PAPERS AND SHORT REPORTS

Height of primary school children and parents' perceptions of food intolerance

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Abstract

In the national study of health and growth parents' responses to a self completed questionnaire were used to categorise children according to their experience of food intolerance. The heights of the children in each group were then compared. Useful responses to the questions on food intolerance were received for 6813 (85%) children in the sample and measurements of height obtained for 7856 (98%). Children with food intolerance were shorter than other children. A difference in height of about 1.5 cm remained after adjusting for social and biological factors and some common symptoms in childhood using multiple regression. The number of different types of food avoided was associated with shortness in the food intolerant group but not in the non-food-intolerant group.

Regardless of the underlying aetiology, these findings suggest that parents' complaints of food intolerance in their children should be taken seriously.

Introduction

Using the answers to a questionnaire completed by parents we have shown that food intolerance in their children was associated with symptoms such as asthma and eczema and that the prevalence of food intolerance varied with social background.¹ This study explores the relation between food intolerance and the height of the child.

In recent years food intolerance has been suggested as a causative factor in numerous conditions, including many which are common in childhood, such as asthma, eczema, and "hyperactivity."² Ascertaining whether food is indeed a cause of these conditions is

problematic because of the lack of reliable diagnostic tests and the difficulty of distinguishing between organic and psychogenic effects of food and diet.³ Though recognising that food intolerance exists, many doctors remain sceptical about the importance of idiosyncratic reactions to foods in the cause of illness. They point out that many food intolerances are comparatively minor and that in most people who are investigated for food intolerance no objective evidence can be found.⁴

Determining the prevalence of food intolerance and its severity is important to improve public and professional knowledge and to gain insight into the processes of the condition. The task is not straightforward. Food intolerance is an imprecise term which covers a wide variety of symptoms and conditions for which there is no single reliable diagnostic test. In children a simple indicator of the severity of a condition is its effect on growth. Other things being equal, growth—that is, in terms of height—is a general measure of health which may be influenced by diet and disease as well as psychological wellbeing,⁵ all of which may play a part in food intolerance.

In the national study of health and growth we have used parents' perceptions to define a group of children as food intolerant and the height of these children as an indicator of their overall health.¹

Population and methods

The study was performed as part of the 1984 national study of health and growth. This is a survey of the nutritional state of primary school children which has taken place each year since 1972.⁶ At each survey the parents are sent a questionnaire to complete and measurements are made of the children's height, weight, and triceps skinfold thickness. A total of 8049 children participated in the 1984 survey. The sample included all children attending primary school in 27 areas in England and Scotland. The areas were selected by stratified random sampling to include proportionally more children from poorer social groups.

The questionnaire used in the survey includes questions on parents' height, child's weight at birth, number of children in the family, and the child's respiratory symptoms in terms of a history of asthma and bronchitis in the past 12 months and symptoms of cough and wheeze. It also contains questions on parents' employment and the mother's education.

In 1984 a three part section on food intolerance was included in the questionnaire. The first part contained questions on the child's history of food intolerance. The second part asked parents to indicate what foods they

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had ever cut out of their child's diet and the third part asked about the occurrence of some respiratory symptoms and some other symptoms commonly associated with food intolerance¹ (see table III).

The exact questions on the history of food intolerance were, "Has this child ever had an illness or trouble caused by eating a particular food or foods?" and "Has this child nearly always had the same illness or trouble after eating this type of food?" A child was classified as food intolerant if the answer was "yes" to both questions. When the answer to the first question was "no" the child was classed as not food intolerant. When the answer to the first question was "yes" but the second answer was "no" or was not completed, then the child's food intolerance state was recorded as "uncertain."² The question on food avoidance was, "Have you ever cut out any of the following types of food from this child's meals for a long period of time and if so was it following a doctor's advice or your own decision? (Please do not answer YES for types of food avoided just because of dislike or religious reasons.)" Parents were asked to indicate from a list which foods had been avoided for at least six months (see table IV for the food items listed).

