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The Relationship between Dietary Patterns, Body Mass Index Percentile, and Household Food Security in Young Urban Children

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Abstract

Background: The relationship between food insecurity and child obesity is unclear. Few studies have examined dietary patterns in children with regard to household food security and weight status. The aim of this study was to examine the association between household food security, dietary intake, and BMI percentile in low-income, preschool children.

Methods: Low-income caregivers ($n = 222$) with children ages 2–4 years were enrolled in a primary-care–based obesity prevention/reversal study (Steps to Growing Up Healthy) between October 2010 and December 2011. At baseline, demographic data, household food security status (US Household Food Security Instrument) and dietary intake (Children's Dietary Questionnaire; CDQ) were collected. BMI percentile was calculated from anthropometric data.

Results: Participating children were primarily Hispanic (90%), Medicaid insured (95%), 50% female, 35 ± 8.7 months of age (mean ± standard deviation), 19% overweight (BMI 85th–94th percentile), and 29% obese (≥95th percentile). Thirty-eight percent of interviews were conducted in Spanish. Twenty-five percent of households reported food insecurity. There was no association between household food insecurity and child BMI percentile. Dietary patterns of the children based on the CDQ did not differ by household food security status. Food group subscale scores (fruit and vegetable, fat from dairy, sweetened beverages, and noncore foods) on the CDQ did not differ between normal weight and overweight/obese children. Maternal depression and stress did not mediate the relationship between household food insecurity and child weight status. Hispanic children were more likely to be overweight or obese in both food-secure and food-insecure households.

Conclusions: Household food insecurity was not associated with child BMI percentile in this study. Dietary intake patterns of children from food-insecure households were not different compared to those from food-secure households.

Introduction

Seventeen percent of children and adolescents in the United States between the ages of 2 and 19 years are obese, with disproportionately higher rates in Hispanic and non-Hispanic black children and adolescents.[1] Though the etiology of these racial/ethnic disparities in obesity rates is not entirely understood and is likely multifactorial, differences in built environment, genetics, and maternal factors may account for the higher rates observed.[2] Among low-income children, nearly one third of children ages 2–4 years are overweight or obese.[3] Childhood obesity is associated with cardiovascular dysfunction and other comorbidities that may have a significant impact on future health.[4,5]

Many risk factors for obesity in young children from low-income households have been suggested, including food insecurity.[6] Low-income households experience high

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rates of food insecurity, which is defined as ''the limited or uncertain availability of nutritionally adequate and safe foods and limited or uncertain ability to acquire acceptable foods in a socially acceptable way.''[7] The relationship between household food insecurity and overweight has been consistently observed in adults, and especially women, but the data in children are conflicting.[8–14] Gundersen and colleagues did not find an association between household food insecurity and childhood obesity using multiple measures of obesity.[15] However, a recent longitudinal study in low-income children 2–5 years of age found that persistent household food insecurity was associated with 22% greater odds of child obesity.[16]

Few studies of weight status and household food security have examined dietary intake patterns in children. Several studies have demonstrated an association between household food insecurity and altered dietary patterns, particularly decreased vegetable consumption, but these studies either did not examine child BMI or they found no difference in child BMI percentile between food secure and insecure households.[17–20] Only one study examined food insecurity, diet, and weight status in children and found that food-insecure children were more likely to be overweight and have greater intake of high-fat cereals, salty foods, and high-energy-density sweets, as compared to food-secure children.[21]

The aim of the current study, part of the larger Steps to Growing Up Healthy study,[22] was to examine the association between household food security status, dietary intake, and BMI percentile in a group of urban-dwelling, low-income, preschool children. We hypothesized that household food insecurity would be associated with higher child BMI percentile and that children from food-insecure households would have greater consumption of noncore (energy-dense, processed) foods, compared to those from food-secure households. We also examined how maternal depression and stress might mediate the relationship between household food insecurity and child weight status (Fig. 1) given that maternal depression and mental health problems have been associated with both food insecurity and child overweight/obesity independently.[23–30]

Methods

Study Design

Caregivers and their 2-4-year-old children were recruited between October 2010 and December 2011 by bilingual research staff to participate in an obesity prevention/reversal study (Steps to Growing Up Healthy) that examined the short-term efficacy of brief motivational counseling (BMC) and selected behavioral change strategies to prevent/reverse obesity in young children. Each BMC session was approximately 3–5 minutes in length and focused on basic motivational interviewing strategies, including positive affirmations, goal setting, and contracting around four key behavioral targets (reducing/eliminating sugar-sweetened beverages [SSBs], change type/quality of milk consumed, decreasing screen time, and increasing physical activity).[22] Mother-child dyads were approached in the waiting room of a large, urban primary care clinic that mainly services Hispanic and other minority patients to determine eligibility.

