

Changes in Body Mass Index Associated With Head Start Participation

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abstract

OBJECTIVES: The goal of this study was to determine if Head Start participation is associated with healthy changes in BMI.

METHODS: The sample included children participating in Head Start between 2005 and 2013 and children from 2 comparison groups drawn from a Michigan primary care health system: 5405 receiving Medicaid and 19 320 not receiving Medicaid. Change in BMI z score from the beginning to the end of each of 2 academic years and the intervening summer was compared between groups by using piecewise linear mixed models adjusted for age, gender, and race/ethnicity.

RESULTS: The total sample included 43 748 children providing 83 239 anthropometric measures. The Head Start sample was 64.9% white, 10.8% black, and 14.4% Hispanic; 16.8% of the children were obese and 16.6% were overweight at the initial observation. Children who entered Head Start as obese exhibited a greater decline in the BMI z score during the first academic year versus the comparison groups ($\beta = -0.70$ [SE: 0.05] vs -0.07 [0.08] in the Medicaid group [$P < .001$] and -0.15 [SE: 0.05] in the Not Medicaid group [$P < .001$]); patterns were similar for overweight children. Head Start participants were less obese, less overweight, and less underweight at follow-up than children in the comparison groups.

CONCLUSIONS: Preschool-aged children with an unhealthy weight status who participated in Head Start had a significantly healthier BMI by kindergarten entry age than comparison children in a primary care health system (both those receiving and those not receiving Medicaid).



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Dr Lumeng conceptualized and designed the study and drafted the initial manuscript; Dr Kaciroti conceptualized and designed the study, conducted the analyses, and reviewed and revised the manuscript; Ms Sturza conducted the analyses and reviewed and revised the manuscript; Ms Krusky coordinated and supervised data collection and critically reviewed the manuscript; Drs Miller, Peterson, Lipton, and Reischl conceptualized and designed the study and critically reviewed the manuscript; and all authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: Head Start, a federally funded preschool program for low-income US children, has been reported to have beneficial effects on developmental outcomes. The association of Head Start participation with changes in children's BMI has not been examined.

WHAT THIS STUDY ADDS: Preschool-aged children with an unhealthy weight status who participated in Head Start had a significantly healthier BMI by kindergarten entry age than comparison children in a primary care health system (both those receiving and those not receiving Medicaid).

National data indicate that 22.8% of preschool-aged children are overweight or obese,¹ with higher rates among lower socioeconomic groups.² One in 4 US children aged <6 years lives in poverty (defined as <100% of the federal poverty line).³ Childhood overweight tracks into adulthood,⁴ and preventive interventions are needed.

Head Start is a federally funded preschool program that is free to 3- to 5-year-old US children living in poverty. The prevalence of obesity within Head Start programs is higher than national estimates.⁵⁻⁸ Head Start program regulations mandate nutritional and health services, adequate time and space for active play, and parental involvement.⁹ Given its expansive reach (42% of preschoolers in poverty¹⁰), Head Start could be an important setting for obesity intervention and prevention.

Although federal Head Start regulations mandate that programs monitor children's height and weight,⁹ there is no centralized national data bank of these measures. One previous study has shown healthy changes in BMI during the academic year at Head Start, but the study sample was limited to a single Head Start program, and there was no comparison group.¹¹ The present study analyzed changes in children's BMI within 12 Head Start agencies in Michigan compared with BMI change in 2 age-matched samples drawn from a primary care health care system.

METHODS

Participants

We invited all 51 Head Start programs in Michigan to participate, and 12 (23.5%) agreed. The participating agencies serve rural and urban communities. Head Start agencies have latitude in determining which risk factors give a child priority for enrollment, but the key federally

defined eligibility criterion is a family income <100% of the federal poverty line.¹² Head Start agencies provided anthropometric data collected between February 1, 2005, and August 1, 2013. For the 2 comparison groups, data were obtained from children who attended at least 1 primary care clinic visit within the University of Michigan Health System in the matched time interval and age range. These children were categorized into 2 groups: children insured by Medicaid and children not insured by Medicaid ("Not Medicaid"). No children were excluded a priori. The study was approved by the University of Michigan institutional review board.

