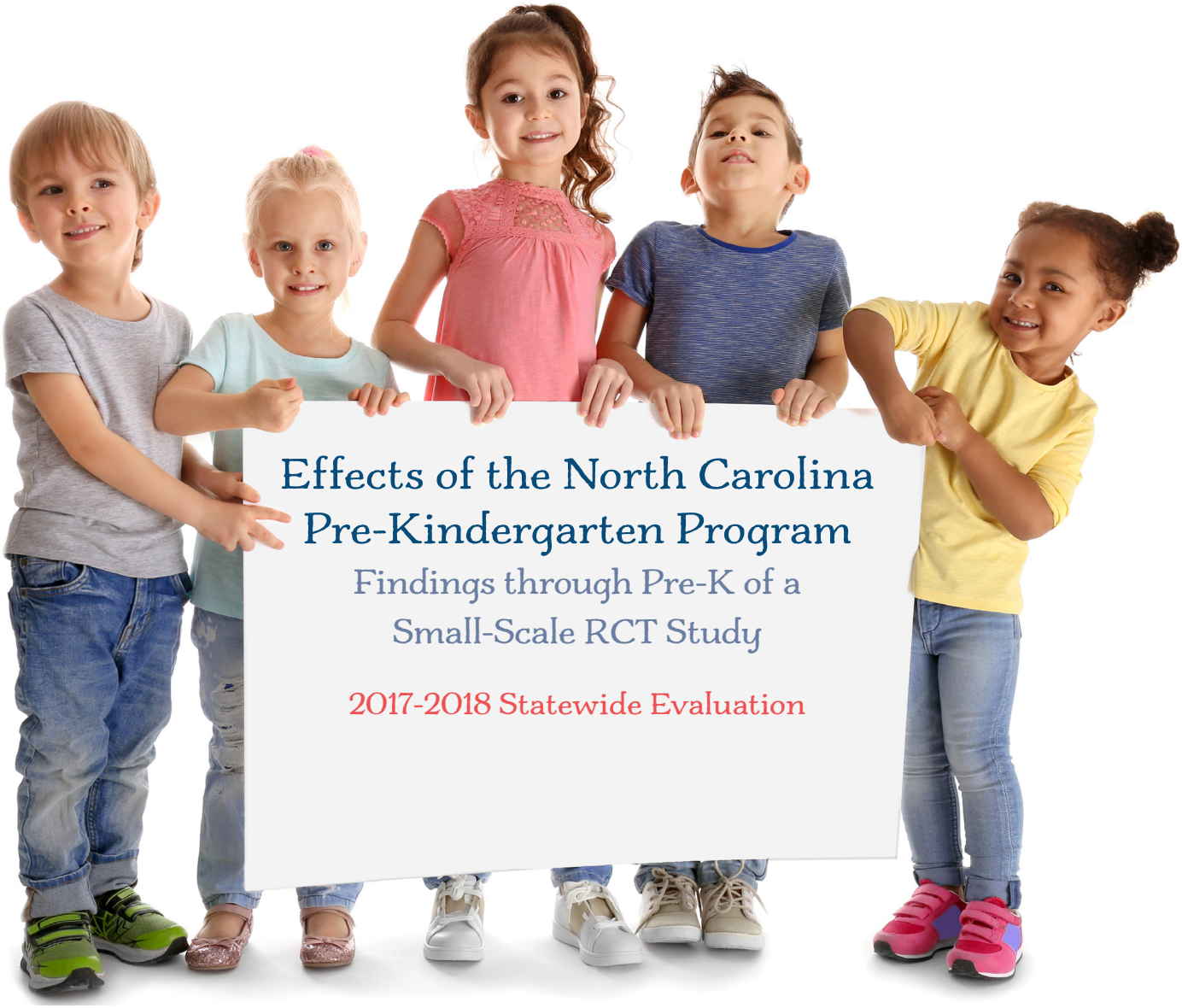
NC Pre-K Program Evaluation Project



Effects of the North Carolina Pre-Kindergarten Program

Findings through Pre-K of a Small-Scale RCT Study

2017-2018 Statewide Evaluation

Ellen Peisner-Feinberg, PhD, Sabrina Zadrozny, PhD,
Laura Kuhn, PhD, & Karen Van Manen, PhD

UNC
FRANK PORTER GRAHAM
CHILD DEVELOPMENT INSTITUTE

We wish to acknowledge the members of our NC Pre-K Program Evaluation Team who provided invaluable support and effort to conduct this study.
Research staff – Dr. Treshawn Anderson, Shannon Casey, Alexis Kokoska, Tom Leggett, Cristina Luna-Evans, Judith Owen, Andrea Reubens, Maria Sanchez, Stefanie Schwartz, and Gina Walker.
Data collectors – Shaunna Barbee, Carol Carter, Laura Clay, Evadine Codd, Kristine Cortina, Kelly Downing, Lori Dwyer, Aaron Freeman, Isaura Godinez, Kate Hodge, Diana Knechtel, Martha Lee, Cyndee Lohr, Dr. Irina Mokrova, Rosemary McNiel, Cecilia Pepper, Jeremy Pienik, Quinny Sanchez Lopez, Karen Stewart, Tia Walt McCallum, Towanda White-Miller and Susan Wyland Witek.
Statistical consultant – Dr. Margaret Burchinal.

In addition, we offer our appreciation to all those who participated in and assisted with this study, including the children and families, and the teachers, administrators, and other staff in the pre-k programs, and the staff of the North Carolina Division of Child Development and Early Education, Department of Health and Human Services.

Cover by Gina Harrison.

Suggested citation: Peisner-Feinberg, E., Zadrozny, S., Kuhn, L., & Van Manen, K. (2019). *Effects of the North Carolina Pre-Kindergarten Program: Findings through Pre-K of a Small-Scale RCT Study.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute.

This study was funded by the North Carolina Division of Child Development and Early Education, Department of Health and Human Services. The opinions expressed in this report do not necessarily reflect those of the funding agency.

Table of Contents

List of Tables

List of Figures

Overview of the NC Pre-K Program

NC Pre-K is a state-funded educational program for eligible 4-year-olds, designed to enhance their school readiness skills. Initiated in 2001–2002, the program became statewide by 2003–2004.[1] Since its inception, the statewide pre-k program has served over 400,000 children. According to program guidelines,[i] children are eligible for NC Pre-K primarily based on age and family income. Children must be four years old by August 31 of the program year, with a gross family income at or below 75% of state median income (SMI). Within a local program, up to 20% of age-eligible children with higher family incomes may be enrolled if the child has at least one of the following additional factors: limited English proficiency, identified developmental disability, chronic health condition, or educational need (based on developmental screening or an IEP). In addition, children with a parent serving in the military are eligible regardless of family income or other eligibility factors. Programs also are encouraged to serve children in families who are experiencing homelessness. NC Pre-K provides funding for serving eligible children in classroom-based educational programs in a variety of setting types, including public schools, Head Start, and private child care centers (both for-profit and nonprofit).

The requirements for NC Pre-K are designed to provide a high-quality, classroom-based educational experience for children, and to ensure uniformity in the program across the state, to the extent possible. The NC Pre-K Program operates on a school day and school calendar basis for 6-1/2 hours/day and 36 weeks/year. Local sites are expected to meet a variety of program standards around curriculum, screening and assessment, training and education levels for teachers and administrators, class size, adult:child ratios, North Carolina child care licensing levels, and provision of other program services.[i] Class sizes are restricted to 18 children with a lead and assistant teacher, with adult:child ratios of 1:9. Lead teachers are required to hold or be working toward a NC Birth through Kindergarten (B-K) license or the equivalent and assistant teachers are required to hold or be working toward an Associate Degree in early childhood education or child development (ECE/CD) or a Child Development Associate (CDA) credential. Classroom activities and instruction are based on the state early learning standards[ii] and an approved curriculum; classroom staff are expected to conduct developmental screenings and ongoing assessments to gather information on individual children's growth and skill development as well as to inform instruction. Monthly reimbursement rates by the NC Pre-K Program vary by the type of classroom and teacher qualifications, from up to $400 per child (in Head Start sites) to a maximum of $650 (private sites with a B-K-licensed lead teacher), with an average annual cost per child estimated at $5,534, representing 61% of the total cost of $9,126.[iii]

The program is administered at the state level by the Division of Child Development and Early Education (DCDEE), NC Department of Health and Human Services (NC DHHS), which then contracts with county or multi-county administrators to oversee local implementation. Contract administrators are primarily either local public school systems or local Smart Start partnerships, and must include collaboration among members of the local early childhood community (e.g., local public school systems, local Smart Start partnerships, Head Start, child care providers, resource and referral agencies) through an oversight committee.

[1] In 2011, the North Carolina General Assembly transferred the existing state pre-k program from the Department of Public Instruction (DPI) to the Division of Child Development and Early Education (DCDEE) in the North Carolina Department of Health and Human Services (DHHS) and renamed it from the More at Four Pre-Kindergarten Program to the North Carolina Pre-Kindergarten Program.

Purpose of the NC Pre-K Evaluation – Randomized Controlled Trial Study

The FPG Child Development Institute has conducted independent evaluation studies of the NC Pre-K Program (formerly More at Four) since its inception in the 2001-2002 school year. These evaluations have included multiple studies of program characteristics, classroom quality, and children's outcomes over the course of the pre-k year as well as longitudinally into kindergarten and third grade. The evaluation designs have used a variety of methodologies, including pre and post, two-group comparison, regression discontinuity, and propensity score matching to examine both short-term and long-term outcomes. (See Appendix 1 for a list of previous reports.)

The primary purpose of the 2017-2018 NC Pre-Kindergarten (NC Pre-K) Evaluation was to examine the effectiveness of the NC Pre-K Program using a randomized controlled trial (RCT) design. The major issue addressed by this type of study is around the benefits of offering children access to enrollment in NC Pre-K. An RCT is considered the gold-standard design for addressing such a question because children are randomly assigned to either receive the program (treatment) or not (control). Therefore, differences in outcomes can be causally attributed to whether or not they received treatment rather than to other differences between the children and families in the two different groups.

This study is designed to follow children longitudinally from pre-k into elementary school in order to examine the short- and longer-term effects. The current study (2017-2018) provided baseline data about children's outcomes during their pre-k year. This small-scale study compared 582 children who were randomly assigned to either NC Pre-K (Treatment=473) or the waitlist (Control=109) in two selected counties with substantially large waitlists. Because children in both groups had applied to and were eligible for NC Pre-K, they had similar characteristics. However, because not everyone could be served with the available number of program slots, random assignment was used to select children for NC Pre-K or the waitlist (with very few crossovers between groups). The study considered factors that might affect the impact of receiving the treatment – specifically, children's level of oral language proficiency and classroom quality for children in preschool settings. In addition, the study also included a sample of children who were Spanish-speaking dual language learners and gathered data in both Spanish and English to examine the effects of treatment in both their first and second languages.

The RCT study addressed three primary research questions:

1) Do children who receive access to enrollment in NC Pre-K (treatment group) exhibit better outcomes than children who do not receive access to enrollment (control group)?
2) Are there factors that affect the impact of treatment – children's level of oral language proficiency or pre-k classroom quality?
3) What are the effects for children who are dual-language learners?

Data collection included individual assessments of children's language, literacy, math, executive function, and behavior skills. Demographic information about the children and families was obtained from state administrative data and parent surveys, and observations of classroom quality and teacher demographic surveys were gathered for children in pre-k settings. In addition, key characteristics of the NC Pre-K Program during the 2017-2018 year, along with trends over time (2003-2004 to 2017-2018), were examined based on statewide administrative data (NC Pre-K Kids and NC Pre-K Plan). Information examined included characteristics of the local NC Pre-K settings, the children served, the qualifications of teachers, and distributions and counts of program participants and service providers.

Method

Study Design

Feasibility Study

During the previous year (2016-2017), a statewide study of local variations in enrollment and waitlist practices was conducted, and these data were used to inform the feasibility and design of the current RCT study. The study involved all 91 local NC Pre-K Program contracts (counties or multi-county regions), with data gathered through both surveys and phone interviews. The results provided information about local variations in implementation of the NC Pre-K Program across four major categories of practices: recruitment, application, placement, and waitlist.[iv] These data provided information about how children were recruited and placed, which populations of children were served by the program, where there were sufficient waitlists to conduct random assignment into the program, and the likely make-up of the control group to help guide decision-making related to the feasibility of conducting an RCT. The data were reviewed to determine these various conditions related to potential sample selection, study recruitment, and the development of procedures for collaborating with local Pre-K administrators and programs on the study. Given that NC Pre-K is a mature state pre-k program, it was important to consider whether there were local NC Pre-K Programs at the contract level that were likely to have sufficiently large applicant lists, enrollment, and waitlists, were not likely to re-assign most children on the waitlist to the program or to a similar program, had a relatively low rate of relocation out of the county among their families, and were willing to agree to a random assignment process for program/waitlist selection for eligible applicants.

Random Assignment Process

A small-scale RCT design was used to evaluate the impact of the NC Pre-Kindergarten program in two counties. Within each county, children who were eligible for and had applied to the NC Pre-K program were randomly assigned into either the treatment (NC Pre-K) or control (waitlist) group. Following random assignment and notification of the selection decision, families from both groups were recruited for participation in the evaluation study.

The study used a partially nested, cluster randomized-controlled design. Randomization occurred in slightly different ways across the two counties. In county A, randomization was conducted using simple random sampling. In county B, randomization occurred within income strata to meet program requirements (80% at or below 75% state median income and 20% above). Each county provided the researchers with a subset of their lists of eligible applicants for randomization into treatment (NC Pre-K) and control (waitlist) groups using a unique identification number. Prior to assignment, the program confirmed that all children were eligible for NC Pre-K, based on criteria related to age and family income. The number of assignments to the treatment group was made based on the number of slots the program needed to fill, with remaining applicants in the pool randomly assigned to the control group.

Participants

Children/Families

Randomization was conducted in two local NC Pre-K contracts (counties) which met the criteria based on the feasibility study results. Both counties served relatively large numbers of NC Pre-K children (as necessary for the study). In one county the program was administered by a public school system and in the other by a local Smart Start partnership. The initial randomization pool included a total of 2,243 children (n=821 county A, n=1,422 county B). Of these, 1,723 were assigned to the treatment condition (n=515 county A, n=1,208 county B) and 520 to the control condition (n=306 county A, n= 214 county B).

Following the randomization process and the notification of the selection decision by the local NC Pre-K programs in each county, families were then recruited for participation in the evaluation study. This timing and sequence of events resulted in some methodological challenges for sample recruitment. Information describing the study, parent permission forms, and parent demographic surveys were mailed to families' homes and also sent via email to families for whom email addresses were available. All families were given the option to respond via U.S. mail, email, or online through a dedicated website. Additional mailings, follow up emails, and phone calls were carried out, with at least 5 attempts for all non-respondents. For children in the random assignment sample who were in classroom-based early care and education (ECE) settings, recruitment materials also were sent home by teachers (once they agreed to participate) for families who had not yet responded to recruitment requests.

The study participants included a total sample of 582 children (Treatment=473, Control=109), of whom 163 children (Treatment=132, Control=31) were Spanish-speaking dual language learners (DLLs). Thus, the participation rate from the initial randomization pool was 26% (582/2,243), with slightly higher rates for the treatment group (28%) than the control group (21%).

There was a low rate of crossovers between study conditions – i.e., children who were randomly assigned to the treatment group not attending NC Pre-K or children who were randomly assigned to the control group attending NC Pre-K. A total of 8 children crossed over between both study conditions, including 5 assigned to the control group and 3 to the treatment group. Baseline equivalence analyses were conducted to compare characteristics of study participants to non-participants and treatment and control groups, and resulting weights were included in the analyses of treatment effects (see analysis approach and Appendix 2 for further details).

The rate of attrition was low overall; 570 children remained in the study from fall to spring during the pre-k year and 12 had only fall data. Comparisons of children who remained in the study (i.e., those with both fall and spring data) vs those who left the study (i.e., those with only fall data) revealed a few significant differences between these two groups for initial skill levels and demographic characteristics. Children with fall-only data had higher scores on two measures of literacy skills (WJ Letter Word and Passage Comprehension), were slightly older, and had more educated parents. Therefore, the analyses of treatment effects adjusted for fall scores as well as included weights based on demographic characteristics (see analysis approach for further details).

Teachers/Classrooms

Once families gave permission for their children to participate in the study, we contacted the site directors or principals of the pre-k programs for children enrolled in classroom-based ECE settings to inform them about the study. We then contacted the preschool teachers of study participants to obtain their consent to participate. The same recruitment strategies were used for both NC Pre-K and non-NC Pre-K classroom-based ECE settings; however, NC Pre-K sites and teachers were required to participate in study activities as part of their program requirements, whereas participation for Non-NC Pre-K sites and teachers was completely voluntary. A total of 140/156 teachers (90%, Treatment=115, Control=25) agreed to participate in the study. These represent the classrooms for 465 (98%) children in the treatment group and 27 (25%) children in the control group.

As seen in Table 1, most characteristics were similar between classrooms attended by children in the treatment and control groups. The vast majority of teachers were female (99%); about two-thirds (66%) were Black/African-American and about one-quarter (28%) White, with about 7% of Hispanic/Latino ethnicity (slightly higher in the control group). Teachers reported an average of about 8-9 years of experience teaching pre-k, and an average of about 14-15 years of total teaching experience. The average class size was approximately 16 children (about half boys and half girls), and about 70% of the children had English as a primary language, about 20% Spanish, and about 10% other languages (with higher percentages of English and lower percentages for all other languages for control group classrooms). The largest difference was teacher qualifications, which were significantly higher in the treatment group. All (100%) of the treatment group teachers held a Bachelor's degree or higher compared to about half (47%) of the control group. The majority (88%) of treatment group teachers had a B-K license compared to about one-quarter (26%) of the control group.

