Online Supplement

A Comprehensive, Multi-Systemic Early Childhood Program and Obesity at Age 37 Years

Background

The epidemic of obesity has major consequences for health and well-being, Since over 40% of U. S. adults are obese as defined by a Body Mass Index (BMI) of at least 30 and 20% more overweight,[1] the majority of the population is at heightened risk for cardiovascular disease, hypertension, diabetes, metabolic disorders, and economic burdens.[2,3] The coronavirus disease 2019 (COVID-19) pandemic has exacerbated this state of affairs, in both contributing to the severity of the disease and increasing racial disparities. Black Americans are at least three times more likely to be hospitalized and die as COVID-19 patients in which obesity and other health conditions such as hypertension are major drivers.[4,5] These should be viewed within the larger structural and institutional contexts of poverty, segregation, and racial discrimination.[6-9] For the health of current and future generations, there is an urgent need for innovative and multifaceted intervention strategies that include prevention. Because of the limited effectiveness of obesity prevention programs in middle childhood and beyond, early childhood programs in the first five years of life have increasingly documented positive short-term effects on healthy body mass, nutrition, and health behaviors.[10-14] However, long-term effects on adult obesity have rarely been assessed and none for large-scale contemporary programs. School-based programs are particularly amenable to scaling.

This study assesses the long-term effect on midlife obesity of the Child-Parent Center (CPC) preschool program at age 3 and 4 years in the Chicago Public School District. Given prior evidence that the program links to higher educational attainment, economic well-being, and lower rates of crime and health compromising behaviors,[15-17] we expected these benefits to carry over to healthier body mass and lower obesity. Thus, by extension, this study is a confirmatory analysis of these impacts. Moreover, on the basis of earlier findings that the magnitude of effects vary by gender, neighborhood poverty, and family risk status, these were also examined.

Body Mass Index Measurement

A participant's Body Mass Index (BMI) was assessed via a participant's reported height and weight on the adult survey/interview from ages 32 to 37 (2012 to 2017; mean age of 35 years). With an average length of 150 minutes and covering a wide range of topics, the survey/interview was completed via phone, online, in person, or mail-in. Participants were asked both for their height and weight at their current age while taking the survey, as well as what they believe their height and weight was at age 18. BMI is one general indicator of body fat and is calculated as height (in meters) divided by weight (in kilograms) squared. Overweight is defined as a BMI between 25 and 29.9 m/kg^2 and obesity applies to those with a BMI of 30.0 m/kg^2 or higher. Moderate and severe obesity is defined at the thresholds of 35.0 and 40.0, respectively. After performing this calculation with participant responses, 1051 participants had a complete age BMI score. Ten of these participants were removed from the sample because they reported they were pregnant at the time. Additionally, one participant was added because they were only missing their midlife height; therefore, their age 18 height was used in the calculation. The final number of participants used in this analysis was 1042. Two hundred and eighty-six participants completed both the self-report survey by age 37 as well as a comprehensive in-person health exam at ages 37 to 39, where their BMI was also computed: when examining the correlation between these two measures, the self-report measure was found to be a valid measure of BMI (r = .85). Self-reported BMI was also highly correlated with the in-person body composition score (r = .65) and waist circumference (r = .78). The correlation between self-reported BMI and the in-person exam was similar for females and males (0.81 and 0.90) and for those in the bottom and top half of the self-report distribution (0.70 and 0.66).

Covariates and Group Equivalence

Based on administrative records from multiple sources and parent surveys,[15-18] 16 variables were included as model covariates. They were measured primarily from birth to age 3 as baseline characteristics. Two significant differences were detected between groups: CPC participants grew up in higher poverty

neighborhoods and their parents had higher rates of high school completion (but not college attendance). The supplemental table shows that the program and comparison groups were similar on a range of baseline characteristics at the age 37 years follow up and at the beginning of the study. This equivalence was similar for women and men. Rates of attrition and the characteristics of those missing at follow up were similar within and between groups, especially after accounting for the process of attrition (see below; supplemental table).

A primary explanation for equivalence between groups on most indicators was that the comparison group included all children from five randomly selected schools (out of 27 citywide) in similar low-income neighborhoods that participated in the usual early childhood program at the time: full-day kindergarten without earlier preschool participation. All cohort participants enrolled in the Chicago Public School District beginning at ages 3 or 4 with nearly all comparison group participants entering in kindergarten. Fifteen percent of the comparison group attended Head Start preschool as part of the usual programming.[15-17] Although the focus of the current study is the preschool component, CPC services are provided up to 2nd or 3rd grade in 20 schools. Program expansion has occurred in Chicago and other Midwest districts.

