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Eliminating cows' milk, but not wheat, barley or rye, increases the risk of growth deceleration and nutritional inadequacies

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ABSTRACT

Aim: Our study examined the growth and nutritional intake of children on milk and, or, wheat, barley or rye elimination diets.

Methods: This was a nested case-control study within the Finnish Type 1 Diabetes Prediction and Prevention Study. It investigated 295 children born in the Tampere University Hospital area between 1997-2004 on a diet without cows' milk and, or, wheat, barley or rye due to food allergies and 265 matched controls. Nutritional intake was recorded with three-day food records at the ages of one, two and three years. Serial growth measurements were recorded annually up to the age of five years.

Results: Despite consuming a balanced diet with sufficient energy and protein, the children on milk elimination diets grew slower than the control children ($p=0.009$). Wheat, barley or rye elimination was not associated with growth. The intakes of protein and calcium were lower in children in the milk elimination group than the controls, at $p < 0.05$ for all. However, children on elimination diets consumed less saturated fats and sugar and more vitamin C and iron than the control children.

Conclusion: Children on elimination diets faced an increased risk of growth deceleration and suboptimal intake of several micronutrients.

Key Notes:

- This large nested case-control study described the growth and nutritional intake of children on elimination diets and compared them with controls.
- It showed that children on milk elimination diets, but not wheat, barley or rye, had an increased risk of growth deceleration and suboptimal intake of several micronutrients.
- However, children on elimination diets consumed less saturated fats and sugar and more vitamin C and iron than the control children.
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Key words: elimination diet, food allergies, children, growth, nutritional intake

INTRODUCTION

Food allergies are a common reason for therapeutic elimination diets and usually affect 3-9% of children in early childhood (1). The standard treatment for a food allergy is to eliminate the offending food from the diet (2). In well-conducted elimination diets, the offending food is replaced with a compensatory tolerated food to secure normal growth and development. However, children with dietary restrictions do not always get all the necessary nutrients they need from food (3-5) and dietary intakes of calcium (5-7), vitamin D (6), riboflavin (5) and niacin (5) have been reported to be lower in children on milk elimination diets or on multiple food elimination diets compared to controls. Lower serum albumin levels have also been reported (4). The available evidence indicates that the growth of children with food allergies on an elimination diet can be compromised, even when the intake of nutrients is within the recommended range (5,8). On the other hand, one study showed that a balanced elimination diet compensated for a growth delay before cows' milk allergy (CMA) was diagnosed after commencing the elimination diet (9). The extent of the dietary elimination has an impact on the risk of poor growth. In cross-sectional studies from France and the USA, those children who avoided two food items were shorter than those who only avoided one food item (6,10).

In addition, a retrospective Japanese study reported that past avoidance of cows' milk or more than one food item due to a food allergy led to a growth lag that extended for up to 10 years of age (11). However, in two other studies, multi-sensitisation was not associated with impaired growth (4,12). A large cross-sectional study from the USA found that children with CMA had a lower height standard deviation (SD) and body mass index than healthy children, while other food allergies were not shown to be associated with growth (7).

Cereal products, along with milk or infant formulas, are major constituents of childhood diets (13). The effects of wheat, barley or rye elimination diet on nutritional intake and status have not been studied as much as the effects of a milk elimination diet. The aim of this nested case-control study was to compare growth patterns and nutrient intakes of children on milk and, or, wheat, barley or rye elimination diets to their matched controls.

PATIENTS AND METHODS

Study population

The Finnish Type 1 Diabetes Prediction and Prevention (DIPP) study is a multidisciplinary prospective population-based birth cohort study (14). Between 1997 and 2004, after parental informed consent was obtained, all newborn infants from the catchment areas of Turku, Oulu and Tampere university hospitals in Finland were screened for human leukocyte antigen (HLA) conferred susceptibility to type 1 diabetes from cord blood samples. Families with infants carrying HLA genotypes conferring high and moderate risks for type 1 diabetes - 14% of those screened - were invited to participate in the study. Children with severe congenital abnormalities or diseases, or whose parents were of non-Caucasian origin or did not understand Finnish, Swedish or English, were excluded. The local ethical committees approved the study. All families provided written informed consent.