Eligibility Criteria

Caregivers were eligible if they had a child 2–4 years of age at time of enrollment, who was Hispanic or African

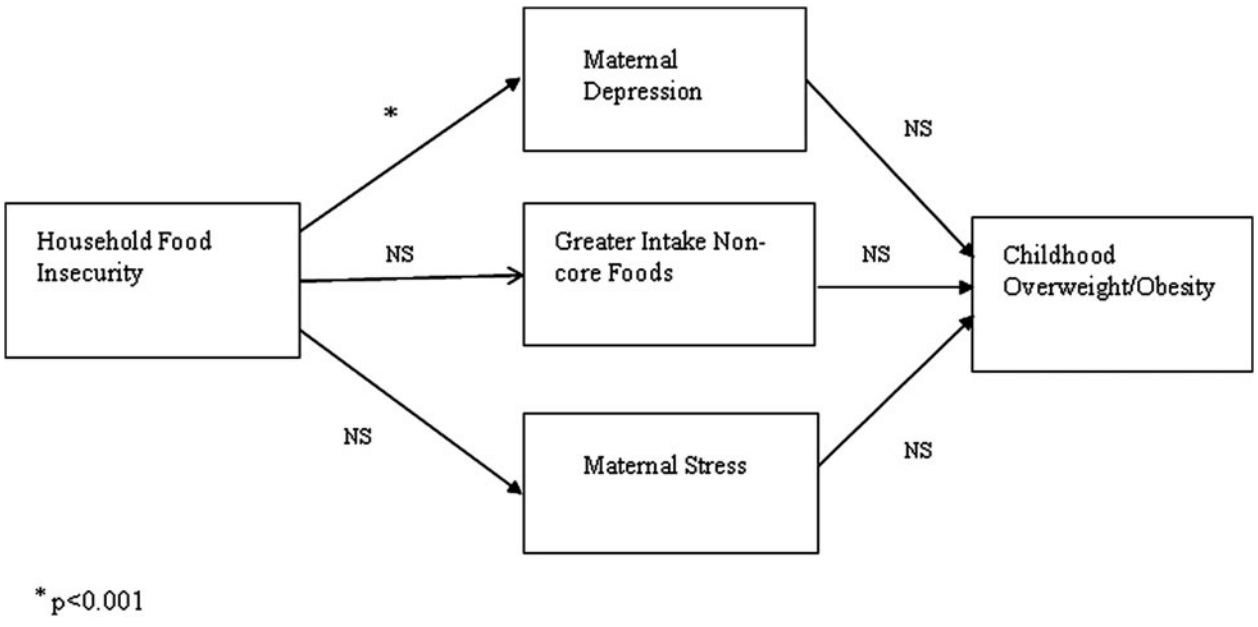

Figure 1. Hypothesized model of relationship between household food insecurity, maternal stress/depression and child overweight/obesity. NS, not significant.

American by maternal report, and receiving services through the Supplemental Nutrition Assistance Program for Women, Infants, and Children. Dyads were excluded if the mother was younger than 18 years of age, if the family did not live in the Greater Hartford area or was planning to move in the next 12 months, or if the child or mother had special dietary or physical needs and/or a psychological disorder that interfered with ability to participate. A total of 535 caregivers were screened and 248 met all eligibility criteria.

Caregivers completed questionnaires and anthropometric data were obtained at baseline and at 12 months. Baseline data were used for this analysis, which was conducted in 2013. This study was approved by the institutional review boards of Connecticut Children's Medical Center (Hartford, CT) and the University of Connecticut Health Center (Farmington, CT).

