Asthma is a common chronic inflammatory condition in adults and youth. It’s a heterogeneous disease with variability in characteristics among individuals, such as BMI, waist circumference, lung function, inflammation markers, responsiveness to medications, and other symptoms. Being overweight or obese increases the risk of many diseases and health conditions including hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems, and some cancers. The Centers for Disease Control and Prevention (CDC) recently added asthma to the latter list of conditions.\(^1\) Some researchers, however, instead believe that having asthma leads to behaviors that promote weight gain. The relationship between excess weight and asthma, then, may work in both directions, but the underlying mechanisms remain unknown. Regardless of the cause of asthma, obese adults and youth often are less responsive to standard treatments to control symptoms and manage the underlying inflammatory process.

Potential dietary factors that may influence asthma development and control—including the intake of antioxidants, omega-3 fatty acids, fish oil supplements, selenium, and vitamins C, D, and E—as well as the role of breast-feeding and the diet of lactating women, and the presence of gastroesophageal reflux disease (GERD) are beyond the scope of this course.\(^2\) Their potential role will be recognized briefly in the discussion of finding the appropriate eating approach for adults and children who have asthma and are overweight or obese.

This continuing education course discusses the observed links between obesity and asthma and examines the potential impact of weight loss on asthma control in adults and youth.

**Prevalence of Asthma**

Asthma is a chronic inflammatory lung disease that causes wheezing, breathlessness, chest tightness, and coughing in response to multiple potential triggers. It’s one of the most common chronic conditions in the world, with 1 in 12 adults and 1 in 11 children diagnosed with asthma.

The CDC reported that in 2014, 7.7% of adults and 8.6% of children in the United States had asthma.\(^1\) In adulthood, females were more likely than males to have asthma, but not in youth. Asthma has been increasing in prevalence over the past several decades in parallel with increasing obesity rates. The rate of asthma among children peaked in 2009 at close to 10% and appears to have leveled, but it’s unknown whether that’s connected to the leveling rates of childhood obesity that also have been observed. It appears that children who are overweight or obese have an increased risk of asthma, but the prevalence of asthma results from an
interplay of complex factors. In addition, asthma is observed more in blacks (9.9%) than whites (7.4%) or Hispanics (5.9%), but the rates among non-Hispanic black children are leveling as well.\(^3\) More data are needed to determine whether asthma prevalence among children will continue to decline or remain at about current levels.

The Asthma Attack

Acute narrowing of the airways, or an asthma attack, can be mild, moderate, serious, or potentially life threatening. Allergic and nonallergic irritants typically trigger an attack, such as air pollution; airway infections; allergens such as cockroach exposure, dust mites, mold, animal dander, and pollen; exercise; and tobacco smoke. It’s estimated that about 2% of people with asthma have food allergies. Some adults and children report that their asthma attacks are triggered by certain foods or sulfites found in foods and beverages such as red wine, beer, and dehydrated soups, although the direct evidence is limited.\(^4,5\) The reactions are both muscular and mucus producing. When the lining of the airways of individuals who are sensitive to allergens or irritants becomes inflamed, the muscles around the airways may spasm, the airways narrow further, and muscles can get tight. The lining of the inflamed airway becomes edematous, or swollen, and produces mucous that blocks the flow of air and causes significant difficulty breathing. Individuals with diagnosed asthma often use a peak flow meter—a handheld device to measure peak expiratory flow rate, or how quickly a person can exhale—to determine the severity of the asthma exacerbation. A peak flow that keeps dropping despite treatment or falls below 50% of the individual’s best rate is a sign of an emergency. All individuals establish their “personal best” by measuring their peak flow twice per day for a period of two to three weeks. Measurement is taken in the morning upon awakening and again in the late afternoon. Peak flow also may be measured 15 to 20 minutes after taking asthma medicine.

Diagnosing Asthma

When a patient first presents with asthma, the severity of the asthma is assessed using patient history, physical examination, and objective tests. This assessment guides decisions about therapeutic interventions, including appropriate medication and therapy for asthma control.

