

DR SUPINDA BUNYAVANICH (Orcid ID : 0000-0001-6108-439X)

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Comparison of Dietary Intake Between Milk Allergic and Non-Food Allergic Children

Kyle Gibson, BA^{1,2}, Stephanie Stanley, MS^{1,2}, Shradha Agarwal, MD³, Marion Groetch, MS, RDN¹, Supinda Bunyavanich, MD, MPH, MPhil^{1,2,#}

¹ Division of Allergy and Immunology, Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, NY

² Department of Genetics and Genomic Sciences, Icahn School of Medicine at Mount Sinai, New York, NY

³ Division of Clinical Immunology, Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, NY

#Corresponding Author and Lead Contact: Supinda Bunyavanich, MD, MPH, MPhil, Icahn School of Medicine at Mount Sinai, 1425 Madison Avenue, # 1498, New York, NY 10029, USA, email: supinda@post.harvard.edu

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To the Editor,

Cow's milk allergy commonly presents in childhood when adequate nutrition is essential. Allergen avoidance can lead to decreased intake of macro- and micronutrients crucial to growth and development.¹ Milk allergy, specifically, is a concern for both its potential to impair calcium and vitamin D intake and its association with growth delays.¹ Few studies have examined the nutritional intake of milk allergic children using data from the past five years during which there has been a dramatic increase in the availability of plant-based dairy substitutes. In fact, 36% of the milk allergic subjects examined in this study reported consuming 1 or more servings of a plant-based milk alternative daily compared to 0% in non-food allergic subjects. Investigation of the nutritional effects of milk allergy in the context of these new non-dairy options is of interest.

We compared the dietary intake of total calories, protein, saturated fat, total fat, calcium, and vitamin D between milk allergic and non-food allergic children. Children age 2-19 years were recruited from pediatric allergy and general pediatric clinics within the Mount Sinai Health System, New York, NY, USA during 2019. This age range was chosen to include a wide range of respondents with a minimum age of 2 years so that the sample would be representative of children who have been weaned and transitioned to solid foods. All families presenting with children in this age range were approached for enrollment. Inclusion criteria were a physician diagnosis of food allergy, or no self- or physician-reported food allergy. Milk allergy was confirmed by allergist assessment based on a convincing history of milk allergy plus positive skin prick test. For non-food allergic children, absence of any known food allergy was confirmed by each child's parent(s) and pediatrician.

Following written informed consent, parents of study participants completed a questionnaire encompassing demographic questions and a 174-item food frequency questionnaire (FFQ) about their child's diet adapted from Project Viva, an established US pre-birth cohort study.² Adaptations to the original FFQ were to add items of concern for food allergic families based on guidance from dietitian study team members who work with food allergic patients. The adapted FFQ is included as a Supplementary item for reference. The study was approved by the Mount Sinai Institutional Review Board.

The cohort included 96 children, including 14 children with milk allergy and 82 non-food allergic children (**Table 1**). Weekly food frequency data was transformed to servings per day, based on recommended serving sizes per age group, which were then used to estimate daily intakes of each survey item with respect to age-appropriate portion sizes.³ Daily intakes were converted to their nutritional components using nutritional profiles from US Department of Agriculture's FoodData Central.⁴ The summation of each item's daily nutritional components served as participants' daily nutritional intakes. Saturated fat, total fat, and protein intakes were assessed as percentages of total caloric intake. Vitamin D and calcium were assessed as percentages of recommended age-appropriate daily allowance (RDA) satisfied.⁵ Assessing macronutrient and micronutrient intakes as percentages of caloric intake and percentages of RDA, respectively, facilitated direct comparisons to dietary guidelines. High or low fat intake relative to recommended ranges was determined based on current guidelines.⁵

We stratified total fat, saturated fat, calcium, and vitamin D intakes by food group categories to compare differences in intake source between cow's milk allergic and non-food allergic subjects. Linear and ordinal logistic regression models were adjusted for age, gender, race/ethnicity, income, and parental education. Independent t-tests were used to compare differences in intake between milk allergic and non-food allergic children among the same food categories. Analyses were conducted with R 3.6.3 software.

