Dietary risk factors for childhood asthma in a semi-urban area of South India: A cross-sectional study

G Muraleetharan, G Anuradha

From Associate Professor, Department of Pediatrics, IRT-Perundurai Medical College and Hospital, Erode, Tamil Nadu, India

Correspondence to: G Anuradha, Department of Pediatrics, IRT-Perundurai Medical College Hospital, Perundurai, Erode - 638 053, Tamil Nadu, India. E-mail: anuanu_guna@rediffmail.com

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ABSTRACT

Background: Although inhaled allergens are more likely to trigger asthma than food allergens, global trends of asthma prevalence emphasize the role of changing dietary habits in modulating the inflammatory mediators involved in the pathogenesis of asthma. **Objective:** The objective of the study was to identify the dietary risk factors associated with childhood asthma in a semi-urban region of South India. **Materials and Methods:** This was a cross-sectional study done at a medical college hospital in South India from October 2016 to January 2017. After obtaining the Ethical Committee approval, children aged 3–15 years attending the pediatric outpatient department were enrolled in the study. Parents were interviewed with a precoded Food Frequency Questionnaire. Details regarding common dietary practices followed at home, frequency of consumption of specific food groups and history of food allergy were obtained. Chi-square tests and logistic regression analysis were used to analyze the data. **Results:** Among 500 subjects, 293 (58.6%) children had physician-diagnosed asthma. Duration of breastfeeding was <1 year (OR 2.01, 95% CI 1.35–2.99); frequent intake of fast food (OR 2.70, 95% CI 1.61–4.52), usage of coloring agents and taste enhancers in cooking (OR 3.93, 95% CI 1.53–10.06), and history of allergy to specific foods (OR 2.21, 95% CI 1.42–3.45) were found to be independent risk factors for childhood asthma. The absence of fish in the diet was significantly associated with increased risk of asthma (OR 1.50, 1.04–2.15) and non-vegetarians were at lesser risk (OR 0.43, 0.24–0.76) of developing asthma. **Conclusion:** Prolonged duration of breastfeeding (>1 year), restriction of fast food, and avoidance of food additives decrease the risk of asthma in children. Non-vegetarian diet with the inclusion of fish offers a protective effect against asthma. Early identification and appropriate management of coexisting food allergies in children with asthma are necessary.

Key words: *Asthma, Children, Diet, Fast food, India, Risk factors*

Asthma is a chronic inflammatory disease of the airways associated with hyperresponsiveness and reversible bronchoconstriction with variable clinical course and outcome. Globally, about 339 million people are estimated to be affected by asthma [1], with considerable higher morbidity and mortality in low-middle-income countries [2]. In the majority of cases, the onset is in early childhood and approximately 6% of children in India suffer from asthma [1]. The treatment of childhood asthma by standard regimen is constantly evolving, yet due to diverse etiological factors, prevention continues to remain elusive. The disease process manifests as the interplay between various environmental triggers, genetic susceptibility and host response.

The role of dietary factors in the precipitation of asthma has gained much attention from the researchers in the past decade [3,4]. Decreased antioxidant intake, changing composition of polyunsaturated fatty acids, and altered gut microbiota are some of the postulated mechanisms resulting in either upregulation of the pro-inflammatory pathways or downregulation of the anti-inflammatory markers [5]. Studies have focused on the association of individual nutrients with asthma (i.e., Vitamin D3 and selenium) [6,7], evaluation of the role of specific foods (i.e., fish) [8], and identification of the protective effects of a dietary pattern (i.e., the Mediterranean diet) [9]. The impact of nutrients in asthma has been studied right from the prenatal period to adolescence and adulthood, although with inconsistent results [5,10]. Dietary habits and food groups beneficial to one population may not be exactly applicable to the other simply due to the difference in the ethnic, genetic, and regional differences.

In general, children's dietary habits depend on the availability, accessibility, local customs, parental beliefs, food fads, and peer group influences, especially in adolescence. Hence, this study was designed to focus on the common food practices in a semi-urban region of South India and to evaluate the role of various dietary factors in precipitating childhood asthma.