Data Collection Procedures

Children were assessed at two time points (Fall and Spring) for both the treatment (NC Pre-K) and waitlist (control) groups. For children in classroom-based ECE settings (which agreed to participate), individual child assessments were conducted by trained data collectors on site at the schools/centers and at home for children not in classroom-based settings. All children in the study sample were administered the child assessment measures in English. Parallel assessment procedures were used with the subsample of Spanish-speaking dual language learners (DLL), with a second administration of the same measures in Spanish by a bilingual data collector approximately 2 weeks later. Parents and teachers in both groups were asked to complete behavior rating scales following the assessments. An initial family demographic survey was gathered at the time of recruitment from the randomization pool and a second family survey was gathered at the end of the school year from the study sample. Teachers completed demographic surveys online; parents were given the option to complete surveys online or via paper forms, in either English or Spanish. For children in pre-k settings, observations of classroom practices were conducted with different trained data collectors gathering classroom quality data than child assessment data in the same classrooms. All data collectors were trained to specified certification/proficiency standards on all measures prior to gathering data. The recommended practices by the developers were followed, including didactic training, field practice with feedback, and proficiency test-offs. Inter-rater reliability data were collected for 20% of the classroom observations.

Measures

Child Assessments

The child assessment battery consisted of measures appropriate for pre-kindergarteners across five primary areas—language, literacy, math, executive function, and behavior skills. (See Table 2 for an overview of these measures, including key constructs and scoring.) All of the child assessment measures were available in both English and Spanish versions. Most of the measures used in the study were norm-referenced, so that for most outcomes, standard scores could be used. These scores take into account children's age, so that the standardized mean score of 100 represents the expected performance for an average child at a given age.

Language and literacy skills were assessed with three subtests from the Woodcock-Johnson III Tests of Achievement (WJ)[iv] in English and the Batería III Woodcock-Muñoz Pruebas de Aprovechamiento (Bat)[v] in Spanish. One measure of language skills was used. The Picture Vocabulary subtest measured vocabulary skills, including aspects of both receptive and expressive language. Two measures of literacy skills were used. The Letter-Word Identification subtest measured basic pre-reading and reading skills, including letter and word recognition and identification skills. The Passage Comprehension subtest measured symbolic learning and basic reading comprehension skills.

Math skills were assessed with two measures from the WJ/Bat. The Applied Problems subtest measured math problem-solving skills including simple comparisons, counting, addition, and subtraction. The Quantitative Concepts subtest measured knowledge of math concepts, symbols, and vocabulary.

Executive function was assessed using two measures: Forward Digit Span (FDS) and the Head-Toes-Knees-Shoulders Test (HTKS). FDS tests the phonological loop component of working memory. HTKS tests children's inhibitory control, working memory, and cognitive flexibility skills.

Behavior skills were assessed with two subscales of the Social Skills Improvement System (SSiS) completed by teachers and parents. The Social Skills subscale involved ratings of behaviors that promote positive interactions while discouraging negative interactions. The Problem Behaviors subscale involved ratings of negative behaviors, some commonly occurring and some less commonly, that interfere with social skills development. Only the parent ratings were used in the current analyses since teacher ratings were not available for control group children not attending classroom-based ECE settings.

In addition, the Pre-IPT Oral (IDEA Proficiency Test) measured oral language proficiency in English for all children and also in Spanish for the DLL subsample. Scores on this measure in the fall were examined as moderators of treatment effects to determine whether differences in children's growth on the various outcome measures were related to their initial level of language proficiency (1-3= Non-or Limited English/Spanish speaker, 4-5= Fluent English/Spanish speaker). Distributions for children in the treatment and control groups for the full sample and the DLL subsample are shown in Table 3.

Teacher Surveys

Preschool teachers in the study sample were asked to complete electronic surveys about demographic and classroom characteristics. The surveys included items about teacher demographic characteristics (gender, race, ethnicity), teacher qualifications (education, licensure, teaching experience), and

classroom characteristics (class size, proportion of boys/girls, and proportion of children with English/Spanish/Other home languages).

Parent Surveys

Demographic surveys were gathered from the initial pool of children/families at the time of study recruitment. Children's primary caregivers were asked to complete survey items about children's demographic characteristics (birthdate, gender); Pre-K experience (type of setting, hours in pre-k, name, location, and teacher); home language (for child and primary caregiver); and family and household characteristics (household composition, caregiver education, family income). A second family survey was gathered from the study sample to obtain information about activities with children at home, books in the home, beliefs about the child's kindergarten success, and preschool involvement (if relevant).

Classroom Observations

For children in classroom-based ECE settings, the quality of teacher-child instructional interactions was measured using the Classroom Assessment Scoring System (CLASS).[v] The CLASS measures teachers' interactions with children in the areas of social and emotional functioning, classroom organization and management, and curriculum implementation to support cognitive and language development. The scale includes 10 dimensions organized into three domains, with separate scores calculated for each domain. Recent research by the developers has suggested that a single total score, based on the mean of the three domain scores, can be used.[vi] For the current study, the total score was used for predictive analyses, with information at the domain and dimension levels included in descriptive analyses. The scale has demonstrated good interrater reliability based on reported data from the developers (mean agreement within one point=87.1%, range=78.8%–96.9%). For the current study, interrater reliability data similarly indicated good agreement within one point based on intraclass correlations (ICC) gathered from 19% (n=27) of the observed classrooms (Total=.91, Emotional Support=.87, Classroom Organization=.90, Instructional Support=.84).

State Administrative Data

Administrative data for the NC Pre-K Program were utilized from three statewide databases—NC Pre-K (APP), NC Pre-K Plan (Plan), and NC Pre-K Kids (Kids). Data are entered by system users from all local NC Pre-K contracts, each representing a county or multi-county region. APP data consist of the electronic application system for NC Pre-K, and include demographic information about children/families, household information, eligibility factors, prior placement, assessment evaluation, disabilities, program preferences, and placement status. Plan data (updated by contracts as needed) include hierarchically-linked information about the contracts (agency contact information), sites (site type, licensing star rating, number of classes, and program service dates), classrooms (curriculum, ongoing assessment tools, developmental screening tools, daily hours of operation, and class size), and teachers (teacher education and licensure/credentials). Kids data (reported by contracts monthly) include hierarchically-linked information about the sites (operation days and teacher workdays), classrooms (total monthly enrollment and classroom composition—number of NC Pre-K and non-NC Pre-K children), and individual children in NC Pre-K (household composition; prior placement; race; ethnicity; gender; birth date; primary caregiver's employment; payment reimbursement rate; attendance; and eligibility factors of family income level, limited English proficiency, developmental disability, identified educational need and/or IEP, chronic health condition, and parent military service).

The NC Pre-K Program Evaluation Team downloaded, verified, corrected, and archived data from these systems monthly. Data from APP were used to examine demographic and family variables associated with determining eligibility to NC Pre-K for the entire randomization pool for the RCT study. Data from Plan and Kids were used to examine statewide program characteristics for NC Pre-K from 2003–2004 through 2017-2018 (July 1–June 30), focusing on the most recent year, along with comparisons of some key characteristics over time.

Analysis Approach

Although most data were available on most measures for most participants, some data were missing due to non-response. For children in the randomization pool, demographic and family variables from NC Pre-K APP data were available for most children. Any missing data were multiply imputed using the fully conditional specification method (FCS) since many of the variables at the level of randomization were binary. For children in the study sample with missing data or who were lost to follow-up over the course of the study, we used Markov chain Monte Carlo methods to multiply impute missing data for children.

Weighting to Account for Potential Bias

The design of this study lent itself to two sources of potential bias: a) confounding bias due to lack of baseline equivalence after randomization (i.e., exchangeability between treatment and control children); and b) selection bias due to non-participation. Standardized mean differences and probability differences were used to identify imbalance in demographic characteristics for the two different sources of bias in the study. To account for these two types of bias, we constructed inverse probability of treatment and censoring weights (IPTCW).

Broadly, inverse probability weights (IPW) are a statistical tool that allows analyses to be adjusted for confounding and selection bias. IPW adjust for these biases by parametrically standardizing the study population to represent a pseudo-population. Inverse probability of treatment weights (IPTW) address confounding due to lack of exchangeability (i.e., baseline equivalence between participant treatment and control groups).[vii] [viii] Inverse probability of censoring weights (IPCW) assume censoring (i.e., participation) can be predicted by measured covariates such that weights allow participation to be independent of those variables.[ix] Inverse probability of treatment and censoring weights (IPTCW) are formed by multiplying treatment and censoring weights. What that means is participants are weighted so that their treatment and participation status are independent of measured confounding covariates.[x] This weighted analysis approach allows the effect of treatment assignment on outcomes to be independent of confounding and selection bias. The contrast we estimated with this approach compares the causal effect of the NC Pre-K program on child outcomes if everyone had been exposed to NC Pre-K and everyone who was randomized had participated compared to the effect on child outcomes if none of the children had been exposed to NC Pre-K. (See Appendix 2 for further technical details about the construction of the weights and the baseline equivalence results.)

Statistical Comparisons

To evaluate the effect of exposure to the NC Pre-K Program on preschool-aged children, we conducted intent-to-treat (ITT) analyses. To accommodate the nesting of children within schools, two-level HLM analyses were used to compare outcomes for children randomly assigned to the treatment (NC Pre-K) or the control (waitlist) groups. Partially nested models were fit to account for the effect of school-level

clustering for children assigned to NCPK.[xi] These models also allowed for separate variances to be estimated for treatment and control children. The models specified random intercepts for treatment and control groups and estimated an ICC for each treatment school that two or more treatment children attended while holding the ICC among the control group children and treatment children who were the only child at their school in the study to be zero. County was included as a fixed effect because randomization took place at the county level. An attempt was made to include county as a block in a blocked partially nested design but this resulted in model over specification. Children's fall scores on the outcome measure also were included to account for potential pre-existing differences and to increase the precision of the treatment impact estimates. The product of the two IPWs were applied as weights in all analyses to account for potential bias due to differences between the sample and participation. Multiple imputations were conducted to account for missing data on the child outcomes (n=20 multiple imputed data sets).

Two models were used to evaluate the impact of NC Pre-K on children's academic and social skills at the end of the Pre-K year. (See Appendix 2 for model specifications.) The first model was intended to determine the most direct impact of treatment with only treatment condition, county and previous fall scores included as predictors. The use of fall scores as a covariate allows for the estimate of residualized gains in children's spring scores. In addition to the main outcome analyses, we also conducted limited moderation analyses that built upon the first model with the inclusion of two moderators. These moderation analyses examined whether NC Pre-K differentially impacted children under certain conditions, specifically oral language proficiency (measured by the pre-IPT in English for English outcomes and in Spanish for Spanish outcomes) and classroom quality (indicated by CLASS total score). Language proficiency scores and CLASS total scores were entered into the model independently and then crossed with treatment to determine if there were any interactions with treatment status. Because many children in the control group were not attending a pre-k program, we created an indicator variable and used the imputed centered mean for classroom measures (e.g., CLASS=0) for those not attending pre-k. To account for testing multiple outcomes, Benjamini-Hochberg adjustments were applied. Effect sizes were calculated for significant effects as the coefficient divided by the pooled standard deviation (β /SD).

To test the sensitivity of the intent-to-treat (ITT) analyses to bias due to condition crossovers, we conducted treatment-on-the treated (TOT) analyses. The analytic strategy for the TOT was identical to that used in the ITT, with the use of partially nested HLM to accommodate the structure of the nested data and two models, an initial model evaluating the impact of treatment and a second model including potential moderators of treatment. The primary difference between the TOT and the ITT analyses was that for the TOT analyses, children who were assigned to the control group but ended up receiving the treatment were reassigned to the treatment group and children who were assigned to the treatment group but did not receive it were reassigned to the control group. Results from the ITT and TOT analyses could then be compared to evaluate the impact of who was assigned to the treatment condition versus who actually received it. The same sets of analyses were conducted for the full sample, the DLL subsample English outcomes, and the DLL subsample Spanish outcomes.

Results

Descriptive Analyses

Information from family surveys were examined descriptively to provide additional information about child and family characteristics for the study sample. The home environments for the treatment and control groups were fairly similar across a number of dimensions. There were no differences in the highest level of parent education, with about one-third in each group having a High School diploma or less (Treatment=34.6%, Control=34.0%), Some college (Treatment=35.2%, Control=34.0%), or a Bachelor's degree or above (Treatment=30.3%, Control=32.0%). Families reported having an average of around 49 books in their homes, with similar numbers reported by each group, although there was substantial variability within groups [Treatment= 47.7 (SD=55.9), Control=51.7 (SD=53.5)]. Families were asked to report the frequency of various activities at home with their children (e.g., reading, telling stories, singing songs, counting, etc.) on a 4-point scale (not at all, 1-2 times/week, 3-6 times/week, every day). The average scores were identical between the two groups (M=2.9, SD=0.6), indicating that families engaged in these activities with their children an average of nearly 3-6 times/week.

Similarly, when families were asked to report the frequency of parent involvement activities with their child's preschool, the overall scores were nearly identical for both groups [Treatment=3.2 (SD=0.9), Control=3.3 (SD=1.1)]. In order to better understand the comparative context of the control group, the researchers asked families to report the type of settings for children in ECE. Just under half (n=47, 45.6%) reported that they did not use any non-parental ECE. Private preschool was reported by 29.1% (n=30); public pre-k settings, including Head Start, by 7.8% (n=8); family child homes by 3.9% (n=4); care in the child's home by 8.7% (n=9); and for the remainder, the type was either unknown (4.9%, n=5) or not reported (5.5%, n=6).

The various outcome measures of children's language, literacy, math, executive function, and social skills were examined descriptively for the treatment and control groups. Children's fall (beginning of the pre-k year) and spring (end of the pre-k year) scores were analyzed for the full sample on English measures and the DLL subsample on both English and Spanish measures. (See Table 4, Table 5, and Table 6.) For the full sample, children in both groups were scoring close to the mean on norm-referenced measures at both time points. For the DLL subsample, scores tended to be lower for skills measured in Spanish than in English.

Observational data measuring the quality of classroom practices also were examined descriptively. Average CLASS total, domain, and dimension scores were calculated for the observed classrooms of children in the treatment and control groups attending pre-k settings. (See Table 7.) Not surprisingly, there were more classrooms represented in the treatment group than in the control group. Scores were higher in the treatment group and were slightly higher than in many samples. However, the pattern was similar for both groups (and similar to the typical pattern for ECE classrooms), with scores in the medium range in most areas (Total, Emotional Support, Classroom Organization) and in the low range for one area (Instructional Support).

Treatment Effects – Full Sample

The effects of NC Pre-K on outcomes in the areas of language, literacy, math, executive function, and social skills were examined for children in the full sample. Analyses compared differences between the treatment and control groups for outcomes during pre-k. In addition, children's oral language

proficiency and pre-k classroom quality were examined as potential moderators of the effects of treatment. Two sets of analyses were conducted – the ITT analyses provided the primary set of results testing the impact of NC Pre-K based on random assignment to treatment condition and the TOT analyses provided comparison results based on actual treatment received (accounting for crossovers).

Intent-to-Treat (ITT) – Full Sample

Two significant differences between the treatment and control groups were found based on the ITT results for the full sample (as indicated by significant coefficients for Treatment). (See Table 8 and Figure 1 and Figure 2.) There were positive effects of treatment on residualized gains for vocabulary skills (WJ Picture Vocabulary β=2.64, effect size=.22) and on letter and word recognition skills (WJ Letter-Word Identification, β=3.90, effect size=.27). There were no moderating effects of children's English proficiency level on treatment for any of the outcome measures. There also were no moderating effects of pre-k classroom quality (CLASS scores) on treatment for children who attended preschool settings.

These results indicate that eligible children who were randomly assigned to NC Pre-K (treatment group) had better vocabulary and letter and word recognition skills at the end of pre-k (after adjusting for their skills at the beginning of pre-k) compared to children who were randomly assigned to the waitlist (control group). Furthermore, these differences were not differentially affected by children's level of English language proficiency or the quality of their pre-k classrooms.

Treatment-on-Treated (TOT) – Full Sample

Next, parallel analyses were conducted to address condition crossovers – a few children in the treatment group did not attend NC Pre-K and a few children in the control group did attend NC Pre-K. The results from the TOT analyses were consistent with the results from the ITT analyses for the full sample, with two significant differences between the treatment and control groups (as indicated by significant coefficients for Treatment). (See Table 9.) There were positive effects of treatment on residualized gains for vocabulary skills (WJ Picture Vocabulary, β=3.24, effect size=.27) and on letter and word recognition skills (WJ Letter-Word Identification, β=4.03, effect size=.28). There were no moderating effects of children's English proficiency level on treatment for any of the outcome measures. There also were no moderating effects of pre-k classroom quality (CLASS scores) on treatment for children who attended preschool settings.

