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Evidence-Based Practice Reports

Obesity, Asthma, and Allergies; the Inflammatory Connection

A Case Study

Theresa Ann Loomis, MS, RD, and Danielle Viola, RD

Abstract: *Rates of obesity have increased dramatically in the past 30 years. This epidemic has been found to be associated with excessive screen time, consumption of calorically dense foods and drinks, increased portion sizes, frequent eating outside of the home, inadequate intake of fruits and vegetables, and inadequate exercise. There has been a concurrent rise in allergies, atopic dermatitis, and asthma that parallels this rise in obesity, which is thought to be the result of an increased inflammatory response. Obesity and inflammation can have a long-lasting influence on cardiovascular health. Further studies are needed to determine if a diet high in omega-3 fatty acids can help alleviate obesity and its associated inflammatory conditions.*

Keywords: allergies; asthma; obesity

Case Background and History

JB is a 15-year-old boy. He weighs 123 kg, his height is 169.2 cm, and his body mass index (BMI) is 43 kg/m², which is significantly greater than the 99th percentile for his age. His Z score is 2.5. His blood pressure is 120/64 mm Hg, which is

considered to be less than the 90th percentile for his age (128/80 mm Hg is the 90th percentile). In addition to obesity, JB has asthma, which was diagnosed at age 4. He was recently diagnosed with food allergies to eggs, milk, and wheat when he developed severe atopic dermatitis. JB's family reports that he snores, and he reports difficulty sleeping because of his itchy skin. He also complains of constipation.

On physical exam JB shows a diffuse, hyperpigmented, papular rash on his upper extremities, lower back, and

that his obesity became an issue when he was about 5 years old. JB was referred to an obesity clinic by his primary care pediatrician because of his obesity and his desire to lose weight and improve his health.

Obesity and Inflammation

Rates of childhood obesity have tripled in the past 30 years. One third of children are currently overweight or obese, defined as a BMI at or above the 85th

“... Weight reduction in obese people with asthma often results in both immediate and long-term alleviation of asthma symptoms.”

forehead; pinkish striae on his abdomen; and acanthosis nigricans around his neck and under his axilla (indicating hyperinsulinemia); his tonsils are 2 plus enlarged, with some tonsillar pitting. JB's family history reveals high cholesterol and asthma on his maternal side and hypertension on the paternal side. JB's younger sister has type 1 diabetes mellitus. His father and both sisters are normal weight, but JB's mother and older brother are obese. JB's mother reports

percentile and at or above the 95th percentile, respectively.¹ Obesity is a state of chronic positive energy balance, which is associated with increased leptin and decreased adiponectin levels, both of which are released from adipose tissue.²⁻⁸ Adiponectin is reduced in obesity, insulin resistance, and type 2 diabetes (T2DM) and is inversely associated with cardiovascular risk factors, such as blood pressure, heart rate, low-density lipoprotein (LDL), and triglyceride levels, and

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is positively related to high-density lipoprotein (HDL) levels.^{9,10} Recent studies suggest that adiponectin may have anti-atherogenic and anti-inflammatory properties.¹¹ In children, interleukin-6 (IL-6), C-reactive protein (CRP), and leptin have all been shown to increase with overweight and obesity.^{6-8,12,13} Additional studies have shown that insulin resistance is positively associated with leptin and CRP and negatively associated with adiponectin in children,⁸ whereas impaired microvascular function has been associated with elevated CRP, IL-6, tumor necrosis factor (TNF), and leptin and low HDL.¹⁴

Asthma and Obesity

There has been an increase in the prevalence in asthma over the past few decades, which parallels the increase in obesity.¹⁵ Asthma and obesity often occur together.¹⁶ Weight reduction in obese people with asthma often results in both immediate and long-term alleviation of asthma symptoms.¹⁶ Asthma is a chronic inflammatory disorder of the airways.¹⁵ This inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness and cough, particularly at night and in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is reversible either spontaneously or with treatment. The inflammation also causes an associated increase in existing bronchial hyperresponsiveness to a variety of stimuli as well as long-term airway remodeling.¹⁷⁻¹⁹ It is unclear whether patients with poorly controlled asthma gain weight because they limit their activities or if being obese increases asthma risk.¹⁵ A possible contributing factor to the increased incidence of asthma in Western societies may be the increased consumption of omega-6 fatty acids, which are considered to be proinflammatory.¹⁵

Atopic Dermatitis and Obesity

Atopic dermatitis is a chronic, recurrent, pruritic inflammatory disorder of the skin that has reached epidemic

proportions throughout the world.²⁰ It typically presents within the first few months of life. The prevalence of atopic dermatitis in childhood has increased from 2% to 3% before 1960, to 9% to 12% after 1970, and to as high as 20%.^{21,22} The reasons for this increase are not well understood, but it has been seen that the rate of obesity has increased during the same time period.^{23,24}

Obesity has been shown to have several effects on the immune system, including preferential activation of leukocytes and proinflammatory immune responses that might modulate the severity of atopic disorders such as atopic dermatitis or asthma.²⁵⁻²⁷ Silverberg et al²⁸ found that prolonged obesity beginning early in life is associated with increased risk for and severity of atopic dermatitis and more frequent visits to the pediatrician associated with atopic dermatitis.