Assessments: Child Measures

Anthropometric data. Child height and weight were measured using standard techniques by trained staff; BMI (kg/m^2) was calculated and BMI percentile was determined from CDC growth curves appropriate for age and sex.[31] Children were classified as normal weight (BMI 5th–84th percentile), overweight (BMI 85th–94th percentile), or obese (BMI ≥ 95th percentile).

Diet. Dietary habits were assessed using the Children's Dietary Questionnaire (CDQ), a 29-item parent-reported instrument that assessed patterns of food intake in their child for both the previous 24 hours as well as over the past 7 days.[32] Four food group subscales were generated: fruit and vegetable (FV) score, fat from dairy score, sweetened beverages (fruit juice/drink and nondiet soda) score, and noncore foods score. The noncore foods score looked at consumption of food items, such as sugared cereals, chips, French fries, pastries, pizza, and fast food. The questionnaire has demonstrated satisfactory test-retest reliability.

Maternal Measures

Demographics. Demographic information (including household size, language spoken at home, marital status, employment status, and household income) was obtained from participants by self-report.

Household food security status. The 18-item US Household Food Security Instrument was used to determine the food security status of the individual households.[33] Questions captured concerns about running out of food, inability to afford balanced meals, and hunger in the previous 12 months. Affirmative responses were summed to generate a raw score where 0 = high food security, 1–2 = marginal food security, 3–7 = low food security, and 8–18 = very low food security. Consistent with recent USDA recommendations for reporting food security status in households with children,[34] households with high or marginal food security (raw scores 0–2) were grouped together and categorized as ''food secure'' in our analysis, whereas those households with raw scores on the household food security instrument of ≥ 3 were categorized as ''food insecure.''

Additional Variables

Caregivers were screened for depression with the Patient Health Questionnaire-2 (PHQ-2). The PHQ-2 is an abbreviated version of the PHQ-9 and has shown good validity.[35] A score of ≥ 3, which indicates risk for major depression with 83% sensitivity and 92% specificity, was used. The four-item Perceived Stress Scale (PSS-4) was used to document caregiver stress in the previous month.[36] Total score on the PSS-4 ranges from 0 to 16 with higher scores indicating higher perceived stress. The PSS-4 has no diagnostic cutoff; scores were compared within the sample.

Statistical Analysis

Data were analyzed using JMP Statistical Software (SAS Institute Inc., Cary, NC). Descriptive statistics were calculated for all measures. Comparisons among groups were evaluated with an inferential statistic appropriate to level of measurement and number of categories (analysis of variance, chi square, Kruskal-Wallis' test, and the Student's *t*-test). All continuously distributed measures were tested for equality of variance. The nonparametric statistic was used to calculate alpha levels when distributions did not satisfy assumptions of the parametric analog. The main outcome measure, child BMI percentile, was treated as normal versus overweight/obese in logistic regression models to minimize the complexity of having three levels of outcome (normal, overweight, and obese), which was felt to be uninformative given the aims of the current study. Household food security was the primary independent variable. Overall logistic regression models were tested to evaluate the influence of mediating variables (maternal depression, stress scores, and demographics) on the outcome. Variables were retained in the model if the overall model chi square changed more than 10% with their removal. Significance was defined as an alpha ≤ 5% and reported *p* values are two-tailed.

Results

Study Participants

Of the 248 eligible, 228 caregivers provided consent to participate in the study (92%). For the final analysis, household food security status, dietary intake, and child BMI percentile were available for 226 caregivers and children. Four children, underweight according to BMI criteria (< 5th percentile), were excluded from analysis, leaving a study sample of 222 participating children—90% were Hispanic, identified as Puerto Rican (60%), and 95% Medicaid insured (Table 1). At time of survey, the mean child age was 35 ± 8.7 (mean ± standard deviation) months old; 50% were female. Forty-eight percent of children in the overall sample were either overweight (19%) or

Table 1. Characteristics of Study Sample[a]

