

Obesity Among US Urban Preschool Children

Relationships to Race, Ethnicity, and Socioeconomic Status

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Objectives: To determine whether there are racial/ethnic differences in the prevalence of obesity among preschool children and to determine whether these differences are explained by socioeconomic factors.

Design: Cross-sectional assessment.

Setting: Twenty large US cities, from 2001 to 2003.

Participants: Of the 4898 children enrolled at birth in the Fragile Families and Child Well-being Study, we analyzed data for the 2452 who, at the age of 3 years, had their height and weight measured during a maternal survey.

Main Exposures: Three socioeconomic indicators were the main exposures—maternal education, household income, and children's food security status, as assessed by the US Household Food Security Survey Module.

Main Outcome Measure: Obesity, defined as a body mass index at the 95th percentile or higher for age and sex.

Results: Of the mothers, 41.0% had education beyond high school, 52.9% of households had an income above the federal poverty threshold, and 79.5% of the children were food secure. The prevalence of obesity was 25.8% among Hispanics (any race), 16.2% among blacks, and 14.8% among whites. Compared with whites, the odds of obesity were significantly higher in Hispanics (odds ratio, 2.00; 95% confidence interval, 1.46-2.73), but not in blacks (odds ratio, 1.10; 95% confidence interval, 0.82-1.48). Neither of these odds ratios changed meaningfully after adjusting for all 3 socioeconomic indicators (Hispanics: odds ratio, 1.86 [95% confidence interval, 1.33-2.60]; and blacks: odds ratio, 1.07 [95% confidence interval, 0.78-1.47]).

Conclusion: In a sample of preschool children drawn from 20 large US cities, the high prevalence of obesity among Hispanics relative to blacks or whites was not explained by racial/ethnic differences in maternal education, household income, or food security.

Arch Pediatr Adolesc Med. 2006;160:578-584

IN THE UNITED STATES, A DISPARITY among racial/ethnic groups in the prevalence of obesity¹ is one of the great concerns and enigmas in the obesity epidemic.^{2,3}

Addressing this disparity is important because it may underlie similar disparities in obesity-related health conditions, such as diabetes mellitus and hypertension.^{4,5} However, to address this racial/ethnic disparity in obesity, we need to understand more about its modifiable root causes.

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It is not known, for example, at what age the disparity emerges, even though it seems to be established by adolescence.⁶⁻⁸ The origin of this disparity may lie in the preschool years, because maternal obesity might influence the risk of childhood obesity by altering the prenatal and the early postnatal environments⁹⁻¹¹ and because the behaviors affecting energy balance begin to develop early in life.

Even if a racial/ethnic disparity in obesity prevalence exists in early childhood, it is not clear that it reflects varying socioeconomic conditions across racial/ethnic groups. Few studies have compared the prevalence of obesity in preschool children across racial/ethnic groups, and, to our knowledge, none has explored whether these differences are related to measures of socioeconomic status. The 1999-2002 National Health and Nutrition Examination Survey provided data on obesity prevalence among 2- to 5-year-old children by racial/ethnic group,^{12,13} but the sample size of preschool children in the National Health and Nutrition Examination Survey limits the analysis of the relationship between socioeconomic factors and obesity within racial/ethnic groups. Other prevalence studies in preschool children were conducted in a specific geographic location¹⁴ or were restricted to low-income children.¹⁵

Although there is no single measure of socioeconomic status for children,¹⁶ parental education and household income are commonly used and have independently explained variability in childhood obesity in

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prior studies.^{17,18} However, among children in economically disadvantaged households, specific measures of material resources may be better than reports of annual household income at capturing meaningful short-term variability in economic well-being. Household food insecurity—a limited or uncertain availability of nutritionally adequate and safe food because of constraints in economic resources¹⁹—may be a specific form of material deprivation that is associated with childhood obesity. Food insecurity has been associated with an increased prevalence of obesity in women.²⁰⁻²⁵ However, the relationship between food insecurity and obesity in children is less clear.²⁶⁻³¹ Food insecurity is an important factor to identify insofar as it can potentially be addressed by food assistance programs.