The DIPP Nutrition study was performed in the catchment areas of Oulu and Tampere University Hospitals. The present nested case-control study comprised 295 children born in the Tampere University Hospital area between 1997-2004 with reported milk and, or, wheat, barley or rye elimination diets. The breakdown by elimination diet is shown in Table 1. The controls were selected individually for each case, so that one child could act as a control for more than one case. Thus we ended up with 265 controls, who were not on food elimination diet due to food allergy, and who were matched for date of birth within three months, sex and HLA genotype. The children attended the study clinic at three, six and 12 months of age and annually after that. Weight and height or recumbent length were measured at each visit by trained nurses. Weights and heights up to five years of age were compared to national growth standards using the Peditator computer software (Tilator Oy, Turku, Finland), yielding height Z-scores and weight-to-height percentiles (15,16). A Z-score for expected height was calculated as follows: $((\text{height of the mother in cm} + \text{height of the father in cm}) / 2 - 171) / 10$. Cases were defined by parentally reported food allergies and elimination diets were queried with open questions at the age of six months and one and two years and with a structured questionnaire at the age of three years.

Dietary methods

The child's diet was studied at one, two and three years of age with a three-day food record (17). The parents were also asked to report the vitamin and mineral supplements that were used during the days that the food records were kept. The research nurses and physicians were continuously trained to advise the parents to fill in the food records and forms and to check the records and forms for possible controversies and omissions. Trained nutritionists entered the food records to the national food database using in-house Finessi software (National Institute for Health and Welfare, Helsinki, Finland). Average daily intakes of nutrients were calculated with the use of the Finnish food composition database (18). The nutritional contents of the dietary supplements were obtained from the National Food

Administration, the manufacturers and from the Finnish pharmacopeia for supplements registered as drugs. Children who were breastfed during the days when the food records were kept were excluded from the present dietary analyses.

Background factors

The local Medical Birth Registry provided information on gestational age, birth weight and length, number of fetuses and maternal smoking during pregnancy. Information on the use of anti-asthmatic drugs was obtained from the Drug Prescription Register of the Social Insurance Institution, as these may have affected growth. It includes drug class according to Anatomical Therapeutic Chemical Classification System, date of purchasing and personal identity code. In Finland, all drugs prescribed by physicians and reimbursed by the National Sickness Insurance Scheme are registered in the Drug Prescription Register. The purchases of inhaled corticosteroids (R03BA01, R03BA02, R03BA05), inhaled corticosteroids in fixed combinations with long-acting beta agonists (R03AK06, R03AK07) or leukotriene receptor antagonists (R03DC03) were included, as were systemic steroids, which had practically no use.

Statistical methods

As the nutrient intake variables did not follow a normal distribution, the Wilcoxon signed rank test was applied to compare the nutrient intakes between cases and controls. Medians and interquartile range were used to describe the data. Differences in growth by age points until five years of age were studied with multiple linear regression. In addition, the differences in growth parameters were studied with random coefficient regression, where the intercept term representing initial height, square root of age and linear age were treated as fixed and random effects to model the mean and the heterogeneity of the children's growth. In addition, the fixed linear part of the growth was allowed to change at knots placed at one,

two and three years of age, and these changes could vary between children with and without milk elimination diets at those times. Thus, the children who were not on milk elimination diet, or were on the milk elimination diet with a milk allergy diagnosed at one, two or three years were each modelled to have possibly different growth profiles from the diagnosis time onwards. This allowed us to test whether the deviations from the normal growth were statistically significant and, if so, how large the deviations were. The Kenward-Roger adjustment was used. A p value below 0.05 was considered statistically significant. Multiple testing was handled by cautious interpretation of the findings. The statistical analyses were performed using IBM SPSS Statistics, version 22 for Windows (IBM, New York, USA) and SAS version 9.4 (SAS Institute Inc, North Carolina, USA).

RESULTS

General characteristics of the study population are presented in Table 1. The standard deviation (SD) from the expected height of the children on the milk elimination diet for at least one year was 0.2-0.3 SD lower than that of the control children. Initially, the groups did not differ from each other (Table 2). When studied with a longitudinal model, the growth of children on the milk elimination diet decelerated within the first year on the diet, after which the difference of 0.2-0.3 SD between the cases and controls remained the same ($p = 0.009$). No catch-up growth was seen by the age of five years.

