Obesity and Asthma: A Dangerous Link in Children

An Integrative Review of the Literature

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ABSTRACT

Obesity and asthma are significant public health problems, both with increasing prevalence in children. During 1980 to 1994 the prevalence of childhood obesity increased 100%, while the prevalence of self-reported asthma in children increased 75%. One common assumption is that weight gain occurs because many asthmatic patients avoid exercise since physical activity can trigger their symptoms; however, many contributing factors coexist. The intrinsic mechanism of obesity and asthma and their association is unclear. The purpose of this integrative review is to explore the link between obesity and childhood asthma, synthesizing its findings for clinical application.

Keywords: asthma, children, obesity, patient education

Emerging data demonstrate a complex, poorly understood association between the 2 leading public health challenges of obesity and childhood asthma.[1] The physical condition and body weight of asthmatic children cannot be discounted as contributing factors to poor health and disease outcomes. Moreover, the prevalence of pediatric obesity has risen sharply in recent decades, with rates tripling between 1980 and 2000.[2]

Interestingly, a growing body of research has documented a complicated, multifaceted overlap between these escalating health concerns.[3] The Centers for Disease Control and Prevention (CDC) reports that, between 1987 and 2001, diseases associated with obesity accounted for 27% of the increases in medical costs.[4] Nine percent of annual United States health care spending is directly attributable to obesity.[4] Numerous studies have reported a link between asthma and obesity in pediatric cohorts.[5] A clear explanation for the rising rates and associated risks of pediatric asthma and obesity remains elusive. The purpose of this integrative review is to explore the link between obesity and childhood asthma, synthesizing its findings for clinical application. Database searches included MEDLINE, PubMed, OVID, and CINAHL.

BACKGROUND AND SIGNIFICANCE

Both obesity and asthma are significant public health problems and epidemics among children.[6-8] During 1980 to 1994 the prevalence of self-reported asthma in children increased 75%, while the prevalence of childhood obesity increased 100%.[9] For children and adolescents 2 to 19 years old, overweight is defined as a body mass index (BMI) at or above the 85th percentile and lower than the 95th percentile.[7] Obesity is defined as a BMI at or above the 95th percentile for children of that same age and gender.[7] A child's weight status is based on an age- and gender-specific percentile for BMI rather than by the BMI categories used for adults. Classifications of overweight and obesity for children and adolescents are age and gender specific because children's body composition varies as they age and varies between boys and girls.[7]

Asthma is a chronic inflammatory disease of the airways in which many cellular elements play a role, in particular mast cells, eosinophils, T-lymphocytes, macrophages, neutrophils, and epithelial cells.[10] In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning.[10] These episodes are usually associated with widespread but variable airflow obstruction that is often reversible, either spontaneously or with bronchodilator treatment.[10]

Evidence suggests that obesity complicates the diagnosis, treatment, and course of asthma, whereas significant weight loss results in improved pulmonary status.

The Centers for Disease Control and Prevention (CDC) reports only one state (Colorado) has an obesity prevalence less than 20%, while 32 states have prevalence equal to or greater than 25%. Six of those 32 states (Alabama, Mississippi, Oklahoma, South Carolina, Tennessee, and West Virginia) have prevalence equal to or greater than 30%.[11] Among children and adolescents 2 to 19 years old, 16.9% are obese and 31.7% are overweight for age.[11] Obesity has more than doubled for preschool children 2 to 5 years old and adolescents 12-19 and have more than tripled for children 6-11 in the past 15 years.[8] While more children are becoming overweight, research demonstrates that the heaviest children are getting even heavier.[8] Based on the continuation of national trends over the past several decades, 46% of US children in the United States were overweight in 2010.[12]

An estimated 6.8 million US children have asthma, and an estimated 9 million children younger than 18 have been diagnosed with asthma at some time in their lives.[7,13] Since 1999, children 5-17 years old have demonstrated higher asthma prevalence rates than any other age group.[14] Asthma prevalence continues to be at historically high levels after dramatic increases from 1980 until the late 1990s.[14] Pediatric asthma ranks in the top 10 prevalent conditions causing limitations of activity, represents the most common chronic illnesses of childhood, and is the third leading cause of hospitalizations among children under the age of 15.[10,14]