Measures

Parent-reported demographic data (child birth date, gender, and race/ethnicity) were obtained from program/health records. Receipt of Medicaid was indicated in the electronic health record. Head Start agencies provided anthropometric data for 1 to 5 academic years. For the 2 health system comparison groups, weight and height measures were obtained from the electronic health record. BMI was calculated, and BMI percentiles and z scores were derived by using age- and gender-specific norms from the Centers for Disease Control and Prevention (CDC) growth charts. According to the CDC's definitions, obese was defined as a BMI \geq 95th percentile, overweight as a BMI \geq 85th percentile but <95th percentile, healthy weight as a BMI \geq fifth percentile but <85th percentile, and underweight as a BMI <fifth percentile.

The study included all anthropometric measures obtained between ages 28.0 and 69.0 months taken within the first and second academic years and the summer between those 2 years (with a 0.5-month buffer on either side). From a total of 89 482 data points for

45 385 children, we excluded 0.03% with missing gender, 0.06% with missing weight, and 0.14% with missing height. The CDC cutoffs¹³ for extreme weight-for-age (WAZ), height-for-age (HAZ), weight-for-height, and BMI-for-age (BMIz) z scores were applied to remove biologically implausible values, resulting in the exclusion of an additional 2.01% of values. Longitudinal cleaning criteria were also applied. Because there are currently no standard longitudinal cleaning criteria for children's anthropometric data, we examined the distributions of change in these measures over time within this sample and considered those changes that were >2 SDs from the sample distribution to be outliers. In this sample, values meeting the following criteria were therefore excluded: change in WAZ, HAZ, or BMIz of >1.5 SD units (based on CDC charts) per month; change in weight of >2.5 kg per month; loss in height of >5 cm over any time period or gain in height of >5 cm per month; or change in BMI of >2.5 kg/m² per month, which resulted in the exclusion of an additional 4.00% of values. The mean number of BMI measures per child was 1.90 (SD: 1.12; range: 1-9). As a data quality assessment, we checked the assumption of constant variance in WAZ, HAZ, and BMIz overall and according to measurement site (ie, Head Start, health system); all SD units were between 0.97 and 1.19, which are within acceptable limits.^{14,15} In summary, the Head Start programs provided BMI data for 20 416 children, of whom 6.82% were excluded, resulting in a final sample size of 19 023 children in Head Start. The health system provided BMI data for 24 969 children, of whom 0.98% were excluded, resulting in a final sample size of 24 725 children. The sample of children included in the analysis versus the sample excluded due to implausible values was more likely

to be female ($P < .05$) and white ($P < .0001$) but did not differ with regard to age.

Statistical Analysis

Piecewise linear mixed models were used to compare changes in BMIz during the time frame when the child was participating in Head Start (September 1–May 15) versus the time frame when the child was not participating in Head Start (May 16–August 31). Thus, we allowed for 3 potential different slopes corresponding to each of the 3 treatment periods: (1) the first academic year (September 1–May 15); (2) the summer break (not enrolled in Head Start; May 16–August 31); and (3) the second Head Start academic year (September 1–May 15). Repeated measures analysis was performed by using mixed models with random intercepts and slopes to account for clustering of children nested in the same centers. In addition, a repeated statement was used specifying a Gaussian serial correlation structure between repeated BMIz measures for the same child over the study period. The Bayesian information criterion was used to obtain the optimal correlation structure for the random effects. The study included a priori covariates known to have an association with weight status, including child gender (male versus female), child age at enrollment, and child race/ethnicity (non-Hispanic white versus not). Similar models were fitted for each of the 2 comparison groups (Medicaid and Not Medicaid). In addition, we tested for group differences between slopes in each observation period, differences between intercepts measured at the beginning and end of the observation period, and change in BMIz from the beginning to the end of the observation period. All analyses were stratified according to initial weight status categorized

as obese, overweight, healthy weight, and underweight.