MATERIALS AND METHODS

This was a cross-sectional observational study done in the pediatric outpatient department of a medical college hospital from October

2016 to January 2017 after obtaining the Institutional Ethical Committee approval. The hospital had a chest clinic and served as a referral center for childhood asthma and tuberculosis; children with respiratory ailments formed a major proportion of OP cases. Children aged 3–15 years attending the OP were included in the study. Children warranting in-patient pigmenti treatment for other systemic illnesses, children with feeding difficulties due to neuromuscular disorders, and children suffering from chronic diarrhea were excluded from the study.

After getting written consent, basic demographic details and anthropometric indices were documented, and nutritional status was categorized using the WHO growth charts for children below 5 years of age and the Indian Academy of Pediatrics growth charts for children above 5 years. Parents were interviewed using a pre-coded food frequency questionnaire. Details regarding common dietary practices followed at home were obtained using "dietary recall" method. Analysis of the frequency of consumption of specific food groups in the present study population was performed. Intake of a particular food 3 or more times in a week was considered as frequent and <3 times in a week or no intake was considered as infrequent. History of any allergic reactions to specific foods was also recorded. Diagnosis of asthma was confirmed on the basis of medical records and the study population was grouped into children with asthma and without asthma.

Data were entered into Microsoft Excel and SPSS version 16.0 was used for statistical analysis. The prevalence of dietary risk factors among the study population was calculated using proportions. Chi-square tests of significance were used to analyze the differences between proportions. Binary logistic regression was used to calculate the adjusted odds ratio (OR) and $p<0.05$ was considered statistically significant.

RESULTS

A total of 500 children were included in the study; 293 (58.6%) subjects had physician-diagnosed asthma and 207 (41.4%) did not suffer from asthma. Among the study population, 298 (59.6%) were males and 336 (67.2%) were above 5 years of age. Nearly two-thirds of the study participants were from rural settings and one-third of them were undernourished. The demographic distribution among the two groups was comparable (Table 1).

A significant association was observed in the total duration of breastfeeding with childhood asthma (Table 2). There was a two-fold increase in the risk of developing asthma in children who were breastfed for <1 year in comparison to those who were breastfed for more than 1 year. The absence of fish in the diet and usage of coloring agents and taste enhancers in cooking were significantly associated with increased risk of asthma (Table 2). Non-vegetarian diet provided a lesser risk of developing asthma in comparison to vegetarian diet. Nearly one-third of the study population, 170 (34%) had a history of allergy to specific foods and majority among them, 123 (72.4%) were diagnosed with asthma; furthermore, these children had a significantly higher risk of developing asthma (OR 2.46, 95% confident interval [CI] 1.65–3.67).

Table 1: Background characteristics of the study population

Characteristics	Asthma (n=293)	No asthma (n=207)	p-value
Age (years)			
<5	100 (34.1)	64 (30.9)	0.45
>5	193 (65.9)	143 (69.1)	
Sex			
Male	174 (59.4)	124 (59.9)	0.90
Female	119 (40.6)	83 (40.1)	
Locality			
Rural	199 (67.9)	133 (64.3)	0.39
Urban	94 (32.1)	74 (35.7)	
Nutritional status			
Undernutrition	110 (37.5)	65 (31.4)	0.18
Normal	173 (59.1)	138 (66.7)	
Overweight	10 (3.4)	4 (1.9)	

Table 3 illustrates the association of childhood asthma with the frequency of specific food groups. Consumption of fast food for 3 or more times a week was significantly associated with increased risk of asthma in children, OR 3.24 (95% CI, 2.02–5.21). Frequent intake of carbonated drinks was also associated with a higher risk of asthma. Children with increased intake of fruits and non-vegetarian diet on a weekly basis had a lesser risk of developing asthma, but the association was not observed to be statistically significant.

In binary logistic regression analysis, a significant association was observed with the duration of breastfeeding for <1 year, frequent intake of fast food, use of coloring agents and taste enhancers in cooking, and history of allergy to food products with an increased risk of childhood asthma (Table 4).

DISCUSSION

In the present study, although any association of the duration of exclusive breastfeeding with asthma was not observed, the total duration of breastfeeding for >1 year demonstrated a protective effect. Children who were breastfed for <1 year were significantly at higher risk of developing asthma. Kemp and Kakakios have concluded that breastfeeding should be recommended for its preventative effects of atopy and asthma in childhood, in addition to various other proven benefits of breastfeeding on child growth and development [11]. The conclusion put forward by them has allayed the concerns raised by a few studies regarding the long-term outcome of increased risk of allergy in later life in breast-fed children [12].