Children with milk allergy had significantly lower fat intake, a healthier fatty acid ratio, and no significant difference in caloric, vitamin D, calcium, and protein intake when compared to non-food allergic children (**Table 2**). Multivariable linear regression models showed that milk allergy was associated with a reduction in both saturated and total fat intakes (**Table 2**). For non-food allergic children, average saturated fat intake represented 12.4% (95%CI, 11.7-13.1%) of caloric intake, above the suggested limit of 10%⁵, and compared to 6.7% in milk allergic children (95%CI, 5.0-8.4%). While differences in the odds of high and low fat intake between the two groups were not significant, children with milk

allergy had markedly lower odds of poor fatty acid intake ratio (OR 0.08, 95%CI, 0.01-0.55) based on the Diet Quality Index-International⁶ (**Table 2**). Neither calcium nor vitamin D intake differed significantly between milk allergic and non-food allergic children; both had average calcium and vitamin D intakes below current recommendations (**Table 2**).

When comparing sources of fat, non-food allergic children had significantly higher total fat and saturated fat intakes from the dairy and fats categories. No other source of saturated or total fat differed (**Fig 1A-B**). This suggests that the differences in total fat and saturated fat intakes may be attributed to differences in consumption of dairy and dairy-derived fats. Recent studies have questioned the unfavorable health effects of dietary fat from dairy on cardiovascular and metabolic health.⁷ However, such studies have not changed dietary guidance,⁵ and further research is needed in this area.

Non-food allergic children had a significantly higher mean intake of calcium from the dairy, fats, and other (encompassing mixed category foods such as pizza) categories (**Fig 1C**). Milk allergic children had non-significant increases in calcium intake from dairy substitutes, grains, proteins, and vegetables (**Fig 1C**). Non-food allergic children also had a significantly higher intake of vitamin D from dairy, whereas milk allergic children had higher but non-significant vitamin D intakes from dairy substitutes, fruits (including juices), and proteins (**Fig 1D**). A lack of differences in calcium and vitamin D intake suggests that milk allergic subjects in our study population are successful in their substitution of calcium and vitamin D typically derived from dairy, to levels comparable to those of their non-food allergic counterparts.

The limitations to this study include a small number of milk allergic subjects in the cohort and assumption of age-appropriate portion sizes applied to FFQ data. However, we note that each milk allergic subject had a confirmed positive milk skin prick test and allergist-confirmed milk allergy diagnosis, reducing classification bias that is seen in studies using self-reported food allergy. Additionally, recent studies have demonstrated comparable efficacy between FFQs and food diaries in assessing dietary intake among children.⁸ Our

study is notable for its description of nutrition patterns of children with milk allergy in current settings of widely available plant-based milk alternatives.

These findings support the need for increased nutritional supervision as well as calcium and vitamin D supplementation for children with and without milk allergy. Alternative sources of vitamin D include fish such as salmon, mackerel, and trout; egg yolk; and fortified cereals and beverages. Alternative sources of calcium include soy products, dark leafy greens, seeds, beans and lentils, almonds, and fortified cereals and beverages. Our findings also support the need for increased supervision of dairy intake among non-milk allergic patients, with encouragement of low-fat options and/or moderation of full fat dairy (where appropriate) to reduce dietary saturated fat intake. While more studies are needed to assess the effects of supervised and informed dietary replacement of dairy with alternative sources of vitamin D and calcium, such replacement presents a strategy for practitioners and parents to lower their children's saturated fat intake without compromising calcium and vitamin D intake.