We used data on 3-year-old children in the Fragile Families and Child Well-being Study,^{32,33} a birth cohort study of children from 20 large US cities, to address the following questions: (1) Are there differences in the prevalence of obesity among preschoolers across 3 major racial/ethnic groups—non-Hispanic whites, non-Hispanic blacks, and Hispanics (any race)? and (2) To what extent is any difference in obesity prevalence between these racial/ethnic groups explained by 3 socioeconomic indicators—household income, maternal education, and food security?

METHODS

STUDY DESIGN AND SAMPLE

The Fragile Families and Child Well-being Study is an ongoing birth cohort study whose sampling design is described elsewhere in detail.^{32,33} The cohort was drawn from births occurring from 1998 to 2000 in 75 hospitals across 20 large (population, >200 000) US cities in 15 states. Nonmarital births, so-called fragile families, were oversampled relative to marital births (3:1).

Families were ineligible (<5% of sampled births) if the child was being placed for adoption, if the mother did not speak either English or Spanish well enough to understand the survey questions, or if the mother was too ill after delivery to participate in an interview. Most hospitals did not allow mothers younger than 18 years to participate. Among eligible mothers, 81.8% of those married and 87.1% of those unmarried agreed to participate. The institutional review boards at all 75 birth hospitals, and those at Princeton University, Princeton, and Columbia University, New York, NY, approved the data collection procedures. All mothers gave informed written consent.

After a survey of mothers in the birth hospital, follow-up surveys of the mothers were conducted approximately 1 and 3 years after delivery. At 3 years, 2452 (50.1%) of the original 4898 mothers in the birth cohort agreed to complete the survey as an in-home interview, during which their child's height and weight were measured. This report involves these 2452 children who, during the in-home survey, were a mean \pm SD age of 38.6 \pm 3.3 months.

CHILDHOOD OBESITY

Interviewers were trained to measure the children's height and weight using a protocol modeled after the one established by the Centers for Disease Control and Prevention.³⁴ Children were measured while wearing light clothing and no shoes. Weight was obtained with an electronic scale (Bella Digital Scale, model 840; SECA, Hanover, Md). Stature was obtained with a portable stadiometer (Road Rod Stadiometer, model 214; SECA). Measurements were taken once and recorded to the nearest pound and to the nearest 0.1 cm. From these measurements, we calculated

body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters) and computed BMI percentiles for age and sex using the Centers for Disease Control and Prevention 2000 growth reference.³⁵ We classified all children with a BMI at the 95th percentile or higher as obese.³⁶

RACE/ETHNICITY AND SOCIOECONOMIC INDICATORS

Race/Ethnicity

The mother was asked separately about her own race and ethnicity (Hispanic origin) and that of the child's father. We created 4 mutually exclusive race/ethnicity categories—non-Hispanic white, non-Hispanic black, Hispanic (any race), and other race (non-Hispanic)—that are hereafter referred to as white, black, Hispanic, and other. For 86.3% of the children, the race/ethnicity category of the 2 parents was the same and was used as the child's category. In the cases in which the race/ethnicity of the 2 parents differed, we based the child's race/ethnicity on the mother's race/ethnicity.

Maternal Education

This variable was based on the mother's report of her educational status 3 years after delivery, and children were placed in 1 of 4 maternal education categories: less than high school, high school degree or equivalent, some college, and college graduate (bachelor's degree) or more.

Household Income

Income data were not available from the 3-year survey. However, on the birth and 1-year surveys, the mother was asked to report the pretax income of the entire household during the prior 12 months. She was instructed to include her own income plus the income of all those living with her and to consider income from all sources, including public assistance. On both surveys, when the mother did not report household income, income was imputed using a regression model that contained other variables available in the survey, such as marital status, age, immigrant status, number of other adults in the household, whether the mother worked in the past year, and whether she received welfare in the past year. In our analysis, we used the income data reported on the 1-year survey, because these data were missing for fewer respondents than on the birth survey. In the 90 cases (3.7% of the sample) in which the mother did not participate in the 1-year survey, household income data were obtained from the birth survey. Altogether, income data were imputed for 142 (5.8%) of the cases in our study sample.

