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Influence of the Home Environment on the Development of Obesity in Children

Richard S. Strauss, MD*, and Judith Knight, MD‡

ABSTRACT. *Context.* **Obesity is the most common health problem facing children. The most recent data from the National Health and Nutrition Examination Survey III suggest that 22% of children and adolescents are overweight and that 11% are obese.**

Objective. **To investigate prospectively the association between the home environment and socioeconomic factors and the development of obesity in children.**

Design. **Prospective cohort study.**

Setting. **The National Longitudinal Survey of Youth.**

Population. **A total of 2913 normal weight children between the ages of 0 and 8 years were followed over a 6-year period. We examined the roles of race, marital status, maternal education, family income, and parental occupation, as well as standardized measures of the home environment (The Home Observation for Measurement of the Environment [HOME]-Short Form) on the development of childhood obesity.**

Primary Outcome Measure. **Incidence of obesity. Obesity was defined as a body mass index >95th percentile for age and gender at the 6-year follow-up.**

Results. **Maternal obesity was the most significant predictor of childhood obesity (OR: 3.62 [2.65–4.96]). The HOME-Short Form cognitive scores and household income were also significant predictors of childhood obesity (OR, low HOME-cognitive: 2.64 [1.48–4.70], medium HOME-cognitive: 2.32 [1.39–3.88]; low income: 2.91 [1.66–5.08], medium income: 2.04 [1.21–3.44]). Children who lived with single mothers were also significantly more likely to become obese by the 6-year follow-up, as were black children, children with nonworking parents, children with nonprofessional parents, and children whose mothers did not complete high school. Neither the child's gender nor the HOME-emotional scores contributed to the development of obesity. After controlling for the child's initial weight-for-height *z*-score, maternal body mass index, race, marital status, occupation, education, and HOME emotional scores, only the HOME cognitive score and family income remained significant predictors of childhood obesity.**

Conclusion. **Children with obese mothers, low family incomes, and lower cognitive stimulation have significantly elevated risks of developing obesity, independent of other demographic and socioeconomic factors. In contrast, increased rates of obesity in black children, children with lower family education, and nonprofessional parents may be mediated through the confounding effects of low income and lower levels of cognitive stimulation.** ***Pediatrics*** **1999;103(6). URL: http://www.pediatrics.org/cgi/content/full/103/6/e85;** ***obesity, environment, socioeconomic, childhood.***

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ABBREVIATIONS. SES, socioeconomic status; BMI, body mass index; NLSY; National Longitudinal Survey of Youth; HOME, The Home Observation for Measurement of the Environment; HOME-SF, The Home Observation for Measurement of the Environment-Short Form.

> If a child is fed when he is hungry, played with when he needs attention, and encouraged to be active when he is restless, he is not likely to grow up inhibited and passive or overstuffed and helpless, unable to control his eating because every discomfort is misinterpreted as a need to eat.
> —Hilde Bruch[1]

The role of the home environment in the development of childhood obesity has been recognized for a long period of time; nonetheless, few studies have documented the extent to which the home environment contributes to childhood obesity. Sϕrensen and Lissau have shown a ninefold increased risk of obesity in children who were neglected.[2] They have also documented a twofold to threefold increase in risk of obesity for children in dilapidated living conditions.[3] However, in both studies, relatively few obese children were studied, and assessment of the home environment was largely subjective. On the basis of several case reports, Christoffel has hypothesized that overeating in obese children may result from self-stimulatory behavior that is a consequence of environmental deprivation.[4]

The importance of socioeconomic factors in the development of childhood obesity also remains controversial. Initial reports by Stanley Garn and colleagues[5] from the Ten State Nutritional Survey indicate that although obesity is associated with higher socioeconomic status (SES) in early childhood, it begins to predominate in poorer females in adolescence. However, a comprehensive review of the relationship between childhood obesity and SES by Sobal and Stunkard reports that about a third of studies show no relationship, a third of studies demonstrate increased obesity associated with low SES, and a third of studies demonstrate increased obesity associated with high SES.[6] Differences in the ages of the children and measures of SES may account for the broad differences among studies.