The children's height was measured at school by school nurses supervised by a full time fieldworker. Height was measured on a portable Holtain Stadiometer to the nearest complete 0.1 cm by a well recognised technique.⁷

To facilitate comparisons between children of different ages and sex each child's height was used to calculate a height standard deviation score. This was calculated for each child as the difference between the child's height and the mean height of children of the same age and sex, divided by the standard deviation for that group. This method of expression standardises for the increased variance in height between the ages of 5 and 11 and almost completely removes the effects of age and sex on height. The standard deviation score was calculated by using measurements of height from the 1984 survey. One standard deviation score is equivalent to about 5 cm at age 5 and about 7 cm at age 11.

Analyses were done to examine the relation between food intolerance and height and to explore possible interactions among food intolerance, the avoidance of some foodstuffs, and the child's symptoms. Multiple regression was performed to assess the contribution of these factors to a child's height when other variables were also taken into account. In the multiple regression the child's height standard deviation score was the dependent variable. Independent biological and social variables which were used in the model throughout were the mother's and father's reported height, the child's birth weight, number of children in the family, father's social class, father's employment state, and mother's education. Variables relating to food intolerance, the number of foods avoided, and symptoms were then added to this model.

Mother's and father's height and the child's birth weight were entered as continuous variables. The number of children in the family was treated as a continuous variable with a range of one to eight. Social class was divided into five categories: non-manual, skilled manual, semiskilled and unskilled manual, not known or unclassifiable, and a category for children living with a single mother. Father's employment was classified into six groups: employed, unemployed for less than 12 months, unemployed for more than 12 months, unemployed when the length of time was unspecified, not known, and not known when a child was living with a single mother. Mother's education was divided into elementary, secondary, technical, university, or not known. With the exception of wheeze, each symptom was treated as a dichotomous variable with one category when the symptom was present and another when the symptom was absent. Incomplete answers to the questions on symptoms were treated as follows: when none of the items relating to symptoms were completed the child was omitted from the analysis; when one or more of the questions on symptoms were completed, then a missing answer was treated as the symptom being absent. Wheeze was divided into three categories: never wheezed or not known, ever wheezed, and wheezes on most days.

A variable describing the number of types of food avoided was created from the answers to the questions on foods cut out of the child's diet. This variable had five levels, no foods avoided and one, two, three, or four or more different types of food avoided. Food intolerance state was divided into four categories based on the answers to the two questions on food intolerance: food intolerant; uncertain; not food intolerant; not known.

Adjusted mean heights were calculated for the food intolerance groups to fixed values of the other variables. The value for continuous variables was the mean for that variable, and for categorical variables the value was adjusted to reflect the value that would be obtained if there was an equal distribution of subjects in each level of the category.

Results

Useful responses to the questions on food intolerance were received for 6813 children (85% of the total sample). Height measurements were

obtained for 7856 children (98%) and for 6763 (99%) of the children for whom questions on food intolerance were completed.

Table I gives the mean heights of children in the four food intolerance categories. Children who were classed as food intolerant were significantly shorter than those whose food intolerance state was uncertain ($p<0.01$) or who were not food intolerant ($p<0.01$). The magnitude of difference in height standard deviation scores between the food intolerant and non-food-intolerant children was -0.31 (95% confidence interval -0.45 to -0.17). Children in the "not known" group were those for whom measurement of height was obtained but for whom no useful answers to the questions on food intolerance were received. These children were not significantly taller than the food intolerant group but were significantly shorter than those who were not food intolerant ($p<0.01$). For most of these children no questionnaire was completed, so it was not possible to include them in subsequent analyses.

A significant difference in height between the food intolerant and non-food-intolerant children ($p<0.01$) remained after adjusting for the following factors in a multiple regression analysis: mother's height, father's height, child's birth weight, number of children in family, father's social class, father's employment state, and mother's education (table II). The difference in height between the group whose food intolerance state was uncertain and the non-food-intolerant group was not significant.

Table III gives the mean height standard deviation scores of children with and without symptoms asked about in the questionnaire. Significant differences in unadjusted height were found for six of the 11 symptoms. When each symptom was added individually to the basic model only eczema and wheeze were significantly associated with height after adjustment for the social and biological variables ($p<0.05$). Adding individual symptoms to the model including food intolerance made very little difference to the estimated mean heights of the food intolerance groups. When all the symptoms were included together with social and biological factors the estimated mean difference in height standard deviation scores between the food intolerant and non-food-intolerant groups was -0.25 (95% confidence interval -0.39 to -0.11).