RELATED HEALTH CARE DISPARITY

Asthma

Asthma, as with obesity, has a widespread and costly impact, particularly among ethnic minorities, low-income families, and inner-city communities.[15] Studies suggest that Puerto Ricans may have higher prevalence of asthma and higher death rates than other Hispanic subgroups, Caucasians, or African Americans.[17] This statistic is alarming when factoring in that African American children have a 60% higher prevalence rate, 260% higher ED visit rate, 250% higher hospitalization rate, and 500% higher death rate than Caucasian children.[16]

Ethnic minorities may have an elevated risk for asthma development because of increased exposure to air pollution as a result of a disproportionate number living in areas failing to meet one or more national standard for air pollutants.[17] It is estimated that 80% of Hispanics live in areas that failed to meet one Environmental Protection Agency (EPA) air quality standard, compared to 65% African Americans and 57% Caucasians.[17] Ethnic differences in asthma prevalence, morbidity, and mortality are highly correlated with poverty, urban air quality, indoor allergens, and lack of patient education and inadequate medical care.[17]

Obesity

The Obesity Society reports African Americans, Hispanics, and Native Americans have the highest obesity and overweight prevalence.[18] Some studies indicate overweight prevalence within these ethnicities approaching 35%-40%.[18] Singh, Siahpush, and Kogan[19] demonstrated obesity prevalence for children in low-education, low-income, and higher unemployment households increased 23%-33% from 2003 to 2007, with substantial social inequalities persisting even after controlling for behavioral factors.[19] During that 4-year time span, obesity prevalence increased markedly among Hispanic children and children from single-mother households.[19] The research established Hispanic, Caucasian, and American Indian children were 3.0 to 3.8 times more likely to be obese or overweight than Asian children, and children from low-income and low-education households

were 3.4 to 4.3 times more likely to be obese than children from higher socioeconomic households.[19]

RELATIONAL ORIGINS OF ASTHMA AND OBESITY

Obesity affects the lungs and is very strongly associated with breathing disorders because of the mechanical effect of central body fat on the airways, meaning that excessive body fat restricts the free movement of air and compresses the lungs.[20] Not only does excessive body fat restrict normal lung movement, research shows reduction in deep breathing associated with obesity and a sedentary lifestyle may also lead to airway narrowing.[21] Such narrowing is caused by the reduction of bronchial smooth muscle expansion from a lack of deep breathing as a result of a restrictive lung pattern and obesity, thereby predisposing the child to asthma development.[21] Evidence suggests that obesity complicates the diagnosis, treatment, and course of asthma, whereas significant weight loss results in improved pulmonary status.[22]

Research has made the case that obesity may lead to asthma development, and at the same time, asthma may lead to obesity. Ciprandi et al.[23] demonstrated that obese children tend to have decreased pulmonary volumes while having more bronchial hyperresponsiveness, making them more susceptible to developing asthma symptoms than children who are not obese.[23] Conversely, Ford and Mannino[24] demonstrated that individuals with asthma are far more likely to be obese than people who do not have asthma in that obese children with a history of asthma will suffer increased asthma symptoms compared to asthmatics with a healthy body weight. There are also a number of prospective studies showing weight gain as antedating the development of asthma.[25] Despite the apparent link between obesity and asthma, the intrinsic mechanism of their association is unclear.[25]

New insights into a shared genetic basis for susceptibility to asthma and obesity disorders further support a causation theory.

ROLE OF INFLAMMATION IN ASTHMA AND OBESITY

It is well-documented in the literature that both asthma and obesity are inflammatory diseases.[10,26] Reported observations suggest that obesity might impact the lung in multiple ways, both extrinsically by excessive body fat that restricts breathing pattern and intrinsically through an inflammatory process.[27] Data from animal and human studies suggest that the increased adipose tissue found in obesity leads to a systemic pro-inflammatory state in patients.[28] Adipose tissue in obese individuals produces a number of pro-inflammatory molecules, and there appears to be significant overlap between the immune function of those molecules and the functions of T lymphocytes and macrophages, particularly with regard to production of inflammatory cytokine.[29,30] This pro-inflammatory state is theorized to lead to a number of the metabolic and cardiovascular complications of obesity, but whether or not T lymphocytes and macrophages, particularly the production of inflammatory cytokines, can also cause airway inflammation, alter lung development or physiology, and lead to asthma is not yet known.[31]

