Prevention Of Asthma In Children

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Abstract

Childhood asthma is a highly morbid respiratory disorder. In spite of effective remedies, heterogeneity of disease process and poor treatment compliance lead to substantial proportion of childhood asthma remaining uncontrolled. Hence, school absenteeism, loss of play hours and sleep disturbances are significant. Strain on health care budget is also high. Newer immunotherapeutic modalities do offer options for a better long-term control. But prevention is always better than cure. Since specific hygrothermal conditions and dietary factors are known to induce and sustain asthma, attention to these environmental and food factors early in life have high potential of averting and reversing the pathophysiologic process and asthma. Health education on these inducing factors and nutritional advice could greatly assist in decreasing asthma prevalence and its associated morbidity and financial costs.

Introduction

Asthma is a chronic inflammatory airway disease characterized by airway hyper-responsiveness which is reversible either spontaneously or with treatment [1]. It has high individual and societal burden. It consumes a substantial fraction of a nation’s health care funds [2-5]. Direct health care costs on medical services, medicines and hospital stay constitute more than 50% of economic loss due to asthma. This expenditure on asthma is quadrupled if child’s asthma is severe enough to require hospitalizations [6, 7]. Over the years, prevalence of childhood asthma has remained high and is increasing [8-10]. Recent advances in management protocols of asthma have decreased mortality and hospitalizations in asthma but morbidity continues to be considerable [9, 10]. In view of this, more focus on prevention of asthma would be beneficial and cost-effective. Since environmental factors and dietary changes have largely contributed to this rise in prevalence of asthma, reversal of these conditions could potentially reduce development of asthma, and its morbidity in persistent disease. Primary multi-faceted preventive measures could possibly minimise emergence of asthma by 50% with similar decline in national health care expenditure on asthma.

Clinical phenotypes of childhood asthma

Greater insights into pathophysiology of childhood asthma have shown that it is a heterogeneous disorder with differential response to standard treatments. Various phenotypes are recognized though the differentiation is not clear-cut. Grossly, asthma in children could be divided into atopic, non-atopic form, transient infantile wheezing and late onset childhood asthma. In the atopic type, there is a history of a close relative suffering from asthma and/or self-history of allergies of eye, nose, or skin. The symptoms start early in life and persist into adulthood with or without a symptomless phase in between. In the non-atopic type of infancy and toddler age group, the child usually wheezes with viral respiratory infections. The frequency of wheeze decreases with age and by 5-6 years, they are usually symptomless. Wheeze response to bronchodilators in them is incomplete and slow. Late onset childhood asthma type usually has an allergic basis. Typing asthma based on clinical symptoms and course, inflammetry, lung functions, genotypes and response to treatment is being attempted and could be more useful [11-14].

What causes wheeze in atopic children?

Environmental factors and dietary elements have been implicated in wheeze in atopic children. Innumerable aeroallergens and food allergens could initiate and sustain childhood wheeze. A host of allergens in child’s environment and excess or deficiencies of certain food factors have been found to be responsible for development of wheeze. Presence of these problems in early life of child causes a genetically predisposed child to start wheezing. Hence moderation of these factors either before or during early exposure holds promise to ward off asthma in these children.

1. Environmental factors:

Inhaled allergens—These could be indoor or outdoor aeroallergens. In infancy, what matters the most are
the indoor allergens. 80-90% of the asthmatics are sensitised to at least one of the common aeroallergens [15, 16]. These indoor allergens have a perennial presence in large numbers in the child’s environment. They are also small enough to be inhaled and reach the lung peripheries wherein their enzymatic degradation initiates an inflammatory process and broncho-constriction. Exposure to these allergens in early life leads to formation of memory T cells which stimulate IgE production on re-exposure to the same allergens [17]. A child exposed to heavy house dust mite load has five times more chances of having asthma than those whose environment is free of these allergens [18]. Allergen sensitization and asthma severity is directly related to the exposure levels [19-28]. High environmental humidity favours growth of these house dust mites. Heavy furnishings and upholstery offer a good microhabitat for house dust mites. Attention to these parameters while designing a house would be useful in diminishing the level of residual house dust mites. Good air exchange rate and dehumidifiers normalise air humidity and hence minimise house dust mite load in environment [19, 29-33]. Domestic pets are another source of indoor allergens. They release allergens in environment which induce and perpetuate asthma. Sensitization to the pet danders is higher in children of families with domestic pets. Chances of sensitization and subsequent asthma increase with longer contact with these animals [16, 25, 26, 34, 35]. Sensitization to other indoor allergens such as cockroach and indoor moulds is also high in children with asthma [36-38]. Grass, weeds and tree pollens are outdoor allergens which could possibly induce type I hypersensitivity in susceptible hosts and lead to development of asthma [39-41].

