trays. There was also less waste, meaning that students consumed more of their selections. In a second study (Wansink & Just, 2015), trayless dining decreased the percentage of students who took salad, but it did not reduce the percentage that took dessert. Overall, there is a lack of high-quality studies about the effectiveness of food environment interventions on the intake and weight of college students.

Nutrition Educational and Behavioral Interventions in Colleges

Educational and behavioral interventions are designed to increase knowledge of healthy eating and nutrition behaviors. Interventions have been conducted in person as well as online. In-person interventions include introductory courses focused on nutrition and chronic disease prevention and food production and social issues, as well as one-on-one consultation session with a fitness specialist. Some in-person interventions also include interactive activities such as cooking, taste testing, and keeping food logs. Web-based interventions have included nutrition courses or modules delivered as part of a health class, cooking videos, access to a nutrition website, personalized

or educational emails, behavior checklists, goal setting, and a nutrition tracker.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

In a systematic review of college-based interventions (Plotnikoff, et al., 2015), approximately half of studies reported positive results on nutrition behaviors (e.g., fruit and vegetable intake, fat intake, calorie intake, whole grain consumption). It was not possible to conduct a meta-analysis, because the interventions varied considerably. In a second review, which looked at in-person and online educational interventions, there were similarly mixed results with respect to dietary intake. Studies found that positive results had small improvements in dietary intake and were not maintained during follow-up (Kelly, Mazzeo, & Bean, 2013). Overall, evidence was from low-quality studies, and findings were mixed.

Physical Activity Educational Interventions in Colleges

Physical activity interventions in the college setting aim to increase the amount of time per day engaged in, number of days per week engaged in, or intensity of physical activity. Educational interventions have included courses focused on physical fitness, delivered in lecture and/or lab format; education in addition to web-based features, such as online social networking and a website with self-monitoring; homework on being physically active; web-based lessons; one-on-one sessions with a certified personal trainer; and one-on-one motivational interviewing with personal feedback.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

In a systematic review of college-based interventions (Plotnikoff, et al., 2015), more than half of studies (18 out of 29) reported significant improvements in physical activity (e.g., minutes of physical activity, days of physical activity, duration of physical activity), bordering on promising, and slightly less than half reported improvements for moderate physical activity and vigorous physical activity. In the meta-analysis, there was no significant difference in total or vigorous physical activity between intervention and control groups, but there was a significant increase in moderate physical activity.

Weight Loss Programs in Colleges

Weight loss programs in college settings are designed to promote weight loss by focusing on lifestyle behavior changes involving diet and physical activity. These programs are similar to lifestyle-based interventions mentioned previously for other settings. Programs often incorporate behavioral theories and strategies to develop healthy lifestyle behaviors (e.g., self-regulation, goal setting) and have included weekly group meetings, phone-based counseling, nutrition instruction, personalized recommendations, and exercise guidance.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

Although lifestyle-based interventions to reduce weight have been tested extensively in other settings and produce consistently positive results when they are of high-intensity and involve diet and physical activity, there have been few studies conducted on these types of interventions specifically in university settings. In a review of interventions in the college setting, four of 12 studies reported significant decreases in weight (Plotnikoff, et al., 2015). Most of these studies were focused on both diet and physical activity. Overall, more evidence is needed to determine

the effectiveness of this intervention type in the college setting.

Other Community-Level Strategies

Multicomponent Interventions in Faith-Based Institutions

Religious settings are a place for community gathering and worship. They are also a place to target interventions specifically to populations with high faith participation and higher levels of chronic disease. Faith-based institutions have partnered with the medical community to deliver a variety of health interventions, including obesity prevention. Integrating obesity prevention strategies such as healthy eating and physical activity with faith-based components such as bible study, prayer, church bulletins, and sermons is one strategy for affecting populations in faith-based settings. Interventions in faith-based settings are typically delivered in groups with culturally tailored materials and messages. Intervention sessions are sometimes led by lay health workers—members of the community who are trained to deliver the intervention. They may include educational sessions as well as physical activity sessions. Print materials and videos on healthy behaviors have been used. Engaging lead church members, such as ministers and pastors, in offering support and promotion for the program can be important in some faith-based settings. Some interventions also engage cooks, providing technical assistance and training to modify food prepared and served at faith-based events and gatherings to be more healthful. An example of a faith-based intervention is a 12-week group educational session followed by six one-hour monthly "booster sessions." Sessions focused on weight loss strategies to reduce calorie and fat intake, encourage physical activity, and modify behaviors through stimulus control, goal setting, and problem solving and were led by members of the church's health ministry (Sattin, et al., 2016).

EVIDENCE OF EFFECTIVENESS: ***Promising***

In a recent review of faith-based interventions for obesity (Maynard, 2017), 11 of 16 studies reported a positive impact on weight-related measures. Many of the studies were of lower quality; however, the largest and most robust study in the review found a significant decrease in weight between intervention and control participants. In a review specifically focused on African American populations (Lancaster, Carter-Edwards, Grilo, Shen, & Schoenthaler, 2014), of the randomized controlled trials that measured weight, slightly less than half reported weight loss (two of five studies), but more than half of studies that measured calorie or fruit and vegetable intake reported positive outcomes. Overall, the majority of faith-based interventions have produced promising findings on weight, but it is unclear whether these interventions are effective for all types of groups.

Other Community-Based Programs

Community-Wide Interventions to Increase Physical Activity

Community-wide interventions aim to increase physical activity levels among residents (e.g., in a specific city or town) and typically involve multiple community partners who work together to organize, facilitate, and promote physical activity opportunities. Programs may take place in a variety of settings, such as outdoor community settings (e.g., parks, trails), indoor community settings (e.g., shopping malls), nonprofit organizations (e.g., the YMCA), or community wellness or fitness centers. Marketing and promotion is used to increase

awareness and promote program activities and may include newspaper advertisements, radio advertisements, television advertisements or features, community calendars of events, and brochures or mailers to households. Many programs focus on increasing walking and include walking groups, which may feature a walking leader. Structured exercise classes, such as yoga, Zumba, Pilates, tai chi, aerobics, strength training, and cycling, may also be offered. Some programs enable physical activity goal setting and tracking—through a program website, for example—and offer incentives for participation. Programs may also offer coordinated health talks or seminars. Environmental change strategies are sometimes included as well.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

In a systematic review of community-wide interventions to increase physical activity (Baker, 2015), there was mixed evidence that interventions led to increases in community physical activity levels. Some studies observed more people walking, in places such as trails; however, overall community physical activity did not increase. One of the challenges in measuring change in these interventions is that community physical activity is difficult and expensive to measure accurately, which is a potential reason for inconsistent effects. Overall, additional research is needed to determine whether community-wide physical activity interventions are effective at increasing physical activity in communities.

Built Environment

In-Store Grocery Store Interventions

In-store grocery store interventions are designed to influence consumers to select healthful items while grocery shopping. Healthy foods targeted may include fruits and vegetables, whole grains, lower-fat milk, lower-calorie beverages, water, low-sugar cereals, and fish. Interventions may use one of the following strategies: increase in the availability or variety of healthy items, pricing strategies (e.g., $10 vouchers for fruits and vegetables, a 50% discount on fruits and vegetables, a cash rebate), or informational strategies, such as shelf labels (e.g., Guiding Stars) (Guiding Stars Licensing Company, 2018), posters, flyers, and educational materials. Interventions engage storeowners in the process of implementing intervention strategies. Consumers may also be engaged through cooking demonstrations, taste tests, and interactive education.

EVIDENCE OF EFFECTIVENESS:
Promising

In a systematic review of in-store grocery store intervention studies of overall medium methodological quality (Adam & Jensen, 2016), all included studies reported that interventions had a positive effect on at least one outcome measure. The most common outcome measure was sales of healthy items. Few studies measured changes in BMI, and those that did primarily used it to assess whether BMI was related to other outcome variables, not to measure change in BMI as a result of the intervention. In one study that measured weight loss, a significant reduction in weight was found. Interventions that combined pricing strategies, including direct price discounts, vouchers, and subsidies for healthy foods, with other components were most effective. Promotional campaigns alone might not be effective. A subsequent review found similarly that pricing strategies were effective at increasing sales of healthy items (23 of 30 studies with positive findings); however, studies that looked at weight found no effect (Gittelsohn, 2017). Overall, grocery

store interventions appear to increase the sale of healthy foods; however, whether this affects total diet and weight status is unclear.

Physical Activity Enhancements to the Built Environment

Physical activity enhancements for the built environment are designed to promote physical activity by offering new places to be physically active (e.g., a new park), enhancing existing green or play spaces (e.g., adding length to a trail, providing benches, adding lighting, removing shrubs, adding water fountains, adding directional or wayfinding signs), adding outdoor exercise equipment (e.g., bicycle share program), and connecting communities to locations to encourage active travel (e.g., through trails, light rail, bike lanes). In addition to built environment enhancements, interventions might include outreach to community members and groups to participate in community assessments and planning and gathering of input, as well as informational and promotional activities to encourage usage of enhanced areas.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

In a systematic review of built environment changes (Mayne, Auchincloss, & Michael, 2015), six out of nine studies, particularly studies with active transportation infrastructure improvements, found improvements in physical activity. Studies that were longer in duration were more likely to report increases in physical activity. Importantly, some studies assessed physical activity levels only at the location of the intervention (e.g., participants on a trail), not individuals' overall physical activity levels, so it is possible that individuals did not change their total physical activity levels but changed where they were being physically active.

Example: Partnership for an Active Community Environment (PACE) (Gustat, Rice, Parker, Becker, & Farley, 2012)

Setting: A low-income, urban, predominantly African American neighborhood in New Orleans.

Participants: 449 participants in household interviews, 54.7% female, 85.7% African American, with an average age of 41.6 years and an average BMI in the overweight category.

Intervention: The intervention area was selected in collaboration with neighborhood leaders and local community organizations. The intervention consisted of the installation of a walking path (eight feet wide, six blocks on a grassy, tree-filled median of a wide neighborhood boulevard) and support of the installation and use of a school playground by KaBOOM!, plus payment of supervisors to keep the fenced playground open after school hours and on weekends.

Results: The proportion of residents that were observed being physically active increased significantly in the section of the intervention neighborhood with the path compared to comparison neighborhoods. Among residents engaged in physical activity, 41% were moderately or vigorously active in the section of the intervention area with the path compared to 24% and 38% in comparison neighborhoods at post-intervention.

When studies reported on total physical activity, slightly less than half (two out of five studies) reported positive outcomes. Few studies assessed changes in BMI. Overall, some physical activity environmental enhancements may be effective at increasing physical activity, but more information is needed to assess whether these enhancements change total physical activity levels and BMI.

Implementing Smart Growth Principles

Smart growth is "an approach to development that encourages a mix of building types and uses, diverse housing and transportation options, development within existing neighborhoods, and community engagement" (Smart Growth America, 2018). There are 10 principles of smart growth:

- Mix land uses.
- Take advantage of a compact design.
- Create a range of housing opportunities and choices.
- Create walkable neighborhoods.
- Foster distinctive, attractive communities with a strong sense of place.
- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Direct development toward existing communities.
- Provide a variety of transportation choices.
- Make development decisions predictable, fair, and cost-effective.
- Encourage community and stakeholder collaboration in development decisions.

EVIDENCE OF EFFECTIVENESS:

Mixed/Inconclusive

Durand and colleagues provided a descriptive review of 204 studies that assessed relationships between smart growth principles, physical activity, and body mass (Durand, Andalib, Dunton, Wolch, & Pentz, 2011). This review found that open space preservation, a range of housing choices, mixed land use, development of existing communities, and compact building design were associated with increases in physical activity. BMI was rarely measured, and when it was, findings were rarely significant. Experimental studies are needed to determine the effectiveness of this approach.