To clarify the relationship between home environment and socioeconomic factors and the develop-

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ment of childhood obesity, we prospectively examined the development of obesity in 2913 normal weight children between the ages of 0 and 8 years who were enrolled in the National Longitudinal Survey of Youth (NLSY). We examined the role of race, marital status, maternal education, and family income, as well as standardized measures of the home environment in the development of childhood obesity over a 6-year period. We also analyzed the effects of the home environment on children with low SES, because these children generally have the poorest home environment and the highest levels of obesity.

METHODS

The sample that was studied was made up of children who were between the ages of 0 and 8 years in 1988 and who were born to mothers in the NLSY cohort. NLSY is a federally funded study administered by the US Department of Labor that was designed originally to study variations in labor market behaviors and experiences. However, over time the NLSY study has expanded its mission and now provides a comprehensive assessment of factors that influence social, emotional, and cognitive development of children born to mothers enrolled in the NLSY. The NLSY consists of a national sample of young adults who were interviewed yearly from 1979 to 1994, as well as a supplemental sample of Hispanic, black, and poor white young adults. Response rates remained above 90% for each of the first 12 interview years and differed by <5% among major ethnic groups for both the maternal and child assessment.[7,8] Data on children in the NLSY cohort were collected prospectively every 2 years. The weighted sample of children is nationally representative of young children born to mothers who were 23 to 30 years old in 1988.[6,7] Over-sampled poor white individuals were excluded from the analysis because a lack of funding precluded follow-up data after 1990.

Demographics

Detailed information on education, marital status, family income, and employment were updated yearly during in-home interviews. Information that was missing from the 1988 survey was obtained from the 1987 response. Demographic data consisted of racial and marital status. Socioeconomic factors that were analyzed included family income, maternal education, and parental occupation. (We have used the term SES to refer to children with either low family incomes, low maternal education, or nonworking parent(s) [n = 1252]). Family income was categorized as low, middle, or high based on the nationally weighted 15th and 85th percentiles of total family income of the entire 1988 NLSY cohort. Occupation was coded according to the most recent employment by the 1970 US Census Bureau Codes.[9] Paternal occupation was included only if the father was living in the same household as the child. Complete demographic and socioeconomic data were available in >94% of the eligible cohort. Maternal body mass index (BMI) was calculated from self-reported height and weight in 1988 or 1989. Previous studies in adults have reported correlations between actual and reported heights and weights typically range between .96 and .99.[10,11] Maternal BMI was categorized as low (BMI < 20.0), normal (20.0 ≤ BMI < 25), overweight (25.0 ≤ BMI < 30.0), or obese (BMI ≥ 30) according to the World Health Organization/Department of Health and Human Services guidelines.[12] In addition, television viewing was assessed by parental report in 1994 in 89% of the eligible cohort.

Obesity

Growth data of children in 1988 were available for about 3846 children between the ages of 0 and 8 years (91% of the eligible cohort). These data included 400 to 550 children for each age, from birth to 8 years old. Follow-up weight and height data in 1994 were available in 3320 of these children (ages 6–14 years). Weights and heights were measured by the in-home interviewer using a portable scale and tape measure (height: 85% measured; and weight: 79% measured). In the remaining subjects, parental reports were used. Weight-for-height Z scores and percentiles were calculated using the Centers for Disease Control and Prevention anthropometry software. Mean weight-for-height percentiles were identical for measured and reported weights and heights (47.7 ± 29 vs 47.1 ± 31). There was no difference in demographic or The Home Observation for Measurement of the Environment (HOME) variables between those children with and without follow-up weights and heights (Table 1).

We defined obesity as a BMI >95th percentile for age and gender derived from combined data of the first and second National Health and Nutrition Examination Surveys.[13] This definition is in accordance with recommendations of the expert panel on childhood obesity.[14] Incidence of obesity and relative risk ratios were calculated based on the sample of normal weight children in 1988 who developed obesity by 1994 (n = 263/2913).