Case Study: Dietary Intake, Physical Activity, and Inactive Time

At JB's first clinic visit, a usual daily intake record was taken. He reported that he eats breakfast at home, which is usually wheat-free pancakes, wheat-free waffles, and hash browns. He drinks water with breakfast. He reported that he usually skips lunch. The family eats dinner around 4:30 in the afternoon, which consists of rice or wheat and egg- and wheat-free pasta, meat, and vegetables. He reported that his servings of rice or pasta are at least 2 to 3 cups, and he has 8 to 10 ounces of meat. JB reports snacking on chips and wheat-free crackers after dinner. He drinks mostly water, diet soda, and other calorie-free beverages with occasional soy milk. The family reported eating out 1 to 2 times per week.

JB participates in gym class 2 to 3 days per week for 30 minutes. Within 2 weeks of his first clinic visit, he started his own exercise routine, which consisted of running up and down the stairs of his home, lifting free weights, and doing crunches. This routine takes 15 to 20 minutes to complete. Prior to this time, JB had no additional activity. The family has a treadmill located in the basement; however,

JB's asthma flares up because of mildew issues in the basement. JB spends about 1 to 2 hours per day watching television. He also spends 1 to 2 hours per day on the computer during the week. On the weekend, he spends 2 to 3 hours each day playing video games. JB does have a TV in his room, but he reports not using it routinely.

Lifestyle Factors and Oxidative Stress Associated With Obesity

The obesity epidemic has been linked to numerous factors, including increased TV/screen time, decreased physical activity, changes in the living environment, increased variety and consumption of calorie-dense foods and drinks, increased portion sizes, eating away from home, and increased food marketing and advertising aimed at children.²⁹ The causes are most likely multifactorial and are ultimately a result of a positive energy balance where energy taken in is greater than energy expended.²⁹⁻³³

The typical American diet has changed in the past 30 years, with a greater percentage of meals consumed away from home. Snack foods and sweets are often substituted at mealtimes, resulting in an overall decrease in consumption of balanced meals that include fruits, vegetables, whole grains, and calcium-rich foods.³⁰⁻³³ In addition, many children are not consuming sources of antioxidants, phytochemicals, and omega-3 fatty acids, which may be of potential benefit in combating inflammation associated with excess adiposity.²⁹ Overweight children have increased oxidative stress that can be reversed with weight loss.³⁴ Antioxidants may combat inflammation because children with hyperlipidemia have been shown to have improved endothelial function after supplementation for 6 weeks with vitamins C and E.³⁵ It is possible that diets rich in fruits and vegetables may help mediate some of the inflammation that is associated with the metabolic stress of obesity.³⁵

The majority of American children and adults are not physically active.³⁶⁻³⁹ A recent study showed that only 42% of 6- to

11-year-olds and 8% of 12- to 19-year-olds meet the Surgeon General's recommended 60 minutes of physical activity per day.⁴⁰ Physical activity enhances enzymatic antioxidant status and is associated with a favorable blood lipid profile.^{41,42} Physical activity that is not extremely intense or long in duration has also been associated with a decreased expression of inflammatory mediators and decreased circulating levels of inflammatory biomarkers.^{43,44} Physical activity and resultant increased fitness benefits the body through improving the health of exercising muscle tissue and by decreasing adipose tissue and its associated inflammatory properties.²⁹ It is possible that physical fitness alone may decrease metabolic risk factors, independent of body weight.²⁹

Case Study: Recommendations

JB's intake record and history reveals a diet high in carbohydrates, low in calcium-rich foods and omega-3 fats, and low in fruits and vegetables; exercise was also inadequate. One recommendation made to JB on his first clinic visit was to bring a lunch to school. Some ideas for lunch foods were fruits and vegetables with peanut butter or hummus, soy yogurt, a trail mix that included walnuts, or a sandwich on wheat-free bread. The goal of adding this meal was to improve his portion sizes at dinner. He was also encouraged to have fruit after dinner as his snack rather than chips and high-fat crackers. It was suggested that JB increase his calcium intake by adding soy milk to his diet daily. He was encouraged to increase his cardiovascular exercise to 30 minutes per day as a starting goal. His weight loss goal of up to 2 pounds per month was based on the American Academy of Pediatrics Expert Committee Recommendations.⁴⁵ It was recommended that JB have fasting lipid levels, insulin levels, and vitamin D level checked. He recently had a complete metabolic panel and thyroid function tests assessed, which were all normal. JB was given a 3-day log to keep record of 2 school days and 1 weekend day prior to returning for follow-up.