Locating Grocery Stores in Low-Access Areas

Low-income neighborhoods and rural communities often have disproportionately high levels of obesity. One of the reasons suggested for this inequality is access to healthy food. The term "food desert" is often used to describe areas with a dearth of grocery store options, requiring individuals to travel farther outside of their communities to access food. Locating grocery stores in low-access areas is one strategy that has been proposed as a solution to reduce unequal access to grocery stores. The U.S. Department of Agriculture (USDA) Healthy Food Financing Initiative (HFFI) (U.S. Department of Health & Human Services, 2017) was created in 2010 to bring grocery stores and other healthy food retailers to underserved urban and rural communities, and similar initiatives have sought to encourage grocers to locate in low-access areas in the hope that increasing access to healthy foods would increase consumption of healthier foods and reduce chronic diseases.

EVIDENCE OF EFFECTIVENESS:

Mixed/Inconclusive

In a systematic review of built environment changes (Mayne, Auchincloss, & Michael, 2015), two studies that assessed the impact of opening supermarkets in areas that previously had low access found no significant impact. A subsequent study found that the addition of a grocery store to a location that had had no grocery store for three decades did not change where customers were shopping and that the addition of a grocery store did not increase availability more than a similar comparison community (Ghosh-Dastidar, et al., 2017). Another study estimated the effect of a supermarket entering a community and concluded that the difference in local access to supermarkets explains approximately 5% of the difference in healthy eating between high- and low-income households. Exposing low-income households to the same availability and prices experienced in high-income neighborhoods explained 9% of the nutrition inequality. The study concluded that the majority of the inequality was due to differences in demand and not access. Individuals travel a long way for grocery shopping, regardless of whether they live in a food desert, and the entry of a grocery store into the market would mostly divert shopping from one store to another (Allcott, Diamond, & Dube, 2018).

Community-Supported Agriculture

Community-supported agriculture (CSA) is a system that creates cooperative relationships between farmers and consumers. Consumers purchase a share of the farmer's products up front at the beginning of the growing season and then receive weekly or biweekly shares of produce as it is harvested. In interventions, shares may be provided for free or at a reduced cost to participants, with a goal of increasing their fruit and vegetable intake by offsetting the costs of purchasing fruits and vegetables. An educational component, such as group education classes, is also commonly included. These classes may feature nutrition information, recipes using produce from the CSA share, and cooking demonstration and teaching.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

There is very little evidence of the effectiveness of CSAs at increasing fruit and vegetable intake and preventing or reducing obesity. A recent review (Vasquez, Sherwood, Larson, & Story, 2017) highlighted benefits to farmers' financial security, cost savings to consumers, the ability to foster a sense of community, the ability to provide high-quality produce, and satisfaction with the overall experience as positive findings associated with CSAs. Findings regarding the impact of CSAs on fruit and vegetable consumption, consumption of more food at home rather than elsewhere, and weight loss look encouraging; however, most studies used self-reported measures and some lacked baseline measurement. A recent focus group study (White, et al., 2018) of low-income CSA participants reported that participants were more satisfied with the CSA when they could select the produce they wanted and thus were less likely to receive produce that was unfamiliar. Participants also noted transportation challenges associated with picking up CSA shares and payment structure as barriers. Overall, evidence to support improved dietary intake or reduction in BMI with a CSA intervention is limited, and more research is needed to assess the effectiveness of this approach.

Policy Strategies to Address Obesity

Although smaller-scale interventions may be effective at preventing, screening for, or treating obesity within an individual workplace, healthcare clinic, or community-based organization, policy change at the national, state, and local levels can affect larger segments of the population (Wright, Smith, & Hellowell, 2017). Governments can utilize a variety of policy mechanisms to support obesity prevention, screening, and treatment, including implementation of taxes, subsidies, or regulation to improve health and safety or providing constituents with services, information, or education (Shroff, Jones, Frongillo, & Howlett, 2012).

In this chapter, we describe policy approaches for obesity according to the categories described below:

- **Taxes:** Taxes intended to decrease the consumption of health-damaging products, such as a sales tax on soda or junk food, as well as taxes intended to increase the cost of production or distribution.
- **Subsidies/grants:** Subsidies intended to increase the consumption of healthy food by reducing the price or increasing access. This category includes subsidies and grants that can be combined with regulations to improve access to physical activity.
- **Regulations:** Government-directed and enforced actions or processes, including labeling requirements, land use and zoning restrictions, nutrition and physical activity requirements in school and child care settings, and professional licensing and credentialing standards.
- **Provision of services:** Government provision of new or expanded services or organized outreach to connect users to existing services.

Each strategy includes a brief summary of the approach and the evidence of effectiveness, along with the effectiveness classification (see Table 4). Under each category, strategies are organized by their evidence classification, from the highest evidence of a positive effect (i.e., recommended) to the lowest evidence of a positive effect (i.e., mixed/inconclusive).

Evidence Summary

There is evidence of dietary and physical activity behavior change following the implementation of public policies; however, there is limited evidence of detectable changes in health outcomes. Many policy studies model or estimate the potential future effect of policy change, but it is difficult to conduct randomized controlled trials in the policy arena due to ethical, logistical, and other considerations. Many studies gather process-level outcomes related to implementation and adoption of policies across states and localities (Slining, Neelon, & Duffey, 2014) (Shroff, Jones, Frongillo, & Howlett, 2012) (Pomeranz, Gostin, & Lawrence, 2009). Policies are not "one-size-fits-all." While each type of policy instrument (e.g., tax, subsidy) has an overarching structure, these instruments often allow for flexibility in implementation, depending on the capacity of the organization and its specific needs (Shroff, Jones, Frongillo, & Howlett, 2012). Additionally, dozens of policies may affect organizations at the same time (Shroff, Jones, Frongillo, & Howlett, 2012). Thus, it is difficult to connect changes to any particular policy.

Additionally, policy change takes time and is often incremental. The policies described in this chapter took years or even decades to arrive at their current state. There are many reasons for difficulty in passing obesity-related policies, including differing political ideologies, the power of industry lobbyists to advance or block change,

and lack of public pressure for policy change (Clarke, Swinburn, & Sacks, 2016). In the obesity prevention realm, there is often debate on whether policies banning certain products (such as those containing trans fats) infringe on personal decision-making or the free market (Clarke, Swinburn, & Sacks, 2016).

A recent study of obesity prevention policies found that most are based on the multiple-streams framework or the Advocacy Coalition Framework (Clarke, Swinburn, & Sacks, 2016). These theories take into account the many influencers of policy adoption, including coalitions, groups, networks, or key individuals who are key drivers or champions advocating for the policy (Clarke, Swinburn, & Sacks, 2016). Those interested in advocating for change in public health policy must not only have an in-depth understanding of these actors but also understand the prevailing political ideology, understand the timing of the policy process, and be able to develop a narrative that promotes the issue with clarity by utilizing evidence to describe the need for action (Clarke, Swinburn, & Sacks, 2016).

Taxes

In the U.S., the retail sales tax is a broad tax on consumption levied by the states (Slemrod, 1999). The tax is added to the price of retail goods at the point of purchase. Five states (Alaska, Delaware, Montana, New Hampshire, and Oregon) do not have a retail sales tax. Local governments can also levy their own taxes. While many state and local governments have implemented similar laws, the tax structure varies considerably, with some exemptions for food purchased for preparation at home, clothing, prescription medication, and utilities (Slemrod, 1999). For more than 40 years, states have been levying a retail sales tax on the sale of tobacco to both generate revenue and discourage smoking (Bloomberg BNA, 2017). In more recent years, states and localities have instituted similar "sin" taxes on items such as liquor, gambling, marijuana, and plastic bags (Bloomberg BNA, 2017). Taxes can be levied either directly on the consumer or on the producer or distributor of the product (Bloomberg BNA, 2017) (Wright, Smith, & Hellowell, 2017). Levying retail sales tax to achieve public health goals has three primary aims: (1) to reduce consumption of certain products that have a negative effect on health (e.g., alcohol, tobacco), (2) to generate revenue that can be redistributed towards other health objectives, and (3) to make changes sustainable for the long term by providing a funding mechanism to support continued implementation (Alagiyawanna, et al., 2015) (Slemrod, 1999) (Wright, Smith, & Hellowell, 2017) (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013).

Sugar-Sweetened Beverage Tax

Although sugar-sweetened beverage (SSB) consumption has declined in recent years, beverages account for approximately 10% to 15% of caloric intake in children and adolescents, and consumption of SSBs increases the risk of chronic disease (Brownell & Frieden, 2009) (The CHOICES Learning Collaborative Project, 2016). Following the well-established evidence of behavior change after the implementation of the tobacco tax, policymakers sought to improve population health by reducing consumption of soft drinks and other SSBs (Thow, Jan, Leeder, & Swinburn, 2010). As of 2017, six cities collected a tax on the sale of SSBs, and several other cities were considering the policy (The CHOICES Learning Collaborative Project, 2016). SSB taxes typically range from $0.01 to $0.02 per ounce. The definition of "sweetened" varies from locality to locality, with laws that include a variety of products based on sugar (e.g., glucose, sucrose) and/or artificial sugar substitutes (e.g., aspartame, sucralose). Milk and 100% juice are typically excluded (The CHOICES Learning Collaborative Project, 2016).

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

Most studies on the effectiveness of beverage taxes have been natural experiments or modeling studies. Two systematic reviews including more than 100 studies on food and beverage taxes found that approximately half of those studies included outcomes related to behavior change or public health (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013) (Wright, Smith, & Hellowell, 2017). The other half included outcomes related to design and implementation, media coverage, and public opinion. About half of the studies were modeling experiments utilizing empirical data to estimate price elasticities. Results were dependent on income, weight, sex, and age group (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013).

Of the more rigorous evaluation or mixed-methods studies, half found a modest positive health impact, and half found either no impact or a negative health impact (Wright, Smith, & Hellowell, 2017) (Powell, Chriqui, Khan, Wada, & Chaloupka, 2013). On average, studies indicated a reduction of 50 calories per day with a 10% increase in tax (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013). This would translate to a reduction in weight by 1.5 pounds per year (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013).

Eight studies identified positive health impacts at a tax rate of 20% or more, whereas only three studies identified positive health effects at a tax rate of 20% or less (Wright, Smith, & Hellowell, 2017). However, even at the 20% or greater tax rate, positive health impacts were modest, with one study projecting a decrease in BMI by 0.006 (Alagiyawanna, et al., 2015) (Pomeranz, 2012). Another study found that a 20% reduction in taxes increased average soft drink consumption by 6.8% (Alagiyawanna, et al., 2015). Small taxes are likely to yield revenue for states but are unlikely to affect obesity rates (Franck, Grandi, & Eisenberg, 2013).

This tax approach assumes that consumers are well-informed about the tax and also price-sensitive (Maniadakis, Kapaki, Damianidi, & Kourlaba, 2013). Researchers noted that when sales taxes are not itemized on the receipt, consumers may be less sensitive to tax-related changes in price because of a lack of transparency about the true cost. Younger and poorer groups may be more price sensitive (Thow, Jan, Leeder, & Swinburn, 2010) (Wright, Smith, & Hellowell, 2017). Some localities tax the distributor rather than the consumer, further limiting price transparency (Bloomberg BNA, 2017). There is also some concern that customers may substitute a less healthy beverage (e.g., soda) for another less healthy option, such as a sports drink, if the law is not comprehensive in its definition of "sweetened" (Alagiyawanna, et al., 2015) (Wright, Smith, & Hellowell, 2017).

