

Proposal for 2009 PAA Conference

Dosage Effects of Classroom-based Interventions on Children's School Readiness:

Evidence from a Randomized Experiment in Head Start Settings

Fuhua Zhai

fuhua.zhai@nyu.edu

New York University Steinhardt School of Culture, Education, and Human Development

C. Cybele Raver

cybele.raver@nyu.edu

New York University Steinhardt School of Culture, Education, and Human Development

Stephanie M. Jones

stephanie_m_jones@gse.harvard.edu

Harvard University Graduate School of Education

Christine Li-Grining

cligrining@luc.edu

Loyola University Chicago Department of Psychology

Emily Pressler

eap4@nyu.edu

New York University Steinhardt School of Culture, Education, and Human Development

Qin Gao

aqigao@fordam.edu

Fordham University Graduate School of Social Service

Darlene Jones-Lewis

jonesd39@sbcglobal.net

Office of Children and Family Services, City of Chicago

Abstract

Program participation level or dosage (e.g., take-up or not, attendance rates, or the length of “treatment”) in social interventions has been increasingly identified as a critical source of variability in program outcomes. The dosage effects of interventions may provide serious implications for policy makers and program administrators, but have been poorly understood due to the issue of selection bias. This study uses a principal score matching method to examine the dosage effects of a randomized classroom-based intervention with multi-components in Head Start settings, the Chicago School Readiness Project, on children’s school readiness. Overall this study finds that compared to intention-to-treat (ITT) estimates, high dosage of teachers’ training and mental health consultation was associated with higher program effects on children’s reduction in teacher-reported behavior problems and improvement in observer-reported social emotional skills and cognitive development, while low dosage was related to lower or insignificant program effects.

Extended Abstract

Description of the Topic and Background

Program participation level or dosage (e.g., take-up or not, attendance rates, or the length of “treatment”) in social interventions has been increasingly identified as a critical source of variability in program outcomes. Randomized experimental designs used in policy and clinical trials create treatment and control groups that on average have similar observed and unobserved characteristics. Nevertheless, most experimental interventions involving human subjects have suffered from complications due to noncompliance with randomized assignment. The dosage effects of interventions may provide serious implications for policy makers and program administrators, but have been poorly understood due to the issue of selection bias. To address this issue, this study uses a principal score matching method to examine the dosage effects of a randomized classroom-based intervention with multi-components in Head Start settings, the Chicago School Readiness Project (CSRP), on children’s school readiness.

Prior research has shown that classroom-based interventions focusing on preschool teachers’ training and mental health consultation, such as the Incredible Years Training Series, are associated with the reductions in children’s disruptive behaviors and the improvement in social competence and adaptation. Most of these studies only provided intention-to-treat (ITT) estimates for the average treatment effects of the interventions. As a conventional and rigorous test of intervention effects, ITT analysis compares the average outcomes of the treatment group and those of the control group no matter whether or not participants actually comply, or to what extent comply, with assigned intervention conditions. Nevertheless, in recent years it has been concerned that many participants do not comply with their assigned treatment status, either without taking up or fully receiving the intervention services. Moreover, many social

interventions include multiple components of services, but few studies have examined the impacts of individual components beyond the impacts of a combination of these services.

Furthermore, one major empirical hurdle to analyses of program dosage effects is the persistent problem of selection bias. Both observable and unobservable factors may be associated with the dosage level of participation for individuals assigned to the treatment. Meanwhile, these factors may also be related to the outcomes of interest. As a result, simply comparing participants who received high-dosage level of treatment with the low-dosage treatment or with the entire control group is inappropriate and may bias the estimates of dosage effects. Therefore, it is important to identify comparable participants in the control group to those who receive high- or low-dosage intervention in the treatment group.

Data and Measures

The CSRP targeted teachers' provision of positive emotional support and effective classroom management strategies with low-income, ethnic minority preschoolers' as a way to support children's development of self-regulation, to reduce their risk of behavioral difficulty, and to increase their opportunities for learning. Using a clustered randomized controlled trial (RCT) design, the CSRP provided a multi-component classroom-based intervention to Head Start programs in seven economically disadvantaged neighborhoods in Chicago. It was implemented among two cohorts of Head Start children and teachers, with Cohort One participating from fall to spring in 2004-05 and Cohort Two participating from fall to spring in 2005-06. Overall CSRP included 602 children in 35 classrooms led by 94 teachers.

