

# Marginal, Low, and Very-Low Food Security among Children Are Associated with Intake of Select Dietary Factors during Summer

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## ARTICLE INFORMATION

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## ABSTRACT

**Background** School meals are associated with improved food security status and dietary intake. Children receiving free and reduced-price school meals lose access to these meals during the summer. The association between food security status and dietary intake in these children during summer is unclear.

**Objective** To examine the association between food security status (high, marginal, low, and very-low food security) among children and intake of select dietary factors during summer in children certified for free and reduced-price school meals by age group (3 to 4 years, 5 to 8 years, 9 to 12 years, and 13 to 17 years).

**Design** Cross-sectional analysis.

**Participants/setting** Secondary data from 11,873 children aged 3 to 17 years in the control group of the US Department of Agriculture Summer Electronic Benefit Transfer for Children Demonstration Project.

**Main outcome measures** Consumption of total fruits and vegetables; fruits and vegetables, excluding fried potatoes; whole grains; added sugars; added sugars, excluding cereals; added sugars from sugar-sweetened beverages; and dairy products assessed using questions from the 2009–2010 National Health and Nutrition Examination Survey Multifactor Diet Screener.

**Statistical analysis** Multiple linear regression.

**Results** For the majority of age groups, marginal food security, low food security, and very-low food security were associated with lower fruit and vegetable consumption and low food security and very-low food security were associated with lower dairy consumption, with children from households with very-low food security having the lowest consumption. Children from households with very-low food security consumed 0.73 (95% CI –0.93 to –0.53) to 0.99 (95% CI –1.59 to –0.39) cup equivalents less per day of fruits and vegetables and 0.49 (95% CI –0.65 to –0.34) to 0.68 (95% CI –1.07 to –0.29) cup equivalents less per day of dairy compared with children from households experiencing high food security.

**Conclusions** Lower food security was associated with reduced consumption of fruits and vegetables and dairy products during summer in children from low-income households.

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**F**OOD SECURITY IS DEFINED AS “ACCESS BY ALL PEOPLE at all times to enough food for an active, healthy life.”<sup>1</sup> The US Department of Agriculture (USDA), describes food security status using four categories: high (no

problems or limitations related to food access), marginal (one or two problems or limitations related to food access, such as anxiety around accessing food, with little or no changes in food intake), low (reduction in variety, quality, or desirability of diet, but little or no reduction in food intake), and very low (multiple indications of reduced intake and disrupted eating patterns).<sup>2</sup> Households reporting high food security (HFS) or marginal food security (MFS) are often referred to as food secure and households reporting low food security (LFS) or very-low food security (VLFS) are typically referred to as food insecure.<sup>2</sup> During 2019, 13.6% of US households with children experienced food insecurity at some point during the year.<sup>1</sup> This is alarming because 10.7 million children lived in food-insecure households, and 5.3 million children lived in households where at least one child experienced food

insecurity.<sup>1</sup> Food insecurity has become an even more serious issue during the coronavirus disease 2019 (COVID-19) pandemic, with a report by the Urban Institute finding that nearly one in four households with children experienced food insecurity during September 2020.<sup>3</sup>

Poor dietary intake is another concern, with the average daily consumption of US children and adolescents not meeting 2015 Dietary Guidelines for Americans (2015 DGA) recommendations for fruits, vegetables, whole grains, and dairy and exceeding recommendations for added sugars, saturated fat, and sodium.<sup>4</sup> This is an important issue because poor diet is associated with a variety of chronic health conditions.<sup>4</sup> Diet quality has also been shown to be lower among children and adolescents from lower-income households.<sup>5,6</sup> Although some evidence suggests that food insecurity is associated with poorer dietary outcomes in children, the evidence is less consistent than associations found in adults.<sup>7,8</sup> Food insecurity may affect children's dietary intake differently depending on age group. Different age groups have different nutrient requirements and past research on children in the United States suggests that younger children are more likely to meet dietary recommendations for a variety of nutrients compared with older children.<sup>8</sup> Differences in access to so-called healthy foods may exist between younger and older children due to younger children being more likely to be protected from food insecurity than older siblings.<sup>8</sup> Many studies examining the association between food security status and dietary intake focus on a limited age group and not all age groups have been studied equally, with adolescents aged 12 to 19 years being included in fewer studies than children aged 1 to 5 years or 6 to 11 years, making additional research on these associations by age group important.<sup>8</sup>