Junk Food or Fat Tax

Similar to the SSB tax, a so-called junk food or fat tax aims to limit the consumption of highly processed, energy-dense snack foods in favor of more nutrient-rich foods. As the prices of these snack foods are often lower than the prices of nutrient-rich foods (e.g., fresh produce), policymakers theorize that an increase in the price of junk foods will lead consumers to make healthier choices (Franck, Grandi, & Eisenberg, 2013). There are typically two types of tax structures: (1) a tax on foods with low nutritional value (e.g., high fat, high sugar) and (2) a tax on a broad category of foods (e.g., snack foods such as candy, chewing gum, chips, ice cream, and baked goods) (Franck, Grandi, & Eisenberg, 2013).

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

There is limited experimental or empirical research on junk food taxes in the U.S. Some studies have been conducted in Denmark, where the first fat tax was implemented in 2011 on foods with more

than 2.3% saturated fat content (Franck, Grandi, & Eisenberg, 2013). One study found a 10% to 15% decrease in the purchase of butter, butter blends, margarine, and oils, while another found a 4% to 6% decrease in intake of saturated fat from minced beef and cream (Sisnowski, Street, & Merlin, 2017). However, researchers hypothesize that residents may have hoarded these items before the tax took effect. The tax was later repealed, limiting the opportunity for study beyond 15 months (Sisnowski, Street, & Merlin, 2017).

The few modeling studies conducted in the U.S. use price elasticity estimates to simulate potential changes in price (Thow, Jan, Leeder, & Swinburn, 2010). Four modeling studies identified positive health impacts at a tax rate of 20% or less, whereas three studies identified positive health impacts at a tax rate greater than 20% (Wright, Smith, & Hellowell, 2017). Estimated reductions in sugar consumption ranged from 16% to 17.5%, and estimated reductions in saturated fat consumption ranged from 8% to 20% (Thow, Jan, Leeder, & Swinburn, 2010). One peer-reviewed modeling study on U.S. dairy consumption estimated that a 50% tax on dairy fat would result in a 3% reduction of fat intake from dairy products and would have no effect on weight (Thow, Jan, Leeder, & Swinburn, 2010). A study that modeled the impact of a 100% tax on "unhealthy" food predicted a 1% reduction in BMI and a 1% to 2% reduction in the incidence of overweight and obesity (Thow, Jan, Leeder, & Swinburn, 2010). Another study found that a tax of 8% or more in fast food restaurants was significantly associated with a reduction in BMI (by 0.55 kg/m^2) in women (Alagiyawanna, et al., 2015). While several studies found no impact, one study estimated a negative impact. An analysis of historical data on food eaten away from home in the U.S. found that body weight would increase slightly due to a disproportionate increase in calories consumed at home (Alagiyawanna, et al., 2015) (Thow, Jan, Leeder, & Swinburn, 2010).

While taxes on food would need to be quite high to result in improved health outcomes, researchers note that taxes could be used to reinforce efforts to educate consumers about unhealthy food (Thow, Jan, Leeder, & Swinburn, 2010). Implementing a tax based on nutrient value, as opposed to a broad category, would be highly complicated and resource intensive for food vendors (Thow, Jan, Leeder, & Swinburn, 2010). Like the SSB tax, junk food taxes may pose a disproportionate burden on younger and poorer consumers (Thow, Jan, Leeder, & Swinburn, 2010) (Wright, Smith, & Hellowell, 2017).

Subsidies and Grants

Subsidies are typically provided to encourage a voluntary action (e.g., purchase of healthy foods, construction of a new grocery store in a food desert) or to transfer resources from one government or organization to another. These subsidies may be provided to organizations (often in the form of grants) or to individuals (often in the form of vouchers). Subsidies that may have an impact on obesity include those that aim to (1) encourage the purchase of healthy foods (e.g., the Supplemental Nutrition Assistance Program [SNAP], WIC, Double Up Food Bucks), (2) improve access to healthy foods (e.g., the Healthy Food Financing Initiative), and (3) improve access to physical activity (e.g., the addition of new parks and playgrounds, vouchers for public transportation or bike sharing).

Subsidies and Grants to Improve the Physical Activity Environment

There are a variety of ways, including subsidies and grants, in which a state or local government can improve the physical activity environment. Subsidies and grants can spur the development of new or improved parks, playgrounds, protected bike lanes, bike paths, and public transportation systems. One example of a government initiative

to create a safe walking and bicycling environment is the Safe Routes to Schools program. Walking and biking to school are easy ways for children to increase their physical activity. The federal Fixing America's Surface Transportation Act provides funding to states, localities, and school districts to implement SRTS (Trust for America's Health, 2018). Subsidies and grants may also be paired with regulations. For instance, a city may receive federal grant funding to build new bike lanes, but local infrastructure changes may require new or updated land use or zoning regulations.

Other government investments to encourage active transportation include subsidies to individuals to cover costs associated with utilizing public transportation or bicycle sharing programs. These subsidies aim to encourage active transportation and decrease reliance on cars. Such policies have dual outcomes: (1) reduction of traffic congestion and associated air pollution and (2) an increase in physical activity.

EVIDENCE OF EFFECTIVENESS: *Promising*

In general, there is moderate evidence that improvements to the physical activity environment lead to increases in exercise for adults and children. However, results related to long-term impacts on obesity are inconclusive. The addition of neighborhood parks and playgrounds has been found to significantly affect obesity rates in children. An analysis of 2007 National Survey of Children's Health data found that access to neighborhood parks and playgrounds decreased BMI as well as the risk of being overweight or obese by 1% to 16% for males and 2% to 42% for females (Fan & Jin, 2013). However, the level of effect varies based on gender, age, race, household income, neighborhood safety, and other neighborhood amenities (Fan & Jin, 2013).

One study of 800 schools in four states found increases in rates of walking and biking to schools following the implementation of SRTS (McDonald, et al., 2014). Researchers estimate that effects of SRTS engineering improvements on walking and bicycling would be cumulative over time, leading to a 25% increase in walking and biking over the course of five years (McDonald, et al., 2014)

Studies found stronger impacts when the intervention involved improvements to active transportation. Studies conducted in the U.S., the U.K., and Germany found that subsidized transportation passes led to significant increases in physical activity levels (Martin, Suhrcke, & Ogilvie, 2012). Two studies assessing impacts on obesity following the development of a light rail system observed a significant reduction in BMI for new riders and one study also estimated a public health cost savings of $903,000 in the first year of operations (Mayne, Auchincloss, & Michael, 2015) (McKinnon, Siddiqui, Chaloupka, Mancino, & Prasad, 2016).

In recent years, free or low-cost bicycle sharing programs have begun to pop up in cities across the country, including Capital Bikeshare in Washington, D.C., and Citi Bike in New York City. Few studies conducted in Denmark, Australia, and Sweden found that free bicycle programs increased the proportion of trips made by bike (Martin, Suhrcke, & Ogilvie, 2012). However, such programs are relatively new and have not been evaluated yet for impacts related to weight, obesity, or BMI.

Vouchers to Subsidize the Purchase of Healthy Foods

Since 1939, the federal government, through the USDA, has provided a variety of subsidies to increase access to healthy food and reduce food insecurity in low-income populations (Caswell & Yaktine, 2013). These programs include SNAP, WIC, and the Commodity Supplemental Food Program. In some instances, such as the Commodity Supplemental Food Program, the

government provides food directly to low-income individuals. In other instances, such as SNAP and WIC, the government provides subsidies to individuals to purchase food. These programs are administered through state social service agencies and include eligibility requirements based on income and assets (Caswell & Yaktine, 2013).

SNAP provides a monthly cash subsidy to individuals and families via an Electronic Benefits Transfer card that can be used at SNAP-authorized food retailers. The WIC program provides nutrition subsidies for pregnant, breastfeeding, and postpartum women; infants; and children up to age five. In 2009, WIC revised its list of eligible foods to encourage fruit, vegetable, whole grain, and dairy consumption through the provision of $10 cash value vouchers per month (Schultz, Byker, & Houghtaling, 2015).

Since the 1970s, policymakers have debated whether junk foods should be eligible for purchase with federal funds (Caswell & Yaktine, 2013). Current law restricts the purchase of alcoholic beverages, tobacco, hot food products ready for immediate consumption that will not be eaten inside the grocery store (e.g., restaurant food), and non-food items such as vitamins (Caswell & Yaktine, 2013). Rather than restricting specific foods, some states have gone further to incentivize the purchase of nutrient-rich foods by providing subsidies specifically for the purchase of fresh fruits and vegetables (Olstad, et al., 2017) (Thow, Jan, Leeder, & Swinburn, 2010). One such initiative, the Double Up Food Bucks program, doubles the value of federal SNAP benefits at participating farmers' markets and grocery stores for the purchase of fruits and vegetables (Fair Food Network, 2018). This model, which blends funding from the USDA as well as other state and nonprofit funding sources, originated in Michigan and is now being implemented by local partners in more than 20 states (Fair Food Network, 2018)

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Twenty studies assessed the effectiveness of 2009 WIC food package changes (Schultz, Byker, & Houghtaling, 2015). Across the eight studies examining changes in dietary intake, enrolled households increased purchases of whole grain breads and brown rice and decreased purchases of juice and whole milk. Changes in intake of fruits and vegetables were minimal (Alagiyawanna, et al., 2015) (Mayne, Auchincloss, & Michael, 2015) (Schultz, Byker, & Houghtaling, 2015). Significant changes, including increased fruit intake (0.33 more servings of per day) and increased low-fat dairy intake (0.21 more servings per day), were found in dietary intake among Hispanic and Native American mothers and children (Schultz, Byker, & Houghtaling, 2015). Decreases in high-fat milk and cheese products resulted in decreased saturated fat intake (by 85 to 107 grams/month) (Schultz, Byker, & Houghtaling, 2015).

A study comparing National Health and Nutrition Examination Survey data to state-level policies that affect SNAP participation found that SNAP participants increased consumption of whole fruits (US Department of Agriculture Economic Research Service, 2013). However, consumption of dark green or orange vegetables decreased (US Department of Agriculture Economic Research Service, 2013). The cause of this decrease is unknown, but researchers hypothesize that it could be due to attractiveness of dark green or orange foods, increased costs of such foods, or the level of effort required to prepare such foods (US Department of Agriculture Economic Research Service, 2013).

Three studies on the use of SNAP benefits for the purchase of produce at mobile vendors and farmers' markets found an increase in the dollar amount spent on produce compared with cash purchases (Sisnowski, Street, & Merlin, 2017). However, evidence on the intake of fruits and

vegetables is mixed. Studies of voucher programs in New York City and Philadelphia found increases in produce sales, but one study found no impact on adults' total daily fruit and vegetable intake (Olstad, et al., 2017) (Sisnowski, Street, & Merlin, 2017). Participants in the Philadelphia program self-reported increased fruit and vegetable consumption (Sisnowski, Street, & Merlin, 2017).

Empirical and modeling studies estimate that a combination of taxes on junk foods and a subsidy for the purchase of healthy foods results in health improvements for adults, including improved diet, increased fruit and vegetable consumption, a decrease in obesity rates, and a decrease in deaths related to cardiovascular disease, coronary heart disease, and cancer (Thow, Jan, Leeder, & Swinburn, 2010) (Niebylski, Redburn, Duhaney, & Campbell, 2015). However, few experimental studies have been conducted in this area in the U.S. In Denmark, a 50% discount on fruits and vegetables in a web-based supermarket significantly increased purchases (Niebylski, Redburn, Duhaney, & Campbell, 2015). A randomized controlled trial of eight supermarkets in New Zealand assessed priced discounts of 12.5% on healthy foods paired with nutrition information. At six months, there was minimal difference in the change in saturated fat or other nutrients in food purchased (Niebylski, Redburn, Duhaney, & Campbell, 2015).