These results indicate that eligible children who attended NC Pre-K had better vocabulary and letter and word recognition skills at the end of pre-k (after adjusting for their skills at the beginning of pre-k) compared to children did not attend NC Pre-K. Furthermore, these differences were not differentially affected by children's level of English language proficiency or the quality of their pre-k classrooms. These findings from the TOT analyses are consistent with those from the ITT analyses. The similarity of the two sets of results indicates that any differences among families that may have affected decisions to enroll in NC Pre-K did not have any significant impact on the effects of treatment. Thus, these findings suggest that the ITT results are robust to potential threats from selection bias due to variability in treatment uptake by those initially offered NC Pre-K through random assignment and to exposure to treatment by those in the control group.

Treatment Effects – DLL Subsample

The effects of NC Pre-K on outcomes in the areas of language, literacy, math, executive function, and social skills were examined for children in the DLL subsample. Analyses compared differences between the treatment and control groups for outcomes in both English and Spanish during pre-k. In addition, children's oral language proficiency and pre-k classroom quality were examined as potential moderators of the effects of treatment. These analyses provided an additional set of results to specifically examine the outcomes for this subsample of children. Two sets of analyses were conducted to examine the effects for the DLL subsample – the ITT comparisons provided the primary set of results to test the impact of NC Pre-K based on random assignment to treatment and the TOT comparisons provided results of sensitivity analyses to test the impact of NC Pre-K based on actual treatment received.

ITT - DLL Subsample

For skill measured in English, two significant differences between the treatment and control groups were found based on the ITT results for the DLL subsample (as indicated by significant coefficients for Treatment). (See Table 10 and Figure 3 and Figure 4.) There were positive effects of treatment on residualized gains for letter and word recognition skills (WJ Letter-Word Identification, β=7.93, effect size=.64) and knowledge of math concepts (WJ Quantitative Concepts, β=5.27, effect size=.39). For two additional measures, vocabulary (WJ Picture Vocabulary) and math problem-solving (WJ Applied Problems), significant effects were not maintained after applying the adjustments for multiple tests. There were no moderating effects of children's English proficiency level on treatment for any of the outcome measures. There also were no moderating effects of pre-k classroom quality (CLASS scores) on treatment for children who attended preschool settings.

These results indicate that among the DLL subsample, eligible children who were randomly assigned to NC Pre-K (treatment group) had better letter and word recognition skills and knowledge of math concepts at the end of pre-k (after adjusting for their skills at the beginning of pre-k) compared to children who were randomly assigned to the waitlist (control group). Furthermore, these differences were not differentially affected by children's level of English language proficiency or the quality of their pre-k classrooms.

For these same skills measured in Spanish, the ITT analyses found no significant differences between the treatment and control groups for children in the DLL subsample. (See Table 11.) There was one marginally significant effect for written comprehension skills (Bat PC), but this effect did not persist after applying the adjustments for multiple tests. There also were no moderating effects of children's Spanish proficiency level or pre-k classroom quality (for children who attended preschool settings) on treatment.

TOT - DLL Subsample

Similar results for the TOT analyses and the ITT analyses were found for the DLL subsample for skills measured in English. Three significant differences between the treatment and control groups (as indicated by significant coefficients for Treatment) were found for the TOT analyses. (See Table 12.) There were positive effects of treatment on residualized gains for vocabulary skills (WJ Picture Vocabulary, β=5.56, effect size=.42), on letter and word recognition skills (WJ Letter-Word Identification, β=8.81, effect size=.71), and on knowledge of math concepts (WJ quantitative concepts, β=5.61, effect size=.43). Similarly to the ITT results, significant effects for math problem-solving (WJ AP) were not maintained after applying the adjustments for multiple tests, as well as for one measure of executive function skills (HTKS). There were no moderating effects of children's English proficiency level on

treatment for any of the outcome measures. There also were no moderating effects of pre-k classroom quality (CLASS scores) on treatment for children who attended preschool settings.

These results indicate that among children in the DLL subsample, eligible children who attended NC Pre-K had better vocabulary, letter and word recognition skills, and knowledge of math concepts at the end of pre-k (after adjusting for their skills at the beginning of pre-k) compared to children who did not attend NC Pre-K. Furthermore, these differences were not differentially affected by children's level of English language proficiency or the quality of their pre-k classrooms. The TOT results paralleled the findings from the ITT analyses for both measures (math concepts and letter/word recognition). For a third measure (vocabulary), only the TOT results were significant. However, the coefficient for vocabulary in the ITT analyses was statistically significant ($p<.01$, effect size=.33) before applying the adjustments for multiple tests.

For these same skills measured in Spanish, the TOT analyses found no significant differences between the treatment and control groups for children in the DLL subsample. (See Table 13.) Similarly to the results for the ITT analyses, there was one significant effect for written comprehension skills (Bat PC), but this effect did not persist after applying the adjustments for multiple tests. There also were no moderating effects of children's Spanish proficiency level or pre-k classroom quality (for children who attended preschool settings) on treatment. These findings are consistent between the ITT and TOT analyses.

Program Characteristics

Descriptive data were analyzed to provide information about the NC Pre-K Program for the 2017-2018 school year. In 2017-2018, the NC Pre-K Program served 30,035 children in 2,007 classrooms located in 1,167 sites. The average total class size was approximately 16 children, with an average of 86% (13.5) of those children funded by NC Pre-K. On average, children attended NC Pre-K for 137 days, which represents 81% of the average days of operation (170) or 76% of the 180 intended days of operation based on program guidelines. In terms of NC star-rated licenses (the Quality Rating and Improvement System or QRIS in NC), nearly 80% of the sites had a five-star rating and 15% had a four-star rating, with the remainder either temporary or in process. (See Table 14.)

Almost all classrooms reported using an early childhood curriculum, ongoing assessment tool, and developmental screening tool from the approved lists provided by the NC Pre-K Program Guidelines. Over 90% of classrooms reported using Creative Curriculum and its companion assessment (Teaching Strategies Gold or the Creative Curriculum Developmental Continuum). All classrooms reported using an approved developmental screening tool, with most using either DIAL (53%) or Brigance (39%). (See Table 15.) NC Pre-K classrooms were located in approximately half (52%) public school settings; about one-third (33%) private settings (25% for-profit and 8% non-profit child care centers); and 15% Head Start (4% administered by public schools and 11% not). (See Table 16.)

In 2017-2018, the children served in NC Pre-K were about half boys and half girls from a variety of racial and ethnic backgrounds, including slightly under one-half (48%) White, over one-third (36%) Black/African-American, and almost one-quarter (24%) of Hispanic/Latino ethnicity. Nearly 80% of the children attending NC Pre-K had at least one parent in the workforce. (See Table 17.) Children served by the NC Pre-K Program primarily came from low-income families, with 88% eligible for free or reduced-price lunch. Children also varied on other eligibility factors, ranging from 19-22% with limited

English proficiency or a developmental/educational need to 4-5% with an identified disability, chronic health condition, or military parent. (See Table 18.) Information on children's prior placement indicated that almost three-quarters had never previously been served in any preschool setting (58%) or were currently unserved (14%) at the time of enrollment (see Table 19).

Almost all (over 99%) lead teachers in the NC Pre-K Program in 2017–2018 had at least a bachelor's degree in both public school and private settings (see Table 20). Nearly all teachers in public school settings (96%) and most in private settings (86%) had a Birth-Kindergarten (B-K) license (or the equivalent). Relatively few teachers in public school settings (0.4%) and in private settings (11%) reported no credential. (See Table 21.)

Trend Analyses

Results from trend analyses examined whether there have been any long-term changes in key program characteristics since the NC Pre-K Program (formerly More at Four) became statewide (2003-2004) through the 2017-2018 program year. Evidence of a linear trend, or change over time in a given characteristic, is indicated by $R^2 \geq .70$; conversely, evidence of no linear trend, or little change over time, is indicated by $R^2 < .70$. Distributions are shown for key program characteristics over time, including setting type (see Table 22), children's prior placement (see Table 23), teacher education (see Table 24), and teacher licensure/credentials (see Table 25).

Results indicated that there was little change over time in the distribution of NC Pre-K classrooms by setting types (percentages of public pre-k, private, and Head Start), with no evidence of linear trends for any of these categories (as indicated by $R^2 < .70$). (See Figure 5.) The results for children's prior placement similarly showed fairly consistent patterns over time, with no evidence of linear trends for the proportion of children never served (never served) and the proportion not served at the time of enrollment (unserved). (See Figure 6.)

Results from trend analyses indicated that one consistent change in the program has been the increases in teacher qualifications (education and licensure/credentials) over time. There were significant changes over time for all three aspects of teacher qualifications that were examined (see Figure 7). For teacher education (percentage with bachelor's degree or above), results indicate an increasing trend over time ($R^2 = 0.78$). It should be noted that teacher education has essentially reached the maximum level from cohorts 9-13, which decreases the goodness-of-fit statistic, although it is still within the acceptable range. For lead teacher licensure and credentials, the results indicate two parallel trends – an increasing trend in the percentage of those with a B-K license ($R^2 = 0.98$) and a decreasing trend in the percentage of those with no credential ($R^2 = 0.79$).

Conclusions

The current study addressed the issue of the benefits of offering children and families access to enrollment in NC Pre-K – the state pre-k program in North Carolina. Whether children benefit from participation in NC Pre-K was tested through a small-scale RCT study conducted in two counties. Such a design is considered the gold standard for examining this type of question.

Children who were eligible for and had applied to NC Pre-K were randomly assigned to either the program (treatment group) or the waitlist (control group). Results from the study indicated some consistent effects on language and literacy skills at the end of pre-k, with better performance for children in the treatment group than in the control group (after adjusting for initial performance). Differences were found for vocabulary and letter and word recognition skills – two key measures related to subsequent school readiness as well as later reading and school success. For the subsample of Spanish-speaking DLLs, these effects again were found for letter and word recognition skills measured in English, as well as for knowledge of math concepts in English (a skill that has both math and literacy aspects). Moreover, all of these results were found in both the ITT and the TOT analyses, suggesting that these effects are consistent when considering actual treatment received rather than randomly assigned.

However, it also is important to note that the study did not find significant effects for other measures after adjusting for multiple tests, including other measures of literacy (written comprehension) and math skills (problem solving), executive function, and parent ratings of social skills and problem behaviors. The researchers used strict criteria for significance as well as conservative adjustments to guard against false positive effects, and thus excluded some results from the final set of findings that did not meet these criteria. There also were no significant differences when skills were measured in Spanish rather than in English for the DLL subsample, although that is less surprising given that the language of instruction in these classrooms generally is in English. We also asked, secondarily, whether children's level of oral language proficiency or the quality of their pre-k classroom (for children in pre-k settings) affected the impact of treatment. The results indicated that treatment was not differentially affected by either of these factors.

Although the study had few cases of children not receiving the treatment condition they were assigned (crossovers) or not remaining in the study for the duration (attrition), the analysis approach utilized methods to address any resulting differences in baseline equivalence. However, there were methodological challenges affecting sample size that may have implications for the limited set of findings as well as the generalizability of the results. First, given that NC Pre-K is a mature state pre-k program, a feasibility study was conducted to determine viable locations for conducting the study. Based on these results, the study was limited to the selection of two counties that met the criteria with regard to program enrollment, waitlist, and ability to utilize a random assignment selection process. Second, children and families were recruited for study participation following randomization and notification of the selection decision by the program, which may have reduced the study participation rate, even slightly more for the control group.

The limited set of positive findings with regard to treatment effects may be partially explained by the settings in which the study was conducted. North Carolina in general has a long-standing history of providing ECE and family supports that are particularly directed toward low-income families such as those applying to the NC Pre-K Program. Even though the majority of children in the control group were

not in a pre-k program, they still may have benefited from services provided through initiatives such as Smart Start that would have positive impacts on the types of outcomes measured in the current study. Further, the small-scale design of the study, along with the necessary conditions for feasibility, imposed limitations on the locales within which it could be conducted. Because the study included only two counties, both of which were well-resourced, families in the control group likely had other opportunities for educational and social supports outside of participation in a pre-k program.

Results from previous evaluations of the NC Pre-K Program generally have found a wider range of positive effects of pre-k participation on children's school readiness and early elementary academic and social outcomes using other types of comparison designs.[xii] [xiii] [xiv] However, these studies have included more representative samples with greater power to detect differences. Similar results have been found for other studies of state pre-k programs using similar methodologies. [xv] [xvi] A recent statewide study of the TN VPK Program also using an RCT design with a larger sample found significant positive effects on children's academic skills through pre-k, but these effects did not last as they followed them from kindergarten through third grade. [xvii]

In sum, the results from this small-scale RCT study suggest that there is some evidence of positive effects for participation in the NC Pre-K Program, particularly around language and literacy knowledge, as well as literacy and math concepts for DLLs. However, there are limitations to the current study and further research would be beneficial. State pre-k programs are widespread throughout the U.S., and there is a range of research evidence to support the benefits of ECE programs. [xv] [xvi] However, there still are unanswered questions about the best ways to support and sustain young children's learning and education in pre-k and beyond in order to meet the goal of helping all children achieve success in school.

Table 1. Characteristics of Sample Teachers and Classrooms

Teacher Characteristics	All (n=140)	Control (n=25)	Treatment (n=115)
	n (%)	n (%)	n (%)
Gender			
Female	121 (99.2)	19 (100)	102 (99.0)
Male	1 (0.8)	0	1 (1.0)
Race			
Black/African-American	80 (66.1)	11 (61.1)	69 (67.0)
Other	7 (5.8)	1 (5.6)	6 (5.8)
White	34 (28.1)	6 (33.3)	28 (27.2)
Hispanic/Latino ethnicity	8 (6.6)	2 (10.5)	6 (5.8)
Education			
HS/AS	10 (8.5)	10 (52.6)	0
BA/BS	94 (79.7)	4 (21.1)	90 (90.9)
MA/MS	14 (11.9)	5 (26.3)	9 (9.1)
Licensure			
Birth to Kindergarten	96 (78.7)	5 (26.3)	91 (88.3)
Other state/NC license	5 (4.1)	1 (5.3)	4 (3.9)
None	21 (17.2)	13 (68.4)	8 (7.8)
Teacher Type			
Non-NC Pre-K	18 (14.8)	17 (89.5)	1 (1.0)
NC Pre-K	104 (85.2)	2 (10.5)	102 (99.0)
Teacher Experience			
Years teaching pre-k			
Mean (SD)	9.0 (6.7)	8.0 (7.3)	9.2 (6.6)
Min-Max	0.0 (33.8)	0.0 (25.0)	0.0 (33.8)
Years teaching any age			
Mean (SD)	14.6 (8.2)	13.3(7.0)	14.8 (8.3)
Min-Max	0.0 (40.8)	1.0(28.0)	0.0 (40.8)
Classroom Characteristics	Mean (SD)	Mean (SD)	Mean (SD)
Class size	16.3 (3.1)	14.7 (5.1)	16.6 (2.5)
Proportion of boys	0.5 (0.1)	0.5 (0.2)	0.5 (0.1)
Proportion of children's home languages			
English	0.7 (0.2)	0.9 (0.2)	0.7 (0.2)
Spanish	0.2 (0.2)	0.1 (0.2)	0.2 (0.2)
Other	0.1 (0.1)	0.0 (0.1)	0.1 (0.1)

Table 2. Child Outcome and Classroom Quality Measures

Measure	Scoring
Language Skills	
Vocabulary	
WJ Picture Vocabulary (Subtest 14) / Bat Vocabulario sobre Dibujos (Prueba 14)	Standard score Mean=100, SD=15
Literacy Skills	
Letter-and Word Recognition	
WJ Letter-Word Identification (Subtest 1) / Bat Identificación de Letras y Palabras (Prueba 1)	Standard score Mean=100, SD=15
Written Comprehension	
WJ Passage Comprehension (Subtest 9) / Bat Comprension de Textos (Prueba 9)	Standard score Mean=100, SD=15
Math Skills	
Math Problem-Solving	
WJ Applied Problems (Subtest 10) / Bat Problemas Aplicados (Prueba 10)	Standard score Mean=100, SD=15
Math Concepts and Symbols	
WJ Quantitative Concepts (Subtest 18) / Bat Razonamiento Cuantitativo (Prueba 18)	Standard score Mean=100, SD=15
Executive Function	
Working Memory	Raw score
Forward Digit Span (English/Spanish)	Range=1-8
Executive Function	Raw score
Head-Toes-Knees-Shoulders Test (HTKS) (English/Spanish)	Range=0-60
Behavior Skills	
Social Skills	Standard score
SSiS Social Skills subscale	Mean=100, SD=15
Problem Behaviors	Standard score
SSiS Problem Behaviors subscale	Mean=100, SD=15
Classroom Quality	
Teacher-Child Instructional Interactions	
CLASS Total & Emotional Support, Classroom Observation, & Instructional Support Domains	Total and Domain scores range=1.0–7.0

WJ = *Woodcock III Johnson Tests of Achievement*; Bat = *Batería III Woodcock-Muñoz Pruebas de Aprovechamiento*; SSiS = *Social Skills Improvement System*; CLASS = *Classroom Assessment Scoring System.*