The authors are only aware of one prior study focusing on association between food security status and dietary outcomes in children during the summer. That study was limited to 218 children from Minnesota and found no significant associations with dietary outcomes on weekdays, but significantly lower consumption of whole fruits and energy per every 1,000 kcal and higher intake of sugar-sweetened beverages in children from food-insecure households compared with food-secure households.<sup>9</sup> It is especially important to examine the association between food security status and dietary outcomes in low-income households during summer because many children lose access to free and reduced-price (FRP) meals through programs such as the National School Lunch Program (NSLP) and School Breakfast Program when they are not in school. Meals served through these programs must meet federal nutrition standards, which can help children meet dietary recommendations for foods such as fruits, vegetables, whole grains, and low-fat/fat-free dairy.<sup>10</sup> With the challenges many children face related to receiving meals while attending school remotely due to the COVID-19 pandemic,<sup>11</sup> it is imperative to gain a better understanding of this issue.

The objective of this study was to examine the association between food security status among children and intake of select dietary factors during summer in prekindergarten through grade 12 children certified for FRP meals by age group (3 to 4 years, 5 to 8 years, 9 to 12 years, and 13 to 17 years). It was hypothesized that MFS, LFS, and VLFS among children would be associated with a lower intake of fruits and vegetables, whole grains, and dairy products and higher

## RESEARCH SNAPSHOT

**Research Question:** What is the association between food security status among children and intake of select dietary factors during the summer in children certified for free and reduced-price school meals by age group (3 to 4 years, 5 to 8 years, 9 to 12 years, and 13 to 17 years).

**Key Findings:** This cross-sectional analysis of 11,873 children found that marginal, low, and very-low food security was associated with a lower consumption of fruits and vegetables and dairy products for most age groups. Children from households experiencing very-low food security among children had the lowest consumption of these dietary factors.

intake of added sugars during summer among children certified for FRP meals.

## METHODS

### Participants

Cross-sectional data from children in the control group of the 2012 USDA Summer Electronic Benefit Transfer for Children (SEBTC) demonstration were included in this study. The design of the SEBTC demonstration, including detailed participant recruitment information, has been described elsewhere.<sup>12</sup> Briefly, the SEBTC demonstration was a randomized controlled trial assessing the efficacy of providing monthly benefits to children certified for FRP school meals that could be used to purchase food during summer. The primary outcome was VLFS among children and secondary outcomes included intake of select dietary factors. The 2012 demonstration included 10 grantees and 14 sites from across the United States. Grantees were from Cherokee Nation, Chickasaw Nation, Connecticut, Delaware, Michigan, Missouri, Nevada, Oregon, Texas, and Washington. Eligibility criteria for the demonstration was having at least one child in prekindergarten through 12th grade certified for FRP meals during the 2011-2012 school year. The SEBTC study was approved by the institutional review board of Abt Associates (Cambridge, MA). The Washington State and Michigan Department of Community Health Institutional Review Boards approved the parts of the study taking place in Washington and Michigan, respectively. A subsample of households were randomly selected to participate in the household survey. Surveys were administered using computer-assisted telephone interviewing and completed by an adult respondent in English or Spanish.

The analyses for this study used data from the household survey conducted during summer 2012 from the public use data file. Data collection for all households began 30 days after households in the benefit group started receiving SEBTC benefits.<sup>13</sup> SEBTC has been shown to be effective at both reducing food insecurity among children and improving dietary intake during the summer,<sup>12</sup> so this study included only participants in the control group who did not receive any EBT benefits that may have influenced their food security status or dietary intake.

### Measures

Food security status was assessed over the past 30 days using the 18-item US Household Food Security Module, which has

been shown to be valid and reliable.<sup>14</sup> Eight of the 18 items are specific to children younger than age 18 years and comprise US Children's Food Security Scale. Responses to these eight questions were used to classify households as having HFS (score of 0), MFS (score = 1), LFS (score = 2 to 4), or VLFS (score = 5 to 8) among children.<sup>15</sup>

For households with multiple children, one child was randomly selected as the focus for child-level survey questions, including intake of select dietary factors and nutrition program participation. The adult respondent answered the child-level survey questions. Twenty-four of the 26 items from the 2009-2010 National Health and Nutrition Examination Survey Multifactor Diet Screener (DSQ) were used to assess intake of select dietary factors in children during the previous 30 days.<sup>16</sup> The DSQ has been cognitively tested and many of the items included have undergone validity testing.<sup>17</sup> Dietary factors examined were consumption of total fruits and vegetables; fruits and vegetables, excluding fried potatoes; whole grains; added sugars; added sugars, excluding cereals; added sugars from sugar-sweetened beverages; and dairy products. These items were selected because they assess dietary components addressed by the 2010 DGA and have been associated with nutritional risk among children.<sup>12</sup> Respondents had the option of reporting consumption as number of times items were consumed per day, week, or month. Methods developed by the National Cancer Institute were used to convert reported consumption into cup equivalents per day for fruits and vegetables and dairy products, ounce-equivalents per day for whole grains, and teaspoons per day for added sugars.<sup>18</sup> The two items excluded from the DSQ were unrelated to the dietary factors examined (red and processed meat) and therefore did not influence these calculations.