Characteristic	Study sample ($n=222$)
Child characteristics	
Age (months)	35 ± 8.7
Sex: female	111 (50)
Ethnicity	
Hispanic: Puerto Rican	135 (61)
Hispanic: other	64 (29)
Black/African American	23 (10)
BMI classification	
Normal (5th–84th%ile)	116 (52)
Overweight (BMI 85th–94th%ile)	41 (19)
Obese (BMI ≥95th%ile)	65 (29)
Insurance coverage: Medicaid	211 (95)
Caregiver/maternal characteristics	
Survey language ($n=197$)	
English	122 (62)
Spanish	75 (38)
Employment status: employed	98 (44)
Marital status: never married	174 (78)
Maternal psychosocial	
Depressive symptoms: (PHQ-2 ≥3)	30 (14)
PSS-4 stress score	8.2 ± 2.0
Household characteristics	
Household size	4.3 ± 1.5
Food security	
% secure	166 (75)
% insecure	56 (25)

[a]Data presented as *n* (%) or mean ± standard deviation.

%tile, percentile; PHQ-2, Patient Health Questionnaire-2; PSS-4, four-item Perceived Stress Scale.

obese (29%). Almost two thirds (61%) of the caregivers completed the surveys in English. All caregivers were female. The majority were unemployed and had never married.

Food Insecurity

Twenty-five percent of caregivers responded positively to three or more questions on the household food security instrument, classifying their households as food insecure. Food-insecure households differed sharply on several individual questions. They more often reported worry about running out of food (88% vs. 17%), reliance on a few kinds of low-cost foods owing to lack of money (82% vs. 10%), running out of food with no money to buy more (71% vs. 4%), could not afford balanced meals (67% vs. 2%), and could not afford balanced meals for the child (46% vs. 0; all differences were statistically significant at $p<0.001$). No caregivers reported that the child skipped meals, did not eat when hungry, or did not eat for an entire day. Caregivers from food-insecure households were more likely to report depressive symptoms (27% vs. 9%; $p<0.001$), compared to the food secure, although perceived stress scores were not different between the groups ($p=0.50$).

Food Security Status and Maternal Depression/Stress

Although caregivers from food-insecure households reported more depressive symptoms than caregivers from food-secure households, there was no relationship between maternal PHQ-2 scores and child BMI percentile (Table 2). In regression analysis with household food security and depression in the model, food-insecure households exhibited both the lowest average noncore intake (1.09 servings) and the highest noncore intake (1.4 servings) depending on caregiver-adjusted depression scores, low versus high, respectively ($p<0.03$). The relationship between depressive symptoms and food security, as well as dietary intake, was not influenced by reported stress levels.

Food Security Status and Child Body Mass Index Percentile

No direct association was found between household food security status and child overweight/obesity in the overall study sample. Rates of child overweight/obesity were the same for both food-insecure and food-secure households.

Food Security, Child Body Mass Index Percentile, and Dietary Intake

Dietary patterns did not differ based on household food security status, nor were there differences in the CDQ food group subscale scores between normal weight and overweight/obese children. Intake of FV, as well as sweetened beverages and dairy, was similar between food-secure and food-insecure households (Table 2).

Food Security, Ethnicity, and Child Body Mass Index Percentile

Among all ethnic groups, household food security status was not associated with child weight nor was food security associated with dietary patterns that could increase the risk of obesity. In this urban sample, the highest rates of obesity and overweight were observed among Hispanic children. These children did not differ by age, sex, or by dietary intake, compared to non-Hispanic children. Fifty percent of Hispanic children had BMI percentiles at the 85th percentile or greater, compared to 23% among other children, who were primarily African American ($p<0.03$). In multiple linear regression models, this relationship was not altered by household food security status or maternal demographic or psychosocial characteristics.

Table 2. Associations with Household Food Security Status and Child BMI Percentile[a]