In 2007, the National Asthma Education and Prevention Program issued clinical guidelines for the diagnosis and management of asthma that are widely followed in the United States today.\(^6\)

The asthma diagnosis is primarily based on history of breathing problems (especially after physical activity), night coughing, chest tightness, colds lasting longer than 10 days, family history of allergies or asthma, and school or work absences due to breathing problems. The gold standard for diagnosing asthma is called spirometry, typically an office procedure that measures how much and how quickly air is exhaled. The asthma guidelines use forced expiratory volume (FEV) and forced vital capacity (FVC) to classify impairment and asthma severity. The FEV1 is the maximal amount of air an individual can forcefully exhale in one second. Normally, 80% or more of full exhalation (ie, FVC) is expelled in the first second of exhalation. If there’s obstruction, the individual can’t forcefully exhale quickly. Peak flow readings and spirometry can be used to monitor the effectiveness of a medication or combination of medications given to asthma patients. The peak flow is an inexpensive test, but it’s typically less sensitive in detecting mild changes when compared with FEV1. Peak flow
readings of the amount of air an individual can blow out in one fast, hard blast are obtained using a peak flow meter. These numbers are used to develop and monitor an asthma action plan. It’s not the actual value from one test but the change in numbers from a “personal best” that’s important for monitoring. The significance of a peak flow measurement depends on the zones into which one’s value falls. The green zone ranges from 80% to 100% of personal best and indicates asthma is under control. The yellow zone, from 50% to 80%, signals that asthma is getting worse. A value in the red zone, below 50%, signals an emergency.

**Standard Treatments**

The Global Initiative for Asthma, launched in 1993 in collaboration with the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health and the World Health Organization, outlined a step approach for the management of intermittent and persistent asthma in children, teens, and adults. The components of asthma management that the NHLBI recommends include patient education, control of environmental factors through the identification and avoidance of triggers, management of comorbidities, and pharmacologic therapy, which is individualized for patients’ needs. Individuals with optimal self-management, which involves self-monitoring of symptoms and/or peak flow and following a written asthma action plan, experience fewer hospitalizations and emergency department visits for asthma.

Pharmacologic therapy typically involves the use of controller medications (inhaled corticosteroid receptor antagonists and oral leukotriene receptor antagonists) that prevent asthma attacks and also quick-relief or rescue medications (short-acting beta-agonists). The medicine can be delivered in several different ways such as with inhalers and nebulizers or breathing machines. Injected anti-IgE antibody medication also may be used for patients with more severe asthma.

Some patients are interested in herbal medicines that have been traditionally used in China and India such as *Tylophora indica* and *Boswellia serrata*. Most of the studies conducted on these herbal medicines were done between 1970 and 1990, and evidence of safety and efficacy is lacking.

**Which Comes First, Obesity or Asthma?**

Obesity can have a significant impact on asthma risk and may cause more frequent and severe asthma symptoms, lower quality of life, and the need for increased doses of medication, increasing frequency of rescue medication, and greater health care use.

Patients with asthma generally weigh more than patients without asthma. The CDC reported in 2010 that the obesity rate among adults with asthma (38.8%) was significantly higher than that among adults without asthma (26.8%). And while the rates varied by states, in all but eight states the rate of obese adults with asthma was higher than that of nonobese adults with asthma. Other data suggest that obesity precedes asthma by as long as five years. Obese youth participating in the National Health and Nutrition Examination Survey III were 68% more likely to have asthma than were nonobese participants. This surprises many older health care professionals who, because obesity was once thought to protect against asthma development, expect to see asthma in thin, rather than overweight, children.
The increased risk of asthma with weight gain has been observed in other countries as well. For example, a 2004 report from Norway showed asthma risk increased in men by 10% for each unit of increased BMI between 25 and 30. For women, the increase was 7% starting at a BMI of 22.10

Some experts believe asthma precedes obesity. Ali and Urik concluded that "obesity is associated with a unique asthma phenotype characterized by more severe disease and with variable response to conventional asthma therapies."12 Other experts suggest that asthma is responsible for an increased risk of weight gain, especially in children. At least one researcher believes that the obesity and asthma link is due to a diet of high caloric and low antioxidant content. Children with asthma are observed to avoid exercise, increase sedentary time, and use medications that boost appetite.13

As stated earlier, the basis for the association between obesity and asthma is unknown; however, a variety of pathways, including mechanical, immunological, genetic, epigenetic, hormonal, and environmental, have been proposed.12,14 While the possible mechanisms remain controversial, that obesity complicates the diagnosis and management of asthma generally is accepted, though not universally recognized.15

**Response to Medication**

Obese adults with asthma don’t always respond as normal-weight patients do to standard controller therapy, possibly due to greater oxidative stress and systemic inflammation.12,16 Patients’ BMI influences their odds of achieving good asthma control with inhaled corticosteroids and/or long-acting beta-agonist therapy. Improved delivery of inhaled medications may be accomplished by the use of an aero chamber attached to the metered dose inhaler.17 At this time, however, no change in asthma management guidelines for obese patients has been issued, as the optimal pharmacological treatment for these individuals is unknown.

