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The impact of a healthy weight intervention embedded in a home-visiting program on children's weight and mothers' feeding practices

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Abstract

Objective: To examine whether a healthy weight intervention embedded in the Parents as Teachers (PAT) home visiting program, previously found to improve mothers' BMI and obesity-related behaviors, changed the BMI of preschool children or feeding practices used by the mothers.

Methods: This stratified randomized trial included preschool-age children at risk of overweight whose mothers were overweight or had obesity (N=179). The Healthy Eating & Active Living Taught at Home (HEALTH) intervention was based on the Diabetes Prevention Program. Differences were examined using repeated-measures mixed analysis of variance models.

Results: Compared to PAT usual care, HEALTH intervention had no effect on children's BMI or mothers' feeding practices. However, combined analyses showed that children's BMI percentile decreased, BMI z-scores maintained, and three of eight feeding practices improved over time.

Conclusions and Implications: Additional research is needed to assess the effectiveness of PAT to prevent preschool-age obesity using rigorous designs (e.g., group-randomized trials) and to identify its active components. HEALTH is ready to be scaled-up for prevention of maternal weight gain through embedding within the national PAT program.

Keywords

obesity; preschool children; home-based intervention; mother-child dyad

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Potential conflicts of interest

The authors have no conflicts of interest to report.

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INTRODUCTION

Obesity in early childhood is a serious, largely preventable public health problem, which tracks into adulthood, is associated with several childhood and adulthood morbidities including diabetes, and is difficult to reverse as children grow older.¹ Children's dietary preferences and habits become established early (i.e., in utero and during early childhood),² making this formative period crucial for prevention of obesity. Parents and other caregivers play a critical role in shaping children's risk of obesity by selecting the foods that are available to the child, utilizing appropriate feeding practices, and role-modeling eating behaviors.^{2,3} Parental weight status is also an important risk factor for development and severity of obesity in their children.^{4,5} There is increasing recognition of the importance of parental participation in weight-related interventions for children, and the degree of their involvement is positively associated with intervention effectiveness.^{6,7} In addition, the importance of a healthy family home environment in early childhood for prevention of excessive weight gain is well established, but not consistently targeted in interventions to prevent obesity in young children.^{8,9}

When intervening with preschool-age children, targeting mothers as part of an intervention may have the additional benefit of addressing weight gained during pregnancy and potentially disrupting the intergenerational transfer of obesity.¹⁰ However, only a small proportion of mother-targeted interventions with preschool-age children assesses the effect on mothers' eating or physical activity, and even fewer assess mothers' weight.¹¹ This makes it difficult to determine whether interventions targeting mothers and their preschool children result in effects for both groups, rather than just the primary target. Though research with other caregivers is necessary and sparse,¹² this study focuses on mothers due to their increased obesity risk and primary caregiving role during early childhood.^{2,10}

The Healthy Eating & Active Living Taught at Home (HEALTH) study was a five-year project that adapted and embedded the Diabetes Prevention Program (DPP)¹³ within the St. Louis Parents as Teachers (PAT) child development home visiting program. The primary aim was achieving and maintaining weight loss among mothers who were overweight or had obesity and whose child was of preschool-age. The findings from the primary aim were published elsewhere¹⁴ and demonstrate that participating in this intervention made mothers more likely to achieve a 5% weight reduction compared to mothers receiving usual PAT programming. In addition, the intervention improved mothers' waist circumference and physical activity, and reduced mothers' sugar consumption and home soda availability and accessibility.^{14,15}

To understand whether the changes in mothers' weight and behaviors transferred to benefit their preschool-age children, the present study examines the impact of the HEALTH intervention on children's BMI and mothers' feeding practices with their preschool child. It is hypothesized that the HEALTH intervention will result in maintenance or reduction in children's weight status and improvements in mothers' feeding practices.

METHODS

Study design

A stratified randomized pragmatic trial¹⁶ was carried out in partnership with PAT-affiliated programs in eight St. Louis regions. Participants were assigned into the usual care and intervention groups using a process of randomization stratified by region. The study continuously enrolled participants from 2012 to 2014, and they were followed for up to 24 months. The Washington University in St. Louis Institutional Review Board approved the study.

