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The interplay of obesity and asthma

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The Interplay of Obesity and Asthma

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The relationships, interactions, and association between obesity and asthma are complex, and are active sources of hypotheses and research. An association between obesity and asthma has been reported in many studies, although considerable debate about the existence of the association and its meaning still exists. Potential associative relationships may result from genetics, immune system modifications, and mechanical mechanisms. The rising prevalence of asthma and obesity in children and adults, and the significant morbidity from both, makes it imperative that clinicians recognize the importance of weight management in patients with and without asthma.

Introduction

Asthma and obesity are two chronic medical conditions in children, adolescents, and adults that share common threads. The prevalence of both conditions continues to increase, resulting in significant morbidity, mortality, economic loss, and escalating health care expenditures. The relationships, interactions, and association between obesity and asthma are complex, and are active sources of hypotheses and research. Though the direct relationships between asthma and obesity remain controversial, there is growing and significant evidence that the two conditions have multiple areas of interplay, particularly in the inflammatory microenvironment. Obesity, with excessive white adipose tissue, produces a myriad of complications through its endocrine function. This review presents the most recent prevalence statistics, theories on the interplay and associations between asthma and obesity, and suggestions for management for clinicians who deal with patients who are overweight or obese and/or asthmatic.

Obesity

Results from the 2003 to 2004 National Health and Nutrition Examination Survey (NHANES), using measured weights and heights, indicate that an estimated 66% of adults in the United States are either overweight or obese. One of the national health objectives for 2010 is to reduce the prevalence of obesity in adults to less than 15%. The data show that 32.2% of adults 20 years of age and over—over 60 million people—had a body mass index (BMI) of 30 or greater in 2003 to 2004 compared with 23% in 1994, and 15% in 1976 to 1980. Meanwhile, the number of children who are overweight (defined as BMI-for-age at or above the 95th percentile of the Centers for Disease Control and Prevention [CDC] Growth Charts) continued to increase. Among children and teens ages 6 to 19, 15% (over 8 million) are overweight (BMI above the 95th percentile) according to the data from 2003 to 2004, or triple what the proportion was in 1980. In addition to the 15% of children and teens ages 6 to 19 who were overweight in 2003 to 2004, another 15% were considered at risk of becoming

overweight (a BMI-for-age between the 85th and 95th percentiles). In women, overweight and obesity are higher among members of racial and ethnic minority populations than in non-Hispanic white women [1].

Although there are many causes, the rise in obesity is, in part, a result of the progressive decline in levels of physical activity, and adoption of a more sedentary lifestyle, fueled by television, computer and video games, lack of access to safe areas for physical activity, and sprawling residential neighborhoods that have increased reliance on the automobile for transportation.

The consequences of obesity encompass health and a variety of social and economic factors affecting individuals and society. In addition to its potential relationship to, and association with, asthma, obesity leads to an increased risk of type II diabetes, cardiovascular disease, some cancers, and osteoarthritis, as well as social stigmatization, discrimination, and poor body image, which may lead to depression. The adverse health effects of obesity have created enormous direct and indirect health care costs. According to 2002 data from the US Department of Health and Human Services, the economic costs related to obesity were estimated at more than 117 billion dollars. A study examining the relationships of BMI in young adulthood and middle age to subsequent health care expenditure at ages 65 years and older found average annual and cumulative Medicare charges were significantly higher for individuals, both men and women, with a higher baseline BMI [2].

Personal, cultural, environmental, and economic factors make it difficult, particularly for minority populations, to engage in healthy lifestyles. Focus groups with individuals from urban minority neighborhoods, conducted in 2005, emphasize a lack of access to fresh low-cost fruits and vegetables; the expense of weight loss or physical activity programs; the stress of having to exercise in a "life already too stressful"; the need to build physical activity seamlessly into routine activities; and the need for skill-building activities such as meal planning, healthy eating on a limited budget, healthy snacks, and healthy cooking for families (Brawer, Personal communication).

