Food Insecurity is Linked to Dietary Intake but not Growth of Children in the Caribbean

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Short title: Food Insecurity and Children's Nutritional Health in the Caribbean

Synopsis: In this cross-sectional study among 390 Caribbean children, 24% of children lived in food insecure households. Household food insecurity was associated with lower intake of protein and zinc, and anemia among children but not growth.

Abstract

Objective: To examine food insecurity and its relationship with children's nutritional health.

Methods: Data for 390 children aged 7-12 years and their caregivers, recruited from eight schools in Trinidad and seven schools in St. Kitts in 2013-14 from a study dealing with food and nutrition security. Food insecurity, assessed using the USDA's Household Food Security Survey Module, and 24-hour dietary recall of children were assessed in home interviews. Height and weight were measured and a capillary blood sample was collected at school.

Results: Overall, 41.5% of caregivers reported household food insecurity, with 15% of the children living in households with very low food security. Daily intakes of protein and zinc were higher among children from "food secure" vs. "food insecure" households (protein, 59.6 ± 31.5 g vs. 50.9 ± 24.4 g, p=0.003; zinc, 7.33 ± 5.02 mg vs. 6.20 ± 3.47 mg, p=0.004, respectively). There were no other differences in dietary intake. Children's BMI z-score, weight status, and height-for-age z-score were not associated with food insecurity, and there was no evidence of stunting in either group. Anemia, however, was prevalent (30%) and higher among children from food insecure households (39% vs. 23%; p=0.002).

Conclusion: Household food insecurity was reflected in some lower intakes of some nutrients and anemia rates were higher among children living in food insecure households but food insecurity was not related to indicators of growth or weight status.

Keywords: food security, nutritional health, children, Caribbean

Introduction

Despite efforts to improve global food security, there remain important challenges in addressing this problem. Substantial strides have been made in reducing child underweight, but this has been globally disproportionate and few indicators of food insecurity and undernourishment have been tracked at the household level (1).

The association between food insecurity and dietary intake in developing countries is less widely studied. In North America, food insecurity among children and youth has been linked to low intakes of fruits and vegetables (2), inadequate intakes of calcium (3) and protein (4), and lower intakes of vitamin D (5). Also, the relationship between food insecurity and children's nutritional status is not clear. In a number of developing countries where stunting, wasting and underweight are prevalent, such as Colombia, Pakistan and Tanzania, food insecurity has been associated with stunting and underweight among children (6-9). Studies conducted in North America reveal no such associations (10). A relationship between food insecurity and weight gain as well as obesity has been found in some studies (11), but stronger evidence suggests no link between these variables (10, 12, 13). A relationship between food insecurity and anemia among young children and adolescents has been documented in both developed (14) and developing settings (15).

Among Caribbean children, underweight has declined and obesity has become increasingly prevalent (16-19). While food availability data indicate an overabundance of energy, sugars and fats (20, 21), there is a dearth of information on food insecurity and nutritional indicators. Our aim in this study was to examine the association between food insecurity and dietary intake, linear growth, weight status and anemia of children in two upper-income developing countries in the Caribbean.

Subjects and Methods

The study was part of a broader multidisciplinary project dealing with food and nutrition security, with a focus on interventions with local farmers and school feeding programs to improve nutritional outcomes of children in the Caribbean Community (CARICOM) (22). Ethical approvals were obtained from the McGill Ethics Review Board and Ministries of Education and the Ministries of Health in Trinidad and Tobago and St. Kitts and Nevis.

Data for this study were collected between September 2013 and April 2014. Children aged 7-12 years and their caregivers were recruited from eight schools in Trinidad and Tobago and seven schools in St. Kitts and Nevis. In Trinidad, schools selected were those with a high proportion of children consuming the school lunch meals, which are offered to families in need. Schools in St. Kitts, where all children are offered a free lunch, were selected from rural areas near the capital of Basseterre. One child per family providing signed consent was enrolled.

A baseline and a follow-up survey were conducted but only the follow-up survey data were used in this study, as a comprehensive measure of food security was used only at this time. Half of the children were in schools where the project intervention was conducted to increase fruit and vegetable consumption (22).

Measurements

Children's height was measured using a stadiometer and body weight was measured with a digital floor scale. A CardioChek **(**PTS Diagnostics, Indianapolis, Indiana USA) was used to measure hemoglobin based on a finger prick capillary blood sample.