Subsidies and Grants to Improve Food Access

In addition to vouchers, the USDA provides healthy foods directly to individuals and families via a variety of programs aimed at improving the overall diet and encouraging more healthful eating habits. These programs include the National School Lunch Program, the School Breakfast Program, the Child and Adult Care Food Program, and the Fresh Fruit and Vegetable Program. Given the number of hours that children spend in school, day care centers, and afterschool care centers, these programs have become a prime setting for provision of resources and information to promote healthy growth and development.

The National School Lunch Program and the School Breakfast Program provide free or reduced-price meals and snacks to students in public schools, private schools, and residential child care facilities (Trust for America's Health, 2018). Schools with high percentages of eligible students can participate in the Community Eligibility Provision, which allows them to offer free meals to all students and eliminates the burden on families to submit eligibility applications to quality for free or reduced-price meals based on income (Trust for America's Health, 2018). CACFP provides nutritious food to children, older adults, and persons with disabilities as part of the care they receive in child and adult care institutions (Trust for America's Health, 2018). The FFVP aims to improve the total number of fruits and vegetables consumed, as well as total energy or caloric intake, by providing free fresh fruits or vegetables to children in schools (Trust for America's Health, 2018). Other programs provide meals during summer vacation, low-fat or skim milk to students who do not participate in the school meal programs, and fresh produce from local farms and school gardening initiatives (Trust for America's Health, 2018). The federal government allocates funding for these programs based on the percentage of low-income students enrolled in the school or the child or adult day care center. State agencies are typically responsible for overseeing administration of the program, with schools and day care centers implementing day-to-day activities at the local level. Agencies administering the program are reimbursed by the federal government.

In addition to improving access to healthy foods through the direct provision of goods, government agencies can also provide subsidies or grants to retailers to incentivize improvements in the food

retail environment that would expand access to healthy foods. One such initiative is the USDA Healthy Food Financing Initiative (HFFI). HFFI aims to eliminate food deserts, or areas in which residents lack affordable and healthy food retailers, by providing loans and grants to retailers to make infrastructure and operational improvements to improve accessibility of healthy foods in underserved areas. Another initiative is the U.S. Department of Treasury's New Markets Tax Credit Program, which provides funding and technical assistance to spur community development of grocery stores, farmers' markets, and other sources of fresh nutritious food.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Evidence of effectiveness in this area is mixed. While the federal government provides guidelines for implementation, implementers at the local level have flexibility to tailor the program to meet the needs of the population they serve. A review of 11 interventions, delivered in child care and preschool settings, reported an impact on children's dietary intake. Researchers found that meal and snack reimbursement resulted in improvements in milk, fruit, and fruit juice consumption and reductions in consumption of fast food, sweet snacks, and soda (Bell & Golley, 2015).

One study evaluating the FFVP found that the provision of two or more free fresh fruits or vegetables per week reduced children's BMI and improved children's total daily fruit and vegetable intake (Olstad, et al., 2017). A similar initiative implemented in New Zealand schools found improved fruit intake during the school day but no change in total daily food intake (Olstad, et al., 2017).

Studies assessing fruit and vegetable consumption following changes to the food retail involvement report minimal increases (by 0.1 to 0.3 servings/day) in intake (Tseng, et al., 2018). Two studies assessed fruit and vegetable intake among 100 to 200 households following the opening of a large grocery store in a food desert 10 months post-implementation. Neither study found a significant impact (Mayne, Auchincloss, & Michael, 2015). Three additional studies assessing the effect of building grocery stores on BMI found minimal or no difference in BMI between intervention and control groups (Tseng, et al., 2018). Studies assessing the addition of community gardens, farmers' markets, and healthy foods in park concession stands in cities found that all methods increased access to healthy foods and beverages (Silberfarb, Savre, & Geber, 2013). However, the studies did not assess outcomes related to weight, obesity, or BMI (Silberfarb, Savre, & Geber, 2013).

Regulations

Regulations are actions or processes directed and enforced by the government. Regulations can apply to individuals, businesses, lower-level government entities, nonprofit institutions, and others. The government uses regulations to force private entities to perform certain actions when self-regulation has proven ineffective. In the area of obesity prevention and control, governments have implemented a variety of regulations including labeling requirements, land use and zoning restrictions, nutrition and physical activity requirements in school and child care settings, and professional licensing and credentialing standards.

Nutrition and Physical Activity Regulations in Schools

The federal Healthy, Hunger-Free Kids Act of 2010 (HHFKA) requires that, as of fall 2014, all food sold a la carte at schools meet certain nutrition standards. This "smart snacks" rule applies to any food or beverages sold on a school campus (e.g., in the school store, in vending machines) and also applies to events occurring outside of the normal school day (e.g., athletic events,

fundraisers) (US Department of Agriculture, 2014). However, the USDA recognizes that school-sponsored fundraisers may occasionally require some flexibility, and it allows states to determine whether schools can apply for exemptions as well as the maximum number of exemptions that may be allowed during the year (US Department of Agriculture, 2014). The HHFKA also requires that, as of academic year 2017, school districts participating in federal child nutrition programs develop school wellness policies. These policies must include nutrition promotion and physical activity goals, include guidelines for foods available on campus, and limit marketing of food products to meet the Smart Snacks standards.

While there is no federal requirement for physical activity in schools, the Every Student Succeeds Act of 2015 includes school health and physical education as a key component of a student's education (Trust for America's Health, 2018). Many state- and local-level departments of education have implemented regulations around physical activity in schools. This may include requirements for physical education, recess, and after school programs. Policies on the provision of physical education in schools may include physical education class size restrictions, requirement of physical education credits, or requirement of a minimum number of minutes of physical education per week (Trust for America's Health, 2018). Policies on the provision of recess may include requirements of daily recess for all students in grades K through 12, recess before lunch, age-appropriate equipment and facilities for recess, and annual professional development for staff supervising recess (Trust for America's Health, 2018).

EVIDENCE OF EFFECTIVENESS: *Promising*

In a review of studies on implementation of nutrition guidelines in schools, researchers found marked heterogeneity between studies with a wide range of methods and outcomes reported. All studies showed an increase in fruit and vegetable availability, and half the studies documented decreased fat intake (Jaime & Lock, 2009). Six repeat cross-sectional studies evaluated impacts of restrictions on sugary foods and beverages in schools and/or increases in availability of milk or fruits and vegetables. One study found that, following policy implementation, elementary students were more likely to meet recommendations for fruit and vegetable intake (Micha, et al., 2018).

Studies that evaluated policies governing the sale of foods and beverages sold outside of the school meals program found consistent evidence of positive change in the availability and consumption of healthy foods (Chriqui, Pickel, & Story, 2014). However, evidence of policy influence on BMI was mixed (Chriqui, Pickel, & Story, 2014). Few studies that included these outcome variables, and only one examined longitudinal changes in BMI and weight outcomes.

There is consistent evidence of effectiveness of physical activity in school. Studies have shown that state- and district-level policies around "active" physical education and recess in elementary and middle schools (i.e. moderate to vigorous activity), as well as state-level policies around healthy eating and physical activity in afterschool programs, are effective at increasing physical activity levels among children and adolescents (Cradock, et al., 2017) (Trust for America's Health, 2018). Researchers have also found implementation of these programs to be cost-effective. One review estimated that funding afterschool programs could result in obesity-related healthcare cost savings of $185 million in 10 years (Cradock, et al., 2017).

Professional Licensing and Credentialing Regulations

Government agencies may require professional licensing or credentialing to ensure that

professionals have undergone adequate training in topics like approaches for addressing obesity. This is particularly true in the medical profession, where state medical boards oversee licensure, discipline, and regulation of physicians and other healthcare professionals to ensure the health and safety of patients. States may also regulate other professionals, including teachers, social workers, and psychologists. Standards vary from state to state, but state boards work together in some cases to develop uniform standards or procedures. Individuals interested in becoming licensed need to complete certain education requirements, pass a licensure exam, and pay any required feeds. Licensure requirements often include ongoing continuing education for renewal. Many nongovernmental organizations, such as member associations (e.g., the American Medical Association, the American Academy of Pediatrics) and colleges/universities, offer continuing education programs to support individuals in maintaining licensure.

EVIDENCE OF EFFECTIVENESS:
Mixed/Inconclusive

While there is much information available on the requirements for licensure in a given field and some on the quality of licensed professionals (such as in the Quality Rating and Improvement Systems [QRISs] for early childhood care and education providers), our search did not find any systematic reviews on the effect of licensure regulations on weight-related outcomes for clients. Policymakers posit that if medical providers, early childhood care and education providers, teachers, and others receive continuing evidence-based education on a topic such as obesity, they will be able to communicate more effectively about that topic with their patients, students, and others. In turn, the information and recommendations shared will lead to individual-level behavior change.

Licensure and accreditation requirements frequently change and often include multiple topics. There is often some flexibility for individuals to choose topics of interest to them while meeting a required number of hours of continuing education over a two- to five-year period. For organizations to become accredited, they may need to implement a certain number of policies from a larger bucket of options, as in the breastfeeding example. The lack of evidence in this area may be due to difficulties in collecting data in a heterogeneous policy implementation environment.

Land Use and Zoning

In an effort to improve food infrastructure, local governments can implement zoning policies to either encourage businesses to open or ban the operation of certain businesses. As previously noted, land use and zoning regulations may also be paired with subsidies and grants to facilitate rapid change. One example of a zoning regulation to improve food access is New York City's Green Carts policy, which provided permits to mobile produce vendors, incentivizing them to vend in disadvantaged neighborhoods (Sisnowski, Street, & Merlin, 2017). Conversely, South Los Angeles used its zoning process to ban new free-standing fast food and "fast-casual" chain outlets (Sisnowski, Street, & Merlin, 2017).

Zoning policies can also encourage mixed-use neighborhoods, where worksites, residences, and commercial areas are all within walking distance of each other. One example of a land use policy to promote convenient and safe walking environments is the Complete Streets initiative. Policy implementation varies from location to location and may include features such as more streetlights and bike paths, street furniture, street-facing windows, connected sidewalks, street-crossing safety features, and more greenery and trees (Trust for America's Health, 2018). Thirty-three states and more than 1,000 local communities have implemented Complete Streets policies (Trust for America's Health, 2018).

Other land use policies aim for increased shared use of public land. In many communities, students use school recreation facilities for only a portion of the school day and a portion of the academic year. Shared use agreements would allow community organizations to access school facilities outside of school hours. Six states (California, Hawaii, Massachusetts, Michigan, Ohio, and Utah) legally require schools to allow community access to school recreational facilities outside of school hours (Trust for America's Health, 2018).

EVIDENCE OF EFFECTIVENESS: ***Promising***

There is strong evidence of the effectiveness of multicomponent land use policies that include traffic-calming measures, streetscape improvements, and greater street connectivity (University of Wisconsin, 2017). Such improvements have been associated with higher levels of walking, increased physical activity, lower rates of overweight and obesity, and lower BMIs (University of Wisconsin, 2017). There is less evidence of impacts of zoning restrictions. A study of the ban on new freestanding fast food chain restaurants in South Los Angeles found no significant differences in diet and BMI compared with control jurisdictions (Sisnowski, Street, & Merlin, 2017). As the policy would affect only new stand-alone businesses, it may have had limited reach.