Well-controlled clinical trials have demonstrated that lifestyle modification can decrease blood pressure [3,4], prevent or forestall development of type 2 diabetes [5,6], and reduce other risk factors for cardiovascular disease [7,8]. The health benefits of weight loss and increased physical activity are well established. Modest weight loss, of 5% to 10%, is associated with significant improvement in blood pressure, lipoprotein profile, glucose tolerance, and insulin sensitivity [9••]. Physical activity has similar benefits on cardiovascular risk factors [10].

Health care providers can and should be primary motivators and monitors of behavior change in individuals and families [11]. However, obese individuals receive advice to lose weight only 50% of the time [12]. Only 34% of adults seeing a physician in the prior year reported being counseled about physical activity at their last physician visit [13]. Disparities exist in professional advice to lose weight: the lower the income and educational attainment, the less likely the provider to offer advice to lose weight [14]. African Americans, compared with whites, have significantly lower odds of receiving weight advice counseling [15]. Providers also underdiagnose obesity by relying on appearance and not BMI, emphasizing the importance of teaching and modeling the use of BMI to diagnose overweight and obesity [16]. Health care providers fail to address obesity for a variety of reasons, including "clinical inertia" or the failure to initiate or intensify therapy when indicated [17], lack of time, perceived noncompliance of participants, and lack of training in counseling and motivating participants to change behavior [9••,18]. Clinical guidelines exist for obesity assessment and management [19], but are not routinely used [9••].

Asthma

The burden from asthma in the United States has also increased over the past two decades. According to the National Center for Health Statistics (2002), 10%, or 21.9 million, of US noninstitutionaled adults and 12.2% or 8.9 million noninstitutionalized children had ever been diagnosed with asthma in 2002, and in 2003, 4.2 million children had an asthma attack in the previous year [20]. The prevalence of asthma in non-Hispanic blacks was 10% higher than in non-Hispanic whites and about 40% higher compared to Hispanics [21]. The etiology of asthma is complex and multifactorial; as with obesity, environmental factors contribute to an increased risk. Risk factors for asthma include a genetic predisposition and exposure to indoor and outdoor environmental and infectious triggers. Outdoor environmental triggers include respiratory irritant pollutants such as ground-level ozone and respirable particulate matter, which are both increased by use of the

automobile. A dramatic example of the relationship between automobile use, air quality, and asthma occurred during the 1996 Summer Olympics in Atlanta, GA. The city instituted a plan to reduce automobile congestion during the games through widespread use of public transportation. These efforts led to a 22% decline in traffic counts, a 28% decline in daily ozone concentrations, and most importantly, a 41% decline in asthma acute-care events [22]. The consequences of asthma are numerous and include lost productivity, emergency department crowding, and excessive hospitalizations. Asthma is one of the leading causes of school absenteeism.

Obesity and Asthma Interactions

The relationships, interactions, and association between obesity and asthma are complex, and active sources of hypotheses and research. An association between obesity and asthma incidence and/or severity has been reported in many studies, although considerable debate still exists about the existence of the association and its meaning [23••]. However, being overweight has been associated with an increased risk of new-onset asthma in boys and in nonallergic children [24]. Asthma is a risk for obesity in urban minority children and adolescents [25]. In an extensive review of the epidemiology of obesity and asthma, Ford [23••] concludes that, despite the number of studies using different study designs, excess weight might increase the risk of developing asthma. However, the association remains controversial because of potential methodologic limitations inherent in many of these studies.

In an extensive review of the association between asthma and obesity, Tantisra and Weiss [26] describe potential associative and/or causal relationships that rely on genetics, immune system modification, and mechanical mechanisms. Based on examination of the current evidence, they find the following:

- Obesity has been associated with increases in the incidence and prevalence of asthma in several epidemiologic studies of adults and children.
- Weight loss in obese subjects results in an improvement in overall pulmonary function and asthma symptoms, as well as decreases in asthma medication usage.
- Obesity may directly affect the asthma phenotype by mechanical effects including airway latching, cytokine modulation via adipose tissue, through common genes or genetic regions, or by sex-specific effects, including the hormone estrogen.
- Obesity may also be related to asthma by genetic interactions with environmental exposures, including physical activity and diet.
- The Barker hypothesis may underscore the developmental relationship of obesity with asthma. This hypothesis postulates that fetal programming can effect the subsequent development of chronic diseases. The programming results from a stimulus or insult at a critical sensitive period in early fetal development.