Table 3. Child Language Proficiency Levels

Pre-IPT Proficiency Level	Full Sample						DLL Subsample									
	English Proficiency						English Proficiency						Spanish Proficiency			
	All		Control		Treatment		All		Control		Treatment		Control		Treatment	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Level 1 (Non-Speaking)	7.0	41	9.0	9	6.6	31	16.7	27	30.0	9	13.6	18	10.0	3	19.8	26
Level 2 (Limited)	15.8	90	12.0	12	16.6	78	24.1	39	20.0	6	25.0	33	40.0	12	27.5	36
Level 3 (Limited)	15.1	86	19.0	19	14.3	67	16.7	27	16.7	5	16.7	22	20.0	6	20.6	27
Level 4 (Fluent)	18.6	106	16.0	16	19.2	90	18.5	30	10.0	3	20.5	27	10.0	3	14.5	19
Level 5 (Fluent)	43.4	247	44.0	44	43.3	203	24.1	39	23.3	7	24.2	32	20.0	6	17.6	23
Total	100.0	582	100.0	109	100.0	473	100.0	163	100.0	31	100.0	132	100.0	31	100.0	132

Table 4. Outcome Scores for Full Sample

		All					Control					Treatment			
		N	*Mean*	*SD*	*Min*	*Max*	*N*	*Mean*	*SD*	*Min*	*Max*	*N*	*Mean*	*SD*	*Min*	*Max*
Language																
WJ Picture Vocab	*fall*	560	96.41	13.30	42	133	98	97.08	14.52	48	133	462	96.27	13.04	42	132
	spring	556	96.74	11.97	44	137	100	95.94	13.41	52	126	456	96.92	11.64	44	137
Literacy																
WJ Letter-Word ID	*fall*	569	100.2	14.32	64	178	100	100.8	17.21	66	178	469	100.1	13.64	64	159
	spring	561	101.6	14.67	61	176	103	99.49	18.78	61	161	458	102.1	13.55	68	176
WJ Passage Comp	*fall*	568	98.90	9.56	71	138	100	99.36	10.87	72	138	468	98.81	9.26	71	138
	spring	560	100.2	9.78	68	144	103	102.3	11.18	73	144	457	99.70	9.38	68	138
Math																
WJ Applied Problems	*fall*	569	102.0	12.56	51	149	100	102.4	13.57	58	149	469	101.9	12.35	51	136
	spring	561	103.5	11.45	53	150	103	103.1	14.29	53	150	458	103.6	10.72	55	135
WJ Quant Concepts	*fall*	553	95.43	13.34	68	149	97	96.71	15.94	73	149	456	95.16	12.72	68	137
	spring	557	96.50	13.81	61	145	101	96.97	16.12	63	145	456	96.40	13.26	61	134
Executive Function																
Forward Digit Span	*fall*	569	3.89	0.95	1	70	100	3.88	0.88	1	5	469	3.90	0.97	1	7
	spring	561	4.20	0.98	1	80	103	4.20	1.11	1	8	458	4.20	0.95	1	8
HTKS	*fall*	568	11.72	15.25	0	550	100	10.22	14.09	0	46	468	12.04	15.48	0	55
	spring	559	21.59	18.28	0	600	103	20.17	17.32	0	55	456	21.91	18.50	0	60

Table 4 (Cont.) Outcome Scores for Full Sample

		All					Control					Treatment			
		N	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*
Behavior Skills																
SSiS Social Skills	*fall*	379	107.6	12.93	67	134	84	105.9	12.30	67	134	295	108.1	13.08	71	134
	spring	432	110.5	14.08	51	134	84	108.8	13.66	75	134	348	110.9	14.17	51	134
SSiS Problem Behaviors	*fall*	375	98.22	14.93	77	160	81	100.2	16.54	77	160	294	97.69	14.44	77	156
	spring	432	97.88	15.67	77	160	84	101.4	17.94	77	160	348	97.03	14.97	77	160

Table 5. Outcome Scores for DLL Subsample – English Measures

		All					Control					Treatment			
		N	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*
Language																
WJ Picture Vocab	*fall*	155	86.59	15.94	42	117	28	84.21	17.41	48	112	127	87.12	15.62	42	117
	spring	157	88.35	13.43	44	115	28	85.14	16.95	52	110	129	89.05	12.51	44	115
Literacy																
WJ Letter-Word ID	*fall*	162	94.33	11.94	64	119	30	88.93	9.56	66	113	132	95.56	12.12	64	119
	spring	161	95.40	13.31	61	133	31	86.06	13.82	61	133	130	97.63	12.22	69	130
WJ Passage Comp	*fall*	162	98.93	8.01	71	116	30	98.93	8.32	76	115	132	98.92	7.97	71	116
	spring	161	100.1	7.55	82	133	31	100.1	9.66	82	133	130	100.1	7.00	86	120
Math																
WJ Applied Problems	*fall*	162	97.88	13.30	58	128	30	94.73	13.97	58	118	132	98.59	13.09	62	128
	spring	161	100.4	12.14	53	129	31	93.84	14.90	53	120	130	102.0	10.87	76	129
WJ Quant Concepts	*fall*	152	91.42	11.53	68	121	27	90.00	11.11	74	121	125	91.73	11.64	68	120
	spring	159	92.92	13.28	61	122	29	88.28	11.63	63	111	130	93.95	13.44	61	122
Executive Function																
Forward Digit Span	*fall*	162	3.55	0.87	1	6	30	3.60	1.00	1	5	132	3.54	0.84	1	6
	spring	161	3.83	0.77	1	6	31	3.74	0.73	3	6	130	3.85	0.78	1	6
HTKS	*fall*	162	11.33	15.98	0	55	30	8.60	13.07	0	43	132	11.95	16.55	0	55
	spring	161	20.84	18.79	0	60	31	15.55	16.81	0	54	130	22.11	19.07	0	60
Behavior Skills																
SSiS Social Skills	*fall*	102	107.6	11.97	67	134	26	104.7	12.22	67	120	76	108.5	11.81	83	134
	spring	102	109.5	13.26	75	133	24	106.0	13.90	75	126	78	110.5	12.97	82	133
SSiS Problem Behaviors	*fall*	98	101.3	11.71	77	134	23	100.6	10.39	84	122	75	101.6	12.13	77	134
	spring	101	102.7	13.80	77	160	23	105.8	18.23	78	160	78	101.8	12.20	77	142

Table 6. Outcome Scores for DLL Subsample – Spanish Measures

		All					Control					Treatment			
		N	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*	*N*	*Mean*	*Std*	*Min*	*Max*
Language																
Bat Picture Vocab	*fall*	148	74.63	18.75	41	114	29	73.52	21.77	43	110	119	74.90	18.03	41	114
	spring	143	73.54	18.72	41	113	29	71.17	20.04	41	110	114	74.14	18.42	42	113
Literacy																
Bat Letter-Word ID	*fall*	161	90.76	9.72	67	119	30	86.87	10.37	69	107	131	91.66	9.38	67	119
	spring	161	89.41	10.27	67	117	31	86.39	9.77	69	107	130	90.13	10.29	67	117
Bat Passage Comp	*fall*	152	87.37	16.85	47	120	27	82.63	15.73	48	115	125	88.39	16.96	47	120
	spring	157	90.59	16.69	46	118	30	87.60	16.59	48	110	127	91.30	16.70	46	118
Math																
Bat Applied Problems	*fall*	161	94.71	11.33	57	125	30	94.40	9.39	77	113	131	94.79	11.76	57	125
	spring	161	96.25	12.30	52	131	31	94.39	8.43	80	112	130	96.70	13.04	52	131
Bat Quant Concepts	*fall*	159	86.83	10.25	64	118	30	82.90	9.87	68	113	129	87.74	10.16	64	118
	spring	160	86.04	11.16	59	128	31	83.23	9.17	64	100	129	86.72	11.51	59	128
Executive Function																
Forward Digit Span - Spanish	*fall*	161	3.52	0.81	1	6	30	3.37	0.93	1	5	131	3.55	0.79	1	6
	spring	160	3.60	0.84	1	6	30	3.50	0.82	2	6	130	3.62	0.85	1	5
HTKS - Spanish	*fall*	161	14.78	18.18	0	59	30	12.33	16.27	0	52	131	15.34	18.60	0	59
	spring	160	25.36	20.78	0	59	31	22.45	21.32	0	58	129	26.05	20.67	0	59

Table 7. Classroom Quality Scores

	Total (n=139)	Control (n=25)	Treatment (n=114)
	Mean (SD)	Mean (SD)	Mean (SD)
CLASS Total	**4.5 (0.6)**	**3.9 (0.6)**	**4.7 (0.5)**
(Range)	2.8 - 6.0	2.8 - 5.4	3.3 - 6.0
Emotional Support	**5.7 (0.6)**	**5.1 (0.6)**	**5.8 (0.5)**
(Range)	3.6 - 6.8	3.6 - 6.1	3.9 - 6.8
Positive Climate	5.7 (0.8)	5.0 (0.8)	5.8 (0.7)
Negative Climate	1.2 (0.3)	1.4 (0.5)	1.2 (0.3)
Teacher Sensitivity	5.3 (0.9)	4.5 (0.9)	5.5 (0.8)
Regard for Student Perspectives	4.9 (0.9)	4.2 (0.9)	5.0 (0.8)
Classroom Organization	**5.3 (0.7)**	**4.5 (0.7)**	**5.4 (0.6)**
(Range)	2.8 - 6.9	2.8 - 6.1	4.0 - 6.9
Behavior Management	5.6 (0.8)	5.0 (0.9)	5.8 (0.6)
Productivity	5.6 (0.8)	4.9 (0.8)	5.8 (0.6)
Instrumental Learning Formats	4.6 (0.8)	3.7 (0.7)	4.8 (0.7)
Instructional Support	**2.7 (0.7)**	**2.0 (0.6)**	**2.8 (0.6)**
(Range)	1.2 - 4.6	1.4 - 4.0	1.2 - 4.6
Concept Development	2.2 (0.7)	1.5 (0.6)	2.3 (0.7)
Quality of Feedback	2.5 (0.8)	2.0 (0.7)	2.7 (0.8)
Language Modeling	3.3 (0.9)	2.6 (0.8)	3.4 (0.9)

Table 8. ITT Results – Full Sample

	Executive Function		Language / Literacy		
	FDS	HTKS	WJ PV	WJ LW	WJ PC
Model 1					
Intercept	4.16 (0.11)	21.82 (1.69)	93.79 (0.71)	97.55 (0.85)	101.41 (1.11)
Treatment	0.02 (0.11)	0.35 (1.85)	2.64***(0.77)	3.9***(0.87)	-1.46 (1.16)
County	0.11 (0.09)	0.06 (1.75)	1.78 (0.64)	2.37 (0.69)	-0.21 (0.95)
Fall score	0.56 (0.03)	0.69 (0.04)	0.74 (0.02)	0.85 (0.03)	0.3 (0.04)
Model 2					
CLASS	-0.07 (0.26)	-0.37 (4.49)	-0.16 (1.83)	1.16 (2.2)	4.48 (2.83)
English Prof	-0.08 (0.21)	2.11 (3.31)	3.61 (1.48)	2.18 (1.67)	-1.03 (2.22)
No PK	0.2 (0.22)	2.17 (3.97)	-1.5 (1.59)	-3.91 (1.84)	-0.64 (2.38)
CLASS x Trt	0.23 (0.28)	2.74 (4.77)	0.69 (1.93)	-0.87 (2.31)	-3.09 (2.96)
Eng Prf x Trt	0.21 (0.22)	0.28 (3.58)	-1.89 (1.58)	-3.01+ (1.81)	0.65 (2.41)

	Math		Behavior Skills	
	WJ AP	WJ QC	SSiS Social Skills	SSiS Prob Beh
Model 1				
Intercept	102.82 (0.94)	94.8 (1.06)	110.18 (1.22)	99.17 (1.52)
Treatment	0.47 (0.97)	1.06 (1.09)	0.51 (1.25)	-2.36 (1.57)
County	1 (0.79)	2.09 (0.82)	0.62 (1.01)	1.95 (1.27)
Fall score	0.67 (0.03)	0.75 (0.03)	0.75 (0.04)	0.72 (0.05)
Model 2				
CLASS	1.88 (2.37)	3.26 (2.74)	-0.24 (2.95)	-1.44 (3.53)
English Prof	4.01 (1.84)	3.59 (2.15)	-1.55 (2.23)	0.52 (2.65)
No PK	-2.31 (1.93)	0.83 (2.35)	0.17 (2.53)	3.21 (2.89)
CLASS x Trt	-0.75 (2.48)	-3.89 (2.87)	1.14 (3.16)	0.77 (3.73)
Eng Prf x Trt	-4.01 (1.94)	-2.91 (2.3)	0.85 (2.5)	-1.55 (3.02)

p-values * p<.05; **p<.01; ***p<.001

Figure 1. ITT- Full Sample WJ Picture Vocabulary

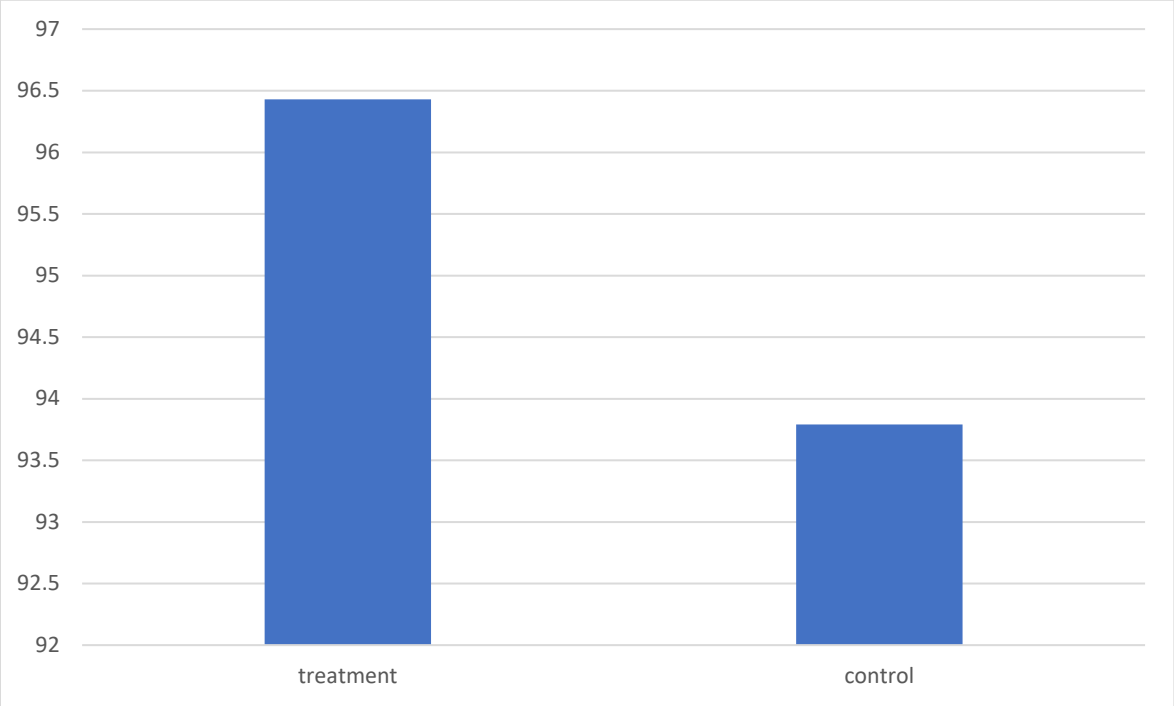


Figure 2. ITT- Full Sample WJ Letter-Word Identification

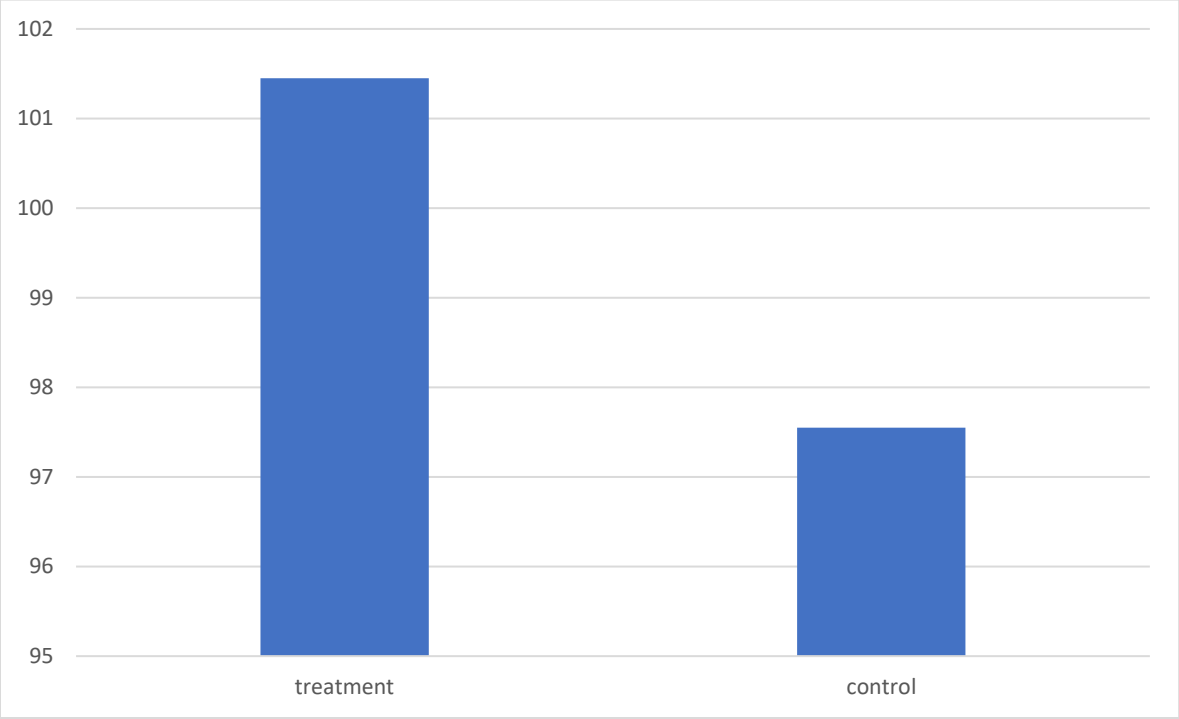


Table 9. TOT Results – Full Sample

	Executive Function		Language / Literacy		
	FDS	HTKS	WJ PV	WJ LW	WJ PC
Model 1					
Intercept	4.24 (0.11)	20.49 (1.71)	93.11 (0.78)	97.35 (0.87)	101.27 (1.14)
Treatment	-0.06 (0.12)	1.44 (1.83)	3.24***(0.83)	4.03***(0.9)	-1.36 (1.18)
County	0.07 (0.1)	0.34 (1.7)	1.99 (0.67)	2.41 (0.72)	-0.08 (0.97)
Fall score	0.57 (0.03)	0.69 (0.04)	0.74 (0.02)	0.86 (0.03)	0.3 (0.04)
Model 2					
CLASS	-0.26 (0.26)	-2.22 (4.14)	0.04 (1.8)	-0.05 (2.06)	3.28 (2.68)
English Prof	-0.06 (0.23)	4.87 (3.36)	4.71 (1.66)	2.7 (1.72)	-0.14 (2.3)
No PK	0.27 (0.22)	2.2 (3.97)	-1.66 (1.68)	-4.3 (1.85)	-0.71 (2.42)
CLASS x Trt	0.42 (0.27)	4.74 (4.41)	0.54 (1.9)	0.25 (2.17)	-1.85 (2.82)
Eng Prf x Trt	0.2 (0.24)	-2.49 (3.66)	-3.01 (1.72)	-3.66 (1.86)	-0.18 (2.46)