We calculated the income-to-poverty ratio by dividing the household income by the income at the US poverty threshold for a given household size for the year of the survey (data available at: <http://www.census.gov/hhes/poverty/threshld.html>). By using this ratio, we then placed children into 1 of 5 income categories: less than 0.50, 0.50 to 0.99, 1.00 to 1.85, 1.86 to 1.99, 2.00 to 2.99, and 3.00 or greater. We selected these categories because they divided the study population into groups of similar size while also using the cut point of 1.85, the criterion for determining income eligibility for the Special Supplemental Nutrition Program for Women, Infants, and Children.

Food Security

Households are considered "food secure" when all members have "access at all times to enough food for an active healthy life."^{19(p1575)} The standard for measuring food security is the 18-

Item	Positive Response
We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food. Was that often, sometimes, or never true for you in the last 12 months?	Often or sometimes
We couldn't feed the children a balanced meal because we couldn't afford that. Was that often, sometimes, or never true for you in the last 12 months?	Often or sometimes
The children were not eating enough because we just couldn't afford enough food. Was that often, sometimes, or never true for you in the last 12 months?	Often or sometimes
In the last 12 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food?	Yes
In the last 12 months, did any of the children ever skip meals because there wasn't enough money for food?	Yes
How often did this [item above] happen—almost every month, some months but not every month, or in only 1 or 2 months?	Almost every month or some months but not every month
In the last 12 months, were the children ever hungry but you just couldn't afford more food?	Yes
In the last 12 months, did any of the children ever not eat for a whole day because there wasn't enough money for food?	Yes

Figure. Items on the Children's Food Security Scale. The first 2 items were preceded by the following: "Now I'm going to read you several statements that people have made about their food situation."

item US Household Food Security Survey Module,^{37,38} which mothers completed as part of the 3-year survey. The items assess food security along a continuum by asking about a range of conditions and behaviors families experience when, because of lack of money or other resources, the quality or amount of available food is constrained.

The Children's Food Security Scale consists of the 8 questions in the module that reference the children in the household (**Figure**).³⁷ The scale score is based on the total number of food-insecure conditions reported.³⁹ We used previously described procedures to score item responses as positive and to code any missing responses.³⁷ Categorical designations of food security status based on the children's scale are not well established.³⁹ We used 3 mutually exclusive categories: "fully food secure" (0 positive items), "reduced diet quality" (1 or 2 positive responses), and "reduced food intake" (≥ 3 positive responses). In doing so, we tried to distinguish positive responses on the first 2 items ("relied on a few kinds of low-cost food for children" and "couldn't feed the children a balanced meal"), which might have indicated reduced diet quality, from positive responses on later items, which indicated reduced food intake.

DATA ANALYSES

We conducted all our analyses using categorical variables to facilitate interpretation of our results. We used χ^2 tests to examine the bivariate relationship of childhood obesity to race/ethnicity and to the 3 socioeconomic indicators (maternal education, household income, and children's food security). χ^2 Tests were also used to compare the levels of the 3 socioeconomic indicators within each of the 3 major racial/ethnic groups (whites, blacks, and Hispanics). In these and other analyses in which we examined subject characteristics by race/ethnicity, we excluded the "other" group, because it contained too few subjects ($n=75$) to permit stable estimates for that group.

We used logistic regression models, with childhood obesity as the dependent variable, to determine to what extent, if any, the socioeconomic indicators mediated the relationship between race/ethnicity and obesity. We focused on the extent to which the odds ratios for the racial/ethnic groups changed between the base model (race/ethnicity as the only independent variable) and the models containing the socioeconomic

indicators (entered individually and as a group). A small change from the base-model odds ratios for race/ethnicity or the lack of any significant bivariate association between the socioeconomic indicator and obesity would suggest that the socioeconomic indicator did not mediate the relationship between race/ethnicity and obesity.⁴⁰