Because the CPCs were opened in the highest poverty areas of the city, the neibghborhoods surrounding the centers were generally more disadvantaged than other areas. This is shown in the supplemental table However, this provides a conservative bias in estimating impacts, since lower-resourced settings link to higher rates of educational and health problems as well as lower access to high-quality health services and preventive care. We controlled for this and other factors in Table 1. In addition, these factors were also included in the estimated propensity score for addressing potential attrition bias (see below). At baseline, 50% of the CLS cohort (N = 520; 522 were below threshold) resided in high-poverty neighborhoods, defined as 40% or more of the neighborhood population (census tracks) at or below the federal poverty level. At the midlife follow up, the percentage of the cohort currently residing in high-poverty neighborhoods was 26% (N = 275; 767 below threshold). Roughly two-thirds of the sample lived in Chicago at follow up.

Those covariates measured dichotomously were CPC school-age enrollment, Black, Female, eight sociodemographic family risk factors (e.g., parent dropped out of high school, family income 130% of the federal poverty line or below, single parent status, attended school in a low-income area), family risk indicator was imputed, received child welfare services, stressful home environment (retrospective report from participants), parent attended college, resided in high poverty neighborhood (40% or more of residents were at/below federal poverty level), and resided in neighborhood with relatively high human capital (10% or more of residents ages 25 and above had a 4-year college degree). Birth weight in pounds from the Illinois Department of Health was the only continuous measure.

Inverse Propensity Score Weighting

Following prior studies,[15,17] Inverse Propensity Score Weighting (IPW) was used to adjustment for potential attrition bias. Nearly 30% of the original cohort did not complete the midlife survey. IPW methods can reduced attrition bias arising from measurable factor influencing sample recovery status.[19] The regression model included the following weight variable:

$$W_i = 1/P_i$$

$$P_{i\,(SR)} = \text{Constant} + \boldsymbol{B_j}\text{BD} + \mathbf{B_j}\text{HE} + \mathbf{B}_j\text{PR} + \mathbf{B}_j\text{SN} + e$$

The predicted probabilities of sample recovery (SR; age 37 survey) were estimated by logistic regression (OLS regression also yields consistent estimates) with 31 input predictors hypothesized or known to be important. These included birth outcomes and demographics (BD), home environment (HE), program (PR), school, and neighborhood factors (SN). In the outcome regressions, this weight was applied such that individuals with higher weights were counted more heavily in program effect estimates (they have lower probabilities of responding to the adult survey). Those with lower weights were counted less. The weight variable (W) ranged from 1.08 to 3.08 with mean of 1.5. Thus, cases at the mean were counted nearly 40% more than those in the lower range. Standard errors were adjusted for the weighted regressions. Analyses revealed that estimated program impacts were similar between IPW and non IPW models. The supplemental

table shows that IPW effectively adjusted for group differences in rates of sample recovery.

Program Description

The CPC program began in 1967 in four new centers on Chicago's westside (East and West Garfield Park, North Lawndale). These were, and remain today, the highest poverty neighborhoods in the city. This was the result of the landmark Elementary and Secondary Education Act of 1965 for which federal funding from Title I of the Act was used by the school district to open the centers. The Chicago Public School District was the first to use Title I for preschool and thereby established CPC as the second oldest (after Head Start) federally-funded preschool.[20]

The program was developed in response to three major problems facing Chicago schools: low rates of attendance, family disengagement with schools, and low student achievement.[20,21] The conceptual foundation is that well-being is a product of proximal and distal influences at multiple levels of contexts (individual, family, school, community) experienced during the entire early childhood period (ages 3 to 9). Although CPC began as a comprehensive preschool program, children received continuing services in kindergarten and the early grades the following year, resulting in the preschool to 3rd grade program that it is today. The program was modified as a school reform model in 2012 as part of expansion in and outside of Chicago funded by the U. S. Department of Education. Six core elements are implemented; effective learning experiences, collaborative leadership, aligned curriculum, parent involvement and engagement, professional development, and continuity and stability.[22] At present, there are 19 centers in Chicago.