	Food secure ($n=166$)		Food insecure ($n=56$)	
	Normal wt 85 (51)	Overwt/obese 81 (49)	Normal wt 31 (55)	Overwt/obese 25 (45)
Child characteristics				
Age (months)	34.5 ± 8.7	36.4 ± 8.34	33.7 ± 8.5	37.0 ± 9.4
Sex: female	48 (54)	40 (46)	14 (45)	9 (36)
Ethnicity				
Hispanic: Puerto Rican	51 (60)	56 (69)	13 (42)	15 (60)
Hispanic: other	20 (24)	21 (26)	15 (50)	8 (32)
Black/African American	14 (16)	4 (11)	3 (10)	1 (4)
CDQ scores				
Fruit and vegetable	11.3 ± 4.5	11.5 ± 5.8	12.8 ± 4.3	11.1 ± 4.6
Fat from dairy	3.0 ± 2.3	2.7 ± 2.1	2.9 ± 2.4	2.5 ± 2.1
Sweetened beverages	2.8 ± 1.7	2.6 ± 1.8	2.7 ± 1.7	2.5 ± 1.5
Noncore foods	1.2 ± 0.05	1.3 ± 0.1	1.2 ± 0.5	1.2 ± 0.6
Maternal characteristics				
Depressive symptoms (PHQ-2 ≥ 3)	7 (8)	8 (10)	11 (37)	4 (16)
PSS-4 stress score	8.0 ± 1.9	8.5 ± 1.9	8.1 ± 2.4	7.8 ± 2.0

[a]Data presented as *n* (%) or mean ± standard deviation.

CDQ, Children's Dietary Questionnaire; PHQ-2, Patient Health Questionnaire-2; PSS-4, four-item Perceived Stress Scale' wt, weight; Overwt, overweight.

Although not associated with household food security status, dietary patterns potentially associated with obesity risk were generally higher among Puerto Rican children, compared to other Hispanic children. Average daily consumption of noncore foods was almost 50% higher ($p<0.001$) and vegetable consumption somewhat lower (24-hour frequency, $p<0.06$) for Puerto Rican children, compared to Mexican and other Hispanic children.

Food Security, Child Body Mass Index Percentile, and Child Age

Subgroup analyses revealed an increase in child BMI percentile with increasing age among households reporting high food security (score of zero on US Household Food Security Instrument) that was not observed for households with marginal, low, or very low food security. The proportion of children in these highly food-secure households with overweight and obesity nearly doubled between 2 and 3 years of age (33%, 59%, and 58% for 2-, 3-, and 4-year-olds, respectively; $p<0.02$). This increase in weight among age groups was not observed for households reporting any degree of food insecurity. Although overall diet was not significantly different between the food-secure and -insecure households with regard to overall subscale scores on the CDQ, in highly food-secure households, children at age 4 years demonstrated an average of one full serving of soda above 2-year-olds (1.6 vs. 0.6 servings; $p<0.05$).

Discussion

In this sample of low-income, primarily Puerto Rican children and their caregivers, household food insecurity was not associated with higher rates of child obesity. Contrary to our hypothesis, scores on the CDQ did not differ based on household food security status. Children from food-insecure households did not have greater reported consumption of noncore foods and there were no differences in dietary patterns between normal weight and overweight/obese children. Though caregivers from food-insecure households reported more depressive symptoms than caregivers from food-secure households, there was no relationship between maternal depression and child BMI percentile. Maternal levels of stress were unrelated to weight status in children, and levels of stress were similar between food-secure and food-insecure households.

In a survey of low-income Mexican American families, Kaiser and colleagues found that severe food insecurity (child hunger) was associated with a diet less likely to meet Food Guide Pyramid recommendations, but similar to our results, they did not demonstrate a relationship between food insecurity and child overweight/obesity.[19] Unlike

Kaiser and colleague's study, our study population was primarily Puerto Rican and lived in an urban setting. In addition, Kaiser and colleagues also only looked at food insecurity during one season of the year and did not use the USDA instrument to measure food security status. These same researchers later found that food-insecure Latino households with preschool children had fewer varieties of food supplies, particularly FV, but did not address the potential relationship between food security status and child weight.[17]

In a group of Mexican American households with elementary school-aged children, maternal pressure to eat was associated with greater vegetable consumption in food-secure households, but not for the food insecure.[18] However, though dietary recalls were used in this study, researchers did not specifically look for differences in diet between children from food-secure and food-insecure households, nor did they address whether or not there was a relationship between food security status, diet, and child BMI percentile, as was examined in our study.