	Math		Behavior Skills	
	WJ AP	WJ QC	SSiS Social Skills	SSiS Prob Beh
Model 1				
Intercept	102.56 (0.97)	94.01 (1.08)	110.16 (1.16)	98.72 (1.45)
Treatment	0.69 (1.01)	1.74 (1.11)	0.46 (1.2)	-1.78 (1.5)
County	1.1 (0.82)	2.17 (0.85)	0.61 (1.01)	2.04 (1.29)
Fall score	0.66 (0.03)	0.75 (0.03)	0.75 (0.04)	0.71 (0.05)
Model 2				
CLASS	1.35 (2.28)	2.07 (2.56)	1.03 (2.92)	-1.46 (3.4)
English Prof	4.46 (1.96)	4.31 (2.21)	0.62 (2.34)	0.67 (2.75)
No PKe	-2.41 (2.03)	1.16 (2.32)	-0.86 (2.65)	3.87 (2.96)
CLASS x Trt	-0.41 (2.4)	-2.64 (2.7)	-0.07 (3.05)	0.63 (3.65)
Eng Prf x Trt	-4.56 (2.04)	-3.37 (2.35)	-1.57 (2.59)	-1.61 (3.12)

p-values * p<.05; **p<.01; ***p<.001

Table 10. ITT Results - DLL Subsample English Outcomes

	Executive Function		Language / Literacy		
	FDS	HTKS	WJ PV	WJ LW	WJ PC
Model 1					
Intercept	4.01 (0.15)	17.64 (3.05)	91.39 (1.66)	90.92 (1.88)	99.25 (1.78)
Treatment	0.02 (0.14)	4.27 (3.14)	4.11 (1.58)	7.93***(1.83)	0.93 (1.77)
County	-0.1 (0.13)	0.2 (2.97)	0.91 (1.09)	5.09 (1.66)	-0.26 (1.23)
Fall score	0.4 (0.06)	0.63 (0.08)	0.7 (0.03)	0.71 (0.06)	0.06 (0.07)
Model 2					
CLASS	-0.27 (0.36)	5.66 (6.83)	-0.8 (3.63)	0.54 (4.03)	2.26 (4.64)
English Prof	-0.3 (0.32)	11.09 (6.03)	6.25 (3.36)	-1.71 (3.61)	-2.48 (4.16)
No PK	0.27 (0.34)	-8.14 (6.53)	-2.6 (3.42)	-10.7 (3.85)	1.6 (4.21)
CLASS x Trt	0.42 (0.37)	-2.37 (7.29)	2.13 (3.74)	-1 (4.26)	-2.18 (4.74)
Eng Prf x Trt	0.27 (0.34)	-4.84 (6.62)	-6.51+ (3.52)	2.24 (3.94)	1.86 (4.37)

	Math		Behavior Skills	
	WJ AP	WJ QC	SSiS Social Skills	SSiS Prob Beh
Model 1				
Intercept	97.72 (2.07)	90.36 (1.54)	109.27 (2.34)	102.07 (2.83)
Treatment	5.2 (2.02)	5.27***(1.49)	0.91 (2.27)	-3.57 (2.81)
County	3.22 (1.48)	3.44 (1.31)	-0.15(1.84)	2.55 (2.21)
Fall score	0.62 (0.05)	0.79 (0.05)	0.71 (0.08)	0.69 (0.09)
Model 2				
CLASS	-0.32 (5.36)	0.05 (3.66)	0.36 (5.35)	0.18 (6.93)
English Prof	0.6 (5.02)	3.03 (3.34)	-2.52 (4.99)	-2.45 (6.67)
No PK	-5.36 (4.72)	1.95 (3.63)	0.92 (5.64)	-2.69 (6.62)
CLASS x Trt	0.45 (5.47)	-1.56 (3.87)	0.88 (5.57)	-1.23 (7.1)
Eng Prf x Trt	1.1 (5.12)	-1.05 (3.64)	1.2 (5.26)	1.42 (7.21)

p-values * p<.05; **p<.01; ***p<.001

Figure 3. ITT- DLL Subsample WJ Letter-Word Identification

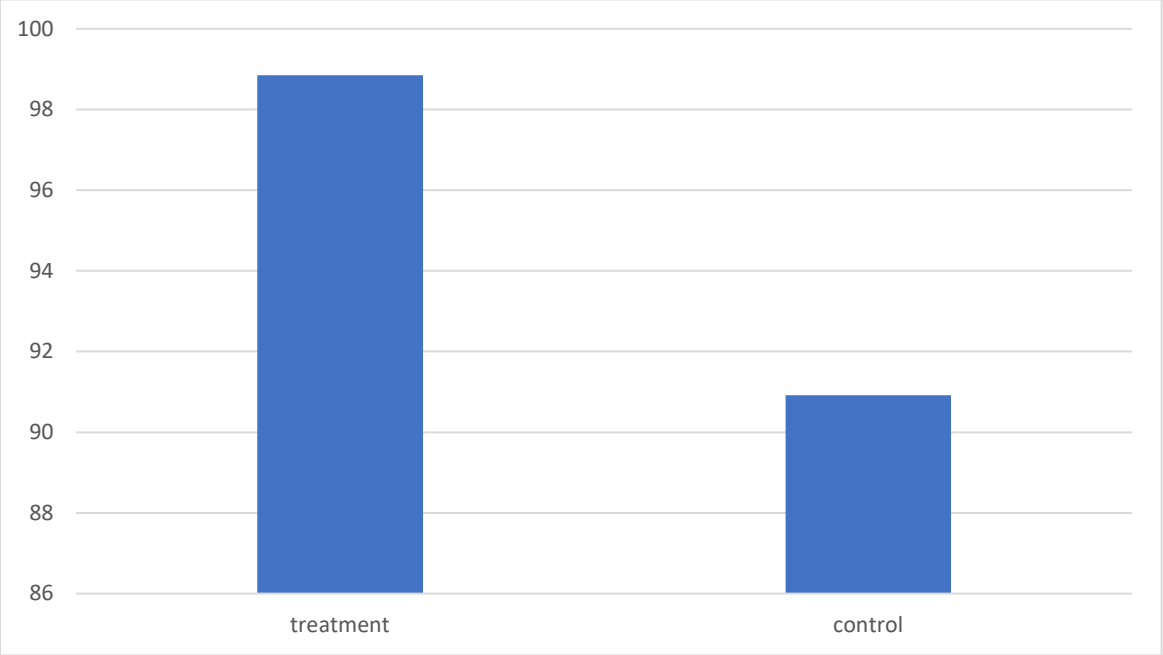


Figure 4. ITT- DLL Subsample WJ Quantitative Concepts

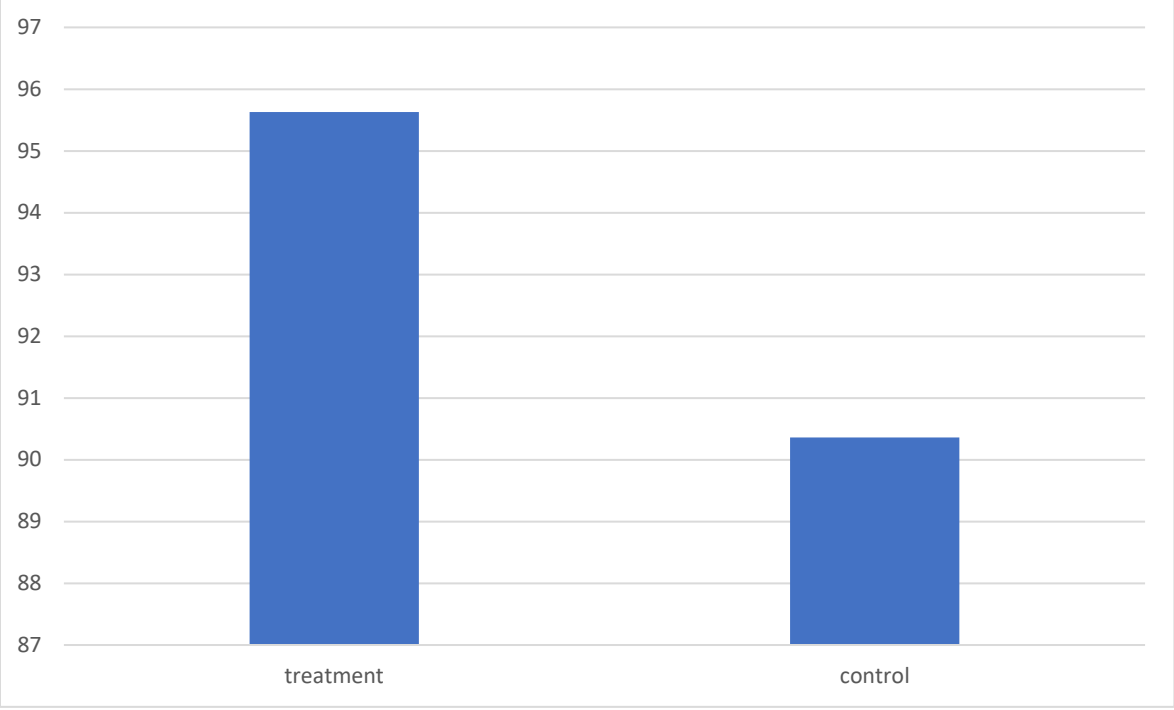


Table 11. ITT Results - DLL Subsample Spanish Outcomes

	Executive Function		Language / Literacy		
	FDS	HTKS	BAT PV	BAT LW	BAT PC
Model 1					
Intercept	3.42 (0.15)	23.12 (3.65)	70.56 (2.78)	86.16 (1.61)	84.35 (3.18)
Treatment	0.13 (0.15)	1.57 (3.66)	-0.35 (2.93)	2.04 (1.62)	5.32 (3.23)
County	0.13 (0.13)	2.11 (2.86)	0.3 (2.26)	3.21 (1.38)	3.32 (2.86)
Fall score	0.49 (0.07)	0.69 (0.07)	0.93 (0.08)	0.6 (0.07)	0.12 (0.09)
Model 2					
CLASS	0.11 (0.28)	20 (8.01)	3.01 (5.06)	1.5 (3.5)	11.55 (7.41)
English Prof	0.58 (0.25)	-5.58 (7)	-7.62 (4.79)	5.64 (3.1)	-1.22 (6.73)
No PK	0.59 (0.29)	-5.39 (7.91)	-8.79 (5.17)	-1.26 (3.59)	-12.07 (7.61)
CLASS x Trt	0.17 (0.3)	-13.97 (8.47)	-3.55 (5.42)	-1.4 (3.72)	-11.39 (7.92)
Eng Prf x Trt	-0.26 (0.29)	14.88 (7.6)	11.1 (5.51)	-3.19 (3.46)	3.51 (7.56)

	Math	
	BAT AP	BAT QC
Model 1		
Intercept	92.11 (1.85)	85.75 (1.59)
Treatment	2.69 (1.86)	0.32 (1.6)
County	4.03 (1.67)	-0.14 (1.31)
Fall score	0.67 (0.06)	0.7 (0.06)
Model 2		
CLASS	11.54 (3.81)	2.91 (3.66)
English Prof	-1.4 (3.34)	1.05 (3.29)
No PK	-4.03 (3.84)	1.68 (3.74)
CLASS x Trt	-10.61 (4.13)	-4.05 (3.86)
Eng Prf x Trt	5.04 (3.67)	0.18 (3.58)

p-values * p<.05; **p<.01; ***p<.001

Table 12. TOT Results - DLL Subsample English Outcomes

	Executive Function		Language / Literacy		
	FDS	HTKS	WJ PV	WJ LW	WJ PC
Model 1					
Intercept	4.07 (0.15)	15.41 (3.01)	89.84 (1.74)	89.79 (1.78)	99.18 (1.74)
Treatment	-0.04 (0.15)	6.35 (3.16)	5.56**(1.68)	8.81***(1.78)	1.1 (1.76)
County	-0.1 (0.13)	0.99 (2.93)	1.24 (1.12)	5.27 (1.68)	-0.29 (1.21)
Fall score	0.4 (0.06)	0.62 (0.08)	0.69 (0.03)	0.69 (0.06)	0.07 (0.07)
Model 2					
CLASS	-0.34 (0.41)	2.99 (8.02)	-1.67 (4.22)	0.56 (4.26)	0.87 (5)
English Prof	-0.41 (0.37)	11.03 (6.94)	6.19 (3.86)	-1.29 (3.76)	-3.93 (4.44)
No PK	0.37 (0.38)	-4.73 (7.63)	-2.13 (3.89)	-10.87 (4.09)	2.76 (4.44)
CLASS x Trt	0.52 (0.42)	0.14 (8.37)	2.9 (4.31)	-1.33 (4.48)	-0.63 (5.09)
Eng Prf x Trt	0.43 (0.38)	-4.66 (7.47)	-6.19 (3.99)	1.63 (4.07)	3.58 (4.63)

	Math		Behavior Skills	
	WJ AP	WJ QC	SSiS Social Skills	SSiS Prob Beh
Model 1				
Intercept	97.73 (2.25)	90.13 (1.49)	109.17 (2.18)	101 (2.71)
Treatment	5.09 (2.23)	5.61***(1.47)	0.97 (2.21)	-2.56 (2.82)
County	3.24 (1.54)	3.16 (1.33)	-0.02 (1.83)	2.72 (2.2)
Fall score	0.62 (0.05)	0.78 (0.06)	0.72 (0.08)	0.69 (0.09)
Model 2				
CLASS	0.96 (6.5)	-0.39 (3.97)	1.66 (5.94)	0.07 (7.57)
English Prof	0.51 (6.05)	2.66 (3.56)	-0.49 (5.43)	-0.9 (7.08)
No PK	-7.69 (5.35)	2.15 (3.98)	-0.08 (6.1)	-2.32 (7.08)
CLASS x Trt	-0.81 (6.59)	-1.04 (4.16)	-0.22 (6.11)	-1.35 (7.71)
Eng Prf x Trt	0.59 (6.12)	-0.21 (3.82)	-1.14 (5.66)	0.08 (7.57)

p-values * p<.05; **p<.01; ***p<.001

Table 13. TOT Results - DLL Subsample Spanish Outcomes

	Executive Function		Language / Literacy		
	FDS	HTKS	BAT PV	BAT LW	BAT PC
Model 1					
Intercept	3.52 (0.15)	23.1 (3.6)	70.62 (2.93)	86.31 (1.6)	82.51 (2.96)
Treatment	0.04 (0.15)	1.55 (3.67)	-0.57 (3.08)	1.89 (1.64)	6.92 (3.11)
County	0.09 (0.14)	2.18 (2.85)	0.37 (2.25)	3.21 (1.36)	4.09 (2.81)
Fall score	0.48 (0.07)	0.7 (0.07)	0.94 (0.08)	0.6 (0.07)	0.12(0.09)
Model 2					
CLASS	0.14 (0.31)	17.62 (8.96)	3.5 (5.57)	1.7 (3.76)	9.89 (7.63)
English Prof	0.53 (0.25)	-7.77 (7.21)	-7.49 (5.06)	6.78 (3.03)	-0.77 (6.47)
No PK	0.59+ (0.33)	-0.22 (8.88)	-9.7 (5.83)	-2.12 (3.93)	-10.99 (8.02)
CLASS x Trt	0.14 (0.33)	-12.09 (9.34)	-4.14 (5.88)	-1.46 (3.95)	-9.83 (8.08)
Eng Prf x Trt	-0.21 (0.29)	17.26 (7.78)	10.43 (5.79)	-4.16 (3.39)	3.01 (7.33)