Because studies^{7,17,41} of older children have suggested that race/ethnicity may modify the relationship between socioeconomic indicators and obesity, we also examined the bivariate association between each socioeconomic indicator and obesity after stratifying by race/ethnicity. We then developed logistic regression models to assess the statistical significance of any apparent interaction. By using the likelihood ratio statistic, we compared 2 logistic models: (1) a "reduced model" that contained only race/ethnicity plus the socioeconomic indicator and (2) a "full model" that also contained the variables for the interaction between race/ethnicity and the socioeconomic indicator. Because of the few children in the other race category, we excluded this group from these regression analyses. In the regression models, race/ethnicity was entered as 2 dummy variables (black and Hispanic). To limit the number of terms needed to model each interaction (and the degrees of freedom for statistical testing), each socioeconomic indicator was added to the model as a single linearly ordered variable—values of 1 through 5 for the income categories, 1 through 4 for the education categories, and 1 through 3 for the food security categories. Each interaction was modeled as 2 variables (black \times socioeconomic indicator and Hispanic \times socioeconomic indicator).

RESULTS

In comparing the 2452 children in the initial birth cohort who had height and weight measurements (those in the study sample) with the 2446 children who did not (those not in the study sample), we found the mean household income to be lower (income-to-poverty ratio at the child's birth, 1.70 vs 1.99; $P<.001$) and the racial/ethnic composition different (white, 19.3% vs 22.8%; black, 52.2% vs 43.0%; Hispanic, 25.4% vs 29.3%; and other race/ethnicity, 3.1% vs 4.9%; $P<.001$). However, there was no significant difference ($P=.10$) between these 2 groups in the mothers' education level at delivery.

In the study sample, 41.0% of mothers had some education beyond high school and 52.9% of children lived in households with incomes above the federal poverty threshold (**Table 1**). Based on the Children's Food Security Scale, 16.5% of children had reduced diet quality and another 4.0% had reduced food intake. Of the 116 children who had reduced food intake, 22 met the criteria for "food insecurity with hunger" (≥ 5 positive items on the children's scale).³⁹

The prevalence of obesity (BMI, ≥ 95 th percentile) was 18.4%, and the prevalence of BMI at the 90th percentile or higher, the 85th percentile or higher, and less than the 5th percentile was 27.2%, 35.6%, and 4.2%, respectively. There was no significant difference in the prevalence of obesity between boys and girls (18.9% vs 17.8%; $P=.47$), nor was there a significant difference by sex within racial/ethnic group (data not shown).

The prevalence of obesity was not significantly different between black and white children. However, among Hispanic children, one fourth of whom were obese (Table 1), the prevalence of obesity was significantly higher than in either black or white children. There was a significant in-

Table 1. Prevalence of Preschooler Obesity by Level of Socioeconomic Indicator*

Indicator	Prevalence of Factor (N = 2452)†	Prevalence of Obesity
Race/ethnicity		
White, non-Hispanic	474 (19.3)	70/474 (14.8)
Black, non-Hispanic	1280 (52.2)	207/1280 (16.2)
Hispanic (any race)	623 (25.4)	161/623 (25.8)
Other race, non-Hispanic	75 (3.1)	12/75 (16.0)
P value‡	...	<.001
Maternal education		
Less than high school	731 (29.8)	157/731 (21.5)
High school degree or equivalent	713 (29.1)	125/713 (17.5)
Some college	745 (30.4)	129/745 (17.3)
College graduate or more	260 (10.6)	38/260 (14.6)
P value§	...	.008
Household income-poverty ratio		
<0.50	670 (27.3)	113/670 (16.9)
0.50-0.99	485 (19.8)	107/485 (22.1)
1.00-1.85	562 (22.9)	109/562 (19.4)
1.86-2.99	360 (14.7)	59/360 (16.4)
≥3.00	375 (15.3)	62/375 (16.5)
P value§	...	.48
Children's food security||		
Fully food secure	1939 (79.5)	361/1939 (18.6)
Reduced diet quality	402 (16.5)	71/402 (17.7)
Reduced food intake	97 (4.0)	13/97 (13.4)
P value§	...	.23

*Obesity was defined as a body mass index at the 95th percentile or higher.

