[Journal of Applied Research on Children: Informing Policy for Children at Risk](https://digitalcommons.library.tmc.edu/childrenatrisk)

Volume 6
Issue 2 *Nutrition and Food Insecurity*

Article 14

2015

Household food insecurity status and Hispanic immigrant children's body mass index and adiposity

Daphne C. Hernandez
University of Houston, dhernandez26@uh.edu

Layton Reesor
lmreesor@uh.edu

Yanely Alonso
yanely_alonso@yahoo.com

Sally G. Eagleton
Oklahoma State University, sallyge@ostatemail.okstate.edu

Sheryl O. Hughes
USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, Shughes@bcm.edu

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Acknowledgements

Funding was provided by several University of Houston internal grant programs: College of Liberal Arts & Social Science Research Outreach Grant Program, Department of Health & Human Performance Summer Research Program, and Women's, Gender and Sexuality Studies Faculty Summer Fellowship to Hernandez. In addition, the project received support from the University of Houston's Summer Undergraduate Research Fellowship program to Alonso. Authors are thankful for the editorial assistance provided by Matthew Cross.

Introduction

The prevalence of obesity among young children aged 2 to 5 years has decreased from 14.0% in 2003-2004 to 8.4% in 2011-2012.[1] Although at first glance it may appear as a public health "win," a closer look at the obesity prevalence rates by race/ethnicity and household income among this age group indicates that disparities exist. For example, Hispanic children (16.7%), followed by non-Hispanic black children (11.3%), have much higher obesity prevalence rates than do non-Hispanic Asian (3.4%) and non-Hispanic white (3.5%) children.[1] Furthermore, childhood obesity is more prevalent among low-income families.[2] In Harris County, which encompasses Houston, Texas, 41% of the residents are of Hispanic or Latino origin, 26% of them live in poverty, and 48% experience economic hardship.[3,4] In addition, 19% of fourth-grade children were classified as overweight in 2007, and 27% were classified as obese.[5]

Various health behaviors place Hispanic children at risk for overweight/obesity. Although some consider it a paradox,[6,7] a nutrition-related factor that co-exists with overweight/obesity is food insecurity, or the lack of availability of or access to healthful food because of insufficient money and other resources.[8] Food insecurity is highly prevalent among households with children in Harris County (26%)[9] and more prevalent nationwide among Hispanic households with children (26.9%) than among white households with children (14.0%).[8] Immigrant households are at an elevated risk for experiencing food insecurity.[10-17] Even though there are high prevalence rates of obesity and food insecurity among Hispanics and immigrants, along with significant negative health consequences stemming from these two independent public health factors,[17-19] there is a dearth of research on the direct relationship between food insecurity and obesity among children of Hispanic immigrants. Some research suggests that there is no relationship between food insecurity and weight status among Mexican American and Hispanic preschool-age children,[14,20] rural preschool-age Hispanic and American Indian children,[21] and older (8-16 years) Mexican American children,[6] whereas other research has found a positive association among Hispanic children aged 2 to 8 years.[22] On the other hand, some research suggests that food insecurity is associated with lower body mass index (BMI) among Hispanic fifth-grade children,[23] as well as Latino immigrant and non-immigrant children aged 2 to 17 years.[24] Thus, there are discrepancies in the literature that make it difficult to make a conclusion on the association between food insecurity and weight status among children of Hispanic immigrants.