## Statistical Analysis

The analyses included households who completed the summer 2012 survey and had data on at least one outcome measure and complete information on all other variables used in the models (food security status, age category, and covariates). The public use data file only included child age categories (3 to 4 years, 5 to 8 years, 9 to 12 years, 13 to 15 years, 16 to 17 years, and  $\geq 18$  years). The 13 to 15 years and 16 to 17 years groups were combined to be as close to the age categories used by the 2010 DGA (2 to 3 years, 4 to 8 years, 9 to 13 years, and 14 to 18 years). The US Children's Food Security Scale applies to children younger than age 18 years, so participants aged 18 years or older were excluded from analyses. Analyses were conducted separately for each age group. A total of 12,980 households completed the summer 2012 survey and 595 were excluded where the focal child was aged 18 years or older. An additional 512 households were excluded for missing data, leaving an analytical sample of 11,873. Adjusted mean intake of each dietary outcome was calculated for each food security status group. Multiple linear regression assessed the association between food security status among children with each dietary outcome. Covariates related to participation in food assistance programs were included in the models because these programs have been associated with both food security status and diet.<sup>19-22</sup> Covariates related to household, respondent, and child characteristics were

also included. Table 1 shows the full list of covariates. Survey weights were included in the analyses to account for unequal probabilities of selection and differential nonresponse. All analyses were conducted using SAS version 9.4.<sup>23</sup> A *P* value < 0.05 was considered statistically significant.

## RESULTS

Only 36% of children in the sample lived in households with HFS. The proportion of children in the sample living in households with MFS, LFS, and VLFS, respectively, for each age group was: 3 to 4 years (19%, 27%, 5%), 5 to 8 years (20%, 33%, 7%), 9 to 12 years (21%, 35%, 10%), and 13 to 17 years (17%, 39%, 13%). Child, respondent, and household characteristics of participants by age group and food security status are described in Table 1.

Table 2 shows the adjusted mean intake of dietary factors by age group and food security status and the results of the multiple linear regression models. For children aged 3 to 4, 5 to 8, and 13 to 17 years from households with MFS and all age groups for children from households with LFS or VLFS, children had significantly lower consumption of fruits and vegetables and fruits and vegetables, excluding fried potatoes. In looking at consumption of whole grains, children aged 5 to 8 years from households with LFS and aged 13 to 17 years old from households with VLFS consumed 0.16 oz equivalents/day ( $P = 0.04$ ) less and 0.42 oz equivalents/day ( $P = 0.04$ ) less, respectively, than children from households with HFS. Among children aged 9 to 12 years, those from households with MFS consumed 0.42 oz equivalents/day ( $P = .05$ ) more than children from households with HFS. There were no other significant associations between food security status and consumption of whole grains.

For both total added sugar and added sugar, excluding cereal, children aged 3 to 4 years from households with LFS and children aged 9 to 12 years and 13 to 17 years from households with VLFS consumed less compared with children from households with HFS. Children who were aged 3 to 4 years from households with LFS also consumed less added sugar from sugar-sweetened beverages. Children who were aged 5 to 8 years from households with MFS consumed more total added sugar; added sugar, excluding cereal; and added sugar from sugar-sweetened beverages. Compared with children from households with HFS, dairy consumption was lower for all age groups except 3- to 4-year olds from households with LFS and for all age groups for children from households with VLFS.

