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Demographic Disparities in the Efficacy of a Family-based Treatment Program for Pediatric Obesity

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Introduction

Recent estimates suggest that rates of overweight (OV) and obesity (OB) remain high among youth in the United States. Between 2015 and 2016 approximately 35.1% of youth aged 2-19 had OV and an additional 26.4% had OB.[1] Pediatric OV/OB is associated with increased risk of poor health[2], specific physical health problems including asthma[3], insulin resistance[4], and coronary heart disease[5], and worse mental health and psychosocial outcomes.[2,6] Overweight and obesity are also associated with increased risk of disordered eating in youth.[7]

While overall rates of OV/OB are high in American youth, there are also notable racial and ethnic disparities in the prevalence of OV/OB. African American and Hispanic youth have higher rates of both OV and OB relative to White and Asian American youth. Indeed African American youth are over three times as likely to have severe obesity relative to White youth.[1] In addition to racial and ethnic disparities, socioeconomic status (SES) is associated with different rates of OV/OB in children. Socioeconomic status can broadly be defined as an individual, family or group's position within a social hierarchy and access to resources.[8] It is usually assessed through some combination of income, education, and occupational prestige.[9] One study found that children in the lowest quintile of SES (as measured by parental education, occupation, and family income) were 70% more likely to have OV or OB compared to children in the highest quintile.[10]

Several factors may contribute to these disparities. Both racial and ethnic minorities and those who are low SES experience disproportionately greater stress than those who are white or higher SES.[11,12] In turn, increased levels of stress are associated with higher prevalence of obesity and obesity-related morbidity via the impact of stress on both physiology and behavior.[13] Neighborhood environmental factors may also play a role. Research suggests that low-SES and racial/ethnic minority individuals in the U.S. are more likely to live in "food deserts" (neighborhoods with reduced access to grocery stores selling affordable, healthy food) and "food swamps" (neighborhoods with a high density of fast food restaurants and convenience stores) compared to high-SES and White individuals.[14] Both "food deserts" and "food swamps" have been found to be associated with increased rates of childhood OV/OB.[15,16] Minority children and lower SES children also experience disparities in access to physical activity facilities.[17]

Given increased rates of OV/OB among racial/ethnic minority and low SES youth, and their exposure to obesogenic environments, it is important that we understand how treatments for obesity impact these populations. It is possible that factors such as increased stress and neighborhood environment may also lead to disparities in treatment outcomes. At present, family-based treatment (FBT) for pediatric obesity is considered a first line behavioral treatment[18] and has demonstrated long-lasting weight loss in both children and parents.[19] However, previous research focusing on family-based treatments for pediatric obesity has found that demographic factors including child race and family income predict program drop-out and low attendance.[20] A 2017 review of other behavioral treatments for pediatric obesity (including non-family based treatments) found that Black households and households with lower incomes had higher drop-out rates and lower program compliance respectively.[21] The literature on behavioral weight loss treatments in adults has also found that on average, Black participants lose less weight than White participants.[22]

Work exploring the relationship between demographics and FBT outcomes demonstrate few differences across demographic groups. A recent analysis of the impact of race/ethnicity on treatment outcomes in FBT for pediatric obesity did not find evidence of disparities between racial/ethnic minority children and White children in terms of weight loss, energy intake, or physical activity.[23] However, this study did not examine Black children specifically, and the association between SES and treatment outcomes in FBT for pediatric obesity has not been assessed.

The present study seeks to disentangle the relationship between race and SES on treatment outcomes among children enrolled in FBT and an accompanying maintenance intervention. Determining the degree to which FBT is effective at helping groups at increased risk for OV/OB lose weight will inform both treatment recommendations and provide future direction for treatment development. This study uses data from a previous randomized clinical trial testing the dose and content of social facilitation maintenance interventions on weight loss following 4 months of FBT.[24]

Materials and Methods[1]

Participants

Participants were children aged 7-11 years who had OV/OB based on a body mass index (BMI) (weight in kilograms/height in meters^2) greater than or equal to the 85th percentile for their age and sex and at least one parent whose BMI was greater than or equal to 25. Participants were recruited through media, advertisements, and provider referrals. Parent and child dyads participated at university-based clinics in St. Louis, Missouri and Seattle, Washington. Parents and children were excluded if either was participating in a different weight loss program, was using any medications that might affect weight, or had a psychiatric or medical condition that would interfere in their ability to participate.