The studies previously mentioned have focused on weight status or a body composition measure that takes into consideration height and weight, such as BMI. Previously, research focusing on young children of Hispanic immigrants has not expanded to include measures of adiposity. Although BMI is correlated with adiposity, it is not a direct measurement of adiposity.[25] In contrast, waist circumference (WC) and percentage of body fat (%BF) are direct measures of adiposity. Placing a tape measure around the abdominal region determines the circumference of the waist, which is suggestive of the amount of body fat in that particular area of the body. It has been implied that WC is a better determinant than BMI of cardiovascular disease risk factors and metabolic syndrome in children.[26,27] Further, to calculate the percentage of fat in the entire body, a full-body scan with dual-energy X-ray absorptiometry (DEXA) is highly regarded as the best practice. However, full-body DEXA requires the availability of certified technicians and the use of expensive specialized equipment that is not portable. This method is not feasible when one is working with vulnerable populations, such as low-income children of Hispanic immigrants, in community settings.[28] For this reason, prior studies that focused on food insecurity and body composition among children of Hispanic immigrants may not have considered %BF as an outcome measurement. On the other hand, foot-to-foot bioelectrical impedance analysis (BIA) with an instrument such as the Tanita BF-689 (Tanita Corporation, Arlington Heights, Illinois),[29] which is a portable, fairly inexpensive device, can provide information on fat mass quickly. The Tanita BF-689 is highly specific for classifying children as overfat and obese.[28] Although prior research has investigated the association between food insecurity and %BF among older Hispanic children (ages 8-17 years),[30] research that has focused on the young children (ages 3-6 years) of low-income Hispanic immigrants has not investigated the relationship between food insecurity and %BF. Thus, the current study contributes to the literature by examining the association between food insecurity and two measures of adiposity among low-income children of Hispanic immigrants.

This study focuses on the association between food insecurity, adiposity, and BMI among children of low-income Hispanic immigrants who reside in Harris County, Texas. The focus on two adiposity measures (ie, WC and %BF) in relation to food insecurity status is a unique contribution to the literature as it provides a nuanced opportunity to better understand the paradoxical relationship between food insecurity and body composition in a highly vulnerable population. When we compared children residing in food-insecure households with those residing in food-secure households (ie, bivariate analyses), we hypothesized that a greater proportion of food-insecure children would be overfat or obese (%BF), have an elevated WC, and be overweight or obese (BMI). This was based on research demonstrating that food insecurity and obesity are highly prevalent, or co-exist, among low-income Hispanic households with children.[2,5,8] We also predicted no direct relationship between food insecurity and children's body composition measures (ie, multivariate regression analyses) based on two prior studies that focused on preschool-age Mexican American and Hispanic children within the same age range as those in the current study.[14,20]

Methods

Data Source: La Salud de Mamá y Niños *Study*

La Salud de Mamá y Niños study was designed to examine the health of low-income Hispanic women and their young children. The recruitment process took place at two local community centers in the Houston area between July 2014 and December 2014. Participants were eligible for the study if they were low-income, English- or Spanish-speaking Hispanic mothers between the ages of 18 and 59 years who had a child within the age range of 3 to 6 years. Because BIA was used to calculate the women's body fat percentage, pregnant women or women with a pacemaker were ineligible to participate. Mothers who had more than one child in the age range were allowed to enroll all children if they desired. Recruitment was held at food fairs, food pantries, and back-to-school events held at community centers. A total of 105 mothers and their young children were recruited, and three mother-child dyads were ineligible to participate because they did not fit the eligibility criteria. In the end, 70 mothers and their 96 children participated in the overarching study. Of these 70 families, 47 mothers had 1 child in the study, 20 mothers had 2 children in the study, and 3 mothers had 3 children in the study. The demographic characteristics of the study participants were similar to those of the larger population served through the community centers.

The study protocol and consent forms were approved by the University of Houston's institutional review board. Before data collection, consent and assent forms were reviewed with the mothers and their children; the mothers signed the forms. The first phase of the study consisted of anthropometric measurements of the mother and child. Research assistants were trained on how to collect anthropometric measurements according to the protocol outlined by the Centers for Disease Control and Prevention National Health and Nutrition Examination Survey.[31] The second phase of the study consisted of structured survey questions filled out by the mothers in a private room. Mothers chose to fill out the survey in the language (English or Spanish) with which they felt most comfortable. Spanish surveys went through a translator assurance process that is required by the University of Houston's institutional review board. In addition, mothers were assisted one-on-one by bilingual research assistants who were trained to follow a standard protocol to ensure compliance. Families were compensated with a $30 grocery gift card for their time, and child care was provided during data collection.

There were 96 children and 70 mothers who participated in the overarching study. In order to calculate the children's %BF, a foot-to-foot BIA device, Tanita BF-689, was used.[29] The scale uses an age- and sex-specific formula to calculate %BF in children 5 to 17 years of age. For that reason, we excluded 46 children who were between the ages of 3 and 4 years from this analysis. Further, we excluded a child whose mother had been born in the United States. This resulted in a sample of 49 low-income Hispanic immigrant children between 5 and 6 years of age and their 44 mothers. Of these 44 families, 39 mothers had 1 child in the study, while 5 mothers had 2 children in the study.