Home Environment

The Home Observation for Measurement of the Environment-Short Form (HOME-SF) was performed at the time of assessment of weight and height in 1988. The HOME-SF was the primary measure of the quality of a child's environment included in the NLSY child survey.[7] The HOME-SF was designed by the coordinators of the NLSY in consultation with Robert Bradley as an abbreviated version of the full HOME assessment that he had designed and validated previously.[15,16] Previous studies have documented that HOME is a dynamic measure sensitive to both changes in family environment and parenting abilities.[17] The HOME-SF consists of two subscores reflecting the cognitive stimulation of the child's environment and the emotional relationship between the mother and child (see "Appendix"). Previous studies using the NLSY data have demonstrated the construct validity and reliability of the HOME-SF and its two subscales.[8,18] The HOME-SF scores were categorized as low, medium, or high based on the nationally weighted 15th and 85th percentiles (≈mean ± SD). Complete data from the HOME-SF were available in >95% of the eligible cohort.

TABLE 1. Demographic Characteristics of Children With and Without Follow-up Weights and Heights in 1994

	No Follow-up (n = 526)	Follow-up (n = 3320)	
Gender (% male)	55	51	P = .06
Marital status (% single mothers)	40	36	P = .09
Race			
% Black	36	32	
% Hispanic	23	22	P = .13
% White	41	46	
Occupation			
% Parent(s) not working	11	10	
% At least 1 parent working (nonprofessional)	66	69	P = .24
% At least 1 parent working (professional/managerial)	23	21	
Maternal education (y)	11.8 ± 4.2	12.0 ± 2.1	P = .13
Family income	21 700 ± 16 500 (n = 400)	23 500 ± 17 400 (n = 2791)	P = .06
Home-SF cognitive score	975 ± 162 (n = 424)	968 ± 160 (n = 2997)	P = .41
Home-SF emotional score	981 ± 161 (n = 405)	977 ± 158 (n = 2914)	P = .66

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Data Analysis

Because the NLSY over-sampled black and Hispanic individuals, we weighted the data with sample weights provided by the NLSY so that all statistics reflected a national representative sample of children between the ages of 0 and 8 years. The child sampling weights also adjust for nonresponse in 1988. Data were analyzed using the SPSS-X program (SPSS Inc, Chicago, IL). Differences in proportions were compared with χ^2 after back-weighting to the actual survey subsample size.[19] Relative risk of developing obesity was assessed using logistic regression and 95% CIs were calculated from these regressions. Multivariate logistic regression was used to assess the effects of social and economic variables on incidence of obesity.

RESULTS

Demographic Factors

Family characteristics in 1988 are described in Table 1. Approximately a third of the mothers were single, 27% received more than a high school education, and 29% were high school drop-outs. In addition, 40% of mothers were either overweight or obese. A total of ~8% of the nonobese 1988 cohort were obese at the 6-year follow-up. A total of 56% of children who were obese at 6-year follow-up were male, and 44% were female ($P = .09$). Children who became obese were initially mildly heavier (weight-for-height Z score: $+.36 \pm 1.20$ vs $-.05 \pm 1.16$; $P < .001$) than those children who remained within the normal weight range.

Risk Factors for Childhood Obesity

Univariate logistic regression demonstrated a significantly decreased risk of obesity in children whose mothers had a low BMI ($P < .01$), and significantly increased risk of obesity in children whose mothers were overweight ($P < .01$) or obese ($P < .001$; see Table 2). After adjusting for the child's initial weight-for-height z-score, children whose mothers were overweight ($25.0 \leq \text{BMI} < 30.0$) had a 1.5-fold increased risk for obesity ($P < .01$), and children whose mothers were obese ($\text{BMI} \geq 30$) had more than a threefold increased risk of childhood obesity ($P < .001$).