Procedures

[1] For detailed methods and procedures see Wilfley et al., 2017.

From 0-4 months, parent-child dyads (n=241) participated in FBT. Following FBT, 172 participants at each site were randomized into three Social Facilitation Maintenance (SFM) conditions: a HIGH SFM condition, a LOW SFM condition, and a CONTROL condition (months 4-12). Weight status was assessed at 0, 2, 4, 8, and 12 months. The present study is based on weight at 0, 4, and 12 months.

Family-Based Behavioral Weight Loss Treatment

All parent-child dyads participated in FBT for four months, attending 16 30-minute sessions each week as well as 45-minute separate parent and child group sessions. This treatment addresses health behavior change in parents and children through standard behavior change techniques such as reinforcement, stimulus control, preplanning, and relapse prevention.[19,25] Modifications to the family's diet were facilitated by the Traffic Light Plan.[19]

SFM Interventions

Social facilitation maintenance HIGH and LOW conditions were similar in content, but the LOW group met every other week for 32 weeks (16 sessions total) while the HIGH group met weekly for 32 weeks. Both groups received content in 30-minute family sessions as well as 45-minute separate parent and child groups sessions. These sessions focused on helping parents and children create a social and physical environment across all facets of their lives that was conducive to healthy behaviors and successful weight management. The goal was to help them generalize skills and tools learned during FBT to school, work, and home environments. The SFM intervention also focused on skills introduced in FBT to help navigate negative peer interactions such as bullying or teasing and emphasized building supportive social environments with family and peers.

Control Condition

The CONTROL condition was a weight management education intervention (16, every other week sessions) in which parents and children received additional information about nutrition and physical activity and participated in hands-on activities such as cooking and shopping demos. The use of skills taught in FBT was not discussed.

Measures

Demographic variables including parent and child race, ethnicity, age, and sex, BMI percentile/BMI, occupation, income, education, and social status (SS) were assessed at baseline. Socioeconomic status was assessed using two measures: the Barratt Simplified Measure of Social Status (BSMSS)[26] and family income. The BSMSS is based on an individual's, their spouse's, and their parents' education and occupation. Those with more education and more prestigious occupations and those whose spouses and parents have more education and more prestigious occupations have higher scores. Scores range from 8-66 with higher scores indicating higher SS. Family income was self-reported by the parent via 11 income categories. Categories 1-10 were in $10,000 increments, while category 11 was >$100,000. Families' income was analyzed by converting each category to the mid-point of the range (e.g. a family with category 1 ($0 to $10,000) would be converted to $5,000. Family income was then compared to the Area Median Family Income (AMI)[27] for their city and year in the study as defined by the U.S. Department of Housing and Urban Development (HUD). Family income was dichotomized such that those with incomes below 50% of the area median were categorized as low-income based on HUD's definition of very low-income.[28] This definition of low-income was chosen in order to provide an objective classification of low-income status and to control for differences in median area family income between the two study sites.

Anthropometrics (BMI percentile/BMI) were calculated from weight (via electronic scales calibrated to the nearest 0.1 kg) and height (via stadiometer to the nearest 0.1 cm). Centers for Disease Control and Prevention norms from 2000[29] were used to determine child percentage overweight (child % OV; percentage that the child's BMI was above the median for their age and sex). Child % OV was chosen due to its sensitivity to change across a wide range of BMIs[30]; a 9-unit change in child % OV was considered clinically significant[24].

Statistical Analyses

Bivariate analyses of participant demographics and raw change scores between baseline and post-FBT, and between post-FBT and post-maintenance were conducted using t-tests, Chi-square tests, and ANOVAs as appropriate. Tukey's HSD tests were used following significant ANOVA results.

We used latent change score (LCS) modeling, a class of structural equation modeling[31], to evaluate the association between social status, income, race, and change in child % OV following FBT and after the maintenance intervention phase. In this framework, observed variables—e.g., child % OV at baseline, post-FBT, and post-maintenance—were used to model change in child % OV between these timepoints. This approach also allowed us to control for baseline child % OV by incorporating children's' starting measures into the model. Maintenance conditions were collapsed for purposes of analysis due to sample size constraints and social status, which was continuous, was standardized to allow for ease of comparison to race and income variables. Models were fit using maximum likelihood estimation and full information maximum likelihood. All analyses were conducted using R (R Core Team: 2018) and the lavaan library[32].