## DISCUSSION

Lower food security was associated with reduced consumption of fruits and vegetables and dairy products, with children from households experiencing VLFS consuming the least. The magnitude of difference compared with children from households experiencing HFS was both statistically and practically significant with children from households with VLFS consuming nearly three-quarters to 1 c equivalents of fruits and vegetables less per day and approximately one-half to two-thirds cup equivalents less per day of dairy products. Although differences among age groups was not formally tested, the magnitude of difference was largest for 3- to 4-year old children and second largest for 13- to 17-year old

**Table 1.** Child, respondent, and household characteristics by food security status among a sample of children from households certified for free and reduced-price school meals during summer 2012

Characteristic	High Food Security (n = 4,254)	Marginal Food Security (n = 2,271)	Low Food Security (n = 4,214)	Very-Low Food Security (n = 1,134)
	————— <i>n (%)</i> <sup>a</sup> —————→			
<b>Age group (y)</b>				
3-4	204 (5)	83 (4)	117 (3)	22 (2)
5-8	1,590 (37)	760 (33)	1,279 (30)	266 (23)
9-12	1,226 (29)	761 (34)	1,284 (30)	353 (31)
13-17	1,234 (29)	667 (29)	1,534 (36)	493 (43)
<b>Child sex</b>				
Female	2,060 (48)	1,102 (49)	2,034 (48)	536 (47)
Male	2,194 (52)	1,169 (51)	2,180 (52)	598 (53)
<b>Respondent race/ethnicity<sup>b</sup></b>				
Hispanic	1,254 (29)	595 (26)	1,417 (34)	423 (37)
Non-Hispanic Black	895 (21)	435 (19)	740 (18)	245 (22)
Non-Hispanic White	1,773 (42)	1,067 (47)	1,758 (42)	377 (33)
Non-Hispanic other or multiple races	332 (8)	174 (8)	299 (7)	89 (8)
<b>Respondent education level<sup>b</sup></b>				
Less than high school	1,041 (24)	556 (24)	1,301 (31)	418 (37)
High school or General Educational Development tests	1,413 (33)	752 (33)	1,284 (30)	328 (29)
Some college	1,429 (34)	785 (35)	1362 (32)	316 (28)
4-y degree or higher	371 (9)	178 (8)	267 (6)	72 (6)
<b>Ratio of household income to federal poverty threshold</b>				
Below poverty line	2,774 (65)	1,575 (69)	3,052 (72)	930 (82)
101%-130%	536 (13)	330 (15)	620 (15)	122 (11)
131%-184%	564 (13)	279 (12)	425 (10)	67 (6)
≥185%	380 (9)	87 (4)	117 (3)	15 (1)
<b>Household composition</b>				
Single female-headed	1,973 (46)	1,092 (48)	2,068 (49)	655 (58)
Single male-headed	173 (4)	100 (4)	130 (3)	40 (4)
Two or more adults in household	2,108 (50)	1,079 (48)	2,016 (48)	439 (39)
<b>Household size</b>				
2	407 (10)	210 (9)	377 (9)	120 (11)
3	957 (23)	495 (22)	891 (21)	224 (20)
4	1,211 (28)	638 (28)	1,164 (28)	287 (25)
5	927 (22)	506 (22)	943 (22)	260 (23)
6	429 (10)	236 (10)	489 (12)	128 (11)
7	178 (4)	115 (5)	192 (5)	61 (5)
≥ 8	145 (3)	71 (3)	158 (4)	54 (5)
<b>Number of children in household</b>				
1	1,129 (27)	487 (21)	887 (21)	244 (22)

*(continued on next page)*

**Table 1.** Child, respondent, and household characteristics by food security status among a sample of children from households certified for free and reduced-price school meals during summer 2012 (*continued*)

Characteristic	High Food Security (n = 4,254)	Marginal Food Security (n = 2,271)	Low Food Security (n = 4,214)	Very-Low Food Security (n = 1,134)
2	1,505 (35)	841 (37)	1522 (36)	346 (31)
3	978 (23)	579 (26)	1,082 (26)	319 (28)
4	411 (10)	218 (10)	465 (11)	148 (13)
5	149 (4)	97 (4)	173 (4)	51 (5)
≥ 6	82 (2)	49 (2)	85 (2)	26 (2)
<b>At least 1 employed adult in household</b>	3,105 (73)	1,631 (72)	2,918 (69)	721 (64)
<b>Participation in nutrition assistance benefits for children<sup>cd</sup></b>	508 (12)	300 (13)	539 (13)	173 (15)
<b>Household participation in WIC<sup>ce</sup></b>	932 (22)	480 (21)	825 (20)	176 (16)
<b>Household participation in SNAP<sup>cf</sup></b>	2,578 (61)	1,440 (63)	2,692 (64)	709 (63)
<b>Household received food from food pantry, food bank, or emergency kitchen<sup>c</sup></b>	289 (7)	314 (14)	846 (20)	305 (27)

<sup>a</sup>Percentages may not add up to 100 due to rounding.

<sup>b</sup>Information on race/ethnicity and education were reported for the adult respondent who completed the survey questions.