†Data signify the number (percentage) of subjects at each level of the indicator. Percentages may not total 100 because of rounding. For the 2452 subjects, data were missing on maternal education for 3 subjects and on the food security measures for 14 subjects.

‡P value for the χ^2 test (Pearson). P values for specific comparisons between non-Hispanic blacks (B), non-Hispanic whites (W), and Hispanics (H) are as follows: B vs W, $P=.47$; B vs H, $P<.001$; and W vs H, $P<.001$.

§P value for the χ^2 test (Cochran-Armitage trend test).

||Categories are based on the Children's Food Security Scale: fully food secure (0 positive responses), reduced diet quality (1 or 2 positive responses), and reduced food intake (≥ 3 positive responses).

verse relationship between maternal education and obesity prevalence, but there was no significant relationship between household income and obesity or between children's food security level and obesity. These findings on the bivariate relationship with the 3 socioeconomic indicators also held true when we used the 90th or 85th percentile as a BMI cut point. When all 18 items on the US Household Food Security Survey Module, including the 10 adult-referenced items, were scored to establish a single measure of household food security,³⁷ this measure was also not significantly related to childhood obesity. The prevalence of obesity was 18.4%, 18.0%, and 15.2% in the categories of food secure, food insecure without hunger, and food insecure with hunger, respectively ($P=.47$).

Hispanics and blacks had similar levels of food security and income, but Hispanics had lower levels of maternal education than blacks (**Table 2**). Whites had significantly higher levels of food security, income, and education than either Hispanics or blacks. Despite the differences between the racial/ethnic groups on socioeconomic indicators, there was no evidence that these indicators were important mediators of the risk of obesity in Hispanic children (**Table 3**). In re-

Table 2. Comparison Between Racial/Ethnic Groups in the Prevalence of Socioeconomic Indicators*

Indicator	Whites (Non-Hispanic)	Blacks (Non-Hispanic)	Hispanics (Any Race)
Maternal education			
Less than high school	69 (14.6)	350 (27.4)	298 (47.9)
High school degree or equivalent	113 (23.8)	429 (33.5)	156 (25.1)
Some college	151 (31.9)	433 (33.9)	138 (22.2)
College graduate or more	141 (29.7)	67 (5.2)	30 (4.8)
Income-to-poverty ratio			
<0.50	34 (7.2)	431 (33.7)	191 (30.7)
0.50-0.99	53 (11.2)	267 (20.9)	149 (23.9)
1.00-1.85	101 (21.3)	290 (22.7)	159 (25.5)
1.86-2.99	107 (22.6)	179 (14.0)	63 (10.1)
≥3.00	179 (37.8)	113 (8.8)	61 (9.8)
Children's food security			
Fully food secure	405 (85.6)	1002 (78.8)	471 (76.2)
Reduced diet quality	60 (12.7)	216 (17.0)	116 (18.8)
Reduced food intake	8 (1.7)	54 (4.2)	31 (5.0)

*Data are given as number (percentage) of each group. Percentages are based on the total for each indicator and may not total 100 because of rounding. All P values for the χ^2 test comparing the difference in the prevalence of a given socioeconomic indicator between 2 racial/ethnic groups were significant at $P<.001$, except as follows: children's food security, blacks vs whites, $P=.002$, and blacks vs Hispanics, $P=.44$; and household income-to-poverty ratio, blacks vs Hispanics, $P=.04$.

gression models that controlled for maternal education, household income, and children's food security (as single indicators or together), the odds of obesity were still 84% to 104% higher for Hispanic children compared with white children (Table 3). Maternal education, for example, reduced the odds ratio for Hispanic race/ethnicity only 8.0%, from 2.00 to 1.84. In both models that contained income (models 2 and 4 in Table 3), the odds of obesity were approximately 40% higher in those children with household incomes between 50% and 99% of the poverty threshold than in those below 50% of the poverty threshold, but there was no evidence that income differences accounted for the increased risk of obesity in Hispanic children.

