

# The effects of maternal diet and breastfeeding on children with asthma and allergy

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## Abstract

The increase in the prevalence of asthma and allergic diseases highlights the need for devising effective prevention strategies. Several studies have investigated the preventive effect of maternal avoidance of highly allergenic foods, such as cow's milk, eggs, and nuts, during pregnancy to protect the foetus from the effect of food allergens ingested by the mother.

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## Introduction

Asthma is a chronic, complex, obstructive lung disease, characterised by acute symptomatic episodes of varying bronchial constriction that occur in response to viral infections or other triggers, such as allergens and exercise.<sup>1,2</sup> The disorders and syndromes associated with immediate-onset allergy are classified as atopic and non-atopic disorders.<sup>3</sup> Immunoglobulin E (IgE) interacts with its high-affinity receptor, Fc epsilon RI, and is considered to be a major contributing factor to most types of allergy. However, depending on the type of allergy, a subgroup of patients may display common symptoms, but lack elevated levels of total serum IgE or antigen-specific IgE.

There has been a dramatic increase in the prevalence of asthma and other allergic diseases over the last few decades. They are now major public health problems,<sup>2,4</sup> and place an enormous burden on healthcare resources.<sup>5</sup> Severe asthma and systemic allergic reactions are potentially life-threatening conditions. Additionally, these diseases adversely affect the quality of life of millions of children and adults. Common clinical manifestations of allergy include asthma, allergic rhinitis, atopic dermatitis and food allergy. The definition and diagnosis of asthma in early childhood is most challenging in view of the lack of uniform criteria and availability of objective tests to support the diagnosis. Early childhood allergic manifestations are often transient, and yet many studies report short-term (< 5 years follow-up) periods. Most studies suggest that an intervention such as exclusive breastfeeding prevents wheeze in early childhood.<sup>6</sup> However, recently, it has been reported that it might increase the risk of asthma in early adult life.<sup>7</sup>

## Pathophysiology

IgE antibody-mediated responses are the most widely recognised form of food allergy, and account for acute

reactions. Patients with atopy produce IgE antibodies to specific epitopes (areas of the protein) of one, or more, food allergens. These antibodies bind to high-affinity IgE receptors on circulating basophils and tissue mast cells present throughout the body, including the skin, gastrointestinal tract and respiratory tract.

Subsequent allergen exposure binds and cross-links IgE antibodies on the cell surface, resulting in receptor activation and intracellular signalling, that initiates the release of inflammatory mediators, e.g. histamine, and the synthesis of additional factors, e.g. chemotactic factors and cytokines, that promote allergic inflammation. The effects of these mediators on surrounding tissues result in vasodilatation, smooth muscle contraction and mucus secretion, which, in turn, are responsible for the spectrum of clinical symptoms observed during acute allergic reactions to food.

## Breastfeeding

The duration of the preventive effect of breastfeeding in allergic diseases remains controversial. Exclusive breastfeeding does seem to prevent wheeze and atopic dermatitis during early childhood.<sup>6,8</sup> Despite the fact that many studies report short-term (< 5 years follow-up) periods, a relatively small study of at-risk children with 15 years prospective follow-up, showed a reduction in allergic manifestations in the breastfed children, compared with those fed cow's milk or soy milk.<sup>9</sup>

However, several large observational studies failed to show a long-term prospective effect of exclusive breastfeeding on asthma or other allergic manifestations.<sup>7,10,11</sup> Two systematic reviews showed that exclusive breastfeeding seems to have some prospective effect on the development of allergy.<sup>12</sup> This effect might be due to avoidance of cow's milk protein allergen, other dietary constituents of breast

milk, an immunomodulatory effect, or a combination of these. Recently, it was suggested that the effect of exclusive breastfeeding might be dependent on atopic heredity. Those with a genetic predisposition had a lower incidence of sensitisation, whereas children without such a predisposition had an increased risk.<sup>12,13</sup>

### Maternal diet

A randomised controlled trial showed that a maternal diet excluding cow's milk and egg during pregnancy does not protect against the development of allergic manifestations in genetically predisposed children.<sup>14</sup> Zeiger et al<sup>15</sup> evaluated the effect of maternal avoidance of allergenic foods (cow's milk, eggs, nuts, fish and soy) during late pregnancy and lactation, supplementation with extensive hydrolysate, and avoidance of solids up to six months. There was a reduction in food sensitisation on skin prick tests, food allergy manifestations and atopic dermatitis at the age of two years. However, no long-term benefit beyond early childhood was observed.<sup>16</sup> Lack of weight gain during the third trimester was again a concern in mothers who practised an avoidance diet.<sup>17</sup> In contrast, children of substantial weight, either at birth or later in childhood, are at increased risk of acquiring asthma in the future.<sup>18</sup> In a randomised controlled trial, maternal avoidance of highly allergenic foods (dairy produce, eggs, fish, peanuts and soy) during breastfeeding of high-risk infants led to a reduction in the prevalence of atopic dermatitis at 18 months.<sup>19</sup>