During a home visit, caregivers and their children were asked by trained interviewers to recall the types and amounts of foods consumed by the child on the previous day in order to complete a single 24-hour dietary recall. Portion models (Santé Quebec, Montreal, Canada) were

used to estimate amounts consumed. Dietary data were compiled using CANDAT Nutrient Analysis Software (Godin London Incorporated, London, ON), based on the Canadian Nutrient File (2010 version) (23) and Canada's Food Guide (CFG) to define portions (24). Local food labels or recipes were added to the database where needed. Foods were grouped based on the Six Caribbean Food Groups (25) and further division of these food groups was undertaken to measure milk and milk products as well as "ground provisions". Vitamin and mineral supplements taken on the day of the recall were included in the nutrient intake values.

An interviewer administered questionnaire was conducted with the child's caregiver to obtain demographic data and measure food security using the 18-item U.S. Household Food Security Survey Module of the United States Department of Agriculture (USDA) to classify household food security status (26). This measure was previously validated for use in the Caribbean (27).

The Household Food Security Survey Module of the USDA was validated for this sample by the Rasch model using WINSTEP software (28). Based on the main assumptions in the Rasch model, the 18-item U.S. Household Food Security Survey Module of the USDA was found to be valid (see **Supplementary Table 1)**. Household food security status was categorized according to USDA procedures (26).

WHO cut-off points for BMI (29) were used to define weight status of children and their caregivers. The WHO cut-off points for hemoglobin were used to identify anemia among children aged 5-11 years are <11.5 g/dL and <12.0 g/dL for children aged 12 years (30); however, race-specific adjustment for the WHO cut-offs was applied in this study to diagnose anemia among individuals of African descent, as recommended by the WHO/UNICEF/UNU (31).

Statistical analyses

T-tests and analysis of variance (ANOVA) were used to compare the means of the various groups and Chi-square tests were used to compare proportions. Statistical tests were 2-tailed, and a significance level of $p < 0.05$ was adopted; Tukey's pairwise comparisons were undertaken to test associations of food insecurity and dietary intake. All statistical analyses were performed using SAS® software version 9.4 (2013, SAS Institute Inc., Cary, NC, USA).

Results

A total of 390 children and their caregivers (232 from Trinidad and 158 from St. Kitts) were included in this study, after excluding 7.0% (n=26) of children with very high energy intake (> 4000 kcal), 1.2% (n=5) with very low energy intakes (< 700 kcal), and 3.2% (n=13) and 5.6% (n=23) of children, respectively, for whom data on food security and dietary intake were missing. Hemoglobin data were available for only 331 children.

Overall, 41.5% of households reported being food insecure with higher prevalence in Trinidad than St. Kitts (46% vs. 35%, p=0.044). Demographic variables by household food security status are shown in **Table 1**. Caregivers in food insecure households were younger (p =0.036) and more likely to be unmarried (p=0.023) than those in food secure households. There were no other differences in demographic characteristics between food secure and food insecure households.

Dietary intakes of children living in food secure vs food insecure households are shown in **Table 2**. In general, mean daily intakes (by portions) of milk and milk products, fruits and vegetables were low as compared to recommendations of the CFG (32) and the WHO/FAO (33). Mean protein intake for children from food insecure households was 1.46 g/kg body weight vs. 1.69 g/kg body weight for children from food secure households. Dietary intakes of protein and zinc were lower among children from food insecure households as compared to food secure households. There were no other differences in macro or micronutrient intakes between the two

groups. Intakes of staples, ground provisions, milk, meat, legumes, fruits and vegetables were similar among food secure and food insecure groups.

Anthropometric measurements of children living in food secure vs. insecure households are presented in **Table 3.** There were no differences in Height-for-Age (HFA) z-scores of children across these two groups and both groups had mean HFA above the mean of the WHO reference values of HFA. Stunting was rare among children and there was no difference among children from food secure and food insecure households in thinness, overweight or obesity among children.

Thirty percent of children included in this study were anemic. More anemic children were living in food insecure households and means levels of hemoglobin levels were also lower among children in food insecure households (**Table 4)**.

Discussion

Despite the high prevalence of food insecurity at the household level, no association was found between household food insecurity and children's growth or weight status; only lower intake of protein and zinc was found to be linked to household food insecurity. In this study, children are growing well, as the mean height for both groups were well above the mean of the WHO growth reference (mean HFA has a z-score of 0). The lack of association between food insecurity and children's growth is consistent with findings of a study from Brazil (34), where stunting was not prevalent (1.3%). However, our results contrasts with reports from Columbia (8, 9) and Tanzania (6), countries with high prevalence of stunting and/or underweight. The prevalence of obesity was also unrelated to food insecurity, this finding contrasts with a number of studies conducted in the U.S (10, 35). Although a substantial proportion of families are food insecure, our study reveals that food insecurity status was not related to linear growth or weight status.