Dependent Variables

Child's waist circumference. A tape measure placed midway between the lower rib margin and the iliac crest was used to measure WC in centimeters. A dichotomous dependent variable was created where the primary focus was to predict elevated WC, defined as a WC measurement at or above the 90th percentile for age and sex (N = 49).[32]

Child's elevated percentage of body fat. The BIA Tanita BF-689 was used to measure body fat percentage.[29] Children's age and gender were entered into the BIA Tanita BF-689. Next, children's bare feet were guided onto the BIA foot sensors by the research assistants to ensure optimal contact and centralized heel placement. Children's %BF and color-coded classification were displayed on the device. Children were classified as underfat (blue), healthy (green), overfat (orange-yellow), or obese (red). A dichotomous dependent variable was created where the primary focus was to predict elevated %BF; children's %BF was overfat/obese vs healthy fat in the regression model (N = 49).

Child's elevated body mass index. Height was measured with a standard stadiometer while the child was without footwear. Weight was obtained with the BIA Tanita BF-689 as described above.[29] BMI was calculated based on measured height and weight and was standardized to create BMI Z-scores by using age and gender normative data from the Centers for Disease Control and Prevention.[33] This information was then

DOI: 10.58464/2155-5834.1268

used to categorize children according to their BMI percentile ranking: underweight (BMI <5th percentile), normal weight (5th percentile to <85th percentile), overweight (85th percentile to <95th percentile), and obese (≥95th percentile).[34] Three dichotomous dependent variables were created where the primary focus was to predict the higher BMI category when the BMI was at least in the 85th percentile or higher in regression models: (1) overweight vs normal weight (n = 34); (2) obese vs normal weight (n = 39); and (3) overweight/obese vs normal weight (n = 46). Underweight children (n = 3) were excluded from the above indicator variables.

Independent Variable: Household Food Security/Insecurity Status

An 18-item US Department of Agriculture scale that assesses food hardship due to financial constraints (eg, running out of food, perceptions that food in a household is of inadequate quality or quantity, reduced food intake by adults or children) during the past 12 months was used.[8] Households were considered food insecure if mothers responded affirmatively to 3 or more items based on previously reported criteria.[8]

Covariates

Several self-reported maternal demographic characteristics were included in the regression models to reflect selection factors potentially related to both the independent and dependent variables: age (years); marital status (1, single; 0, married/cohabiting); education (1, less than high school diploma; 0, high school diploma or more); and length of US residence (years). The regression models also included measures of maternal body composition that were directly assessed because an intergenerational transmission of weight status has been well documented.[35-37] WC was measured in inches with the same technique previously described for children. Maternal %BF was calculated with a BIA Tanita TBF-310GS (Tanita Corporation, Arlington Heights, IL).[38] Maternal BMI was calculated based on height, which was measured with a standard stadiometer, and weight, which was obtained with the BIA Tanita TBF-310GS.[38] Maternal BMI was calculated as outlined for adults by the Centers for Disease Control and Prevention.[39] All maternal body composition measures were included in the regression models as continuous variables.

Statistical Analysis

Descriptive statistics were calculated on the full sample (N = 49). Bivariate differences between household food insecurity status and child's body composition measures and covariates were conducted with the Kruskal-Wallis test for continuous variables and the Wilcoxon signed rank test for dichotomous variables. Logistic regression modeling was used to estimate the association between household food insecurity and a child's body composition measures, controlling for maternal demographic characteristics. In addition, each regression model included the maternal body composition measure that corresponded with the dependent variable; for example, maternal WC, but not %BF nor BMI, was entered in the regression model predicting the child's elevated WC. Child BMI Z-score, age, and gender were included in the descriptive analyses, but they were not included in the regression models because they were embedded in the child's body composition measures. In all regression models, standard errors were adjusted to account for the lack of independence of observations, as some children (n = 10) were clustered within families. All statistical analyses were completed with Stata/SE 12.1 statistical software (StataCorp LP, College Station, Texas).