RESULTS

Characteristics of the sample are shown in Table 1. The total sample included 43 748 children providing 83 239 anthropometric measures. The Head Start sample was 64.9% white, 10.8% black, and 14.4% Hispanic; 16.8% of the children were obese and 16.6% were overweight at the initial observation. The primary care health system Medicaid sample was 50.8% white, 33.0% black, and 4.8% Hispanic; 12.3% of the children were obese and 14.9% were overweight at the initial observation. The primary care health system Not Medicaid sample was 71.3% white, 8.2% black, and 2.2% Hispanic; 6.8% of the children were obese and 11.9% were overweight at the initial observation.

Results of the regression analyses are shown in Table 2 and Fig 1. Figure 2 shows the change in BMIz from the beginning to the end of the observation period according to weight status at the beginning of the observation period and according to

group. Children who entered Head Start obese exhibited a statistically significant decline in BMIz over the first academic year ($\beta = -0.70$ [SE: 0.04]), which was greater than that of children in the Medicaid group ($\beta = -0.07$ [SE: 0.08]) and the Not Medicaid group ($\beta = -0.15$ [SE: 0.05]). Children who entered Head Start obese also exhibited a significant decline in BMIz over the subsequent summer ($\beta = -0.31$ [SE: 0.10]), although this finding was not statistically significantly greater than the declines in the comparison groups ($\beta = -0.49$ [SE: 0.23] in the Medicaid group and $\beta = -0.33$ [SE: 0.17] in the Not Medicaid group). There were no significant changes in BMIz during the second academic year among children who began the observation period obese in any group. By the end of the observation period, children who had entered Head Start obese had significantly lower mean \pm SE BMIz (1.66 ± 0.06) than children in either comparison group (2.04 ± 0.08 in the Medicaid group and 1.84 ± 0.05 in the Not Medicaid group). Children who entered Head Start overweight showed a significant decline in BMIz over the first

TABLE 1 Characteristics of the Samples

Characteristic	Head Start	Health Care System		Total
		Medicaid	Not Medicaid	
No. of children	19 023 (43.5)	5405 (12.4)	19 320 (44.2)	43 748
No. of BMI observations	47 811 (57.4)	8021 (9.6)	27 407 (32.9)	83 239
Age at enrollment, y	3.75 \pm 0.55	3.23 \pm 0.86	3.31 \pm 0.88	3.49 \pm 0.79
Child gender ^a				
Male	9569 (50.3)	2790 (51.6)	9946 (51.5)	22 305 (51.0)
Female	9454 (49.7)	2615 (48.4)	9374 (48.5)	21 443 (49.0)
Race/ethnicity ^a				
White, non-Hispanic	12 354 (64.9)	2744 (50.8)	13 780 (71.3)	28 878 (66.0)
Black, non-Hispanic	2054 (10.8)	1781 (33.0)	1578 (8.2)	5413 (12.4)
Other, non-Hispanic	1885 (9.9)	621 (11.5)	3527 (18.3)	6033 (13.8)
Hispanic, any race	2730 (14.4)	259 (4.8)	435 (2.2)	3424 (7.8)
Weight status at beginning of observation period ^a				
Obese	3189 (16.8)	663 (12.3)	1314 (6.8)	5166 (11.8)
Overweight	3168 (16.6)	804 (14.9)	2305 (11.9)	6277 (14.4)
Healthy	11 864 (62.4)	3654 (67.6)	14 593 (75.5)	30 111 (68.8)
Underweight	802 (4.2)	284 (5.2)	1108 (5.7)	2194 (5.0)
BMIz at beginning of observation period	0.54 \pm 1.21	0.37 \pm 1.17	0.14 \pm 1.08	0.34 \pm 1.16

Data are presented as *n* (%) or mean \pm SD.

^a Number (%) of participants.