While dietary intakes were found to be similar between children from food secure and food insecure households, intakes of protein and zinc were lower among children from food insecure households. These findings may reflect lower meat consumption among this group, but we could not identify this relationship using a single day's intake as this does not provide a true representation of an individual usual dietary intake. Lower meat intakes among children and lower meat supplies in food insecure households are reported in the U.S. (36) and Ecuador (37). Protein intakes of children in our study are unlikely to be a serious nutritional concern, since the mean intake of protein double the Estimated Average Requirement (EAR) (protein 0.76 g/kg/d for children aged 4-13) for even those in the food insecure group (38, 39).

Despite the clear indication that anemia was more prevalent among children from food insecure households, mean dietary iron intake did not differ by food security status. The relationship between food insecurity and anemia found in this study is in keeping with findings among young children in Indonesia (15), as well as among American adolescents (14).

In developed countries, such as the U.S. and Canada, studies have reported lower intakes of fruits and vegetables, as well as milk among children from food insecure households (2, 5, 40). In our study, there was no such association between food insecurity and fruit and vegetable intakes. This lack of association might be due to the very low intakes of fruit and vegetable among the entire population.

This study is the first study to investigate the problem of food insecurity in relation to dietary intake, growth, weight status and anemia among children the Caribbean but we would caution against extrapolating the rates of food insecurity and nutritional status to national populations. For example, in the sample from Trinidad, the schools selected were those with a high proportion of children receiving the free lunch, which is offered on the basis of household

economic status. The links made between food insecurity and lower protein and zinc intake as well as anemia, however, can be clearly made within this high-risk group.

Conclusion

This study reveals that there is no evidence to suggest that children's growth and weight status are affected by food insecurity. However, the diet quality of children is affected by food insecurity and may be linked to anemia and less apparent differences in nutritional status. Further research is needed to determine the prevalence of anemia, using a better measure such as a venous blood sample, in order to better understand and address the issue of anemia in school-aged children in the Caribbean.

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Author Contributions

W Mumena analyzed data, wrote the paper and had primary responsibility for final content.

I Francis-Granderson designed the research, oversaw data collection, revised manuscript and approved final version. L Phillip designed the research, oversaw data collection, revised the manuscript and approved final version. L Johnson-Down oversaw data entry, contributed to the

statistical analysis and approved final version. K Gray-Donald designed the research, oversaw data collection and critically revised the manuscript and approved final version. The authors declare that they have no conflicts of interest.

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Table 1. Demographic characteristics by household food security status in children and their caregivers from Trinidad and Tobago and St. Kitts and Nevis (n=390)

	Food Secure (n=228)	**Food Insecure (n=162)**	***p***
Child			
Age, y [a]	9.2 ± 0.97	9.3 ± 0.99	0.210
Girls [b]	49.8	47.5	0.662
Caregiver			
Age, y [a] *	36.1 ± 9.06	34.0 ± 8.32	0.036
BMI kg/m^2 [a]	40.4 ± 8.85	39.9 ± 9.50	0.628
Overweight/Obese [b]	97.7	96.1	0.422
Female [b]	93.5	94.7	0.662
Unmarried female [b] *	57.9	71.2	0.023
Household size [a]	4.9 ± 1.74	5.3 ± 1.77	0.067
Education, less than secondary [b]	40.0	51.0	0.095

[a] mean ± SD
[b] %
* Indicate significance at the 0.05 level

Table 2. Food and nutrient intake by household food security status among children from Trinidad and Tobago and St. Kitts and Nevis (n=390)