Key Words: Milk allergy, diet, nutrition, milk substitute, calcium, vitamin D, fat

Kyle Gibson, BA, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Stephanie Stanley, MS, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Shradha Agarwal, MD, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Marion Groetch, MS, RDN, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Supinda Bunyavanich, MD, MPH, MPhil, Icahn School of Medicine at Mount Sinai, New York, NY, USA

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Table 1: Study population characteristics stratified by milk allergy status

	Milk Allergic (n=14)	Non-allergic control (n=82)	P-value
Age (years)	10.9 (5.7)	7.1 (4.7)	0.007
Height Percentile	0.46 (0.33)	0.61 (0.28)	0.10
Weight percentile	0.50 (0.30)	0.60 (0.29)	0.25
Gender			0.30
Male	9 (64.3%)	37 (45.1%)	
Female	5 (35.7%)	45 (54.9%)	
Race/ethnicity			0.13
Asian	1 (7.1%)	8 (9.8%)	
Black	1 (7.1%)	18 (22.0%)	
Latino	1 (7.1%)	17 (20.7%)	
Mixed	1 (7.1%)	11 (13.4%)	
White	10 (71.4%)	28 (34.1%)	
Income			0.08
> \$70,000	11 (100%)	52 (66.7%)	
\$40,000-\$70,000	0 (0%)	13 (16.7%)	
< \$40,000	0 (0%)	13 (16.7%)	
Parent Education			0.11
Graduate degree	12 (85.7%)	47 (58.8%)	
Bachelor's degree	2 (14.3%)	18 (22.5%)	
Less than Bachelor	0 (0%)	15 (18.8%)	
Consumes ≥ 1 serving of plant-based milk substitute	5 (36%)	9 (0%)	<0.001

Mean (standard deviation) or number (percent) are shown. Student t-test used for continuous variables and chi-square test used for categorical variables.

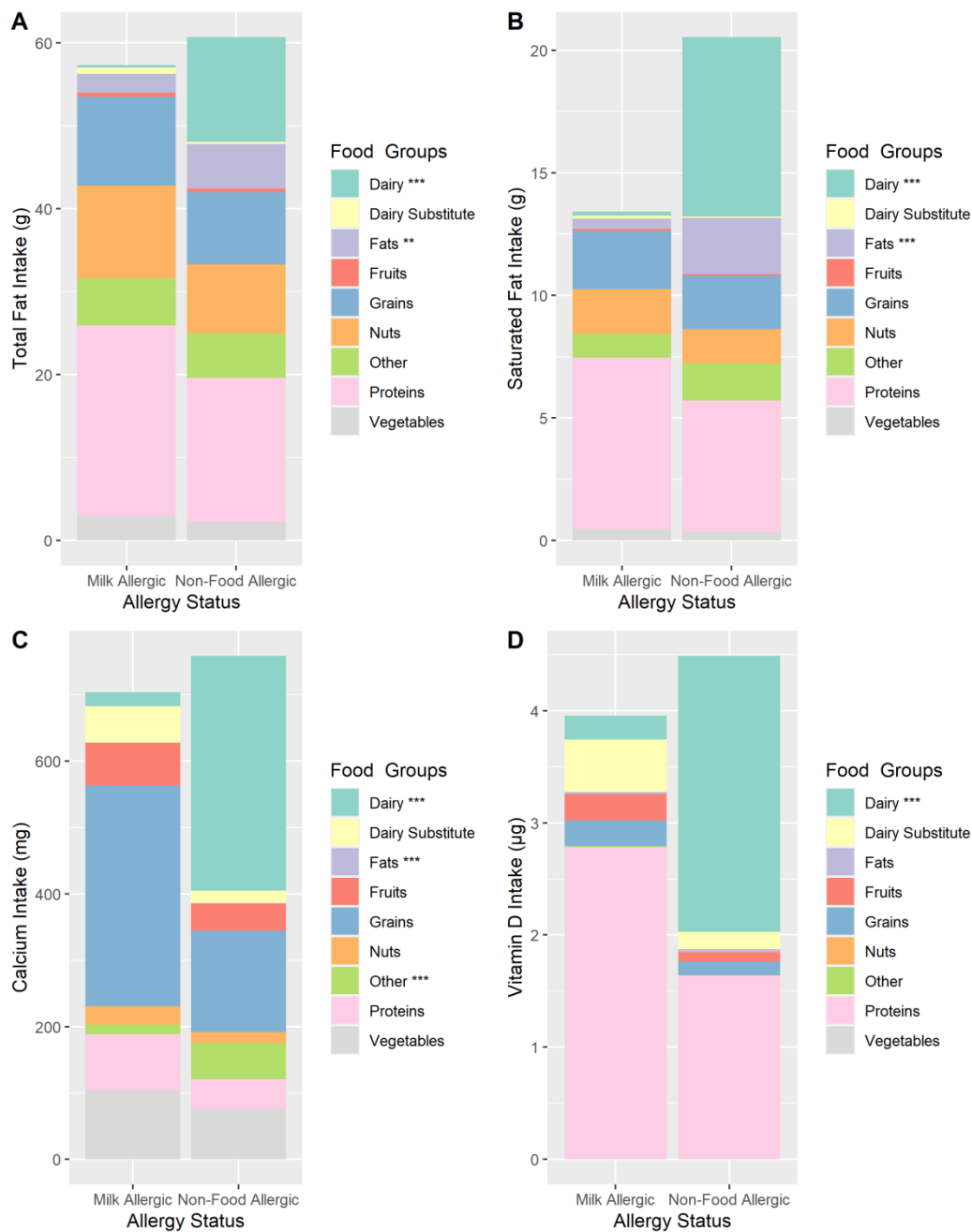
Table 2: Differences in nutrient intake between milk allergic and non-food allergic children