Much of the literature focusing on the relationship between obesity, airway inflammation, and asthma has focused on the role of leptin. Leptin, the product of the *Ob* gene, is increased in obese humans and is also a central mediator of inflammation in obesity.[32] Leptin is important for normal lung development, serving as a critical mediator of the differentiation of lipofibroblasts to normal fibroblasts and of pulmonary surfactant synthesis.[33] However, other clinical studies in children demonstrate that the role of leptin may be independent of obesity. Guler et al.[34] demonstrated a significant elevation in serum leptin in children with asthma when compared with healthy children, despite similar mean body mass index.

Although the risk of asthma from obesity remains unclear, a theory of causation can be supported, at least tentatively, by animal studies that provide biological underpinnings to an association between the 2 disorders.[31] Epidemiologic studies suggesting the relationship between these 2 disorders is clinically important, and new insights into a shared genetic basis for susceptibility to both disorders further support a causation theory.[31]

RELATIONSHIP OF ASTHMA, OBESITY, AND INACTIVITY

A growing body of literature implicates decreased physical activity as a contributor to the increase of asthma prevalence.[25] Obesity leads to increased asthma symptoms and worsening disease, which itself can be associated with less

physical activity. Less physical activity, in turn, predisposes a patient to obesity and long-term respiratory problems, thereby sustaining the vicious cycle of inactivity, obesity, and worsening asthma.[35] Lucas and Platts-Mills[35] found that asthmatic children have a lower aerobic fitness level than their non-asthmatic peers, citing a complex interrelationship between asthma, obesity, and inactivity.

National activity guidelines for children recommend 60 or more minutes of physical activity daily, and it is estimated that the majority do not meet this goal, including children with asthma and those who are overweight.[14,36] Rasmussen et al.[37] demonstrated the level of physical fitness among schoolchildren age 8 years or older is inversely related to provider-diagnosed asthma, concluding that the less physically active a child, the more likely he or she is to develop asthma. Abramson et al.[38] proposed a vicious cycle occurring between asthma and inactivity in that having a diagnosis of asthma often results in behavioral changes, such as a diminished enthusiasm for physical activity. This in turn influences weight trajectories and increases the risk of developing obesity, thereby exacerbating poor health outcomes.[38]

The effect of increasing physical activity on overall health status has long been recognized as a possible method of improving asthma outcomes, despite its possible contribution to increasing morbidity in some.[35] Because excess weight may adversely affect the respiratory health of children with asthma, weight management and increasing physical activity for overweight and obese children is an important component in their care.[35] Life-long exercise increases lung function.[27] Activities such as running and swimming, if tolerable, are associated with improved fitness and decreased severity of asthma symptoms, making them great suggestions to share with patients.[28]

Obesity and asthma are diseases of high prevalence with significant increases in the last 2 decades.

Research demonstrates that asthma severity contributes to lower activity level among some school-aged children.[39,40] However, Westermann et al.[41] caution against assuming a direct causal link between asthma severity and increased symptoms with physical activity and suggests the presence of external influences has greater effect than severity level. Lang et al.[39] found that *negative parental health beliefs*, such as external or self-imposed restraints placed on asthmatic child's activity levels, unnecessarily prevent the children from participating in physical activity (see Table 1). The researchers demonstrated that while 98% of parents with asthmatic children believed exercise was important for children, 35% believed exercise made their child's asthma worse, 26% believed their child would get sick if they exercised, 18% believed exercise was dangerous for their child because they had asthma, and 6% believed their child should never exercise at all.[39]

The lines of causation remain blurred between asthma, obesity, and inactivity, evoking a discussion as to "which came first." The reality is that any of the 3 may be the primary causative condition in any given patient, hence the challenge of treatment. The nurse practitioner, as clinician and educator, is in a key position to improve the health outcomes for these children.