Short-term side effects of long-term systemic corticosteroid treatment for obese and nonobese patients may include increased appetite leading to greater food intake, weight gain, and fluid retention. Some individuals experience redistribution of body fat, which results in moon face, buffalo hump, and truncal obesity. Since one side effect of inhaled corticosteroids is a decrease in bone density in the hip and trochanter, vitamin D (already expected to be low in obese individuals), calcium supplementation, and exercise usually are recommended.

**Weight Loss and Asthma Control**

The first studies exploring whether weight loss in adults could positively affect asthma were published in the early 1990s, when researchers looked at individuals who lost weight quickly after bariatric surgery and observed an improvement in asthma. A decade later, researchers found that the improvement in asthma wasn’t necessarily a consequence of surgery, because they also observed that individuals who lost weight through the more conventional approach of diet and exercise also experienced an improvement in asthma.18

In preparing the 2007 asthma guidelines, the expert committee of the National Asthma Education and Prevention Program conducted a rigorous systematic review of the published
medical literature to ensure that the guidelines reflected the latest scientific advances. The 2007 guidelines included the recommendation that clinicians evaluate patients for the presence of chronic comorbid conditions such as obesity when their asthma can’t be well controlled. It assigned a “B” level of evidence for treating obesity, recognizing further study was warranted.6

Weight management is recommended in the Global Initiative for Asthma Guidelines.7 However, the authors of a 2012 Cochrane systematic review concluded that the quality of available evidence was low, and the benefit of weight loss as an intervention for asthma control in adults remains uncertain.19 Juel and colleagues also reviewed published studies to determine whether weight loss improved asthma control.20 While the total number of studies and number of participants are small, four who lost weight through caloric restriction and 10 by a surgical procedure reported improvement in symptoms, control, or both. The reported weight loss from caloric restriction ranged from 8% to 14.6%. Three of the studies reviewed tested a supervised, eight-week, very low-calorie diet, and the other used an alternate-day caloric restriction. Better results were seen with the very low-calorie diet. Unfortunately, different clinical measures were used in these studies, making it difficult to compare the impact on asthma symptoms and control. One study stated there was improvement in pulmonary mechanics and better control of airway obstruction. Another suggested that weight loss improved respiratory function independent of the severity of airway responsiveness. Another study demonstrated that weight gain was related to worse asthma-related responsiveness.20 Although alternate-day or intermittent fasting had been considered by many as a fad approach to weight loss, it’s now receiving serious study as a potential option for achieving weight loss and maintenance.21 However, the optimal frequency and duration for fasting is unknown, and some researchers suggest there’s insufficient evidence to recommend its use.22

A systematic review published in 2015 included an additional three studies of adults who lost weight through nonsurgical means, including the largest randomized trial to date—the Breathe Easier through Weight Loss Lifestyle (BE WELL) intervention study.14,23 The authors concluded that while evidence shows promise of improved asthma control with weight loss, definitive data are needed to guide clinical and public health practice.

In another systematic review, the authors indicated that bariatric surgery in obese patients with asthma was responsible for some improvement in asthma severity, dyspnea, exercise tolerance, and acute exacerbations of asthma as well as reduced use of pharmacotherapy in participants with weight loss.20

Putting It Into Practice
While researchers continue to study weight loss for asthma control, dietitians may find it useful to review the strategies used in the most recent studies.

Johnson and colleagues enrolled 10 obese adults in an eight-week trial. Participants were instructed to eat whatever they normally ate to the point of satisfaction without overeating and to consume a meal replacement shake (320 kcal for women and 380 kcal for men) on alternate days. Nine adults adhered to instructions and lost an average of 8% of their initial weight. Their asthma-related symptoms, control, and quality of life measures improved significantly within
three to four weeks with weight loss of 4% of baseline. The researchers hypothesize that adults may be able to adhere to a pattern of eating that consisted of repeating cycles of about 36 hours of very low-calorie intake with 12-hour periods of ad lib eating.\textsuperscript{24}