TABLE 2 Means and SEs for BMz Among Children in the Head Start and Comparison Groups, Stratified According to Weight Status at the Start of the Observation Period

Initial Weight Status	Starting BMz	Rate of Change in BMz (per year)			Ending BMz
		1st Academic Year	Summer	2nd Academic Year	
Obese					
Head Start	2.34 ^a (0.02)***	-0.70 ^{a,e} (0.04)***	-0.31 ^{a,f} (0.10)**	-0.13 ^{a,f} (0.07)	1.66 ^a (0.06)***
Medicaid	2.23 ^b (0.03)***	-0.07 ^{b,e} (0.08)	-0.49 ^{a,e} (0.23)*	0.00 ^{a,e} (0.15)	2.04 ^b (0.08)***
Not Medicaid	2.17 ^b (0.02)***	-0.15 ^{b,e} (0.05)**	-0.33 ^{a,e} (0.17)	-0.18 ^{a,e} (0.10)	1.84 ^c (0.05)***
Overweight					
Head Start	1.35 ^a (0.01)***	-0.36 ^{a,e} (0.03)***	0.17 ^{a,f} (0.08)*	-0.09 ^{a,g} (0.05)	1.08 ^a (0.04)***
Medicaid	1.33 ^a (0.01)***	-0.04 ^{b,e} (0.04)	-0.20 ^{b,e} (0.14)	0.10 ^{a,b,e} (0.12)	1.31 ^b (0.07)***
Not Medicaid	1.32 ^a (0.01)***	-0.03 ^{b,e} (0.02)	-0.36 ^{b,f} (0.09)***	0.15 ^{b,g} (0.07)*	1.30 ^b (0.04)***
Healthy weight					
Head Start	0.03 ^a (0.01)**	0.18 ^{a,e} (0.02)***	0.08 ^{a,f} (0.05)	0.06 ^{a,f} (0.03)	0.22 ^a (0.03)***
Medicaid	-0.05 ^b (0.02)*	0.16 ^{a,e,f} (0.04)***	0.43 ^{b,e} (0.12)***	0.08 ^{a,b,f} (0.07)	0.25 ^a (0.03)***
Not Medicaid	-0.13 ^c (0.01)***	0.17 ^{a,e} (0.02)***	0.09 ^{a,e} (0.06)	0.19 ^{b,e} (0.03)***	0.15 ^b (0.01)***
Underweight					
Head Start	-2.41 ^a (0.05)***	1.72 ^{a,e} (0.11)***	0.44 ^{a,f} (0.31)	0.10 ^{a,f} (0.19)	-1.00 ^a (0.12)***
Medicaid	-2.33 ^b (0.08)***	0.42 ^{b,e} (0.19)*	3.54 ^{b,f} (0.53)***	-0.47 ^{a,g} (0.35)	-1.32 ^{a,b} (0.19)***
Not Medicaid	-2.29 ^b (0.04)***	0.42 ^{b,e} (0.09)***	1.80 ^{c,f} (0.25)***	-0.02 ^{a,g} (0.15)	-1.48 ^b (0.08)***

All analyses adjusted for age at start of observation period, child gender, and child race/ethnicity. Superscripts a, b, and c that differ from one another denote significant differences between Head Start, Medicaid, and Not Medicaid within each weight status group within the given observation period. Superscripts e, f, and g that differ from one another denote significant differences across observation periods within the given group (Head Start, Medicaid, and Not Medicaid) within the given weight status group. *** $P < .001$, ** $P < .01$, * $P < .05$.