The effects of demographic and socioeconomic variables on the development of childhood obesity were assessed also (Table 3). HOME-SF cognitive scores, household income, and parental occupation were the most significant predictors of childhood obesity. Children whose HOME cognitive scores were low or average were significantly more likely to develop obesity compared with children whose HOME cognitive scores were in the upper 15th percentile [(relative risk, low HOME-cognitive: 2.64 [1.48–4.70]), $P < .001$; medium HOME-cognitive: 2.32 [1.39–3.88], $P < .01$). Children whose family income was either low or average were significantly more likely to develop obesity compared with children whose family income was in the upper 15th percentile (relative risk, low income: 2.91 [1.66–5.08], $P < .001$; medium income: 2.04 [1.21–3.44], $P < .01$). Similarly, children whose parents were either not used or whose occupation was nonprofessional were significantly more likely to develop obesity compared with children with a parent in a professional/managerial occupation (relative risk, not used: 2.36 [1.50–4.17], $P < .001$; nonprofessional: 1.76 [1.15–2.67] $P < .01$). Children who lived with single mothers ($P < .05$) were also significantly more likely to develop obesity by the 6-year follow-up, as were black children ($P < .001$) and children of mothers who did not complete high school ($P < .05$). We found no evidence that the emotional HOME score contributed to the development of childhood obesity. The inverse linear relationship between incidence of obesity and family income, parental occupation, and maternal education was confirmed using the Mantel-Haenszel χ^2 test (family income, $P < .001$; parental employment, $P < .001$; and maternal education, $P < .05$).

We also performed a multivariate logistic regression analysis controlling for maternal BMI, child's initial weight-for-height z-score, gender, race, maternal education, maternal marital status, family income, occupation, HOME-SF cognitive scores, and HOME-SF emotional scores (Table 3). The addition of these control variables revealed no independent risk for race, marital status, maternal education, parental occupation, or HOME emotional score. The HOME cognitive score remained associated significantly with the development of childhood obesity 6 years later (low cognitive score, $P < .05$; and medium cognitive score, $P < .01$). Children raised in environments with low and average cognitive stimulation had a 2.3- to 2.7-fold increased risk of developing obesity. A linear relationship was observed between family household income and the development of childhood obesity. Children in middle income families had a 1.8-fold increased risk of developing obesity ($P < .05$), whereas children in low income families had a 2.8-fold increased risk of developing obesity 6 years later ($P < .01$).

Home Cognitive Environment

We analyzed separately the effects of the HOME cognitive environment in each racial, marital, in-

TABLE 2. Six-Year Cumulative Incidence and Risk of Childhood Obesity According to Maternal BMI

	Cumulative Incidence (%)†	Risk 95% CI	Adjusted Risk‡ 95% CI
BMI (mother)			
Low (BMI < 20.0)	3.2**	.54 (.33–.89)**	.55 (.34–.91)*
Normal (20.0 ≤ BMI < 25)	5.9	1.00	
Overweight (25.0 ≤ BMI < 30.0)	9.2	1.61 (1.17–2.23)**	1.48 (1.05–2.08)*
Obese (BMI ≥ 30)	18.5***	3.62 (2.65–4.96)***	3.69 (2.68–5.08)***

* $P < .05$; ** $P < .01$; *** $P < .001$.
† Statistical significance was assessed compared to the reference group by χ^2 test.
‡ Risk adjusted for initial weight-for-height.

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TABLE 3. Six-Year Cumulative Incidence and Risk of Childhood Obesity According to Demographic and Socioeconomic Factors