Labeling Requirements

Since the 1960s, the FDA has regulated nutrition labels to some extent. Following several reports on the implications of a healthy diet on chronic disease prevention and reduction, Congress passed the Nutrition Labeling and Education Act (NLEA) of 1990 (Institute of Medicine, 2010). The NLEA required the FDA to establish standard food labeling requirements for most foods. Industry producers were required to include on most packaged foods a Nutrition Facts panel that included calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamins A and C, calcium, and iron (Institute of Medicine, 2010). Policymakers debated whether to include trans fat in the panel. Following additional evaluation of studies on trans fat's effect on cholesterol levels, the FDA mandated the inclusion of trans fat on the panel as of 2003 (Institute of Medicine, 2010). In 2016, additional changes were made to increase the size of text on the nutrition panel, require reporting of added sugars, and adjust serving sizes to more accurately reflect dietary habits. While some manufacturers have already voluntarily implemented the new requirements, large manufacturers have until 2020 to comply, with an extended deadline of 2021 for smaller manufactures (Trust for America's Health, 2018).

Like nutrition labeling on packaged foods, menu labels are meant to provide nutrition information to consumers eating prepared food away from home (Trust for America's Health, 2018). As support and demand for the provision of easy-to-understand nutrition information (e.g., calories, fat, trans fat, sodium) has grown, regulations requiring restaurants to provide such information on menus and menu boards also grew (Sisnowski, Street, & Merlin, 2017). Menu labeling regulations were implemented in several states (California, Massachusetts, Maine, and Oregon) and localities (Seattle, Philadelphia, New York City, and Nashville). In May 2018, federal requirements included in the Patient Protection and Affordable Care Act went into effect, requiring chain restaurants with 20 or more locations to post calorie counts on menus and menu boards (Trust for America's Health, 2018).

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Most studies in this area utilize nutrition receipts to assess the potential impact on calories and dietary quality one to nine months following

implementation of the policy (Mayne, Auchincloss, & Michael, 2015). Nutrition receipts are typically sales receipts that are annotated or coded to provide researchers with additional detail on the contents of each purchase. Across 19 studies of calorie posting on menus at chain restaurants, researchers found that menu labeling with calories per item did not affect consumer purchasing behavior (Sisnowski, Street, & Merlin, 2017) (Tseng, et al., 2018). While consumers did report increased knowledge of the policy change (i.e., noticing the calorie information), they did not report use of the calorie information in purchasing decisions. However, three studies reported a 151- to 250-calorie decrease (6% to 14%) after enactment of the menu labeling law (Mayne, Auchincloss, & Michael, 2015) (Sisnowski, Street, & Merlin, 2017) (Yang, Nichols, & Len, 2011). While this reduction in calories may not seem substantial, a modeling study estimated that if 10% of chain restaurant consumers reduced their calorie intake by 100 calories per meal, it could result in a population-level impact, averting weight gain in 40% of the U.S. population (Yang, Nichols, & Len, 2011).

Across studies, there was no significant change in the frequency of visits to fast food restaurants. However, one study found that adults who self-reported noticing menu labels consumed fast food less frequently (4.9 meals versus 6.6 meals) (Vidiveloo, Dixon, & Elbel, 2011). There is some evidence that menu labeling requirements may lead restaurants to reformulate their food (Trust for America's Health, 2018). A review of global policies found that in high-income countries, where literacy levels are high, labeling requirements may be more effective. Researchers suggest that the food industry may be more likely to reformulate its products if it knows that consumers will value and demand products with certain nutrition components (Downs, Thow, & Leeder, 2013). In King County, Washington, chain restaurants reported reformulating their menus to contain an average of 41 fewer calories per entrée at 18 months after enactment of the regulation (Sisnowski, Street, & Merlin, 2017). Evidence is currently mixed for menu labeling; however, with recent revisions to labeling laws affecting restaurants across the country, there will likely be more data on the effects of labeling in the next several years.

Nutrition and Physical Activity Regulations in Child Care Settings

Since many children from birth to age five spend time in care outside of their home (e.g., at child care centers, child development centers, preschool, places of worship, recreation spaces), early childhood education (ECE) providers are often mandated to meet certain nutrition and physical activity requirements. Federally funded Head Start and Early Head Start programs provide health, education, and social services to children from low-income families. While the federal government provides funding and oversight, local agencies administer the programs (Trust for America's Health, 2018). All programs are required to participate in either the National School Lunch Program or Child and Adult Care Food Program and meet nutritional and physical activities standards that include obesity prevention requirements (Trust for America's Health, 2018).

Many states also have their own regulations for ECE. States may incorporate these requirements as part of licensure requirements. Forty states track and measure adherence through their Quality Rating and Improvement Systems (QRISs). All 50 states and the District of Columbia (D.C.) require licensed ECE programs to have healthy eating policies and provide time for daily physical activity (Trust for America's Health, 2018). Fifty percent of states include licensure requirements regarding breastfeeding supports (Trust for America's Health, 2018). Twenty-nine states and D.C. require licensed ECE programs to prohibit screen time for children under age two or sets limits (Trust for America's

Health, 2018). Other common state policies include making drinking water available and providing meals and snacks that meet USDA or CACFP guidelines (Trust for America's Health, 2018).

EVIDENCE OF EFFECTIVENESS: *Mixed/Inconclusive*

Many studies have been conducted on the relationship between physical activity and health in early childhood. Such reviews have found positive health impacts of physical activity for children from birth to age five, including improved cardiometabolic health (Carson, et al., 2017). Physical activity (e.g., active play, dance, and structured/organized activity) was consistently associated with positive impacts on bone health, skeletal health, and fitness (Carson, et al., 2017). This evidence has led to many agencies to implement programs and policies targeting children early in life for obesity prevention (Stanhope, Kay, Stevenson, & Gazmararian, 2017). However, few studies have quantified these

Example: Active Living Workshops
(Indiana State Department of Health, n.d.)

Setting: 46 locations within Indiana.

Population: More than 2,500 individuals, including city planners, engineers, public health professionals, school administrators, and community leaders.

Intervention: The Indiana State Department of Health's Division of Nutrition and Physical Activity partnered with Health by Design, a statewide coalition that works with Indiana communities to ensure they have infrastructure that promotes physical activity and healthy eating, to offer Active Living Workshops. The purpose of the Active Living Workshops was to raise awareness of how community planning and design affect physical activity, introduce Complete Streets principles, and provide participants with tools and resources to build healthier neighborhoods. Workshop participants from each community worked together to create an action plan and then implemented recommendations from the plan over the next year. The Indiana State Department of Health provided technical assistance to communities to implement action plans. Two statewide peer summit workshops brought communities together to learn from each other. Part of the funding for the workshops was provided by the CDC 1305 grant, which provided funding resources to states to promote and increase access to opportunities for healthy eating and physical activity.

Results: One community, Lebanon, was highlighted as making significant improvements as a result of the Active Living Workshops. As a result of a workshop, Lebanon created an Active Living Committee. The committee conducted assessments that identified barriers to active living and created the city's first-ever bicycle and pedestrian plan. The city initiated multiple infrastructure improvements since the plan was adopted, including installing pavement markings to help bicyclists and motorists move safely on a shared roadway and completion of a new sidewalk and crosswalk that connects two major parks. In addition to Lebanon, 15 communities adopted bicycle and pedestrian plans that cover a population of more than 500,000 Indiana residents.

impacts following a specific policy change. Several qualitative studies have been conducted on agency progress and challenges related to implementation of their state's Quality Rating and Improvement System and early childhood care and education policies (Nemours Children's Health System, 2016) (Byrd-Williams, et al., 2017) (National Collaborative on Childhood Obesity, 2018). These studies have not included intermediate or long-term outcomes.

Provision of Information

In some instances, policy change may not be necessary or possible. In other cases, a policy may already exist but levels of adoption and implementation are lower than anticipated. The general public and even potential implementers may not be aware of the policy. In each of these instances, government agencies may choose to provide information to the public to reduce or prevent information asymmetries, particularly when available information is lengthy or complex. The government can provide information to market new or existing policies or programs. They can also provide a list of standards, guidelines, or ratings that recommend the use of tested, evidence-based strategies or programs. Lastly, they can provide training and technical support on how to implement programs, policies, or guidelines effectively.

Provision of Training and Technical Assistance for Policy Implementation

Training and technical support are essential for effective implementation of best practices. Many federal agencies include training and technical assistance to support the implementation of grants at the local level. For instance, the National Center on Early Childhood Health and Wellness supports early childhood care and education providers, healthcare providers, and families to implement best practices around health and wellness. The CDC's Early Care and Education Learning Collaborative provides training and technical assistance to states to help them implement obesity prevention recommendations in early care and education settings.

Government agencies may develop in-person or virtual trainings, implementation toolkits, and other materials. For instance, the CDC offers the Training and Continuing Education Online platform, which provides the public health and healthcare workforce access to free continuing education. Government agencies may also authorize third-party organizations to provide training and technical assistance on their behalf. These groups may be membership associations, colleges and universities, or other nonprofits.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Training and technical assistance has been shown to significantly improve the implementation of recommended practices. Technical assistance provided to 2,300 early care and education providers in 15 states led to a significant increase in adoption of best practices for healthy eating, physical activity, reduced screen time, and breastfeeding support (Trust for America's Health, 2018). While these are process-level outcomes, intermediate and long-term outcomes rely on the effective implementation of policies and programs.

Government Standards, Ratings, or Guidelines

The public's ability to quickly and efficiently sort through all of the relevant evidence on a topic is limited. Tools to provide a snapshot of high-quality evidence and recommendations can help individuals make better choices about their health and healthcare. Some of these tools include government standards, guidelines, or ratings systems. In the realm of obesity prevention, the federal government provides a variety of

standards, guidelines, and rating systems to help the public make healthy choices related to nutrition and physical activity. For instance, the U.S. Department of Health and Human Services (HHS) established the Community Preventive Services Task Force in 1996 to develop guidance on community-based health promotion and disease prevention interventions (Community Preventive Services Task Force, n.d.). This independent, nonfederal panel combs through available scientific evidence on a variety of topics and publishes its recommendations in The Community Guide. Topic areas studied include cardiovascular disease, diabetes, nutrition, obesity, physical activity, tobacco, and excessive alcohol consumption, among others. Interventions and programs are given a rating ("insufficient evidence," "recommended against," or "recommended") to help guide public health practitioners, funders, and researchers in decision-making (Community Preventive Services Task Force, n.d.).

To promote a healthy diet and physical activity, HHS publishes guidelines for all Americans. Two sets of guidelines are published every five years: Dietary Guidelines for Americans and Physical Activity Guidelines for Americans (US Department of Health and Human Services, 2018). Dietary Guidelines for Americans provides evidence-based nutrition information and advice for people age two and older to help Americans make healthy choices about food and beverages in their daily lives. Physical Activity Guidelines for Americans aims to help Americans understand the types and amounts of physical activity that offer important health benefits. For instance, the second edition of the physical activity guidelines, published in October 2018, recommends the following physical activity benchmarks:

- **Adults:** 150 to 300 minutes a week of moderate-intensity aerobic activity, or 75 to 150 minutes a week of vigorous-intensity aerobic activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Preferably, aerobic activity would be spread throughout the week and would include muscle-strengthening activities of moderate or greater intensity involving all major muscle groups on two or more days a week.
- **Youth ages six to 15:** At least 60 minutes of physical activity per day, including aerobic, muscle-strengthening, and bone-strengthening activities.
- **Preschool youth ages three to five:** Physical activity throughout the day, through active play that includes a variety of activity types, to enhance growth and development.