	Math	
	BAT AP	BAT QC
Model 1		
Intercept	93.46 (1.84)	85.75 (1.47)
Treatment	1.42 (1.9)	0.45 (1.53)
County	3.56 (1.71)	-0.09 (1.34)
Fall score	0.69 (0.06)	0.76 (0.06)
Model 2		
CLASS	12.17 (4.27)	1.98 (3.56)
English Prof	-1.89 (3.42)	-1.38 (2.9)
No PK	-3.83 (4.43)	4.47 (3.8)
CLASS x Trt	-11.52 (4.56)	-3.16 (3.78)
Eng Prf x Trt	5.67 (3.73)	3.15 (3.24)

p-values * p<.05; **p<.01; ***p<.001

Table 14. NC Pre-K Program Characteristics (2017–2018)

Program Characteristic		
Total NC Pre-K Sites (Centers/Schools)	n=1,167	
Total NC Pre-K Classrooms	n=2,007	
Total Children Served	n=30,035	
	Mean	(SD)
Class Size	15.7	(3.5)
Number of NC Pre-K Children per Class	13.5	(4.2)
Proportion of NC Pre-K Children per Class	0.86	(0.18)
Days of Attendance per Child	137	(38.4)
Days of Operation	170	(13.3)
NC Star-Rated License	%	n
Five-Star	79.9	932
Four-Star	15.3	178
Temporary	1.6	19
Public School in Process	3.3	38

Table 15. NC Pre-K Classrooms: Early Childhood Curricula, Formative Assessments, and Developmental Screening Measures (2017–2018)

Educational Resources Used	n=2,007	%	n
Early Childhood Curriculum			
Creative Curriculum for Preschool		90.1	1,808
Opening the World of Learning (OWL)		5.5	111
High/Scope Preschool Curriculum		2.4	49
Tools of the Mind		1.2	24
Investigator Club Prekindergarten Learning System		0.2	3
Passports: Experiences for Pre-K Success		0.2	3
Formative Assessment			
Teaching Strategies GOLD / Creative Curriculum Developmental Continuum		91.0	1,826
Work Sampling System		5.4	109
COR Advantage / Preschool Child Observation Record (COR)		2.5	50
Galileo Online Assessment System		0.9	17
Investigator Club		0.1	2
Developmental Screening Measure			
Developmental Indicators for the Assessment of Learning (DIAL)		52.9	1,062
Brigance		38.5	772
Ages & Stages Questionnaire (ASQ)		6.9	140
Parents' Evaluation of Developmental Status (PEDS)		1.6	33

Table 16. Distribution of NC Pre-K Classrooms by Setting Type (2017–2018)

Setting Type	n=2,007	%	n
Public School		52.1	1,046
Private		33.0	662
Private For-Profit		25.3	507
Private Non-Profit		7.7	155
Head Start		14.9	299
Head Start Not Administered by Public School		10.7	214
Head Start Administered by Public School		4.2	85

Table 17. Characteristics of NC Pre-K Children (2017–2018)

Characteristic n=30,035	%/Mean	n
Child's age on 8/31 of program year	4.5	30,035
Gender		
Male	50.6%	15,210
Female	49.4%	14,825
Race		
White/European-American	48.0%	14,409
Black/African-American	36.2%	10,866
Native American/Alaskan Native	4.5%	1,350
Multiracial	7.0%	2,113
Asian	2.9%	885
Native Hawaiian/Pacific Islander	1.4%	412
Ethnicity		
Non-Hispanic/Latino	76.1%	22,866
Hispanic/Latino	23.9%	7,169
Parents Employed		
Mother	51.4%	15,435
Father	48.6%	14,599
Mother and/or Father	78.8%	23,658

Table 18. Eligibility Factors for NC Pre-K Children (2017–2018)

Eligibility Factors[2]	n=30,035	%	n
Family Income			
130% of poverty and below (eligible for free lunch)		70.4	21,134
131–185% of poverty (eligible for reduced-price lunch)		17.1	5,125
186–200% of poverty		3.3	991
201–250% of poverty		4.0	1,201
>251% of poverty		5.3	1,584
Limited English Proficiency			
Family and/or child speak limited or no English in the home		18.8	5,660
Educational Need			
Indicated by performance on approved developmental screening or an IEP		22.0	6,602
Identified Developmental Disability			
Child has been screened and evaluated		5.3	1,579
Chronic Health Condition(s)			
Indicated by diagnosis from a professional health care provider		4.0	1,186
Military Family			
Parent on active duty or injured, receiving military disability retirement, or killed on active duty		5.1	1,538

[2] Children are eligible for the NC Pre-K Program primarily based on age and family income. Children must be four years old by August 31 of the program year, with a gross family income up to 75% of state median income. Children who do not meet the income eligibility may be eligible if they have at least one of the following: limited English proficiency, identified disability, chronic health condition, educational need, or a parent serving in the military.

Table 19. Prior Placement for NC Pre-K Children (2017–2018)

Prior Placement n=30,035	%	n
Children who have never been served in any preschool or child care setting	58.0	17,422
Children who are currently unserved (may previously have been in preschool or child care)	13.8	4,141
Children who are in unregulated child care	2.4	727
Children who are not receiving subsidy but in a regulated preschool or child care program	15.3	4,597
Children who are receiving subsidy and in regulated child care or preschool program	9.9	2,969
Not reported	0.6	179

Table 20. Education Levels of NC Pre-K Lead Teachers (2017–2018)

		Highest Education Level							
		MA/MS or higher		BA/BS		AA/AAS		HS Diploma/GED	
Setting Type[3]	Total n[4]	%	n	%	n	%	n	%	n
Public School	1,147	17.7	203	82.2	943	0	0	0.1	1
Private	916	8.6	79	90.1	825	0.1	1	0	0
All	2,063	13.7	283	85.7	1,768	0.1	1	0.1	1

Table 21. Licensure/Credential Levels of NC Pre-K Lead Teachers (2017–2018)

		Highest Licensure/Credential									
		B-K License[5]		Other Teacher's License[6]		CDA Credential[7]		NCECC[8]		None	
Setting Type[a]	Total n	%	n	%	n	%	n	%	n	%	n
Public School	1147	96.3	1,104	3.3	38	0	0	0	0	0.4	5
Private	916	85.5	783	2.6	24	0.2	2	0.8	7	10.9	100
All	2,063	91.5	1,887	3.0	62	0.1	2	0.3	7	5.1	105

[3] Teachers in Head Start classrooms administered by public schools are included in public school setting types; teachers in Head Start classrooms not administered by public schools are included in private setting types.
[4] Data were not reported for 24 teachers.
[5] B-K = Birth-Kindergarten license. This category includes teachers with a B-K license, Initial B-K license (formerly SP I), Continuing B-K license (formerly SP II), Lateral Entry B-K license, Provisional B-K license, or Preschool Add-on license.
[6] Other teacher's license includes non-early childhood licenses and licenses from other states.
[7] CDA = Child Development Associate.
[8] NCECC = North Carolina Early Childhood Credential.

Table 22. Pre-K Classrooms by Setting Type (2003-04 – 2017-18)

Setting Type	2003–2004 n=866	2004–2005 n=1,027	2005–2006 n=1,218	2006–2007 n=1,439	2007–2008 n=2,110	2008–2009 n=2,322	2009–2010 n=2,308	2010–2011 n=2,262	2011–2012 n=2,057	2012-2013 n=2,150	2013-2014 n=1,993	2014-2015 n=1,974	2015-2016 n=1,962	2016-2017 n=1,949	2017-2018 n=1,949
Public Preschool	**49.7% (430)**	**54.1% (556)**	**53.0% (646)**	**55.0% (791)**	**53.4% (1,127)**	**51.9% (1,205)**	**52.2% (1,205)**	**54.1% (1,223)**	**50.6% (1,041)**	**50.7% (1,090)**	**54.2% (1,080)**	**51.6% (1,019)**	**51.6% (1,013)**	**52.3% (1019)**	**52.1% (1046)**
Private	**35.2% (305)**	**34.8% (357)**	**35.1% (427)**	**32.0% (461)**	**28.5% (602)**	**28.8% (669)**	**28.1% (649)**	**27.1% (613)**	**33.3% (686)**	**33.5% (719)**	**31.9% (636)**	**33.2% (655)**	**32.9% (645)**	**32.5% (633)**	**33.0% (662)**
Private For-Profit	25.1% (217)	24.1% (247)	23.6% (287)	21.3% (306)	19.4% (409)	20.1% (467)	19.3% (446)	18.7% (424)	24.2% (497)	24.3% (522)	23.4% (466)	24.9% (491)	25.2% (494)	24.9% (485)	25.3% (507)
Private Non-Profit	10.2% (88)	10.7% (110)	11.5% (140)	10.8% (155)	9.1% (193)	8.7% (202)	8.8% (203)	8.4% (189)	9.2% (189)	9.2% (197)	8.5% (170)	8.3% (164)	7.7% (151)	7.6% (148)	7.7% (155)
Head Start	**15.1% (131)**	**11.1% (114)**	**11.9% (145)**	**13.0% (187)**	**18.1% (381)**	**19.3% (448)**	**19.7% (454)**	**18.8% (426)**	**16.0% (330)**	**15.8% (341)**	**13.9% (277)**	**15.2% (300)**	**15.5% (304)**	**15.2% (297)**	**14.9% (299)**
Head Start Not Administered by Public School	9.2% (80)	8.4% (86)	9.0% (110)	10.1% (145)	14.8% (313)	15.8% (366)	15.8% (364)	14.9% (338)	12.4% (256)	12.8% (276)	10.6% (212)	10.6% (209)	10.7% (209)	10.4% (202)	10.7% (214)
Head Start Administered by Public School	5.9% (51)	2.7% (28)	2.9% (35)	2.9% (42)	3.2% (68)	3.5% (82)	3.9% (90)	3.9% (88)	3.6% (74)	3.0% (65)	3.3% (65)	4.6% (91)	4.8% (95)	4.9% (95)	4.2% (85)

Table 23. Prior Placement of Pre-K Children (2003-04 – 2017-18)

Prior Placement	2003–2004 n=10,891	2004–2005 n=13,515	2005–2006 n=17,251	2006–2007 n=20,468	2007–2008 n=29,978	2008–2009 n=33,798	2009–2010 n=34,212	2010–2011 n=33,747	2011–2012 n=29,311	2012-2013 n=32,142	2013-2014 n=29,346	2014-2015 n=29,271	2015-2016 n=28,757	2016-2017 n=28,905	2017-2018 n=30035
Children who have never been served in any preschool or child care setting	62.3% (6,788)	60.4% (8,165)	59.9% (10,325)	58.8% (12,033)	54.6% (16,353)	54.0% (18,237)	54.8% (18,755)	57.5% (19,397)	59.6% (17,484)	59.5% (19,120)	61.7% (18,111)	57.7% (16,904)	59.4% (17,069)	59.2% (17,114)	58.0% (17,422)
Children who are currently unserved (may previously have been in preschool or child care)	20.9% (2,282)	17.9% (2,418)	13.2% (2,270)	13.1% (2,676)	13.1% (3,938)	16.1% (5,433)	15.1% (5,155)	14.6% (4,918)	17.9% (5,234)	19.2% (6,181)	16.1% (4,729)	13.9% (4,055)	14.4% (4,131)	14.3% (4,125)	13.8% (4,141)
Children who are in unregulated child care	--	4.5% (608)	4.2% (716)	4.0% (814)	5.3% (1,592)	5.9% (1,981)	4.7% (1,609)	3.8% (1,291)	2.8% (810)	2.0% (647)	1.8% (520)	2.2% (646)	1.8% (509)	1.9% (546)	2.4% (727)
Children who are not receiving subsidy, but are in a regulated preschool or child care program	5.6% (606)	3.4% (463)	2.1% (364)	2.4% (497)	3.6% (1,072)	4.5% (1,510)	4.7% (1,612)	5.2% (1,765)	13.5% (3,955)	12.0% (3,845)	13.4% (3,928)	17.2% (5,022)	15.5% (4,460)	14.5% (4,193)	15.3% (4,597)
Children who are receiving subsidy and in regulated child care or preschool program	--	--	--	--	--	--	--	--	6.2% (1,828)	7.3% (2,349)	7.0% (2,058)	8.8% (2,575)	8.6% (2,474)	9.7% (2,794)	9.9% (2,969)
Children served for 5 months or less in the year prior to More at Four program in any preschool or child care	--	3.2% (436)	5.9% (1,022)	4.1% (849)	3.9% (1,161)	2.3% (780)	2.1% (721)	1.5% (520)	--	--	--	--	--	--	
Other children, including those in pre-kindergartens or child care settings that do not meet More at Four program standards.	11.2% (1,215)	10.5% (1,425)	7.2% (1,236)	7.2% (1,474)	8.5% (2,556)	4.6% (1,570)	4.4% (1,507)	4.5% (1,527)	--	--	--	--	--	--	
Children served by this site as 3-year-olds.	--	--	7.6% (1,318)	10.4% (2,125)	11.0% (3,306)	12.7% (4,287)	14.2% (4,853)	12.8% (4,329)	--	--	--	--	--	--	

Table 24. Education Levels of Pre-K Lead Teachers (2003-04 – 2017-18)

		Highest Education Level							
		MA/MS or higher		BA/BS		AA/AAS		HS diploma/GED	
Setting Type[a]	Total n[b]	%	n	%	n	%	n	%	n
2003–2004									
Public School	450	17.1	77	77.1	347	2.4	11	3.3	15
Private	534	4.1	22	62.5	334	25.3	135	8.1	43
All	984	10.1	99	69.2	681	14.8	146	5.9	58
2004–2005									
Public School	615	15.1	93	83.6	514	1.0	6	0.3	2
Private	519	4.2	22	61.3	318	29.5	153	5.0	26
All	1,133	10.2	115	73.3	831	14.0	159	2.5	28
2005–2006									
Public School	725	13.8	100	84.6	613	1.4	10	0.3	2
Private	620	3.4	21	61.0	378	31.8	197	3.9	24
All	1,342	9.0	121	73.7	989	15.4	206	1.9	26
2006–2007									
Public School	875	15.1	132	84.0	735	0.8	7	0.1	1
Private	684	4.4	30	57.9	396	34.2	234	3.5	24
All	1,555	10.4	162	72.5	1,128	15.4	240	1.6	25
2007–2008									
Public School	1,197	13.8	165	84.5	1,012	1.5	18	0.2	2
Private	990	3.8	38	50.0	495	41.8	414	4.3	43
All	2,183	9.3	203	68.9	1,503	19.8	432	2.1	45
2008–2009									
Public School	1,305	14.9	195	83.5	1,090	1.4	18	0.2	2
Private	1,109	4.2	47	52.4	581	41.3	458	2.1	23
All	2,409	10.0	241	69.2	1,667	19.8	476	1.0	25
2009–2010									
Public School	1,308	15.3	200	83.0	1,085	1.8	23	0.0	0
Private	1,107	5.3	59	62.2	689	31.7	351	0.7	8
All	2,412	10.7	259	73.5	1,772	15.5	373	0.3	8
2010–2011									
Public School	1,333	16.0	213	82.9	1,105	1.1	15	0.0	0
Private	1,065	7.2	77	73.9	787	18.8	200	0.1	1
All	2,395	12.1	289	78.9	1,889	9.0	216	0.0	1
2011–2012									
Public School	1,142	15.8	181	83.7	956	0.4	5	0.0	0
Private	1,054	8.6	91	87.3	920	3.6	38	0.5	5
All	2,191	12.4	271	85.4	1,872	2.0	43	0.2	5
2012-2013									
Public School	1,191	16.3	194	83.5	995	0.2	2	0.0	0
Private	1,064	7.9	84	89.9	957	2.1	22	0.1	1
All	2,255	12.3	278	86.6	1,952	1.1	24	0.0	1

[a] Teachers in Head Start classrooms administered by public schools are included in public school setting types; teachers in Head Start classrooms not administered by public schools are included in private setting types.

[b] In some cases, the *n* for All is less than the sum of the *n*'s for Public School and Private because some teachers worked in both public and private settings (n=1 in 2004–2005; n=3 in 2005–2006 and 2009–2010; n=4 in 2006–2007, 2007–2008, and 2010–2011; and n=5 in 2008–2009 and 2011–2012).