Participants

Preschool-age children (two to four years old at baseline) and their mothers participating in PAT comprised the participants for this study. Child-mother pairs were included if mothers were: 1) able to provide informed consent; 2) were 18–45 years old; 3) were overweight or had obesity (BMI 25–45 kg/m²); 4) had at least one preschool-age child at risk for overweight (BMI percentile ≥ 60%)¹⁷ living in the home; 5) planned to continue in PAT for at least two years; 6) were not pregnant nor planning to become pregnant in the next 24 months; 7) spoke English; and 8) were not currently enrolled in a weight loss program, undergoing treatment for diabetes or eating disorders, or unable to engage in a walking program. Informed consent was obtained from the eligible mothers for themselves and the participating child by study staff at onsite screenings or by telephone during determination of eligibility. For each completed data collection point (i.e., baseline, 12 months, 24 months) the participants received a \$50 gift card. Additional details regarding the recruitment and participation, loss to follow-up, and the intention-to-treat approach are provided elsewhere.¹⁴

Intervention Groups

The mothers and their children randomized to the usual care group received the standard PAT curriculum, which is delivered by parent educators and centered around parent-child communication, child development, and family well-being with the goal of promoting school readiness.¹⁸

The HEALTH intervention is a lifestyle intervention based on the DPP¹³ that is embedded in the standard PAT curriculum, with the goal of promoting maternal-child interaction and maternal role modeling of healthy eating and activity behaviors. The HEALTH intervention focuses on maternal obesity-related behaviors such as: limiting intake of sugar sweetened beverages, substituting fruits and vegetables for high caloric snacks, limiting portion sizes, increasing physical activity by walking 30 minutes per day, and decreasing sedentary activity. Behavior change strategies are guided by the Social Cognitive Theory and address interpersonal, intrapersonal, and home environment factors.¹⁹ The HEALTH intervention does not include additional responsive feeding elements beyond what is provided through the standard PAT curriculum. Additional details about the HEALTH intervention and its implementation are provided elsewhere.¹⁴

Measures

Participants were assessed three times during the study period: at baseline, at 12 months, and at 24 months.

Trained study personnel performed the anthropometric measures at the study site according to NHANES procedures.²⁰ The 2000 CDC growth charts²¹ were used to calculate children's BMI percentiles and z-scores.

Maternal feeding practices were measured using the Preschooler Feeding Questionnaire.^{22,23} Mothers rated 34 items on a 5-point Likert scale, which were then converted into measures of eight feeding constructs: difficulty in child feeding, concern about child overeating or being overweight, pushing the child to eat more, using food to calm the child, concerns about child being underweight, child's control of feeding interactions, structure during feeding interactions, and age-inappropriate feeding.

Surveys carried out with the mothers also assessed sociodemographic measures, including children's and mothers' age, gender, and race; mothers' education, marital status, and participation in government assistance programs; and household annual income.

Statistical analyses

Participant characteristics at baseline were compared using the independent samples t-test (continuous variables), Wilcoxon's test (ordinal variables), and chi-square test (categorical variables).

To examine equality of changes in children's BMI and maternal feeding practices across the three time points between intervention and usual care groups, repeated measures mixed model analysis of variance (RM-ANOVA) with an autoregressive covariance structure was used. The RM-ANOVA model included the effects for treatment group, time point, and the interaction between treatment and time point. Statistical contrasts within the models tested whether changes between baseline and 24 months in the usual care group were equal to corresponding changes in the intervention group. In addition, where the interaction between time and treatment group was not statistically significant, RM-ANOVA models with time point as the main effect variable and treatment group as a covariate were used, and changes between baseline and 24 months in the combined group were examined.

Additionally, to examine whether there were differences in changes between children's weight status categories (less than 60th percentile, 60–74.9th percentile, 75–84.9th percentile, 85–94.9th percentile, 95th percentile or higher) over time, generalized estimating equations with a multinomial distribution, cumulative logit link function, and independent correlation structure were used. The analytic model was similar to the one described for RM-ANOVA above.