The CSRP provided a three-component intervention from fall to spring in the Head Start year: (1) 30 hours of teacher training focusing on behavior management strategies, (2) weekly

coaching of teachers by mental health consultants (MHCs), and (3) one-on-one consultation for a small number of children (3-4 children per class) with high behavioral problems.

This study focuses on the dosage effects of individual CSRP interventions on children's school readiness in spring of Head Start year using data collected in fall and spring of Head Start year pooled from both cohorts. Child school readiness was measured by behavioral and cognitive scales, including teacher-reported Behavior Problems Index (BPI) (i.e., internalizing and externalizing scales), observer-reported social-emotional skills (i.e., attention/impulsivity and positive emotion), and observer-rated cognitive development (i.e., Peabody Picture Vocabulary Test [PPVT] and early math skills).

The dosage levels of treatment on three CSRP components are defined. Regarding teacher training, teachers in the treatment group on average received 18.4 hours of training with a standard deviation of 9.0 hours. As shown in Figure 1, there was a considerable gap of average training hours (an 8-hour gap) between two groups of teachers in the treatment group (one class with no teacher attending). Thus the first group (with 9-18 hours of training) is defined as low-dosage training group and the second (with 26-30 hours of training) as high-dosage training group. Similarly, teachers who received MHC services of 100-126 hours are in the low-dosage MHC group while those with 132-152 hours in the high-dosage MHC group. Since only a small number of children ($n = 125$) in the treatment group received individual MHC services, this study only examines the effects of whether or not children received any individual MHC services.

Other covariates in this study include characteristics of child, teacher/classroom, and site. Child-level covariates include child gender, race/ethnicity, family poverty-related risks, and pre-treatment scores in September for respective outcome variables in May. Class-level covariates include teacher's personal and work-related stressors, classroom quality measured by the

Classroom Assessment Scoring System (CLASS) and the Early Childhood Environment Rating Scale-R (ECERS-R), class size, and the number of adults in classroom. In addition, a limited number of site-level covariates were entered into models, including the availability of a fulltime family worker at the Head Start site, the size of the program, the proportion of the teachers with bachelors' degrees, the proportion of teaching assistants with any college education, and the proportion of the families served that were employed.

Analytic Approach

To address the issue of selection bias and identify comparable children in the control group to those who received high- or low-dosage treatment, we used principal score matching, a derivative of propensity score matching, which is similar to the methodology recently developed and used for take-up subgroup analysis in social experiments. In particular, the analyses included three stages. In the first stage, the propensity of a participant in the treatment group actually received high- or low-dosage treatment of CSRP was estimated. The propensity of receiving a dosage level (D) of CSRP treatment for child i in class c was estimated by the logit model specified in Equation (1):

$$\Pr(D_{ic} = 1 | \sum X_{ic}, T = 1) \quad (1)$$

where $\sum X_{ic}$ is a sum of the factors that capture the characteristics of child and teachers that possibly influenced their propensity of receiving high-dosage treatment. These characteristics were collected prior to CSRP treatment (i.e., in September of the Head Start year), including child gender, race/ethnicity, family poverty-related risks, and teacher-reported behavioral problems; teacher personal stressors and work-related stressors; classroom ECERS-R scores; class size; and the number of adults in classroom. T denotes treatment assignment, thus $T = 1$ indicating the estimation is conducted within the treatment group.

Then using the coefficients obtained from Equation (1), the dosage propensity scores were estimated for children in the control groups. These dosage propensity scores are referred to as principal scores since they are used to stratify the population into mutually exclusive subgroups (“principal strata”) based on theoretical pre-treatment variables. The difference between propensity scores and principal scores is the ways in which estimates are obtained. In general, propensity score matching involves a binary variable indicating whether participants are in either the treatment ($T = 1$) or the control ($T = 0$) group. In contrast, in principal score matching approach, the propensity of receiving high- or low-dosage treatment for individuals in the treatment group ($T = 1$), rather than all individuals in the sample, is first estimated. Then the resulting coefficients are applied to individuals in the control group ($T = 0$) to estimate their probabilities of participating at high- or low-dosage treatment if they had been assigned to the treatment group, given their observed characteristics of $\sum X_{ic}$. Therefore, principal score matching is specifically appropriate for investigating dosage effects such as in this study.

In the second stage, based on their principal scores estimated in the first stage, children in the high- or low-dosage group were matched with those in the control group who had the closest principal scores, using one-to-one nearest neighbor matching without replacement. Among children in the control group who had the same principal scores, one of them was chosen randomly for matching.