	Cumulative Incidence (%)†	Risk 95% CI	Adjusted Risk‡ 95% CI
Gender			
Female	7.1	1.0	
Male	8.6	1.24 (.96–1.59)	1.43 (1.07–1.94)*
Race			
White	6.8	1.0	
Hispanic	8.6	1.28 (.82–1.99)	1.05 (.62–1.77)
Black	12.1***	1.86 (1.39–2.49)***	1.19 (.80–1.76)
Marital status			
Married	7.2	1.0	
Single	9.6	1.36 (1.04–1.78)*	.81 (.53–1.24)
Maternal education			
College or professional	6.6	1.0	
High school only	8.1	1.24 (.92–1.68)	.97 (.63–1.51)
Less than high school	9.4*	1.47 (1.04–2.08)*	.96 (.67–1.37)
Occupation			
At least 1 parent professional/managerial	5.7	1.0	
At least 1 parent nonprofessional	8.4**	1.76 (1.15–2.67)**	1.11 (.78–1.58)
Parent(s) not working	12.4***	2.36 (1.50–4.17)***	1.28 (.65–2.52)
Family income			
High (>85th percentile)	3.9	1.0	
Middle (15th percentile < income ≤ 85th percentile)	7.6	2.04 (1.21–3.44)**	1.84 (1.01–3.34)*
Low (≤15th percentile)	10.5	2.91 (1.66–5.08)***	2.84 (1.39–5.78)**
HOME score (cognitive)			
High (>85th percentile)	3.7	1.0	
Middle (15th percentile < score ≤ 85th percentile)	8.3	2.32 (1.39–3.88)**	2.67 (1.43–4.97)**
Low (≤15th percentile)	9.3	2.64 (1.48–4.70)***	2.28 (1.10–4.72)*
HOME score (emotional)			
High (>85th percentile)	7.4	1.00	
Middle (15th percentile < score ≤ 85th percentile)	7.7	1.05 (.72–1.54)	.90 (.59–1.37)
Low (≤15th percentile)	7.3	.98 (.59–1.59)	.65 (.36–1.15)

* $P < .05$; ** $P < .01$; *** $P < .001$.
† Statistical significance assessed compared to reference group by χ^2 test.
‡ Risk adjusted for maternal BMI, initial weight-for-height Z score, gender, race, maternal education, marital status, family income, HOME cognitive score, and HOME emotional score.

come, occupational, and educational subgroup. The increased risks of obesity associated with low and average HOME cognitive scores were seen consistently across almost all subgroups analyzed (Table 4). Although similar trends were observed in children with highly educated parents, nonworking parents, and professional parents, these results did not reach statistical significance (highly educated, $P = .10$; nonworking, $P = .12$; professional, $P = .09$).

Individuals with the highest scores on the HOME cognitive scale watched significantly fewer hours of television per day than children with lower scores (low score, 31.1 hours/week; medium score, 27.5 hours/week; and high score, 21.1 hours/week; $P <$

TABLE 4. Six-Year Cumulative Incidence of Childhood Obesity Stratified by Demographic and Socioeconomic Variables

	Low HOME-Cognitive Score (%)	Medium HOME-Cognitive Score (%)	High HOME-Cognitive Score (%)
Race			
Black	13 (n = 227)	12 (n = 575)	4 (n = 59)*,**,***
White/Hispanic	8 (n = 236)	8 (n = 1308)	4 (n = 273)*,**,***
Marital status			
Single mother	10 (n = 251)	10 (n = 620)	2 (n = 56)*,**,***
Married	9 (n = 200)	8 (n = 1271)	4 (n = 284)*,**,***
Maternal education			
Less than high school	9 (n = 204)	10 (n = 460)	3 (n = 67)**,***
High school only	10 (n = 161)	8 (n = 904)	4 (n = 140)*,**,***
More than high school	8 (n = 74)	8 (n = 522)	4 (n = 147)
Occupation			
Parent(s) not employed	14 (n = 106)	13 (n = 153)	0 (n = 5)
At least one parent employed (nonprofessional)	9 (n = 297)	9 (n = 1267)	4 (n = 201)*,**,***
At least one parent employed (professional/managerial)	6 (n = 52)	7 (n = 470)	3 (n = 131)
Family income			
Low	8 (n = 193)	12 (n = 406)	2 (n = 52)**,***
Middle	11 (n = 201)	8 (n = 1255)	4 (n = 233)**,***
High	0 (n = 21)	5 (n = 154)	2 (n = 44)

There were no significant differences in incidence of obesity between low and medium HOME-cognitive scores among any of the groups analyzed. Differences in number of children in each subgroup reflect different response rates.
* $P < .05$ High score vs low score; ** $P < .05$ High score vs medium score; *** $P < .05$ High score vs (low or medium score).