Table 24 (Cont) Education Levels of Pre-K Lead Teachers (2003-04 – 2017-18)

		Highest Education Level							
		MA/MS or higher		BA/BS		AA/AAS		HS diploma/GED	
Setting Type[a]	Total n[b]	%	n	%	n	%	n	%	n
2013–2014									
Public School	1,168	15.4	180	84.4	985	0.2	2	0.0	0
Private	932	11.2	104	88.0	819	1.0	9	0.0	0
All	2,099	13.6	285	85.9	1,803	0.5	11	0.0	0
2014-2015									
Public School	1,149	19.4	223	80.4	924	0.1	1	0.1	1
Private	911	10.0	92	90.0	819	0.0	0	0.0	0
All	2,060	15.3	315	84.7	1,743	0.0	1	0.0	1
2015-2016									
Public School	1,125	18.3	206	81.4	916	0.0	0	0.3	3
Private	881	10.1	89	89.7	790	0.1	1	0.1	1
All	2,006	14.7	295	85.0	1,706	0.0	1	0.2	4
2016-2017									
Public School	1135	17.6	200	82.1	932	0.1	1	0.2	2
Private	864	9.4	81	90.2	779	0.3	3	0.1	1
All	1999	14.1	281	85.6	1,711	0.2	4	0.1	3
2017-2018									
Public School	1,147	17.7	203	82.2	943	0	0	0.1	1
Private	916	8.6	79	90.1	825	0.1	1	0	0
All	2,063	13.7	283	85.7	1,768	0.1	1	0.1	1

Table 25. Licensure/Credential Levels of Pre-K Lead Teachers (2003-04 – 2017-18)

		Highest Licensure/Credential									
		B-K License[a]		Other Teacher's License[b]		CDA Credential[c]		NCECC[d]		None	
Setting Type[e]	Total n[f]	%	n	%	n	%	n	%	n	%	n
2003–2004											
Public School	454	68.1	309	18.3	83	0.0	0	1.1	5	12.6	57
Private	535	16.4	88	10.5	56	3.9	21	16.3	87	52.9	283
All	989	40.1	397	14.1	139	2.1	21	9.3	92	34.4	340
2004–2005											
Public School	615	75.4	464	13.5	83	0.7	4	1.1	7	9.3	57
Private	519	15.2	79	9.1	47	9.6	50	28.9	150	37.2	193
All	1,133	47.8	542	11.5	130	4.8	54	13.9	157	22.1	250
2005–2006											
Public School	725	83.1	601	9.8	71	0.6	4	1.1	8	5.7	41
Private	620	16.5	103	8.5	53	6.5	40	31.5	195	36.9	229
All	1,342	52.3	702	9.2	124	3.3	44	15.1	202	20.0	269
2006–2007											
Public School	875	86.2	753	8.0	70	0.6	5	1.3	11	4.1	36
Private	684	20.6	142	7.5	51	5.6	38	32.3	221	33.9	232
All	1,555	57.4	893	7.7	120	2.8	43	14.9	231	17.2	268
2007–2008											
Public School	1,197	85.7	1,025	7.2	86	0.9	11	1.1	13	5.2	62
Private	990	17.1	172	5.7	56	6.5	64	37.9	375	32.6	323
All	2,183	54.7	1,194	6.5	142	3.4	75	17.7	387	17.6	385
2008–2009											
Public School	1,305	86.8	1,134	7.5	98	0.6	8	1.2	16	3.8	49
Private	1,109	22.7	256	5.8	64	4.4	49	39.2	435	27.5	305
All	2,409	57.5	1,385	6.7	162	2.4	57	18.7	451	14.7	354
2009–2010											
Public School	1,308	88.5	1,156	7.0	91	0.5	6	1.9	25	2.3	30
Private	1,107	30.8	341	7.6	84	4.6	51	32.9	364	24.1	267
All	2,412	62.0	1,496	7.3	175	2.3	56	16.1	388	12.3	297

[a] B-K = Birth-Kindergarten license. This category includes teachers with a B-K license, Initial B-K license (formerly SP I), Continuing B-K license (formerly SP II), Lateral Entry B-K license, Provisional B-K license, or Preschool Add-on license.
[b] Other teacher's license includes non-early childhood licenses and licenses from other states.
[c] CDA = Child Development Associate.
[d] NCECC = North Carolina Early Childhood Credential.
[e] Teachers in Head Start classrooms administered by public schools are included in public school setting types; teachers in Head Start classrooms not administered by public schools are included in private setting types.
[f] In some cases, the *n* for All is less than the sum of the *n*'s for Public School and Private because teachers worked in both setting types (n=1 in 2004–2005; n=3 in 2005–2006 and 2009–2010; n=4 in 2006–2007, 2007–2008, and 2010–2011; and n=5 in 2008–2009 and 2011–2012).

Table 25 (Continued) Licensure/Credential Levels of Pre-K Lead Teachers (2003-04 – 2017-18)

		Highest Licensure/Credential									
		B-K License[b]		Other Teacher's License		CDA Credential		NCECC		None	
Setting Type[c]	Total n[d]	%	n	%	n	%	n	%	n	%	n
2010–2011											
Public School	1,333	92.8	1,237	4.6	61	0.2	3	1.3	17	1.1	15
Private	1,065	44.0	471	9.2	98	2.9	31	22.6	241	21.0	224
All	2,394	71.2	1,704	6.6	159	1.4	34	10.8	259	10.0	239
2011–2012											
Public School	1,142	91.3	1,043	6.0	68	0.1	1	0.7	8	1.9	22
Private	1,054	51.0	538	11.0	116	1.4	15	12.9	135	23.7	250
All	2,191	72.0	1,578	8.4	183	0.7	16	6.5	143	12.4	271
2012–2013											
Public School	1,191	92.9	1,106	4.9	58	0.1	1	0.3	3	1.9	23
Private	1,064	57.0	606	9.0	96	0.9	10	11.2	119	21.9	233
All	2,255	75.9	1,712	6.8	154	0.5	11	5.4	122	11.4	256
2013–2014											
Public School	1,168	93.7	1,093	5.1	59	0.1	1	0.1	1	1.2	14
Private	932	63.8	594	10.5	98	0.9	8	6.3	59	18.6	173
All	2,099	80.3	1,686	7.5	157	0.4	9	2.9	60	8.9	187
2014-2015											
Public School	1,149	91.7	1,054	1.7	20	0.0	0	0.5	6	6.0	69
Private	911	74.5	679	6.3	57	0.1	1	4.3	39	14.8	135
All	2,060	84.1	1,733	3.8	77	0.0	1	2.2	45	9.9	204
2015-2016											
Public School	1,125	96.0	1,080	2.7	30	0.0	0	0.0	0	1.3	15
Private	881	76.7	676	4.2	37	0.6	5	2.2	19	16.3	144
All	2,006	87.5	1,756	3.3	67	0.2	5	0.9	19	7.9	159
2016-2017											
Public School	1,136	96.2	1093	3.3	38	0.0	0	0.1	1	0.4	4
Private	887	80.2	711	5.1	45	0.3	3	1.1	10	13.3	118
All	2023	89.2	1804	4.1	83	0.1	3	0.5	11	6.0	122
2017-2018											
Public School	1147	96.3	1,104	3.3	38	0	0	0	0	0.4	5
Private	916	85.5	783	2.6	24	0.2	2	0.8	7	10.9	100
All	2,063	91.5	1,887	3.0	62	0.1	2	0.3	7	5.1	105

Figure 5. NC Pre-K Setting Types by Cohort

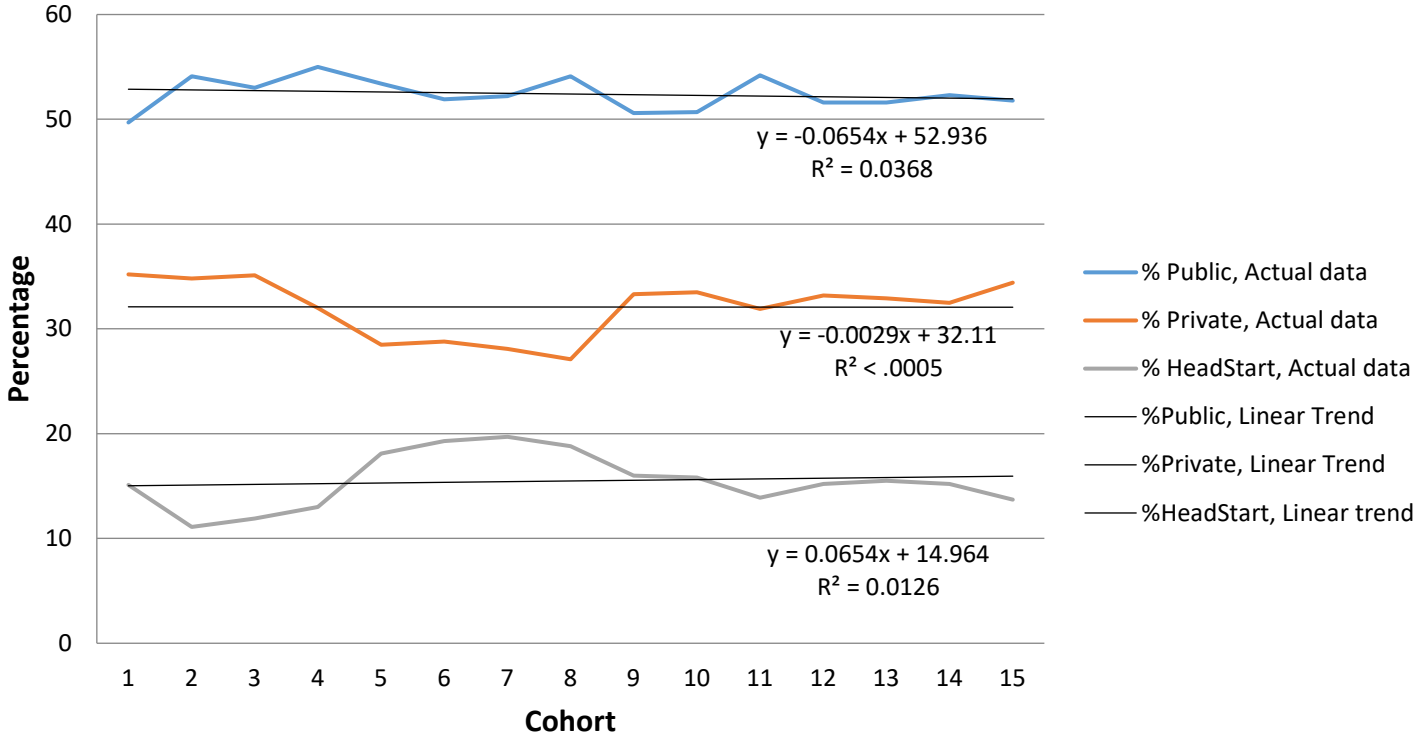


Figure 6. Prior Placement for NC Pre-K Children by Cohort

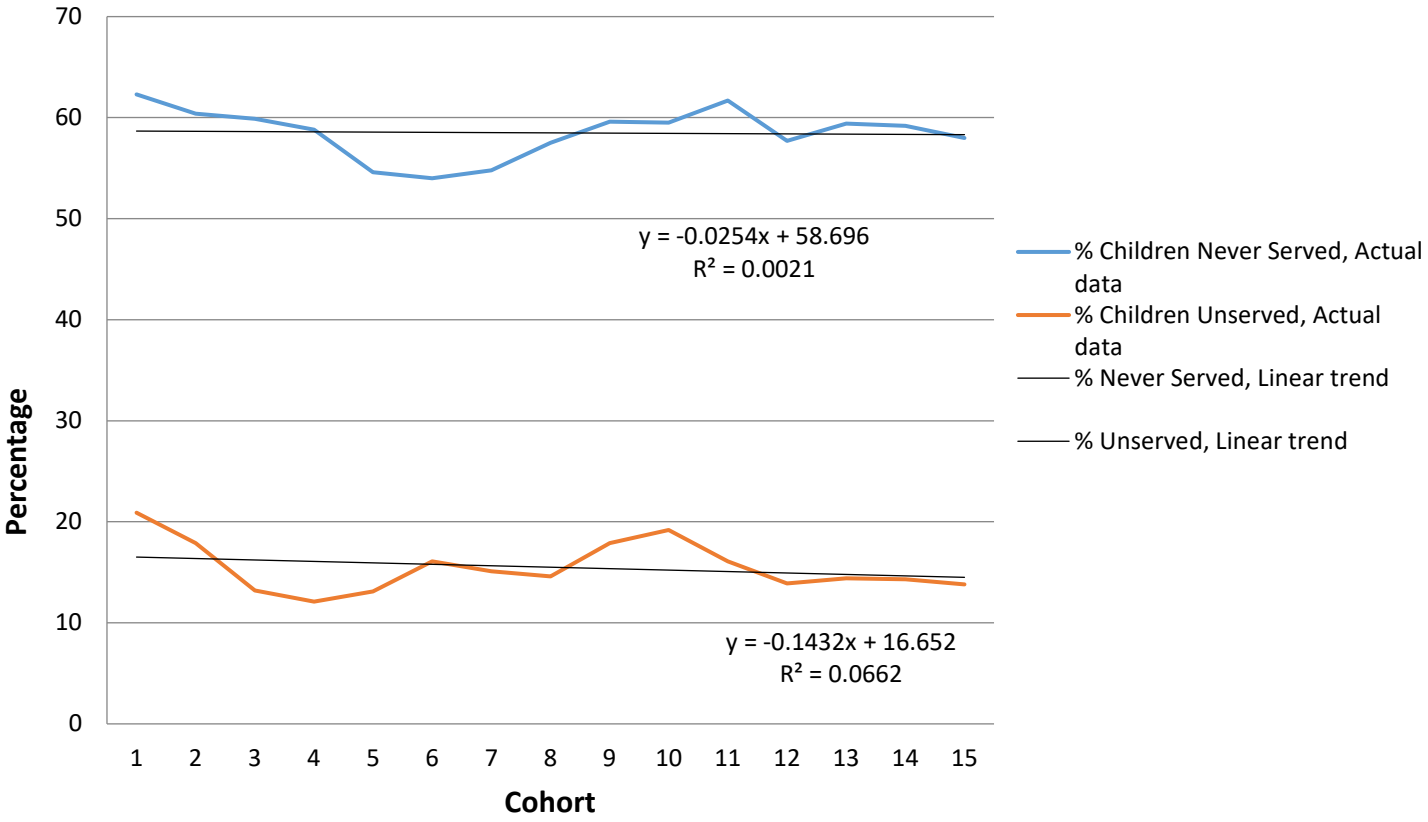
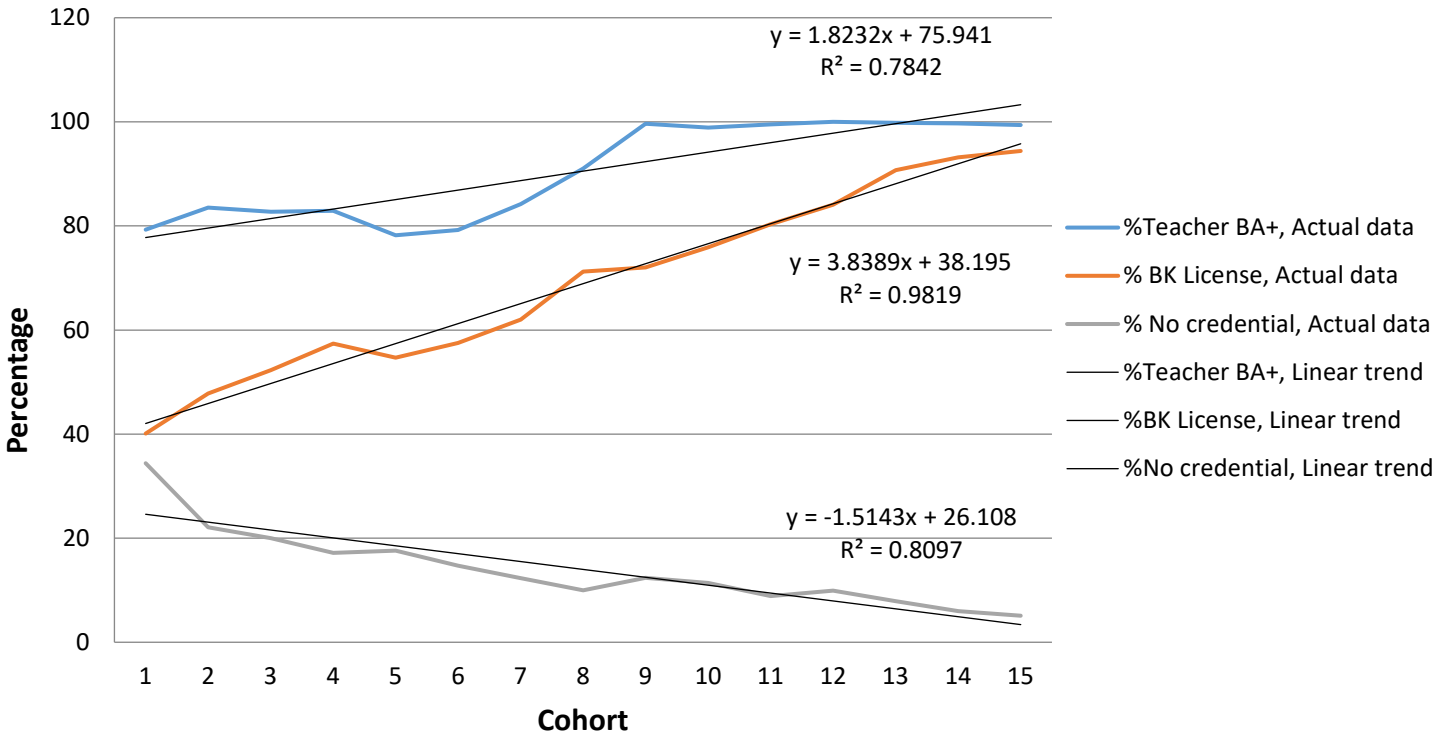


Figure 7. NC Pre-K Teacher Qualifications by Cohort



Appendix 1

List of NC Pre-K Evaluation Reports

Peisner-Feinberg, E. S. (2003). *Child and program characteristics of the North Carolina More at Four Pre-kindergarten Program: Year 1 (January–June 2002).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Maris, C. L. (2005). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Year 2 (July 1, 2002–June 30, 2003).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Maris, C. L. (2005). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Year 3 Report (July 1, 2003–June 30, 2004).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Maris, C. L. (2006). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Children's longitudinal outcomes and classroom quality in kindergarten.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Elander, K.C., & Maris, C. L. (2006). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Year 4 (July 1, 2004–June 30, 2005) Program characteristics and services.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Schaaf, J. M. (2007). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Children's outcomes and program quality in the fifth year.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Schaaf, J. M. (2008). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Children's longitudinal outcomes and program quality over time (2003–2007).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Schaaf, J.M. (2008). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: Performance and progress in the seventh year (2007–2008).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S. & Schaaf, J. M. (2009). *Evaluation of the North Carolina More at Four Pre-kindergarten Program: A look across time at children's outcomes and classroom quality from pre-k through kindergarten (2003–2009).* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Schaaf, J.M. (2010). *Long-term effects of the North Carolina More at Four Pre-kindergarten Program: Children's reading and math skills at third grade.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., & Schaaf, J.M. (2011). *Effects of the North Carolina More at Four Pre-kindergarten Program on children's school readiness skills: Key findings*. Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Schaaf, J. M., Hildebrandt, L., & LaForett, D. R. (2013). *Quality and characteristics of the North Carolina Pre-Kindergarten Program: 2011–2012 statewide evaluation.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., LaForett, D. R., Schaaf, J. M., Hildebrandt, L. M., Sideris, J., & Pan, Y. (2014). *Children's outcomes and program quality in the North Carolina Pre-Kindergarten Program: 2012–2013 Statewide evaluation.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Schaaf, J. M., Hildebrandt, L. M., Pan, Y. & Warnaar, B. L. (2015). *Children's kindergarten outcomes and program quality in the North Carolina Pre-Kindergarten Program: 2013–2014 statewide evaluation.* Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Garwood, J. D., & Mokrova, I. L. (2016). *Children's pre-k experiences and outcomes in the North Carolina Pre-Kindergarten Program: 2014–2015 statewide evaluation*. Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Mokrova, I. L., & Anderson, T. L. (2017). *Effects of participation in the North Carolina Pre-Kindergarten Program at the end of kindergarten: 2015-2016 statewide evaluation.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute.