In the third stage, the dosage effects of CSRPs were estimated by the regression-adjusted differences on the outcomes between children in the treatment and control groups within the same matched pairs, as presented in Equation (2):

$$O_{ipcs} = \beta_0 + \beta_1 D_{ipcs} + \beta_2 X_{ipcs} + \beta_3 C_{ps} + \beta_4 S_p + \phi + \xi \quad (2)$$

where O_{ipcs} represents the outcomes of child i in matched pair p in class c located in site s ; D_{ipcs} stands for the dosage of treatment (1 = high/low dosage; 0 = matched control); X_{ipcs} is a vector of child characteristics; C_{ps} and S_p represent the covariates of teacher and classroom as well as site, respectively; ϕ denotes pair fixed effects; and ξ is a random error term.

The processes of calculating principal scores and matching children were performed separately for low- and high-dosage treatment of each component of CSRP intervention (i.e., high- and low-dosage teacher training, high- and low-dosage mental health consultation for teachers, and whether or not receiving individual consultation by children). In a conventional propensity score matching approach, each individual is associated with one propensity score representing his/her probability of being treated. In contrast, in the dosage analyses of multiple components, each individual has principal scores for low- and high-dosage treatment of each component of CSRP intervention representing his/her probabilities of receiving respective dosage levels of individual treatment components.

Preliminary Results

Figures 2A and 2B graphically show the kernel densities of principal scores for children whose teachers received low- and high-dosage training, respectively. In both situations, children in the respective matched groups whose teachers received no training (as represented by dashed lines) overall were more similar to those in high or low dosage groups (as denoted by solid lines) than all children in the control group (as shown by dotted lines) when compared by their kernel densities of principal scores. Therefore, the comparison between high- or low-dosage treatment group and respective matched groups might be able to reduce biases in the estimation of dosage effects. Similar patterns show in the principal matching of children with teachers receiving low- and high-dosage MHC services and children who received individual MHC services.

Table 1 presents the preliminary results on the dosage effects of CSRП intervention components. As a comparison to the estimates of dosage effects, previous findings on ITT effects of CSRП (Raver et al., 2008) were also presented, which were estimated by using Hierarchical Linear Modeling (HLM) to account for the hierarchical structure of CSRП data in which children were nested in classrooms and sites.

Overall this study finds that compared to ITT estimates, high dosage of training and MHC services received by teachers was associated with higher program effects on children's reduction in teacher-reported behavior problems and improvement in observer-reported social emotional skills and cognitive development, while low dosage was related to lower or insignificant effects. Moreover, children who had high behavioral problems prior to the intervention and received individual MHC services also had significant gains in school readiness measures compared to their counterparts who had similar pre-treatment characteristics but did not receive individual MHC services. Detailed results and implications for policy making and research will be discussed in the paper.