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.001). However, after adjusting for the amount of television viewed, increased risks of obesity remained in individuals with low and medium HOME cognitive scores compared with individuals with high HOME cognitive scores [(relative risk: low HOME-cognitive, 2.36 [1.30–4.29], $P < .01$, medium HOME-cognitive, 2.23 [1.33–3.74], $P < .01$). Similar results were observed when the hours of television viewed were included in a multivariate regression that also controlled maternal BMI initial weight-for-height *z*-score, gender, race, maternal education, maternal marital status, family income, occupation, and HOME-SF emotional scores (relative risk: low HOME-cognitive, 2.30 [1.10–4.84], $P < .05$; medium HOME-cognitive, 2.64 [1.41–4.94], $P < .01$).

Finally, HOME-SF cognitive scores were relatively stable over the 6-year period ($r = .43$; $P < .001$). In the majority of families, changes in the HOME-SF cognitive scores were relatively mild. However, ~16% of families demonstrated scores that were lower in 1994 by >1 SD compared with their 1988 scores. After adjusting for initial HOME-SF cognitive scores, these children were significantly more likely to become obese than those whose HOME-SF cognitive scores did not worsen (relative risk: 1.73 [1.25–2.59]; $P < .01$). Similar results were demonstrated also after adjusting for confounding variables (relative risk: 1.61 [1.02–2.57]; $P < .05$). In contrast, after adjusting for initial HOME-SF cognitive scores, families whose HOME-SF cognitive scores improved over the 6-year period demonstrated significantly lower risks of obesity compared with those whose HOME-SF cognitive scores worsened (relative risk, .70 [.52–.93; $P < .05$]).

Comment

The home environment is a critical factor in the development of childhood obesity. We have documented prospectively a greater than twofold increased risk of developing obesity in children with lower cognitive stimulation compared with those having the highest levels of cognitive stimulation. The increased incidence of obesity remained after correcting for maternal obesity, initial weight-for-height *z*-score, gender, socioeconomic factors, race, and marital status. The increased risk of childhood obesity associated with lower cognitive stimulation was demonstrated consistently among single mothers and minorities as well as those with the lowest income and education. This finding is particularly important because minority children and children with lower SES generally have the poorest home environment and the highest levels of obesity. Although a similar trend was observed in children of nonworking parents, highly educated families and professional, working parents, this did not achieve statistical significance. Our findings support the work of Sϕrensen and colleagues who also demonstrated a 2.2-fold increased incidence of childhood obesity in children living in dilapidated living conditions, independent of parental education and occupation.[3]

The findings of similarly increased risks of obesity in children raised in environments with low and moderate cognitive stimulation suggest that a threshold effect exists in the relationship between cognitive stimulation and childhood obesity; the risk of childhood obesity is decreased only in highly stimulating environments. We hypothesize that children raised in stimulating/interactive home environments are more likely to engage in regular physical activity and less likely to engage in sedentary activities (eg, television viewing). However, an increased amount of television viewing in itself does not account for the increased risk of obesity that we observed; children with the highest HOME cognitive scores had significantly lower rates of obesity even after controlling for the amount of television viewing. Instead, increased television viewing most likely serves as an indicator of overall low levels of physical activity in children with low levels of cognitive stimulation.