Contrary to the popular perception, consuming non-vegetarian diet was associated with a lower risk of asthma in the present study group. Koolwal *et al*. have reported similarly in a community-based observational study in North India [13]. Compared to the West, consumption of processed and tinned meat is very less in India and the method of cooking meat is also different. In the present study, it was observed that low fish intake was linked to increased risks of asthma. This link well documented further in a multicentric study. Antova *et al*. demonstrated the beneficial effects of even a minimal fish intake of one portion per

Table 2: Association of dietary factors with childhood asthma

Dietary risk factors	Children with asthma N (%)	Without asthma N (%)	Odds ratio (95% CI)	p-value
Exclusive breastfeeding (months)				
<4	83 (56.5)	64 (43.5)	0.88 (0.59–1.30)	0.53
>4	210 (59.5)	143 (40.5)		
Total duration of breastfeeding (year)				
<1	203 (66.3)	103 (33.7)	2.27 (1.57–3.29)	<0.001*
>1	90 (46.4)	104 (53.6)		
Diet pattern				
Non-vegetarian	240 (55.9)	189 (44.1)	0.43 (0.24–0.76)	0.003*
Vegetarian	53 (74.6)	18 (25.4)		
Fish				
No fish	147 (63.9)	83 (36.1)	1.50 (1.04–2.15)	0.026*
Fish in diet	146 (54.1)	124 (45.9)		
Cooking oil				
Sunflower/refined oil/vanaspati	281 (59.3)	193 (40.7)	1.66 (0.76–3.75)	0.18
Gingelly/groundnut/coconut oil	12 (46.2)	14 (53.8)		
Coloring agents and taste enhancers				
Yes	51 (89.5)	6 (10.5)	7.06 (2.9–16.7)	<0.001*
No	242 (54.6)	201 (45.4)		
History of food allergy				
Yes	123 (72.4)	47 (27.6)	2.46 (1.65–3.67)	<0.001*
No	170 (51.5)	160 (48.5)		

***Statistically significant, CI: Confident interval**

Table 3: Association of the consumption of specific food groups and childhood asthma

Food groups (times/week)	With asthma N (%)	Without asthma N (%)	Odds ratio (95% CI)	p-value
Leafy vegetables				
<3	198 (57.6)	146 (42.4)	0.87 (0.59–1.28)	0.48
≥3	95 (60.9)	61 (39.1)		
Fruits				
<3	156 (61.4)	98 (38.6)	1.26 (0.88–1.80)	0.19
≥3	137 (55.7)	109 (44.3)		
Non-vegetarian diet				
≥3	11 (42.3)	15 (57.7)	0.49 (0.22–1.11)	0.083
<3	282 (59.5)	192 (40.5)		
Carbonated drinks				
≥3	67 (67)	33 (33)	1.56 (0.98–2.47)	0.057
<3	226 (56.5)	174 (43.5)		
Fast food				
≥3	96 (78)	27 (22)	3.24 (2.02–5.21)	<0.001*
<3	197 (52.3)	180 (47.7)		
Biscuits/packed snacks				
≥3	220 (58.8)	154 (41.2)	1.03 (0.68–1.56)	0.86
<3	73 (57.9)	53 (42.1)		
Hotel food				
≥3	29 (51.8)	27 (48.2)	0.73 (0.41–1.27)	0.27
<3	264 (59.5)	180 (40.5)		

***Statistically significant, CI: Confident interval, OR: Odds ratio**

month in reducing the prevalence of asthma-related respiratory symptoms [14].

In the present study, traditional cooking oils used in South India such as gingelly oil, groundnut oil, and coconut oil offered a protective effect against asthma in children, but the group was small and the association was not significant. The risk of increased levels of trans-fat in the hydrogenation of vegetable oils has been established by Dorni *et al*. [15]. The effects of modern oil extraction and processing

Table 4: Logistic regression analysis for dietary risk factors in childhood asthma

Dietary risk factors	Unadjusted OR	Adjusted OR	95% CI for adjusted OR	p-value
Breastfeeding <1 year	2.27	2.01	1.35–2.99	0.01*
Non-vegetarian diet	0.43	0.57	0.29–1.12	0.10
No fish in the diet	1.50	1.44	0.92–2.26	0.10
Fast food (≥3 times/week)	3.24	2.70	1.61–4.52	<0.001*
Coloring/taste enhancer	7.06	3.93	1.53–10.06	0.04*
H/O food allergy	2.46	2.21	1.42–3.45	<0.001*

***Statistically significant, CI: Confident interval, OR: Odds ratio**

techniques in altering the unique fatty acid composition of vegetable oils and its impact on human health needed further evaluation.