The wheat, barley or rye elimination diet was not associated with poor growth, apart from at the age of two years in the unadjusted analysis (Table 2), and it was not associated with growth patterns in the longitudinal model. The wheat, barley or rye elimination diet, however, tended to associate with a lower weight-to-height ratio. The children following a wheat, barley or rye elimination diet had on average a 1.6-2.1 percentage points lower weight-to-height ratio than controls, which is roughly equivalent to 0.16-0.21 SD, but this difference was not statistically significant after adjusting for confounders (data not shown). The growth

of children with both milk and wheat, barley or rye elimination diets followed a similar pattern to those with only a milk allergy.

Stunting was rare and of the two-year-old children who had been on a milk elimination diet since the age of one year, 4.3% were more than -2 SD below their expected height. The same result was seen in 0.7% of the controls ($p = 0.020$). At other age points, the difference between the cases and controls was not statistically significant. Altogether, 2.9%, 1.7%, 1.6% and 0.7% of the children were more than -2SD from their expected height at the ages of one, two, three and five years in the whole study population, respectively. The obesity rate at five years was 4.7% for those who had been on the milk elimination diet and 5.7% among the controls ($p = 0.829$).

In children with elimination diets, the median (interquartile range) number of foods avoided was seven (3-9), six (2-9) and seven (4-9) at the age of one, two and three years, respectively. The number of avoided food items at one or two years of age had a borderline association with growth at the age of three years in the unadjusted model ($B = -0.02$, $p = 0.04$ for both), but the association was no longer statistically significant after adjusting for potential confounders. Otherwise the number of avoided food items was not associated with growth. Furthermore, the number of avoided food items did not seem to be associated with the weight-to-height ratio of the children (data not shown).

The proportion of children using infant formulas was higher in those on milk and, or, wheat, barley or rye elimination diets compared to the controls: 92% and 54% ($p < 0.001$), 38% and 1% ($p < 0.001$) and 3% and 0% ($p=0.25$) at the ages of one, two and three years, respectively. In all age groups, the children on elimination diets tended to eat more pureed food, such as commercial fruit purees and porridge than the control children (data not shown).

The children on elimination diets consumed more meat at the ages of two and three than the control children and total meat consumption was 70g versus 61g ($p = 0.002$) and 84g versus 60g ($p < 0.001$), respectively. Their meat intake leaned toward pork and game, while control

children consumed more poultry, fish and eggs ($p < 0.05$ for all). At the ages of one and two, children on elimination diets had a higher total fruit and berry intake than the controls, with a median of 125g versus 113g ($p = 0.014$) and 138g versus 84g ($p < 0.001$), respectively. At the age of three years the difference was no longer statistically significant, at a median of 117g versus 110g ($p = 0.079$). Protein intake was significantly lower in the children on milk elimination diets than the controls at all time points studied, with a median of 2.4-3.0g/kg versus 3.3-3.8g/kg depending on age ($p < 0.05$ for all) (Tables S1, S2 and S3), while sugar intake was higher in the controls at one year of age, but not later. The children on elimination diets consumed less saturated fatty acids and more polyunsaturated fatty acids and n-3 and n-6 fatty acids than the controls.

At one year of age, there were seven children who were not breastfed and did not receive infant formula. They only received vitamin D and calcium substitution. Their median intakes of calcium were 190mg/day from food and 325mg/day with supplements. In addition, the median riboflavin intake of these children was 0.5mg/day. At two years of age, there were 40 children who did not consume cows' milk, breast milk or infant formula, whose median daily intakes were lower than recommended for calcium from food (200mg from food and 640mg with supplementation), vitamin D (1.4 μ g from food and 7.6 μ g with supplementation) and zinc (5.8mg from food with no supplementation). On the other hand, their intakes were sufficient for riboflavin (0.5mg/day without and 0.6mg/day with supplementation), iodine (88mg/day without and 99mg/day with supplementation) and selenium (28 μ g/day). Intakes at three years of age were similar to those of the two-year-old children (data not shown). Despite the suboptimal intakes of some micronutrients, we did not detect differences in the growth between children with milk elimination diets consuming breast milk, special infant formulas or neither.

DISCUSSION

Children on a milk elimination diet for at least one year grew slightly slower than the controls and their deviation from expected height was approximately 0.2-0.3 SD lower. The percentage of children with poor growth, defined as a relative height of less than - 2 SD, decreased from 2.9% at the age of one year to 0.7% at the age of five years. The children on a milk-free diet received less protein than the controls, but their protein intake was still two to three times higher than the safe minimum level of protein intake of the respective age groups (19).