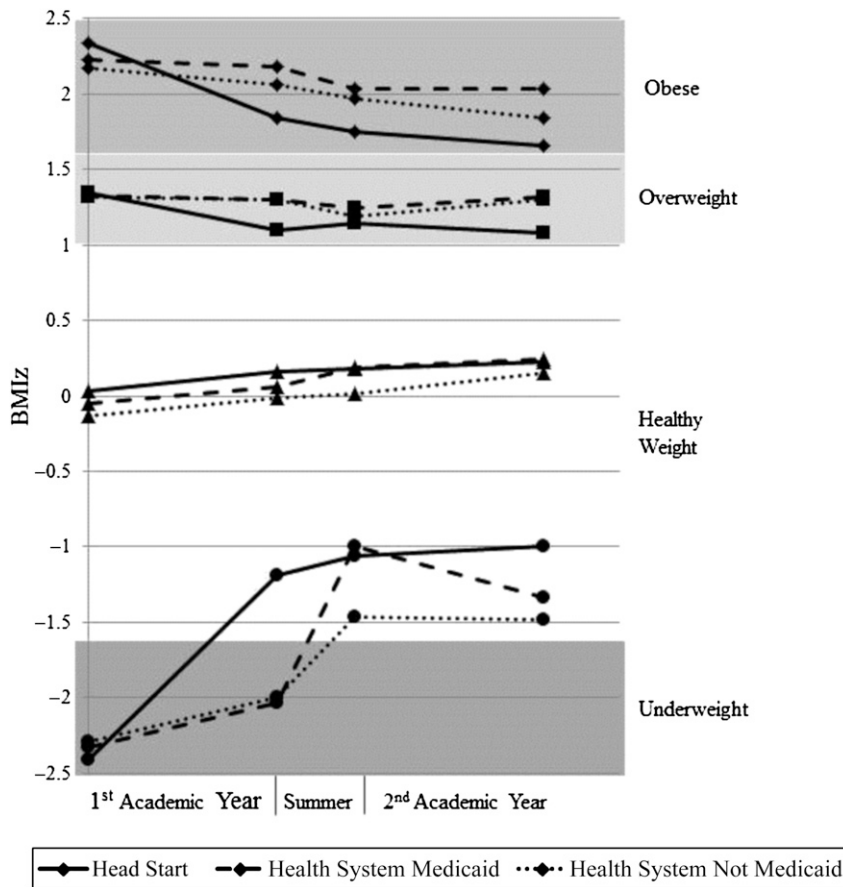


FIGURE 1 Change in BMz across time among children in Head Start and comparison groups, stratified according to initial weight status. Adjusted for age, gender, and race/ethnicity.

academic year ($\beta = -0.36$ [SE: 0.03]), which was greater than that of children in the Medicaid group ($\beta = -0.04$ [SE: 0.04]) and the Not Medicaid group ($\beta = -0.03$ [SE: 0.02]), neither of which showed a significant change. Children who entered Head Start overweight experienced a significant upward rebound of BMz over the summer ($\beta = 0.17$ [SE: 0.08]), which was significantly greater than changes in the comparison groups ($\beta = -0.20$ [SE: 0.14] in the Medicaid group and $\beta = -0.36$ [SE: 0.09] in the Not Medicaid group). There was no significant change in BMz during the second academic year among children who began the observation period overweight in the Head Start or Medicaid groups, but there was a significant increase in BMz in the Not Medicaid group, which differed from the Head Start group. By the end of the observation period, children who had entered Head Start overweight had a significantly lower mean BMz (1.08 [SE: 0.04]) than children in either comparison group (1.31 [SE: 0.07] in the Medicaid group and 1.30 [SE: 0.04] in the Not Medicaid group).