Results

Participant Demographics

Table 1.1 describes the baseline characteristics of the sample. Of the 172 children who were randomized into maintenance intervention conditions following FBT, the average age was 9.4 (SD=1.3), 61.6% were female, 70.1% were White, 15.7% were Black, and 13.4% identified as another race. Average SS as assessed by the BSMSS was 44.0 (SD=10.2), 14.5% of participants had family income that was less than 50% of AMI, and average baseline child % OV was 64.2 (SD=25.2).

Table 1.1. Participant Demographics

Characteristic	% or Mean (SD)
Child Age	9.4 (1.3)
Child % Female	61.6
Income	
$0-50,000	24.4
$50,001-100,000	38.3
>$100,000	36.6
<50% Area Median Income	14.5
Social Status	44.0 (10.2)
Child race	
White	70.1
Black	15.7
Other	13.4
Baseline Child % OV	64.2 (25.2)
Observations	172

OV=Overweight

Bivariate Comparisons

Compared to children from households with ≥50% AMI, children from households with <50% AMI had higher baseline % OV (78.05 [SD=29.45] vs. 61.89 [SD=23.78], p=0.014), lower SS (37.79 [SD=8.85] vs. 44.94 [SD=10.12], p=0.001) and were more likely to be non-White ($X^2(2)$=30.99, p<0.001). Compared to Black children and children of other races, White children had higher SS (45.56 [SD=9.55] vs. 40.08 [SD=10.54] and 40.04 [SD=11.58], p=0.006). See Table 1.2.

Table 1.2. Baseline Sample Characteristics, by Income and Race

	<50 % AMI	≥50 % AMI	White	Black	Other
			% or Mean (SD)		
Baseline Child % OV	78.05**	61.89	61.99	70.99	67.59
	(29.45)	(23.78)	(26.97)	(18.56)	(20.89)
Race					
White	24.00***	78.88	100.00	0.00	0.00
Black	40.00***	11.64	0.00	100.00	0.00
Other	36.00***	6.16	0.00	0.00	100
Child's Age	9.28	9.47	9.43	9.82	9.04
	(1.46)	(1.25)	(1.19)	(1.44)	(1.43)
Child % Female	64.00	60.96	60.66	70.37	56.52
Social Status	37.79***	44.94	45.56**	40.08	40.04
	(8.85)	(10.12)	(9.55)	(10.54)	(11.58)
Observations	25	146	122	27	23

Comparisons between <50 % AMI and ≥50% AMI made via t-test and chi-square test, comparisons between racial groups made via ANOVA and chi-square test as appropriate. OV=Overweight, AMI=Area Median Income. **p<0.01, ***p<0.001. N=172.

Table 1.3 presents a comparison of mean difference scores between baseline and post-FBT and between post-FBT and post-maintenance across income and racial groups and between children with high and low social status (median split). On average, between baseline and post-FBT, children from households with ≥50% AMI had greater decreases in child % OV compared to children from households with <50% AMI (-14.06 [SD=7.95] vs. -9.92 [SD=7.99], p=0.022). White children also had greater decreases in child % OV compared to Black children or children of other races (-14.50 [SD=8.19] vs. -10.81 [SD=6.55] and -10.50 [SD=8.12], p=0.018). Social status was not associated with differences in change in child % OV and no differences in mean change scores were found between post-FBT and post-maintenance.

Table 1.3. Change in Child % Overweight Over Study Period, by Income and Race

	Baseline Child % OV	ΔChild % OV Post-FBT	ΔChild % OV Post-Maintenance
		Mean (SD)	
Full Sample	64.2 (25.2)	-13.39 (8.10)	-1.52 (9.34)
Income			
<50 % AMI	78.05 (29.45)	-9.92* (7.99)	-1.78 (10.47)
≥50 % AMI	61.89 (23.78)	-14.06 (7.95)	-1.44 (9.20)
Social Status			
<Median	69.38 (27.30)	-13.41 (8.21)	-1.62 (9.97)
≥Median	59.04 (21.97)	-13.37 (8.03)	-1.41 (8.75)
Race			
White	61.99 (26.97)	-14.50* (8.19)	-1.64 (9.41)
Black	70.99 (18.56)	-10.81 (6.55)	-1.20 (8.77)
Other	67.59 (20.89)	-10.50 (8.12)	-1.22 (10.08)

Comparisons between <50 % AMI and ≥50% AMI, <Median and ≥Median Social Status made via t-test, comparisons between racial groups made via ANOVA. OV=Overweight, AMI=Area Median Income. *p<0.05. N=172.