Environmental tobacco smoke: Prenatal exposure to environmental tobacco smoke increases risk of prematurity, low birth weight and narrow airways. There are high chances of respiratory infections and airway hyperresponsiveness in such babies [42-47]. Various studies have also revealed that passive smoking in early infancy favours mechanisms which promote airway reactivity and asthma [48-50]. Elimination of this irritant in a child’s environment has the potential to decrease substantially risk of wheeze and respiratory infections.

2. Allergic march:

Allergic rhinitis-Allergic rhinitis and bronchial asthma are elements of the same disease process but with different symptomatology (the ‘united airways’ concept) [51-55]. In line with ‘allergic march’, allergic rhinitis often precedes asthma and is a recognized risk factor for it [56-59]. A useful strategy to prevent asthma would be optimal management of allergic rhinitis. Treatment of allergic rhinitis decreases or delays development of asthma and halves risk of asthma-related events [60-64]. Allergen immunotherapy (AIT) or specific immunotherapy (SIT) has been found to play a promising role as disease modifying agent. Follow-up of children treated with SIT has shown that asthma development is lessened in them [63, 65-69].

Atopic dermatitis-Atopic dermatitis has similarly been found to predispose to asthma [70, 71]. Prompt and adequate treatment of atopic dermatitis thwarts the onset of asthma [72].

3. Dietary factors:

Breastfeeding and weaning-Breastfeeding is protective against respiratory and other infections due to maternal transfer of antibodies and immune factors [73, 74]. Also, exclusive breastfeeding causes delay in introduction of cow’s milk which supposedly has 10 million times more of allergenic substances (such as β-lactoglobulin) compared to breast milk [75, 76]. Therefore, breastfed infants are found to have less serum IgE levels and less sensitization to various allergens [77, 78]. Atopic manifestations and asthma are also lesser in breastfed children [78, 79-82]. However, this protective association has not been consistently proven [83-85]. It is believed now that breastfeeding only protects against early wheezing and has no protective effect on asthma in older atopic children [83]. In fact, lesser infections in breastfed babies lead to rise in allergic tendency (hygiene hypothesis). There is also no role of any dietary restrictions for lactating mothers to prevent asthma and atopy in susceptible children [86]. Weaning after 4-6 months with less allergenic foods such as fruits, vegetables, cereals which are introduced one at a time is effective for asthma prevention.

Food components-Fatty acids have been found to play an important role in respiratory health. Omega-3 fatty acids are protective against and omega-6 fatty acids act as promoters of airway inflammation [87, 88]. Fish oils are rich in omega-3 fatty acids and children on oily fish diets have 30-70% less chances of asthma compared to those on standard diets [89-91]. The element, sodium has been found to have an important role in regulation of smooth muscle tone. High salt intake has been found to increase airway
hyper-responsiveness and asthma-related mortality [92-95]. But some studies have concluded to the contrary [96-98]. Sparrow et al and Schwartz et al found that both potassium and sodium have a direct influence on airway hyperactivity and asthma development [96, 99]. On the other hand, magnesium has a bronchodilator action [100]. A UK-based study revealed that those with impaired lung functions and higher wheeze had lower magnesium levels [101]. Thus, magnesium supplementation would aid in bringing down asthma risk and asthma. Compared to standard formulas, partially hydrolyzed formulas are also found to be less allergenic with 60% more improved taste. Infants fed such special formulas were found to have 42-55% reduced risk of atopic dermatitis compared to those on standard formulas [102-105]. Addition of Lactobacillus GG to infant milk formulas has a similar negative effect on development of atopic dermatitis in children [106]. The decline in atopic dermatitis cases would simultaneously cause a similar decrease in asthma and hence such a step would have economic benefits. Vitamins A, C and E are known to possess anti-oxidant properties and can mop up oxygen-free radicals. Cellular damage and inflammation due to these radicals does not take place when levels of these vitamins in diet are sufficient. Fruits and vegetables are rich sources of these vitamins. Hence a diet deficient in fruits and vegetables increases the propensity for respiratory illnesses and wheeze [107, 108]. Strachan et al and Britton et al found that lung function parameters were lower in those with deficiency of these anti-oxidants [109, 110]. But other studies have failed to demonstrate this association [111-113]. However, vitamin D has been found to have an airway protective role and holds promise as a preventive strategy for asthma [114].