We conducted several sensitivity tests of the regression models shown in Table 3. By using blacks rather than whites as the referent racial/ethnic group, the odds of obesity in each model were still significantly higher for Hispanic children compared with black children, with the odds ratios ranging from 1.74 to 1.83 in the models. Our findings in all the models were not significantly changed when we (1) made the cut point for the binary dependent variable either at a BMI at the 85th percentile or higher or at a BMI at the 90th percentile or higher, (2) excluded those cases in which income data were imputed, (3) used the 18-item household food security measure rather than the children's measure, (4) used the father's race/ethnicity rather than the mother's race/ethnicity for those children whose parents differed in their race/ethnicity, (5) excluded children whose parents differed in race/ethnicity, or (6) examined models for boys and girls separately.

Stratified analyses (**Table 4**) showed an inverse bivariate relationship between maternal education and child obesity in whites and Hispanics, but not in blacks. Although income was not significantly related to obesity

Table 3. Odds of Preschooler Obesity From Multivariate Logistic Regression Models*

Variable†	Model				
	Base	1	2	3	4
Race/ethnicity					
White, non-Hispanic	1.00	1.00	1.00	1.00	1.00
Black, non-Hispanic	1.10 (0.82-1.48)	1.04 (0.76-1.42)	1.09 (0.80-1.50)	1.12 (0.83-1.50)	1.07 (0.78-1.47)
Hispanic (any race)	2.00 (1.46-2.73)	1.84 (1.32-2.55)	1.96 (1.41-2.73)	2.04 (1.49-2.79)	1.86 (1.33-2.60)
Other race, non-Hispanic	1.00 (0.50-2.00)	1.00 (0.50-1.99)	0.99 (0.50-1.98)	1.02 (0.51-2.03)	1.01 (0.51-2.02)
Maternal education					
<High school degree	...	1.00	...	...	1.00
High school degree	NA	0.86 (0.66-1.13)	NA	NA	0.83 (0.63-1.09)
Some college	NA	0.87 (0.66-1.14)	NA	NA	0.83 (0.62-1.10)
College degree or more	NA	0.74 (0.49-1.12)	NA	NA	0.69 (0.43-1.11)
Income-to-poverty ratio					
<0.50	...	...	1.00	...	1.00
0.50-0.99	NA	NA	1.37 (1.02-1.85)	NA	1.38 (1.02-1.87)
1.00-1.85	NA	NA	1.18 (0.88-1.58)	NA	1.22 (0.90-1.65)
1.86-2.99	NA	NA	1.06 (0.74-1.50)	NA	1.11 (0.77-1.61)
≥3.00	NA	NA	1.08 (0.75-1.56)	NA	1.20 (0.80-1.81)
Children's food security					
Fully food secure	...	...	...	1.00	1.00
Reduced diet quality	NA	NA	NA	0.91 (0.69-1.21)	0.90 (0.67-1.20)
Reduced food intake	NA	NA	NA	0.64 (0.35-1.16)	0.63 (0.34-1.15)
P value‡	NA	.47	.32	.26	.31

Abbreviation: NA, not applicable (ie, the variable was not included in the regression model).

*Data are given as odds ratio (95% confidence interval). Obesity indicates a body mass index (calculated as the weight in kilograms divided by the square of height in meters) at the 95th percentile or higher.

†The referents were as follows: for race/ethnicity, non-Hispanic white; for maternal education, less than a high school degree; for income-to-poverty ratio, less than 0.50; and for children's food security, fully food secure.

‡Values are for the likelihood ratio statistic comparing the base model with the specified model.

Table 4. Prevalence of Preschooler Obesity by Level of Socioeconomic Indicator and by Race/Ethnicity*