CLINICAL IMPLICATIONS FOR HEALTH CARE PROVIDERS

The national standard for treating asthma are the guidelines published by the National Heart, Lung and Blood Institute: National Asthma Education and Prevention Program (NAEPP) Expert Panel-3, Guidelines for the Diagnosis and Management of Asthma.[14] The NAEPP guidelines give health care providers an evidence-based approach to the diagnosis, treatment, and management of asthma, with the cornerstone recommendation of inhaled corticosteroids (ICS) for patients with persistent asthma.[14]

While the NAEPP guidelines do not discuss treatment approaches to obesity as related to asthma, they do acknowledge, "Obesity may be a risk factor for asthma due to the generation of unique inflammatory mediators that lead to airway dysfunction."[14]

Recommendations for the clinical intervention and treatment of obese and overweight children are offered by several national organizations, including the American Academy of Pediatrics (AAP), National Association of Pediatric Nurse Practitioners (NAPNAP), and the American Heart Association (AHA).

The AAP recommends screening children at 2 years for obesity with BMI measurements and offering behavior-modification programs and nutritional counseling as an evidence-based approach to patient care.[42] NAPNAP strongly values prevention and believes that healthy habits

Table 1. Exercise-Related Beliefs Among Parents of Children with Asthma

Results	Parental Beliefs of Children With Asthma
99%	Exercise is important for adults.
98%	Exercise is important for children.
72%	Child enjoys strenuous activities or exercise.
64%	Children with asthma can do as much physical activity as children without it.
63%	For children with asthma, some sports are better than others.
58%	When child exercises or runs, he or she has trouble with asthma.
37%	Exercise may make a child's asthma better.
35%	Exercise may make a child's asthma worse.
27%	Child gets upset when he or she plays or exercises hard enough to sweat.
26%	Child will get sick if he or she exercises.
18%	Exercise is dangerous for children with asthma.
6%	Children with asthma should never run.

in nutrition and physical activity are critical to good health for all children and provides evidence-based guidance to nutrition and physical activity to establish healthy behaviors for life through a program initiative called HEAT: Healthy Eating and Activity Together.[43] The aim of the HEAT Program is to improve child health through culturally appropriate interventions that enhance the family's ability to achieve the ideal balance between nutrition and physical activity to support optimal growth and wellness.[43] The HEAT Clinical Practice Guideline, "Identifying and Preventing Overweight in Childhood," was designed for use by nurse practitioners who work with children from infancy through adolescence in ambulatory settings.[43]

The AHA recommends that patient counseling include instruction to eat foods low in saturated fat, trans fat, cholesterol, salt, and added sugars as prevention of disease and part of a healthy lifestyle for children (see Table 2).[44] Among core recommendations are serving whole-grain and high-fiber breads and cereals; a variety of fruits and vegetable daily, while limiting juice intake; and fat-free or low-fat dairy foods.[44] The AHA recommends children keep total fat intake between 30%-35% of calories for 2- to 3-year-olds and between 25%-35% of calories for 4- to 18-year-olds, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils.[44] Furthermore, the AHA recommends advising children and their families to only eat enough calories to maintain a healthy weight for their height and build. Estimated calories needed by children range from 900/day for 1-year-olds to 1800 for a 14- to 18-year-old girl and 2200 for a 14- to 18-year-old boy.[44]

Table 2. AHA Recommendations for Childhood Healthy Eating

1. Serve whole-grain/high-fiber breads and cereals. Recommended grain intake ranges from 2 oz/day for a 1-year-old to 7 oz/day for a 14- to 18-year-olds.
2. Serve a variety of fruits and vegetables daily, while limiting juice intake. Each meal should contain at least 1 fruit or vegetable. Children's recommended fruit intake ranges from 1 cup/day for 1- to 3-year-olds to 2 cups/day for 14- to 18-year-olds.
3. Recommended vegetable intake ranges from ¾ cup/day at 1 year to 3 cups/day for 14- to 18-year-olds.
4. Serve fat-free and low-fat dairy food. Children 1- to 8-years-old need 2 cups/day of milk or its equivalent each day. Children 9- to 18-years-old need 3 cups/day.