	Milk Allergic (n=14)	Non-allergic control (n=82)	B coefficient (95% CI)	P-value
Mean total daily caloric intake (kcal)	1455 (1107)	1534 (1077)	46.0 (-319.0 to 410.9)	0.80
% of caloric intake from protein	15.5 (2.4)	15.5 (2.4)	-0.24 (-1.07 to 0.59)	0.56
% of caloric intake from fat	29.7 (7.1)	35.8 (6.9)	-3.6 (-6.0 to -1.2)	0.004
% of caloric intake from saturated fat	6.7 (3.2)	12.4 (3.1)	-3.2 (-4.3 to -2.1)	<0.001
% Calcium RDA satisfied	60.7 (41.9)	76.3 (40.7)	-16.0 (-42.9 to 10.9)	0.23
% Vitamin D RDA satisfied	34.6 (52.4)	30.0 (24.3)	-2.2 (-19.0 to 14.5)	0.79
Odds Ratio (95% CI)				
High fat intake	5 (34%)	37 (45%)	0.54 (0.13 to 2.18)	
Low fat intake	4 (29%)	8 (10%)	1.85 (0.46 to 7.68)	
Poor fatty acid ratio	6 (43%)	77 (94%)	0.08 (0.01 to 0.55)	

Mean (standard deviation) or number (percent) are shown in the first two columns. β coefficients and ORs are from multivariable linear regression and ordinal logistic regression, respectively, adjusted for age, sex, race/ethnicity, and income, and presented with 95% CIs in parenthesis.

Figure Legend

Figure 1: Differences in nutrition source between milk allergic and non-food allergic children. Mean contributions of total fat (A), saturated fat (B), calcium (C), and vitamin D (D) in milk allergic (n=14) and non-food allergic (n=82) children from dairy, dairy substitutes, fats, fruits (including juices), grains, nuts, other (e.g. fries, pizza), proteins, and vegetables. Categories that differed significantly between groups via unpaired t-test are marked (* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$).



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Diet Questionnaire

Thank you for taking the time to complete this questionnaire. Your participation will help us better understand diet and nutrition in children with and without food allergy. Your answers to the first section of questions will help us understand demographic and health factors that can influence diet and nutrition in children. We appreciate your contributions to our study.

- 1) First Name: _____
- 2) Last Name: _____
- 3) Date of Birth: _____
- 4) Today's Date: _____
- 5) Height (cm): _____
- 6) Weight (kg) : _____
- 7) Has a doctor diagnosed your child with food allergy
☐ Yes
☐ No
- 8) Has a doctor diagnosed your child with eczema or atopic dermatitis
☐ Yes
☐ No
- 9) Has a doctor diagnosed your child with asthma
☐ Yes
☐ No
- 10) Has a doctor diagnosed your child with hayfever, seasonal allergies, or allergic rhinitis
☐ Yes
☐ No
- 11) Has a doctor diagnosed your child with drug allergy
☐ Yes
☐ No
- 12) Please indicate your child's race/ethnicity:
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☐ White
☐ Hispanic or Latino or Spanish Origin
☐ Race unknown
☐ More than one race
- 13) Please indicate the highest level of education of the mother of your child:
☐ Less than bachelors (BA/BS)
☐ BA/BS
☐ Graduate degree
- 14) Please indicate the highest education level of the father of your child:
☐ Less than bachelors (BA/BS)
☐ BA/BS
☐ Graduate degree
- 15) Please indicate the father's country of birth:
☐ United States
☐ Outside of the United States (please specify country): _____
- 16) Please indicate the mother's country of birth:
☐ United States
☐ Outside of the United States (please specify country): _____
- 17) Please indicate the child's country of birth:
☐ United States
☐ Outside of the United States (please specify): _____