Analyses were conducted using the Statistical Analysis Systems (SAS) version 9.4 (SAS Institute, Cary, NC, USA; 2014).

RESULTS

Two-hundred and thirty participants completed the baseline assessment, and 179 (78%) of these completed at least one follow-up measure and thus were included in analyses. The intervention (n=97) and usual care (n=82) groups were similar at baseline on most characteristics except for mother's education level (Table 1). Mothers of children in the usual care group had a higher level of education than mothers of children in the intervention group. Children participating in this study were on average 3.4 years old, 45% female, with average BMI percentile of 81.5. They were predominantly White (57%) or African American (33%) and of diverse income levels. Their mothers' average age and BMI were 32 years and 34.4 kg/m², respectively, and the majority of the children's mothers were married (61%) and received help from WIC or other programs (51%).

There were no differences between the intervention and usual care groups in change over time in child BMI percentile and z-scores. Additionally, there were no differences between groups in the degree that children changed between weight status categories (less than 60th percentile, 60–74.9th percentile, 75–84.9th percentile, 85–94.9th percentile, 95th percentile or higher) over time (p=0.98). Changes in maternal feeding practices over time also did not differ between the intervention and usual care groups.

As the interaction between time and treatment group was not significant for any outcome, as part of post hoc analyses, the groups were combined and changes over time were examined while controlling for treatment assignment. Children in combined groups experienced a decrease in BMI percentile (–3.62 percentiles) and maintained their BMI z-score between baseline and 24 months of follow-up. Mothers decreased the practice of using food to calm the child and age-inappropriate feeding, and increased the use of structure during feeding between baseline and 24 months. No other feeding practices changed significantly during the follow-up period.

DISCUSSION

This study demonstrates that a healthy weight intervention embedded in a home visiting program, which was previously found to improve mothers' BMI and obesity-related behaviors, did not affect the weight status of their preschool children or feeding practices used by the mothers. Children in both intervention and usual care groups maintained their BMI during the two years of follow-up, despite the study hypothesis that children in the HEALTH group will be more likely to do so than children in the usual care group. Post hoc analyses demonstrated decreases in children's BMI percentile and several feeding practices and no changes in BMI z-scores over time in the combined group exposed to PAT.

The BMI z-score is a better measure of change in weight status in preschool-age children than the BMI percentile.²⁴ The BMI percentile is less able to detect changes at the extremes of the BMI percentile range than in the middle of the age.²⁴ The BMI z-score is more appropriate for measuring changes in adiposity over time, which indicates that the post hoc findings for the combined groups in this study should be interpreted as maintenance of children's BMI over time.

The main findings are largely in line with similar effectiveness studies. Nezami et al. (2017)²⁵ examined a hybrid smartphone and in-person home intervention targeting sugar-sweetened beverage consumption and detected weight loss among participating mothers but not their preschool-age children over six months of follow-up, though both groups reduced their unhealthy beverage intake. Haire-Joshu et al. (2008)²⁶ examined a home visiting intervention delivered through the PAT program and found that among parents, nearly all of whom (98.5%) were mothers, the intervention led to increased fruit intake, improved fruit and vegetable availability in the home, improved fruit and vegetable knowledge, but counter to expectations, decrease in non-coercive feeding practices. Among children, the intervention only improved fruit and vegetable intake among those with normal weight but not among those who were overweight. In a study that included predominantly mothers (85%) but also other caregivers (e.g., grandmothers), Tomayko et al. (2016)²⁷ detected no changes over one year of follow-up in BMI or obesity-related behaviors of caregivers or their children following an obesity prevention intervention that included in-person in-home mentoring, perhaps in part because they used an active comparison group that received newsletters containing the intervention information.