CONCLUSION

Obesity and asthma are diseases of high prevalence with significant increases occurring in the past 2 decades. Obesity makes the diagnosis, treatment, and course of asthma difficult, and both of these public health problems put our children at greater risk for future health problems. If sedentary behaviors and physical activity avoidance contribute to the relationship between asthma and obesity, age at diagnosis could be an important factor. Children who receive an asthma diagnosis at a younger age develop more entrenched sedentary patterns than those who have healthy activity patterns that are well-established before diagnosis. Additional research is needed to further understand the link between obesity and childhood asthma, as well to establish guidelines for anthropometric evaluation methods (commonly used as indices of growth and development), physical activity levels, and healthy eating lifestyles for asthma patients. JNP

References

1. Lara M, Rosenbaum S, Rachelefsky G, Nicholas W, Morton SC, Emont S. Improving childhood asthma outcomes in the United States: A blueprint for policy action. *Pediatrics.* 2002;109(5):919-930.
2. Ogden D, Carroll M, Flegal K. Epidemiologic trends in overweight and obesity. *Endocrinol Metab Clin North Am.* 2003;32(4):741-760.

3. Weiss S, Shore S. Obesity and asthma: directions for research. *Am J Respir Crit Care Med*. 2004;169(8):963-968.
4. Centers for Disease Control and Prevention. *Lean works*. http://www.cdc.gov/Features/LeanWorks. Accessed March 28, 2010.
5. Luder E, Ehrlich R, Lou W, Melnik T, Kattan M. Body mass index and the risk of asthma in adults. *Respir Med*. 2004;98(1):29-37.
6. Akinbami LJ, National Center for Health Statistics U.S. The state of childhood asthma, United States, 1980-2005. *Advance Data* 2006;381:1-24.
7. Centers for Disease Control and Prevention. *Healthy weight: body mass index*. 2009. http://www.cdc.gov/healthyweight/assessing/bmi. Accessed September 22, 2009.
8. Centers for Disease Control and Prevention. *NCHS-NHIS early releases of selected estimates*. 2009. http://www.cdc.gov/nchs/about/major/nhis/releases.htm. Accessed February 21, 2009.
9. Romieu I, Mannino DM, Redd SC, McGeehin MA. Dietary intake, physical activity, body mass index, and childhood asthma in the third national health and nutrition survey (NHANES III). *Pediatr Pulmonol*. 2004;38(1):31-42.
10. National Heart, Lung, and Blood Institute. *Export panel report 3: Guidelines for the diagnosis and treatment of asthma*. 2007. http://www.nhlbi.nih.gov/guidelines/asthma. Accessed September 9, 2008.
11. Centers for Disease Control and Prevention. *Obesity Trends: Trends by State 1985-2008*. 2010. http://www.cdc.gov/obesity/data/trend.html. Accessed June 26, 2010.
12. Wang Y, Lobstein T. *Childhood Obesity Projected to Increase Dramatically by 2010*. http://www.jhsph.edu/publichealthnews/articles/2006/wang_obesity.html. Accessed June 26, 2010.
13. Respiratory & Allergic Disease Foundation. *Learning center*. http://www.rad-foundation.org/programs.asp?pg=learn&prog=EmergencyDepartment/home. Accessed March 18, 2009.
14. American Lung Association. *Childhood asthma overview*. 2009. http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=22782. Accessed January 20, 2009.
15. Baskin M, Ard J, Franklin F, Allison D. Prevalence of obesity in the United States. *Obes Reviews*. 2005;6(1):5-7.
16. Akinbami LJ, LaFleur BJ, Schoendorf KC. Racial and income disparities in childhood asthma in the United States. *Ambulatory Pediatr*. 2002;2(5):382-387.
17. Asthma and Allergy Foundation of America. *Asthma Facts and Figures*. http://www.aafa.org. Accessed June 26, 2010.
18. Obesity Society. *Childhood overweight*. 2010. http://www.obesity.org. Accessed March 28, 2010.
19. Singh G, Siahpush M, Kogan M. Rising social inequalities in U.S. childhood obesity 2003-3007. *Ann Epidemiol*. 2010;20(1):40-52.