The strength of the present study was the nested case-control design conducted in a prospective birth cohort, which was likely to be representative with regard to food allergies, and the large number of children studied. Also, the dietary information was meticulously handled: it was collected with three-day food records, checked by continuously trained nurses or physicians when it was returned and entered by trained nutritionists using the national food composition database (18), which was continuously updated and checked at analysis, ensuring good quality of the dietary information. The information on food allergies was collected using a questionnaire, which showed good correlation between parentally reported and physician diagnosed food allergies in the validation studies (20,21). To specifically study the effects of the elimination diet, we were able to control for several factors known to affect height, which increased the reliability of our results, namely: the use of corticosteroid medication, duration of gestation, length of breastfeeding and maternal gestational diabetes and smoking during pregnancy,

The limitations of the current study included the fact that the exact time when the children recovered from their food allergy was not known. Also, although the information on food allergies was gathered with a validated method, the justification of the elimination diets were uncertain, as we did not confirm the diagnoses of the food allergies with any additional tests, but relied on the diagnoses made by the child's own paediatrician (1). If there were, in fact, children who were not truly allergic, this could have biased the study of growth, because

allergic inflammation may increase the need for energy and nutrients as well as have an impact on nutrient absorption, potentially compromising growth, regardless of diet (4,5,8).

For now, we cannot distinguish whether the differences found were due to the allergic disease itself or the elimination diet. Furthermore, the nutrient intakes of the breastfed children could not be assessed, which introduced a possible bias.

Unlike two cross-sectional studies, we did not find a relationship between the number of avoided food items and growth (6,10). Nor did we find any association between a milk elimination diet and weight-to-height ratio, as opposed to a study from the UK, where children with food allergies were more likely to be underweight than the general population. However, the study from the UK did not include control children, but compared the growth of children who had food allergies to national growth charts (12). Our findings also differ from those by Savino *et al*, who reported a lower weight-to-age in infants with milk allergies compared to a control group of children with atopic dermatitis (22). However, they did not report the differences in the children's heights, or the body mass indexes or weight-to height ratio, which would have been more appropriate markers of growth. It is noteworthy that the protein intake in our study, even in children with food allergies, was two to three times higher than the safe minimum level of protein intake, set at 1g/kg/day for one-year-old children and 0.9g/kg/day for two to three-year-old children (19), and yet their growth was slightly slower than in the controls. We are not aware of studies that have assessed the growth of children avoiding wheat, barley or rye in their diets. According to our findings, the wheat, barley or rye elimination diet did not seem to be associated with growth. The slight differences seen in the present study were caused by the fact that a third of the children on the wheat, barley or rye elimination diet also followed a milk elimination diet.

The Nordic Nutrition Recommendations from 2012 reduced the estimated adequate intake of protein from previous recommendations (19). The rationale behind this was that children with higher protein intakes have an increased risk of obesity. The largest randomised controlled trial studying the effects of an infant formula with a lower protein content showed that the

obesity risk was higher in six-year-old children with higher intakes of protein at three, six and 12 months of age (23). In contrast, we did not find differences in the weight-to-height ratio, or the obesity rate between the children on milk elimination diets and the controls, and the difference in protein intakes between the groups in our cohort were comparable to that study.

Energy intakes between the cases and the controls were not different and the children on the milk elimination diet received more than the safe minimum amount of protein recommended by the Nordic Nutrition Recommendations (19). This means that the slight growth deceleration seen in the children on the milk-free diet must have been due to other reasons. The median calcium intakes were approximately 70% of the recommended nutrient intake of one-year-old children, which could be one contributing factor. In their review, Hoppe et al suggest that not only calcium and amino acids, but also bioactive peptides and cows' milk insulin-like growth factor have a growth-stimulating effect (24). Population-based studies have shown an association between the amount of milk consumed and growth, with the effect on growth velocity being greater in teenagers than in younger children (24).