- 18) Please indicate your household's income:
- ☐ Less than \$40,000
 - ☐ \$40,000 - \$70,000
 - ☐ Greater than \$70,000
- 19) Does the mother of your child have:
- ☐ Food Allergy
 - ☐ Other Allergy
- 20) Does the father of your child have:
- ☐ Food Allergy
 - ☐ Other Allergy
- 21) Has your child had prior dietary counseling with a nutritionist?
- ☐ Yes
 - ☐ No
- 22) Does your child's siblings have:
- ☐ Food Allergy
 - ☐ Other allergy
 - ☐ N/A (no siblings)
- 23) If your child has had counseling with a nutritionist, please indicate the number of sessions: _____
- 24) If your child received dietary counseling, please indicate who it was from:
- ☐ Dietician (Certified Nutritionist)
 - ☐ Nurse
 - ☐ Physician
 - ☐ Medical Assistant
 - ☐ Online Resources
 - ☐ Other (please specify): _____
- 25) What are your sources for dietary guidance?
- ☐ Online Resources
 - ☐ Friends
 - ☐ Books
 - ☐ TV
 - ☐ Doctor
 - ☐ Dietician
 - ☐ Other: _____
- 26) What foods is your child currently allergic to? (please indicate below)
- ☐ Milk (all)
 - ☐ Egg (all)
 - ☐ Unbaked milk
 - ☐ Unbaked egg
 - ☐ Wheat
 - ☐ Soy
 - ☐ Peanut
 - ☐ Almond
 - ☐ Hazelnut
 - ☐ Cashew
 - ☐ Pistachio
 - ☐ Pecan
 - ☐ Walnut
 - ☐ Other tree nut (please specify): _____
 - ☐ Sesame
 - ☐ Legumes
 - ☐ Fish
 - ☐ Shellfish
 - ☐ Other (please specify): _____

27) What foods was your child previously allergic to but no longer is (please indicate below):

- ☐ Baked Milk
- ☐ Baked Egg
- ☐ Unbaked milk
- ☐ Unbaked egg
- ☐ Wheat
- ☐ Soy
- ☐ Peanut
- ☐ Almond
- ☐ Hazelnut
- ☐ Cashew
- ☐ Pistachio
- ☐ Pecan
- ☐ Walnut
- ☐ Other treat nut (please specify): _____
- ☐ Sesame
- ☐ Legumes
- ☐ Fish
- ☐ Shellfish
- ☐ Other (please specify): _____

28) Please indicate when your child was diagnosed with food allergy (eg. 2001) : _____

29) Please indicate the time since your child's dietary restrictions: _____

Overall Diet

Please indicate how much you agree or disagree with each of the following statements

	Strongly agree	Agree	Disagree	Strongly Disagree
30) I often have to encourage my child to eat more	☐	☐	☐	☐
31) I have to be sure that my child finishes everything in the cup	☐	☐	☐	☐
32) If my child refuses to eat a new food, I continue to offer it to him/her at other times	☐	☐	☐	☐
33) My child likes vegetables	☐	☐	☐	☐
34) My child likes fruits	☐	☐	☐	☐
35) My child usually likes new foods	☐	☐	☐	☐
36) I have to be careful not to feed my child too much	☐	☐	☐	☐
37) I often prepare something else if my child doesn't eat what I first offer	☐	☐	☐	☐

Vitamins/Supplements

38) Please indicate if your child has taken any of the following vitamins or supplements in the past month