Children who entered Head Start at a healthy weight exhibited

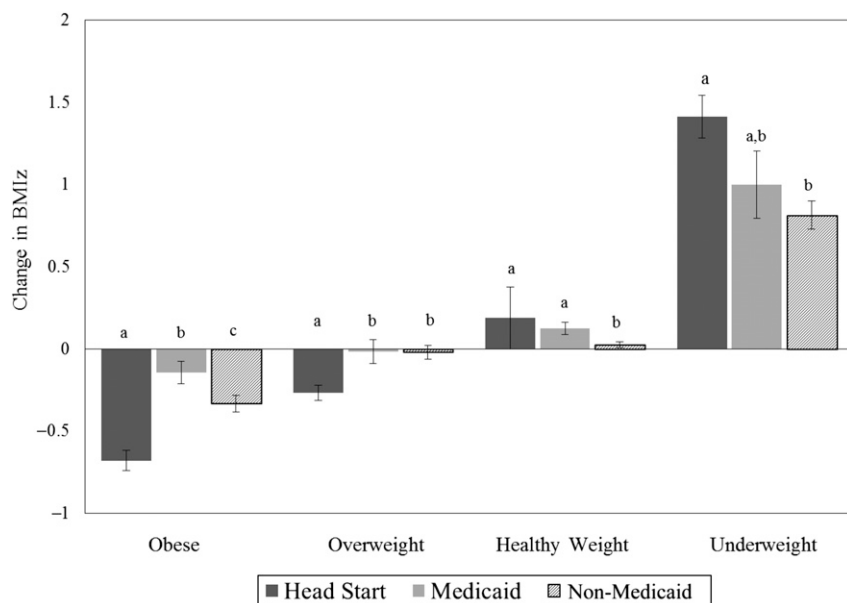


FIGURE 2 Change in BMIz from the beginning to the end of the observation period according to initial weight status and group. The letters above each bar that differ indicate statistically significant differences between groups within the given weight status.

a significant increase in BMIz over the first academic year ($\beta = 0.18$ [SE: 0.02]), which did not differ from the significant increases in the comparison groups. During the subsequent summer, children who entered Head Start at a healthy weight showed no significant change in BMIz, which was similar to the Not Medicaid group but differed from the Medicaid group, which experienced a significant increase in BMIz during the summer. There was no significant change in BMIz during the second academic year among children who began the observation period at a healthy weight in the Head Start or Medicaid groups, but there was a significant increase in BMIz in the Not Medicaid group, which differed from the Head Start group. By the end of the observation period, children who had entered Head Start at a healthy weight had a mean BMIz (0.22 [SE: 0.03]) that was similar to that of children in the Medicaid group (0.25 [SE: 0.03]) but greater than that of children in the Not Medicaid group (0.15 [SE: 0.01]).

Children who entered Head Start underweight exhibited a significant

increase in BMIz during the first academic year ($\beta = 1.72$ [SE: 0.11]) that was greater than the significant increases in both comparison groups ($\beta = 0.42$ [SE: 0.19] in the Medicaid group and $\beta = 0.42$ [SE: 0.09] in the Not Medicaid group). Children who began the observation period underweight and participated in Head Start showed no change over the summer, whereas children in both comparison groups exhibited significant increases. During the second academic year, there was no significant change in any of the 3 groups. By the end of the observation period, children who had entered Head Start underweight had a mean BMIz (-1.00 [SE: 0.12]) that was no different from that of children in the Medicaid group (-1.32 [SE: 0.19]) and greater than that of children in the Not Medicaid group (-1.48 [SE: 0.08]).

To examine the potential effects of differential attrition across groups, we repeated the analyses, restricting the sample to only those participants with at least 2 BMI measures >100 days apart. The proportions of children meeting these criteria were 67.1%, 41.7%, and 40.1% in the Head Start,

Medicaid, and Not Medicaid groups, respectively. The results for the children who were initially obese, overweight, or a healthy weight were essentially unchanged in the analysis of the restricted sample. However, the models for initially underweight children in the Head Start group did not converge.

DISCUSSION

Children who entered Head Start obese or overweight experienced a greater decline in BMIz over an academic year compared with each of the 2 comparison groups. In addition, children who entered Head Start underweight experienced a greater increase in BMIz compared with each of the 2 comparison groups. Children entering Head Start obese, overweight, or underweight all showed either maintenance of or ongoing improvement in the BMIz changes made during the first academic year of enrollment. During the second academic year of enrollment, changes were maintained, but there were no additional significant changes in BMIz in the Head Start group. Even though children in the Head Start group began the observation period more obese, equally overweight, and more underweight than children in the comparison groups, at the end of the observation period the initially obese and overweight Head Start children were substantially less obese and overweight than the children in the comparison groups. In addition, the initially underweight children were substantially less underweight than children in the Not Medicaid group. To our knowledge, this study is the first to document associations of Head Start participation with changes in children's BMIz in a sample including more than a single Head Start program, while also including multiple comparison groups.