Follow-up

When JB returned to clinic 6 weeks after his initial visit, his weight was down by 6 pounds. He continued to eat his usual breakfast of wheat-free waffles or pancakes with hash browns. He was more consistent with packing lunch and reported bringing peanuts and fruit or trail mix. He also reported decreasing his portion sizes at dinner. He was still struggling with his after-dinner snack and has been eating rice cereal treats and wheat-free granola bars and drinking soy milk. He has been drinking 3 glasses of soy milk per day. JB was hospitalized for an asthma exacerbation 2 weeks prior to this visit, so he has been having a hard time with his exercise regimen. He had to cut out his cardiovascular exercise, but he was able to continue doing the free weights. He had not had time to obtain his lab work. Recommendations included a decrease in carbohydrates at breakfast and adding a fruit and a protein such as soy milk or turkey sausage, adding fruit to his lunch, and working on his cardiovascular exercise once his asthma was under control. JB was asked to keep a 3-day food and exercise log with 2 school days and 1 weekend day, to return to clinic in 4 to 6 weeks, and to try to get his blood work drawn prior to the next visit.

Obstacles to Weight Loss

JB returned to clinic 1 month later. He had experienced another asthma exacerbation and was put on a 2-week course of steroids. His weight was up 2 pounds from his last visit but was still down 4 pounds from his initial appointment. He reported being frustrated with his inability to stick with his plan because of his repeated courses of steroids. He reported not being able to exercise at all since his last visit, and his appetite was increased while taking the steroids. He had tried adding protein to his breakfast but was not doing so consistently. He had stopped taking his lunch to school, and thus, his dinner portions remained larger than recommended. His after-dinner snack was the one area he felt he was

gaining control of and was having fruit and soy milk. The goals were restated from the last visit, which were to cut down his carbohydrates at breakfast and add protein and fruit. He was encouraged to bring his lunch to school, so he could get an additional fruit and also decrease his portions at dinner. He was educated on the importance of his exercise routine once his asthma was back under control. He had obtained his lab work prior to this visit, which revealed normal lipid levels, but his insulin was 43 $\mu\text{U}/\text{mL}$ (normal is 1.8-24.6 $\mu\text{U}/\text{mL}$), and his vitamin D level was 15 ng/dL (normal is greater than 30 ng/dL). It was suggested that JB take 2000 IU of vitamin D per day and that he return to clinic in 1 month.

Vitamin D and Obesity

Low serum vitamin D and the resultant hyperparathyroidism are associated with obesity.⁴⁶ Those with hypovitaminosis D are also believed to be at higher risk for insulin resistance and metabolic syndrome.^{47,48} It is hypothesized by McCarty and Thomas⁴⁹ that the physiological increase in parathyroid hormone levels in response to hypovitaminosis D is believed to increase intracellular calcium in adipocytes, which leads to increased lipogenesis and weight gain. Abnormal calcium metabolism has been associated with weight gain, and a high calcium intake is believed to prevent obesity.^{50,51} The reduction in serum vitamin D levels with increased adiposity is assumed to be a result of enhanced sequestration of vitamin D in fat stores.⁵² At this time, it is unclear whether supplementation with vitamin D will improve serum levels and aid in weight loss.

Case Study Discussion and Areas for Further Research

It is clear that childhood obesity is an inflammatory condition.²⁹ This case study demonstrates the likely implications of the inflammatory state on overall health. JB's diagnoses of allergies and asthma are inflammatory conditions that are associated with obesity. His

low serum vitamin D level may be both indicative of his lifestyle (decreased time spent outdoors and being active) and may be further contributing to his obesity.⁴⁹ JB also consumed a diet low in omega-3 fatty acids. The emphasis over the past few decades to replace dietary lard and saturated fat has led to an increased intake in vegetable oils rich in omega-6 polyunsaturated fats and a simultaneous decrease in consumption of oily fish and leafy vegetables, which are the major sources of omega-3 polyunsaturated fatty acids.¹⁵ The well-documented anti-inflammatory properties of omega-3 fats and the proinflammatory properties of dietary omega-6 fats has led to the theory that these dietary trends may have predisposed some individuals to inflammatory disorders such as asthma and atopic dermatitis.¹⁵ Replacing omega-6 fats with omega-3 fats in the diet or supplementing the diet with omega-3 fatty acids has not yet been demonstrated in research to promote weight loss or to decrease symptoms associated with asthma or atopic dermatitis. Although hypovitaminosis D is thought to lead to weight gain, research has yet to demonstrate weight loss or stabilization with repletion of serum levels.⁴⁹ A study looking at increased omega-3 fatty acid consumption and vitamin D supplementation and whether or not this has the ability to change anthropometric and biochemical measures is warranted. ■

Author Note

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