In a review of obesity, smooth muscle, and airway hyperresponsiveness, Shore and Fredberg [27] suggest three possibilities that relate obesity to airway hyperresponsiveness.

The first possibility consists of simple mechanical static and dynamic factors. Static factors include increased abdominal and chest wall mass in the obese individual that causes lower than normal functional residual capacity. Dynamic factors include the tidal action of spontaneous breathing imposing tidal strains on airway smooth muscle. The obese individual breathes at higher frequencies but smaller tidal volumes compared with the lean individual, resulting in a compromise in the bronchodilating mechanism and predisposing increased airway responsiveness compared with the lean individual.

The second possibility is related to differences in anatomy of the lungs and airways. In children the mechanical load of obesity might affect lung growth. Obesity might also lead to more accelerated airway remodeling with each asthma exacerbation.

The third possibility for the relationship of obesity to airway hyperresponsiveness is the inflammatory microenvironment. White adipose tissue, which represents the vast majority of adipose tissue in the human, is no longer

considered an inert tissue devoted to energy storage, but is emerging as an active participant in regulating physiologic and pathologic processes, including immunity and inflammation [28•]. In fact, adipose tissue is now considered the largest endocrine organ in the human body. There is a growing body of literature that relates the possible role of adipose tissue in modulating asthma susceptibility and symptoms. For example:

- Compared to lean controls, there are altered T-cell responses and mast cell numbers in the trachea of obese mice sensitized to ovalbumin [29].

- The presence of increased airway hyperresponsiveness and inflammation to ozone in obese mice [30].

- Administration of leptin (a 16-kd protein encoded by the ob gene) increases airway hyperresponsiveness and cytokine production in ovalbumin-sensitized mice [31].

- A protein called aP2, which helps fat cells store fat molecules, inflames cells lining the surface of the lung's airways. If the aP2 gene is removed in mice models, mice without aP2 are protected from asthma attacks [32

There is also high prevalence of asthma in morbidly obese adults, and major reductions in asthma occur after laproscopic adjustable gastric banding surgery for weight loss. Mechanisms other than direct weight loss appear to play a part in this improvement. Prevention of gastroesophageal reflux may be an important factor [33].

The role that physical activity plays in the increasing prevalence of both obesity and asthma is increasingly being evaluated. Despite the proven benefits of physical activity on weight management, more than 60% of American adults do not get enough physical activity to provide health benefits. More than a third of young people in grades 9 to 12 do not engage in vigorous physical activity. The reasons for this are complex and are in part due to built and social environmental conditions [34••] (Fig. 1). Recent research suggests that overweight/obesity is related to a decline in physical activity with root causes embedded in the built environment [34••].

There is a growing body of literature that implicates lifestyle change, specifically decreased physical activity, as a contributor to the increase in asthma prevalence and severity. Some authors argue that an exercise prescription should be part of the treatment of all cases of asthma [35]. This certainly should be the case with the overweight or obese asthmatic patient.

It may be likely that programs and approaches to environmental modification leading to increased opportunities for physical activity will decrease the prevalence of obesity and may directly impact the prevalence and the severity of asthma [36]. Nationally, several programs, interventions, and guidelines have been developed that will affect the obesity and asthma epidemics through study and modification of the built and social environments [34••].

Conclusions

The interplay between asthma and obesity is clear, but the association between asthma and obesity is less clear as to cause and effect. However, the rising prevalence of both conditions, and the significant morbidity and mortality form both, makes it imperative that clinicians stress the importance of weight management in patients with and without asthma.

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Figure 1. The influence of the environment on physical activity, obesity, and asthma.