Head Start may exert beneficial effects on BMI through several mechanisms. The federally regulated quality of meals and snacks provided at

Head Start⁹ may be higher than that in many eligible children's homes or in other child care facilities that do not have to meet federal meal standards. Head Start nutrition guidelines are consistent with the recommendations of the Academy of Nutrition and Dietetics.¹⁶ Head Start programs are also required to adhere to the federal Child and Adult Care Food Program guidelines,¹⁷ which mandate a certain amount of fruits and vegetables at each meal and restrict sugar-sweetened beverages, each of which are recommended strategies for obesity prevention and treatment.¹⁸⁻²¹ Head Start programs self-report exceeding both federal performance standards and Child and Adult Care Food Program guidelines (eg, of 1583 programs, 97% serve a vegetable every day other than French fries, tater tots, or hash browns and 94% serve some fruit every day other than juice).²² Head Start regulations emphasize exercise and the development of gross motor skills,⁹ and children's preschool environments strongly predict physical activity levels more than demographic characteristics.²³ Head Start regulations also prohibit television viewing,⁹ a risk factor for preschool overweight,²⁴ and require that programs facilitate children's access to a continuous source of pediatric health care, which may contribute to a reduction in obesity risk. Head Start participation is associated with improvement in children's ability to cope with stress and reductions in behavior problems,²⁵ and psychosocial stress and poor behavioral self-regulation are each associated with obesity risk.^{26,27} Finally, by providing free child care, Head Start may allow families to allocate their limited financial resources to purchasing healthier food.

There are several limitations to our study. The ideal design would be a randomized controlled trial in which low-income children were randomized to participate in Head Start versus not participate, but given the currently accepted benefits of

early childhood education, such a design would not be ethical or feasible. Our analysis was limited to data from a single state, and it is unknown whether the results would be generalizable to children from other states. Only a subset (23.5%) of Head Start programs in Michigan agreed to participate, and this subset may have had a greater focus on nutrition, physical activity, and obesity than the subset that declined participation. We did not have children's attendance data, although all children in the analytic sample attended at least 85% of program days. The comparison groups were drawn from a single health system in southeastern Michigan, and some children in the health care system enrolled in Medicaid may also have been participating in Head Start. However, the fact that some children in the comparison group enrolled in Medicaid may also have been participating in Head Start provides a stronger test because it would be expected to weaken any observed differences between groups. Finally, anthropometric measurements were performed by Head Start or clinical practitioners, but we found that the percent excluded was small, and the quality of data comparable with similar studies.^{14,15}

The results of the present study should be interpreted with several caveats. First, although differential attrition did not alter the findings among children who were initially obese, overweight, or a healthy weight, differential attrition led to instability of the models for initially underweight children in the Head Start group. Therefore, conclusions regarding associations of Head Start participation with improvements in BMI among underweight children should be made with caution. Second, this study did not compare impoverished children participating in Head Start with impoverished children not participating in Head Start. Rather, the study compared children participating in Head Start (the majority of whom are

impoverished) with a group of impoverished children whose child care, preschool, or Head Start participation is unknown. Third, children in the comparison groups drawn from the health care system are a select group; that is, children not regularly accessing the health care system are not included. Furthermore, children in the health care system groups, compared with the Head Start group, were less likely to have 2 BMI measures at least 100 days apart, suggesting that the comparison groups may not be frequent health care users.

CONCLUSIONS

Head Start participation was associated with robust, early, and sustained beneficial effects on children's BMI such that by the age of entry to kindergarten, children participating in Head Start had significantly healthier BMIs than children enrolled in Medicaid in general and children not enrolled in Medicaid. Head Start is associated with improved social and educational outcomes for low-income children.²⁸ Healthy changes in BMI may be an additional benefit of Head Start participation.

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