<sup>c</sup>Participation was assessed over the past 30 days.

<sup>d</sup>Nutrition assistance benefits for children include the National School Lunch Program, School Breakfast Program, Summer Food Service Program, afterschool program providing free supper, and summer backpack programs.

<sup>e</sup>WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

<sup>f</sup>SNAP = Supplemental Nutrition Assistance Program.

children. It is possible that children aged 5 to 8 years and 9 to 12 years were more protected from the influence of food insecurity compared with older children.<sup>8</sup> Among all food security status categories, the estimated mean intake for the majority of age groups was lower than the 2010 DGA recommendations (applicable when data for the study were collected) for fruits and vegetables (2.5 to 6.5 c equivalents depending on age and activity level), whole grains (2 to 5 oz equivalents depending on age and activity level), and dairy products (2.5 to 3 c equivalents per day depending on age and activity level).<sup>24</sup>

A variety of barriers may contribute to lower fruit and vegetable consumption among children from more food insecure households, including cost, access, and time for preparing fruits and vegetables.<sup>25,26</sup> Although there have been past studies finding some associations between fruit and vegetable<sup>27-29</sup> and dairy<sup>30</sup> consumption and food security status, many studies not focused on summer have found no significant associations.<sup>31-36</sup> Studies taking place during the school year may be less likely to find significant associations in the case that children are consuming a large portion of their dietary intake through school meals. A prior study found that 57.7% of the fruit, 40.6% of the vegetables, and 69.9% of the dairy products children consumed were from school meals.<sup>37</sup>

The majority of analyses showed no significant differences for the association between food security status and consumption of whole grains. The only significant findings were a slightly lower intake for children aged 5 to 8 years with LFS

and slightly higher intake for children aged 9 to 12 years with MFS. Limited past research has looked at the association of food security status and consumption of whole grains. A past study found that children aged 2 to 15 years experiencing VLFS had lower consumption of whole grains compared with food secure children,<sup>38</sup> whereas two other studies found no significant associations.<sup>39,40</sup> Additional research on the association between food security status and consumption of whole grains in children is needed.

An unexpected finding was that certain age groups of children from households experiencing LFS and VLFS consumed less added sugars than children from households with HFS. Although consuming less added sugar is beneficial, children in this study from all age groups and food security status categories exceeded the 2015-2020 DGA recommends limiting daily intake of added sugars to <10% of calories,<sup>4</sup> which equates to 7.5 tsp/day to a child consuming 1,200 kcal/day and 12.5 tsp/day for a child consuming 2,000 kcal/day (the 2010 DGA, which were applicable when the data were collected, did not include specific added sugar recommendations). The results agree with the findings from a study by Casey and colleagues<sup>29</sup> that found that children from food insufficient households consumed less added sugar than children from low-income food-sufficient households. However, most other studies looking at the association of food security and consumption of added sugars found food-insecure children to consume more added sugar compared with food-secure children.<sup>38,41-43</sup> The analyses did not take into account overall dietary intake because these data were

**Table 2.** Association of food security status among children and dietary outcomes by age category among a sample of children from households certified for free and reduced-price school meals during summer 2012<sup>a</sup>