### Antioxidants

Some observational studies link the intake of antioxidants, such as vitamins C, E and A, and selenium, with the occurrence of atopy and asthma.<sup>11,20</sup> Studies consistently show a protective effect of omega-3 polyunsaturated fatty acids (PUFAs), and an increased risk with a high intake of omega-6 PUFAs.<sup>21,22</sup>

### Vitamin C

Studies have demonstrated that dietary vitamin C (ascorbate) is positively associated with forced expiratory volume in one second (FEV<sub>1</sub>) in children and adults.<sup>23,24</sup> In the First National and Nutrition Examination Survey (NHANES I), dietary vitamin C intake was positively associated with FEV<sub>1</sub> in adults, with a mean 40 ml FEV<sub>1</sub> difference between subjects with the highest and lowest centiles of vitamin C intake.<sup>24</sup> Dietary vitamin C has been less frequently associated with asthma and wheezing symptoms in children and adults.<sup>24,25</sup> In NHANES III, a negative association between ascorbate and asthma was reported in children aged 4-16 years, with a standard deviation increase in serum ascorbate associated with a 19% reduction in asthma prevalence.<sup>26</sup>

### Vitamin E

Lipid-soluble vitamin E is the principal defence mechanism against oxidant-induced membrane injury. In contrast to vitamin C, it also has non-antioxidant effects on immune function, which might account for differences in its epidemiological associations. Studies have consistently demonstrated beneficial associations between dietary vitamin E and ventilatory function,<sup>27-29</sup> and a few have demonstrated beneficial associations with asthma and atopy.<sup>30,31</sup> In a study among children aged 11-19 years, dietary vitamin E intake was positively associated with ventilatory function.<sup>28</sup> These associations were more marked in boys, with dietary vitamin E intakes in the lowest centiles being associated with reduced FEV<sub>25-75</sub> (8.9%), FEV<sub>1</sub> to forced vital capacity ratio (2.3%) and peak expiratory flow rate (5.1%). The Caerphilly heart disease study<sup>29</sup> reported that dietary vitamin E intake was positively associated with FEV<sub>1</sub> in a cross-sectional analysis. Dietary vitamin E intake was negatively associated with asthma and wheezing in a case-control study of 12-year-old Saudi Arabian children.<sup>30</sup>

### Selenium

Selenium is an important antioxidant, principally because of its incorporation into glutathione peroxidase, an enzyme that plays a key role in protecting cells against oxidative damage. Selenium status has been negatively associated with asthma, respiratory symptoms and ventilatory function.<sup>26,27,32</sup>

### Fruit

Beneficial associations have been reported between fruit intake and asthma,<sup>32,33</sup> ventilatory function<sup>29</sup> and respiratory symptoms<sup>34</sup> in children.

### Lipids

An attractive feature of the hypothesis is the proposed mechanism by which atopic sensitisation and inflammation could be promoted by decreasing dietary intakes of omega-6 PUFAs from margarine and vegetable oils, and increasing intake of omega-3 PUFAs from oily fish.<sup>35</sup> Several studies have reported the beneficial associations between dietary fish intake, asthma, and atopic disease.<sup>36-38</sup> Hodge et al<sup>38</sup> reported that in children aged 8-11 years, the risk of current asthma was significantly reduced in those who included fish oil in their diet.

### Hydrolysed milk formula

A number of trials have been conducted over the last two decades to assess the preventive effect of replacing cow's milk formula with hydrolysate or soy milk formula. Chandra et al<sup>39,40</sup> compared the development of allergies (asthma, atopic dermatitis and food allergy) in groups of children fed breast milk, hydrolysed formula, cow's milk formula and soy formula. Another study, comparing cow's milk formula and whey hydrolysate, showed a reduction in cow's milk allergy

and atopic dermatitis in the first year of life.<sup>41</sup> In a study by Marini et al,<sup>42</sup> it was found that exclusive breastfeeding, combined with hydrolysate supplementation, led to a significant reduction in various allergic manifestations up to the age of three years. Another trial showed the prevention of atopic dermatitis, but not asthma, with the use of hydrolysed formula.<sup>43</sup>

## Conclusion

Restriction of proposed allergenic foods (cow's milk, eggs, peanuts, fish and soy) during pregnancy may not prevent allergy. Maternal food allergen avoidance may be of some benefit during lactation. Dietary antioxidants probably have antioxidant and non-antioxidant immunomodulatory effects. Dietary lipids have numerous complex effects on proinflammatory and immunologic pathways. Further research to determine whether dietary intervention can reduce the risk of asthma is needed.

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