CPC provides comprehensive, multi-systemic services in education and schooling, family support, health, and community outreach.[20-22] Under the direction of the Head Teacher at each site and in collaboration with the Principal, CPC enhances school readiness and achievement, promotes parent involvement and engagement in the school and community, and enhances socio-emotional learning with an emphasis on self-control, self-efficacy, and personal responsibility. Breakfasts and lunches are provided, school nurses work with families on site, and referrals to health centers, speech therapy and other supports are provided. CPCs are in a stand-alone school or center in which all children receive services. After a part-day program (3 hours, 5 days per week) at ages 3 and/or 4 in small classes with child-teacher ratios of 17:2, the K–3rd components provide reduced class sizes (maximum of 25), teacher aides for each class, health services, continued parent involvement opportunities, and enriched classroom environments for strengthening language and literacy, math, science, and social-emotional learning.

To promote wholistic well-being, including physical health, each center has a parent resource room and family program run by the Parent-Resource Teacher in collaboration with the School-Community Representative. The later conducts home visits, engages parents in the school, mobilizes resources in the community and provides referrals to health, employment and job training, and related services. Parent workshops and trainings are a predominant element of the program, and they most frequently include child development, health literacy, nutrition, financial literacy, and personal development topics. GED courses are often provided on site and parents volunteer in the classroom and in community organizations. Given the physically located resource room in the centers, peer support among parents and family members is another key feature.

Based on the goals and foci of the program, participants' experiences, and impacts to date,[20-25] the program is expected to promote healthy body mass and reduce obesity over the life course through enhancing for mechanisms of change:

a. educational success and attainment
b. self-control and self-efficacy behaviors
c. health literacy and practices
d. social support and engagement.

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Supplement Table. Group Equivalence at Age 37 Follow Up and for Original Chicago Longitudinal Study Cohort (N=1,539)

Child or Family Characteristic	Follow up sample				Men P vs C		Women P vs C	
	Prog. Group (n=689)	Comp. Group (n=353)	P-value	Original sample P-value	Follow up P-value	Original sample P-value	Follow up P-value	Original sample P-value
Percent of original cohort in follow up (unadjusted)	69.7	64.2	.03*	--	.58	--	.05	
Percent of original cohort in follow up (attrition adj)	69.5	68.0	.57	--	.46	--	.13	
Percent women	54.3	47.9	.06	.09	--	--	--	--
Percent Black	93.5	94.3	.69	.68	.85	.68	.33	.21
Family risk index (0-7) by child's age 3	4.42	4.46	.68	.80	.32	.31	.81	.11
Percent four or more risk factors by child's age 3	71.1	71.4	.94	.63	.84	.87	1.0	.29
Percent mother not completed high school by child's age 3[1]	49.8	56.9	.03*	<.01*	.40	.15	.03*	<.01*
Percent mother completed some college child's age 3	13.4	10.8	.28	.10	.58	.26	.33	.13
Percent single parent by child's age 3[1]	75.0	76.2	.70	.75	.07	.29	.23	.09
Percent mother not employed by child's age 3[1]	65.6	64.0	.63	.29	.39	.48	.16	.01*
Percent ever reported receiving free lunch by child's age 3[1]	82.9	82.7	.99	.52	.57	1.0	.60	.29
Percent ever reported receiving AFDC by child's age 3[1]	60.4	61.2	.84	.24	.26	.36	.56	.10
Percent having 4 or more children at home by child's age 3[1]	16.1	18.4	.38	.35	.39	.68	.04*	.06
Percentage of children in school area in low income families (<185% of poverty level[1])	66.6	67.1	.39	.15	.38	.27	.72	.26
Reside in neighborhood ≥40% pop. at poverty line	56.2	37.1	<.01*	<.01*	<.01*	<.01*	<.01*	<.01*
Percent child welfare history by child's age 3	3.0	4.2	.37	.09	.30	.31	3.3	.17
Percent mother was teen at child's birth[1]	14.7	16.1	.52	.39	.53	.28	.90	.92
Percent missing on any family risk indicators	14.7	17.9	.40	.45	.39	.41	.36	.32
Birthweight in pounds	6.83	6.72	.21	.26	.38	.34	.18	.37
Number of home environment problem ages 0-5	0.17	0.14	.41	.23	.22	.10	.96	1.0

Note. 1. Family risk baseline indicators. Characteristics were measured from administrative records (e.g., birth records) from primarily ages 0 to 5, parent reports up to age 12, and for home environment problems and adverse child experiences retrospective reports by participants. Demographics were measured from school records. Attrition adjusted means are after accounting for Inverse Propensity Score Weighting (IPW). The P-value indicates that IPW accounted for most of the group difference in sample retention status. Group differences in mother's high school dropout status in the total sample and for women were nonsignificant once IPW attrition was taken into account. The original cohort sample sizes are 989 (program group) and 550 (comparison group). 7 comparison group and 1 program group participant had missing gender information.

*95% CI does not include zero.