One likely explanation for the absence of intervention effect in this study is the high quality of the standard PAT program that the usual care group received. The maintenance of children's BMI in both groups exposed to PAT observed in this study may indicate that the PAT program already provides some protective effect against obesity to the participating children. The PAT-embedded HEALTH intervention delivered to the intervention group focused primarily on mothers as the main intervention targets, because they are a group at a particularly high risk for weight gain.¹⁰ The rationale for the hypothesized changes in children's weight status was that as the mother changes the family's home eating environment and her own obesity-related behaviors, the child benefits through the improved eating environment and from role-modeling by their mother. The HEALTH intervention topics also included child-focused skills (e.g., serving appropriate child portion sizes, calorie requirements for the child, mealtime routines), but these were building on the solid foundation of skills that the standard PAT provides and which the usual care group received (e.g., developmentally-appropriate feeding skills and routines, general parenting practices, positive social-emotional environment). Participants in both groups also likely benefited from the significant social support provided by PAT.

This may explain why maternal feeding practices^{28,29} did not differ between the groups. The HEALTH intervention did not include additional responsive feeding components. A hypothesis behind testing the effect of the intervention on maternal feeding practices was that as the intervention group mothers received additional elements targeting their own obesity-related behaviors, the responsive feeding elements of the standard PAT program would be enhanced indirectly. However, the post hoc analyses from this study suggests that PAT already improves some feeding practices and that any potential indirect effects of the HEALTH intervention were not sufficiently substantial to manifest as differences between groups in maternal feeding practices.

One limitation of this study was that it was unable to assess dietary or activity behaviors in the children. Given that other studies documented dietary behavior changes in children

following similar interventions,^{25,26} it is possible that the HEALTH intervention resulted in similar changes which may only manifest as changes in weight status as children grow older. Therefore, a longer follow-up window could have been necessary to detect effect on children's weight status. Although an intervention effect on mothers' feeding practices was not found, improvements in the home food environment (e.g., reduced accessibility to soda)¹⁵ and role-modeling of healthy dietary behaviors by the mothers¹⁴ may have led to improvements to children's dietary intake as observed in other studies.^{26,30} In addition, as this study examined a secondary aim of the HEALTH intervention, sample size calculations were not carried for assessing differences in child BMI and feeding practices, which may have resulted in inadequate power for these components of the study. Finally, the intervention did not include explicit content around responsive feeding, which may have limited its impact on children's weight status.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study demonstrates that the success of an intervention to improve mothers' weight and obesity-related behaviors does not necessarily translate to intervention effect on children's weight status. The embedding of the HEALTH intervention with PAT and similar programs can be scaled up to prevent weight gain in mothers of preschool-age children. The role of PAT in preventing obesity and changing obesity-related behaviors should also be explored in future research. Based on this study's post hoc results, it is possible that PAT prevents excessive weight gain in participating children. Upon analysis of effectiveness using more rigorous designs (e.g., group-randomized trials) and identifying key PAT elements responsible for obesity prevention, these elements of the PAT model could be made available as an obesity prevention strategy in communities facing obesity disparities.

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Table 1.Baseline characteristics of participants in the HEALTH study, overall and by treatment group (N=179).^a