Outcome and age category	High food security		Marginal food security			Low food security			Very-low food security		
	n	Mean (95% CI)	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)
<b>Fruits and vegetables (c equivalents/d)</b>											
3-4 y	199	2.61 (2.24 to 2.98)	80	1.82 (1.20 to 2.43)	-0.80 (-1.36 to -0.24)**	116	1.86 (1.38 to 2.34)	-0.76 (-1.21 to -0.30)**	22	1.62 (0.98 to 2.26)	-0.99 (-1.59 to -0.39)**
5-8 y	1,545	2.99 (2.86 to 3.12)	739	2.79 (2.63 to 2.95)	-0.20 (-0.36 to -0.05)**	1,256	2.56 (2.41 to 2.71)	-0.43 (-0.56 to -0.30)***	261	2.26 (2.05 to 2.47)	-0.73 (-0.93 to -0.53)***
9-12 y	1,189	2.89 (2.73 to 3.05)	750	2.89 (2.70 to 3.08)	0.00 (-0.19 to 0.20)	1,260	2.48 (2.33 to 2.63)	-0.41 (-0.57 to -0.25)***	344	2.10 (1.89 to 2.30)	-0.79 (-1.01 to -0.58)***
13-17 y	1,196	3.17 (2.99 to 3.35)	648	2.93 (2.74 to 3.12)	-0.24 (-0.45 to -0.03)*	1,487	2.61 (2.47 to 2.75)	-0.56 (-0.74 to -0.38)***	481	2.24 (2.05 to 2.43)	-0.93 (-1.14 to -0.71)***
<b>Fruits and vegetables, excluding fried potatoes (c equivalents/d)</b>											
3-4 y	199	2.51 (2.15 to 2.86)	80	1.76 (1.18 to 2.34)	-0.74 (-1.27 to -0.22)**	116	1.80 (1.35 to 2.26)	-0.71 (-1.13 to -0.28)**	22	1.58 (0.97 to 2.20)	-0.92 (-1.50 to -0.34)**
5-8 y	1,548	2.88 (2.75 to 3.00)	740	2.68 (2.52 to 2.83)	-0.20 (-0.35 to -0.05)**	1,256	2.46 (2.31 to 2.60)	-0.42 (-0.54 to -0.30)***	261	2.15 (1.94 to 2.35)	-0.73 (-0.92 to -0.53)***
9-12 y	1,190	2.77 (2.61 to 2.92)	751	2.77 (2.58 to 2.96)	0.00 (-0.19 to 0.20)	1,260	2.37 (2.22 to 2.51)	-0.40 (-0.56 to -0.24)***	344	1.98 (1.78 to 2.18)	-0.79 (-1.00 to -0.58)***
13-17 y	1,197	3.02 (2.84 to 3.19)	649	2.77 (2.58 to 2.96)	-0.25 (-0.45 to -0.05)*	1,489	2.47 (2.33 to 2.60)	-0.55 (-0.72 to -0.38)***	481	2.07 (1.89 to 2.25)	-0.94 (-1.14 to -0.74)***
<b>Whole grains (oz equivalents/d)</b>											
3-4 y	200	1.08 (0.75 to 1.40)	80	0.89 (0.52 to 1.27)	-0.18 (-0.45 to 0.08)	115	0.86 (0.50 to 1.21)	-0.22 (-0.45 to 0.01)	22	1.24 (0.62 to 1.87)	0.16 (-0.41 to 0.74)
5-8 y	1,563	1.40 (1.19 to 1.61)	746	1.32 (1.12 to 1.52)	-0.08 (-0.25 to 0.09)	1,272	1.24 (1.05 to 1.44)	-0.16 (-0.31 to -0.00)*	264	1.13 (0.81 to 1.45)	-0.27 (-0.57 to 0.02)
9-12 y	1,210	1.46 (1.23 to 1.69)	757	1.88 (1.47 to 2.28)	0.42 (0.01 to 0.83)*	1,267	1.57 (1.32 to 1.81)	0.11 (-0.13 to 0.34)	351	1.37 (1.05 to 1.68)	-0.09 (-0.40 to 0.21)
13-17 y	1,203	1.92 (1.58 to 2.25)	651	2.28 (1.84 to 2.71)	0.36 (-0.05 to 0.77)	1,504	2.00 (1.70 to 2.30)	0.09 (-0.24 to 0.41)	484	1.49 (1.03 to 1.96)	-0.42 (-0.83 to -0.01)*
<b>Added sugar (tsp/d)</b>											
3-4 y	199	14.59 (12.00 to 17.19)	78	13.57 (10.49 to 16.66)	-1.02 (-3.40 to 1.36)	116	11.74 (9.25 to 14.24)	-2.85 (-4.50 to -1.20)***	22	12.01 (8.07 to 15.96)	-2.58 (-5.98 to 0.82)

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**Table 2.** Association of food security status among children and dietary outcomes by age category among a sample of children from households certified for free and reduced-price school meals during summer 2012<sup>a</sup> (continued)