	Food Secure (n=228)	**Food Insecure (n=162)**	***p***
Staples, portions	5.0 ± 2.8	4.77 ± 3.24	0.224
Ground provisions, portions	0.36 ± 0.95	0.35 ± 0.64	0.220
Meat, portions	1.7 ± 1.4	1.4 ± 1.2	0.127
Legumes and nuts, portions	0.22 ± 0.50	0.24 ± 0.48	0.200
Milk, portions	0.66 ± 1.08	0.54 ± 0.76	0.606
Fruits, portions	1.0 ± 1.5	1.1 ± 1.6	0.972
Vegetables, portions	0.56 ± 0.86	0.53 ± 0.89	0.790
Energy, kcal	1728 ± 620	1635 ± 634	0.105
Carbohydrate, g	248 ± 99.0	243 ± 100	0.704
Protein, g *	59.6 ± 31.5	50.9 ± 24.4	0.003
Fat, g	56.5 ± 30.3	52.5 ± 28.6	0.170
Fiber, g	11.0 ± 6.79	11.3 ± 6.2	0.554
Calcium, mg	535 ± 384	491 ± 294	0.296
Iron, mg	12.2 ± 8.9	11.3 ± 8.4	0.076
Potassium, mg	1540 ± 762	1447 ± 661	0.225
Vitamin A, µg	627 ± 864	552 ± 841	0.190
Vitamin C, mg	175 ± 149	186 ± 185	0.358
Zinc, mg *	7.3 ± 5.0	6.2 ± 3.5	0.004
Total sugar, g	104 ± 56.8	103 ± 55.0	0.794

Values in cells are means ± SD
* Indicate significance at the 0.005 level
Note: Foods were grouped based on the Six Caribbean Food Groups; “milk products” group was a subcategory from “food from animals”, and “ground provisions” group was a subcategory from “staples”
Serving sizes were calculated based on Canada's Food Guide

Table 3. Weight status of children in Trinidad and Tobago and St. Kitts and Nevis by household food security status (n=390)

	Food Secure (n=228)	**Food Insecure (n=162)**	***p***
Height-for-age z-score *	0.46 ± 1.0	0.38 ±1.2	0.511
Stunting	0.44	2.5	0.079
BMI z-score *	0.44 ± 1.5	0.30 ± 1.5	0.399
Wasting	4.4	7.6	0.194
Healthy weight	62.4	63.5	0. 496
Overweight	13.7	13.8	
Obese	19.5	15.1	
Overweight/obese	33.2	28.9	0.375

Note: Values in cells are percentages unless otherwise specified
* Mean ± SD

Table 4. Anemia status of children from Trinidad and Tobago and St. Kitts and Nevis using race-specific cut-offs for Afro-Caribbean children by household food security status (n=331)

	Food Secure (n=209)	**Food Insecure (n=156)**	***p***
Anemia, %	23.2	39.0	0.002
Hemoglobin, mean ± SD	11.9 ± 1.4	11.5 ± 1.4	0.004

Supplementary Table 1: Item calibrations and item-fit statistics of items in the 18-item U.S. Household Food Security Survey Module of the USDA

Item	Item calibration*	Item infit	Item outfit
In the last 12 months, did (your child/any of the children) ever not eat for a whole day because there wasn't enough money for food?	5.93	1.20	1.70
In the last 12 months, did (you/ you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?	3.39	0.86	1.09
In the last 12 months, did you lose weight because there wasn't enough money for food?	3.11	0.89	0.28
In the last 12 months, did (child's name/any of the children) ever skip meals because there wasn't enough money for food?	2.60	0.77	0.29
In the last 12 months, (was your child/were the children) ever hungry but you just couldn't afford more food?	2.28	1.03	1.57
In the last 12 months, since (current month) of last year, did you ever cut the size of (your child/any of the children's) meals because there wasn't enough money for food?	0.84	0.77	0.42
In the last month, were you ever hungry but didn't eat because there wasn't enough money for food?	0.74	0.98	0.54
"(My/our child was/the children were) not eating enough because (I/we) just couldn't afford enough food." Was that <u>often</u>, <u>sometimes</u>, or <u>never</u> true for (you/your household) in the last 12 months?	0.19	0.84	0.40

In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?	− 0.07	1.00	0.75
In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?	− 0.70	0.79	0.61
"(I/we) couldn't feed (my/our) child/the children) a balanced meal, because (I/we) couldn't afford that." Was that often, sometimes, or never true for (you/your household) in the last 12 months?	− 2.14	0.91	0.72
"(I/We) relied on only a few kinds of low-cost food to feed (my/our) child/the children) because (I was/we were) running out of money to buy food." Was that often, sometimes, or never true for (you/your household) in the last 12 months?	− 2.78	1.09	1.15
"The food that (I/we) bought just didn't last and (I/we) didn't have money to get more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?	− 3.77	0.85	1.31
"(I/we) couldn't afford to eat balanced meals." Was that often, sometimes, or never true for (you/your household) in the last 12 months?	− 3.78	1.19	9.90
"(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?	− 5.83	1.15	2.07

*Item calibration indicates the severity of the item