Characteristic	Overall (N = 179)		By treatment group				P-value
			Intervention (n =97)		Usual care (n =82)		
	mean or n	SD or %	mean or n	SD or %	mean or n	SD or %	
Child characteristics							
Age, mean (SD), years	3.40	0.79	3.42	0.83	3.38	0.77	0.730 ^b
Female	81	45.3%	38	46.3%	43	44.3%	0.788 ^b
BMI percentile, mean (SD)	81.53	12.54	81.28	12.76	81.75	12.42	0.806 ^b
BMI category ¹⁷							
At risk I, 60–74.9th percentile	66	36.9%	31	37.8%	35	36.1%	0.758 ^d
At risk II, 75–84.9th percentile	33	18.4%	17	20.7%	16	16.5%	
Overweight, 85–94.9th percentile	45	25.1%	17	20.7%	28	28.9%	
Obese, 95th percentile or higher	35	19.6%	17	20.7%	18	18.6%	
Race							
Black or African American	59	33.0%	27	32.9%	32	33.0%	0.341 ^c
White	102	57.0%	47	57.3%	55	56.7%	
Other	13	7.3%	4	4.9%	9	9.3%	
Unknown, not reporting race	5	2.8%	4	4.9%	1	1.0%	
Maternal and household characteristics							
Mother’s age, mean (SD), years	32	6	32	6	33	5	0.91 ^b
Mother’s BMI, mean (SD), kg/m ²	34.4	5.2	34.4	5.3	34.5	5.2	0.91 ^b
Mother’s highest grade of school completed							
Some high school, high school graduate	25	14%	15	19%	10	10%	0.05 ^d
Some college/technical/ vocational school	65	37%	32	40%	33	34%	
College of university graduate	56	31%	22	27%	34	35%	
Graduate or professional school	32	18%	12	15%	20	21%	
Presently married	109	61%	50	61%	59	61%	0.98 ^c
Annual household income from all sources							
Under \$30,000	66	39%	30	40%	36	38%	0.65 ^d
30,000-\$74,999	62	36%	28	37%	34	36%	
75,000- Over \$100,000	42	25%	17	23%	25	26%	
WIC or other program assistance	89	51%	46	58%	43	46%	0.14 ^a

SD, standard deviation; BMI, body mass index.

^aDue to missing data, sample sizes vary across variables. The participants are mothers participating in a St. Louis Parents as Teachers program, who had obesity or were overweight at recruitment, and who had at least one preschool-age child at risk for overweight (BMI percentile ≥ 60%) living in the home.

^bComparison of treatment groups using an independent samples t-test.

^cComparison of treatment groups using a chi-square test for independence.

^dComparison of treatment groups using a Wilcoxon's rank sum test.

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Table 2.Changes in BMI percentile from baseline to 12 and 24 months by treatment group (N=178).^a

Outcome (range)	Adjusted Mean (SE)			Adjusted mean change over time (SE)	P-value, difference between groups in change over time ^b	P-value, change in combined group over time ^c
	Baseline	12 months	24 months			
BMI percentile (7.1–100.0)						
Usual care	81.85 (1.69)	78.57 (1.70)	78.51 (1.75)	−3.34 (1.82)	0.819	
HEALTH intervention	81.28 (1.83)	78.20 (1.84)	77.33 (1.92)	−3.96 (1.98)		
Combined group	81.56 (1.25)	78.37 (1.25)	77.94 (1.29)	−3.62 (1.34)		0.007
BMI z-score (−1.5, 4.1)						
Usual care	1.10 (0.08)	1.06 (0.08)	1.03 (0.08)	−0.08 (0.08)	0.926	
HEALTH intervention	1.10 (0.09)	1.03 (0.09)	1.02 (0.09)	−0.09 (0.09)		
Combined group	1.10 (0.06)	1.04 (0.06)	1.02 (0.06)	−0.08 (0.06)		0.187

SE, standard error; BMI, body mass index.

^aThe participants are mothers participating in a St. Louis Parents as Teachers program, who had obesity or were overweight at recruitment, and who had at least one preschool-age child at risk for overweight (BMI percentile ≥ 60%) living in the home.

^bRepeated measures mixed analysis of variance (RM-ANOVA) models with an autoregressive covariance structure that include: treatment group, time point, and interaction between treatment group and time point. The p-values are for the statistical contrasts within the models testing whether changes between baseline and 24 months in the usual care group were equal to corresponding changes in the intervention group.

^cRM-ANOVA models with an autoregressive covariance structure that include: time point and treatment group. The p-values are for the statistical contrasts within the models testing whether there was a change between baseline and 24 months in the combined group, while adjusting for group assignment.