- ☐ Multivitamins (i.e Flintstones complete, Nordic Berries, One A Day Kids complete)
- ☐ Poly-Vi-Sol
- ☐ Tri-Vi-Sol
- ☐ Poly-Vi-Flor
- ☐ Tri-Vi-Flor
- ☐ 400 IU Vitamin D
- ☐ 600 IU Vitamin D
- ☐ 1000 IU Vitamin D
- ☐ 2000 IU Vitamin D
- ☐ Probiotics
- ☐ Calcium
- ☐ Omega-3
- ☐ Fish Oil
- ☐ Other : _____

Fruits

The following questions are about your child's diet over the past month. Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

	Never	Less than once per week	Once per week	2-4 times per week	Nearly daily or daily	2 or more times per day
39) Orange or grapefruit	☐	☐	☐	☐	☐	☐
40) Banana	☐	☐	☐	☐	☐	☐
41) Apple or apple sauce	☐	☐	☐	☐	☐	☐
42) Grapes	☐	☐	☐	☐	☐	☐
43) Peach or plum	☐	☐	☐	☐	☐	☐
44) Strawberries or other berries	☐	☐	☐	☐	☐	☐
45) Cantaloupe	☐	☐	☐	☐	☐	☐
46) Watermelon	☐	☐	☐	☐	☐	☐
47) Pear	☐	☐	☐	☐	☐	☐
48) Raisins or prunes	☐	☐	☐	☐	☐	☐
49) Papaya	☐	☐	☐	☐	☐	☐
50) Mango	☐	☐	☐	☐	☐	☐
51) Kiwi	☐	☐	☐	☐	☐	☐

52) Other fruit or vegetable: _____

53) In what form do you eat these fruits?

- ☐ Whole
- ☐ Puree/sauce
- ☐ Combination

Vegetables

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

	Never	Less than once per week	Once per week	2-4 times per week	Nearly daily or daily	2 or more times per day
54) Corn	☐	☐	☐	☐	☐	☐
55) Peas (canned, frozen or fresh)	☐	☐	☐	☐	☐	☐
56) Tomatoes	☐	☐	☐	☐	☐	☐
57) Peppers (green, red, or hot)	☐	☐	☐	☐	☐	☐
58) Carrots	☐	☐	☐	☐	☐	☐
59) Broccoli	☐	☐	☐	☐	☐	☐
60) Green beans	☐	☐	☐	☐	☐	☐
61) Spinach	☐	☐	☐	☐	☐	☐
62) Squash (orange or winter)	☐	☐	☐	☐	☐	☐
63) French fries, fried potatoes	☐	☐	☐	☐	☐	☐
64) Potatoes (baked, boiled, or mashed)	☐	☐	☐	☐	☐	☐
65) Sweet potatoes or yams	☐	☐	☐	☐	☐	☐
66) Cabbage, coleslaw, cauliflower	☐	☐	☐	☐	☐	☐
67) Lettuce salad	☐	☐	☐	☐	☐	☐
68) Spinach (or other greens)	☐	☐	☐	☐	☐	☐
69) Mixed vegetables	☐	☐	☐	☐	☐	☐
70) Baked beans or chili beans	☐	☐	☐	☐	☐	☐
71) Other beans, peas, or lentils	☐	☐	☐	☐	☐	☐
72) Avocado	☐	☐	☐	☐	☐	☐

73) Other: _____

74) In what form do you eat these vegetables?

- ☐ Whole
☐ Puree/sauce
☐ Combination

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

[illegible]