4. Other infections:

Mild infections in early life cause a predominant Th1 type of immune response to be activated. Since Th2 is suppressed, allergic tendency is lessened. Viruses, helminths and H.pylori infections have been studied and found to protect against allergic asthma [115-118].

What causes wheeze in non-atopic children?

Poverty, environmental dirt, microbes and psychosocial stress have been implicated in causation of asthma in poor countries [119]. The infections reduce atopy but not asthma. The non-microbicidal irritants also induce and perpetuate wheeze in such children. Attention to these factors would help eliminate and lessen chances of asthma in them.

At risk group

Children with one/both parent(s) suffering from asthma/allergy, those with allergic rhinitis or atopic dermatitis, those having sensitization to one or more allergens, preterm babies, low birth weight babies and those with narrowed airways are susceptible to wheeze. Cord blood IgE levels has been found not to correlate well with asthma tendency. Children exposed to tobacco smoke in utero or early in life are also at increased risk for asthma in later life. Children who are breastfed for less than 4 months, those who have a diet deficient in anti-oxidants/omega-3 fatty acids or diet high in sodium have higher likelihood of asthma. Having known this, measures directed at overcoming these inducing factors may prove effective as preventive strategies for asthma.

Preventive strategies

Various experimental and occupational models have proven beyond doubt that environmental control measures and dietary modifications greatly assist in bringing down the prevalence of asthma [120, 121]. A controlled intervention in ‘at risk’ children reduced to a significant extent development of asthma [122, 123]. House dust mites proliferate in humid conditions. Hence dehumidifying the living areas could lead to a fall in house dust mite population and hence lessen likelihood of asthma. Indoor humidity should be maintained below 50%. Increasing ventilation and removal of humidifying sources in the house such as flower-pots, fish tanks, fountains would be beneficial. Proper humidity could also be achieved by balanced settings for heating and air-conditioning systems [124, 125]. House should be well aerated and sun-exposed. This will create hygrothermal conditions which will minimise house dust mite proliferation. Decarpet the house and avoid heavy upholstery, curtains and furnishings. Vacuum clean and launder the rugs well at regular intervals. Mattresses carry a heavy load of house dust mites. Sun exposure could kill them [126]. Use of dust mite protective covers for the mattresses can also reduce the allergen encumbrance and asthma risk in susceptible children. Bed-sheets should be washed regularly in hot water and preferably sundried. Pillows should be changed at frequent intervals. Soft toys in the child’s environment should
be removed/lessened [127]. Anti-mite chemicals can eradicate the mites but simultaneously care should be taken to remove the dead mites and their allergens from the furnishings as these also induce asthma [128-130]. The above steps taken in early life have the potential to prevent asthma. For allergy to pet dander/hairs/secretions, restricting the entry of pets to the house especially the bedroom may help cut down the asthma risk [131]. If sensitized patient is reluctant to part with the pet, change to wooden or hard floors, adequate frequent laundering of furnishings and daily appropriate dusting of smooth surfaces and brooming/vacuuming of floors will minimise the allergen level in the atmosphere and hence asthma risk [132]. It has been seen that after a cat is removed from the house it may take as long as 6 months for the effect of the allergen avoidance to be noticeable [133]. Damp moldy areas in the house should be fixed [134]. Elimination of the environmental tobacco smoke exposure can decrease respiratory symptoms including wheeze [135]. Children with nasal/eye allergy due to pollens are benefited by prophylactic drugs or pre-seasonal and coseasonal immunotherapy. Control of these allergies prevents asthma development [136]. Similarly, effective management of atopic dermatitis either delays or stops asthma in later life [137]. Breastfeeding for at least 4-6 months has a protective effect on asthma and wheeze-related respiratory infections [138]. Ensuring adequate amounts of recommended vitamins, minerals and essential fatty acids in diet in the long run avoids development of asthma. Supplementation with omega-3 fatty acids in ‘at-risk’ group reduces chances of asthma and wheeze [114, 139-141]. Since serious viral infections in infancy predispose to later wheeze, prevention of such infections with adequate care and vaccinations would be useful in prevention of asthma [142, 143].

**Conclusion**

Thus childhood asthma is multi-factorial. Various inducing factors are involved in its causation. At the same time, many environmental and dietary factors when controlled could protect against occurrence of asthma. Thus cutback of ‘inducers’ and augmentation of ‘protectors’ could help prevent asthma. It is no doubt a multi-pronged, tedious, time-consuming, laborious and sometimes unpredictable approach, but such preventive measures would have long-term individual, social and financial connotations. Health education and community approaches to disseminate such preventive strategies should be carried out for better success and outcomes. With successful implementation of such measures, freedom from asthma would not be an impossible dream!

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