Variable	Whites (Non-Hispanic)	Blacks (Non-Hispanic)	Hispanics (Any Race)
Maternal education			
Less than high school	14/69 (20.3)	52/350 (14.9)	90/298 (30.2)
High school degree or equivalent	16/113 (14.2)	70/429 (16.3)	37/156 (23.7)
Some college	24/151 (15.9)	73/433 (16.9)	28/138 (20.3)
College graduate or more	16/141 (11.3)	12/67 (17.9)	6/30 (20.0)
P value†	.14	.40	.02
Income-to-poverty ratio			
<0.50	6/34 (17.6)	55/431 (12.8)	50/191 (26.2)
0.50-0.99	10/53 (18.9)	49/267 (18.4)	44/149 (29.5)
1.00-1.85	16/101 (15.8)	53/290 (18.3)	38/159 (23.9)
1.86-2.99	16/107 (15.0)	29/179 (16.2)	13/63 (20.6)
≥3.00	22/179 (12.3)	21/113 (18.6)	16/61 (26.2)
P value†	.19	.09	.50
Children's food security			
Fully food secure	57/405 (14.1)	175/1002 (17.5)	119/471 (25.3)
Reduced diet quality	11/60 (18.3)	25/216 (11.6)	33/116 (28.4)
Reduced food intake	2/8 (25.0)	4/54 (7.4)	7/31 (22.6)
P value†	.24	.006	.84

*Data are given as number/total (percentage) of subjects in each group. Obesity indicates a body mass index (calculated as the weight in kilograms divided by the square of height in meters) at the 95th percentile or higher.

†Values are for the χ^2 test (Cochran-Armitage trend test).

in any of the racial/ethnic groups, it was only among white children that those in the highest income stratum had the lowest prevalence of obesity. Only among blacks was

the prevalence of obesity significantly higher in children who were fully food secure. Based on regression models to test the statistical significance of the interaction between race/ethnicity and each of the 3 socioeconomic indicators, the P values for the likelihood ratio statistics were as follows: education (P=.04), income (P=.09), and children's food security (P=.02).

COMMENT

SUMMARY OF MAIN FINDINGS

Based on heights and weights measured between 2001 and 2003 for more than 2400 three-year-old children living in 20 large US cities, we found that the prevalence of obesity was significantly higher in Hispanics than in either whites or blacks, but that it did not differ significantly between whites and blacks. This elevated risk for obesity in Hispanic children was not explained by racial/ethnic differences in 3 socioeconomic indicators (maternal education, household income, and children's food security).

COMPARISON WITH PRIOR STUDIES

The differences we found in obesity prevalence by race/ethnicity are consistent with those of 2 other large national studies. In the 1999-2002 National Health and Nutrition Examination Survey, the estimated prevalence of obesity among the 739 two- to five-year-old non-Hispanic white, non-Hispanic black, and Mexican American children was 8.6%, 8.8%, and 13.1%, respectively.¹³ A similar pattern by race/ethnicity was also seen in 2000 data from the Special

Supplemental Nutrition Program for Women, Infants, and Children for more than 2 million 2- to 4-year-old white, African American, and Hispanic children in whom the prevalence of obesity was 11.4%, 11.7%, and 17.9%, respectively.¹⁵ Both studies, like ours, showed that the prevalence of obesity in Hispanics was approximately 50% higher than in either blacks or whites. Our data were collected more recently, and the higher prevalence of obesity that we found in each racial/ethnic group could partly reflect continuing increases in the prevalence of obesity in US preschool children.

We found no overall association between the level of food security and childhood obesity. This finding is consistent with those of several other studies,²⁶⁻³¹ despite the differences between them in the age of the children studied, the specific measure of food security, and the cut point for obesity or overweight. To our knowledge, no other studies have examined whether the association between food security and childhood obesity differs by race/ethnicity. The significant interaction between food security and race/ethnicity, suggested by our findings, should be explored in future studies, as should the application of the Children's Food Security Scale, which, to our knowledge, has not been used in prior studies of childhood obesity.

Our data suggest that the association of maternal education and household income with childhood obesity also differs by race/ethnicity. Interaction between socioeconomic status and race/ethnicity has been shown in other studies^{7,17,41} of obesity in older children or adolescents. In these studies, an inverse relationship between socioeconomic status and obesity was seen primarily in white children but not in nonwhite children, a finding that was particularly true among females. This interaction between socioeconomic status and race/ethnicity may be one reason for the inconsistent findings across studies that have focused on the overall relationship between obesity and socioeconomic status in children.⁴²

LIMITATIONS

Although this sample was drawn from 15 states, all the children were living in large metropolitan areas and many were born to unwed parents. The findings are not meant to apply to all US 3-year-old children, especially those living outside large cities. Less emphasis should be placed on the specific prevalence of obesity that we found within subgroups, as defined by race/ethnicity and socioeconomic factors, and more emphasis should be placed on how the prevalence differed across these subgroups.