Dias-Júnior and colleagues enrolled 22 obese adults in a program of reduced caloric intake, use of prescription sibutramine and orlistat, and behavior modification.\textsuperscript{25} (Sibutramine was removed from the market in 2010 due to potential increased risk of stroke and cardiovascular disease.) Twelve of the 22 patients achieved a weight loss goal of greater than 10% of baseline body weight over a six-month period and experienced clinically significant improvements, such as an increase in symptom-free days, less use of rescue medication, fewer visits to the emergency department, increased FVC, and improved scores on the Asthma Control Questionnaire, which is widely used to measure the adequacy of asthma control and change in asthma control that occurs either spontaneously or as a result of treatment.\textsuperscript{26}

Scott and colleagues suggest that a weight loss goal of 5% to 10% is needed to improve lung function, asthma control, and quality of life.\textsuperscript{27,28} They enrolled 46 overweight/obese adults in a 10-week program of caloric restriction, exercise, or both. The diet contained 885 kcal to 1,170 kcal per day, including two liquid meal replacements, a regular meal, and snack. Participants received nutrition education and behavior modification counseling during weekly visits with a diettian and short phone calls. They were asked to keep food diaries. The exercise plan included a 12-week gym membership with weekly group personal training. In addition to working out at the gym three times per week, participants were instructed to increase their steps by 10% weekly, with the goal of reaching 10,000 steps per day. About 83% of the participants were retained. Those who achieved the 5% to 10% weight loss from baseline had significant improvement in FVC, quality of life, and asthma control. Interestingly, weight loss in excess of 10% didn’t confer additional benefit.

Pakhale and colleagues enrolled 16 adults with a BMI greater than 32.5 and severe asthma in a three-month behavioral weight reduction program that included three daily meal replacement supplements of 300 kcal each.\textsuperscript{29} These adults participated in weekly group sessions with presentations by nutritionists, behavior therapists, and exercise specialists. The mean weight loss was 14.2% ± 7.9% from baseline, and they experienced normalization or improvements in airway hyperresponsiveness, lung function, asthma control, and quality of life.

The BE WELL study enrolled 165 obese adults with uncontrolled asthma in a 12-month comprehensive lifestyle intervention program adapted from the Diabetes Prevention Program trial.\textsuperscript{14} A standard curriculum was used for the 12 weekly in-person group sessions over the first four months, then two monthly in-person individual sessions, and then three bimonthly or more frequent phone consultations depending on the individual’s needs, preferences, and availability. The target caloric reduction was usually 500 kcal to 1,000 kcal per day, but participants were instructed not to consume fewer than 1,200 kcal per day. The physical activity goal was at least 150 minutes per week of moderate intensity. The mean weight loss achieved at six months was 5% of baseline and at 12 months 4.1%. At 12 months, 38.7%, 33.3%, and 25.3% of the participants achieved 5%, 7%, and 10% or greater weight loss, respectively. Those who experienced greater than 10% weight loss had the most improvement
in quality of life measures. While participants had improvement in cardiometabolic risk factors, there was no significant benefit for asthma control. In this study, the researchers suggest that weight loss of 10% or more may be needed for clinically meaningful improvement in asthma. Importantly, none of the participants’ asthma worsened; therefore, this type of intervention can be considered safe.

**Strategies for Children and Teens**

Lang concluded after reviewing studies of obese children with asthma that weight loss strategies that include “increased exercise, reduced calories particularly from processed fast foods and a focus on fish, fruits, and vegetables” could be useful.\(^{30}\) Lv and colleagues included other randomized controlled trials of obese children and adolescents in their review and concluded “modest calorie reductions alone or combined with increased physical activity, or even a healthy normocaloric diet, may lead to improved asthma outcomes.” They call for more definitive data to guide practice.\(^{23}\)

van Leeuwen and colleagues enrolled 20 overweight children aged 8 to 18 (mean age 16 years), mostly boys, in a six-week trial. They had a mean weight loss of 2.6% + 2.9%. Few details were given in the report other than they used three age-specific diets written by a dietitian. Participants were asked to use a nutrition chart to plan three meals per day, normalize portion sizes, and consume a maximum of two snacks.\(^{31}\)