Latent Change Score Models

Results from the LCS model assessing the association between social status, income, and race on change in child % OV between baseline and post-FBT and between post-FBT and post-maintenance intervention are summarized in Table 1.4. In the full model, child % OV decreased on average by 13.1 (SE=1.5, *p*<0.001) units between baseline and post-FBT. The change between post-FBT and post-maintenance was not significant. Of the demographic variables assessed, child race was associated with differences in change in child % OV such that Black participants saw a decrease of 3.3 fewer units compared to White participants (SE=1.5, *p*=0.03) between baseline and FBT. Trend level differences were also present for children of other races compared to White participants (3.5, SE=2.0, *p*=0.076) and for participants with income <50% AMI relative to participants with income ≥50% AMI (3.1, SE=1.9, *p*=0.095). No factors were associated with a difference in the change between post-FBT and post-maintenance intervention. In models 1 and 2, income was significantly associated with differences in the change in child % OV between baseline and post-FBT (4.6, SE=1.8, *p*=0.01 in model 1 and 4.8, SE=1.8, *p*=0.007

in model 2). This association was stronger in model 2 when controlling for SS, but SS was not significantly associated with differences in any model. Baseline child % OV was not associated with change at either time point in any of the three models.

Fit statistics for the full LCS model (see Table 1.4) suggest relatively poor model fit (model $X^2(9)=93.39$, $p=0.000$, RMSEA=0.232, CFI=0.894, SRMR=0.173). However, the purpose of the present analysis is to assess the impact of income, SS, and race on change in child % OV rather than to generate an explanatory model. Therefore, particularly given a CFI close to 0.9, which is commonly used as a minimum CFI value to indicate acceptable or better model fit[33], we consider the model acceptable for the present study.

Table 1.4. Predictors of Change in Child % Overweight, Conditional Latent Change Score Model

	Model 1	Model 2	Model 3
Post-FBT			
Baseline Child % OV	-0.031	-0.027	-0.027
	(0.022)	(0.023)	(0.023)
<50% AMI (Ref.=≥50% AMI)	4.606*	4.820**	3.136†
	(1.795)	(1.784)	(1.878)
Social Status		0.480	0.706
		(0.571)	(0.579)
Race (Ref.=White)			
Black			3.302*
			(1.524)
Other			3.458†
			(1.952)
Post-Maintenance			
Baseline Child % OV	0.006	0.007	0.007
	(0.031)	(0.032)	(0.032)
<50% AMI (Ref.=≥50% AMI)	-0.440	-0.388	-0.719
	(2.146)	(2.195)	(2.501)
Social Status		0.069	0.124
		(0.771)	(0.784)
Race (Ref.=White)			
Black			0.696
			(2.080)
Other			0.676
			(2.586)
Intercepts			
Baseline Child % OV	64.151***	64.151***	64.151***
	(1.917)	(1.917)	(1.917)
ΔChild % OV Post-FBT	-12.057***	-12.376***	-13.093***
	(1.381)	(1.446)	(1.457)
ΔChild % OV Post-Maintenance	-1.860	-1.918	-2.087
	(2.041)	(2.124)	(2.119)
Model Fit Statistics			
Chi-square	44.444***	55.67***	92.140***
RMSEA	0.283	0.243	0.232
CFI	0.947	0.935	0.894
SRMR	0.155	0.164	0.173
R^2			
ΔChild % OV Post-FBT	0.056	0.056	0.105
ΔChild % OV Post-Maint.	0.001	0.001	0.002

This table presents the results of a nested conditional latent change score model, in which the change in Child % OV between baseline and post-FBT and between post-FBT and post-maintenance is predicted by baseline Child % OV, <50% AMI, race, and social status. Standard errors in parentheses. OV=Overweight, AMI=Area Median Income, RMSEA=Root Mean Square Error of Approximation, CFI=Comparative Fit Index, SRMR=Standardized Root Mean Square Residual. N=172; †$p < 0.10$, *$p < 0.05$, **$p<0.01$, ***$p < 0.001$.

Discussion

The results of this study suggest that there are some demographic differences in FBT treatment outcomes for pediatric obesity. Specifically, Black children showed less weight loss following FBT compared to White children. Children of other racial groups and low-income children showed marginal differences relative to White children and higher-income children respectively. Notably, the observed racial differences persist when controlling for income and SS suggesting an independent effect of race. However, the observed differences in change in child % OV between groups were not large (about 3 units) and on average all groups achieved clinically significant change, with no differences between groups detected during the maintenance phase of the study. Furthermore, SS, income and child race only explained about 10% of variance in change scores between baseline and post-FBT.