Results

In our sample, 65% of the households had experienced food insecurity in the past year (Table 1). Of the children, 14% had an elevated WC, 31% were obese in terms of %BF, and 24% were obese in terms of BMI. Children on average were approximately 5.5 years of age and 55% female, and the mothers were approximately 35.6 years of age. Of the mothers, 84% were married/cohabiting, 43% had not completed high school, and 92% were unemployed (data not shown). The majority of the mothers were born in Mexico (68%), followed by countries in Central America: Honduras (16%), El Salvador (12%), and Guatemala (4%; data not shown). On average, foreign-born mothers had lived in the United States for approximately 13 years and spoke only Spanish at home (data not shown). Mothers had a mean WC of 39 inches, %BF of 39, and BMI of approximately 32. Of the mothers, 73% had an elevated WC (ie, WC more than 35 inches),[40] 82% were classified with a %BF as above average,[41] and 86% were classified as overweight/obese (data not shown).

Several differences in child body composition and demographic characteristics were observed between food-insecure and food-secure households. A greater percentage of food-secure children (29%) were classified as having an elevated WC compared with food-insecure children (6%, $P < .001$). Further, a greater percentage of food-secure children were classified as overfat (24% vs 19%, $P < .01$) or obese (53% vs 19%, $P < .01$) in terms of %BF and BMI (53% vs 9%, $P < .01$), whereas a greater percentage of food-insecure children were classified as having a healthy %BF (62% vs 24%, $P < .05$) and an overweight BMI (19% vs 6%, $P < .001$). A greater proportion of mothers in food-insecure households had

DOI: 10.58464/2155-5834.1268

less than a high school diploma (56% vs 18%, *P* < .01), whereas mothers in food-secure households had been in the United States for more years (approximately 16 years) compared with mothers in food-insecure households (approximately 12 years, *P* < .05).

The correlations between the three child body composition measures are noted in Table 2. BMI Z-score (0.85, *P* < .01) and WC (0.70, *P* < .01) were highly correlated with %BF. WC and BMI Z-score had a low correlation (0.48, *P* < .01).

Table 3 displays the odds ratios from the multivariate logistic regression model that was used to investigate the association between household food insecurity and child elevated WC. A relationship was not observed between food security status and elevated WC (OR = .08, *P* = .10).

The odds ratios from the multivariate logistic regression model that was used to examine the relationship between household food insecurity and child %BF, controlling for maternal demographic characteristics, is presented in Table 4. Children living in food-insecure households had 89% lower odds of having an elevated %BF (OR = 0.11, *P* < .01).

The findings of the multivariate logistic regression models used to explore the association between household food insecurity and several BMI categories are displayed in Table 5. Children in food-insecure households had 93% lower odds of being obese (OR = 0.07, *P* < .05) (compared with normal weight) and 87% lower odds of being overweight/obese (OR = 0.13, *P* < .05) (compared with normal weight).

Discussion

The goal of this study was to examine the association between food insecurity and adiposity (ie, WC and %BF) and BMI among children of low-income Hispanic immigrants. Overall, the sample was highly disadvantaged, with 65% of the children residing in food-insecure households. In addition, 31% of the children were obese in terms of %BF, and 24% were obese in terms of BMI. Thus, the study demonstrated the feasibility of using a BIA device to calculate %BF in children of low-income Hispanic immigrants. The study also highlights the discrepancy between adiposity and weight status indicators, and additional research is needed to confirm this finding. Consequently, the use of adiposity and weight status indicators may provide a more comprehensive description of children's health and be useful for providing parents with feedback regarding their children's weight management.

In terms of disparities by food security status, the findings suggest that a greater proportion of food-secure children were overfat/obese, whereas a greater proportion of food-insecure children had a healthy %BF. In addition, food insecurity was significantly related to lower odds of having an elevated %BF. This is contrary to prior research finding food insecurity not to be related to %BF among older Hispanic children (ages 8-17 years).[30] In terms of BMI, a greater proportion of food-secure children were obese, whereas a greater proportion of food-insecure children were overweight. Further, food insecurity was significantly related to lower odds of being obese and overweight/obese (vs normal weight). Although the results are not what were predicted, they do coincide with prior results finding food insecurity to be associated with lower BMI among Hispanic fifth-grade children,[23] as well as Latino immigrant and non-immigrant children aged 2 to 17 years.[24]