Fifteen individuals with a mean age of 11.7 participated in a 10-week study that included nutrition education focusing on healthful eating, reduced portion sizes, and goal setting. Most of the participants were boys and ranged in age from 8 to 17.\(^{32}\) Each had an individualized diet plan with a 500-kcal reduction planned with a dietitian they met with seven times in person and spoke with three times on the phone. They lost an average of 7.5 lbs, while controls lost 2.9 lbs. The children who received the intervention had clinically important changes in BMI z-scores and improvement in asthma outcomes, although not statistically significant when compared with controls. As children change in height with time, a change in the BMI z-score or standard deviation often is used rather than a change in the BMI percentile in the clinical setting to accurately reflect improvement in weight for children who are considered overweight based on BMI percentile.

da Silva and colleagues randomized 26 postpubertal obese 15- to 19-year-old youths with asthma to a year-long study of weekly education, exercise, and medication or to an educational control group.\(^{33}\) Interdisciplinary therapy three times per week resulted in improved inflammatory biomarker profiles and lung function. In a separate study, the researchers also enrolled 55 adolescents in a year-long program with weekly nutrition lessons (eg, the food pyramid, food record, weight loss diets, diet and light concepts, fat and cholesterol, and eating disorders); 35 teens completed the study. The teens without asthma lost 26.4 ± 8.8 lbs. The teens with asthma lost 33.1 ± 8 lbs.

The most successful nonsurgical approach in adults has been the use of very low-calorie diets. Since there’s concern that very low-calorie diets may affect growth in youth, Luna-Pech and colleagues didn’t put the obese teens they studied on a reduced-calorie plan.\(^{34}\) They enrolled 26 pubertal obese teens in a 28-week program comprised of a health-promoting diet designed
to be 10% to 15% protein, 50% to 60% carbohydrates (with no more than 10% from refined carbohydrates), and 25% to 30% fat (with less than 10% from saturated fat). Each teen’s calorie needs were calculated and distributed over breakfast (25%), lunch (30%), snack (15% to 20%), and dinner (25% to 30%). In biweekly visits with a nutritionist, the teens’ daily food recalls were reviewed and adjusted. Suggestions for use of nonnutritive sweeteners and free consumption of water were given. A significant decline in BMI z-scores compared with those of 25 teens who had no dietary intervention was observed. Those with a supervised diet program had improved quality of life and some aspects of asthma control.

**Takeaway Message for RDs**
The National Asthma Education and Prevention Program treatment guidelines, which haven’t been updated since 2007, mention weight loss only as a strategy to manage the comorbid condition of obesity. But researchers since that time have concluded that weight loss in obese adults and children has the potential to improve quality of life and asthma control. No published studies have reported asthma symptoms worsening with weight loss.

As stated earlier, of the nonsurgical approaches to weight loss in obese adults with asthma, the use of very low-calorie diets has produced the best improvement in asthma control. While one study noted improvement occurred with a 3% to 4% weight loss from baseline, other researchers suggest a 10% loss is needed for improvement. There’s evidence that partial meal replacement plans can help adults achieve a clinically significant weight loss and that patients achieve better outcomes when RDs lead the programs. The recent randomized trial using a protocol adapted from the landmark Diabetes Prevention Program described earlier found the best impact on asthma quality of life was observed with a weight loss of at least 10%. The Diabetes Prevention Program uses a small-steps approach to eating less fat and reducing calories to achieve a weight loss of 7%. The standard lifestyle change curriculum is available from [http://niddk.gov](http://niddk.gov). RDs should try patient-centered and affordable approaches to weight loss and maintenance that support at least a 10% loss. The nutrition and obesity literature is filled with strategies that may work for some adults and children, but there aren’t yet sufficient data to support evidence-based recommendations. Alternate-day or intermittent fasting, as described earlier, is one example of such a strategy that may be appropriate for some adults. Experiments with the use of a variety of technologies to support individuals in weight loss programs are being conducted. For obese children and adolescents, actions that do no harm, such as weight loss (5% to 10% from baseline) and routine physical activity, can be encouraged.

This course is focused on the observed links between obesity and asthma and examines the potential impact of weight loss on asthma control in adults and youth. However, RDs who are assisting patients with an eating approach to improve their weight and asthma may choose to discuss what’s known about how comorbidities such as GERD and selected dietary components affect asthma risk. There’s evidence, although not conclusive, that people with diets higher in vitamins C and E, beta-carotene, flavonoids, magnesium, selenium, and omega-3 fatty acids have lower asthma rates. The Mediterranean diet, characterized by high intake of vegetables; pulses; fruit; nuts; whole grain cereals; and unsaturated fatty acids, mainly from olive oil, fish, and moderate or low intake of meat and dairy products, has been associated with good asthma control in adults. Although this is just one study and was
conducted outside of the United States, the Mediterranean diet is an eating approach that may benefit adults and children with asthma. And following a Mediterranean-type diet has been shown to produce greater sustained weight loss than a low-fat diet in patients who were overweight or obese. A healthful Mediterranean-style eating pattern with varying calorie levels is described in the 2015–2020 Dietary Guidelines for Americans.