In line with previous studies, the most marked differences were seen in the intakes of calcium and riboflavin between children on milk elimination diets and their controls (3,25). Overall, the children on milk or wheat, barley or rye elimination diets seemed to consume a healthier diet than the controls. The children on elimination diets also used multivitamin and mineral supplements more often than the controls. Among elimination diets, their use was most common in children with both milk and wheat, barley or rye eliminated from their diet. In addition to receiving more vitamins D, C, E and A, a finding in line with a previous study (10), the children on milk elimination diets received less saturated and more polyunsaturated fatty acids and n-3 and n-6 fatty acids than the controls. The children on an elimination diet met the recommended intake of 1%E of n-3 and 3%E n-6 polyunsaturated fatty acids, whereas the controls did not. This finding was in line with a small study by Tiainen et al, who reported a higher polyunsaturated to saturated fatty acid ratio in children with milk

elimination diets than in controls (8). On the downside, advancing to more textured food was slower in the children on food elimination diets and they ate more pureed food, such as fruit or berry purees and porridge than the controls. Previous studies have reported that children with CMA consumed a less varied diet than children without CMA and food preferences changed slowly even after the food allergy had been resolved (26,27).

Allergic children who are not breastfed and do not consume special infant formulas are of particular concern. Similarly, as reported by a study from the UK (25), we found that the micronutrient intakes of these children were not sufficient and the median intakes of calcium, vitamin D, riboflavin and iodine at the age of one year were below the recommended levels, as well as lower than the median intake of these nutrients in children on milk elimination. Furthermore, the children did not receive enough supplements to compensate for the low intakes of riboflavin and vitamin D from food.

CONCLUSION

In conclusion, children following an elimination diet due to CMA faced a risk of growth deceleration during the first year on the diet compared to controls. The children on elimination diets received enough energy and protein, but their intake of calcium and vitamins D and B2, together with other micronutrients, need to be monitored. They also need to receive vitamin and mineral supplements, especially if they are not given breast milk, milk products or infant formulas.

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ABBREVIATIONS

CMA, cows' milk allergy

DIPP, The Finnish Type 1 Diabetes Prediction and Prevention Study

IQ-range, interquartile range

SD, standard deviation

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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Table 1. General characteristics (n (%) or median (IQ range)) of the study population (n = 560)

		CM elimination diet only ^a n = 90	WBR elimination diet only ^a n = 75	CM and WBR elimination diet ^a n = 130	Controls n = 265	p-value ^b
Duration of gestation (days)	Median (IQ range)	283 (275,286)	279 (272,286)	279 (272, 285)	280 (272,287)	0.203
	missing information	0	0	0	2	
Maternal smoking during pregnancy	No	85 (96.6)	67 (90.5)	120 (96.8)	(39 (92.3)	0.178
	Yes	3 (3.4)	7 (9.5)	4 (3.2)	20 (7.7)	
	Missing information	2	1	6	6	
Twin pregnancy	No	85 (94.4)	67 (89.3)	128 (98.5)	255 (96.2)	0.017
	Yes	5(5.6)	8 (10.7)	2 (1.5)	10 (3.8)	
Maternal gestational diabetes	No	84 (97.7)	68 (95.8)	121 (96.8)	214 (94.5)	0.652
	Yes	2 (2.3)	3 (4.2)	4 (3.2)	14 (5.5)	
	missing information	4	4	5	10	
Sex	Boys	52 (57.8)	44 (58.7)	87 (66.9)	158 (59.6)	0.445
	Girls	38 (42.2)	31 (41.3)	43 (33.1)	107 (40.4)	
Breastfed at the age of 1 year	No	59 (81.9)	51 (91.1)	104 (92.0)	235 (77.3)	0.001
	Yes	13 (18.1)	5 (8.9)	8 (7.1)	69 (22.7)	
Breastfed at the age of 2 years	No	61 (98.4)	45 (97.8)	69 (100.0)	306 (97.5)	0.714
	Yes	1 (1.6)	1 (2.2)	0 (0.0)	8 (2.5)	
Breastfed at the age of 3 years	No	35 (100.0)	30 (100.0)	26 (100.0)	367 (99.7)	1.000
	Yes	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	
Use of inhaled steroids up to 5 years of age	No	85 (94.4)	69 (92.0)	104 (80.0)	248 (93.6)	< 0.001
	Yes	5 (5.6)	6 (8.0)	26 (20.0)	17 (6.4)	
Use of systemic steroids up to 5 years of age	No	88 (97.8)	73 (97.3)	124 (95.4)	263 (99.2)	0.061
	Yes	2 (2.2)	2 (2.7)	6 (4.6)	2 (0.8)	
Calcium	No	54 (74.6)	56 (100)	82 (73.2)	302 (99.3)	< 0.001