By definition, food-insecure households have limited funds to buy food. Although the quality and quantity of the food among low-income, food-insecure Hispanic households with young children have been documented as being poor,[42] at this point in the children's development the limited funds may not be contributing to the overconsumption of calories. For this reason, we may not be observing a positive direct relationship between food insecurity and elevated weight (and adiposity), as observed in food-insecure Hispanic children who were slightly older than the current sample.[22]

Conversely, it may be that food-secure households have access to and the means to buy healthful (eg, fruits and vegetables) in addition to unhealthful (eg, fried foods and high-calorie desserts) foods, which may contribute to the consumption of additional calories and weight gain. Less knowledge about the importance of physical activity among this population could also play a role in body composition. Further, children in food-secure households had mothers who had been living in the United States for a longer period compared with children in food-insecure households. Hispanic immigrants who have been in the United States for a longer time make changes to their diet, or undergo dietary assimilation, in which homeland dietary behaviors become less normative and a Western diet pattern (ie, high in saturated fat, sugary beverages, and processed meats) is adopted.[43] These changes have been associated with higher BMIs and worse health among Hispanic adult immigrants and Puerto Rican-born women.[44,45] Thus, the poor nutritional patterns observed in diet-assimilated Hispanic adult immigrants may be a contributing factor in how food security status influences children's health. Because parents are children's gateway to nutrition and physical activity, studies are needed that focus on low-income Hispanic adult immigrants' access to and knowledge of nutrition and physical activity. Public policies designed to address food insecurity need also to stress the importance of nutrition and physical activity as a way to facilitate improvement in health.

However, the discrepancy in the current findings compared with those of prior studies could be related to the differences in children's developmental stages, as well as the amount of exposure to food insecurity. As of now, it is routine to measure children's height and weight at well-child visits and less common to screen for %BF. In the latest policy statement, the American Academy of Pediatrics recommended screening all children for food insecurity.[46] Collecting information on household food insecurity status, in addition to several adiposity and weight measurements, starting at age 3 and continuing through adulthood, may assist in documenting risk patterns of elevated %BF and BMI. The risk patterns could facilitate learning about the association between food insecurity status and adiposity and weight status in relation to developmental growth periods. Such information may provide insight into whether there are critical developmental periods during which exposure to food insecurity places children at greater risk for obesity in terms of %BF and BMI, and how repeated exposures to food insecurity may be related to elevated %BF and BMI in adulthood. For instance, prior research has indicated that repeated exposure to poverty during childhood is associated with overweight/obese status in young adulthood.[47] Thus, longitudinal data that are used to examine patterns of food insecurity experiences in relation to developmental growth periods may inform childhood obesity interventions, along with public policies (eg, Supplemental Nutrition Assistance Program Education [SNAP-Ed]) and community-based programs designed to improve the health of families at risk for food insecurity.

Although this study contributed to the small body of food insecurity research that has focused on young children of Hispanic immigrants, limitations related to factors that may influence body composition measures were present. Elevated adiposity and BMI are a result of overconsumption of calories and limited physical activity. Although food insecurity is a proxy for poor nutrition, a measure of dietary intake, including caloric intake, is missing from the study, as is a measure of physical activity. Furthermore, the BIA device used in the current study, the Tanita BF-689, has been shown to have a low sensitivity and specificity for healthy %BF classification.[28] This suggests that the rate of adiposity may be higher than the results suggest. Despite this limitation, the study demonstrated the feasibility of collecting %BF measurements from a vulnerable population with a BIA device. The portability and speedy results obtained with the device assisted with this task.

The design and sample selection of the study also present some limitations. The cross-sectional design limits the opportunity to learn how early childhood experiences with food insecurity influence the health of Hispanic immigrant children in middle childhood and adolescence. As previously stated, longitudinal studies are needed to better understand the influence of early environmental factors such as food insecurity on body composition later in life. Related, the study was based on a small, urban sample of immigrants from two local community centers and is not generalizable to other racial/ethnic minorities and non-immigrant families who experience food insecurity, along with impoverished families who reside in rural areas. On the other hand, the findings of the study are highly relevant to counties similar to Harris County, Texas, which has a significant Hispanic population and where 26% of households with children experience food insecurity, a rate significantly higher than the national average of 20%.[3,9]

In sum, among children of Hispanic immigrants, food insecurity was related to lower odds of having an elevated %BF (compared with a healthy %BF) and to lower odds of being obese and overweight/obese (compared with normal weight). Studies that track the weight status and adiposity of children of Hispanic immigrants in relation to food insecurity over time, along with parental access to and knowledge of nutrition and physical activity, are needed to further understand why food insecurity and obesity co-exist for some groups but not others.