TABLE I—Unadjusted mean height standard deviation scores* of children stratified by food intolerance state

	No	Mean height standard deviation score	Standard error
Food intolerant	189	-0.28	0.07
Not food intolerant	6472	0.03	0.01
Uncertain	102	0.02	0.08
Not known	1093	-0.16	0.03

*See text for method of calculating standard deviation score.

TABLE II—Estimated mean height standard deviation scores of children categorised by food intolerance state adjusted for social and biological factors*

	Mean height standard deviation score	Standard error
Food intolerant	-0.27	0.07
Uncertain	-0.10	0.09
Not food intolerant	0.01	0.03

Total number of observations 5944.

*Factors were parents' reported height, child's birth weight, number of children in family, father's employment and social class, and mother's education.

TABLE III—Unadjusted differences in height standard deviation scores between children with and without each symptom in 1984 national study of health and growth

Symptom	No with symptom (% of total measured)	Difference in height standard deviation score	95% Confidence interval
Diarrhoea and vomiting	91 (1.2)	-0.429	-0.634 to -0.224
Wheeze frequently	214 (2.7)	-0.324	-0.459 to -0.189
Cough in day or night	573 (7.3)	-0.232	-0.317 to -0.147
Irritability	155 (2.0)	-0.205	-0.363 to -0.047
Cough in morning	294 (3.7)	-0.177	-0.293 to -0.061
Headache	172 (2.2)	-0.174	-0.324 to -0.024
Hives	432 (5.5)	-0.161	-0.339 to 0.017
Asthma	310 (3.9)	-0.072	-0.185 to 0.041
Eczema	469 (6.0)	-0.071	-0.164 to 0.022
Rhinitis	462 (5.9)	-0.012	-0.114 to 0.074
Wheeze ever	555 (7.1)	-0.012	-0.098 to 0.074
Hay fever	432 (5.5)	0.054	-0.043 to 0.151

Seven food intolerant children (4%) had a height less than minus two standard deviations below the mean. This proportion was greater than the 2.3% expected from the normal distribution but the difference was not significant.

There were differences in the types of food cut out of the diet between the food intolerant and non-food-intolerant children (table IV). Milk, eggs, citrus fruit, chocolate, and fish were more often avoided by children with food intolerance, whereas those who were not food intolerant more often avoided nuts, lamb, beef or pork, chicken, and cauliflower.

TABLE IV—Food cut out of diets of food intolerant and non-food-intolerant children.* Findings expressed as frequencies and rank order for each type of food avoided

Type of food cut out	Food intolerant (n=189)		Not food intolerant (n=6472)	
	No (%)	Rank	No (%)	Rank
Orange squash	56 (29.6)	1	206 (3.2)	1
Milk	49 (25.9)	2	45 (0.7)	10
Eggs	43 (22.8)	3	44 (0.7)	11
Oranges or lemons	32 (16.9)	4	29 (0.4)	13
Chocolate	30 (15.9)	5	64 (1.0)	5
Fish or shellfish	25 (13.2)	6	53 (0.8)	8
Nuts	23 (12.2)	7	140 (2.1)	2
Fish fingers	21 (11.1)	8	83 (1.3)	4
Flour	11 (5.8)	9	29 (0.4)	13
Tomatoes	10 (5.3)	10	54 (0.8)	9
Lamb	5 (2.6)	11	89 (1.4)	3
Peas or beans	5 (2.6)	12	29 (0.4)	13
Cauliflower	4 (2.1)	13	58 (0.9)	7
Apples	4 (2.1)	14	13 (0.2)	16
Beef or pork	3 (1.6)	15	61 (0.9)	6
Chicken	3 (1.6)	16	36 (0.6)	12
Potatoes	1 (0.5)	17	9 (0.1)	17
Other	11 (5.8)	—	95 (1.5)	—
One or more foods	171 (90.5)		597 (9.2)	

*Includes only those children for whom measurement of height was also obtained.