Maternal obesity was also a significant factor predicting the development of obesity during middle childhood in this study. Garn and colleagues have demonstrated previously that children whose family members are obese are four times more likely to be obese themselves than children whose family members are lean. Locard and colleagues[20] have reported a threefold increase in childhood obesity when either parent is overweight. Similarly, Whitaker et al[21] have also reported that parental obesity increased the risk of childhood obesity by twofold to threefold at all ages. The influence of parental obesity on childhood obesity most likely results from a mixture of genetic and environmental influences. Children as young as 3- to 5-years old already demonstrate increased preferences for high fat foods if their parents are obese.[22] In addition, children of obese parents also demonstrate decreased physical activity.[23,24]

We observed a significant inverse relationship between the development of obesity and markers of SES such as family income level, occupational status, and maternal education. Lower SES may be related to increased risks of obesity because of its relationship to decreased physical activity in children.[25,26] In addition, lower SES may also be related to childhood obesity because of less healthy eating patterns. Although Popkin et al[27] did not demonstrate significant dietary differences among racial and socioeconomic groups, this study did not account for under-reporting bias that may occur in adults of lower SES.[28] Other studies indicate that adolescents and children of lower SES are less likely to eat fruits and vegetables,[29–31] and more likely to eat foods higher in total fat and saturated fat.[31] Finally, lower SES may influence the development of childhood obesity through its association with a poorer home environment.[32]

We have documented a >86% increased incidence of obesity in black children compared with white children over a 6-year period. Although national nutritional surveys have demonstrated the highest prevalence of childhood obesity among Hispanic individuals, rates of obesity have increased most significantly over the last decade among black children.[33–35] Increased risks of obesity were also observed in single mother families. However, no relationship was observed between race, maternal education, parental occupation, or marital status and the incidence of obesity in a multivariate regression

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model that included socioeconomic variables, demographic variables, and HOME scores. This suggests that the increased risks of obesity in black families with single mothers, poorly educated families, and nonprofessional families may be mediated through either low family income or low HOME cognitive scores, both of which are common among these groups.

An important negative finding of our study is that we did not observe any association between family emotional support and the development of childhood obesity. Children who became obese were equally likely to be hugged, kissed, or spanked as children who did not develop obesity. These results suggest that previous studies that have related neglect to childhood obesity may have been confounded by the effects of low income and low levels of cognitive stimulation. Our study supports the work by Kinston and colleagues who have failed also to demonstrate significant family emotional impairment associated with childhood obesity, although subtle changes in family interaction are detectable.[36,37] Unfortunately, standardized evaluation of the emotional relationships within families may not distinguish between parents who are positive and supportive toward their children and those who are over-enmeshed with their children.

Our study has ramifications for the prevention of childhood obesity. A recent study by Whitaker and colleagues[21] suggests that by 3 to 9 years of age, obese children demonstrate a fivefold to ninefold increased likelihood of remaining obese into adulthood. Unfortunately, previous studies that have focused on school-based interventions in older children show minimal changes in weight or BMI.[38] The most comprehensive school based program was the Child and Adolescent Trial for Cardiovascular Health that was a multicenter study involving ~5000 students. Intervention schools received standardized training of the physical activity teachers, food preparation courses, and nutrition classes and assignments involving both the children and their parents. Control schools did not receive the intervention. At the 3-year follow-up, no significant differences were observed in the weight of the students, skin folds, BMI, cholesterol, or blood pressure between the intervention schools and the control schools.[39,40]

We suggest that future public health initiatives explore whether targeting changes in the home environment can affect the development of childhood obesity, particularly among younger, lower SES children. Data from the Pediatric Nutritional Surveillance System indicate that the prevalence of obesity continues to increase in low-income preschool children among all ethnic groups.[35] Work by Hamilton,[41] Johnson et al,[42] Slater,[43] and Metzl[44] have all documented that parental education programs are effective in improving the home environment, particularly among lower income families. Garrett and colleagues have also demonstrated that the greatest responsiveness in the quality of the home environment occurs among the poorest households.[45] In addition, targeting changes in the home environment can have additional benefits besides decreasing the prevalence of childhood obesity; improved childhood social and intellectual development may occur also.[44,46]