Ortiz-Hernandez and colleagues found that children from the most food-insecure households in Mexico City had greater intake of high-energy-density sweets, salty foods, and fatty cereals.[21] These children were much older than our study population, however, and the results may not be applicable for preschool-aged children. Rosas and colleagues found that children of Mexican descent living in a migrant community in California who experienced food insecurity had increased consumption of fat and fried snacks, but unlike our study, these children were not primarily living in an urban setting and were older than our study population.[37]

Our study is an important contribution to the literature on the relationship between household food security status, dietary intake (through use of the CDQ), and child BMI percentile in an urban environment. Our results do not support a relationship between household food security status and overall dietary patterns. Food group subscale scores on the CDQ did not differ between food-secure and food-insecure children, suggesting that, at least in these four domains, their diets were similar. We also did not find a relationship between household food insecurity and child overweight/obesity for the group as a whole. Though not related to household food security status, the highest rates of obesity and overweight were observed among Latino children in our sample, compared to non-Latino children. Additionally, Puerto Rican children demonstrated higher noncore food intake and lower vegetable consumption, compared to other Hispanic children. These results suggest the need to examine cultural group differences within ethnic categories, which may play an important role in childhood obesity risk.

What might account for the discrepant findings across studies regarding household food insecurity and its relationship to child weight status? One major limitation of the current food security module is the difficulty in inferring food security status at the individual level from a household measurement.[38] It is possible that there are important differences in how caregivers provide for their children when resources are limited that are not reflected by this instrument. Whereas 25% of our households reported being food insecure, it is not possible to determine how much of an impact, if any, this had on an individual child in terms of their nutritional needs being met. It is also possible that caregivers exhibit differential practices in how they feed their offspring, depending on the age and perceived needs of the child in question.

An unexpected finding of our research revealed that the highest level of household food security was associated with increasing child BMI percentile with increasing age. Though our primary analysis followed the USDA recommendations for categorizing households with both high and marginal food security as ''food secure,'' our results suggest that the current recommended method of categorization may be problematic. Cook and colleagues found that households with marginal food security are more similar to households with food insecurity than those who are food secure, and that even marginal food security can be associated with adverse health outcomes in young children.[39]

Although the overall diets of the participants were not different in the areas of FV consumption, fat from dairy, sweetened beverages as a whole, or for noncore foods, food-secure children had higher intake of nondiet soda, compared to the food insecure. Further, increased rates of overweight and obesity among children from households with the highest level of food security was accompanied by increased consumption of sugar-sweetened soda. Consumption of SSBs has been linked to increased weight gain in numerous observational studies.[40–43] DeBoer and colleagues found that children at age 2 who drank SSBs daily showed a greater increase in BMI *z*-score over time, and that children at age 5 were more likely to be obese if they were regular consumers of SSBs.[44] Decreasing SSBs has been shown to lead to reductions in fat mass and weight gain in normal weight children.[45] These studies strongly suggest that SSBs are associated with increased rates of obesity and offer pediatricians and others caring for young children an opportunity to counsel families on the importance of limiting consumption, which may be especially important for families where there is less concern for food availability.

We used the CDQ to assess dietary patterns in study participants. Even though overall diet was not significantly different based on food security status, we did not examine the potential impact of portion size on child BMI percentile, number of days of fast food consumption, or other measures that have been associated with weight status in children. It is possible that owing to better financial circumstances, food-secure children consume larger portions than food-insecure children, even if overall dietary patterns are not significantly different, which may also contribute to the increasing BMI percentile observed in children from the most food-secure households.

Other limitations in this study include the fact that most of the data collected were obtained by self-report, which may have introduced bias into the results. We made every attempt to minimize this possibility by using validated instruments. The anthropometric measures were collected by trained staff blinded to the study. We also used cross-sectional data in our analyses; thus, the BMI percentile changes observed among the highly food-secure age groups do not reflect individual differences in weight status over time. Additionally, there are likely other factors, such as genetic influences, maternal differences during pregnancy, and other early-life predictors, that contribute to child weight gain, irrespective of income and/or food security status, that require further study.

Conclusions

In summary, while household food insecurity was prevalent in our study, it was not associated with child BMI percentile. Dietary patterns did not differ based on household food security status. Maternal depression and stress did not mediate the relationship between household food insecurity and child weight status. While overall dietary patterns were not different based on household food security status, children from food secure households had greater non-diet soda intake compared to the food insecure. Future work, including prospective studies, is needed to better understand the factors associated with early life weight gain in order to promote healthy lifestyle habits and prevent childhood overweight/obesity.

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Author Disclosure Statement

No competing financial interests exist.

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