supplement use at 1 year of age	Yes	18 (25.4)	0 (0.0)	30 (26.8)	2 (0.7)	
Vitamin D supplement use at 1 year of age	No	8 (11.1)	5 (8.9)	11 (9.8)	44 (14.5)	0.458
	Yes	64 (88.9)	51 (91.1)	101 (90.2)	260 (85.5)	
Use of other vitamin-mineral supplements at 1 year of age	No	65 (91.5)	53 (94.6)	82 (73.2)	294 (96.7)	< 0.001
	Yes	6 (8.5)	3 (5.4)	30 (26.8)	10 (3.3)	
Calcium supplement use at 2 years of age	No	30 (48.4)	41 (89.1)	23 (33.3)	308 (97.8)	< 0.001
	Yes	32 (51.6)	5 (10.9)	46 (66.7)	7 (2.2)	
Vitamin D supplement use at 2 years of age	No	17 (27.4)	11 (23.9)	20 (29.0)	107 (34.0)	0.424
	Yes	45 (27.6)	35 (76.1)	49 (71.0)	208 (66.0)	
Use of other vitamin-mineral supplements at 2 years of age	No	52 (89.3)	33 (71.7)	37 (53.6)	293 (93.0)	< 0.001
	Yes	10 (16.1)	13 (28.3)	32 (46.4)	22 (7.0)	
Calcium supplement use at 3 years of age	No	13 (35.1)	30 (96.8)	5 (19.2)	343 (93.2)	< 0.001
	Yes	23 (63.9)	1 (3.2)	21 (80.8)	25 (6.8)	
Vitamin D supplement use at 3 years of age	No	15 (41.7)	12 (38.7)	5 (19.2)	220 (59.8)	< 0.001
	Yes	21 (58.3)	19 (61.3)	21 (80.8)	148 (40.2)	
Use of other vitamin-mineral supplements at 3 years of age	No	28 (77.8)	20 (64.5)	13 (50.0)	306 (83.2)	< 0.001
	Yes	8 (22.2)	11 (35.5)	13 (50.0)	62 (16.8)	

^aElimination diet at 1, 2, or 3 years of age

^bComparison between groups with chi square or Fisher's exact test for categorical variables and by Kruskal-Wallis test for continuous variables.

CM, cow's milk; WBR, wheat, barley or rye; IQ, interquartile range

Table 2. Differences in height between children on elimination diets and controls in unadjusted and adjusted models, studied by multiple linear regression.

		Difference in deviation from expected height SD							
		At 1 year of age		At 2 years of age		At 3 years of age		At 5 years of age	
		n = 533*		n = 489*		n = 473*		n = 434*	
	Age	B	p-value	B	p-value	B	p-value	B	p-value
Milk elimination diet	1 yr	-0.086	0.315	-0.212	0.013	-0.266	0.002	-0.279	0.003
	Unadjusted								
	1 yr, adjusted**	-0.102	0.232	-0.207	0.017	-0.242	0.007	-0.239	0.013
	2 yrs, unadjusted			-0.082	0.365	-0.190	0.041	-0.228;	0.021
	2 yrs, adjusted**			-0.096	0.296	-0.180	0.055	-0.219	0.028
	3 yrs, unadjusted					-0.136	0.291	-0.317	0.019
WBR elimination diet	3 yrs, adjusted**					-0.146	0.258	-0.341	0.012
	1 yr, unadjusted	-0.044	0.615	-0.052	0.555	-0.165	0.065	-0.176	0.071
	1 yr, adjusted**	-0.056	0.521	-0.022	0.804	-0.102	0.269	-0.088	0.380
	2 yrs, unadjusted			-0.003	0.974	-0.195	0.046	-0.211	0.043
	2 yrs, adjusted**			-0.006	0.954	-.0163	0.106	-0.170	0.115
	3 yrs, unadjusted					-0.101	0.449	-0.239	0.086
	3 yrs, adjusted**					-0.060	0.659	-0.196	0.165

* The number of children for whom the deviation from expected height could be calculated (the height of the child and of both parents are known)

** Adjusted for use of systemic steroids up until the time of measurements, use of inhaled steroids within the last year of the measurement, twin pregnancies, sex, duration of overall breastfeeding, duration of gestation, gestational diabetes, HLA-conferred genotype for type 1 diabetes and maternal smoking during pregnancy.

B, regression coefficient

WBR, wheat, barley or rye