Following changes to the National School Lunch Program and the School Breakfast Program that took effect in 2012, the USDA published a rule regarding certification of School Food Authorities (the administering unit for the operation of a school feeding program). The rule aims to encourage school compliance with the new standards, which improve the quality of meals consumed at school and encourage healthy eating habits (Federal Register, 2014). School food authorities that are in compliance with the new meal standards and ongoing monitoring receive an additional $0.06 for each reimbursable meal served (Federal Register, 2014). While the USDA developed the certification process and materials, state agencies are responsible for overseeing the certified school food authorities and collecting required documentation of program operations, including information on meal patterns and nutrient standards (Federal Register, 2014). This is an example of a regulation paired with standards.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

The examples of guidelines provided above barely touch the surface in terms of the breadth of individual- and systems-level standards and guidelines that may affect obesity. It is also

difficult to know which state government, local government, or community-based organizations reference or adopt specific guidelines. Individuals and organizations may choose to adopt one recommendation from an entire menu of options. Guidelines and standards are also regularly updated, sometimes annually. This makes them difficult to evaluate.

Dissemination of Information on New or Existing Policies and Services

While policy interventions are important, disseminating information to improve knowledge and adoption of those interventions among individuals and organizations is also important. This may include stories from the field or highlights of organizations that have successfully implemented a particular intervention. It may also include more general marketing and communications about new or existing policies or services. Communications campaigns can also engage and mobilize citizens to support or advocate for policy change or implementation.

Governments often share research results, briefing, meeting, or press conference minutes, and other digital media on their websites or via e-newsletters. They may also market specific programs or policies via television, newspaper, radio, subway stations, bus shelters, or other locations likely to reach their target audience. In the last decade, social media has increasingly been incorporated into government communication campaigns. Social media applications, such as Twitter, Facebook, and YouTube, allow rapid communication of information, particularly during public health crises and natural disasters.

EVIDENCE OF EFFECTIVENESS: ***Mixed/Inconclusive***

Evidence of mass media campaign effectiveness on nutrition and physical activity behavior change is mixed. Studies suggest that campaigns focused on a single factor (e.g., fruits, vegetables, salt), such as the "5 A Day" campaign, can improve individual diets (Afshin, et al., 2015). However, a review of mass media campaigns targeting adult obesity from 2000 to 2017 found that while most campaigns have an impact on knowledge and attitudes, evidence of behavior change is lacking (Kite, et al., 2018).

Evidence also indicates that mass media campaigns are effective for mobilizing advocates for policy change. The Voices for Healthy Kids campaign mobilized individuals to advocate for evidence-based legislation to address childhood obesity at the state level. The average number of bills related to childhood obesity per state increased by 6.6 (Bleich, Jones-Smith, Jones, O'Hara, & Rutkow, 2016). Further evaluation is needed to assess effectiveness of other digital communication channels, including social media. Researchers have found that government-run social media campaigns improve transparency and trust in government (Song & Lee, 2015).

Obesity Policy in Indiana

We conducted an environmental scan to determine whether and, if so, to what extent Indiana government agencies have adopted the policies described in this report. The tables below have been adapted from Trust for America's Health State of Obesity Report 2018 and the CDC's National Center for Chronic Disease Prevention and Health Promotion's Data, Trend, and Maps website to provide an easy-to-reference obesity prevention policy snapshot for the State of Indiana.

Indiana's Retail Sales Tax Policies

As highlighted in Table 5 below, soda is treated differently from groceries for sales tax purposes. Indiana has a general retail sales tax of 7%. However, "grocery" foods and food ingredients are exempt from such taxes. Grocery foods do not include tobacco, alcoholic beverages, candy, dietary supplements, heated prepared foods, and soft drinks. Soft drinks are defined as non-alcoholic beverages containing natural or artificial sweeteners. Milk, milk substitutes, and juices containing at least 50% vegetable or fruit juice are exempt.

Indiana's Subsidy and Grant Programs

A variety of subsidy and grant programs help offset the cost of healthy eating, physical activity, and overall health and wellness for Indiana residents. The following section highlights a sample of public financing mechanisms utilized throughout the state.

Healthy Eating Financing

In fiscal year 2017, federal Supplemental Nutrition Assistance Program (SNAP) dollars reached 672,000 Indiana residents or approximately 10% of the state population, with an average monthly SNAP benefit for each household member of $118. In fiscal year 2015, Indiana WIC served 154,485 residents each month at 138 WIC clinics across the state. In 2012, 11.7% of farmers' markets accepted SNAP benefits, and 40.6% accepted WIC Farmers' Market Nutrition Program benefits to purchase locally grown fruits and vegetables.

In 2016, a community development organization in Indianapolis received a federal Healthy Food Financing Initiative grant to expand an urban

Table 5. Potential Tax Policies for Obesity

Healthy Food Financing and Taxes	In Indiana?
Soda treated same as groceries for sales tax determination (2018)	
Soda treated differently than groceries for sales tax determination (2018)	√[c]

[c]Groceries exempt from sales tax

indoor farm called Food 365. The expansion, which is ongoing through September 2021, aims to increase production, distribution, and consumption of fresh, healthy, affordable food in Indiana (Health and Human Services, 2016).

Physical Activity Financing

Since 2006, the Indiana Department of Transportation has received federal funding to implement the Safe Routes to School program to fund infrastructure improvements and encourage, support, and enforce other non-infrastructure activities that include safe biking and walking to school for children in grades K to 8 (Indiana Department of Transportation, 2016).

As of October 2017, the state has utilized a portion of its federal Preventive Health and Health Services Block Grant funding to provide professional development and training for schoolteachers, early childhood care and education providers, and other community education agencies and partners with the goal of improving access to physical activity for adolescents (State of Indiana, 2018).

Public Health Insurance

Improving access to publicly funded health insurance (i.e., Medicaid, Medicare, and the Children's Health Insurance Program) is one mechanism for federal and state governments to support low- or no-cost obesity prevention initiatives. For instance, individuals insured through Medicaid are more likely than the uninsured to have at least one outpatient physician visit annually (Christopher, et al., 2016). These annual visits are an important tool for prevention and screening of obesity, diabetes, hypertension, and a host of other chronic diseases (Christopher, et al., 2016). Access to insurance coverage may also facilitate an individual's ability to treat or control chronic conditions. States have some flexibility in determining what the basic benefits package includes. For instance, following the implementation of the Patient Protection and Affordable Care Act, many states passed legislation requiring state-funded health plans to include coverage for interventions to address morbid obesity, such as bariatric surgery. Indiana requires some but not all of its publicly funded health plans to provide coverage for bariatric surgery (State of Indiana, 2018). However, even for patients with health insurance coverage, there are many barriers to accessing care and making dietary and lifestyle changes, including family responsibilities; work responsibilities; transportation barriers; provider-level barriers, including language, cultural, and religious barriers; and other financial barriers, such as out-of-pocket costs (Allen, Call, Beebe, McAlpine, & Johnson, 2017).

Indiana's Land and Zoning Policies

As of 2015, 26.2% of adults in Indiana lived within half a mile of a park. In 2016, a slightly higher percentage of parents reported that their children had access to parks, playgrounds, community centers, sidewalks, or walking paths in their neighborhood.

Table 6 highlights whether shared use policies are recommended or required. While the State of Indiana does not require schools to allow community access of recreation facilities outside of school hours, the Indiana Department of Natural Resources includes legal shared-use agreements as a recommendation in its Planning Guidelines for 5-Year Parks and Recreation Master Plans (Indiana Department of Natural Resources, 2016).

Table 7 highlights potential Complete Streets policies and whether such policies have been adopted in Indiana. The Indiana Department of Transportation has adopted a Complete Streets policy (Indiana Department of Transportation, n.d.). Over the years, the department has made improvements to sidewalks, crosswalks, traffic signal timing, pedestrian crossing signals, and access management strategies that align with the Complete Streets framework. However, the state has not allocated specific funding towards Complete Streets implementation. Local agencies are encouraged but not required to adopt Complete Streets policies that improve safety, can be achieved within existing budgets, and can add lasting value for the community.

Indiana's K–12 School Physical Activity Policies

Table 8 highlights potential policies to improve physical activity in schools and whether these policies are recommended or required by the state. In 2017, the Indiana Department of Education updated its Indiana Academic Standards for Physical Education to go into effect for the 2018 to 2019 school year (Indiana Department of Education, 2017). The standards closely align with national standards recommended by the Society of Health and Physical Educators in 2014. Indiana requires all high school students to complete two credits of physical education before graduation (Indiana Department of Education, 2016).

Table 6. Potential Shared Use Policies for Obesity

Shared Use Agreements (2018)	In Indiana?
State requires schools to allow community access to school recreational facilities outside of school hours	
State recommends cooperation in allowing community access to school recreational facilities outside of school hours	√
State does not have shared use policy	

Table 7. Potential Complete Streets Policies for Obesity

Complete Streets Policies and Intent for Action (2018)	In Indiana?
State provides guidance on policies for school districts or schools on walking or biking to or from school	
State's CSP includes mandatory requirements for clear actions that demonstrate intent to meet needs of all users	
State's CSP includes mandatory requirements, but does not have clear action or intent	√
State's CSP does not include mandatory requirements or has not adopted a CSP	

Table 8. Potential School Physical Activity Policies for Obesity

School Physical Activity Policy	In Indiana?
State requires at least 40 minutes of PE* per week in elementary school	
State requires at least 40 minutes of PE per week in middle school	
State requires at least 40 minutes of PE per week in high school	
State requires PE credits for high school graduation	√
State has recess requirements	√
State recommends recess	
State has general activity requirements	

The state requires daily physical activity in elementary school, which may include the use of recess. The state does not require a minimum number of minutes of physical education per week.

Indiana's K–12 School Nutrition Policies

Table 9 provides examples of nutrition policies that can be implemented in schools and the extent to which schools in Indiana have begun to implement such policies. As of 2016, 100% of school food authorities in Indiana have been certified as meeting the USDA's standards for the National School Lunch Program and the School Breakfast Program. However, the state does allow local school districts to submit applications for exemptions of fundraising events that do not meet the "smart snacks" rule. In Indiana, 90.8% of schools that participate in the National School Lunch Program also participate in the School Breakfast Program. Approximately 50% of students who receive free or reduced-price lunch also receive breakfast. Thirty percent of eligible school districts utilize the Community Eligibility Provision to offer meals to their students at no charge.

Indiana's Early Childhood Education Policies

Table 10 highlights potential obesity prevention policies that can be implemented in the early childhood education setting and the extent to which the State of Indiana has implemented such policies. There are more than 30 early childhood care and education degree programs in Indiana, including those at Indiana University, Ball State University, and Purdue University. Early childhood care and education providers are eligible for one of three types of licenses: instructional, administrative, or school services. During the 2016 to 2017 academic year, more

*Physical Education (PE)

Table 9. Potential School Nutrition Policies for Obesity

School Nutrition Policy	In Indiana?
Percent of secondary schools that allowed students to purchase soda pop or fruit drinks from one or more vending machines or at the school store, canteen, or snack bar (2016)	29.4
Percent of secondary schools that allowed students to purchase sports drinks from one or more vending machines or at the school store, canteen, or snack bar (2016)	43.7
Percent of eligible districts adopting the community eligibility provision take-up (2016-2017)	30
State policy allows one or more fundraising exemptions (2018)	√
Percent of School Food Authorities Certified (2016)	100
Free and Reduced Price (FRP) Students in School Breakfast Program per 100 FRP Students in National School Lunch Program (2016-2017)	51.6
School Breakfast Program Schools as % of National School Lunch Program Schools (2016-2017)	90.8

Table 10. Potential ECE Policies for Obesity

State Requirements for Licensed ECE Programs	In Indiana?
Have healthy eating policies	√LQ
Regulations align with national standards for avoiding sugar, including concentrated sweets such as candy, sodas, sweetened drinks, fruit nectars, and flavored milk (2016)	
Regulations align with national standards for serving fruits (2016)	
Regulations align with national standards for serving vegetables (2016)	
Allow/encourage breastfeeding	√L
Allow/encourage onsite breastfeeding	

Table 10. Potential ECE Policies for Obesity (cont.)