20. Kopelman P, Caterson I, Dietz W. *Clinical Obesity in Adults and Children*. London: Wiley-Blackwell Publishing; 2006.
21. Platts-Mills T, Sporik R, Chapman M, Heymann P. The role of domestic allergens. *Ciba Foundation Symposium*. 1997;206:173-189.
22. Sturdy P, Victor C, Anderson H, Bland J, Wilman C, Butland B. Psychological, social, and health behavior risk factors for deaths certified as asthma: a national case-control study. *Thorax*. 2002;57(12):1034-1039.
23. Ciprandi G, Pistorio A, Tosca M, Ferraro MR, Cirillo I. Body mass of asthma. *Respir Med*. 2008;103(2):289-295.
24. Ford ES, Mannino DM. Time trends in obesity among adults with asthma in the United States: Findings from three national surveys. *J Asthma*. 2004;42(2):91-95.
25. Schaub B, Von Mutius E. Obesity and asthma, what are the links? *Curr Opin Allergy Clin Immunol*. 2005;5:185-193.
26. Ramos E, Xu Y, Romanova I, et al. Is obesity an inflammatory disease? *Surgery*. 2003;134(2):329-335.
27. Shaaban R, Leynart B, Soussan D, et al. Physical activity and bronchial hyperresponsiveness: European community health survey. *Thorax*. 2007;62,403-410.
28. Fantuzzi G. Adipose tissue, adipokines, and inflammation. *J Allergy Clin Immunol*. 2005;115:911-919.
29. Weisberg S, McCann D, Desai M, Rosenbaum M, Leibel R, Ferrante A. Obesity is associated with macrophage accumulation in adipose tissue. *J Clin Investigation*, 2003;112:1796-1808.
30. Wellen K, Hotamisligil G. Obesity-induced inflammatory changes in adipose tissue. *J Clin Invest*. 2003;112:1785-1788.
31. Beuther D, Weiss S, Sutherland R. Obesity and asthma. *Am J Respir Crit Care*. 2006;174(2):112-120.
32. Sierra-Honigmann M, Nath A, Murakami C, et al. Biological action of leptin as an angiogenic factor. *Science*. 1998;281:1683-1686.
33. Torday J, Sun H, Wang L, Torres E, Sunday M, Rubin L. Leptin mediates the parathyroid hormone-related protein paracrine stimulation of fetal lung maturation. *Am J Physiol Lung Cell Mol Physiol*. 2002;282:405-410.
34. Guler N, Kirerleri E, Ones U, Tamay Z, Salmayenli N, Darendeliler F. Leptin: does it have any role in asthma. *J Asthma Allergy Clin Immunol*. 2004;114:254-259.
35. Lucas S, Platts-Mills T. Physical activity and exercise in asthma: relevance to etiology and treatment. *J Asthma Allergy Clin Immunol*. 2005;115(5):928-934.
36. Centers for Disease Control and Prevention. *Physical activity for everyone: guidelines for children*. http://www.cdc.gov/physicalactivity/everyone/guidelines/children.html. Accessed February 23, 2009.
37. Rasmussen F, Lambrechtsen J, Siersted H, Hansen H, Hansen N. Low physical fitness in childhood is associated with the development of asthma in young adulthood: The Odense Schoolchild Study. *Europ Respir J*. 2000;16(5):866.
38. Abramson M, Wamboldt F, Mansell A, Carter R, Federico M, Wamboldt M. Frequency and correlates of overweight status in adolescent asthma. *J Asthma*. 2008;45:135-139.
39. Lang DM, Butz AM, Duggan AK, Serwint JR. Physical activity in urban school-aged children with asthma. *Pediatrics*. 2004;113(4):e341-346.
40. Firrincieli V, Keller A, Ehrensberger R, et al. Decreased physical activity among head start children with a history of wheezing: Use of an accelerometer to measure activity. *Pediatr Pulmonol*. 2005;40(1):57.
41. Westermann H, Choi T, Briggs W, Charlson M, Mancuso C. Obesity and exercise habits of asthmatic patients. *Ann Aller Asthma Immunol*. 2008;101(5):488-494.
42. American Academy of Pediatrics. *Prevention and treatment of childhood overweight and obesity*. http://www.aap.org/obesity/index.html. Accessed March 28, 2010.
43. National Association of Pediatric Nurse Practitioners. *HEAT clinical practice guidelines*. http://www.napnap.org/ProgramsAndInitiatives/HEAT/HEATclinicalPracticeGuideline.aspx. Accessed March 28, 2010.
44. American Heart Association. Healthier kids. http://www.heart.org/presenter.jhtml?identifier=1477. Accessed March 28, 2010.

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