Starches and grains

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

	Never	Less than once per week	Once per week	2-4 times per week	Nearly daily or daily	2-4 times per day	5 or more times per day
95) Pasta (wheat based)	☐	☐	☐	☐	☐	☐	☐
96) White Rice	☐	☐	☐	☐	☐	☐	☐
97) Brown Rice	☐	☐	☐	☐	☐	☐	☐
98) White Bread (slice, rolls, or pita)	☐	☐	☐	☐	☐	☐	☐
99) Whole-wheat or Whole-Grain Bread (slice, rolls, or pita)	☐	☐	☐	☐	☐	☐	☐
100) Cornbread or corn	☐	☐	☐	☐	☐	☐	☐
101) Cereal (hot or cold)	☐	☐	☐	☐	☐	☐	☐
102) Donut	☐	☐	☐	☐	☐	☐	☐
103) Sweet roll, muffin, or scone	☐	☐	☐	☐	☐	☐	☐
104) Pancake, waffle, or French Toast	☐	☐	☐	☐	☐	☐	☐
105) English muffin or bagel	☐	☐	☐	☐	☐	☐	☐
106) Quinoa	☐	☐	☐	☐	☐	☐	☐
107) Buckwheat, amaranth, or millet	☐	☐	☐	☐	☐	☐	☐
108) Oats	☐	☐	☐	☐	☐	☐	☐

109) Are you eating gluten free versions of the items listed below? Please specify

- ☐ Yes
☐ No

110) Gluten-free:

- ☐ Pasta
☐ Rice
☐ Bread
☐ Cereal
☐ Sweet rolls, muffins, or scones
☐ Pancake, waffle, or french toast
☐ Other (please specify): _____

Drinks

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

	Never	Less than once per week	Once per week	2-4 times per week	Nearly daily or daily	2-4 times per day	5 or more times per day		
111) Orange Juice	☐	☐	☐	☐	☐	☐	☐		
112) Other 100% Juice	☐	☐	☐	☐	☐	☐	☐		
113) Fruit drinks (Hi-C, Kool-Aid, lemonade)	☐	☐	☐	☐	☐	☐	☐		
114) Soda (not sugar-free)	☐	☐	☐	☐	☐	☐	☐		
115) Sugar-free soda	☐	☐	☐	☐	☐	☐	☐		
116) Cow's Milk, including chocolate milk	☐	☐	☐	☐	☐	☐	☐		

	Never	Less than once per week	Once per week	2-4 times per week	Nearly daily or daily	2-4 times per day	5 or more times per day	Enriched	Not enriched
117) Soy Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
118) Oat Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
119) Hemp Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
120) Quinoa Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
121) Almond Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
122) Cashew Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
123) Almond and Cashew Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐
124) Pea Milk	☐	☐	☐	☐	☐	☐	☐	☐	☐

Does your child drink any of the following types of formula?

	Yes	No
125) Alfamino	☐	☐
126) Elecare	☐	☐
127) Neocate infant	☐	☐
128) Neocate Syneo	☐	☐
129) PurAmino	☐	☐
130) Alfamino junior	☐	☐
131) Elecare junior	☐	☐
132) Neocate junior	☐	☐
133) PurAmino Toddler	☐	☐
134) Splash	☐	☐
135) Pregestimil	☐	☐
136) Alimenum	☐	☐
137) Nutramigen	☐	☐
138) Gerber Extensive HA	☐	☐
139) Nutramigen Toddler	☐	☐

140) Are you avoiding dairy?

☐ Yes (please answer the following question)

☐ No (please skip the following question)

141) What kind of milk does your child usually drink?

☐ Whole Milk

☐ 2% milk

☐ 1% milk

☐ Skim milk

☐ Other (Please specify: _____)

☐ My child does not drink milk

Are you having cows milk- free versions of those listed below:

	Yes	No
142) Whole milk	☐	☐
143) 2% milk	☐	☐
144) 1% milk	☐	☐
145) Skim milk	☐	☐
146) Other (please specify)	☐	☐

Other dairy

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

[illegible]

Please check the box that best represents how often your child eats each of the foods listed, on average, in the past month.

Snacks and sweets

[illegible]

Other foods your child eats at least once per week

Are there any other foods not mentioned above that your child eats at least once per week?
Please write in the name of the food and check the box that best represents how often your
child eats each food, on average, in the past month

	Once per week	2-4 times per week	Nearly daily or daily	2-4 times per day	5 or more times per day
170) _____	☐	☐	☐	☐	☐
171) _____	☐	☐	☐	☐	☐
172) _____	☐	☐	☐	☐	☐
173) _____	☐	☐	☐	☐	☐
174) _____	☐	☐	☐	☐	☐