State Requirements for Licensed ECE Programs	In Indiana?
Have private space available for breastfeeding	
Have time for daily physical activity	√ LQ
Prohibit screen time for children under age two or sets limits	√ LQ
Make drinking water available to children	√L
Provide meals and snacks that meet general USDA and/or CACFP standards	

L=licensing regulations; Q=QRIS standards

than 38,000 licenses were granted by the Indiana Department of Education (Indiana Department of Education, 2018).

The Indiana Family and Social Services Administration's Office of Early Childhood and Out-of-School Learning provides oversight of the state's early childhood initiatives. The state requires licensed early childhood education programs to have healthy eating policies, allow or encourage breastfeeding, have time for daily physical activity, prohibit screen time for children under age two, and provide meals and snacks that meet USDA or Child and Adult Care Food Program standards (State of Indiana, 2014). In addition, many of these requirements are also incorporated into the state's quality rating and improvement system, Paths to Quality, which encourages child care providers to adopt evidence-based practices.

Indiana's Baby-Friendly Policies

Table 11 highlights potential Baby-Friendly policies and the extent to which hospitals within the State of Indiana have adopted such policies. While the state of Indiana does not have an official Baby-Friendly policy, it does encourage hospitals to seek designation. Supported by CDC funding, the state's Division of Nutrition and Physical Activity and the Indiana Perinatal Network recently supported a learning collaborative to provide technical assistance to seven hospitals seeking designation (State of Indiana, 2017). The CDC estimates that in Indiana in 2016, there were 4.7 International Board Certified Lactation Consultants (IBCLCs) per 1,000 live births, which is higher than the national average of 3.79.

Table 11. Potential Baby-Friendly Policies for Implementation

State Licensure and Accreditation	In Indiana
Number of hospitals with Baby-Friendly designation (2017)	17
Percentage of live births in Indiana that occur at facilities designated as Baby-Friendly by the Baby-Friendly Hospital Initiative (2018)	31.0
Number of IBCLCs per 1,000 live births (2016)	4.7

Conclusion

Obesity has serious consequences for the health, vitality, and economic future of Indiana and Marion County. Left unmitigated, obesity rates are likely to continue to rise, placing additional strain on individuals, healthcare settings, worksites, schools, and communities. The rise in obesity over the past several decades is not the result of changes to the gene pool or the failure of individuals; it is thought to be the result of changes to policies and environments, which, along with social determinants, influence our health behaviors. To effectively address obesity, we must address the root causes of obesity, as well as policies and environments that influence our health behaviors. Information alone is not likely to reduce obesity across a population; neither is a single policy, environmental change, or program. In order to be effective, solutions must be applied broadly and encompass all of the places where people live, work, learn, and play. No one organization will be able to reduce or prevent obesity alone; partners from all settings must be engaged. Solutions also must be applied for longer periods of time before we can expect to see results. The obesity epidemic did not arise in one, two, or even five years, and we cannot expect to see results across populations in a short period.

In this report, we identified potential solutions to address obesity in healthcare, worksites, schools, and communities, as well as policy solutions that address these settings. Interventions with the best or most consistent evidence for an effect on weight were rated as recommended; those are the strategies most likely to have an impact on weight status and should be considered first when deciding how to address obesity in a particular setting. Promising strategies have the potential to reduce obesity but are more likely to produce changes in behaviors related to obesity, such as dietary intake, physical activity, and time spent being sedentary. When comparing one approach to another, recommended and promising strategies are more likely to achieve behavior and weight change. We are still learning about interventions and policies that were rated as mixed or inconclusive. As the research community continues to test these interventions, we will glean more about their effectiveness or lack thereof. A rating of mixed or inconclusive does not mean these interventions or policies are definitely ineffective or without merit. Rather, there is a lack of clear and consistent evidence at this time. In fact, no strategies that we reviewed for this report had high-quality evidence that definitively proved they were ineffective. Importantly, for settings without recommended strategies, we should not wait until we have the best evidence possible to act. We must act on the best evidence available now.

Policy-based strategies that affect populations hold considerable promise, because they do not require individuals to opt in to an intervention and they affect large proportions of the population. Environmental strategies similarly have the potential to affect large groups and do not require signing up or joining anything, and some intervention types, such as encouraging employees to take the stairs, are simple and low in cost. It is challenging to compare the effectiveness of these types of changes that affect populations with the effectiveness of interventions, such as those in the healthcare setting, that affect individuals. Changes in behavior or weight that are too small to be clinically significant on an individual level may still be significant on a population level. It is important to make this distinction when reviewing the findings from this report.

In conclusion, there are effective interventions to address obesity in healthcare and worksite settings, and there are promising strategies to address

obesity through policy change and interventions in schools and communities. Implementing any one strategy alone may affect the weight or health behaviors of individuals or groups; however, it is unlikely to affect obesity rates on a population level unless there are population-level strategies used in addition to effective primary prevention and treatment solutions for individuals and groups. Since obesity has risen because of multiple influences and factors, effective solutions must similarly address obesity through multiple settings, strategies, and policies.

Recommendations

Based on our literature review and critical analysis of the literature, interviews with local and state leaders in Indiana, national experts in obesity, and our own conclusions about this process, we offer the following recommendations for the five key areas of focus for this report:

For Healthcare Providers and Institutions

- Follow best-practice guidelines for obesity and screen for obesity annually in children and adults.
- Offer high-intensity, in-person multicomponent interventions for overweight and obese children, adolescents, and adults and for pregnant women to prevent excess weight gain during pregnancy. Multicomponent interventions should address diet and physical activity and provide behavioral counseling. If in-person interventions are not feasible, technology-based approaches delivered using computers, online social networks, mobile text messaging, and apps are a promising alternative strategy, especially if combined with some in-person contact.
- Provide pharmaceutical options as an adjunct therapy to lifestyle-based interventions for adults and adolescents with severe obesity. Offer bariatric surgery options for severely obese adults.
- Birthing facilities should seek Baby-Friendly designation by implementing Ten Steps to Successful Breastfeeding and the International Code of Marketing of Breast-milk Substitutes.

For Employers

- Offer overweight or obese employees high-intensity, structured, lifestyle-based, multicomponent programs that address behavior change, nutrition, and physical activity. For worksites where cost is prohibitive, reach out to partners in the community, such as YMCAs and healthcare institutions, to identify whether there are cost-effective ways to partner to offer these services.
- To support a culture of health among employees and prevent the onset of obesity, consider encouraging healthy behaviors by offering active workstations to employees and offering multicomponent interventions to improve diet and reduce workplace sitting.

For K–12 Schools

- Ensure that schools have a high-quality PE* curriculum and that teachers receive training and equipment to implement the curriculum effectively.
- Engage elementary school–age children in more physical activity by offering active recess opportunities, such as structured games, equipment that supports physical activity, and playground markings.
- Modify the cafeteria environment to promote the healthiest options for students. Increasing

*Physical Education (PE)

the variety of healthy foods available, offering sliced fruit, using creative names for fruits and vegetables, and using character branding on fruits and vegetables are among the promising practices, as is training cafeteria staff to implement these strategies effectively.

- Implement multicomponent interventions that combine various strategies for improving nutrition and physical activity, such as offering nutrition education and PE, modifying the cafeteria environment, offering active recess, and creating organizational policies that support healthy eating and physical activity.

For Community Partners

- Engage the faith community in promoting healthy weight through high-intensity, multicomponent, lifestyle-based interventions that address nutrition and physical activity.
- Work with grocery stores to provide in-store interventions designed to improve sales of healthier items. Combine pricing strategies, including direct price discounts, vouchers, and subsidies for healthy foods with other components such as information (e.g., labeling) and increasing availability of healthy foods.
- To prevent obesity in the general population, consider implementing a variety of strategies that support active transportation, physical activity, and healthy eating in communities, early childhood care and education settings, afterschool programs, and colleges. It is unlikely that any one of these interventions will reduce obesity, but community settings can reinforce healthy behaviors and raise consciousness of healthy lifestyle behaviors to work toward culture changes around food and activity.

For Policymakers and Advocates

- Provide subsidies and grants to improve the built environment in ways that promote physical activity.
- Support nutrition and physical activity regulations in schools by providing tools and resources to implement policies effectively.
- Support professional licensing and credentialing regulations that assist practitioners in various settings to increase their knowledge of obesity and of effective strategies to prevent it in their respective settings, such as healthcare and early care and education.
- Provide information, training, and technical support to healthcare providers, teachers, and others who are implementing policies to ensure that the policies are implemented effectively.
- Advance land use requirements and zoning requirements that affect physical activity and nutrition behaviors of people in the community.

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Appendix A. Economic Analysis Data Sources and Methods

Methodology and the Value of Health Tool

We applied the best available research on the negative impacts of obesity on health, healthcare spending, and earnings to estimate the total economic burdens of obesity for Indiana and Marion County. We estimated these impacts for a single year (2017) and for the populations living in Indiana and Marion County at that time. The economic impacts were calculated as the costs of obesity in health, healthcare spending, and earnings relative to the same population if everyone were of healthy weight over a single year. This economic burden represents the increased costs of obesity and lost potential economic output relative to a population that hypothetically had an obesity prevalence rate of 0%. This economic burden calculation also represents the best estimate of the hypothetical "potential benefits" of eliminating obesity: If an intervention were capable of helping all members of the population achieve a healthy weight, the total cost estimates would be the expected gains achieved.

The "effect sizes" or magnitudes of impacts on obesity were estimated by using previously curated research findings from the academic literature and focusing on impacts on healthcare costs, premature mortality costs, and the labor market, including increased presentism and absenteeism for employed obese individuals. Details on these data sources are discussed below.

The costs measured are all expected to accrue within the year measured (i.e., excess healthcare costs include excess spending only during 2017), with the exception of the costs of premature mortality. Where the model estimated lost future earnings as a result of a premature death due to an increased risk from obesity, we included the total future lifetime earnings and healthcare costs for that individual, discounted at a 3% rate. The economic burden was calculated as an annual cost; therefore, assuming obesity prevalence, health and earnings impacts, and other economic data remain mostly constant, these costs would be expected to continue each year into the near future.

After calculating the economic impacts by type of cost burden, we apportioned those costs by expected payer. For example, increased healthcare costs were apportioned based on the percentage of healthcare expenditures expected to be paid by private insurance, Medicare, Medicaid, and other payers across the relevant age categories. Medicare, Medicaid, and other insurance expenses were allocated to the relevant federal and state government stakeholders, while private insurance costs were expected to be paid by households and the private sector. Earnings impacts were apportioned across households, the federal government, and state/local governments based on marginal tax rates for Indiana residents from federal, state, and local governments. The combined economic impacts in 2017 for the State of Indiana are shown in Figure 11, the first chart showing the burden by type of cost and the second showing the burden by payer.

We calculated these impacts in constant dollars by using the most detailed available data on obesity prevalence, healthcare costs, earnings, and other economic factors for Marion County and Indiana. Wherever possible, county- and state-specific data were applied to the analysis; however, in some cases, estimates of state- and county-level data were used by applying adjustment factors to data from a larger geographic area (such as national data). The economic calculations began with a set

of baseline characteristics for the population in Marion County and Indiana and then estimated the percentage impacts of obesity on key economic outcomes by applying research from previous academic studies.