True food allergies can trigger asthma attacks as well; therefore, foods and beverages containing known allergens should be avoided. RDs can help patients ensure they obtain all the needed nutrients even while avoiding specific foods. Since some individuals are sensitive to sulfites, and sulfur dioxide can irritate the lungs, RDs can educate their patients about the processed foods, condiments, dried fruits, and wines that may contain them.

As much as 70% of people with asthma experience GERD, making control more difficult. Weight loss and avoidance of caffeine and alcohol may reduce GERD. RDs can help identify any foods that trigger GERD and ensure that eliminating them doesn’t compromise the patients’ nutritional status.

There are no data that describe weight maintenance or regain among those in the trials who had short-term weight loss and either remission of asthma or reduction in symptoms. RDs must support patients to prevent further weight gain or regain, which can lead to greater use of medications and hospitalizations. For those patients who experience increased appetite while taking asthma medications, RDs should discuss strategies to control appetite. For example, Rolls and colleagues have studied the role of low-calorie, high-volume foods in controlling appetite and published a diet called Volumetrics. Other research groups are exploring how consumption of lean protein can affect hunger and feelings of fullness. Moreover, RDs should counsel or refer children and adults to exercise specialists for appropriate physical activity programs.

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References


Quiz

1. According to a 2013 Centers for Disease Control and Prevention report, the prevalence of asthma was which of the following?
   A. 5% of adults and 10% of children
   B. 7.7% of adults and 8.6% of children
   C. 10% of adults and 10% of children
   D. 10% of adults and 5% of children

2. Why are patients with asthma heavier than patients without asthma?
   A. Asthma predisposes an individual to obesity.
   B. Children with asthma aren’t given prescriptions for exercise.
   C. Diets high in calories and low in antioxidants cause the development of asthma.
   D. Medications used to treat asthma often increase appetite, leading patients to overeat.

3. According to the 2007 National Asthma Education Program guidelines, which comorbidity may result in poor response to standard pharmacological treatment?
   A. Chronic stress and depression
   B. Diabetes
   C. Obesity
   D. Obstructive sleep apnea

4. Which of the following diets does high-quality evidence show can improve asthma control in adults?
   A. The Diabetes Prevention Program diet
   B. The DASH (Dietary Approaches to Stop Hypertension) diet
   C. The National Institutes of Health Asthma diet
   D. The Portfolio diet

5. John has a BMI of 35 and mild, persistent asthma. According to the Breathe Easier Through Weight Loss Lifestyle Intervention study, to improve his asthma, his weight loss goal should be which of the following?
   A. 5% from baseline
   B. 7% from baseline
   C. 10% from baseline
   D. 20% from baseline

6. Weight loss accomplished by using which of the following strategies has been shown to improve asthma symptoms?
   A. Using appetite suppressant medications
   B. Using daily dietary supplementation with antioxidants
   C. Using meal replacement products
   D. Using the mindful approach
7. Obese adults with asthma may not respond to standard controller therapies due to which of the following?
A. Increased appetite, which leads to excess caloric intake, which overwhelms the capacity of the therapy
B. Low levels of vitamin D
C. Oxidative stress and systemic inflammation
D. Sedentary behavior, which prevents the uptake of the medications

8. Mike is a 10-year-old with a BMI greater than the 99th percentile for his age. He has been asthmatic since infancy, and his parents have discouraged him from running and playing outdoors for fear that he’ll have an asthma attack. His mother’s BMI is 21 and his father’s BMI is 24. It’s likely that his obesity is a result of which of the following?
A. A unique asthma phenotype
B. Genetics
C. Sedentary lifestyle
D. Viral infection

9. Which of the following describes asthma?
A. Can be managed to reduce emergency department visits
B. Has escalating rates among children
C. Is more common in girls than boys
D. Is more common in white youths than black youths

10. In studies, which of the following demonstrates an improvement in asthma control with weight loss?
A. A peak flow rate of 50%
B. Decreased forced expiratory volume
C. Deceased forced vital capacity
D. Improved scores on the Asthma Control Questionnaire