Peisner-Feinberg, E. S., Van Manen, K.W., & Mokrova, I. L. (2018). *Variations in enrollment practices in the NC Pre-K Program: 2016-2017 statewide evaluation.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute.

Reports can be downloaded at: https://fpg.unc.edu/resource-list/750

Appendix 2

Technical Information for Analysis Approach

Constructions of Weights to Account for Potential Bias

Baseline Non-equivalence & Inverse Probability of Treatment Weights (IPTW)

First, we evaluated baseline equivalence among children randomized to the treatment and control groups by comparing whether distributions of demographic characteristics were exchangeable (i.e., balanced) between groups. Randomization occurred differently in the two counties, which resulted in potential confounding bias due to lack of baseline equivalence (i.e., exchangeability) between treatment and comparison groups. Adjusting for confounding using inverse probability of treatment weights (IPTW) creates a pseudo-population in which treatment assignment is independent of measured confounding covariates, allowing estimation of a consistent causal effect of NC Pre-K exposure on child assessment outcomes. After an evaluation of baseline equivalence among selected children who were eligible and randomized, the following characteristics were imbalanced across treatment and control groups after randomization: county, race, limited English proficiency, educational need, and Hispanic/Latino ethnicity. (See Table 26.) Given the variation in demographic distribution between the two participating counties, and the way in which randomization was conducted, these differences were expected.

We constructed stabilized IPTW to create balance between the treatment and control groups at the point of randomization. For individuals who received treatment, the stabilized IPTW were comprised of a numerator representing the probability of treatment in the population, and a denominator which was the probability that each individual would receive the treatment they actually received, modeled using logistic regression, conditional on a set of measured confounding variables (i.e., county, race, limited English, educational need and Hispanic/Latino ethnicity). For children randomized to NC Pre-K, weights reflected the probability of being randomly assigned to treatment divided by the probability of being assigned to treatment given the factors listed above. For children in the control group, their IPTW reflected the probability of being randomly assigned to control divided by the probability of being assigned to control given the factors listed above.

IPTW if (NCPreK=1): $\frac{\Pr[NCPreK=1]}{\Pr[\text{NCPreK}=1|\text{confounding variables}]}$, or

if (NCPreK=0): $\frac{1-\Pr[NCPreK=1]}{1-\Pr[\text{NCPreK}=1|\text{confounding variables}]}$

Selection Bias & Inverse Probability of Censoring Weights (IPCW)

Second, we evaluated possible selection bias by comparing distributions of measured characteristics of children and families who were recruited and enrolled in the evaluation study compared to all children who were randomized (i.e., comparing participants with the entire randomized population regardless of participation). The timing of randomization occurred prior to recruitment into the study, resulting in a randomized population that would largely not participate in the evaluation assessments (i.e., who were censored/lost after randomization). Children participating in the study differed from the entire group of children who were randomized in their race, family size and treatment assignment at randomization. (See Table 27.)

To account for the expected differences between participants and all randomized children (i.e., selection bias), we constructed inverse probability of censoring/selection weights (IPCW). The IPCW do not eliminate the effect of censoring. Instead, these weights assume that censoring (i.e., non-participation) occurs at random, conditional on measured covariates. For individuals who participated in the study, the IPCW were comprised of a numerator that was the probability of participating among all randomized children. The denominator reflected the probability that each individual would participate, modeled using logistic regression, conditional on a set of measured confounding variables (race, family size, and treatment assignment). Participating children were assigned a stabilized IPCW such that the marginal probability of participation among all randomized children was divided by the probability that each individual participated conditional on the factors associated with participation. Non-participating children received a weight of zero, since they provided no outcome data to the study

IPCW if (Participant=1): $W = \frac{\Pr[Participant=1]}{\Pr[\text{Participant=1}|\text{confounding variables}]}$, or

if (NCPreK=0), $W = 0$

The IPTW and IPSW were multiplied and added to the statistical analyses of treatment effects on children's outcomes.

Statistical Comparison Models

Proc Mixed in SAS 9.4 (SAS Institute, Cary, NC, USA) was used for model specification and analysis, and Proc Impute and Proc MIAnalyze for conducting and analyzing the results of the multiple imputations. Two models were used to evaluate the impact of NC Pre-K on children's outcomes at the end of the pre-k year.

The first model examined the most direct impact of treatment with only treatment, county and previous fall scores included as predictors.

Model 1

Level 1 (for child i in classroom j)

$Y_{ij+} = B_{0j} + B_{1j}\ \text{Treatment}_{ij} + B_{2j}\ \text{Fall score}_{ijj} + e_{ij}$

Level 2 (for classroom j)

$B_{0j} = p_0 + p_1 + \text{County}_{j+} + z_{0j}$

$B_{1j} = p_1 + z_{1j}$

The second model asked whether classroom quality or English (or Spanish) language proficiency moderated treatment effects.

Model 2

Level 1 (for child i in classroom j)

$$Y_{ij+} = B_{0j} + B_{1j}\,\text{Treatment}_{ij} + B_{2j}\,\text{Fall score}_{ij} + B_{3j}\,\text{English Proficiency}_{ij} + B_{4j}\,\text{English Proficiency}_{ij} \times \text{Treatment}_{ij}\; e_{ij}$$

Level 2 (for classroom j)

$$B_{0j} = p_{00} + p_{10}\,\text{County}_{j+} + p_{20}\,\text{CLASS}_{j+} + p_{30}\,\text{AnyPK}_{j+} + z_{0j}$$

$$B_{1j} = p_{10} + p_{11}\text{CLASS total}_{ij} + 0z_{1j}$$

$$B_{2j} = p_{20}$$

$$B_{3j} = p_{30}$$

Table 26. Baseline Equivalence Results for Full Randomization Sample

Variables	All (N=2243)	Control (N=520)	Treatment (N=1723)	p Value	Absolute Standardized Difference
Family size				0.3479	
Mean (SD)	3.9(1.3)	3.9(1.2)	3.9(1.3)		0.0
Min-Max	1.0 - 13.0	1.0 - 7.0	1.0 - 13.0		
Female				0.7873	
0	1012 (45.2)	231 (44.7)	781 (45.4)		0.0
1	1227 (54.8)	286 (55.3)	941 (54.6)		0.0
Hispanic/Latino				0.0848	
0	1505 (67.3)	366 (70.4)	1139 (66.3)		0.1
1	732 (32.7)	154 (29.6)	578 (33.7)		0.1
Black/African American				0.1452	
0	973 (43.4)	240 (46.2)	733 (42.5)		0.1
1	1270 (56.6)	280 (53.8)	990 (57.5)		0.1
White				0.0014	
0	1380 (61.5)	351 (67.5)	1029 (59.7)		0.2
1	863 (38.5)	169 (32.5)	694 (40.3)		0.2
Military parent				0.0540	
0	2172 (98.2)	495 (97.2)	1677 (98.5)		0.1
1	39 (1.8)	14 (2.8)	25 (1.5)		0.1
≤75% SMI				0.4812	
0	286 (12.8)	71 (13.7)	215 (12.5)		0.0
1	1957 (87.2)	449 (86.3)	1508 (87.5)		0.0
Educational need				<.0001	
0	1696 (76.2)	451 (87.9)	1245 (72.7)		0.4
1	529 (23.8)	62 (12.1)	467 (27.3)		0.4
IEP				0.0010	
0	1440 (96.8)	230 (93.5)	1210 (97.5)		0.2
1	47 (3.2)	16 (6.5)	31 (2.5)		0.2
Limited English proficiency				0.0203	
0	1253 (56.0)	313 (60.4)	940 (54.7)		0.1
1	985 (44.0)	205 (39.6)	780 (45.3)		0.1
Poverty status				0.9476	
Below 130%	1367 (61.0)	319 (61.3)	1048 (60.9)		0.0
131-185%	448 (20.0)	98 (18.8)	350 (20.3)		0.0
186-200%	89 (4.0)	20 (3.8)	69 (4.0)		0.0
201-250%	113 (5.0)	27 (5.2)	86 (5.0)		0.0
251-300%	30 (1.3)	8 (1.5)	22 (1.3)		0.0
Over 300%	192 (8.6)	48 (9.2)	144 (8.4)		0.0

Table 27. Baseline Equivalence Results for Study Participants vs Non-Participants

Variables	All (N=2243)	Non-Participants (N=1661)	Participants (N=582)	P Value	Absolute Standardized Difference
Family size				0.1057	
Mean (SD)	3.9(1.3)	4.0(1.3)	3.8(1.3)		0.2
Min-Max	1.0 - 13.0	1.0 - 13.0	1.0 - 8.0		
Female				0.6556	
0	1012 (45.2)	754 (45.5)	258 (44.4)		0.0
1	1227 (54.8)	904 (54.5)	323 (55.6)		0.0
Hispanic/Latino				0.5007	
0	1505 (67.3)	1120 (67.7)	385 (66.2)		0.0
1	732 (32.7)	535 (32.3)	197 (33.8)		0.0
Black/African American				0.9637	
0	973 (43.4)	721 (43.4)	252 (43.3)		0.0
1	1270 (56.6)	940 (56.6)	330 (56.7)		0.0
White				0.2006	
0	1380 (61.5)	1009 (60.7)	371 (63.7)		0.1
1	863 (38.5)	652 (39.3)	211 (36.3)		0.1
Military parent				0.4196	
0	2172 (98.2)	1602 (98.1)	570 (98.6)		0.0
1	39 (1.8)	31 (1.9)	8 (1.4)		0.0
≤75% SMI				0.1055	
0	286 (12.8)	223 (13.4)	63 (10.8)		0.1
1	1957 (87.2)	1438 (86.6)	519 (89.2)		0.1
Educational need				0.1128	
0	1696 (76.2)	1243 (75.4)	453 (78.6)		0.1
1	529 (23.8)	406 (24.6)	123 (21.4)		0.1
IEP				0.0748	
0	1440 (96.8)	1084 (97.3)	356 (95.4)		0.1
1	47 (3.2)	30 (2.7)	17 (4.6)		0.1
Limited English proficiency				0.2169	
0	1253 (56.0)	915 (55.2)	338 (58.2)		0.1
1	985 (44.0)	742 (44.8)	243 (41.8)		0.1
Randomized to NC Pre-K				0.0031	
0	520 (23.2)	411 (24.7)	109 (18.7)		0.1
1	1723 (76.8)	1250 (75.3)	473 (81.3)		0.1
Poverty status				0.3951	
Below 130%	1367 (61.0)	1005 (60.6)	362 (62.2)		0.0
131-185%	448 (20.0)	335 (20.2)	113 (19.4)		0.0
186-200%	89 (4.0)	68 (4.1)	21 (3.6)		0.0
201-250%	113 (5.0)	76 (4.6)	37 (6.4)		0.1
251-300%	30 (1.3)	25 (1.5)	5 (0.9)		0.1
Over 300%	192 (8.6)	148 (8.9)	44 (7.6)		0.0

References

[i] North Carolina Division of Child Development and Early Education. (2017). *NC Pre-Kindergarten (NC Pre-K) program requirements and guidance. Effective SFY 2017–2018.* Retrieved from http://ncchildcare.dhhs.state.nc.us/pdf_forms/NCPre-K_Program_Requirements_Guidance.pdf

[ii] North Carolina Foundations Task Force. (2013). *North Carolina foundations for early learning and development.* Raleigh, NC. Retrieved from http://ncchildcare.nc.gov/pdf_forms/NC_foundations.pdf

[iii] North Carolina Division of Child Development and Early Education. (2017). Study costs and effectiveness associated with NC Pre-K slots: Report to the House Appropriations Committee on Health and Human Services and Senate Appropriations Committee on Health and Human Services and Fiscal Research Division. Retrieved from http://buildthefoundation.org/wp-content/uploads/2017/02/Costs-Associated-with-NC-PreK-Study.pdf

[iv] Peisner-Feinberg, E. S., Van Manen, K.W., & Mokrova, I. L. (2018). *Variations in enrollment practices in the NC Pre-K Program: 2016-2017 statewide evaluation.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute. Retrieved from https://fpg.unc.edu/resource-list/750

[v] Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2008). *Classroom Assessment Scoring System (CLASS) Manual*, *Pre-K*. Baltimore, MD: Paul H. Brookes Publishing.

[vi] Pianta, R., Vitiello, V., Whittaker, J., & Ruzek, E. (2018, March). *Understanding the Effects of Classroom Processes on Child Outcomes in Pre-Kindergarten.* Paper presented at the Conference of the Society for Research on Educational Effectiveness, Washington, DC.

[vii] Hernan, MA; Robins, JM (2006). Estimating Causal Effects From Epidemiological Data. *J Epi Comm. 60*: 578–596. CiteSeerX 10.1.1.157.9366. doi:10.1136/jech.2004.029496. PMC 2652882.

[viii] Shen C, Li X & Li L. Inverse probability weighting for covariate adjustment in randomized studies. Statistics in Medicine. 2014; 33(4): 555-568.

[ix] Hernan MA, Hernandez-Diaz S, Robins JM. A structural approach to selection bias. Epidemiology. 2004; 15(5): 615-625. https://www.jstor.org/stable/20485961?seq=6#metadata_info_tab_contents

[x] Hernán MA, Robins JM (2019). Causal Inference. Boca Raton: Chapman & Hall/CRC, forthcoming. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1268/2019/01/hernanrobins_v2.17.19.pdf

[xi] Lohr, S., Schochet, P. Z., & Sanders, E. (2014). *Partially Nested Randomized Controlled Trials in Education Research: A Guide to Design and Analysis. NCER 2014-2000.* Retrieved from https://eric.ed.gov/?id=ED545532

[xii] Peisner-Feinberg, E. S., Mokrova, I. L., & Anderson, T. L. (2017). *Effects of participation in the North Carolina Pre-Kindergarten Program at the end of kindergarten: 2015-2016 statewide evaluation.* Chapel Hill, NC: The University of North Carolina, FPG Child Development Institute. Retrieved from https://fpg.unc.edu/resource-list/750

[xiii] Peisner-Feinberg, E. S., & Schaaf, J.M. (2010). *Long-term effects of the North Carolina More at Four Pre-kindergarten Program: Children's reading and math skills at third grade.* Chapel Hill: The University of North Carolina, FPG Child Development Institute. Retrieved from https://fpg.unc.edu/resource-list/750

[xiv] Peisner-Feinberg, E. S., & Schaaf, J.M. (2011). *Effects of the North Carolina More at Four Pre-kindergarten Program on children's school readiness skills: Key findings*. Chapel Hill: The University of North Carolina, FPG Child Development Institute. Retrieved from https://fpg.unc.edu/resource-list/750

[xv] Phillips, D. A., Lipsey, M. W., Dodge, K. A., Haskins, R., Bassok, D., Burchinal, M. R., . . . Weiland, C. (2017). *The current state of scientific knowledge on pre-kindergarten effects.* Retrieved from https://www.brookings.edu/research/puzzling-it-out-the-current-state-of-scientific-knowledge-on-pre-kindergarten-effects/

[xvi] Yoshikawa, H. Weiland, C., Brooks-Gunn, J., Burchinal, M. R., Espinoza, L. M., Gormley, W. T., Ludwig, J., Magnuson, K. A., Phillips, D., & Zaslow, M. J. (2013). Investing in Our Future: The Evidence Base on Preschool Education. Retrieved from https://www.srcd.org/policy-media/policy-updates/meetings-briefings/investing-our-future-evidence-base-preschool

[xvii] Lipsey, M. W., Farran, D. C., & Durkin, K. (2018). Effects of the Tennessee prekindergarten program on children's achievement and behavior through third grade. *Early Childhood Research Quarterly. 45,* 155-176. https://doi.org/10.1016/j.ecresq.2018.03.005