Outcome and age category	High food security			Marginal food security			Low food security			Very-low food security		
	n	Mean (95% CI)		n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)
5-8 y	1,557	14.70 (13.87 to 15.53)		736	15.67 (14.65 to 16.69)	0.97 (0.03 to 1.91)*	1,257	15.04 (14.16 to 15.92)	0.34 (-0.41 to 1.08)	259	15.05 (13.67 to 16.43)	0.35 (-0.92 to 1.63)
9-12 y	1,207	18.35 (17.39 to 19.31)		745	17.95 (16.98 to 18.92)	-0.40 (-1.44 to 0.64)	1,248	17.71 (16.71 to 18.70)	-0.64 (-1.74 to 0.45)	343	16.60 (15.17 to 18.03)	-1.75 (-3.25 to -0.25)*
13-17 y	1,170	22.07 (20.86 to 23.27)		643	22.39 (20.74 to 24.03)	0.32 (-1.33 to 1.97)	1,467	21.95 (20.66 to 23.23)	-0.12 (-1.38 to 1.14)	470	19.68 (18.08 to 21.28)	-2.39 (-4.03 to -0.75)**
<b>Added sugar, excluding cereal (tsp/d)</b>												
3-4 y	202	14.18 (11.76 to 16.60)		79	13.39 (10.50 to 16.29)	-0.79 (-2.98 to 1.40)	116	11.65 (9.29 to 14.01)	-2.53 (-4.06 to -1.01)**	22	11.30 (7.57 to 15.02)	-2.88 (-6.07 to 0.30)
5-8 y	1,570	14.12 (13.36 to 14.88)		746	15.06 (14.12 to 16.00)	0.94 (0.10 to 1.77)*	1,259	14.39 (13.57 to 15.20)	0.26 (-0.39 to 0.92)	261	14.62 (13.30 to 15.93)	0.49 (-0.73 to 1.72)
9-12 y	1,212	17.35 (16.53 to 18.17)		748	17.08 (16.21 to 17.95)	-0.27 (-1.19 to 0.65)	1,259	16.88 (16.00 to 17.75)	-0.48 (-1.45 to 0.49)	345	15.87 (14.49 to 17.25)	-1.48 (-2.90 to -0.06)*
13-17 y	1,186	20.53 (19.48 to 21.57)		647	20.74 (19.35 to 22.13)	0.21 (-1.16 to 1.59)	1,481	20.33 (19.22 to 21.44)	-0.20 (-1.27 to 0.86)	477	18.36 (16.97 to 19.75)	-2.17 (-3.56 to -0.78)**
<b>Added sugar from sugar-sweetened beverages (tsp/d)</b>												
3-4 y	204	5.40 (2.88 to 7.93)		80	5.22 (2.50 to 7.95)	-0.18 (-1.91 to 1.56)	116	3.56 (1.27 to 5.85)	-1.84 (-3.15 to -0.54)**	22	3.85 (0.73 to 6.97)	-1.55 (-3.81 to 0.71)
5-8 y	1,581	4.86 (4.15 to 5.57)		751	5.90 (4.89 to 6.90)	1.04 (0.09 to 1.99)*	1,263	5.43 (4.65 to 6.21)	0.57 (-0.05 to 1.19)	261	5.86 (4.66 to 7.07)	1.00 (-0.09 to 2.10)
9-12 y	1,217	7.78 (6.82 to 8.73)		757	7.28 (6.32 to 8.24)	-0.49 (-1.54 to 0.55)	1,272	7.29 (6.34 to 8.25)	-0.48 (-1.56 to 0.60)	348	6.88 (5.53 to 8.23)	-0.90 (-2.34 to 0.55)
13-17 y	1,208	11.32 (10.16 to 12.48)		657	12.09 (10.45 to 13.72)	0.77 (-0.85 to 2.39)	1,510	11.58 (10.30 to 12.86)	0.26 (-1.01 to 1.53)	488	10.15 (8.59 to 11.71)	-1.17 (-2.78 to 0.44)
<b>Dairy products (c equivalents/d)</b>												
3-4 y	203	2.16 (1.80 to 2.51)		82	1.92 (1.52 to 2.31)	-0.24 (-0.52 to 0.04)	116	1.91 (1.52 to 2.30)	-0.25 (-0.55 to 0.06)	22	1.48 (1.00 to 1.96)	-0.68 (-1.07 to -0.29)***
5-8 y	1,574	2.10 (1.97 to 2.23)		751	2.02 (1.87 to 2.17)	-0.08 (-0.21 to 0.05)	1,267	1.88 (1.75 to 2.01)	-0.22 (-0.32 to -0.12)***	266	1.61 (1.43 to 1.78)	-0.49 (-0.65 to -0.34)***

(continued on next page)

**Table 2.** Association of food security status among children and dietary outcomes by age category among a sample of children from households certified for free and reduced-price school meals during summer 2012<sup>a,c</sup> (continued)

Outcome and age category	High food security			Marginal food security			Low food security			Very-low food security		
	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)	n	Mean (95% CI)	β (95% CI)
9-12 y	1,211	2.21 (2.08 to 2.35)	0.14 (-0.03 to 0.32)	1,273	1.95 (1.82 to 2.07)	-0.26 (-0.38 to -0.15)***	349	1.69 (1.53 to 1.85)	-0.52 (-0.68 to -0.36)***			
13-17 y	1,216	2.58 (2.42 to 2.73)	-0.04 (-0.21 to 0.13)	1,506	2.25 (2.11 to 2.40)	-0.32 (-0.46 to -0.18)***	484	1.95 (1.74 to 2.16)	-0.63 (-0.82 to -0.44)***			