Figure 1. Average Teacher Training Hours

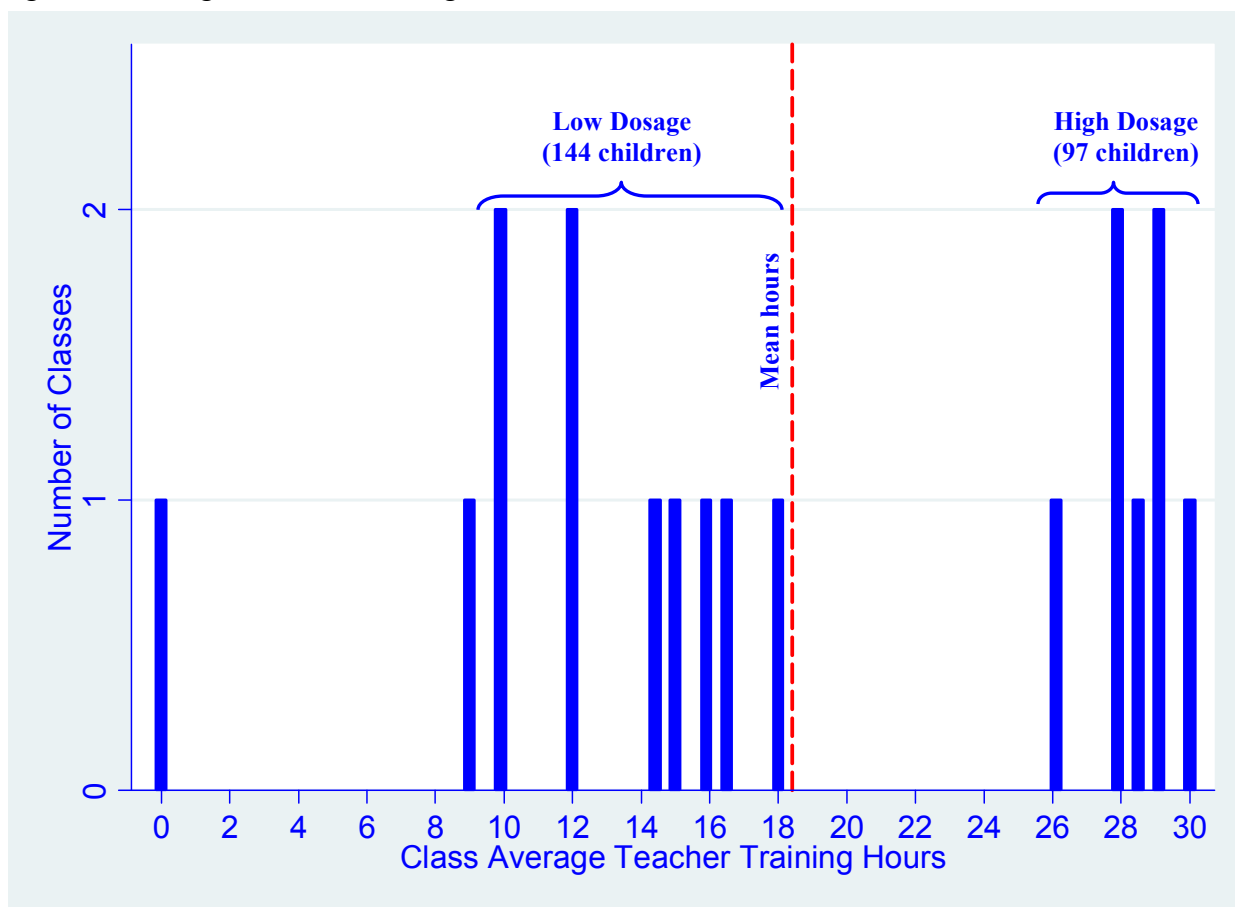


Figure 2A. Kernel Density of Principal Scores for Low-dosage Treatment

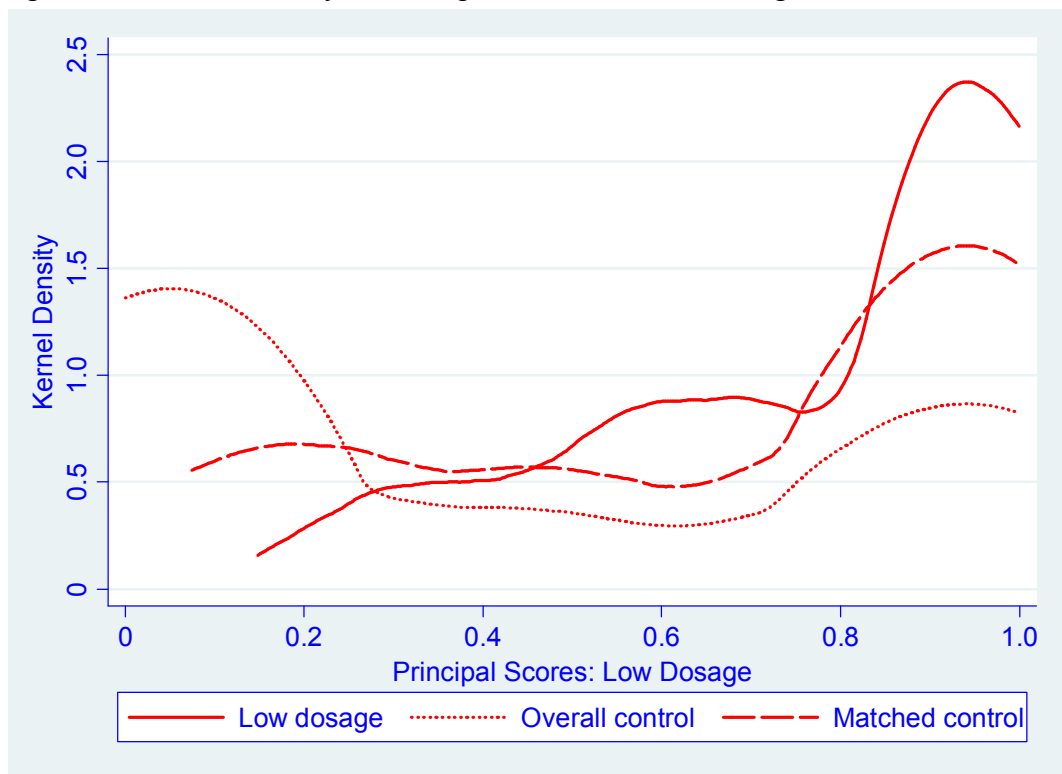


Figure 2B. Kernel Density of Principal Scores for High-dosage Treatment

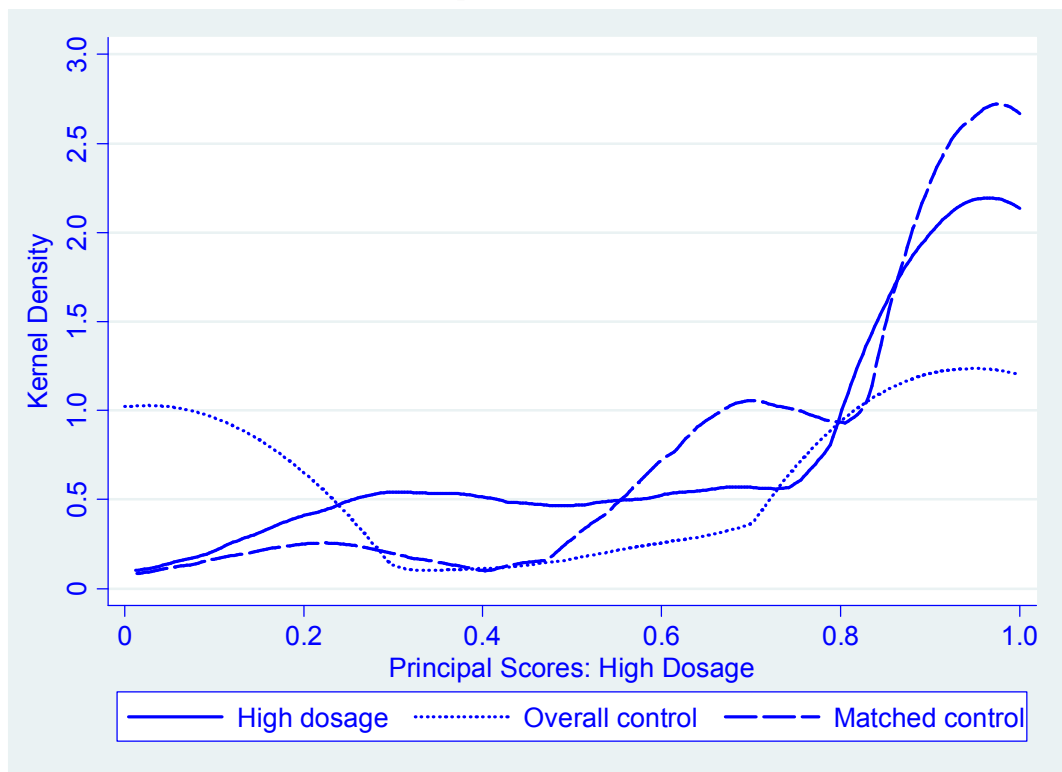


Table 1. Dosage Effects of CSRP Intervention

	ITT	Teacher Training		MHC for Teachers		MHC for Children
		Low Dose	High Dose	Low Dose	High Dose	
<i>Teacher-reported Behavior Problems</i>						
BPI Internalizing	-1.81** (0.43)	-1.40* (0.44)	-1.92** (0.53)	-0.64** (0.13)	-0.92+ (0.41)	-0.89** (0.15)
BPI Externalizing	-2.92* (0.92)	-2.11** (0.58)	-3.80* (1.26)	-2.73** (0.61)	-2.80+ (1.25)	-0.92+ (0.42)
<i>Observer-reported Social-emotional Skills</i>						
Attentive/Impulsive Control	0.20* (0.08)	-0.13 (0.11)	0.50** (0.10)	0.17* (0.06)	0.27* (0.09)	0.14* (0.05)
Positive Emotion	-0.01 (0.08)	-0.02 (0.08)	0.35+ (0.15)	0.07 (0.06)	0.28* (0.09)	0.12* (0.06)
<i>Observer-rated Cognitive Development</i>						
PPVT	1.39* (0.61)	1.46+ (0.74)	3.95** (0.90)	1.26+ (0.62)	2.49** (0.60)	0.96+ (0.51)
Early Math	2.43** (0.52)	1.88+ (0.87)	3.83** (1.02)	1.01** (0.22)	2.01** (0.56)	2.81** (0.28)

Coefficients with standard errors in parentheses; ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$