The economic cost estimates were computed by using the Altarum Value of Health model (Altarum Institute, 2014) and computation tool to synthesize data on the economic and health impacts of particular public health conditions, policies, and interventions to estimate the economic impacts for a population through changes in health, healthcare spending, earnings, morbidity and mortality, and government spending. These costs were calculated based on estimates of "life paths" for individuals who had a health condition or who were receiving an intervention by modeling how their health and earnings trajectories changed over time. In this implementation, we used the tool to estimate the impacts of obesity over a single year for the populations of the State of Indiana and Marion County.

Obesity Prevalence

We estimated the prevalence of obesity for Indiana and Marion County from the CDC BRFSS data (Centers for Disease Control and Prevention, 2017a). These data on the percentage of adults age 18 and older who had obesity in the State of Indiana in 2017 are available, along with detailed age group breakdowns for 2016. We applied the age-specific data from 2016, adjusted to match the 2017 rates, by multiplying the 2016 data by the ratio of the 2017 state totals to the 2016 state totals. The results of the calculations are shown in Table 12. For Marion County, we applied the data from the CDC's 500 Cities Project: Local Data for Better Health, which estimates obesity rates for cities in 2015, using the BRFSS microdata. We adjusted the data from 2015 to 2017, using the ratios of the State of Indiana BRFSS data as we did for the state data as shown in Table 13.

The BRFSS survey is an annually conducted survey that contains self-reported responses to a variety of health and health-related questions. The BRFSS data allow for estimates of obesity to be derived by age category, sex, race, or income; however, estimates across multiple categories cannot be identified due to the sample size of the BRFSS survey. We therefore apply the prevalence by age category statistics, as age is the most important factor for our modeling in estimating earnings, health care costs, and other economic outcomes. Obesity rates for children were taken from separate CDC surveys of high school students (Centers for Disease Control and Prevention, 2015b) and for young children (Pan, et al., 2016).

The rates for 2017 were estimated by using the final reported data for 2016 by age, with each adjusted upward slightly based on preliminary data from the CDC, which has shown that, on average, the obesity prevalence has increased in the State of Indiana. This method assumes that the increased prevalence of obesity was evenly distributed across all age categories.

Population Estimates

We estimated the 2017 population of Indiana and Marion County by using the U.S. Census state and county population total estimates (United States Census Bureau, n.d.). For the State of Indiana, we used the population data by single-year of age for children and adults under age 85. For adults above age 85, we applied the national distribution of those between ages 85 and 100 to the total Indiana population above age 85. For Marion County, the only population estimates available for 2017 were for five-year age groups. To estimate single-year ages, we fit a cubic spline to the five-year age groups to estimate single-year ages and again apply the national distribution for those above age 85. We then rescaled each five-year age group to ensure the totals match the U.S. Census data.

Table 12. State of Indiana Obesity Prevalence

Age	2017 Indiana Obesity Rate Estimate	Estimated Number of People Affected
0-17	15.1%	239,109
18-24	18.2%	119,705
25-34	33.5%	291,020
35-44	36.2%	295,548
45-54	40.7%	348,050
55-64	38.8%	337,528
65+	31.6%	324,231
Total		1,955,191

Table 13. Marion County Obesity Prevalence

Age	2017 Marion County Obesity Rate Estimate	Estimated Number of People Affected
0-17	16.6%	37,265
18-24	19.5%	22,334
25-34	35.9%	49,853
35-44	38.7%	43,583
45-54	43.6%	53,965
55-64	41.5%	47,544
65+	33.9%	39,601
Total		294,146

Productivity Cost Estimates

The two productivity costs of obesity, absenteeism (sick days and days of missed work) and presenteeism (lost productivity while at work), were estimated by using previous literature that analyzed survey data of employees across different BMI categories. The research calculated the expected increase in sick days and lost productivity while at work of an obese worker relative to a healthy weight worker while controlling for other possible confounding characteristics. Ricci and Chee (Ricci, 2005) and Finkelstein and colleagues (Finkelstein E. D., 2010) had the two papers that were applied to the data to estimate these costs. These papers estimated lost productivity and earnings in dollars per employee, which we converted to percentages of wages by using median incomes. The resulting effects incorporated into the model were 2.8% lost potential earnings due to presenteeism and 1.1% lost potential earnings due to absenteeism.

Data on baseline average earnings by age for the State of Indiana were computed from the American Community Survey microdata (United States Census Bureau, n.d.). We estimated the earnings for Marion County residents by applying the ratio of the median of Marion County earnings to the entire State of Indiana for each age year. In order to estimate the impacts of obesity, we applied the findings on absenteeism and presenteeism costs from the above two studies. We estimated the impact of absenteeism and presenteeism as percentage impacts on wages, based on the median wage at the time of publication of the two papers.

Additional research has looked at wage impacts of obesity by comparing the wage and earnings of obese to non-obese workers while controlling for other factors. This research differed from the studies applied to the modeling mentioned above in that, instead of analyzing productivity loss in terms of missed work, the researchers measured the difference in reported wages and earnings for obese and non-obese individuals. The difference in these reported wages likely included two distinct factors: (1) lower wages as a result of less productivity for obese workers and (2) lower wages as a result of discrimination by employers against obese workers, above and beyond productivity losses. The results of these analyses varied significantly, but a recent review article estimated that the wage differences (including discrimination) for women were 6% lower while obese men's wages were not statistically different from non-obese men's wages. We did not use these data in its modeling estimates, because discrimination, while a true cost to workers in lost wages, does not represent lost economic output like the missed workdays due to absenteeism and presenteeism above. If we did choose to include the 6% lost wages in the net of the productivity losses, women in Indiana would be expected to receive $387 million less in earnings relative to a completely non-obese population.

Healthcare Cost Estimates

We estimated the baseline healthcare cost expenditures by age from the Medical Expenditure Panel Survey (Agency for Healthcare Research and Quality, n.d.) data for the United States. We produced an estimate for healthcare spending in the State of Indiana by applying the state-level estimates of total healthcare spending from the CMS state health expenditure accounts (Centers for Medicare & Medicaid Services, 2017) by resident location, after adjusting for the unique age distribution of each state. To estimate the baseline healthcare cost data for Marion County, we adjusted the State of Indiana estimates by the data on average spending per county from the county health rankings and Dartmouth Atlas (University of Wisconsin Population Health Institute, 2018).

Increased healthcare cost estimates were derived from a study conducted by the Congressional Budget Office, which found that obese individuals average healthcare costs that are 38% higher than those of healthy weight individuals, but only 75% of this cost difference could be directly attributed to obesity-related health conditions. Therefore, we applied an effect size of 28.5% to the obese population relative to the healthy weight population. The total excess healthcare spending for the obese population therefore rose as the age of the individual increased, because total baseline healthcare spending also increases with age. This effect size is similar to the findings from other recently published work, which found that of all healthcare costs, 28.2% was attributable to obesity.

Premature Mortality Cost Estimates

The costs of premature mortality measured the expected lost future earnings of an individual when a premature death was attributable to an obesity-related health condition. We then estimated the value of lost potential future earnings and averted healthcare costs for the remaining lost life-years of those individuals. While the prior two cost categories looked at the expected costs for the obese population that would occur within the year 2017, the calculation of costs of premature mortality included future costs, because premature death would lead to economic costs otherwise uncounted in future years. In order to combine future economic costs with those borne in 2017, we discounted all future benefits at a rate of 3% per year.

We applied CDC data on multiple causes of death (Centers for Disease Control and Prevention, 2017c) from 2016 to estimate the 2017 mortality statistics. These data reported by age the numbers of deaths by any cause and the rates of deaths per age in the State of Indiana and Marion County. We applied the rates of death per age to the population statistics above in our modeling. Where the population data were censored, we used population data from above to compute an estimated rate. For Marion County, where the number of deaths were censored (if there were fewer than 10 deaths for any age in the year), we applied the statistics for the State of Indiana for that age year.

The estimates for the negative impacts of obesity on mortality were computed from the Borrell and Samuel data (Borrell & Samuel, 2014). We estimated expected mortality adjustments for obese versus non-obese persons in the age ranges of 18 to 29, 30 to 44, and 45 to 64. The data indicated no expected increased risks of mortality for obese individuals under age 18 or over age 65.

Appendix B. Key Informants

We would like to thank the following individuals for participating in key informant interviews to inform this literature review and report. These individuals graciously shared their time, experience, and knowledge in working on obesity at the local, state, and national levels. Key informant interviews were conducted between August 2018 and December 2018. This acknowledgment in no way is meant to indicate an endorsement of this report, and contents of the report may not reflect the thoughts and opinions of our key informants.

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Appendix C. Literature Review Methods

Criteria for Considering Studies for this Review

Types of Studies

We included the following study types: systematic reviews, meta-analyses, randomized controlled trials, non-randomized controlled trials, quasi-experimental studies, cohort studies, cross-sectional studies, case-control studies, impact and outcome evaluations, cost analyses, and policy analyses. We considered a review "systematic" if it was indicated as such by the authors.

Types of Populations

While there was no restriction on population types eligible for inclusion, we sought evidence of impacts on obesity in children and adults throughout the following lifecycle stages: before conception (women of reproductive age), prenatal (pregnant women), early childhood (ages 0 to five), childhood (ages six to 11), adolescence (ages 12 to 18), adult (age 18 and up), and older adult (age 50 and up). We also sought interventions aimed at the family unit (parents/caregivers and children).

Types of Settings

While there was no restriction on the setting of interventions, each intervention was categorized as being implemented by using one of four focal groups that were selected by the Richard M. Fairbanks Foundation: employers, healthcare, community, and government.

Types of Outcomes

Our primary outcomes included: weight, obesity and overweight, waist circumference, and body mass index (BMI).

Secondary outcomes included: changes in nutrition and physical activity behaviors associated with obesity.

Table 14. Implementation Levers and Settings

Focal Group	Settings Included
Employers	Worksites
Healthcare	Hospitals, primary care clinics, specialty care clinics, nursing homes, or through home health providers or lay health workers
Community	Schools, before/afterschool programs, summer school programs, child care centers, day care homes, restaurants, places of worship, food banks, food pantries, grocers, food manufacturers, parks, trails, farmers markets, gardens, transportation, urban design, environmental policies
Government	Federal, state, or local laws (taxes, regulation, subsidies, grants, rating or certification) or policies implemented by non-governmental organizations

While we did not specifically search for interventions primarily targeting other health outcomes (e.g., stress reduction, cholesterol levels, cardiovascular disease risk), if those articles were included in a systematic review and a secondary impact on the above primary or secondary outcomes was noted, they were included as part of the overarching evidence for that intervention.

Search Strategy

Several electronic databases—EBSCO, PubMed, and Google Scholar—were searched for eligible systematic reviews published between January 2008 and July 2018. Articles meeting our inclusion criteria and published after July 2018 were also eligible. Searches were limited to articles in English.

Two reviewers independently carried out the literature search. Attempts to obtain articles from other sources were made by hand-searching for references of the included articles, as well as by contacting experts in the field. Additional hand searches were conducted based on the information obtained.

Data Extraction

Four reviewers performed data extraction by using a standardized table. Data were extracted from systematic reviews and meta-analyses first. If reviewers identified a gap in the level of evidence for a particular intervention type, data from additional individual articles were extracted.

Data extracted included: citations, abstracts, study designs, lifecycle stages, implementation levers, prevention focuses (primary, secondary, or tertiary), descriptions of the interventions, primary outcomes, primary findings, and limitations. If available in the review, the following data were also extracted: geographic areas (city, state, or country), the durations of the interventions (days, weeks, months, or years), sample sizes, ages (medians or ranges), and male-to-female ratios.

Quality Assessment of the Reviews

If data were originally assessed by the authors of the included reviews,we extracted the data with respect to the methodological quality of studies included. However, we did not perform a formal judgment of this assessment. When formulating our conclusions, we took into account both the quality of the review and the overall quality of evidence across all included studies.