Table 3.Changes in feeding practices from baseline to 12 and 24 months by treatment group (N=178).^a

Feeding practice (range)	Adjusted Mean (SE)			Adjusted mean change over time (SE)	P-value, difference between groups in change over time ^b	P-value, change in combined group over time ^c
	Baseline	12 months	24 months			
Difficulty in child feeding (0.0–3.5)						
Usual care	1.42 (0.08)	1.56 (0.08)	1.44 (0.08)	0.01 (0.08)	0.299	
HEALTH intervention	1.13 (0.09)	1.14 (0.09)	1.02 (0.09)	−0.11 (0.08)		
Combined group	1.27 (0.06)	1.35 (0.06)	1.23 (0.06)	−0.04 (0.06)		0.465
Concern about child overeating / being overweight (0.0–2.7)						
Usual care	0.65 (0.07)	0.63 (0.07)	0.63 (0.07)	−0.03 (0.07)	0.507	
HEALTH intervention	0.70 (0.08)	0.62 (0.08)	0.61 (0.08)	−0.10 (0.08)		
Combined group	0.67 (0.05)	0.62 (0.05)	0.62 (0.05)	−0.06 (0.05)		0.284
Pushing the child to eat more (0.0–4.0)						
Usual care	1.83 (0.08)	1.87 (0.09)	1.84 (0.09)	0.01 (0.09)	0.855	
HEALTH intervention	1.70 (0.09)	1.76 (0.09)	1.69 (0.10)	−0.01 (0.10)		
Combined group	1.77 (0.06)	1.81 (0.06)	1.77 (0.06)	0.00 (0.07)		0.964
Using food to calm the child (0.0–3.5)						
Usual care	0.83 (0.08)	0.67 (0.08)	0.61 (0.08)	−0.22 (0.10)	0.534	
HEALTH intervention	0.59 (0.09)	0.49 (0.09)	0.46 (0.09)	−0.13 (0.11)		
Combined group	0.72 (0.06)	0.58 (0.06)	0.53 (0.06)	−0.19 (0.07)		0.010
Concern about child being underweight (0.0–4.0)						
Usual care	0.59 (0.09)	0.62 (0.09)	0.53 (0.09)	−0.06 (0.12)	0.250	
HEALTH intervention	0.67 (0.10)	0.60 (0.10)	0.41 (0.10)	−0.25 (0.12)		
Combined group	0.62 (0.07)	0.61 (0.07)	0.48 (0.07)	−0.15 (0.09)		0.088
Control over feeding interactions (0.0–3.3)						
Usual care	1.63 (0.07)	1.58 (0.07)	1.63 (0.08)	−0.00 (0.08)	0.843	
HEALTH intervention	1.33 (0.08)	1.36 (0.08)	1.35 (0.08)	0.02 (0.08)		
Combined group	1.48 (0.05)	1.47 (0.06)	1.49 (0.06)	0.01 (0.06)		0.900
Structure during feeding interactions (1.0–4.0)						
Usual care	2.77 (0.07)	2.88 (0.07)	2.90 (0.07)	0.13 (0.08)	1.000	
HEALTH intervention	2.91 (0.07)	2.97 (0.08)	3.03 (0.08)	0.13 (0.09)		
Combined group	2.84 (0.05)	2.93 (0.05)	2.97 (0.05)	0.12 (0.06)		0.041
Age-inappropriate feeding (0.0–3.5)						
Usual care	1.01 (0.08)	0.89 (0.08)	0.90 (0.09)	−0.11 (0.10)	0.251	
HEALTH intervention	0.91 (0.09)	0.68 (0.09)	0.62 (0.09)	−0.28 (0.11)		
Combined group	0.96 (0.06)	0.79 (0.06)	0.78 (0.06)	−0.18 (0.08)		0.018

SE, standard error.

^aThe participants are mothers participating in a St. Louis Parents as Teachers program, who had obesity or were overweight at recruitment, and who had at least one preschool-age child at risk for overweight (BMI percentile ≥ 60%) living in the home.

^b Repeated measures mixed analysis of variance (RM-ANOVA) models with an autoregressive covariance structure that include: treatment group, time point, and interaction between treatment group and time point. The p-values are for the statistical contrasts within the models testing whether changes between baseline and 24 months in the usual care group were equal to corresponding changes in the intervention group.

^c RM-ANOVA models with an autoregressive covariance structure that include: time point and treatment group. The p-values are for the statistical contrasts within the models testing whether there was a change between baseline and 24 months in the combined group, while adjusting for group assignment.

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