Overall, the sample contained a broad range of household income and maternal education levels, but when our analyses were stratified by race, some sample sizes were small. The study involved only half the original birth cohort. Those who had height and weight measurements had a different racial/ethnic composition and lower income levels than those who did not have these measurements. We cannot determine how these differences might have influenced our findings about the relationship between childhood obesity and the socioeconomic factors we examined. For example, it is possible that the Hispanic children who had anthropometric measurements were less likely to be obese than the Hispanic children who did not have these measurements. However, even if the prevalence of obesity were 40% lower

in the measured Hispanic children than in the unmeasured Hispanic children, the prevalence of obesity among all Hispanic children in the birth cohort would still have been 20%.

Socioeconomic status is a complex construct that is only partly captured by the indicators we studied. Income was not measured at the same time as maternal education and food security. Furthermore, among those at the lower end of the income distribution, actual income levels may fluctuate greatly. Income also does not reflect wealth or the possession of assets, economic or social, which may be more strongly associated with childhood obesity. Despite these limitations in measuring income, we found no association between childhood obesity and food insecurity, a specific form of material deprivation that might influence diet quality and thereby obesity.

IMPLICATIONS

Although there is great concern about a racial/ethnic disparity in childhood obesity,² we found that obesity in preschoolers was highly prevalent in all 3 major racial/ethnic groups and that the principal disparity between these groups was for Hispanic children. We found no evidence that this disparity was related to household income, maternal education, or children's food security. This suggests that other unidentified factors, including genes conferring susceptibility to obesity, are the more likely explanation. Thus far, studies in young children have failed to identify possible environmental or behavioral factors to explain this disparity, but measuring such factors in young children is challenging. In this cohort, we have previously shown that perceived neighborhood safety, outdoor play time, and television viewing are all unrelated to childhood obesity,⁴³ and further analyses (Hillary L. Burdette, MD, MS, and R.C.W., unpublished data, 2005) have shown that these negative findings apply to all 3 racial/ethnic groups. Other studies⁴⁴⁻⁴⁶ have not found significant differences in the diet of Hispanic children that could explain their higher prevalence of obesity.

Qualitative research^{47,48} among low-income Hispanic children has suggested some potentially obesity-promoting factors in how mothers approach feeding their young children. However, it is not clear that these practices and beliefs about feeding are different from those among low-income black or white mothers⁴⁹⁻⁵² or are strongly related to child weight.⁵³ Less is known from qualitative research about how physical activity patterns in preschool children may differ by race/ethnicity.

This disparity in obesity between Hispanic and non-Hispanic children seems to develop early in life, so future research into modifiable determinants of this disparity should focus on the period from conception to school entry. This research might benefit from more emphasis on qualitative studies across racial/ethnic groups of those cultural factors that can influence energy balance, such as how young children are nourished and spend their time. Such studies might better detect the differences that underlie this disparity and that may not be easily understood through large epidemiologic studies.

Accepted for Publication: November 22, 2005.

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Author Contributions: Dr Whitaker had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Funding/Support: This study was supported by grant 43-3AEM-4-80086 from the Economic Research Service, US Department of Agriculture; grants R01-HD41141 and R01-HD36916 from the National Institutes of Health; and a consortium of private foundations.

Role of the Sponsor: The funding bodies had no role in data extraction and analyses, in the writing of the manuscript, or in the decision to submit the manuscript for publication.

Acknowledgment: We thank Shannon M. Phillips for her technical assistance and Ronette R. Briefel, DrPH, Thomas D. Koepsell, MD, MPH, Elizabeth Goodman, MD, Mark Nord, PhD, and Ram Chandran, PhD, for their critical review of earlier drafts of this article and for their helpful suggestions.

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