Table V gives the estimated mean heights (after adjustment for social and biological factors) of food intolerant and non-food-intolerant children in relation to the number of different types of food cut out of their diets. In the food intolerant group there was a negative relation between the number of types of food avoided and the child's height which was not found for children perceived as non-food-intolerant. Those children avoiding four or more foods who were perceived as not food intolerant had a mean height standard deviation score of 0.02 (95% confidence interval -0.21 to 0.24), whereas those children who were perceived as food intolerant but who were also avoiding four or more foods had a mean height standard deviation score of -0.72 (95% confidence interval -1.06 to -0.38).

TABLE V—Estimated height standard deviation scores of food intolerant and non-food-intolerant children stratified by numbers of types of food cut out of diets (adjusted for social and biological factors*)

No of foods cut out	Food intolerant		Not food intolerant	
	No	Mean height standard deviation score (95% confidence interval)	No	Mean height standard deviation score (95% confidence interval)
0	15	0.21 (-0.24 to 0.65)	4932	0 (-0.05 to 0.06)
1	56	-0.10 (-0.33 to 0.13)	298	0.08 (-0.03 to 0.19)
2	46	-0.21 (-0.46 to 0.03)	99	0.09 (-0.08 to 0.26)
3	17	-0.72 (-1.13 to -0.31)	51	0.10 (-0.14 to 0.33)
≥4	24	-0.72 (-1.06 to -0.38)	54	0.02 (-0.21 to 0.24)

*Factors were parents' reported height, child's birth weight, number of children in family, father's employment and social class, and mother's education.

Discussion

In this sample of children aged 5 to 11 attending primary schools in Britain we have estimated that those perceived by their parents as food intolerant were roughly 1.5 cm shorter (mean height standard deviation score -0.25) than children perceived as not food intolerant. Children who were avoiding three or more types of food and who were also perceived as food intolerant were on average roughly 4.2 cm shorter than children who were not food intolerant.

There was no association between the number of types of food avoided and height in children who were not food intolerant.

Definitions of food intolerance vary widely. Our definition was based on parents' answers to a questionnaire. To be included as food intolerant the answers had to indicate that the child had always had the same illness or trouble with a particular kind of food. In most clinical series there are some patients who believe that their symptoms are due to food intolerance but in whom no objective evidence can be found. The proportion regarded as not genuine varies with the criteria used and presumably also reflects the population from which the cases are selected. For instance, in a general paediatric department and with the criterion that for food intolerance to be accepted the patient must experience recurrence of symptoms on at least three open challenges with food and relief of symptoms when the food is withdrawn, 68 of 121 children referred by general practitioners were regarded as food intolerant.⁸ In a specialist centre in the United States 81 of 206 children were accepted with "impressive symptoms of adverse reactions to foods" by their responses to double blind challenge.⁹ In adults some centres report that most patients investigated for food intolerance or allergy have genuine reactions to foods,¹⁰ whereas others are able to show that symptoms are due to food in only a minority.^{11,12} Probably a substantial number of the children whom we classified as food intolerant would not be regarded as food intolerant by many clinicians.

A possible explanation for our finding of comparative shortness in children with food intolerance is that symptoms such as asthma and eczema which are associated with food intolerance are also associated with shortness. We tested this explanation by adjusting the observed heights for each food intolerance group for the presence or absence of 11 symptoms and found only a slight decrease in the difference in height between the food intolerant and non-food-intolerant groups.

A second explanation may be that the avoidance of food is associated with shortness and that the observed association of food intolerance and shortness was due entirely to the association between food intolerance and food avoidance. If this were so we might expect to find an association between height and food avoidance in children who were not food intolerant. In our analysis we found no difference in height in the non-food-intolerant children grouped according to the number of types of food they avoided. But in the children perceived as food intolerant we found that the number of different types of food avoided was correlated with height; hence the children who cut out no food or only one type of food showed no significant difference in height from the mean of all other children, whereas the children who were avoiding three or more foods were very much smaller.