We have used the HOME-SF to assess cognitive stimulation and emotional support. Although the quality of the home environment is correlated with SES, modeling data from Garrett et al suggest that the HOME-SF is not simply another measure of demographic characteristics or SES.[47] Menaghan and colleagues have demonstrated that the personal resources that a mother brings to child rearing, such as her self-esteem, values, and occupational experience, are also reflected in the HOME-SF score.[18] It has been argued that SES exerts its influence on social and intellectual development by diminishing the capacity for supportive and consistent parenting.[48] Similarly, using data from the NLSY study, Garrett et al have demonstrated that demographic and socioeconomic variables mediate their influence on childhood development through influences on the home environment.[47] In our study, we found a significant relationship between measures of SES, such as family income, maternal education, and parental occupation and the subsequent development of obesity. However, the HOME-SF cognitive score remained a significant predictor of childhood obesity after either controlling for or stratifying for socioeconomic and demographic variables. Therefore, increased obesity in children with low or medium HOME scores is not simply a reflection of lower SES.

A limitation of our study is the lack of weights and heights of the the biological fathers of the children; however, this is unlikely to affect the conclusions of our study because studies of obese women indicate that parental adiposity has minimal effect on the family environment.[49] In addition, the lack of data on paternal education is unlikely to alter the study results because other measures of SES such as income and occupation are available from the fathers. Finally, the relatively low number of children who developed obesity in the higher socioeconomic groups (professional parents, highly educated mothers, and high income families) did not provide enough power to assess smaller effects of the home environment on the development of childhood obesity in these groups. Therefore, it is not possible to make any definitive conclusions about the role of the home environment on the development of childhood obesity in higher socioeconomic groups.

CONCLUSION

In summary, our results indicate that children raised in environments with high levels of cognitive stimulation have the lowest rates of developing obesity independent of socioeconomic factors, race, maternal marital status, or maternal BMI. Socioeconomic factors and parental obesity are also important to the development of childhood obesity but are less amenable to change. Future efforts to prevent childhood obesity should explore whether parental education programs can decrease the prevalence of obesity by encouraging more stimulating home environments in young children. Hilde Bruch best summarized the importance of the family environment approximately a quarter of a century ago stat-

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APPENDIX. Items Included in the HOME-SF

HOME-SF

Cognitive Items	Emotional Items
Number of cuddle, role playing, and push-pull toys (A)	Mother kept child in view during interview (A)
Frequency mother takes child to grocery (A)	Frequency mother talks to child while working (A)
Parent provided toys or activities during interview (A)	Mother kissed, hugged, or caressed child at least once (A,B)
Frequency child gets out of house (A,B)	Mother spanked child or physically restricted child (A,B)
Play environment safe (A,B,C)	Mother conversed pleasantly with child (A,B,C)
Number of books child owns (A,B,C)	Frequency child spanked in last week (A,B,C)
Frequency of reading stories to child (A,B,C)	Frequency of eating with both mother and father (A,B,C)
Family member helps child with shapes, sizes, letters, Colors, numbers (B).	Mother responded to child's questions, requests (A,B,C)
Home has record player or tape recorder and at least five Children's record's or tapes (B)	Amount of choice child has in choosing food (B)
All visible rooms were reasonably clean (B,C)	Number of hours per day TV is on (B)
All visible rooms were minimally cluttered (B,C)	Mother's voice conveyed positive feelings about child (B,C)
Home interior was not dark or perceptually monotonous (B,C)	Frequency child sees friends or relatives (C)
Family receives magazines or newspaper regularly (B,C)	Amount of time child spends with father (C)
Frequency of taking child to museum (B,C)	Parents response to temper tantrum (talking, grounding, Spanking, etc) (C)
Frequency of taking child to shows or performances (C)	Does child make bed, bathe by self, clean up after self, do Chores (C)
Musical instrument at home (C)	Mother encouraged child verbal contributions (C)
Child gets lessons (C)	
Family encourages hobbies for child (C)	
Frequency that child reads for pleasure (C)	

A: Age 0 – 3 years B: Age: 3 – 6 years C: Age: 6 – 8 years

ing: "To understand the obese child, one needs to remember that he accumulated his extra weight while living in a family that, wittingly or unwittingly, encouraged overeating and inactivity."[1]

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