Interestingly, although SS differs by income and race, SS was not associated with differences in change in child % OV. In contrast, marginal effects were detected for income and when assessed apart from race and controlling for SS, income was quite strongly associated with change in child % OV following FBT. Socioeconomic status is a multifaceted construct typically understood as a combination of one's economic resources, education, and occupation[8]. Measures like the BSMSS, which is based on an individual's, their spouse's, and their parents' education and occupation do not directly capture the financial or social resources available to that individual or their household. It is possible that a child's family's immediate economic circumstances, particularly low-income status, have a greater impact on their program outcomes than their parent's social status.

The substantial correlation observed in this sample between income and race and the small size of these groups makes drawing firm conclusions difficult. Future research using a larger, and more socioeconomically and racially diverse sample would allow for important comparisons including testing interactions between race and SES. It is possible that although the current study did not find evidence for large disparities in treatment outcomes, the effect of being both low-income and non-White is larger than the effect of belonging to either category individually. A larger sample would also allow for more nuanced racial comparisons. For example, evidence suggests that the prevalence of OV and OB among Asian American children is similar to or lower than the prevalence found in White children while Native American or Alaska Native and Native Hawaiian or Pacific Islander children experience higher rates of OV and OB[1]. Collapsing these groups into a single "other" category along with children of more than one race may obscure important differences. Future research may also benefit from additional measures of SES. Beyond family income and aggregate measures of education and occupation, researchers in child development and health disparities have documented the importance other factors such as wealth, income volatility, and human capital in the holistic assessment of SES.[8,34]

The present study suggests that low-income may be associated with an attenuated effect of FBT for pediatric obesity. If this finding is replicated, then future studies should explore possible mechanisms. It is possible that a lack of financial resources makes it difficult for families to adhere to program goals. For example, families may face cost barriers when meal planning or grocery shopping. It is also possible that the observed effects are cognitively and/or emotionally mediated. Previous research on FBT has found that behavioral economics factors such as delay discounting (i.e. the discounting of future rewards relative to more immediate rewards) blunt the effects of FBT[35] while research into the effects of poverty suggests that it can lead to deficits in this type of self-regulatory behavior[36] as well as impede cognitive function more generally.[37] Children in low-income families may therefore experience difficulties with the self-regulation required to adhere to specific diet and physical activity goals. Poverty is also associated worse mental health in children[36] and there is some evidence that suggests that psychopathology may be associated with worse obesity treatment outcomes for children with OV/OB.[38]

The results of this study speak to the need to optimize treatment for non-White families and children. Reviews of interventions for obesity in African American and racial minority children suggest that FBT possesses several strengths with regard to these populations. Specifically, interventions (like FBT) that involve parents, contain multiple components, and integrate goal-setting and lifestyle change were found to be most successful in racial minority youth.[39,40] However, these reviews suggest that interventions should include culturally relevant materials and found that programs that emphasized enjoyment produce better results. Attempts to optimize FBT for non-White families may also wish to explore other elements of FBT including the cultural competency of coaches or other providers.

Strengths and Limitations

To our knowledge, this is the first study to examine the impact of SES (specifically SS and income) on treatment outcomes in FBT for pediatric obesity as well as the first to look at outcomes in Black children separate from other non-White children. The design of the study also allowed use to separate the effects of race, income, and SS on treatment outcomes.

However, the small percentage of low-income and non-White participants in the current sample makes it difficult to draw firm conclusions or thoroughly explore interactions between SS, income, and race. Future research should also explore the possible interaction of maintenance intervention and income and race. Although this study collapsed the three maintenance conditions due to sample size constraints, the social facilitation conditions targeted factors that may be salient to the groups under study including the social and physical environment.

Conclusions

This study found evidence that the effects of FBT for pediatric obesity on child % OV may be attenuated for Black children and children with family income <50% AMI, but that these effects are relatively small. Social status was not associated with differences in change in child % OV, although the effect of income was stronger when controlling for SS. Overall, it appears that FBT was effective at producing clinically significant weight change across income and racial groups. Further research using larger and more racially and socioeconomically diverse samples is needed to explore possible interactions between SS, income, and race. Further research may also be needed to optimize FBT for racial minorities, particularly Black children, and children from low-income families.

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