DOI: 10.58464/2155-5834.1268

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Table 1. Description of the sample, mean (standard deviation) or percentage

	Household food insecurity status		
	Full sample (N = 49)	**Food-insecure[a] (n = 32)**	**Food-secure[b] (n = 17)**
Household food insecurity status			
Food insecure	65%	100%	0%
Food secure	35%	0%	100%
Child body composition measures			
Waist circumference, cm	56.93 (9.23)	54.99 (7.62)	60.58 (11.03)*
Elevated waist circumference	14%	6%	29%***
Body fat percentage	22.48 (5.73)	21.05 (5.59)	25.16 (5.13)
Body fat categories			
Healthy	49%	62%	24%*
Overfat	20%	19%	24%**
Obese	31%	19%	53%**
BMI Z-score	0.32 (1.90)	–0.04 (2.08)	0.99 (1.28)*
BMI categories			
Underweight	6%	9%	0%***
Normal weight	55%	63%	41%
Overweight	14%	19%	6%***
Obese	24%	9%	53%*
Child characteristics			
Age	5.47 (0.50)	5.5 (0.51)	5.41 (0.51)
Female	55%	50%	65%
Mother characteristics			
Age	35.55 (6.34)	34.31 (6.77)	37.88 (4.79)
Marital status			
Married/cohabiting[c]	84%	78%	94%
Not married/cohabiting	16%	22%	6%
Education			
Less than a high school diploma	43%	56%	18%**
High school diploma or more[c]	57%	44%	82%
Residence in the United States, y	13.16 (6.48)	11.78 (6.48)	15.76 (5.78)*
Maternal body composition			
Waist circumference, in	39.04 (5.24)	38.84 (5.37)	39.41 (5.13)
Body fat, %	39.06 (6.56)	38.75 (6.50)	39.65 (6.83)
BMI	31.61 (5.68)	31.62 (5.74)	31.58 (5.74)

BMI, body mass index.

[a] Food-insecure: Households are considered to be food insecure if mothers responded affirmatively to 3 or more items on the 18-item US Department of Agriculture Food Security Scale.
[b] Food-secure: Households are considered to be food secure if mothers responded affirmatively to 2 or fewer items on the 18-item US Department of Agriculture Food Security Scale.
[c] Reference category in multivariate logistic regression models.
* $P < .05$; ** $P < .01$; *** $P < .001$.

DOI: 10.58464/2155-5834.1268

Table 2. Correlations among child body composition measures (N = 49)

	Body fat percentage	Body mass index Z-score	Waist circumference
Body fat percentage	1.00	–	–
Body mass index Z-score	0.85**	1.00	–
Waist circumference	0.70**	0.48**	1.00

** *P* < .01.

Table 3. Logistic regression to predict child's elevated waist circumference (N = 49)[a]

	OR	95% CI
Food-insecure	0.08	(0.00-1.69)

OR, odds ratio; CI, confidence interval.

[a] Covariates included in the model: age, marital status, education, residence in the United States, maternal waist circumference.

Table 4. Logistic regression to predict child's elevated percentage of body fat (N = 49)[a]

	OR	**95% CI**
Food-insecure	0.11**	(0.02-0.51)

OR, odds ratio; CI, confidence interval.

[a] Covariates included in the model: age, marital status, education, residence in the United States, maternal body fat percentage.

** *P* < .01.

Table 5. Logistic regression to predict child's elevated weight status[a]

	Overweight vs normal weight (n = 34)		Obese vs normal weight (n = 39)		Overweight/obese vs normal weight (n = 46)	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Food-insecure	0.73	(0.05-10.67)	0.07*	(0.01-0.54)	0.13*	(0.03-0.69)

OR, odds ratio; CI, confidence interval.

[a] All three models include the following covariates: age, marital status, education, residence in the United States, and maternal body mass index. Children categorized as underweight were omitted from the analyses.

* *P* < .05.

DOI: 10.58464/2155-5834.1268