Usage of coloring agents, taste, and flavor enhancers was an independent risk factor for pediatric asthma with adjusted OR 3.93 (95% CI 1.53–10.06). Common food additives indicted in food intolerance and asthma were sulfites, artificial food colors (i.e., yellow food dye tartrazine), and monosodium glutamate [16]. In a multicenter study, Fuglsang *et al*. demonstrated the intolerance to food additives in children with allergy and atopy [17]. The health impact of food additives has been a topic of discussion for long and a clear cut decision is pending due to the lack of randomized controlled trials in children [18]. Until then, the usage of non-nutritious additives should be avoided in domestic settings.

In general, "food intolerance" refers to any adverse reactions to foods, toxic, or non-toxic. Non-toxic and non-immune-mediated adverse reactions due to enzyme defects (i.e., lactase deficiency), pharmacological effects (i.e., vasoactive amines), and irritants (i.e., spices) are more common than the immune-mediated reactions. Those immune-mediated adverse reactions (Immunoglobulin E [IgE] dependent or non-IgE dependent) that occur reproducibly with repeated exposures to specific foods are termed as "food allergy" [16]. Children with a history of allergic reactions to foodstuffs were at significantly higher risk of developing asthma in the present study.

In a population-based study, Vermeulen *et al*. have demonstrated that infants with oral challenge with proven food allergy at 1 year are at increased risk of developing asthma at 4 years of age and the risks increase three-fold when there are two or more food allergies [19]. Foong *et al*. have suggested that in children with coexisting food allergy and asthma are at increased risk of the occurrence of life-threatening complications such as allergen-triggered asthma episodes, severe asthmatic episodes, and food-induced anaphylaxis [20]. Hence, it is important to consider food allergy in children with poorly controlled asthma with frequent and severe exacerbations in spite of controller medications. Low intake of fruits was associated with non-significant increased risk of asthma. There was no observation obtained that hinted of any association with infrequent intake of green leafy vegetables and asthma in children. Although studies have shown mixed results on the beneficial effects of fruits and vegetables in the prevention of childhood asthma [21], Nagel *et al*. have demonstrated the association of frequent consumption of fruits and vegetables with a lower lifetime prevalence of asthma [22].

Frequent intake of carbonated drinks and fast food was associated with a higher risk of childhood asthma in the present study and fast food was found to be an independent risk factor. Poongadan *et al*. have reported a similar association of fast food with childhood asthma in Northern India [23]. The possible mechanisms suggested include increased levels of trans-fat, fatty acids, sodium, calorie content, and preservatives in fast foods. Furthermore, frequent consumption of fast foods tends to decrease the intake of protective foods. The increased risk of asthma in children with fast foods seems to be a part of a global epidemic as documented by Ellwood *et al*. in the International Study of Asthma and Allergies in Childhood Phase III study [24]. The fast food availability and accessibility link should be strictly monitored and awareness campaigns should be undertaken by the health-care providers and policymakers against the alarming rise in fast food consumption.

As the dietary history was obtained by interviewing the parents, chances of memory bias or recall bias were possible. Family history of asthma, specifically cases of asthma in siblings, was not studied which would have justified the causal role of dietary factors. The present study did not analyze the impact of rice and milk intake with asthma as they were universally taken by the study population. Skin prick tests, *in vitro* IgE assays, or oral provocation tests were not done to establish the diagnosis of food allergy and this was an important limitation of the present study.

CONCLUSION

Prolonged duration of breastfeeding remains the foremost measure in the prevention of asthma in children. Urgent measures are needed to restrict the consumption of fast foods among children. Usage of food additives should be avoided in home settings, early identification and appropriate management of coexisting food allergies in children with asthma would be helpful in decreasing morbidity and mortality. Non-vegetarian diet, particularly with the inclusion of fish, offers a protective effect in decreasing the risk of childhood asthma. Although the results were inconclusive, decreasing the intake of carbonated drinks and increasing the intake of fruits and vegetables should be advised in view of the overall health benefits.

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