<sup>a</sup>Multiple linear regression was used with high food security as the reference group. Covariates included in the models were sex, respondent race/ethnicity, respondent education, ratio of household income to federal poverty threshold, household composition, household size, number of children in household, and participation in the following nutrition assistance programs in the past 30 days: Supplemental Nutrition Assistance Program; Special Supplemental Nutrition Program for Women, Infants, and Children; food bank, food pantry, or emergency kitchen, and nutrition assistance benefits for children (eg, National School Lunch Program, School Breakfast Program, Summer Food Service Program, afterschool program, providing free supper, and summer backpack programs).

\**P* < 0.05.

\*\**P* < 0.01.

\*\*\**P* < 0.001.

not available, so it is possible that the lower added sugar consumption found in our study was due to overall lower food consumption.

Research on effective strategies for mitigating food insecurity and poor dietary outcomes in low-income children during summer is needed. Federal summer nutrition programs, including the Summer Food Service Program and NSLP Seamless Summer Option, aim to fill the gap when school is not in session by serving free meals that meet federal nutrition guidelines to children in low-income areas. These programs are highly underutilized, with only 14 children participating in federal summer nutrition programs for every 100 who participate in the NSLP during the school year.<sup>44</sup> Although federal funding is available for federal summer nutrition programs, there are a variety of barriers to participation, including lack of awareness of meal sites, transportation challenges, absence of convenient meal site locations, and lack of opportunities for age-appropriate enrichment activities and programs that could help attract children and families to meal sites.<sup>44-46</sup> Strategies for increasing participation in these programs are needed, as well as innovative new ways of providing food assistance to children during summer. With the challenges of reaching children through current federal summer nutrition programs, the SEBTC demonstration, from which the participants in this study were part of the control group, was designed as an alternative approach for providing food assistance to children during summer. SEBTC has been shown to be effective at both reducing food insecurity among children and improving dietary intake during the summer.<sup>12</sup> SEBTC remains a demonstration project of the USDA and could potentially improve the food security status and dietary outcomes of millions of children certified for FRP meals during the summer months if it were expanded and made a permanent program.

This study has numerous strengths. It assesses the association of food security status and intake of select dietary factors during summer in low-income children who are certified for FRP meals during the school year, who may be more prone to the effects of food security status on dietary outcomes. The sample size is large compared with other studies of food security status and diet outcomes among children. It also includes a diverse group of children across a wide range of ages from multiple geographic areas. Another strength is that a large age range of children is included and the analyses are conducted separately for different age groups.

This study is not without limitations. Because this was a secondary data analysis of a public use data file, there were limitations with what could be examined through the analyses, including dietary factors included and preconstructed age group categories. The data were collected in 2012, so there may have been changes to food security status and dietary intake in the United States during the years both before and during the COVID-19 pandemic. Because this was a cross-sectional analysis, causality cannot be inferred. Measures were reported by an adult respondent rather than the child. Adults may not have been fully aware of the child's dietary intake, especially in the case that the child consumed meals away from home. This study also used food frequency questions focused on specific dietary factors, which does not allow for an assessment of overall dietary intake. This makes it unclear whether the lower consumption of specific dietary factors observed was due to an overall lower consumption of



food and/or to differences in the types of foods consumed. The food security among children in the household measure addressed all children in the household, not just the focal child, so it is possible that the focal child experienced a different level of food security. This study included children from households certified for FRP school meals from 14 sites in the United States, making the applicability of the results to other populations unclear.

## CONCLUSIONS

In this sample of children certified for FRP meals during the school year, MFS, LFS, and VLFS during the summer were associated with a lower consumption of key dietary factors compared with HFS for all age groups, with children from households experiencing VLFS having the poorest intake. Children in all age groups and food security status categories were not meeting 2010 DGA recommendations. Effective strategies for addressing food insecurity and dietary intake among children during the summer months are needed. Additional research is also needed to look prospectively at changes in food security status and dietary outcomes in children receiving FRP meals throughout the year.

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## STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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## AUTHOR CONTRIBUTIONS

J. Soldavini analyzed the data and drafted the manuscript. A. S. Ammerman provided guidance on the study and commented on the manuscript. Both authors approve the submission of the manuscript in its current form.