A problem in interpreting these results is that each food is not of equivalent importance in children's diets. For example, orange squash, which was the food most often avoided by both groups, is of less nutritional importance than milk, which was the second most frequently avoided food in the food intolerant children but only the 10th most frequent in those children who were not food intolerant. Food avoidance would be expected to affect growth if the child's overall diet was either improved or harmed as a result. In this study it was not possible to get an overall dietary assessment. Food avoidance might be the cause of short stature in food intolerant children, particularly if the types of food avoided are not adequately substituted in the diet. An alternative explanation is that the number of different types of food cut out of the diet of a child who gets symptoms from eating food is a crude measure of the severity of the underlying disorder.

Reduced growth is an important presenting complaint of certain well characterised food intolerances, particularly coeliac disease¹³ and cows' milk allergy.¹⁴ In clinical series of children with food allergy and intolerance failure to thrive is also a common feature.^{8,15,16} Our sample differs from these series in coming from a school rather than a hospital population and including a definition of food intolerance which relied solely on parents' perceptions. Though only a few of the food intolerant children could be described as clinically short, many were of suboptimal height by comparison with their non-food-intolerant peers. This suggests that

important pathological processes may be present. This study sheds little light on whether these processes are primarily organic or associated with psychological or family dynamics. Nevertheless, our findings suggest that when a parent complains of food intolerance in a child, particularly when it is long standing and associated with multiple food avoidance, the complaint needs to be taken seriously by general practitioners and hospital doctors.

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Abnormal flow properties of white blood cells in patients with severe ischaemia of the leg

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Abstract

The possible role of white blood cells in tissue ischaemia has attracted recent interest. White blood cells can block narrow vessels, particularly if perfusion pressure is reduced or if the cells become activated. To investigate the role of white blood cells in ischaemia microfiltration techniques were used to measure the flow properties of these cells in patients with severe leg ischaemia before and after amputation. Compared with controls white blood cells from patients showed impaired ability to flow through 8 μ m and 5 μ m pore filters. This applied to fractionated granulocytes and mononuclear cells as well as to unfractionated mixed white blood cells. White blood cells from blood draining the ischaemic leg had worse filterability than those from arm blood of the same patients. After amputation of the ischaemic leg there was definite improvement, the flow properties of the cells being no longer significantly different from controls.

These abnormalities detected in white blood cells probably reflect activation of the cells by factors released in the ischaemic tissue. As activation alters the mechanical and adhesive properties of white blood cells, a vicious cycle of microcirculatory trapping at low perfusion pressure, activation, tissue damage, and further activation and trapping might contribute to the progressive worsening of tissue ischaemia.

Introduction

Epidemiological evidence that the white cell count is a good predictor of ischaemic events and recent studies of ischaemia in animal models have led to considerable interest in the possible part played by white cells in the development and progression of tissue ischaemia (see Ernst *et al* for review¹). White blood cells are highly resistant to deformation compared with red cells. In the normal circulation their entry into capillaries may take several seconds and gives rise to intermittent plugging of these vessels.² If the tissue perfusion pressure is reduced numerous white cells may become trapped in the microcirculation. Increased haemodynamic resistance will result which may not necessarily be reversed fully when reperfusion occurs. This type of flow disturbance and capillary blockage mediated by white blood cells has been described in animal models of haemorrhagic shock³ and myocardial infarction,⁴ and in perfused isolated organs.^{5,6} A second stage of trapping of white blood cells has been suggested to arise from activation of newly arriving cells by factors released by earlier white cells, possibly as a result of their interaction with endothelial cells.⁷ These activated white cells would be expected to have altered mechanical and adhesive properties,⁸⁻¹⁰ which would increase their tendency to block narrow vessels. Factors released in such circumstances might include leucotrienes, thromboxane, platelet activating factor, and leucocyte derived free radicals. Such factors have been implicated, for example, in changes in neutrophil adhesiveness detected after induction of ischaemia in rat hind limbs.¹¹

A cycle of white cell trapping, activation, and endothelial damage and further activation and trapping might theoretically occur in any ischaemic tissue. Previous studies have been carried out using animal models but little clinical data exist on changes in white cells in man. We have therefore evaluated the rheological properties of white blood cells in patients with severe ischaemia of the leg to test the hypothesis that reduced perfusion pressure due to atherosclerosis may initiate a cycle of changes which results in impaired flow of white blood cells. Unfractionated white blood cells and density separated granulocytes and mononuclear cells were tested

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